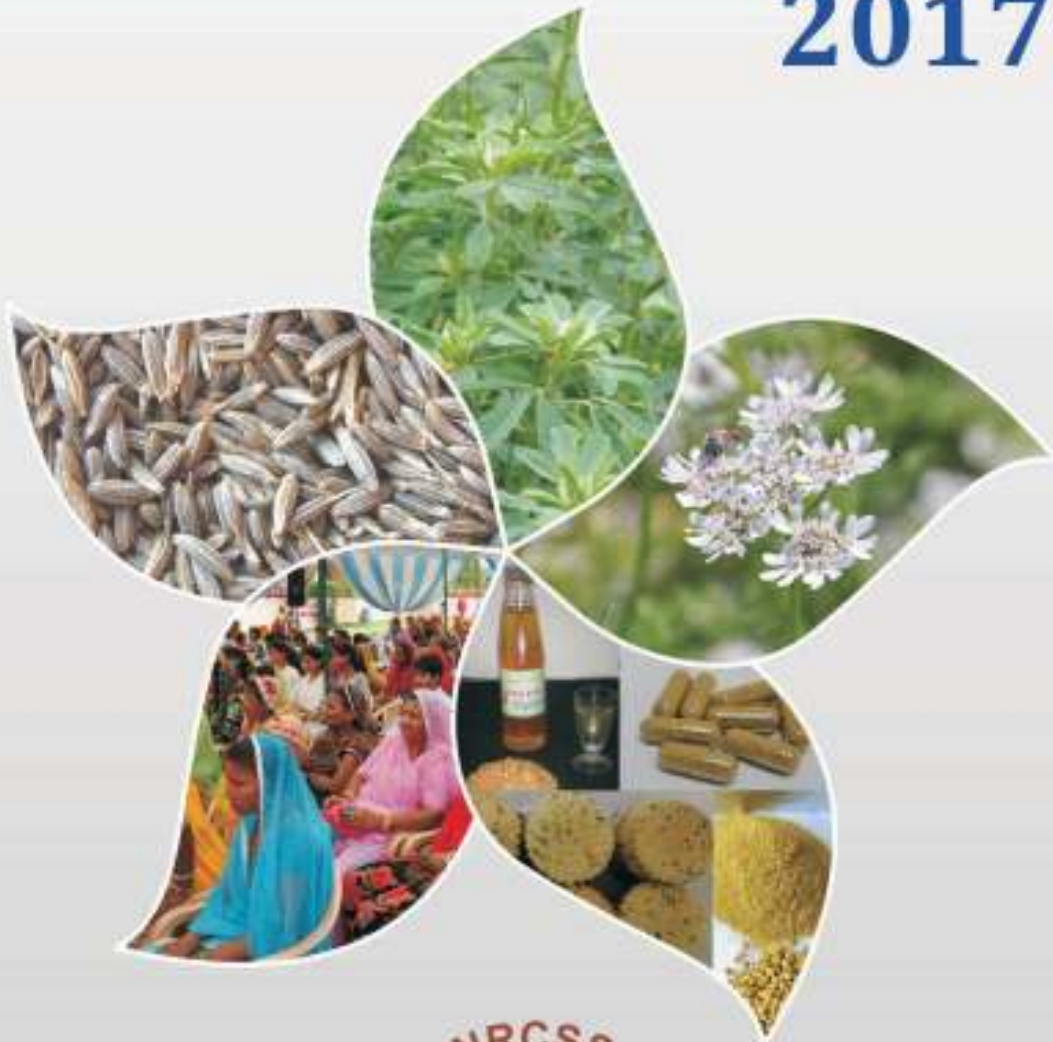




वार्षिक प्रतिवेदन Annual Report 2017-18



भा.कृ.अनु.प. - राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र
तबीजी, अजमेर - 305206 (राजस्थान), भारत

ICAR - National Research Centre on Seed Spices
Tabiji, Ajmer - 305206 (Rajasthan), INDIA



ICAR-NRCSS, Ajmer

The ICAR-NRCSS established during the year 2000 and working on seed spices research and development to provide income security to the people of the country. Besides doing basic and strategic work, NRCSS is also dealing with applied aspects of seed spices research for improving the productivity and quality with respect to domestic consumption and export. Institute is well connected by road & rail and located 13km away from Ajmer railway station on Ajmer Beawar road and the nearest airport is at Jaipur.

Ajmer is the 5th largest city in Rajasthan and is located 135 kilometres west of Jaipur, the state capital and 391 km from Delhi. Ajmer is surrounded by the Aravalli Mountains. It is a pilgrimage centre for the shrine of Sufi Saint Khwaja Moinuddin Chishti and Pushkar (11 km), an ancient Hindu pilgrimage city, famous for the only temple of Lord Brahma in the world.



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(आईएसओ 9001 : 2015 प्रमाणित संस्थान)



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Ajmer - 305206 (Rajasthan)

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(clock wise)

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PREFACE



Agriculture plays a vital role in India's economy. 54.6% of the population is engaged in agriculture and allied activities (census 2011) and it contributes 17.4% to the country's Gross Value Added for the year 2016-17 (at current prices). Given the importance to seed spices as cash crops ICAR-NRC on Seed Spices took several steps for its sustainable development. Steps have been taken to improve soil fertility on a sustainable basis through the green manuring, integrated soil health management, to provide improved varieties of seed spices two new varieties have been identified, one has been released & notified and many elite genotypes are in pipeline. Concerted research efforts are being taken to improve the resource use efficiency specially drip-irrigation and enhanced nutrient & water efficiency through fertigation, to support organic farming through sustainable management of insect pests and diseases. To spread the improved technologies of seed spices cultivation in new areas a dedicated team of scientists is working for transfer of technology in TSP and NEH areas through FLDs and scientist-farmer interaction on regular basis. In this digital era ICT plays an effective role in faster dissemination of information and sharing of ideas. NRCSS has developed a bi-lingual Mobile App "seed spices info" on android platform. NRCSS has also developed a dedicated webpage for Sophisticated Analytical Instrument Facility (SAIF) and same is also available on ICAR website's KM portal. The roof top based solar energy plant inaugurated by Hon'ble Dr. T. Mohapatra, Director General, ICAR, is now bearing the fruits in form of electricity bill savings in tune of lakhs of rupees during 2017-18.

The cumulative rainfall in the country during the monsoon season, i.e. 1st June to 30th September, 2017, has been 5% lower than that of the Long Period Average (LPA), however this has not adversely impacted the seed spices area rather cumin, fennel and fenugreek acreage has increased in some parts of Gujarat and Rajasthan. In last three years from 2014-15 to 2016-17, with addition of more than one lakh hectare to seed spices their acreage in the country, it has expanded more than six per cent, from 16.29 to 17.40 lakh ha. More than this, production has increased by almost 26 per cent as result of increased productivity of seed spices other than area. Export of seed spices has also increased by 139.34 crore rupees from 2607.46 to 2746.80 crore rupees in respective years. During this period highest expansion has been seen under fennel and fenugreek cultivation. Overall share of seed spices in total spice production in the country has increased from 18.90 to 20.54 percent to total spice production.





I am thankful to the Chairman, 3rd QRT of ICAR-NRCSS, Dr. A. R. Pathak, Hon'ble Vice Chancellor, JAU, Junagadh and other members of QRT for their suggestions for further improvement and their emphasis for transfer of technologies to more and more farmers through efficient dissemination mechanism thus enhancing the value chain from farm to fork. After the review of NRCSS, Ajmer, the QRT has rated the NRCSS by EXCELLENT Grade for outstanding research and development made during the reporting period.

I am grateful to Dr. T. Mohapatra, Secretary, DARE and DG ICAR, for pertinent guidance and encouragement. I place on record my sincere gratitude to Dr. A.K. Singh, D.DG (Horticulture Science) for his persistent support and encouragement in R&D activities and progress of the institute. I thank Dr. T. Janakram, ADG (Hort. Sci.- I) for providing all the necessary help from SMD and ICAR/H/Q. I am indebted to the editorial committee for bringing the Annual Report-2017-18 on time. I thank all the scientists, officers and other staff members of the institute for their significant contribution made in fulfilling the mandate. I hope this issue will surely help the stakeholders on many aspects that is essential for the prosperity of seed spice cultivators and benefit of users. I place before the readers this annual report 2017-18 for comments which will be helpful for its future improvement.

Ajmer

15th June, 2018

(Gopal Lal)

Director, ICAR-NRCSS



1. EXECUTIVE SUMMARY

1.1 Crop Improvement

- Total 42 germplasm lines were collected in different seed spices. twenty one germplasm lines were collected from Sikkim which includes 6 coriander, 5 fenugreek, 4 ajwain and 6 nigella. Besides this, 6 coriander, 5 fenugreek and 10 cumin lines were also collected from Nagaur, Barmer and Jaisalmer districts of Rajasthan. NRCSS is having a collection of 2167 germplasm lines from ten seed spice crops.
- Fenugreek variety AFG-5 and coriander variety ACR-2 were identified for national release in XXVIII AICRP on Spice workshop at Guntur (Andhra Pradesh).
- A station trial on coriander was conducted with 9 entries and one check variety (ACr-1). Entry KSR/RSM-21 was recorded highest seed yield (1822 kg/ha) over the check variety ACR-1 (1022 kg/ha). In another station trial was also conducted with 8 entries along with 2 check varieties (ACr-1 and Hisar Suganda). In Entry UD-353 highest seed yield (1491 kg/ha) was recorded over the check varieties ACR-1 (1384 kg/ha) and Hisar Suganda (1047 kg/ha).
- A station trial on cumin was conducted with 12 entry and two checks, among the entries CE-15 (77.07 g) and CE-13 (68.5 g) were recorded higher yield per plot when compared to check variety GC-4 (60.33 g).
- In an experiment conducted on fenugreek with 9 entries along with one check variety (AFG-3). Entry IC-571706 was recorded highest seed yield (1604 kg/ha) over the check variety AFG-3 (1468 kg/ha).
- Through hybridization in fennel, 71 hybrids (F₁) were made.
- Fennel genotype AF-87 was reported lowest disease incidence against *Ramularia* blight (PDI-13.33).
- A station trial on fennel was conducted with 13 entries along with 3 check varieties. Entry AF-257 recorded highest seed yield (1899 kg/ha) and AF-30 also recorded maximum essential oil content (1.746%) over the check varieties AF-1 and AF-2.
- In M₁ generation of fennel, out of 190 mutant lines, 67 mutant lines were found more diverse in one or more characters as compared to their parents (RF-125 and AF-1). Two dwarf (65 cm height) lines RF/225/37/10 and RF/250/73/1 matured early (150-155 days) than its parent variety RF-125 (180 days).
- A trial on ajwain was conducted in which highest yield (1565 kg/ha) was recorded in AA-96 genotype as compared to check variety AA-1 (1094 kg/ha).
- A trial was conducted on 9 advance lines of nigella. The maximum seed yield (1639 kg/ha) was recorded in AN-4 followed by AN-19 (1372 kg/ha).
- A station trial on dill was conducted with 11 entries along with 2 check varieties (AD-1 and AD-2). Entry AD-S-44 gave highest seed yield (2854 kg/ha) and AD-S-45 (1.077 %) gave maximum essential oil in station trial over the check varieties AD-1 (2098 kg/ha & 0.791%) and AD-2 (1176 kg/ha & 0.947%).
- In anise station trial, among the different germplasm lines, maximum seed yield (1100 kg/ha) was recorded in AA-17-S4 line, which was higher than check variety Ajmer Anise-1 (730 kg/ha). Besides high yielding, its mature 15-20 days early than check variety AA-1.
- For celery a station trial was conducted with 13 entries and one check variety (ACel-1). Celery entry A-Cel-14-34 was recorded highest seed yield (1696 kg/ha) and K-24 was recorded maximum essential oil (2.32 %) in station trial over the check variety A-Cel-1.
- High-throughput de novo transcriptome sequencing and differential gene expression (DEG) analyses were carried out using coriander resistance (ACr-1) and susceptible (CS-6) varieties for stem gall. DEGs between samples, found a series of candidate genes and pathways associated with stem gall resistance in coriander.
- SSRs transferred from carrot to coriander were used for molecular diversity analysis of coriander varieties and were found very useful. Dendrogram generated through SSR marker showed similarity coefficient value in range of 0.05 to 0.88.
- ESTs were developed for the coriander crop using transcriptome sequences of the NRCSS, Ajmer variety (ACr-1). 1,15,000 Microsatellites were developed using the MISA v1.0 software from transcriptome.

1.2 Crop Production

- Among the sowing methods, maximum seed yield of all the seed spices were recorded with transplanted crop by raising the nursery in soil less media (2012 kg/ha) followed by pro trays (1921 kg/ha) irrespective of the seed spice crops.



- Among the irrigation methods, maximum water productivity was recorded with raised beds of 75 cm coupled with drip irrigation (68.6 kg seed/ha cm water) followed by raised beds of 150 cm coupled with drip irrigation (63.1 kg seed/ha cm water) and lowest with surface irrigation (19.8 kg seed/ha cm water) irrespective of the seed spice crops. The maximum water productivity was recorded with fenugreek (82.9 kg seed/ha cm water) followed by coriander and lowest with cumin (28.4 kg seed/ha cm water).
 - For highest yield and quality, at least 80-100 kg of N or more was required in light textured soil. Under these conditions P application was not much encouraged however 50 kg of P reported optimum for yield and quality. For good yield (seed and oil) and nutrient use efficiency of fennel, at least 80 kg N was required either with 8 or 12 t of FYM. Under Ajmer conditions, at least 35 kg of S was required to coriander for higher oil yield. Moreover, availability of N, P, S and micronutrients with S application was more while seed yield was not encouraged.
 - In light textured soil, sodic water could be applied up to RSC-14 meq/l successful in dill. However, soil sodicity in terms of soil pH 9.2 could be tolerated by nigella. Rise in temperature reduced the germination and also delayed it in fennel. However, crop yield and quality was optimum when soil temperature was in range of 29-36°C during sowing and at harvesting 26-36°C. Liming in acidic soil (pH 4.8) improved the yield of fennel and dill however, response of dill was prime over the fennel.
 - Fennel crop responded well in terms of growth and yield to soil application of iron (10kg/ha)+ soil application of zinc (5 kg/ha) + zinc foliar application (0.5%) over the control and other elements such as copper, manganese and boron.
 - Exo-rhizospheric (92 strains) and endo-rhizospheric (25 strains) microbes have been isolated from different samples of cumin plant collected from NRCSS field. The maximum bacterial population (72×10^6 cfu/g) was recorded in GC-4 followed by GP-19 (63×10^5 cfu/g) while minimum among tested germplasm lines was recorded in SPS-249/13 (36×10^5 cfu/g). The maximum fungal count was recorded in cumin germplasm ACWMR-16-3 (31.2×10^5 cfu/g) and minimum in SPS-249/13 (12×10^5 cfu/g).
 - The maximum fenugreek seed yield was recorded with T_2 - *Rhizobium* sp +*B. megaterium* (245.4 g per m^2) which was at par with T_1 - *Rhizobium* sp.+*B. subtilis* +*B. megaterium* (241.72 g per sq. m) and minimum seed yield was recorded with T_{10} -control (191.72 g per m^2).
 - In coriander crop 75% potential evaporative (PE) and 75% recommended dose of fertilizes (RDF) are optimum dose of drip irrigation and fertigation levels while in fenugreek drip irrigation at 50% potential evaporative (PE) and 75% RDF is optimum for growth and yield.
- ### 1.3 Crop protection
- Cumin blight was reported more in intensity (PDI 6-18) at Ajmer, Tonk, and Pratapgargh localities whereas the disease was prevailed comparatively lower (PDI 0-6.2) in Nagaur, Barmer, Jodhpur and Jaisalmer.
 - Stem gall disease was in lower intensity (2.5%) in Kota, Baran, Jhalawar, Anta and some adjacent area of Madhya Pradesh.
 - Sclerotium rot disease of coriander in Hadoti region was reported (PDI 0-30)
 - Leaf blight of fenugreek was appeared during 14-21 January and spread there after by increasing the disease PDI.
 - Significant reduction (<50%) in powdery mildew and leaf blight diseases in fenugreek was observed in the spray schedule (copper oxychloride followed by propiconazole/ difenoconazole/ chlorothalonil and hexaconazole).
 - Fenugreek lines A3-23-3, A1-1-2, A2-17-7 and C2-55-4 showed tolerant reaction against leaf blight and C2-55-4, B2-19, A2-17-7, A1-1-2, A3-23-3, AFG-3 and AFG-4 showed tolerant reaction against powdery mildew disease of fenugreek.
 - Amongst eleven botanical products and biopelsticides tested against aphid, plant extract of *Capparis decidua* @10ml/litre and fruit extract of *Citrullus colocynthis* @10ml/litre given best control (reduced 69.04 and 67%) population on coriander.
 - Two wild botanical products (*Capparis deciduas*) plant extract @10ml/litre and *Citrullus colocynthis* fruit extract @10ml/litre were identified and recommended for the management of aphid and thrips population on cumin (mortality 67.48%, 66.74% and 71 and 68.77%).



- In diversity study, a total of 34 floral visitors on ajwain and 27 floral visitors on dill were recorded in which *Apis florae* was recorded most abundantly (27.10 and 19.22 bees/m²/minute) pollinator on both the crops.
- Impact of insect pollinators on yield of ajwain and dill was studied and found that the yield of ajwain (1352.25 kg/ha) and dill (1430.0 kg/ha) was recorded in bee pollinated plots, which were 60.63 and 47.80 per cent higher than without bee pollination plots in both the crop, respectively.
- Population of *Pratylenchus thorne* in cumin soil were fluctuating during the cropping season and two peak population level recorded on the 49th and 7th standard week. However application of soil sterilant Metham sodium and Dazomet gave complete protection up to the maturity of the cumin crop.

1.4 Basic sciences and post-harvest technology

- In fenugreek, water stress given at midterm growth stage (60 DAS) does not affect seed yield in most of the genotypes while terminal water stress (90 DAS) affects seed yield significantly. Under midterm stress condition maximum sapogenin (6.52%) was observed in B4-22-7-2-1 while minimum (5.25%) was recorded in genotype AFg-3. Paczee 10 ppm when sprayed at 90 and 105 DAS gave more yield (1470 kg/ha) than control with significant reduction in plant height (9.6 %) of fennel.
- Value added products from seed spices (Squashes, RTS and fenugreek biscuits) developed/ scaled up followed by marketing and selling at different seminars, conferences kisan melas, spice parlor and others trainings so that commercial output of developed value added products can be achieved.
- The cumin plants were sprayed with Propiconazole in single dose, double dose and five fold doses at the recommended concentration (0.1%). The results indicate significant decrease in soil microbial biomass carbon content for all the three doses of propiconazole as compared to control.
- The soil enzyme Dehydrogenase activity (DHA) decreased up to 30th day after spray at single dose & double dose but it continued to decrease continuously in five fold dose till harvest. The DHA is most susceptible parameter to pesticide application. Fluorescein diacetate hydrolyzing activity (FDHA) is

also a measure of total microbial activity in soils. This activity decreased up to 15 days at single dose & double dose but further decreased in five fold dose till harvest.

1.5 Social sciences

- Dissemination of seed spices production and post-harvest technology through demonstrations, trainings, workshops and seminars under NEH and TSP
- Two hundred and three front line demonstrations (FLDs) of different seed spices were conducted during 2016-17 in Tribal Sub-plan area of Rajasthan in collaboration with Krishi Vigyan Kendra, Pratapgarh, Banswara, Dungarpur, and State Department of Agriculture, Jhadol, Udaipur. Yield of seed spices under demonstration plots was higher in comparison to local checks/practices which were 30.42% higher in coriander, 26.47% in fenugreek, 26.20% in ajwain, 16.44% in nigella, 23.29% in dill and 35.05% in fennel.
- Assessing approachability and facilities of ICT and effective medium of information dissemination to cumin and coriander growers of Western India
- It was observed that ATMA and state trainees were more aware about ICT as compared to field surveyed farmers due to their good economical status, almost all were using the smart phone. Where as more than 90% farmers owns cell phone (basic as well smart) in all groups which were surveyed.
- There is synergy between literacy rate and the digital literacy rate and thus affecting the use of ICT.

1.6 Externally funded projects

- Among the protected structures, maximum seed yield of 1961.4 kg/ha were recorded at plastic sheet vertical wall followed by 1696.6 kg/ha with insect proof net covered walk in tunnels and 1636.5 kg/ha with plastic sheet covered walk-in tunnels. Among the crops maximum seed yield of 2589.3 kg/ha were recorded in fennel with vertical wall.
- Among the different color tested green and black shad net were more effective for off season leafy coriander and fenugreek production than white and red shad nets during June and July. 90% shading intensity of green shad net or 75% black shad nets were equally effective for higher leafy biomass production during off season for both coriander and fenugreek.



- Maximum dry biomass (3130 kg/ha) of kassuri methi were recorded at 80 kg seed/ ha which were declined gradually with decreasing seed rate and lowest dry biomass (2564 kg/ha) were recorded at 20 kg/ha seed rate.
 - The experiments for the development of sustainable seed spices based cropping system in *kharif* (moong bean and cluster bean) and *rabi* (coriander and fennel) were conducted at organic block of research farm, NRCSS, Ajmer.
 - Among six organic based IPM modules (including control) tested against aphid and thrips on coriander and fennel, IPM module M-3 (garlic extract 10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit + fruit extract of *Citrullus colocynthis* 10ml/lit.) was given best management of aphid (67.10% and 66.40% reduction in coriander and fennel, respectively) and thrips (63.84% and 62.37% reduction in coriander and fennel, respectively).
 - In coriander, five organic treatments (including control) viz., soil solarisation (20 days), *Trichoderma* (8g/kg seed as seed treatment + 2.5 kg/ha as soil application), neem cake (0.5t/ha), castor cake (0.5t/ha) were evaluated. Among the treatments, soil solarization was found most effective (PDI 1.7) followed by neem cake (PDI 4.8) while the disease (*Sclerotium* rot of coriander) was recorded maximum (PDI 8.8) under control plots.
 - Honey bee species *Apis florea* was found most abundant pollinator on cumin (13.33 bee/m² bloom area) followed by *Episyrphus balteatus* (10.00 flies/m² bloom area). The result showed that yield of cumin 510.41 kg/ha was obtained in bee pollinated plots (caged) which was 40.03% higher than control. The highest yield of nigella (927.50 kg/ha) was obtained in bee pollinated plots (caged) which was 45.16% higher than control (without bee pollination-caged with insect proof nylon net).
- ### 1.7 Other activities
- Approximately 18, 545 visitors including farmers, stakeholders and students visited the ICAR-NRCSS experimental farm, knowledge park and bio-control lab during 2017-18. Various farmers' group from Rajasthan and adjoining states viz., Gujarat, M.P., U.P., Punjab, Haryana and Maharashtra visited the centre during cropping season as well as off season of seed spices. Groups were explained about the ongoing research activities and various seed spice production technology developed by the centre.
 - Ten day's Yoga Practice organized during June 11-20, 2017 (5.30-7.00 AM) under the guidance of Yoga instructor and demonstrators from Vivekanand Kendra, Kanyakumari, Branch Ajmer.
 - *Beej Vitran Pakhwada* organized, during 14-30 Sept, 2017, awareness campaigning among the farmers towards the HYV developed by NRCSS, Ajmer through "*Beej Rath Yatra*" and vocal means was carried out.
 - A model training course on "Protected cultivation and precision resource management for horticultural crops and seed spices" sponsored by Directorate of Extension, Ministry of Agriculture, Govt of India was organized during 19th to 26th January, 2018 at ICAR-NRCSS, Ajmer.
 - A State Seminar on "Sustainable Agricultural Practices for Seed Spices" was organized jointly by ICAR-National Research Centre on Seed Spices, Ajmer and DASD, Calicut under MIDH during 24-25 February, 2018 at ICAR-NRCSS, Ajmer.
 - Under *Rashtriya Krishi Vikas Yojana* (RKVY) a "Seed Processing Workers" training sponsored by Agriculture Skill Council of India (ASCI) was conducted for 21 days (5-26 March, 2018) at ICAR-NRCSS, Ajmer.
 - Under *Swachh Bharat Abhiyan*, events such as cleanliness drive and awareness campaigns were organized at centre.
 - Under the *Mera Gaon Mera Gaurav* (MGMG) programme, developed technologies on agriculture were transfer to the adopted villages of NRCSS.
 - राजभाषा हिन्दी पखवाड़ा 14- 30 सितम्बर, 2017 के मध्य मनाया गया। पखवाड़ा का शुभारम्भ 14 सितम्बर 2017 को राजभाषा क्रियान्वयन समिति की बैठक के साथ हुई जिस में केन्द्र के निदेशक डॉ. गोपाल लाल ने अध्यक्षता की।
 - दिनांक 05.12.2017 को राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर एवं कृषि विज्ञान केन्द्र, तबीजी, अजमेर के सह-संयोजन में विश्व मृदा दिवस मनाया गया।
 - दिनांक 19.01.2018 को राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र पर केन्द्र का 19वां स्थापना दिवस मनाया गया।



2. INTRODUCTION

The flavour and aroma of Indian spices are spread throughout length and breadth of Globe. Total 109 spices are listed by ISO and 63 spices are grown in India. The seed spices are a group, which denotes all those annuals whose dried fruit or seeds are used as spice. There are about twenty seed spices are grown in India, the important among them are coriander, cumin, fennel, fenugreek, ajwain, dill, celery, anise, nigella and caraway. Almost all the seed spices are winter season crops (rabi) need cool weather conditions for better growth and development. Majority of these seed spices are treated as cash crop in arid and semi-arid regions of India particularly Rajasthan, Gujarat and parts of Madhya Pradesh. However frost leads to major damage to these crops. Late winter rainfall also adversely affect the quality and quantity of production by infestation of disease, pests etc. The seed spices are commonly used in pulverized state, primarily for seasoning or garnishing the foods and beverages. They are also used in preparation of various value added products viz. spice oils, oleoresins and spice powders. Seed spices possess industrial importance and are used in cosmetic, perfumery and various pharmaceutical preparations medicines. The seed spices constitute an important group of agriculture commodities and play a significant role in our national economy. Since ancient time, India has always been recognized as a land of spices. Seed spices account for about 51.79 per cent and 19.06 per cent of total area and production of spices in the country. Out of the twenty seed spices grown in the country ten are prominent. The mandate crops of NRCSS

Ajmer are coriander, cumin, fennel and fenugreek as major seed spices, while ajwain, dill, celery, nigella, caraway and anise constitute minor group of seed spices. Seed spices are less biomass producing and high value crops, requiring less water and nutrient for their successful cultivation. Seed Spices are annual herbs best suited for diversification of existing cropping system of arid and semi arid region of our country. Seed spices also play important role in the annual export basket of spices of our country. Production of seed spices has many constraints that need to be tackled on priority. The most important constraint adversely affecting the promotion of these crops to farmers for diversification of the existing cropping system is low productivity. The major factors presently contributing to low productivity are very low seed replacement rate, the lack of authentic seeds of improved varieties, growing of these crops in low/marginal soil fertility and drought prone conditions, attack of major pest and diseases and above all unorganized marketing. Several factors issues emerge after making analysis of different constraints affecting production of these crops. There is need for systematic and well planned strategic and applied research backed by a vigorous transfer of technology campaign for promotion of the new technologies evolved.

In last three years from 2014-15 to 2016-17, with addition of more than one lakh hectare to seed spices their acreage in the country it has expanded more than six per cent, from 16.29 to 17.40 lakh ha. More than this, production

| Spices | 2014-15 | | | | 2015-16 | | | | 2016-17 (2nd advance estimate) | | | |
|---------------------|-------------------|-------------------------|-----------------------|--------------------------|-------------------|-------------------------|-----------------------|--------------------------|--------------------------------|-------------------------|-----------------------|--------------------------|
| | Area ('000 ha) | Production ('000 MT) | Export | | Area ('000 ha) | Production ('000 MT) | Export | | Area ('000 ha) | Production ('000 MT) | Export | |
| | | | Qty (in tonnes) | Value (In Rs lakh) | | | Qty (in tonnes) | Value (In Rs lakh) | | | Qty (in tonnes) | Value (In Rs lakh) |
| Cumin | 890 | 486 | 155500 | 183820 | 808 | 503 | 97790 | 153113 | 760 | 486 | 119000 | 196320 |
| Coriander | 553 | 462 | 46000 | 49813 | 582 | 585 | 40100 | 42681 | 663 | 609 | 30300 | 29208 |
| Fenugreek | 123 | 131 | 23100 | 13948 | 219 | 247 | 33330 | 23281 | 218 | 220 | 34680 | 18277 |
| Fennel | 39 | 60 | 11650 | 13166 | 76 | 129 | 15320 | 17240 | 75 | 125 | 35150 | 30876 |
| Ajwain | 24 | 16 | - | - | 24 | 16 | - | - | 24 | 14 | - | - |
| Total | 1629 | 1155 | 236250 | 260746 | 1709 | 1480 | 186540 | 236314 | 1740 | 1454 | 219130 | 274680 |
| Seed Spices | | | | | | | | | | | | |
| Total Spices | 3317 | 6108 | 236250 | 260746 | 3474 | 6988 | 186540 | 236314 | 3535 | 7077 | 219130 | 274680 |



has increased by almost 26 per cent as result of increased productivity of seed spices other than area expansion. Export of seed spices has also increased by 139.34 crore rupee from 2607.46 to 2746.80 crore rupees in respective years. During this period highest expansion has been seen under fennel and fenugreek cultivation. Overall share of seed spices in total spice production in the country has increased from 18.90 to 20.54 percent to total spice production.

While, this presents an excellent commercial opportunity for the country, we must remember that there are important competitors waiting in the wings. These countries include Egypt, Iran, Pakistan, Turkey, Iraq, Morocco and Italy. It is thus important that in order to meet this challenge, there must be a quantum jump in the production and productivity of seed spices.

Rajasthan and Gujarat have emerged as "Seed Spice Bowl" and together contribute more than 80 per cent of the total seed spices production in the country. Other important seed spice growing states are Madhya Pradesh, Orissa, Tamil Nadu, Andhra Pradesh, Karnataka, Bihar, Uttar Pradesh, Punjab and West Bengal. India grows about twenty important seed spices. The major among these are coriander, cumin, fennel and fenugreek. Other minor seed spices crops include ajowan, dill, nigella, anise, caraway and celery which are grown in smaller areas in different parts of the country.

3.1 History

There has been ever increasing demand of seed spices and importing countries look at India as consistent source. In view of the aforesaid importance of seed spices in the country, the Indian Council of Agricultural Research established the National Research Centre on Seed Spices at Ajmer to initiate research work on seed spices especially aimed at improving the productivity and quality with reference to export value and domestic demand. The Indian Planning Commission approved establishment of an independent National Research Centre on Seed Spices (NRCSS) during the IX Five-year Plan and came into being on April, 22, 2000. The site selection committee constituted in 1998 by ICAR, recommended establishment of NRCSS at the site offered by the Government of Rajasthan with 50 acres of land.

3.2 Location and Climate

The NRCSS is located in Tabiji farm area on the Ajmer-Beawar road, 13 km away from railway station in the city. The Ajmer city is well connected by road and railway line to Ahmadabad and Delhi with distance of 516 km and 388 km, respectively in opposite directions. The nearby airport is Jaipur, situated about 125 km away from Ajmer.

The centre lies on 74° 35' 39" E to 74° 36' 01" longitude and 26° 22' 12" to 26° 22' 31" N latitude at an altitude of 460.17 m above mean sea level. The soil of the research farm is sandy loam, poor in fertility and water holding capacity, having pH 8 to 8.3, EC 0.07 to 0.12 and organic carbon 0.15 to 0.23%, available N 178.5 kg/ha (low), P_2O_5 12 kg/ha (medium), K_2O 85 kg/ha (low), Ca 214.7 kg/ha (high), Mg 258 kg/ha (medium), S 27 kg/ha (medium).

The rainfall in the area is highly erratic and more than 90% of the rain is received during July to September with several intermittent long dry spells. The monsoon rains generally commence by the end of June but sometimes delayed till the first week of August. The rainfall is confined to the period mostly between July to September, the rainfall averages between 250-500 mm with a maximum of 750 mm in good rainy years and 50-200 mm in scanty rainy years. The temperature ranges from 2-5°C during January and 42-45°C during May. The winter showers are meagre. Occurrence of drought is frequent. The annual loss through PET is 1566 mm. The occurrence of frost is also observed occasionally, generally after a gap of every 2-3 years. The relative humidity in the district is generally higher than 60% during the monsoon season reaching to as high as 75%, but the annual average humidity is less than 50%.

Weather Report (2016-2017) NRCSS, Tabji, Ajmer

The agro meteorological data for the cropping year 2016-17 for which the research results are presented in this report is given in Annexure 1. The monthly weather parameters recorded at agro meteorological observatory, NRCSS, Ajmer for the year 2016 and 2017 are presented in Table 1 & 2. A total rainfall of 674.4 mm was recorded at Agro-met Observatory as compared to the mean annual rainfall of 529.0 mm (for the 100 years). The year 2016 was a high rainfall year (27.4 % of the mean annual rainfall)

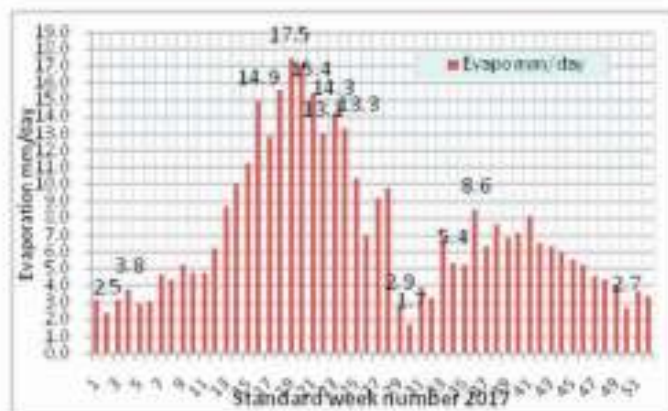
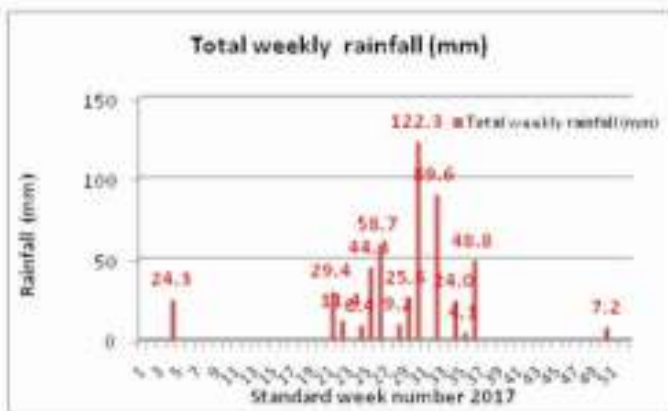
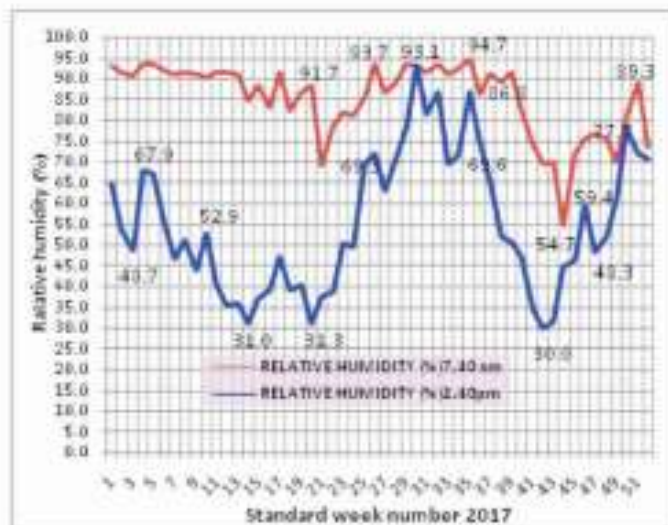


at NRCSS, Ajmer. The maximum monthly rainfall of 279.6 mm was recorded during August, 2016, whereas it was maximum 161.3 mm during July, 2017. The minimum temperatures (-1.0 °C) was recorded on 11, 12 and 13th January, 2016 and a frost event was happened which damaged the seed spices as well as vegetables severely in the area. Whereas, maximum temperatures 43.5 °C were recorded on 8th May, during both the years. The lowest relative humidity was 22 per cent on 23rd April while the highest (96%) was recorded on several occasions during the year. The total open pan evaporation during the year 2016 and 2017 were 2445.5 and 2628.0 mm, which was 3.62 and 5.18 times higher than the annual rainfall. The

lowest evaporation of 0.5 mm was recorded at many times during January and July in both the years, whereas the highest evaporation were recorded 18.5 mm on 6th June, 2016 and 19.0 mm on 3rd June, 2017, respectively.

3.3 Mandate

- Basic, strategic and applied research on genetic resource management, crop improvement, production and protection technologies for enhancing and sustaining productivity of safe seed spices.
- Transfer of technology and capacity building of stakeholders for enhancing and sustaining productivity of seed spices



Weekly weather data (minimum and maximum temperature, relative humidity, evaporation and rainfall) during 2017 at NRCSS Farm



3.4 Mandate crops

1. Coriander (*Coriandrum sativum* L.)
2. Cumin (*Cuminum cyminum* L.)
3. Fennel (*Foeniculum vulgare* Mill.)
4. Fenugreek (*Trigonella foenumgraecum*, *Trigonella corniculata* L.)
5. Ajwain (*Trachyspermum ammi* Sprague)
6. Dill (*Anethum graveolens* L., *Anethum sowa* Kurz.)
7. Nigella (*Nigella sativa* L.)
8. Aniseed (*Pimpinella anisum* L.)
9. Celery (*Apium graveolens* L.)
10. Caraway (*Carum carvi* L.)

3.5 Objectives

1. Collection, evaluation, characterization and conservation of germplasm.
2. Breeding variety with high yield potential, quality and resistance to biotic-abiotic stresses.
3. Developing efficient agro-techniques for achieving the high production and productivity.
4. Evolving better and efficient management system for control of pests and diseases.
5. Study of nutritional and water management aspects.
6. Development of package on organic farming of the seed spices for export, based on environment friendly production of potential technology.
7. Research on seed technology for production of quality seeds of improved varieties.
8. Study of economic of production and marketing.
9. Development of pre and post harvest technology for better processing, storage and utilization.
10. Development of export oriented technology for export of raw and value-added product towards national economy.
11. Transfer of technology for farmers and extension agencies.

3.6 Financial outlay (2017-18)

(Rs. in Lakhs)

| HEAD | Budget | Expenditure |
|---------------------------------|---------------|---------------|
| Equipment | 2.00 | 2.04 |
| Information Technology | 1.50 | 1.56 |
| Furniture & Fixture | 1.50 | 1.40 |
| Salaries | 415.00 | 415.00 |
| Pension | 33.00 | 6.19 |
| Travelling Allowance | 15.00 | 15.00 |
| Research & Operational Expenses | 115.00 | 115.07 |
| Administrative expenses | 265.50 | 265.50 |
| Miscellaneous Expenses | 4.50 | 4.50 |
| TSP | 7.00 | 6.99 |
| NEH | 2.00 | 1.94 |
| Grand total | 862.00 | 835.19 |

3.7 Staff position as on 31-03-2018

| S.No. | Class of Posts | Total sanctioned Posts | Total employees in position |
|-------------------------------------|------------------------|------------------------|-----------------------------|
| 1. Scientific Posts | | | |
| a | RMP Scientist | 1 | 1 |
| b. | Scientist | 12 | 10 |
| c. | Senior Scientist | 07 | 07 |
| d. | Principal Scientist | 1 | 0 |
| | Total | 21 | 18 |
| 2. Technical Posts | | | |
| a | Category I | 4 | 2 |
| b. | Category II | 3 | 3 |
| c. | Category III | 1 | 1 |
| | Total | 8 | 6 |
| 3. Administrative Posts | | | |
| a. | Administrative Officer | 01 | 01 |
| b. | AF&AO/AAO/Assistant | 07 | 05 |
| c. | UDC/ Steno/LDC | 03 | 03 |
| | Total | 11 | 9 |
| 4. Supporting /Skilled Posts | | | |
| | Total | 2 | 2 |
| Grand Total | | 42 | 35 |



3. RESEARCH ACHIEVEMENTS

Project 1: Conservation characterization and utilization of genetic resources in seed spices

CI-1: Management of plant genetic resources of seed spices (2014-19)

(R.S. Meena, S.S. Meena, S. Choudhary and A.K. Verma)

Germplasm collection and conservation: During 2016-17 total 42 germplasm were collected in different seed spices. Twenty one germplasm lines were collected from Sikkim (which includes 6 coriander, 5 fenugreek, 4 ajwain and 6 nigella), 6 coriander, 5 fenugreek and 10 cumin lines were also collected from Nagaur, Barmer and Jaisalmer districts of Rajasthan. NRCSS is having a collection of 2167 germplasm lines from ten seed spice crops. The total assemblage crop wise available at NRCSS is presented in table 3.1.

Table 3.1: Total germplasm assemblages at NRCSS, Ajmer

| Crop | NRCSS Collection | | | NAGS Holding |
|--------------|------------------|-----------|-------------------|--------------|
| | Indigenous | Exotic | Present available | |
| Cumin | 100 | 7 | 107 | 247 |
| Coriander | 200 | 3 | 176 | 549 |
| Fenugreek | 82 | 59 | 135 | 733 |
| Fennel | 118 | 3 | 46 | 297 |
| Ajwain | 99 | 1 | 91 | 100 |
| Dill | 106 | 5 | 108 | 111 |
| Nigella | 21 | 3 | 24 | 24 |
| Celery | 36 | - | 36 | 36 |
| Anise | 18 | - | 18 | 18 |
| Caraway | 8 | 2 | 2 | 10 |
| Total | 790 | 83 | 745 | 2167 |

Germplasm evaluation and maintenance: Evaluation and maintenance of seed spices germplasm is carried out by respective crop curators through sib-mating or selfing as per crop pollination behaviour. The curators are also evaluating germplasm and recording observations as per descriptors. This year, 155 seed spice germplasms were

sown for evaluation and maintenance which includes 114 line of dill, 27 lines of nigella and 14 lines of anise. Besides this, 129 germplasm lines of dill, 12 germplasm lines of celery and 110 germplasm lines of cumin received from NBPGR were also evaluated under CRP on Biodiversity.

Nigella germplasm evaluation

A trial of 24 genotypes of nigella were conducted along with three checks namely, AN-20, Pant Krishna and Azad Kalongi in augmented design. Observations recorded as per descriptor (Table 3.2). Maximum variability (CV) was recorded in seed yield/plot (47.09%).

Table 3.2: Variability recorded in ancillary characters of nigella genotypes

| Characters | Min | Max | Mean | CV (%) |
|---------------------------------|-------|--------|--------|--------|
| Plant height(cm) | 41.80 | 66.00 | 54.87 | 10.70 |
| No. of primary branches/plant | 6.00 | 10.60 | 8.15 | 12.07 |
| No. of secondary branches/plant | 13.20 | 36.20 | 23.01 | 23.08 |
| No. of capsules /plant | 16.80 | 45.80 | 24.93 | 26.35 |
| No. of seeds / capsule | 60.60 | 78.80 | 69.21 | 6.74 |
| Seed yield / plant (gm) | 3.50 | 22.50 | 12.44 | 44.40 |
| Test weight (gm) | 1.19 | 2.50 | 1.83 | 16.47 |
| Seed yield /plot (kg) | 37.50 | 350.00 | 172.30 | 47.09 |

Project 2: Genetic improvement of seed spices for improving productivity, quality and tolerance to biotic and abiotic stresses.

CI-8: Breeding for high yield and quality in dill (2015-20)

(R.S. Meena, Y.K. Sharma and N.K. Meena)

Station trial: A station trial was conducted with 11 entries along with 2 check varieties (AD-1 and AD-2) during the year 2016-17. Entry AD-5-44 (28.54 q/ha) gave highest seed yield and AD-5-45 (1.077 %) gave maximum essential oil in station trial over the check varieties AD-1 (20.98 q/ha & 0.791%) followed by AD-2 (11.76 q/ha & 0.947%). Performance of dill entries are given in Table 3.3 and Fig. 1.



Table 3.3: Performance of dill genotypes for ancillary characters

| Genotype | Plant height (cm) | Primary branches | Secondary branches | Umbel /plant | Umbellate /umbel | Seed /umbellate | Test weight (g) | Essential oil (%) |
|-----------|-------------------|------------------|--------------------|--------------|------------------|-----------------|-----------------|-------------------|
| AD-S-45 | 189.67 | 6.60 | 12.93 | 51.73 | 34.53 | 34.33 | 2.76 | 1.07 |
| AD-S-3-2 | 173.80 | 7.07 | 14.87 | 65.27 | 34.27 | 33.27 | 3.95 | 0.72 |
| AD-S-3-8 | 164.60 | 6.13 | 13.40 | 74.27 | 28.27 | 33.87 | 3.73 | 0.80 |
| AD-S-1-3 | 165.07 | 7.40 | 14.53 | 69.60 | 28.80 | 29.20 | 4.16 | 1.02 |
| AD-S-50 | 158.07 | 7.27 | 15.73 | 79.93 | 38.60 | 31.80 | 4.06 | 0.68 |
| AD-S-14 | 149.07 | 7.27 | 14.40 | 72.20 | 29.87 | 35.13 | 4.53 | 0.71 |
| GEENPOOL | 141.93 | 7.27 | 15.33 | 82.60 | 33.73 | 32.60 | 4.31 | 0.73 |
| AD-S-11 | 167.33 | 6.60 | 13.40 | 70.07 | 36.00 | 31.27 | 4.86 | 0.60 |
| AD-67 | 162.40 | 5.47 | 11.87 | 58.80 | 36.07 | 36.60 | 4.72 | 0.70 |
| AD-S-24 | 170.53 | 5.60 | 12.13 | 56.87 | 34.73 | 35.20 | 4.38 | 0.56 |
| AD-S-44 | 168.67 | 5.67 | 11.40 | 59.80 | 35.80 | 31.67 | 4.04 | 0.80 |
| AD-S-3-35 | 172.27 | 6.33 | 12.80 | 59.73 | 36.40 | 34.33 | 4.41 | 0.70 |
| AD-S-1-28 | 177.80 | 8.53 | 17.47 | 89.73 | 33.80 | 31.80 | 4.39 | 1.05 |
| AD-1 | 172.07 | 7.33 | 15.20 | 92.87 | 40.80 | 35.47 | 4.44 | 0.79 |
| AD-2 | 165.27 | 7.30 | 12.07 | 80.87 | 36.27 | 32.67 | 2.81 | 0.94 |
| Mean | 166.57 | 6.79 | 13.84 | 70.96 | 34.53 | 33.28 | 4.10 | 0.80 |
| SEm± | 20.65 | 0.847 | 1.62 | 8.76 | 4.25 | 3.88 | 0.55 | 0.13 |
| CD (0.05) | 6.94 | 0.47 | 1.43 | 7.84 | 3.15 | 2.06 | 1.60 | 0.40 |
| CV (%) | 0.17 | 0.28 | 0.41 | 0.44 | 0.36 | 0.25 | 1.56 | 2.02 |

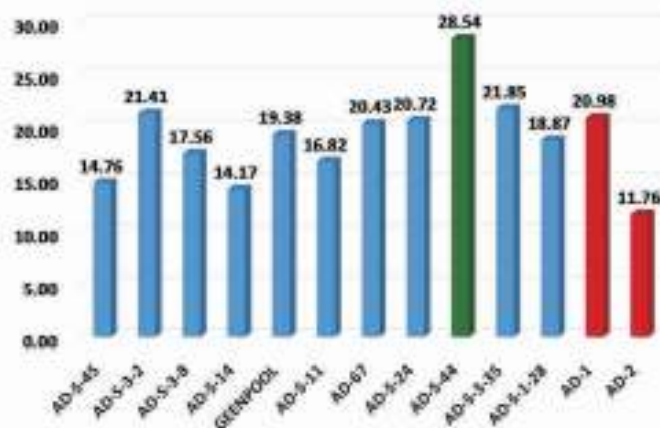


Fig. 1: Average yield of different genotypes of dill (q/ha)

CI-9 : Breeding for high yield and improved quality in ajwain (2015-20)

(S.S. Meena and R.K. Kakani)

A trial was conducted with 17 test entries along with three check varieties namely, Ajmer Ajwain-1, Ajmer Ajwain-2 and GA-1 during the year 2016-17. Observations on growth parameters such as yield and yield attributing traits were recorded. Higher yield attributes and yield (1564.72 kg/ha) recorded in AA-96 genotype as compared to national check. All observations were recorded and data presented in table 3.4 and 3.5 given below.

Table 3.4: Variability recorded in ajwain germplasm

| Genotypes | Days to germination | Plant height (cm) | No. of primary branches/plant | No. of secondary branches/plant | Diameter of main umbel (cm) | No. umbels /plant | No. of umbellates /umbel | No. of seeds/ umbellate |
|------------|---------------------|-------------------|-------------------------------|---------------------------------|-----------------------------|-------------------|--------------------------|-------------------------|
| AA-1 | 10.33 | 124.00 | 15.67 | 176.00 | 5.61 | 267.53 | 17.87 | 22.20 |
| AA-2 | 8.33 | 108.07 | 14.87 | 180.47 | 4.89 | 264.40 | 18.20 | 23.13 |
| AA-84 | 8.67 | 124.53 | 15.47 | 180.87 | 4.98 | 253.80 | 16.60 | 22.00 |
| AA-71 | 11.33 | 116.33 | 14.00 | 165.20 | 5.11 | 221.93 | 16.67 | 20.80 |
| AA-53 | 11.67 | 123.40 | 16.93 | 242.93 | 5.56 | 229.78 | 17.80 | 19.13 |
| AA-51 | 9.67 | 123.80 | 16.47 | 208.60 | 5.44 | 235.20 | 17.73 | 21.00 |
| AA-45 | 8.67 | 121.73 | 13.40 | 213.80 | 4.91 | 271.67 | 15.67 | 22.13 |
| AA-96 | 9.00 | 124.93 | 16.00 | 226.53 | 4.97 | 263.33 | 15.60 | 22.73 |
| AA-74 | 9.00 | 116.67 | 17.47 | 239.07 | 5.15 | 270.27 | 17.07 | 22.20 |
| AA-73 | 9.67 | 120.80 | 17.00 | 203.40 | 5.27 | 263.67 | 17.13 | 21.47 |
| AA-43 | 8.67 | 122.27 | 17.20 | 235.00 | 5.43 | 243.00 | 17.80 | 20.47 |
| AA-27 | 9.00 | 116.60 | 17.60 | 203.00 | 5.12 | 207.40 | 16.60 | 19.33 |
| AA-21 | 9.00 | 122.20 | 18.67 | 254.87 | 5.07 | 248.60 | 17.07 | 21.47 |
| AA-6 | 8.67 | 122.47 | 9.87 | 178.60 | 5.13 | 220.47 | 16.27 | 22.33 |
| GA-1 | 11.67 | 119.33 | 12.87 | 125.20 | 5.31 | 220.20 | 16.27 | 21.87 |
| AA-85 | 9.33 | 120.53 | 17.40 | 228.87 | 5.46 | 199.73 | 16.80 | 21.47 |
| AA-100 | 8.67 | 114.67 | 17.20 | 213.73 | 5.14 | 225.80 | 16.67 | 19.73 |
| AA-44 | 7.67 | 119.53 | 17.47 | 216.07 | 4.78 | 217.13 | 15.87 | 23.20 |
| AA-3 | 7.67 | 121.07 | 12.93 | 146.00 | 4.79 | 228.60 | 16.20 | 20.40 |
| AA-61 | 8.67 | 117.47 | 15.93 | 213.60 | 5.13 | 257.40 | 15.33 | 19.73 |
| SEm ± | 0.52 | 3.51 | 0.83 | 13.82 | 0.15 | 15.31 | 0.67 | 0.79 |
| CD(P=0.05) | 1.49 | 10.05 | 2.38 | 39.57 | 0.44 | 43.84 | 1.93 | 2.26 |
| CV% | 9.75 | 5.07 | 9.17 | 11.82 | 5.12 | 11.03 | 6.95 | 6.40 |

Table 3.5: Performance of ajwain genotypes

| Genotypes | Seed yield /plot (gm) | Seed yield (kg /ha) | Test weight(g) | Essential oil (%) |
|-------------|-----------------------|----------------------|----------------|-------------------|
| AA-1 | 656.67 | 1094.44 | 1.12 | 1.8 |
| AA-2 | 658.67 | 1097.78 | 1.00 | 1.6 |
| AA-84 | 813.17 | 1355.28 | 1.09 | 1.9 |
| AA-71 | 583.00 | 971.67 | 1.11 | 1.5 |
| AA-53 | 573.50 | 955.83 | 0.90 | 3.0 |
| AA-51 | 691.33 | 1152.22 | 1.06 | 2.0 |
| AA-45 | 750.17 | 1250.28 | 0.98 | 1.8 |
| AA-96 | 938.83 | 1564.72 | 1.08 | 1.9 |
| AA-74 | 773.33 | 1288.89 | 0.97 | 1.75 |
| AA-73 | 688.67 | 1147.78 | 1.07 | 1.5 |
| AA-43 | 582.67 | 971.11 | 1.01 | 1.25 |
| AA-27 | 769.50 | 1282.50 | 0.99 | 2.0 |
| AA-21 | 670.50 | 1117.50 | 1.09 | 2.5 |
| AA-6 | 360.33 | 600.56 | 1.06 | 1.8 |
| GA-1 | 688.17 | 1146.94 | 1.10 | 1.9 |
| AA-85 | 778.00 | 1296.67 | 1.16 | 1.6 |
| AA-100 | 839.67 | 1399.44 | 1.13 | 1.5 |
| AA-44 | 888.83 | 1481.39 | 1.14 | 1.75 |
| AA-3 | 781.33 | 1302.22 | 1.00 | 1.8 |
| AA-61 | 794.67 | 1324.44 | 0.98 | 1.8 |
| SEm ± | 28.00 | 46.55 | 0.04 | 0.07 |
| CD (P=0.05) | 80.15 | 133.28 | 0.13 | 0.21 |
| CV% | 6.79 | 6.78 | 7.24 | 6.42 |

CI-15 : Genetic enhancement of anise for yield and yield contributing traits (2011-2017)

(A.K. Verma and O.P. Aishwath)

The trial was comprised of 21 anise germplasm lines along with one check variety Ajmer Anise-1. The average plant height of germplasm lines ranges from 43.32 cm (Ani-14) to 61.32 cm (AGP-Ani-13). Minimum day to flowering were taken by AA-17-S4 (76.33 days), while maximum days were taken by Ajmer Anise-1 (99.11 days). Highest (10.62) number of primary branches was recorded in Ani-5 followed by Ani-7 (10.56), Ani-6 (10.30). With regards to secondary number of branches, maximum (24.22) was recorded in AA-17-S4 followed by Ani-10 (18.78) and Ani-10 (18.67). Highest (39.57) number of umbel/plant was recorded in Ani-15 followed by Ani-10 (39.56) and Ani-16 (39.18), while maximum umbellate per umbel was recorded in Ani-4 (15.07) followed by Ani- 9 (14.82) and AA-17-S4 (14.67). Maximum (197.71) number of seed per umbel was recorded in AA-17-S4 followed by Ani-8 (194.67) (Table 3.6). Enormous variability was recorded with respect to days to maturity, where as earliest (150



days) maturity was recorded in AA-17-S4 followed by Ani-2 (155 days), while check variety AA-1 taken 166 days to get mature. Highest (4.92g) yield per plant was recorded in AA-17-S4 (5.27g) followed by Ani-12 (3.98) and Ani-16 (3.94). Two lines (AGP-2 and AA-17-S4) were found

superior than AA-1 with regards to yield and days to maturity. Fig. 2 revealed that among the different germplasm lines maximum (11 q/ha) yield was recorded in followed by Ani-2 (8.6 q/ha), which was significantly higher than Ajmer Anise-1 (7.3 q/ha).

Table. 3.6: Pooled data of ancillary characters of anise genotypes

| Genotype | Plant height (cm) | Days to flowering | Primary branches | Secondary branches | Umbel/plant | Umbellate /umbel | Seed/ umbel | Duration of maturity | Yield/ plant (g) |
|-----------|-------------------|-------------------|------------------|--------------------|-------------|------------------|-------------|----------------------|------------------|
| Ajmer A-1 | 56.85 | 99.11 | 8.92 | 16.22 | 33.18 | 14.03 | 171.31 | 166 | 3.78 |
| Ani-1 | 56.51 | 94.67 | 10.16 | 17.16 | 32.62 | 14.20 | 177.90 | 158 | 3.14 |
| Ani-2 | 55.35 | 96.89 | 9.89 | 18.78 | 35.44 | 13.88 | 186.75 | 155 | 3.79 |
| Ani-3 | 58.08 | 94.45 | 10.10 | 16.60 | 33.86 | 13.83 | 188.59 | 160 | 3.49 |
| Ani-4 | 56.78 | 91.00 | 10.14 | 15.88 | 33.66 | 15.07 | 183.56 | 158 | 3.32 |
| Ani-5 | 58.08 | 91.66 | 10.62 | 16.77 | 36.87 | 13.76 | 186.98 | 159 | 3.73 |
| Ani-6 | 55.86 | 92.88 | 10.30 | 16.82 | 35.36 | 13.83 | 193.08 | 160 | 3.71 |
| Ani-7 | 55.71 | 95.66 | 10.56 | 17.69 | 38.29 | 14.26 | 186.99 | 160 | 3.51 |
| Ani-8 | 56.22 | 94.89 | 9.98 | 16.90 | 37.40 | 14.29 | 194.67 | 157 | 3.80 |
| Ani-9 | 54.15 | 95.11 | 9.71 | 16.25 | 38.51 | 14.82 | 189.71 | 158 | 3.45 |
| Ani-10 | 54.28 | 94.11 | 9.69 | 18.67 | 39.56 | 12.55 | 167.85 | 157 | 3.54 |
| Ani-11 | 55.30 | 95.00 | 9.37 | 15.90 | 36.10 | 13.18 | 164.89 | 158 | 3.54 |
| Ani-12 | 52.79 | 94.22 | 9.77 | 17.19 | 36.91 | 13.03 | 165.14 | 160 | 3.98 |
| Ani-13 | 61.32 | 92.33 | 9.70 | 18.22 | 38.71 | 12.96 | 185.84 | 156 | 3.36 |
| Ani-14 | 43.32 | 95.00 | 9.77 | 16.32 | 35.38 | 12.18 | 160.45 | 160 | 3.75 |
| Ani-15 | 53.53 | 94.44 | 9.60 | 16.20 | 39.57 | 12.93 | 164.47 | 160 | 3.69 |
| Ani-16 | 45.03 | 93.00 | 9.63 | 15.83 | 39.18 | 12.65 | 153.85 | 160 | 3.94 |
| Ani-17 | 41.59 | 91.56 | 8.91 | 12.78 | 33.83 | 13.32 | 151.05 | 160 | 3.78 |
| Ani-18 | 44.34 | 89.64 | 8.48 | 12.91 | 30.43 | 12.37 | 155.65 | 160 | 3.85 |
| AA-19 | 43.70 | 98.11 | 8.62 | 14.38 | 30.98 | 12.00 | 143.93 | 160 | 3.66 |
| AA-20 | 47.65 | 96.73 | 8.32 | 13.05 | 28.74 | 12.81 | 156.40 | 160 | 3.70 |
| AA-17-S4 | 61.78 | 76.33 | 10.10 | 24.22 | 37.36 | 14.67 | 197.71 | 150 | 4.92 |
| SE(m) | 3.29 | 3.86 | 0.45 | 1.48 | 2.23 | 0.66 | 14.3 | 5.83 | 0.21 |
| CD | 9.43 | N/A | 1.29 | 4.252 | 6.39 | N/A | N/A | N/A | 0.624 |



Difference in maturity period of anise genotypes



Fig. 2: Average yield of different genotype of anise



CI-19: Enhancing genetic variability in cumin (2013-18)

(A.K. Verma and R.S. Meena)

Under this project, three station trials were conducted in cumin. In station trial-I (Table 3.7), there were 15 entries along with two checks (CG-4 and RZ-209). The entries GP 3, GP 6, GP 7, GP 19 and GP 39 had the recorded the higher yield (55.33g, 36.67g, 40.17g and 43.27g respectively) as compared to checks (27.0 & 12.83 g in GC-

4 and RZ 209 respectively), while the highest test weight were recorded in GP-41 (4.18g). In station trial-II (Table 3.8), there were 12 entry with two checks, among the entries, CE-14 (66.9 g), CE-13 (68.5 g), and CE-15 (77.07 g) were found superior to GC-4 (60.33 g.) when compared yield per plot. In station trial-III (Table 3.9), there were 12 entries and two checks. It was found that entry AC-WMT-16-40 and AC-WMT-16-73 recorded higher yield (131.17 & 107.33 g respectively) and resistance/tolerance as compared to checks varieties.

Table 3.7: Performance of different cumin genotypes

| Genotype | Plant Height (cm) | Primary Branches | Secondary Branches | Umbel / Plant | Dry Matter (g) | Yield /Plant (g) | Test weight (g) |
|----------|---------------------|--------------------|---------------------|---------------------|------------------------|-----------------------|-------------------|
| GP 3 | 24.13 ^{bc} | 6.67 ^{bc} | 10.00 ^{ab} | 11.00 ^c | 115.00 ^{abc} | 55.33 ^a | 3.82 ^a |
| GP 6 | 26.33 ^{bc} | 7.20 ^a | 8.50 ^{bc} | 14.27 ^{ab} | 121.67 ^{abcd} | 36.67 ^{abcd} | 3.82 ^a |
| GP 7 | 23.60 ^{bc} | 6.93 ^{bc} | 9.73 ^{ab} | 11.60 ^{ab} | 116.67 ^{bc} | 50.77 ^{ab} | 3.29 ^a |
| GP 15 | 23.13 ^{bc} | 6.00 ^{bc} | 7.33 ^{cd} | 14.27 ^{ab} | 116.67 ^{bc} | 13.83 ^d | 3.35 ^a |
| GP 17 | 26.53 ^{bc} | 6.60 ^{bc} | 8.33 ^{bc} | 13.40 ^{ab} | 114.33 ^{bc} | 18.17 ^{bc} | 3.71 ^a |
| GP 18 | 27.20 ^{bc} | 6.73 ^{bc} | 7.33 ^{cd} | 18.73 ^{ab} | 117.00 ^{bc} | 19.00 ^{bc} | 3.72 ^a |
| GP 19 | 26.67 ^{bc} | 6.47 ^{bc} | 7.33 ^{cd} | 20.60 ^a | 115.67 ^{bc} | 40.17 ^{ab} | 4.18 ^a |
| GP 21 | 26.20 ^{bc} | 5.67 ^{cd} | 7.00 ^{cd} | 16.60 ^{ab} | 115.00 ^{bc} | 22.17 ^{cd} | 3.51 ^a |
| GP 37 | 26.80 ^{bc} | 5.40 ^d | 7.67 ^{cd} | 15.07 ^{ab} | 113.67 ^{bc} | 17.67 ^{cd} | 3.81 ^a |
| GP 39 | 28.93 ^a | 6.27 ^{bc} | 11.0 ^{ab} | 17.00 ^{ab} | 114.33 ^{bc} | 43.27 ^{bc} | 3.87 ^a |
| GP 41 | 22.73 ^{cd} | 5.93 ^{bc} | 6.67 ^{cd} | 14.40 ^{ab} | 117.00 ^{bc} | 15.50 ^d | 4.01 ^a |
| GP 47 | 25.62 ^{bc} | 5.99 ^{bc} | 7.00 ^{cd} | 18.40 ^{ab} | 120.67 ^{bcd} | 15.00 ^d | 3.83 ^a |
| GP 50 | 25.33 ^{bc} | 6.33 ^{bc} | 7.33 ^{cd} | 16.80 ^{ab} | 126.00 ^a | 22.50 ^{cd} | 3.43 ^a |
| GP 58 | 25.80 ^{bc} | 6.67 ^{bc} | 6.00 ^d | 16.67 ^{ab} | 123.33 ^{abc} | 17.83 ^{cd} | 3.49 ^a |
| GP 59 | 25.53 ^{bc} | 6.27 ^{bc} | 7.33 ^{cd} | 16.47 ^{ab} | 122.67 ^{abc} | 27.03 ^{abc} | 3.61 ^a |
| GC 4 | 23.13 ^{bc} | 6.80 ^{bc} | 6.67 ^{cd} | 16.33 ^{ab} | 112.33 ^a | 27.00 ^{abcd} | 3.85 ^a |

Same superscript letters in a column do not differ significantly when compared by DMRT test at 5% level of significance

Table 3.8: Ancillary characters of cumin genotypes

| Genotype | Plant Height (cm) | Primary Branches | Secondary Branches | Umbel / Plant | Yield /Plant (g) | Test weight (g) |
|----------|--------------------|-------------------|--------------------|----------------------|----------------------|--------------------|
| CE 1 | 27.07 ^a | 6.07 ^a | 8.80 ^{bc} | 18.13 ^{ab} | 33.33 ^{abc} | 3.49 ^{bc} |
| CE 2 | 25.67 ^a | 6.60 ^a | 8.47 ^{bc} | 23.30 ^{abc} | 23.67 ^{bc} | 3.93 ^a |
| CE 3 | 27.80 ^a | 6.27 ^a | 9.33 ^b | 25.67 ^{ab} | 19.67 ^{bc} | 3.91 ^{ab} |
| CE 5 | 30.07 ^a | 6.00 ^a | 8.40 ^{bc} | 21.93 ^{abc} | 39.83 ^{abc} | 3.39 ^{ab} |
| CE 6 | 24.67 ^b | 6.20 ^a | 7.60 ^{bc} | 20.40 ^{abc} | 61.90 ^{ab} | 3.51 ^{bc} |
| CE 7 | 24.87 ^b | 6.60 ^a | 7.00 ^c | 21.93 ^{abc} | 41.00 ^{bc} | 2.98 ^b |
| CE 8 | 28.73 ^b | 5.93 ^a | 7.33 ^{bc} | 22.00 ^{abc} | 25.83 ^{bc} | 3.18 ^{ab} |
| CE 10 | 27.53 ^b | 6.40 ^a | 7.10 ^{bc} | 20.80 ^{abc} | 61.00 ^{ab} | 3.55 ^{bc} |
| CE 11 | 26.13 ^b | 5.93 ^a | 8.33 ^{bc} | 19.93 ^{abc} | 53.00 ^{bc} | 3.76 ^{ab} |
| CE 13 | 24.87 ^b | 7.20 ^a | 12.20 ^a | 28.80 ^a | 68.50 ^{ab} | 3.14 ^{ab} |
| CE 14 | 26.73 ^b | 6.60 ^a | 8.00 ^{bc} | 22.50 ^{abc} | 66.90 ^{ab} | 3.55 ^{bc} |
| CE 15 | 29.27 ^b | 6.47 ^a | 13.00 ^a | 24.40 ^{abc} | 77.07 ^a | 3.53 ^{bc} |
| GC 4 | 25.47 ^b | 7.73 ^a | 9.00 ^{bc} | 19.30 ^{abc} | 60.33 ^{bc} | 3.21 ^{bc} |
| RZ 209 | 27.07 ^a | 6.43 ^a | 7.67 ^{bc} | 17.07 ^c | 11.33 ^d | 3.68 ^{ab} |

Same superscript letters in a column do not differ significantly when compared by DMRT test at 5% level of significance



Table 3.9: Ancillary characters of cumin genotypes

| Genotype | Plant height (cm) | Primary branches | Umbel /plant | Days to maturity | Seed yield /plant (g) | Test weight (g) | Wilt infection (%) |
|--------------|----------------------|-------------------|----------------------|-----------------------|-----------------------|---------------------|---------------------|
| AC-WR-16-1 | 22.30 ^a | 4.70 ^a | 17.47 ^a | 113.00 ^a | 66.83 ^a | 3.92 ^{abc} | 54.23 ^a |
| AC-WMR-16-3 | 24.27 ^{cd} | 5.40 ^a | 24.07 ^{bc} | 121.00 ^{ab} | 30.33 ^b | 4.08 ^{bc} | 60.44 ^{bc} |
| AC-WT-16-7 | 26.47 ^{abc} | 5.07 ^a | 27.00 ^{abc} | 117.00 ^{abc} | 34.83 ^b | 3.80 ^{abc} | 54.23 ^a |
| AC-WT-16-14 | 26.67 ^{abc} | 5.00 ^a | 30.40 ^{bc} | 115.67 ^{abc} | 54.77 ^a | 3.48 ^{abc} | 46.98 ^d |
| AC-WT-16-20 | 25.80 ^{abc} | 4.67 ^a | 25.87 ^{bc} | 114.67 ^{abc} | 35.50 ^b | 3.48 ^{abc} | 34.76 ^c |
| AC-WMT-16-2 | 26.17 ^{abc} | 5.23 ^a | 28.53 ^{abc} | 114.67 ^{abc} | 83.33 ^c | 3.79 ^{abc} | 21.43 ^a |
| AC-WMT-16-3 | 30.67 ^{abc} | 4.47 ^a | 27.13 ^{bc} | 114.33 ^{abc} | 39.00 ^b | 3.77 ^{abc} | 53.86 ^d |
| AC-WMT-16-4 | 24.53 ^{bc} | 4.93 ^a | 29.57 ^{abc} | 113.00 ^{bc} | 69.33 ^d | 3.16 ^{bc} | 39.45 ^c |
| AC-WMT-16-40 | 30.00 ^a | 4.40 ^a | 31.93 ^a | 112.33 ^{bc} | 131.17 ^a | 4.28 ^a | 20.12 ^b |
| AC-WMT-16-73 | 26.07 ^{abc} | 4.60 ^a | 23.07 ^{bc} | 111.33 ^c | 107.33 ^b | 3.73 ^{abc} | 19.45 ^a |
| SPS-IS/15 | 27.40 ^{abc} | 5.27 ^a | 26.87 ^{bc} | 114.00 ^{abc} | 31.50 ^b | 3.07 ^{bc} | 25.75 ^b |
| SPS-249/13 | 24.53 ^{bc} | 4.40 ^a | 25.73 ^{bc} | 118.00 ^{abc} | 36.27 ^b | 3.28 ^{abc} | 27.65 ^b |
| GC4 | 30.80 ^a | 5.13 ^a | 24.93 ^{bc} | 122.33 ^a | 39.50 ^b | 3.34 ^{abc} | 29.54 ^{bc} |
| RZ 209 | 25.73 ^{abc} | 4.93 ^a | 27.53 ^{abc} | 119.00 ^{abc} | 20.33 ^a | 2.91 ^c | 25.67 ^b |

Same superscript letters in a column do not differ significantly when compared by DMRT test at 5% level of significance.

CI/13.2.1: Breeding for high yield, powdery mildew resistance and suitability to limited moisture condition in fenugreek (2013-18)

(R.S. Meena, S.N. Saxena and Y.K. Sharma)

Station Trial-I: A station trial was conducted having 9 entries along with one check variety (AFg-3) during the year 2016-17. In entry A3-31-2-7(2) (10.61 q/ha) highest seed yield was recorded over the check variety AFG-3 (9.72 q/ha). Fenagurik variety (AFg-5) was identified for national release.

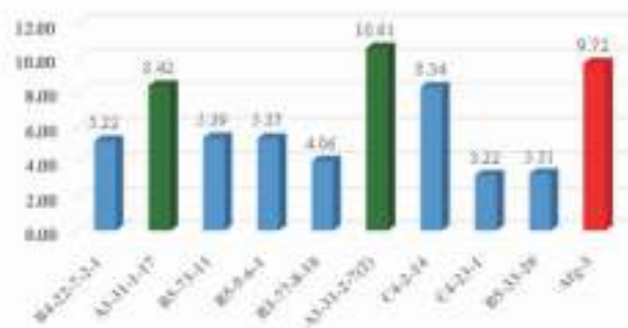


Fig. 5: Seed yield (q/ha) of fenugreek genotypes

Table 3.10: Performance of fenugreek genotypes for ancillary characters

| Genotype | Plant height (cm) | Primary branches/plant | Secondary branches/plant | No. of pod /plant | No. of seed /pod | Test weight (g) |
|--------------|-------------------|------------------------|--------------------------|-------------------|------------------|-----------------|
| B4-22-7-2-1 | 85.07 | 4.53 | 7.33 | 20.80 | 17.40 | 11.00 |
| A3-31-1-17 | 74.00 | 4.53 | 7.00 | 20.80 | 17.40 | 12.03 |
| B5-73-11 | 72.93 | 4.20 | 5.87 | 19.53 | 16.00 | 11.80 |
| B5-5-6-1 | 83.00 | 5.67 | 7.47 | 21.87 | 15.20 | 11.47 |
| B3-77-8-10 | 84.27 | 5.27 | 7.40 | 20.60 | 17.53 | 10.04 |
| A3-31-2-7(2) | 66.33 | 4.93 | 15.60 | 19.00 | 16.00 | 11.27 |
| C4-2-14 | 69.67 | 4.47 | 6.40 | 20.40 | 16.73 | 13.97 |
| C4-23-1 | 70.67 | 4.13 | 6.67 | 19.73 | 16.67 | 10.17 |
| B5-33-20 | 72.73 | 4.00 | 7.27 | 11.87 | 14.60 | 12.97 |
| AFg-3 | 73.33 | 5.40 | 7.40 | 22.40 | 17.60 | 13.47 |
| Mean | 75.20 | 4.71 | 7.84 | 19.70 | 16.51 | 11.82 |
| SEm± | 1.98 | 0.21 | 2.75 | 0.78 | 1.28 | 0.53 |
| CD (0.05) | 5.88 | 0.63 | 8.17 | 2.32 | 3.8 | 1.56 |
| CV (%) | 0.46 | 0.78 | 6.08 | 0.69 | 1.34 | 0.77 |

Station Trial-II: A station trial was conducted with 9 entries along with one check variety (AFg-3) during the year 2016-17. In entry IC-571706 (16.04 q/ha) highest seed yield was recorded over the check variety AFg-3 (14.68 q/ha).

Table 3.11: Performance of fenugreek genotypes for ancillary characters

| Genotype | Plant height (cm) | Primary branches/plant | Secondary branches/plant | No. of pod /plant | No. of seed /pod | Test weight (g) |
|-----------|-------------------|------------------------|--------------------------|-------------------|------------------|-----------------|
| IC-605357 | 194.20 | 4.73 | 6.27 | 22.13 | 18.07 | 11.77 |
| IC-585601 | 209.40 | 5.20 | 6.40 | 21.27 | 17.07 | 10.47 |
| IC-397265 | 212.60 | 5.27 | 6.87 | 23.67 | 17.53 | 13.17 |
| IC-418346 | 205.00 | 4.80 | 6.73 | 22.80 | 16.93 | 11.97 |
| IC-595329 | 216.40 | 4.53 | 6.47 | 25.53 | 18.40 | 11.17 |
| IC-595313 | 214.00 | 4.87 | 6.67 | 24.80 | 17.20 | 13.33 |
| IC-571706 | 212.20 | 5.20 | 6.60 | 27.53 | 17.33 | 14.67 |
| IC-585599 | 230.40 | 4.27 | 6.27 | 23.40 | 16.93 | 12.13 |
| IC-572835 | 200.80 | 4.60 | 6.67 | 23.93 | 17.53 | 12.33 |
| AFg-3 | 221.80 | 5.47 | 7.27 | 30.47 | 18.80 | 13.37 |
| Mean | 211.68 | 4.89 | 6.62 | 24.55 | 17.58 | 12.44 |
| SEm± | 1.66 | 0.20 | 0.23 | 1.33 | 0.41 | 0.80 |
| CD (0.05) | 4.92 | 0.6 | 0.68 | 3.96 | 1.21 | 2.37 |
| CV (%) | 0.41 | 0.71 | 0.6 | 0.94 | 0.4 | 1.11 |

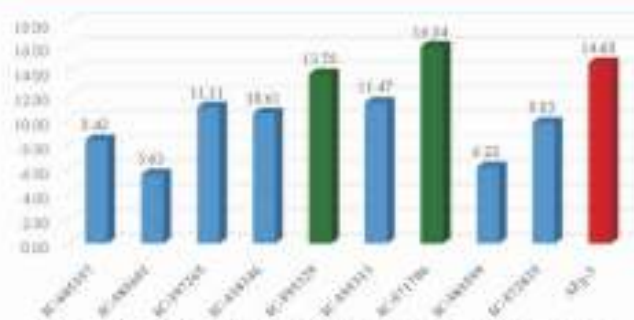


Fig. 5: Seed yield (q/ha) of fenugreek genotypes

CI/13.2.2: Breeding for high yield, small seed size and stem gall resistance in coriander (2013-18)

(R.S. Meena and Y.K. Sharma)

Station Trial-I (Green Leaves): One station trial was conducted with 9 entries having one check variety (ACr-1) during the year 2016-17. In entry KSR/RSM-21 (18.22 q/ha) highest seed yield was recorded over the check variety ACr-1 (10.22 q/ha). coriander variety (ACr-2) was identified for national release in AICRP spices workshop at Guntur.

Table 3.12: Performance of coriander genotypes for ancillary characters in station trial-I (Green Leaves)

| Genotype | Plant height (cm) | Primary branch /plant | Secondary branch /plant | Umbel /plant | Umbellate /umbel | Seed/ umbellate | Test weight (g) | Seed yield (q/ha) |
|-------------|-------------------|-----------------------|-------------------------|--------------|------------------|-----------------|-----------------|-------------------|
| VDV/GL-125 | 109.67 | 6.27 | 7.33 | 14.73 | 5.53 | 4.27 | 8.77 | 5.87 |
| AJMER-GREEN | 109.47 | 4.67 | 6.20 | 15.67 | 5.47 | 5.13 | 8.13 | 9.44 |
| IC-771744 | 122.33 | 4.60 | 5.67 | 18.13 | 5.80 | 5.27 | 8.07 | 13.93 |
| IC-369965 | 123.80 | 6.53 | 8.40 | 16.93 | 6.07 | 5.00 | 8.73 | 12.67 |
| JSS/R-50 | 119.73 | 5.33 | 7.47 | 20.27 | 7.07 | 7.07 | 9.20 | 17.72 |
| KSR/RSM-21 | 117.27 | 5.93 | 7.27 | 20.73 | 6.60 | 7.27 | 11.57 | 18.22 |
| ACr-238 | 126.53 | 7.20 | 8.93 | 17.33 | 5.53 | 5.20 | 9.93 | 13.08 |
| IC-363881 | 117.67 | 5.60 | 7.47 | 17.87 | 5.47 | 5.40 | 11.20 | 12.78 |
| JBT-38/94 | 127.53 | 5.93 | 8.87 | 16.60 | 6.33 | 5.47 | 10.07 | 12.36 |
| ACr-1 | 118.53 | 6.00 | 8.13 | 15.13 | 5.47 | 4.53 | 11.37 | 10.22 |
| Mean | 119.25 | 5.81 | 7.57 | 17.34 | 5.93 | 5.46 | 9.70 | 12.63 |
| SEm± | 3.04 | 0.21 | 0.44 | 1.19 | 0.44 | 0.78 | 0.69 | 2.15 |
| CD (0.05) | 9.03 | 0.63 | 1.32 | 3.53 | 1.3 | 2.33 | 2.06 | 6.38 |



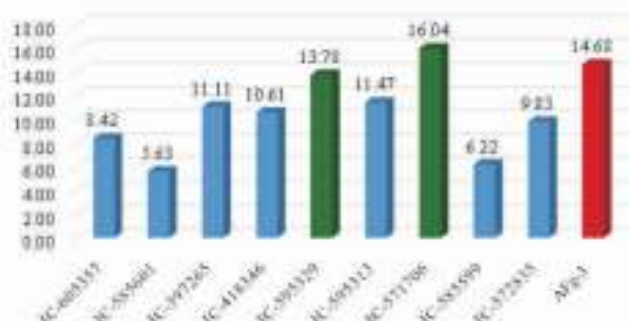


Fig. 6: Performance of coriander genotypes for ancillary characters in station trial-I (green leaves)

Station Trial-II: A station trial was conducted including 8 entries along with 2 check varieties (ACr-1 and Hisar Suganda) during the year 2016-17. In entry UD-353 (14.91 q/ha) highest seed yield was recorded over the check varieties ACr-1 (13.84 q/ha) and Hisar Suganda (10.47 q/ha).

Table 3.13: Performance of coriander genotypes for ancillary characters in station trial-II

| Genotype | Plant height (cm) | Primary branches /plant | Secondary branches /plant | Umbel /plant | Umbellate /umbel | Seed/ umbellate | Test weight (g) |
|---------------|-------------------|-------------------------|---------------------------|--------------|------------------|-----------------|-----------------|
| ACr-1 | 102.67 | 5.47 | 9.20 | 19.33 | 6.20 | 5.53 | 8.73 |
| ACr-213 | 104.47 | 6.27 | 9.80 | 17.93 | 6.40 | 5.27 | 10.97 |
| Hisar Suganda | 113.60 | 6.20 | 9.07 | 14.40 | 5.87 | 5.40 | 11.77 |
| JCO-309 | 122.73 | 6.93 | 10.60 | 24.27 | 6.00 | 5.33 | 12.87 |
| JCO-340 | 118.80 | 5.73 | 9.53 | 19.33 | 5.13 | 4.67 | 14.40 |
| NDCOR-14 | 121.13 | 7.13 | 9.93 | 25.07 | 5.80 | 5.00 | 10.77 |
| VDV/GL-20 | 118.73 | 4.60 | 8.27 | 18.67 | 4.53 | 3.73 | 10.30 |
| UD-353 | 108.00 | 5.27 | 8.53 | 24.67 | 5.87 | 4.53 | 8.93 |
| UD-589 | 67.73 | 7.20 | 8.67 | 21.27 | 5.40 | 4.40 | 12.67 |
| VD-375 | 109.40 | 7.60 | 10.13 | 24.00 | 5.33 | 4.20 | 11.43 |
| Mean | 108.73 | 6.24 | 9.37 | 20.89 | 5.65 | 4.81 | 11.28 |
| SEm± | 10.20 | 0.23 | 0.39 | 0.87 | 0.19 | 0.35 | 0.67 |
| CD (0.05) | 30.3 | 0.67 | 1.15 | 2.58 | 0.58 | 1.03 | 2 |

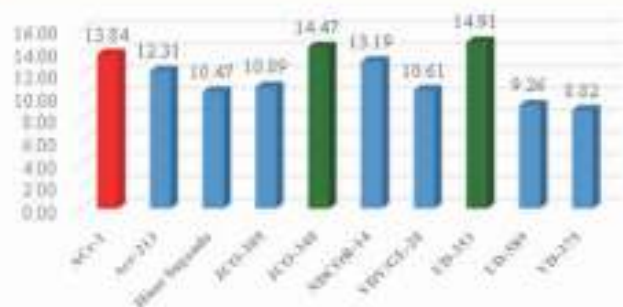


Fig. 7: Performance of coriander genotypes seed yield (q/ha) in station trial-II

mutant plants were evaluated to know the variability and stability of mutants for different characters based on morphological and molecular basis. The earliest (54 days) flower appearance was recorded in M-36 followed by M-39 (55 days) while among the different mutants, highest number of primary branches (20) was found in M-4 followed by M-72 (18) and M-32 (18). Dwarfism (Fig. 8) was observed in some of the mutants and minimum plant height (60 cm) was observed in M-36 followed by M-40 and M-61 (67.5 cm), M-76 (72 cm), M-69 (75 cm) and M-74 (78 cm). Maximum number of secondary branches (58) was recorded in M-72 followed by M-22 (55) and M-70, M-77, M-88 and M-17 were recorded 52 secondary branches. Maximum number of umbels (260) was observed in M-90 and maximum number of umbellate per

CI/14.2.1: Induction of genetic variability in cumin and fennel through gamma radiation (2014-19)

(A. K. Verma, R.D. Meena and Sharda Choudhary)

The selected mutants were evaluated for different trait for which they were selected in M₂ generation. Total 190



umbel (42) was recorded in M-85. Highest number of seeds per umbel (980) was recorded in M-85 while, early crop maturity was observed in was taken by M-38 (155 days) followed by M-36 (161 days. Higher test weight (10 g) was found in M-70 and highest seed yield per plant was recorded in M-4 (307.1 g) followed by M-35 (270.99) and M-2 (261.75 g). Dendrogram generated through RAPD marker showed similarity coefficient value in range of 0.00 to 0.88 (Fig. 9). The dendrogram clearly divided the 24 mutants into 2 main clusters. Cluster I included 23 mutants and cluster II included only one mutant, which was more diverse. The Random Amplified Polymorphic DNA (RAPD) analysis showed broad genetic diversity among the mutants. Total 246 fragments were amplified in all 24 mutants; polymorphic fragment were obtained with all 5 primers with average 14.6 fragments per primer. Out of 246 bands 73 bands were found to be polymorphic and the level of average polymorphism was 29.6%. Out of 20 primers 5 primers showed amplification, the polymorphism ranging from 24.4 per cent (OPE-20) to 37.2 per cent (OPE-15). Polymorphism information content (PIC) ranged from 0.51 to 0.83 with an average of 0.70. In morphological analysis, some mutants did not follow the pattern of RAPD analysis indicating their phenotypic characters to be influenced by the

environmental factors. The SSR primers were amplified but not showing any polymorphism within used set of mutants, all the bands were monomorphic. This may be due to because of we have not crop specific SSR primers. Among the 64 mutants selected from the variety AF-1 in M_1 generation, 12 found superior than its parent at least one characters in M_1 generation. Besides this, 110 mutant lines were also selected from M_1 generation of fennel based on morphological characters. In cumin M_1 generation successfully raised and harvested the seeds and the evaluation and selection of mutants will be done in next generation.

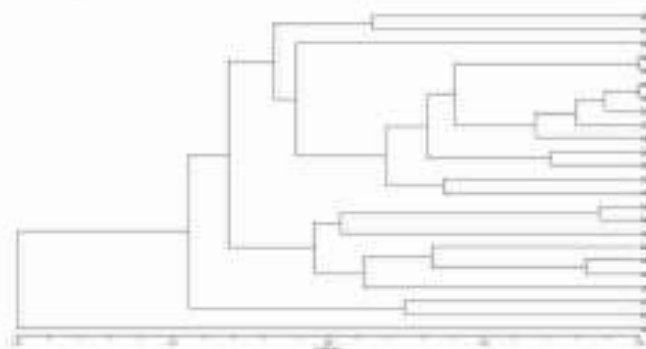


Fig. 9: Dendrogram generated for 24 promising fennel mutants using UPGMA cluster analysis based on RAPD



Dwarf M-40 (67.5 cm)



Semi-dwarf M-72 (105 cm)



Tall M-47 (180 cm)

Various fennel mutants based on plant height



CI/15.2.1: Breeding in *Nigella sativa* L. for higher yield and improved quality (2015-20)

(S.S. Meena and S.N. Saxena)

One trial was conducted on 9 advance lines of nigella.

Plant height, number of branches, days to 50 % flowering, yields attributing traits and seed yield was recorded. The maximum seed yield (1638.89 Kg/ha) were recorded in AN-4 followed by AN-19 (1372.22 Kg/ha).

Table 3.14: Growth parameters of advance lines of nigella

| Genotypes | Plant height (cm) | Primary branch/Plant | Secondary branch/plant | No of capsules /plant |
|-------------|-------------------|----------------------|------------------------|-----------------------|
| AN-4 | 65.87 | 8.20 | 24.80 | 30.80 |
| AN-10 | 65.20 | 8.20 | 24.33 | 30.20 |
| AN-19 | 63.93 | 8.00 | 24.33 | 30.00 |
| AN-24 | 67.07 | 7.80 | 23.07 | 26.80 |
| SEL-4 | 61.80 | 7.93 | 21.07 | 25.80 |
| SEL-4-1 | 64.67 | 7.80 | 21.53 | 26.40 |
| SEL-5 | 61.87 | 7.93 | 20.07 | 26.33 |
| SEL-9 | 76.80 | 8.00 | 20.60 | 24.93 |
| SEL-10 | 74.87 | 7.93 | 22.00 | 29.00 |
| SEm ± | 2.89 | 0.12 | 0.78 | 1.89 |
| CD (P=0.05) | 8.66 | 0.35 | 2.33 | 5.68 |
| CV% | 7.48 | 2.51 | 6.06 | 11.79 |

Table 3.15: Yield and yield attributes of nigella lines

| Genotypes | No. of Seeds /capsule | Seed yield /plant (gm) | Test weight (g) | Seed yield (kg/ha) | Essential oil (%) |
|-------------|-----------------------|------------------------|-----------------|--------------------|-------------------|
| AN-4 | 81.13 | 27.17 | 1.93 | 1638.89 | 1.07 |
| AN-10 | 71.13 | 24.33 | 2.20 | 1238.89 | 1.13 |
| AN-19 | 79.87 | 26.33 | 2.06 | 1372.22 | 1.10 |
| AN-24 | 76.87 | 22.23 | 1.83 | 1261.11 | 1.37 |
| SEL-4 | 76.47 | 23.50 | 1.73 | 1177.78 | 1.50 |
| SEL-4-1 | 78.53 | 22.67 | 2.05 | 791.11 | 1.27 |
| SEL-5 | 74.27 | 25.83 | 1.77 | 1022.22 | 1.21 |
| SEL-9 | 78.40 | 20.83 | 1.50 | 1188.89 | 1.39 |
| SEL-10 | 77.07 | 25.17 | 1.74 | 1347.22 | 0.63 |
| SEm ± | 2.18 | 0.87 | 0.11 | 43.95 | 0.05 |
| CD (P=0.05) | 6.53 | 2.60 | 0.34 | 131.76 | 0.14 |
| CV% | 4.89 | 6.21 | 10.58 | 6.21 | 6.76 |

CI/15.2.2: Development of microsatellites (SSRs) markers for coriander (2015-18)

(Sharda Choudhary and M.K. Vishal)

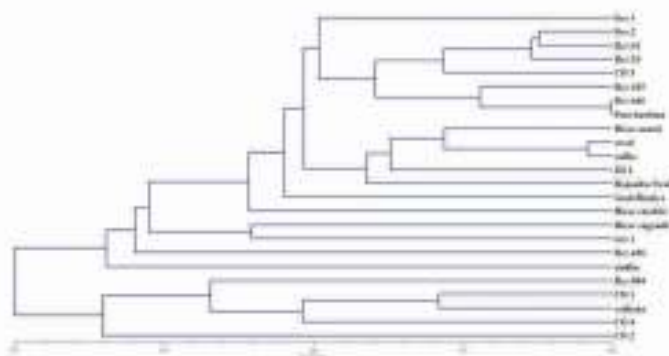
Successful polymorphic SSR primers selected from last year's data were used for molecular diversity analysis of

coriander varieties. Twenty four varieties were used with 30 primers. The Simple Sequence Repeats (SSRs) analysis showed broad genetic diversity. Total 49 fragments were amplified in all the twenty four genotypes; polymorphic fragment were obtained with 20 primers with average



2.45 fragments per primer. Out of 49 bands, 47 bands were found to be polymorphic and the level of average polymorphism was 97.08 %. Out of 30 primers 20 primers produced amplification whereas 10 primers did not show any amplification. Again out 20, only 2 primers showed variable degree of polymorphism ranging from 66.66 per cent (GSSR-139) to 100 per cent in 18 primers.

Dendrogram generated through SSR marker showed similarity coefficient value in range of 0.05 to 0.88. The dendrogram clearly divided the 24 genotypes into 8 main clusters. Cluster I included 8 genotype, cluster II included 5 genotype, cluster III included 1 genotype, cluster IV included 1 genotype, cluster V included 2 genotypes, cluster VI included 1 genotype, cluster VII included 1 genotype and cluster VIII included 5 genotype respectively.



Two and three dimensional principal component analysis based on SSRs showed similar clustering pattern of 24 genotypes as evident from cluster tree analysis. Most of the genotypes were in eight major clusters. The cluster first having maximum genotypes having two minor clusters included total eight genotypes. On the basis of molecular studies (SSR), Co-1 appeared superior, genetically diverse and promising; hence could be gainfully utilized.

ESTs were developed for the coriander crop using transcriptome sequences of the NRCSS, Ajmer variety (ACr-1). Microsatellites were developed using the MISA v1.0 software from transcriptome. Insilico-validation confirmed the SSRs availability at difference sizes and distance.

Details and statistics of SSR identification

| TRANS SCRIPT and SSR DETAILS | SAMPLE 1 NRCSS1 | SAMPLE 2 NRCSS2 |
|--|-----------------|-----------------|
| Total number of transcripts assembled | 6,861 | 59,923 |
| Total size of assembled sequences (bp) | 76,412,878 | 82,389,119 |
| Total number of identified SSRs | 4,213 | 18,126 |
| Number of SSR containing sequences | 7,673 | 8,494 |
| Number of sequences containing more than 1 SSR | 1,211 | 1,373 |
| Number of SSR present in compound formation | 467 | 993 |
| Di-nucleotide repeat | 1,810 | 1,507 |
| Tri-nucleotide repeat | 5,175 | 8,114 |
| Tetra-nucleotide repeat | 173 | 240 |
| Penta-nucleotide repeat | 29 | 41 |
| Hexa-nucleotide repeat | 24 | 19 |

CI/15.2.3: Identification of molecular marker associated with stem gall in coriander (2015-20)

(Sharda Choudhary and R.D. Meena)

Seeds collected from previous years (2015-16) season were sown in the field (two locations KVK, Anta and NRCSS, Ajmer) with taking care for purity for ACr-1 and CS-6. Field Screening was done for stem gall for both the varieties. Total DNA and RNA were isolated from the resistance and susceptible leaf sample. Resampling was done for the confirmed samples for RNA isolation and cDNA libraries were prepared. The RNA-seq paired-end sequencing libraries were prepared. High-throughput de novo transcriptome sequencing and differential gene expression (DEG) analyses were carried out using coriander resistance (ACr-1) and susceptible (CS-6) varieties for stem gall. After removing the low quality sequences from the raw data, 49,163,108 (2 x 75bp) and 43,746,120 (2 x 75bp) high quality reads were retained for resistance and susceptible samples.

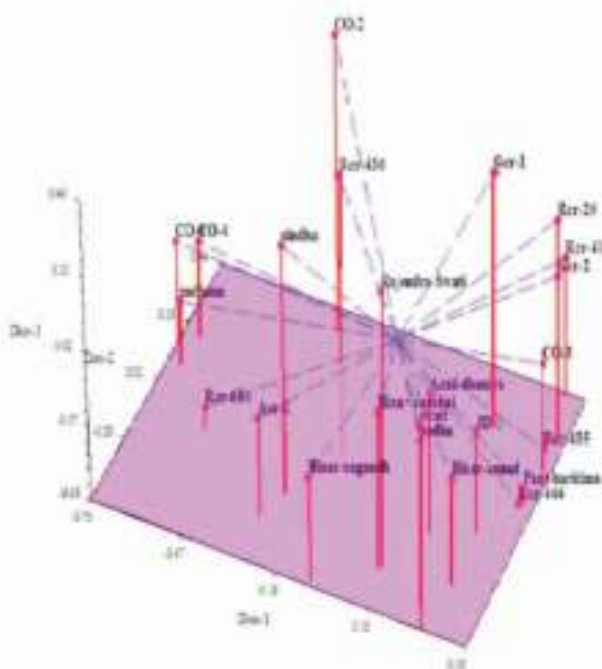
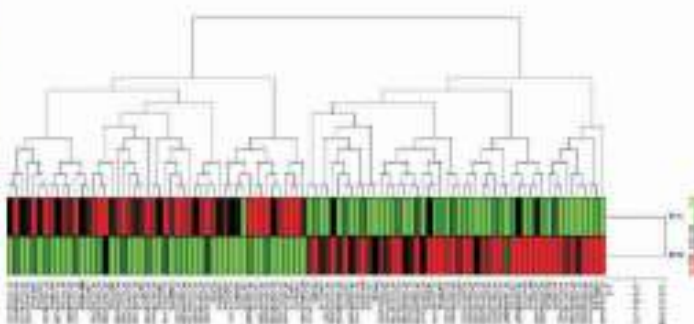


Table 3.16: CDS of 52506 in resistance and 48858 in susceptible sample were identified

| | Cultivars | |
|---------------------------------|---------------|---------------|
| | Resistance | Susceptible |
| Number of reads | 49,163,108 | 43,746,120 |
| Number of bases | 7,404,005,575 | 6,590,095,417 |
| Number of transcripts | 59,933 | 56,861 |
| Total transcript length (bases) | 82,309,113 | 70,412,570 |
| NS0 | 1894 | 1730 |
| Maximum transcript length | 12930 | 13,133 |
| Minimum transcript length | 200 | 200 |
| Mean transcript length | 1373 | 1238 |
| CDS statistics | | |
| Number of CDS length (bases) | 52506 | 48858 |
| Total CDS length (bases) | 54256515 | 45786651 |
| Maximum CDS length | 9114 | 6597 |
| Minimum CDS length | 297 | 297 |
| Mean CDS length | 1033 | 937 |
| Range of CDS | | |
| 200< CDS <500 | 13533 | 13892 |
| 500< CDS <1000 | 18429 | 17914 |
| 1000< CDS <2000 | 15538 | 13831 |
| 2000< CDS <3000 | 3617 | 2610 |
| 3000< CDS <4000 | 1005 | 485 |
| 4000< CDS <5000 | 225 | 100 |
| CDS >500 | 159 | 26 |
| Range of transcript | | |
| 200< transcript <500 | 13237 | 14420 |
| 500< transcript <1000 | 12935 | 13104 |
| 1000< transcript <2000 | 20810 | 19361 |
| 2000< transcript <3000 | 8795 | 7073 |
| 3000< transcript <4000 | 2692 | 2099 |
| 4000< transcript <5000 | 861 | 560 |
| transcript >500 | 603 | 244 |

Viewmap of differentially expressed genes in control and treated sample

Up-regulation and down-regulation is represented by red shading and green shading respectively.



CI/16.2.1: Breeding for dwarfism and *Ramularia* blight resistance/tolerance in fennel (2016-21)

(R.S. Meena, R.D. Meena, S. Choudhary, N.K. Meena and S.N. Sexana)

Breeding for dwarfism: Artificial hybridization was attempted and seed setting was found in 71 crosses. These F₁ seeds were sown in the field for the evaluation. After flowering main umbel of F₁ plants selfed and segregating plants were discarded. Seeds from F₁ plants were harvested separately and F₂ will be evaluated in the next season.



View of cross making in dwarf fennel

Functional annotation using Blastx against protein database



Screening of fennel varieties resistant against *Ramularia* blight: AF-87 genotype was reported lowest disease incidence against *Ramularia* blight (PDI-13.33), while three another genotypes Volina, AF- 2 and AF0 52 were seen as moderately resistance reaction to the disease (Table 3.17). All other remaining genotypes were considered susceptible and highly susceptible against *Ramularia* blight .

Station Trial: A station trial was conducted with 13 entries with 3 check varieties (AF-1, AF-2 and RF-125) during the year 2016-17 (Table 3.18). Entry AF-257 (18.99 q/ha) highest seed yield (Fig. 10) and AF-30 (1.746 %) maximum essential oil was recorded in station trial over the check varieties AF-1 (11.01 q/ha & 1.367%) and AF-2 (17.72 q/ha & 1.736%).

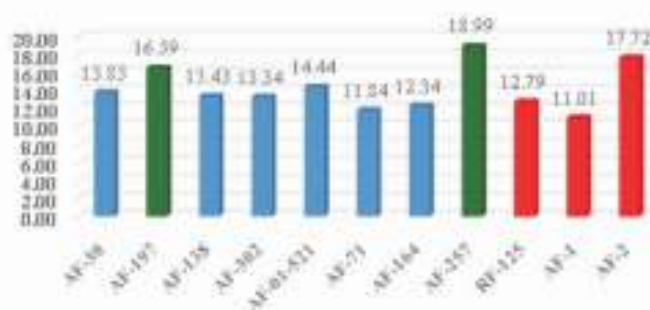


Fig. 10: Seed yield of fennel genotypes (q/ha)

Table 3.18: Performance of fennel genotypes for ancillary characters in station trial

| Genotype | Plant height (cm) | No. of Primary branches | No. of Secondary branches | Umbel/ plant | Umbellate /umbel | Seed/ umbellate | Test weight (g) | Essential oil (%) |
|-------------|-------------------|-------------------------|---------------------------|--------------|------------------|-----------------|-----------------|-------------------|
| AF-256 | 161.67 | 8.73 | 16.93 | 38.13 | 26.93 | 27.67 | 5.53 | 1.72 |
| AF-30 | 182.40 | 9.13 | 18.60 | 40.73 | 28.07 | 28.73 | 6.24 | 1.74 |
| AF-197 | 154.07 | 8.80 | 17.93 | 49.93 | 30.87 | 26.00 | 5.33 | 1.42 |
| AF-138 | 152.67 | 9.73 | 18.00 | 38.27 | 29.00 | 25.93 | 5.13 | 1.54 |
| AF-302 | 178.47 | 8.47 | 21.60 | 49.00 | 30.87 | 27.80 | 6.01 | 1.40 |
| AF-11 | 99.27 | 5.60 | 11.60 | 72.20 | 14.93 | 16.13 | 2.85 | 1.68 |
| AF-01-521 | 160.80 | 8.13 | 19.93 | 41.07 | 29.40 | 27.47 | 5.27 | 1.47 |
| AF-71 | 166.93 | 9.07 | 19.80 | 40.53 | 31.07 | 23.93 | 6.10 | 1.21 |
| AF-134 | 147.93 | 9.53 | 21.13 | 40.60 | 28.73 | 26.47 | 4.96 | 1.70 |
| AF-01-172-4 | 153.07 | 8.47 | 19.60 | 43.87 | 29.60 | 24.20 | 5.50 | 1.51 |
| AF-299 | 166.73 | 7.47 | 20.33 | 41.60 | 27.73 | 28.07 | 4.76 | 1.37 |
| AF-164 | 156.47 | 8.33 | 18.73 | 36.13 | 26.87 | 25.73 | 5.34 | 1.48 |
| AF-257 | 158.00 | 9.67 | 21.47 | 48.67 | 30.60 | 28.60 | 5.76 | 1.47 |
| RF-125 | 170.60 | 8.33 | 18.80 | 38.47 | 29.87 | 29.93 | 5.23 | 1.53 |
| AF-1 | 154.73 | 7.73 | 19.27 | 37.20 | 29.13 | 28.93 | 5.13 | 1.36 |
| AF-2 | 165.13 | 8.20 | 20.20 | 38.60 | 27.27 | 26.07 | 4.70 | 1.73 |
| Mean | 158.06 | 8.46 | 19.00 | 43.44 | 28.18 | 26.35 | 5.24 | 1.52 |
| SEm± | 15.52 | 1.03 | 2.11 | 13.49 | 3.37 | 3.46 | 2.45 | 0.007 |
| CD (0.05) | 44.82 | 2.96 | 6.08 | 38.96 | 9.73 | 9.99 | 1.67 | 0.02 |



CI/16.2.2: Breeding for yield and quality in celery (2016-21)

(R.S. Meena, S. Choudhary, N.K. Meena, A.K. Verma and R.D. Meena)

Station Trial: A station trial was conducted having 13 entries along with one check variety (ACel-1) during the year 2016-17 (Table 3.19). Celery entry A-Cel-14-34 was recorded highest seed yield (16.96 q/ha) and K-24 was recorded maximum essential oil (2.32 %) in station trial over the check varieties A-Cel-1 (12.49 q/ha & 1.66%, respectively).

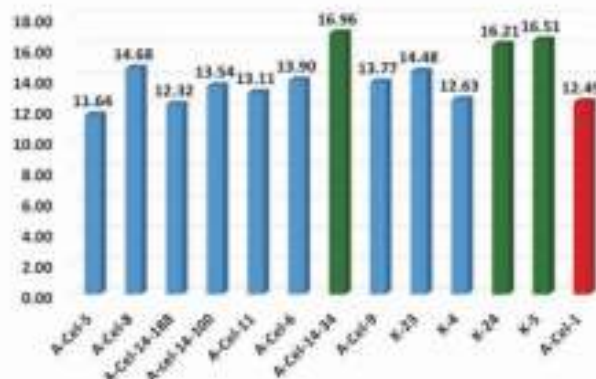


Fig. 11: Performance of celery genotypes for seed yield (q/ha)

Table 3.19: Performance of celery genotypes for ancillary characters in station trial

| Entries | Plant height (cm) | Primary branches /plant | Secondary branches /plant | Umbel/ plant | Umbellate /umbel | Seed/ umbellate | Test weight (g) | Essential oil (%) |
|--------------|-------------------|-------------------------|---------------------------|--------------|------------------|-----------------|-----------------|-------------------|
| A-Cel-5 | 162.00 | 10.00 | 30.20 | 232.40 | 21.47 | 36.73 | 0.43 | 1.42 |
| A-Cel-8 | 147.67 | 15.13 | 33.27 | 301.13 | 25.60 | 30.20 | 0.36 | 0.48 |
| A-Cel-7 | 151.87 | 10.13 | 28.47 | 297.87 | 26.27 | 38.20 | 0.38 | 0.49 |
| A-Ecel-8 | 144.13 | 11.00 | 30.67 | 295.80 | 25.40 | 43.53 | 0.45 | 1.88 |
| A-Cel-14-104 | 147.47 | 11.33 | 27.53 | 255.13 | 25.20 | 37.93 | 0.46 | 1.83 |
| K-25 | 150.67 | 11.67 | 34.67 | 263.60 | 23.33 | 36.33 | 0.40 | 2.04 |
| A-Cel-14-101 | 142.87 | 13.20 | 29.33 | 280.20 | 25.73 | 37.47 | 0.41 | 1.75 |
| A-Cel-14-188 | 145.80 | 10.60 | 31.47 | 295.00 | 28.00 | 35.73 | 0.42 | 1.77 |
| A-cel-14-100 | 143.53 | 11.87 | 29.00 | 324.20 | 24.00 | 40.27 | 0.42 | 1.78 |
| A-Cel-4 | 130.07 | 11.40 | 28.93 | 300.20 | 23.67 | 37.67 | 0.40 | 1.89 |
| A-Cel-11 | 133.00 | 12.20 | 31.20 | 288.27 | 22.47 | 37.60 | 0.38 | 1.75 |
| A-Cel-6 | 128.67 | 12.47 | 30.07 | 284.33 | 23.27 | 36.73 | 0.35 | 2.11 |
| A-Cel-14-34 | 118.33 | 11.73 | 31.13 | 297.60 | 25.40 | 35.33 | 0.42 | 1.75 |
| A-Cel-9 | 123.47 | 12.93 | 28.33 | 278.13 | 39.93 | 34.80 | 0.45 | 1.81 |
| K-23 | 125.87 | 11.27 | 31.87 | 279.60 | 23.53 | 34.40 | 0.42 | 1.85 |
| K-4 | 132.67 | 11.00 | 30.73 | 284.73 | 21.13 | 36.33 | 0.42 | 2.12 |
| K-24 | 141.87 | 12.13 | 30.47 | 292.40 | 23.07 | 40.47 | 0.49 | 2.32 |
| K-5 | 146.93 | 12.60 | 31.67 | 258.00 | 21.93 | 36.87 | 0.60 | 2.24 |
| A-Cel-1 | 129.60 | 12.33 | 31.67 | 303.60 | 25.00 | 38.53 | 0.41 | 1.66 |
| Mean | 139.29 | 11.84 | 30.56 | 284.85 | 24.97 | 37.11 | 0.42 | 1.73 |
| SEmt | 4.89 | 1.28 | 1.64 | 18.75 | 4.22 | 2.78 | 0.06 | 0.011 |
| CD (0.05) | 14.02 | 3.67 | 4.71 | 53.79 | 12.10 | 7.96 | 0.18 | 0.03 |
| CV (%) | 0.32 | 0.99 | 0.49 | 0.60 | 1.54 | 0.68 | 1.45 | 0.06 |

Celery station trial of NRCSS, Ajmer at ATC Ajmer (Rajasthan) in 2016-17

A trial was conducted and 3 entries with one check variety (A-Cel-1) during the year 2016-17. Yield was recorded

6.23 q/ha in A-Cel -5 which was highest among all the genotypes. Essential oil was also estimated i.e. 2.18%. Check variety A-Cel-1 has 4.16 q/ha seed yield and 2.08% essential oil (Table 3.20 and Fig. 11). A proposal of celery variety ACel-2 will be submitted for state release.



Table 3.20: Performance of celery genotypes in station trial

| S. No. | Entries | Plant height (cm) | Primary branches /plant | Secondary branches /plant | Umbel /plant | Umbellate /umbel | Seed/ umbellate | Days to Maturity | Yield (kg/ha) | Test weight | Essential oil (%) (g) |
|--------|-----------|-------------------|-------------------------|---------------------------|--------------|------------------|-----------------|------------------|---------------|-------------|-----------------------|
| 1 | A-Cel-6 | 97.00 | 9.53 | 18.60 | 109.47 | 18.47 | 23.47 | 126 | 581.0 | 0.34 | 2.09 |
| 2 | A-Cel-5 | 100.53 | 10.20 | 19.27 | 110.53 | 19.53 | 24.13 | 123 | 623.0 | 0.38 | 2.18 |
| 3 | A-Cel-8 | 106.07 | 9.40 | 18.20 | 104.33 | 18.45 | 22.47 | 124 | 433.0 | 0.33 | 2.41 |
| 4 | A-Cel-1 | 99.67 | 8.73 | 17.60 | 97.40 | 17.27 | 21.00 | 125 | 416.0 | 0.40 | 2.08 |
| | SEm | 4.70 | 0.06 | 1.11 | 3.42 | 1.08 | 0.07 | 1.60 | 37.00 | 0.04 | 0.01 |
| | CD (0.05) | 16.25 | 0.19 | 3.85 | 11.82 | 3.74 | 0.25 | 5.53 | 128.0 | 0.13 | 0.05 |
| | CV (%) | 2.02 | 0.25 | 3.43 | 1.40 | 2.54 | 0.14 | 0.55 | 311.0 | 4.71 | 0.27 |

Project 3: Development and refinement of efficient crop production technologies of seed spices

CPd-24: Fertigation scheduling for efficient nutrient and water management in major and minor seed spices (2012-17)

(Ravindra Singh, G. Lal, R.S. Mehta, H. Asangi and S.P. Maheria)

Effect of nursery raising techniques, sowing method and plastic mulching on growth and yield of seed spices

An experiment comprising of two factors i.e. 4 seed spice crop (fennel, dill, ajwain and celery) in main plot and 6 planting/sowing method in sub plot were conducted

under drip fertigation. Table 3.21 revealed that among the crops maximum seed yield was recorded in fennel (2306 kg/ha) followed by dill (2289 kg/ha), celery (1070 kg/ha) and lowest in ajwain (787 kg/ha). Among the sowing /transplanting methods, maximum seed yield of all the seed spices were recorded with transplanted crop by raising the nursery in soil less media (2012 kg/ha) followed by pro trays (1921 kg/ha). Lowest seed yield were observed under direct seed sown crop without mulch (1190 kg/ha). Maximum water productivity was recorded in dill followed by fennel, celery and lowest in ajwain.



Different nursery raising techniques and sowing methods of seed spices

Table 3.21: Seed yield of fennel, dill, ajwain and celery as influenced by nursery raising method under drip fertigation

| Treatment Crop | Nursery raising/ sowing method | | | | | | Mean A |
|-----------------------------|--------------------------------|-------|-------------|--------------|--------------|-----------------|--------|
| | Pro-tray | Media | In Soil | DSS+M | DSS-M | Transplanting-M | |
| Fennel | 2,681 | 2,876 | 2,410 | 2,304 | 1,715 | 1,851 | 2,306 |
| Dill | 2,654 | 2,857 | 2,351 | 1,743 | 1,815 | 2,315 | 2,289 |
| Celery | 1,339 | 1,333 | 1,154 | 1,232 | 679 | 684 | 1,070 |
| Ajwain | 1,010 | 980 | 677 | 754 | 553 | 749 | 787 |
| Mean B | 1,921 | 2,012 | 1,648 | 1,508 | 1,190 | 1,400 | |
| Factors | | | C.D. | SE(d) | SE(m) | | |
| Factor(A) | | | 95.5 | 41.6 | 29.4 | | |
| Factor(B) | | | 72.5 | 36.1 | 25.6 | | |
| Factor(B)at same level of A | | | 150.9 | 72.3 | 72.1 | | |
| Factor(A)at same level of B | | | 162.8 | 78.0 | 55.2 | | |

*DSS(Direct seed sown); +M (With Mulch); -M (without mulch)

Table 3.22: Water productivity (litres of water to required produce 1 kg seed)

| Crop | Water applied (Litres/ha) | Mean yield (Kg/ha) | Water productivity (Litre) |
|--------|---------------------------|--------------------|----------------------------|
| Fennel | 2798300 | 2,306 | 1213 |
| Dill | 2498300 | 2,289 | 1091 |
| Celery | 2498300 | 1,070 | 2335 |
| Ajwain | 2398300 | 787 | 3047 |

maximum water productivity was recorded within raised beds of 75 cm coupled with drip irrigation (68.6 kg seed/ha cm water) followed by raised beds of 150 cm coupled with drip irrigation (63.1 kg seed/ha cm water) and lowest with surface irrigation (19.8 kg seed/ha cm water) irrespective of the seed spice crops. Table 3.24 revealed that among the crops maximum water productivity was recorded with fenugreek (82.9 kg seed/ha cm water) followed by coriander and lowest with cumin (28.4 kg seed/ha cm water).

Effect of different irrigation methods on yield of major and minor seed spices

An experiment having 3 sowing methods/ irrigation methods (surface irrigation and drip irrigation coupled with raised beds of 75 and 150 cm width) in main plot and 9 seed spice crops (fenugreek, nigella, anise, coriander, ajwain, celery, dill, fennel and cumin) in sub plot was conducted. It was evident from Table 3.23 that maximum seed yield of different crops was maximum under drip fertigation coupled with raised bed of 75 cm (1519.4 kg/ha) followed by drip fertigation with raised bed of 150 cm (1395.8 kg/ha) and lowest with surface irrigation (1019.7 kg/ha) irrespective of the seed spice crops. Among the crops, maximum seed yield was recorded in fenugreek (2256.1 kg/ha) followed by fennel (1630.4 kg/ha), coriander (1603.5 kg/ha), dill (1379.0 kg/ha), and ajwain (1222.1 kg/ha). Lowest seed yield was observed for cumin (538.9 kg/ha). Among the irrigation methods,



Fennel, dill, celery and ajwain under drip irrigation (150cm raised beds)

Table 3.23: Seed yield of major and minor seed spices as influenced by irrigation methods

| Treatment | Drip fertigation (75 cm raised beds) | Drip fertigation (150 cm raised beds) | Surface irrigation (Flat bed) | Mean |
|---------------|---|--|----------------------------------|--------------|
| Cumin | 634.3 | 554.3 | 428.3 | 538.9 |
| Coriander | 2101.3 | 1870.5 | 838.8 | 1603.5 |
| Fenugreek | 2279.5 | 2044.5 | 2444.3 | 2256.1 |
| Fennel | 1940.0 | 1771.5 | 1179.8 | 1630.4 |
| Ajwain | 1413.8 | 1297.8 | 954.8 | 1222.1 |
| Dill | 1507.0 | 1436.3 | 1193.8 | 1379.0 |
| Celery | 1435.3 | 1161.3 | 806.8 | 1134.4 |
| Nigella | 1094.0 | 1320.0 | 581.3 | 998.4 |
| Anise | 1269.3 | 1105.8 | 749.5 | 1041.5 |
| Mean A | 1519.4 | 1395.8 | 1019.7 | |
| | Factors | C.D. | SE(d) | SE(m) |
| | Factor(A) | 45.2 | 22.7 | 16.0 |
| | Factor(B) | 78.3 | 39.3 | 27.8 |
| | Factor(B)at same level of A | 135.6 | 68.0 | 48.1 |
| | Factor(A)at same level of B | 164.0 | 81.0 | 63.2 |

Table 3.24: Effect of irrigation methods on water productivity (kg seed/ha cm water) of seed spices

| Treatment | Drip fertigation (75 cm raised beds) | Drip fertigation (150 cm raised beds) | Surface irrigation (Flat bed) | Mean |
|---------------|---|--|----------------------------------|--------------|
| Cumin | 35.8 | 31.5 | 18.0 | 28.4 |
| Coriander | 116.8 | 104.0 | 17.3 | 79.3 |
| Fenugreek | 107.3 | 96.5 | 45.0 | 82.9 |
| Fennel | 69.5 | 63.5 | 21.8 | 51.6 |
| Ajwain | 59.0 | 54.0 | 16.5 | 43.2 |
| Dill | 60.5 | 57.5 | 20.8 | 46.3 |
| Celery | 57.3 | 46.5 | 14.5 | 39.4 |
| Nigella | 51.5 | 62.3 | 11.3 | 41.7 |
| Anise | 60.0 | 52.0 | 13.5 | 41.8 |
| Mean A | 68.6 | 63.1 | 19.8 | |
| | Factors | C.D. | SE(d) | SE(m) |
| | Factor(A) | 1.47 | 0.74 | 0.52 |
| | Factor(B) | 2.55 | 1.28 | 0.90 |
| | Factor(B)at same level of A | 4.41 | 2.21 | 1.56 |
| | Factor(A)at same level of B | 5.21 | 3.07 | 2.19 |





Fenugreek, fennel, dill, celery and ajwain under drip irrigation (75 cm raised beds)



Surface irrigation in all seed spices

CPd-25: Nutrient management for sustainable seed spices production (coriander and fennel) (2012-17)

(O.P. Aishwath, R.S. Mehta, P.N. Dubey, Harisha C.B.)

Threshold level of N requirement of fennel (Ajmer Fennel-1) on soil test basis

Under lower availability of N in light textured soil, application of graded levels of, fennel plants were taller

and secondary branches, umbels per plant, umbellate per plant, seeds per umbellate, seed and stover yield were more beyond 40-60 kg N/ha than its lower levels or control (Fig. 12). Moreover, all the parameters were highest at 120 kg N but remained at par to their preceding level. Oil content and oil yield of fennel was substantially higher beyond 60 N per ha. Uptake of macro and micronutrients followed almost similar trend as that of growth and yield and their parameters. It was observed that to achieve the highest yield potential of fennel, approximately 100 kg N was required under said conditions and to maintain the soil health > 100 kg N was required. Availability of macro and micronutrients in soil also increased with N input except K (Fig. 13).

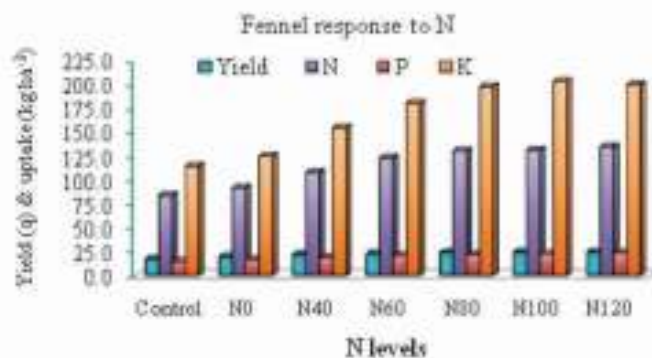


Fig. 12: Yield and uptake of nutrients by fennel with N levels

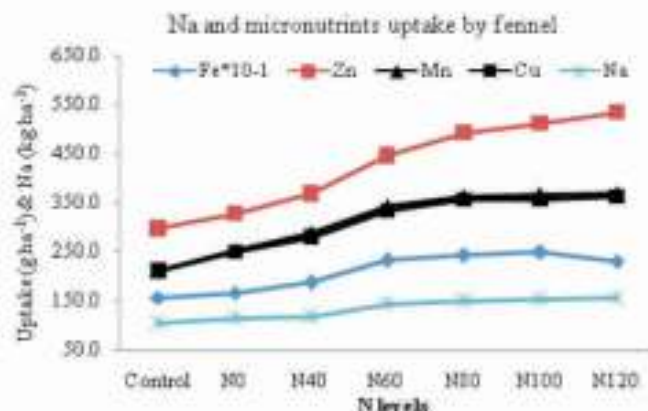


Fig. 13: Uptake of Na and micronutrients by fennel with N levels



Threshold level of P requirement of coriander (Ajmer fennel-1) on soil test basis

All the growth and yield parameters were higher with applied P than control, however these were remained at par with all the higher levels of P. Likewise, yield of both seed and stover was more with applied P but there is no statistical variation within the treatments though it was marginally higher with input (Fig. 14). Oil content was marginally improved by applied P, while oil yield higher beyond the 40 kg P/ha. Uptake of macro and micronutrients was also more with applied P over control, whereas at par with various levels except P. The P content and uptake was higher with each alternate higher levels of applied P. Availability of macronutrients was more with applied P and micronutrients availability remained unchanged in general, while the change in soil available P was not much higher even with applied P. Physiologically, P requirement of crop is about 20 kg /ha and may be replenish accordingly.

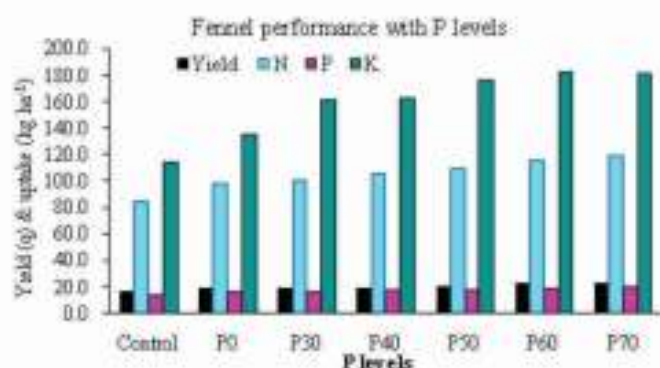


Fig. 14: Yield and uptake of fennel with P levels

Response of fennel with integrated use of manures and fertilizers

All the growth parameters were more with combine use of N and FYM as compared to their distinct application and control. However, yield and yield parameters were higher with combine and separate use of N and FYM (Fig. 15). Oil content and yield was higher with 80 kg N or in combination with FYM levels. Uptake of nutrients was more either with separate or combine use of N and FYM in comparison to control. Soil availability of nutrients did not vary much except N which was higher with combine use of N and FYM.

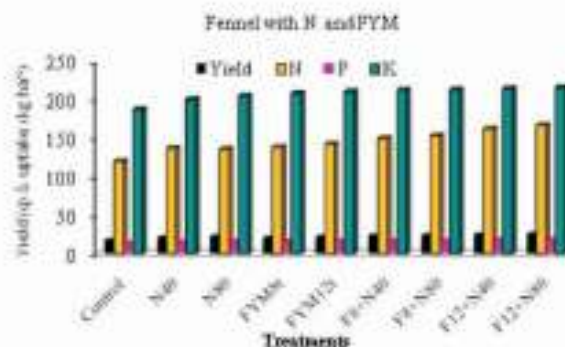


Fig. 15: Performance of fennel with integrated use of N and FYM

Response of coriander to sulphur application

Growth and yield parameters of coriander were higher with alternate levels of S, while these were at par with their each successive level (Fig. 16). Seed yield was higher at and beyond 35 kg S per ha, while stover yield was statistically at par with applied S. Oil content and oil yield of coriander was more with 40 kg and 45 kg S per ha. Uptake of nutrients was more with S application except Cu. Soil available N, P and micro nutrient were more, However, exchangeable Na was lower in soil. Soil SOC and available S was also more with applied S, while EC was negatively influenced by S application.

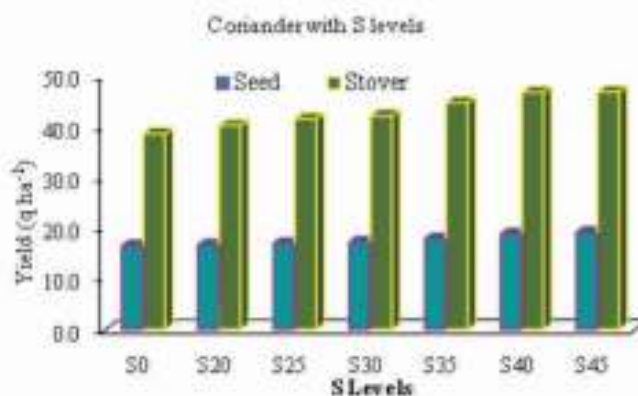


Fig. 16: Yield response of coriander to sulfur

CPd-26: Evaluation of seed spices for edaphic stresses (Coriander, cumin, fennel, fenugreek, anise, nigella and celery)

(O.P. Alshwath, P.N. Dubey, R.K. Yadav, R.L. Meena and B.K. Jha)

Influence of sodic water on dill in Typic Haplustepts

All the growth parameters (plant height, primary and

secondary branches, umbel, umbellate and seeds per umbellate) were increase up to RSC, 10, 12 or 14 milli equivalent (me)/L and reduced beyond the level. Seed and stover yield increased with increase in sodicity of water up to the RSC level of 10 me/L and remain constant up to RSC 12, reduced down thereafter (Fig. 17). Uptake of macro and micronutrients were recorded higher up to 12 or 14 RSC me/L, however availability of N, P and micronutrient marginally decreased and exchangeable Na increased, whereas K did not followed a definite trend. Soil pH increased and SOC decreased with higher RSC, however EC did not follow a definite trend with extended exposure to sodicity.

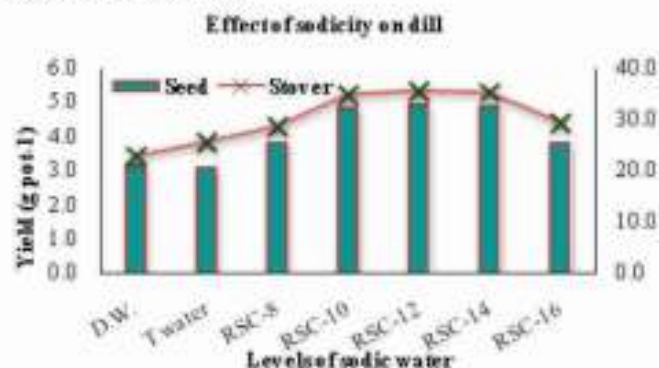


Fig. 17: Yield response of dill with application of sodic water

Influence of soil sodicity on nigella in Typic Haplustepts

All the growth and yield and their parameters (plant height, primary and secondary branches, umbel, umbellate and seeds per umbellate) of nigella were at par up to the soil pH 9.2 in loamy sand soil of Ajmer (Fig. 18). Availability of all the nutrients were either at par or lower with higher pH except K. Exchangeable Na was higher with higher pH ranged from about 850 kg to more than one ton ha⁻¹. SOC and EC were lower with higher sodicity.

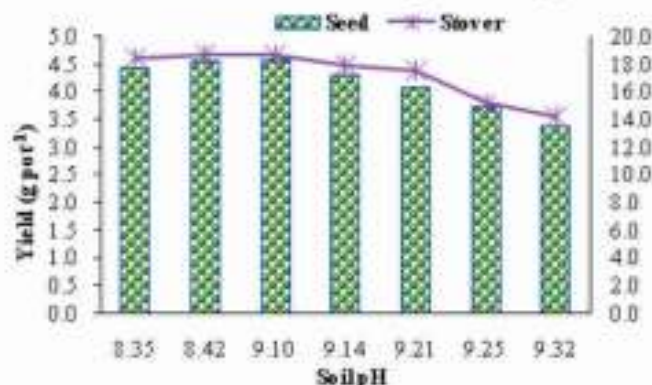


Fig. 18: Yield response of nigella to sodic water

Effect of soil temperature on performance of fennel

Higher temperature levels reduced the germination percentage more in T₁ & T₂ (treatment combination) and delayed the germination for about a day than usual. Both higher and lower temperature reduced the growth parameter yield attributing characters. Current year yield of fennel were highest in T₁ and T₂ as compared to other treatments (Fig. 19). Overall yield this year was lower and much lower T₅ as at the time seed setting temperature shoot up very high. Loos and dilution effect was observed in oil content and its yield with temperature. Oil content was more in late shown fennel and yield was inversely related to the content.

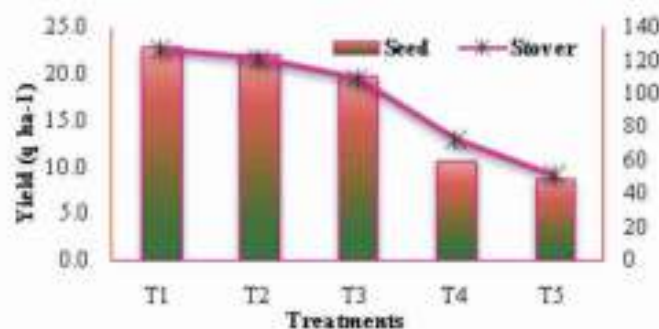


Fig. 19: Yield response of fennel with rise under temperature

Performance of dill and fennel under limed acid soil

Positive effect of liming on growth parameter and yield attributing characters was observed in dill and fennel at Ranchi. Seed and stover yield of fennel was increased with increase in fractions of recommended dose of lime which was about 44.5 % with 100% lime over the control (Fig. 20). Seed yield of dill was more than 1.6 times with 100% use of RDL than control (Fig. 21).

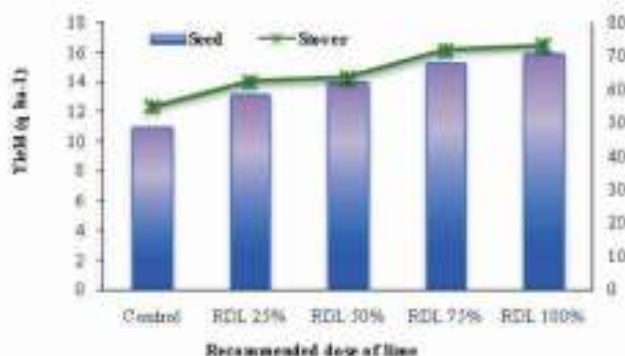


Fig. 20: Yield performance of fennel under limed acid soils

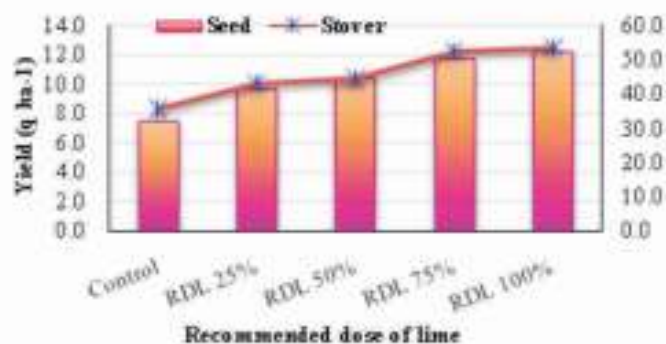


Fig. 21: Yield performance of dill in limed acid soils of Ranchi

CPd/13.6.1: Off season production of coriander and fenugreek for green leaf (2014-17)

(G. Lal, R. Singh, N.K. Meena and S.P. Maheria)

Screening of cultivars for green leaf production of coriander and fenugreek and standardization of POP of the best performing cultivars under off (summer) season was undertaken. Five coriander cultivars (JSS-R-50, JBT-38/94, Ajmer Green, IC-771744 and ACr-1) were sown on 14.04.2017 under green shade net (50%) considering ACr-1 as check in RBD with 03 replications at 15 x 05 cm spacing keeping 4m x 2m (8 m²) for each treatment.

Performance of coriander in M₁ lines

Ajmer Green Coriander took minimum time for germination initiation (6.67 days), germination completion (10.0 days) with maximum plant height (23.05 cm) at harvest. Flower initiation was very late (56.67 DAS) in Ajmer Green cultivar in the summer season, which is a most desirable character for leafy type cultivars, however JBT-38/94 flowered in only 39.33 DAS and ACr-1 (check) flowered only in 45.67 DAS. Similarly, 50% flowering was also recorded after 67.67 DAS in Ajmer Green as compared to JBT-38/94 (49.33 DAS) and ACr-1 (54.00 DAS). With respect to leafy characters it is inferred that Ajmer Green cultivar exhibited longest first leaf (19.65 cm), second leaf (18.63 cm) with maximum number of basal leaves per plant (12.63), longest basal leaf (19.69 cm) and number of leaf lets per plant (7.93). The crop was harvested at 49.33 DAS (JBT-38/94) and at 54.00 DAS (Check- ACr-1), however Ajmer Green Coriander was harvested after 63 DAS due late in 50% flowering. It is

further stated that Ajmer Green Coriander exhibited maximum yield (2706.67 kg/ha) of green leaves as compared to check (ACr-1 (1994.07 kg/ha).

Under crop different nitrogen levels experiments the cultivar AGCr-1 was sown at five levels (30 kg/ha, 40 kg/ha, 50 kg/ha, 60 kg/ha and 70 kg/ha). The performance of crop with respect to almost all the characters was recorded best in N4 (60 kg/ha) treatment combination with longest first leaf (19.05 cm), second leaf (16.26 cm), maximum number of basal leaves per plant (12.33), longest basal leaf (20.43 cm), number of leaf lets per plant (8.33) and yield (1863.33 kg/ha.) of green leaf among all the treatments.

Under crop geometry and fertilizer experiments the cultivar AGCr-1 was sown at three planting geometry (25cm x 10 cm, 25cm x 7.5 cm and 25cm x 5.0 cm) with three fertilizer doses (40:25:20, 50:35:25 and 60:45:30 kg NPK/ha). The performance of crop with respect to almost all the characters was recorded best in G3F3 (25cm x 5.0 cm spacing and 60:45:30 kg NPK/ha) treatment combination with maximum yield (2652.36 kg/ha kg/ha) of green leaf.

Under crop geometry and fertilizer experiments, the cultivar AGCr-1 was sown in winter season at three planting geometry (25cm x 10 cm, 25cm x 7.5cm and 25cm x 5.0cm) with three fertilizer doses (40:25:20, 50:35:25 and 60:45:30 kg NPK/ha). The performance of crop with respect to almost all the characters was recorded best in G2F3 (25cm x 7.5 cm spacing and 60:45:30 kg NPK/ha) treatment combination with highest seed yield (1208.75 kg/ha).

Under date of sowing experiment, cultivar AGCr-1 was sown at five different dates (13 October, 2016, 23 October, 2016, 02 November, 2016, 12 November, 2016 and 22 November, 2016 to study the influence of dates of sowing on the performance of the seed production of the cultivar. Results revealed that first three dates are suitable for winter season seed production of this cultivar. Best yield (2287.50 kg/ha) was recorded in the crop sown on 23 October, 2016 as compared to lowest 310.42 kg/ha seed in the crop sown on 22 November, 2016.



Response of coriander (AGCr-1) to three different irrigation method (Micro Sprinkler, Drip and Surface irrigation) with four water treatments based on IW/CPE ratio [ET/IW Ratio : 0.4, 0.6, 0.8 and 1.0]. The performance of crop with respect to almost all the characters was recorded best in M2W3 (Drip irrigation with ET/IW Ratio: 0.8) treatment combination with highest seed yield (1542.08 kg/ha) as compared to lowest seed yield 1023.13 kg/ha in the M1W1 (Surface irrigation with ET/IW Ratio: 0.4).

Performance of fenugreek lines

In AFG-5, the seed germination was initiated after 2.67 DAS and completed after 4.0 DAS as compared to 3.0 and 5.0 respectively in Hisar Sonali (Check). Maximum plant height (23.54 cm) at harvest was exhibited by AFG-5 as compared to minimum (14.45 cm) in AFG-4. AFG-5 is a late flowering line and bolting was initiated at 37.00 DAS and 50% flowering was recorded at 47.33 DAS as compared to earliest bolting initiation (29.33 DAS) and 50% flowering (35.00 DAS) in AFG-3. Check Hisar Sonali exhibited bolting initiation at 35.00 DAS and 50% flowering at 42.67 DAS. Highest green leaf yield (2303.70 kg/ha) with maximum number of branches (5.23/plant) and minimum number of flowers (3.70/plant) were recorded in AFG-5 cultivar.

The crop geometry and fertilizer application experiment revealed that the performance of crop was best if sown at 15.0 x 5 cm crop geometry with 30:20:20 kg/ha NPK application. Highest green leaf yield (909.19 kg/ha) was recorded in this treatment.

Under date of sowing experiment, cultivar AFG-5 was sown at five different dates (13 October, 2016, 23 October, 2016, 02 November, 2016, 12 November, 2016 and 22 November, 2016 to study the influence of dates of sowing on the performance of the seed production of the cultivar. Results revealed that first three dates are suitable for winter season seed production of this cultivar. Best seed yield (2565.00 kg/ha) was recorded in the crop sown on 23 October, 2016 as compared to lowest 1535.83 kg/ha seed yield in the crop sown on 22 November, 2016.

Response of fenugreek (AFG-5) to three different irrigation methods (Micro Sprinkler, Drip and Surface

irrigation) with four water regimes based on IW/CPE ratio (ET/IW Ratio : 0.4, 0.6, 0.8 and 1.0). The performance of crop with respect to almost all the characters was recorded best in M2W2 (Drip irrigation with ET/IW Ratio: 0.6) treatment combination with highest seed yield (2375.21 kg/ha) as compared to lowest seed yield 1946.88 kg/ha in the M3W1 (Surface irrigation with ET/IW Ratio: 0.4).

CPd/14.3.1: Micronutrient management in cumin (*Cuminum cyminum* L.) and fennel (*Foeniculum vulgare* Mill.) for higher yield and quality (2014-17)

(Harisha, C. B., R. Singh and O.P. Aishwath)

Field experiment was conducted on effect of micro nutrients in combination with different levels of recommended dose of fertilizers (RFD=90:50:20 NPK) at different levels on growth and yield of fennel (Table 3.25). The experiment consists of three micro nutrient doses such combination of iron, manganese, zinc, copper and boron and three major nutrients levels. The results revealed significant differences in growth, yield and yield attributing characters of fennel. Application of major nutrients at 150% RDF with soil application of micro nutrients like iron 10.0 kg, manganese 10.0 kg, copper 5.0 kg, zinc 5.0 kg and boron 2.50 kg per hectare. Similar trend was observed in case of number of primary branches (6.9) per plant, secondary branches (14.1) per plant, total dry matter accumulation per hectare (12.3 t/ha), number of umbels per plant (24.7), number of umbellates per umbel (31.3), seed yield per plant (30.9 g) and per hectare (2063.6 kg/ha) soil application of major nutrients 150% RDF (M₃) was recorded highest values. In case of micronutrients application N₂ (iron 10.0 kg, manganese 10.0 kg, copper 5.0 kg, zinc 5.0 kg and boron 2.50 kg per hectare) recorded higher growth and yield parameters. In case of major nutrient uptake by fennel crop and content in fennel plant sample was found significant with respect to nitrogen and phosphorus. In case of micronutrient uptake by fennel crop was found significant with respect to iron, manganese, copper and zinc. Therefore, addition of 50% higher major nutrients to the recommended dose of fertilizers along with micronutrients is crucial for better fennel growth and productivity in deficit soils. It will also



Table 3.25: Effect of major and micro nutrients on yield attributing characters, seed yield, and quality of fennel

| | Essen. Oil (%) | Seed yield (kg/ha) | Biomass yield (t/ha) | Harvest Index | Fe uptake (g/ha) | Mn uptake (g/ha) | Zn uptake (g/ha) | Cu uptake (g/ha) |
|-----------------------------------|-------------------|-----------------------|----------------------------|------------------|---------------------|------------------------|------------------------|------------------------|
| Major nutrients | | | | | | | | |
| M ₀ -No Major Nutrient | 1.19 | 1467.5 | 8.4 | 17.9 | 5040.5 | 1360.2 | 142.7 | 109.0 |
| M ₁ -Major 50% RDF | 1.09 | 1622.1 | 9.6 | 17.9 | 5893.5 | 1568.0 | 179.4 | 140.3 |
| M ₂ - Major 100% RDF | 1.31 | 2028.6 | 11.4 | 18.8 | 7182.6 | 1927.5 | 179.0 | 153.8 |
| M ₃ - Major 150% RDF | 1.18 | 2063.6 | 12.3 | 16.9 | 7782.2 | 1843.5 | 166.5 | 177.0 |
| F test | NS | * | * | NS | * | * | NS | * |
| S. Em ± | 0.06 | 128.5 | 0.76 | 1.59 | 494.9 | 137.8 | 23.21 | 14.6 |
| CD at 5% | - | 372.9 | 2.22 | - | 1436.4 | 400.1 | - | 42.5 |
| Micro nutrients | | | | | | | | |
| N ₀ - No micro | 1.13 | 1551.7 | 8.4 | 18.6 | 4409.4 | 1291.7 | 90.7 | 122.4 |
| N ₁ - Micro-1 | 1.21 | 1652.1 | 10.4 | 17.3 | 6433.0 | 1742.6 | 155.3 | 139.1 |
| N ₂ -Micro II | 1.22 | 1992.0 | 11.6 | 18.0 | 7816.7 | 1902.0 | 201.0 | 161.6 |
| N ₃ - Micro III | 1.22 | 1986.1 | 11.4 | 17.7 | 7239.7 | 1763.0 | 220.6 | 156.9 |
| F test | NS | * | * | NS | * | * | * | NS |
| S. Em ± | 0.06 | 128.5 | 0.76 | 1.59 | 494.9 | 137.8 | 23.21 | 14.6 |
| CD at 5% | - | 372.9 | 2.22 | - | 1436.4 | 400.1 | 67.3 | - |
| Interaction effect | | | | | | | | |
| M x N (f test) | NS | NS | NS | NS | NS | NS | NS | NS |



(A). Fennel crop without any nutrients (B). without major nutrients (C). with ideal major and micro nutrients

CPd/15.3.1: Isolation and characterization of endophytic microorganisms from cumin and fenugreek (2015-2020)

(B.K. Mishra and Y.K. Sharma)

92 exo-rhizospheric and 25 endo-rhizospheric microbes have been isolated from different samples of cumin plant collected from NRCSS field. Rhizosphere microbial population variability in cumin selected cumin germplasms was recorded but there was not much difference (Table 3.26). Biochemical characterization of an isolated exo-rhizobacteria (92 numbers) and endo-

rhizobacteria of cumin roots was done for different carbon sources utilization. 100 % bacterial isolates were able to use glucose and arabinose, 86 % isolates were able to utilize sorbitol while only 36 % utilized adonitol and 15 % utilized lactose. Similarly, in the screening of cumin rhizobacterial isolates for nitrogen sources, it was observed that 100% bacterial isolates were positive for lysine and ornithine utilization and 45 % were positive for nitrate reduction test. To assess the effect of different promising cumin genotypes on rhizosphere microflora,



total culturable mesophilic bacterial population and mesophilic culturable fungal population were estimated in the soil samples from cumin genotypes grown at NRCSS farm. The maximum bacterial population (72×10^6 cfu/g) was recorded in GC-4 followed by GP-19 (63×10^6 cfu/g) while minimum among tested germplasms was recorded in SPS-249/13 (36×10^6 cfu/g). The maximum fungal count was recorded in cumin germplasm ACWMR-16-3 (31.2×10^5 cfu/g) and minimum was recorded in SPS-249/13 (12×10^5 cfu/g).

To evaluate the effect of previously isolated native *Bacillus* sp. strains on cumin growth and yield, a field experiment was conducted at NRCSS farm during 2016-17. The experiment was consist of seven treatments with three replicates in RBD design on a plot size 3x2 m for each having line to line spacing of 30 cm and plant to plant spacing of 10-12 cm. The maximum number of secondary branches (30 per plant) was recorded in T_2 -*Bacillus megaterium* which was at par with T_1 -*Bacillus megaterium*

+ *Bacillus* sp. and minimum number of secondary branches (23.33 per plant) was recorded with T_1 -control. The highest dry weight (5.77 g per plant) was observed with T_2 -*B. megaterium* followed by T_2 -*B. subtilis* + *B. megaterium* + *B. sp.* (4.80 P/ plant). However, there was statistically non-significant difference with respect to number of primary branches per plant and number of seeds per umbellate. Minimum plant mortality (48.12 %) was recorded in T_2 -*B. subtilis* + *B. megaterium* + *B. sp.* which was at par with T_1 -*B. Sp.* (50.22 %) and maximum plant mortality was recorded in control (85.51 %).

Table 3.26: Effect of cumin germplasm on rhizosphere microbes

| Cumin germplasm | Bacterial count ($\times 10^5$ cfu/g) | Fungal count ($\times 10^5$ cfu/g) | Endorhizo bacteria |
|-----------------|--|-------------------------------------|--------------------|
| SPS-249/13 | 36.0 | 12.0 | nil |
| GP-39 | 45.0 | 25.0 | 02 |
| GP-19 | 63.0 | 27.0 | nil |
| GC-4 | 72.0 | 23.0 | 01 |
| AC. WMR-16-3 | 57.2 | 31.2 | nil |

Table 3.27: Cumin plant biometric data at 30 DAS

| Treatment | Germination at 10 DAS (%) | Germination at 15 DAS (%) | Fresh weight / plant (g) | Root length (cm) | Shoot length (cm) |
|------------------------------------|---------------------------|---------------------------|--------------------------|------------------|-------------------|
| T_1 - <i>Bacillus subtilis</i> | 41.66 | 81.66 | 0.032 | 5.76 | 4.14 |
| T_2 - <i>Bacillus megaterium</i> | 36.66 | 81.66 | 0.029 | 5.28 | 3.98 |
| T_3 - <i>Bacillus sp.</i> | 38.33 | 75.00 | 0.026 | 4.92 | 4.04 |
| T_4 -T1+T2 | 31.66 | 85.00 | 0.023 | 4.60 | 4.34 |
| T_5 -T2+T3 | 37.50 | 85.00 | 0.033 | 2.84 | 4.98 |
| T_6 -T1+T2+T3 | 25.00 | 77.5 | 0.060 | 3.54 | 4.74 |
| T_7 -control | 22.80 | 75.00 | 0.024 | 4.96 | 4.62 |
| CD | NS | NS | NS | 0.57 | NS |

Table 3.28: Cumin plant morphological data at maturity

| Treatment | Primary branches /plant | Secondary branches /plant | Dry wt. /plant (g) | No. of umbels /plant | No. of seed / umbellate |
|------------------------------------|-------------------------|---------------------------|--------------------|----------------------|-------------------------|
| T_1 - <i>Bacillus subtilis</i> | 9.33 | 26.33 | 4.18 | 23.4 | 5.65 |
| T_2 - <i>Bacillus megaterium</i> | 8.66 | 30.0 | 5.77 | 21.4 | 5.825 |
| T_3 - <i>Bacillus sp.</i> | 10.33 | 25.33 | 3.24 | 24.5 | 6 |
| T_4 -T1+T2 | 8.66 | 24.0 | 4.05 | 26.8 | 6.35 |
| T_5 -T2+T3 | 9.33 | 28.0 | 3.71 | 20.4 | 5.625 |
| T_6 -T1+T2+T3 | 10.66 | 27.33 | 4.80 | 27.00 | 5.28 |
| T_7 -control | 9.0 | 23.33 | 3.66 | 25.00 | 5.7 |
| CD | NS | 2.30 | 1.26 | NS | NS |



Table 3.29: Effect of microbes on fenugreek seedling vigour index

| Treatment | % germination 15 days | Seedling length (mm) 15 DAS | Vigour index | Seedling Dry weight (g) |
|---|--------------------------|--------------------------------|-----------------|----------------------------|
| T ₁ - <i>Rhizobium</i> + <i>B. subtilis</i> | 95.0 | 80.6 | 7657 | 0.107 |
| T ₂ - <i>Rhizobium</i> + <i>B. megaterium</i> | 95.0 | 93.0 | 8835 | 0.109 |
| T ₃ - <i>Rhizobium</i> + <i>Bacillus sp.</i> + <i>B. subtilis</i> | 90.0 | 65.0 | 5850 | 0.082 |
| T ₄ - <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i> | 100 | 72.2 | 7220 | 0.087 |
| T ₅ - <i>Bacillus. sp.</i> + <i>B. megaterium</i> | 100 | 65.0 | 6500 | 0.087 |
| T ₆ - <i>Bacillus sp.</i> | 80.0 | 81.0 | 6480 | 0.096 |
| T ₇ - <i>Bacillus subtilis</i> | 75.0 | 97.4 | 7305 | 0.115 |
| T ₈ - <i>B. megaterium</i> | 74.0 | 72.0 | 7120 | 0.082 |
| T ₉ - <i>Rhizobium</i> | 95.0 | 80.6 | 7657 | 0.127 |
| T ₁₀ -control | 85.0 | 69.8 | 5933 | 0.093 |

Table 3.30: Effect of microbes on plant growth and yield attributes at maturity of fenugreek plants

| Treatment | No. of primary branches /plant | No. of pods/plant | No. seeds /pod | Seed yield (g/ sq. m) |
|---|-----------------------------------|----------------------|-------------------|--------------------------|
| T ₁ - <i>Rhizobium</i> + <i>B. subtilis</i> | 4.96 | 51.77 | 16.63 | 212.48 |
| T ₂ - <i>Rhizobium</i> + <i>B. megaterium</i> | 4.96 | 38.77 | 16.10 | 245.40 |
| T ₃ - <i>Rhizobium</i> + <i>Bacillus sp.</i> + <i>B. subtilis</i> | 4.83 | 38.77 | 17.06 | 234.51 |
| T ₄ - <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i> | 4.30 | 41.33 | 17.63 | 241.72 |
| T ₅ - <i>Bacillus. sp.</i> + <i>B. megaterium</i> | 4.83 | 49.77 | 17.83 | 231.24 |
| T ₆ - <i>Bacillus sp.</i> | 4.86 | 58.99 | 16.73 | 201.14 |
| T ₇ - <i>Bacillus subtilis</i> | 4.96 | 50.99 | 16.86 | 208.53 |
| T ₈ - <i>B. megaterium</i> | 4.76 | 48.20 | 15.00 | 204.50 |
| T ₉ - <i>Rhizobium</i> | 4.76 | 47.77 | 16.96 | 228.48 |
| T ₁₀ -control | 4.45 | 35.16 | 17.45 | 191.72 |
| CD | NS | 8.66 | NS | 17.50 |

In case of fenugreek 135 endophytic microbes were isolated from different plant tissues of fenugreek plant samples collected from NRCSS experimental farm. Maximum endophytic microbes were isolated from root nodules (62) congo red yeast extract mannitol agar media (CRYEMA) followed by root nodules on nutrient agar media (43). No endophytic microbes were isolated from stem tissues of fenugreek plants.

Field experiment was conducted for evaluation of microbial consortia for growth and yield of fenugreek. The experiment was consisted of 10 treatments with 3 replications based on 1 native *Rhizobium sp.* isolates and 3 *Bacillus sp.* strains in different combinations. The

highest seedling vigour index (8835) was recorded with T₂-*Rhizobium sp.*+ *B. megaterium* followed by T₇- *Rhizobium sp.* + *B. megaterium* and T₉- *Rhizobium sp.* (7657). The maximum root nodules per plant (31.33) was recorded with T₄- *Rhizobium sp.*+ *B. subtilis* +*B. megaterium* whereas minimum root nodules per plant (22.3) was recorded with T₅- *B. subtilis* +*B. megaterium*. The maximum fenugreek seed yield was recorded with T₂-*Rhizobium sp.*+*B. megaterium* (245.4 g per sq. m) which was at par with T₄- *Rhizobium sp.*+ *B. subtilis* +*B. megaterium* (241.72 g per sq. m) and minimum seed yield was recorded with T₁₀-control (191.72 g per sq. m).



CPd/15.3.2: Effect of drip irrigation regimes and fertigation levels on growth, yield and quality of coriander and fenugreek (2014-17)

(H. Asangi, R. Singh and Harisha C.B.)

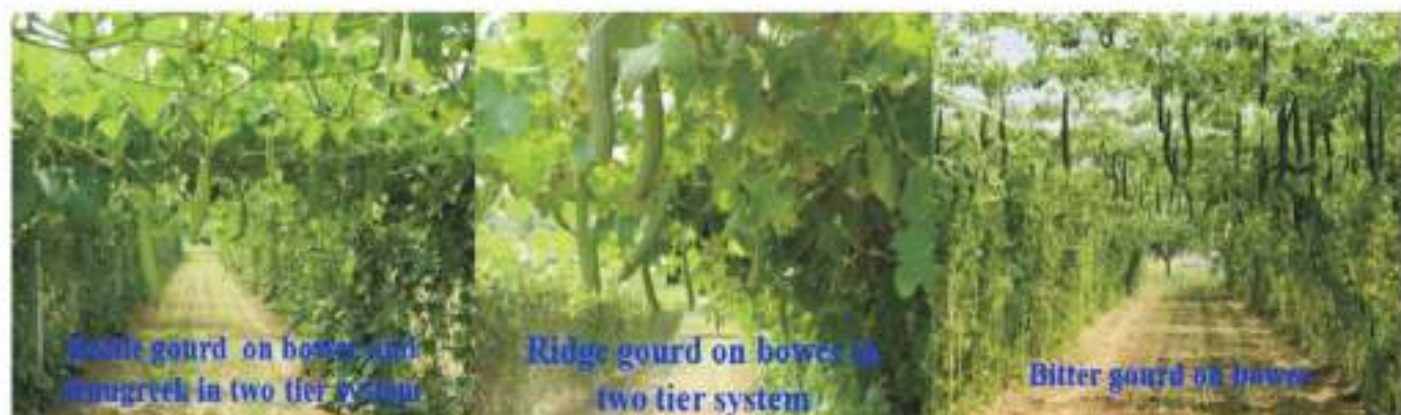
The experiment conducted on three drip irrigation levels (25%, 50 % and 75% potential evaporation (PE) and four fertigation levels (25%, 50% 75% and 100% RDF) to find out the effect on growth, seed yield and 75% PE and 50% PE were at par each other. In case of fenugreek drip irrigation at 50 per cent cumulative pan evaporation (CPE) (I2) was recorded at per results with drip irrigation 75 per cent cumulative pan evaporation. I2 recorded plant height of 75.6 cm, biomass accumulation (7,507.45 kg/ha), number of pods per plant (55.68), number of seeds per pod (7.88), pod length (4.9 cm), test weight of seeds (16.16 g) and seed yield (1,793.8 kg/ha). All these parameters were at par with drip irrigation at 75 per cent CPE. Similarly, fertigation at 100 per cent recommended dose of fertilizers (RDF) (F4) was recorded highest plant height and it is at par with fertigation 75 per cent RDF. However there were no significant differences were found in case of biomass production, number of pods per plant and seed yield. But Fertigation at 100 per cent recommended dose of fertilizers resulted in higher seed protein (30.67 %) content. Water use efficiency was found optimum in drip irrigation at 50 per cent CPE (I2) which is at par with drip irrigation at 25 per cent CPE (I1). In case of coriander crop 50-75% PE recorded higher seed yield and both are at par. In case of fertigation levels 75% RDF recorded highest seed yield. Hence it can be concluded

that 75% PE and 75% RDF are optimum dose of drip irrigation and fertigation levels in coriander.

CPd/16.3.2: Standardization of two tier system of production technology in seed spices with vine vegetables using bower (2016-19)

(R. Singh, G. Lal, K. Kant, R. D. Meena and S.P. Maheria)

Fenugreek and coriander were raised during the rabi season in the cropping system gave 2545 and 1255 kg/ha seed yield. Whereas the vine vegetable seed were sown on the raised bed during Mach, 2017 as relay crop in the cropping system. The vine vegetables were trailed on the bower using crop support nets and GI wires. Mean while the rabi season crops were matured in late March and early April, the canopy of vine vegetables developed and gave natural shading on the ground. The vine vegetables namely bottle gourd taken 7-8 days in germination, ridge guard germinated 8-10 days whereas bitter gourd taken 12-15 days. after fully canopy coverage by the vine vegetables, leafy vegetables namely fenugreek, coriander, spinach and amaranths were sown in soil below the canopy of the vine vegetables in two tier system. All crops were raised with the recommended agronomic practices for nutrient, water and pest management. The yield of ridge gourd, bottle gourd and bitter gourd were recorded 11553, 24098 and 4134 kg/ha as tier 2 crop. Whereas the yield of leafy vegetables namely fenugreek, coriander, spinach and amaranths were recorded 3879, 4590, 2872 and 5786 kg/ha which were raised in soil as tier 1 crop in the bower system. (Fig. 22)



Bottle gourd on bower and fenugreek in two tier system

Ridge gourd on bower in two tier system

Bitter gourd on bower



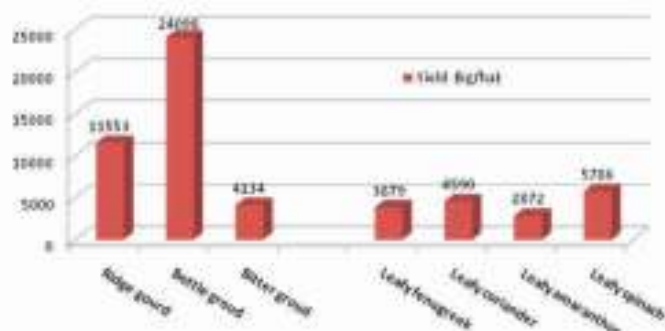


Fig 22: Yield (kg/ha) of vine vegetables (tier 2 crops) and leafy vegetables (tier 1 crops) raised in bower system



Canopy development of vine vegetables trailed on bower and leafy vegetable in flat beds below the bower



Vine vegetables (tier 2 crops) raised in bower system

CPd/16.3.3: Seed spice based inter cropping with remunerative fruit crops (2016-19)

(S.S. Meena, G. Lal, R.S. Mehta, O.P. Aishwath, N.K. Meena and R.D. Meena)

Intercropping of seed spices with guava

The highest seed yield of seed spices was obtained in open space followed by guava association. This might be due to no competition of seed spices with fruit trees in open space. Among the seed spices, the fenugreek resulted in the highest seed yield (1763.86 kg/ha.) followed by ajwain (Table 3.31 & 3.32) were recorded.

Table 3.31: Effect of guava based intercropping on growth parameters of intercropped crops

| Treatments | Days to germination | Plant height (cm) | No. of primary branch/plant | No. of secondary branch/plant |
|-------------------|---------------------|-------------------|-----------------------------|-------------------------------|
| Fenugreek + Guava | 4.00 | 74.07 | 5.27 | 7.33 |
| Coriander + Guava | 12.00 | 96.20 | 12.93 | 43.73 |
| Nigella + Guava | 18.00 | 65.67 | 10.27 | 25.27 |
| Anise + Guava | 12.00 | 62.93 | 7.20 | 16.07 |
| Ajwain + Guava | 13.33 | 115.07 | 15.20 | 182.67 |
| Sole Fenugreek | 4.00 | 73.27 | 5.53 | 7.27 |
| Sole Coriander | 13.00 | 101.47 | 12.53 | 37.53 |
| Sole Nigella | 18.33 | 48.00 | 8.00 | 19.47 |
| Sole Anise | 12.00 | 61.67 | 6.53 | 16.07 |
| Sole Ajwain | 14.00 | 107.93 | 13.60 | 203.47 |
| SEm ± | 0.39 | 2.91 | 0.62 | 4.07 |
| CD (P=0.05) | 1.15 | 8.65 | 1.84 | 12.08 |
| CV% | 5.55 | 6.26 | 11.04 | 12.61 |



Table 3.32: Effect of guava based intercropping on growth parameters of intercropped crops

| Treatments | Pod or umbel /plant | Umbellate /umbel | Seeds /Pod or umbellate | Seed Yield (kg/ha) |
|-------------------|---------------------|------------------|-------------------------|--------------------|
| Fenugreek + Guava | 28.93 | 0.00 | 17.87 | 959.72 |
| Coriander + Guava | 50.60 | 42.13 | 48.27 | 694.03 |
| Nigella + Guava | 36.13 | 0.00 | 68.67 | 332.64 |
| Anise + Guava | 24.73 | 15.67 | 18.00 | 114.58 |
| Ajwain + Guava | 229.60 | 18.20 | 21.87 | 772.22 |
| Sole Fenugreek | 26.80 | 0.00 | 18.67 | 1763.89 |
| Sole Coriander | 45.60 | 40.53 | 45.20 | 799.31 |
| Sole Nigella | 22.20 | 0.00 | 70.07 | 538.89 |
| Sole Anise | 25.07 | 14.73 | 16.67 | 126.25 |
| Sole Ajwain | 247.73 | 16.27 | 21.40 | 1225.69 |
| SEm ± | 5.06 | 0.86 | 1.25 | 29.10 |
| CD (P=0.05) | 15.04 | 2.57 | 3.72 | 86.45 |
| CV% | 11.89 | 10.14 | 6.26 | 6.88 |

Intercropping of seed spices with pomegranate

The highest seed yield of seed spices was obtained in open space followed by with pomegranate association. This might be due to no competition of seed spices with

fruit trees in open space. Among the seed spices the fenugreek also resulted significantly highest seed yield over other seed spices followed by Ajwain (Table 3.33 & 3.34).

Table 3.33: Effect of Pomegranate based intercropping on growth parameters of intercropped crops

| Treatments | Days to germination | Plant height (cm) | No. of primary branch/plant | No. of secondary branch/plant |
|-------------------------|---------------------|-------------------|-----------------------------|-------------------------------|
| Fenugreek + Pomegranate | 3.67 | 72.20 | 5.60 | 7.33 |
| Coriander + Pomegranate | 12.00 | 103.67 | 11.53 | 38.20 |
| Nigella + Pomegranate | 17.67 | 62.93 | 9.07 | 21.73 |
| Anise + Pomegranate | 12.00 | 68.33 | 6.80 | 16.33 |
| Ajwain + Pomegranate | 13.00 | 112.27 | 14.13 | 171.87 |
| Sole Fenugreek | 4.00 | 73.27 | 5.53 | 7.27 |
| Sole Coriander | 13.00 | 101.47 | 12.53 | 37.53 |
| Sole Nigella | 18.33 | 48.00 | 8.00 | 19.47 |
| Sole Anise | 12.00 | 61.67 | 6.53 | 16.07 |
| Sole Ajwain | 14.00 | 107.93 | 13.60 | 203.47 |
| SEm ± | 0.42 | 2.94 | 0.38 | 3.96 |
| CD (P=0.05) | 1.25 | 8.73 | 1.12 | 11.77 |
| CV% | 6.08 | 6.27 | 7.00 | 12.72 |



Table 3.34: Effect of pomegranate based intercropping on yield attributes of intercropped crops

| Treatments | Pod or umbel /plant | Umbellate /umbel | Seeds /Pod or umbellate | Seed Yield (kg/ha) |
|-------------------------|------------------------|---------------------|-------------------------------|-----------------------|
| Fenugreek + Pomegranate | 25.20 | 0.00 | 18.53 | 1303.33 |
| Coriander + Pomegranate | 50.40 | 40.80 | 49.93 | 965.67 |
| Nigella + Pomegranate | 23.20 | 0.00 | 75.20 | 935.00 |
| Anise + Pomegranate | 24.27 | 15.53 | 17.20 | 249.50 |
| Ajwain + Pomegranate | 230.07 | 14.80 | 21.67 | 853.33 |
| Sole Fenugreek | 26.80 | 0.00 | 18.67 | 1760.00 |
| Sole Coriander | 45.60 | 40.53 | 45.20 | 800.31 |
| Sole Nigella | 22.20 | 0.00 | 70.07 | 538.00 |
| Sole Anise | 25.07 | 14.73 | 16.67 | 130.00 |
| Sole Ajwain | 247.73 | 16.27 | 21.40 | 1250.00 |
| SEm ± | 5.04 | 0.69 | 1.39 | 78.35 |
| CD (P=0.05) | 14.98 | 2.04 | 4.14 | 232.80 |
| CV% | 12.12 | 8.33 | 6.80 | 7.72 |

Project 4: Development and refinement of efficient crop protection technologies for production of safe seed spices.

CPT-1 Survey and surveillance of existing and emerging diseases of seed spices

(R.D. Meena, Y.K. Sharma, and M.K. Vishal)

Various seed spices growing areas were surveyed including Ajmer, Jhalawad, Nagaur, Jodhpur, Jaisalmer, Barmer, Jalore, Kota, Baran, Sawal Madhopur and Tonk. During the survey various seed spice diseases were observed, data were taken and disease intensity was calculated separately crop wise for all the diseases. This year low intensity of Ramularia blight disease (0 -1.6%) was recorded and the nature of disease was sporadic as previously it appeared in medium to severe form. Stem gall disease was also seen in lower intensity (2.5%) in Rajasthan including Kota, Baran, Jhalawad, Anta and some adjacent area of Madhya Pradesh having high relative humidity during *Rabi* (Table 3.35).



Various diseases appeared in seed spices during 2016-17 (fenugreek blight, gummosis of fennel, nigell blight, and root rot in fennel)



Table 3.35: Intensity of seed spices diseases / disorders reported during survey

| S.No. | Disease | Intensity (%) |
|-------|------------------------------------|---------------|
| 1. | Stem gall of coriander | 0-2.5 |
| 2. | <i>Sclerotium</i> rot of coriander | 0-30 |
| 3. | Yellowing in cumin | 0.5-10.6 |
| 4. | Wilt of cumin | 2.3-11.0 |
| 5. | <i>Alternaria</i> blight of cumin | 0-18.2 |
| 6. | Powdery mildew of cumin | 0-2.0 |
| 7. | Root rot of fenugreek | 0.1-4.6 |
| 8. | Downy mildew of fenugreek | 0-5.2 |
| 9. | <i>Ramularia</i> blight | 0-1.6 |

Major seed spices diseases were linked with the environmental conditions (factors of disease development) prevailed during the disease development occurred were included temperature ($^{\circ}\text{C}$) relative humidity (RH %) and rainfall (mm). Certain diseases were responded well towards these environmental factors and disease initiation was positively affected by these factors alone or cumulatively in manner (Table 3.36).

During survey from different seed spices growing areas two cumin *Alternaria* blight isolates were collected and maintained. *Sclerotium* rot disease is one of the most important disease of coriander in Rajasthan and its intensity has been increased (0-30%) since few years.

Table 3.36: Interrelationship between environmental conditions and disease initiation

| Std. Week No | Calendar Time | Environmental Factors | | | Disease Severity (%) | | | |
|--------------|--------------------|------------------------------------|--------|----------------|----------------------|--------------------------|------------------|------------------------|
| | | Temperature ($^{\circ}\text{C}$) | RH (%) | Rain fall (mm) | Cumin Blight | Coriander Powdery mildew | Fenugreek Blight | Fenugreek Dowry mildew |
| 1 | Jan 2-8, 2017 | 15.7 | 77.1 | 0.0 | 0.2 | 0 | 0 | 0 |
| 2 | Jan 9-15, 2017 | 11.25 | 75.25 | 0.0 | 1.0 | 0 | 0 | 2 |
| 3 | Jan 16-22, 2017 | 13.65 | 68.1 | 0.0 | 2.5 | 0 | 0 | 2.6 |
| 4 | Jan 23-29, 2017 | 17.15 | 79.15 | 24.3 | 5.1 | 0 | 0.2 | 3.7 |
| 5 | Jan 30-Feb 5, 2017 | 16.85 | 81.65 | 0.0 | 12.6 | 0 | 1.3 | 6.5 |
| 6 | Feb 6-12, 2017 | 14 | 73.3 | 0.0 | 25.9 | 0 | 2.1 | 7.4 |
| 7 | Feb 13-19, 2017 | 18.75 | 69 | 0.0 | 34.5 | 2 | 2.6 | 9.7 |
| 8 | Feb 20-26, 2017 | 17.6 | 71.4 | 0.0 | 38.2 | 3 | 3.2 | 10.2 |
| 9 | Feb 27-Mar 5, 2017 | 20.3 | 67.1 | 0.0 | 45.8 | 3.2 | 3.8 | 11.3 |
| 10 | Mar 6-12, 2017 | 18.75 | 72.45 | 0.0 | 50.2 | 3.8 | 4.0 | 12.9 |
| 11 | Mar 13-19, 2017 | 21.45 | 64.9 | 0.0 | 58.3 | 4.1 | 5.7 | 13.7 |
| 12 | Mar 20-26, 2017 | 26.35 | 63.7 | 0.0 | 63.2 | 4.6 | 6.3 | 15.3 |



Coriander crop in Kota



Sclerotium rot on coriander in Bundi



Cumin crop in Jaisalmer



Fenugreek in Kota

Survey of different seed spice crops at various location of Rajasthan



Table 3.37: The areas surveyed for seed spices diseases and problems *

| S. No. | Area/ region | Seed spice crop | Major disease / problem | Intensity (%) |
|-------------------------|----------------|-----------------|-------------------------|---------------|
| 1 | Nagaur | Fenugreek | Root rot | 2.0 - 3.0 |
| | | | Cumin | Blight |
| | | Fennel | Wilt | 3.0 - 9.2 |
| | | | Powdery mildew | 0 - 2 |
| | | | Reddening | 4 - 6.0 |
| | | | Yellowing | 1-10.6 |
| | | | <i>Ramularia</i> blight | 0 - 0.5 |
| 2 | Osian, Jodhpur | Fenugreek | Root rot | 0 - 0.1 |
| | | Cumin | Blight | 0 |
| | | Fennel | Wilt | 1- 8.0 |
| | | | Powdery mildew | 0 - 0.2 |
| | | | Yellowing | 2 - 4.0 |
| | | | Root rot | 1.0-1.5 |
| | | | Cumin | Yellowing |
| 3 | Jodhpur | Fenugreek | Reddening | 1.0 - 3.0 |
| | | | Wilt | 1.0-6.0 |
| | | Cumin | Powdery mildew | 0 - 0.2 |
| | | | Blight | 1.0-8.6 |
| | | | Wilt | 1.0-2.3 |
| | | | Reddening | 0 - 3.0 |
| | | | Yellowing | 0-0.5 |
| 4 | Jaisalmer | Cumin | Wilt | 1.0-2.3 |
| | | Fenugreek | Reddening | 0 - 3.0 |
| | | | Yellowing | 0-0.5 |
| | | Cumin | Root rot | 0-0.2 |
| | | | Yellowing | 3.0-10.0 |
| | | | Blight | 3.0 - 18.2 |
| | | | Wilt | 2.5-11.0 |
| <i>Ramularia</i> blight | 0.0 - 1.6 | | | |
| 5 | Ajmer | Fennel | <i>Ramularia</i> blight | 0.0 - 1.6 |
| | | Fenugreek | Root rot | 1.0 - 4.6 |
| | | Cumin | Yellowing | 0 - 2.0 |
| | | Cumin | Wilt | 0.5 - 3.5 |
| | | | Blight | 0.0 |
| | | | Stem gall | 0 - 1.5 |
| | | | Stem gall | 0 - 2.5 |
| 6 | Badmer | Cumin | Yellowing | 0 - 2.0 |
| | | Wilt | 0.5 - 3.5 | |
| 7 | Baran | Coriander | Stem gall | 0 - 1.5 |
| | | Coriander | Stem gall | 0 - 2.5 |
| 8 | Kota | Coriander | Stem gall | 0 - 2.5 |
| | | Coriander | Stem gall | 0 - 2.5 |
| 9 | Sawai Madhopur | Fennel | <i>Ramularia</i> blight | 0 - 1.2 |
| | | Fenugreek | Powdery mildew | 2.0-12 |
| 10 | Tonk | Fenugreek | Powdery mildew | 1.0-9.0 |



CPT/13.13.1: Management studies on emerging problems in cumin and fenugreek (2013-16)

(Y.K. Sharma, R.D. Meena and B.S. Shekhawat)

Epidemiology and management of leaf blight of fenugreek

Initial symptoms: Initial symptoms recorded as small necrotic spots and concentric rings on the leaves, light yellow zone surrounded the spot. Lesions coalesced to cover large area of the leaf.



Initial leaf spot symptom in fenugreek

Blight symptoms: Leaves showing blighting of the apical portions of leaflets. In later stage blighted leaves curled inward and become brittle. In severe infection whole leaf weathered and died.



Leaf blight symptom in fenugreek

Isolation, purification and identification of pathogen (*Alternaria alternata*):

Infected leaf samples of fenugreek were collected and causal pathogen was isolated on PDA using standard procedure. The isolated fungus was purified using sub-culturing and single spore culture in plain agar medium. The pathogen was identified as *Alternaria alternata* on the basis of morphological characteristics. Identification was further confirmed from ITCC as well as on molecular level. The sequences were submitted to NCBI data bank.



Growth and sporulation of *A. alternata*

Morphological characterization of *A. alternata*:

The pure culture of *A. alternata* was characterized morphologically using slide culture technique. The mycelium was septate, irregularly branched. Mycelium width measured from 1.5 to 4.7 μ . Conidiophores arise singly or in cluster, straight, swollen at the apex measuring 27.3-110 μ long and 3.15-8.4 μ wide. Conidia born in chains and varied in shape, 1-3 longitudinal and 2-6 transverse septa were observed. The measured 20.80-96 μ in length and 8.2-16.5 μ in width. L: W ratio was calculated 3.49 for conidia and 9.82 for conidiophores (Table 3.38).

Table 3.38. Measurement of different morphological structures of *A. alternata* causing leaf blight of fenugreek (Slide culture technique)

| Morphological structures | | Measurement parameters | | |
|--------------------------|--|------------------------|---------------------|-----------|
| | | Length | Width | L:W ratio |
| Mycelium | Septate, irregularly branched | - | 2.80 (1.5-4.7) | - |
| Conidia | Born in chains, varied in shape, 1-3 longitudinal & 2-6 transverse septa | 47.10 (20.80-96) | 13.50 (8.2-16.5) | 3.49 |
| Conidiophores | Arise singly or in cluster, straight, swollen at apex | 42.25 (27.3-110) | 4.30 (3.15-8.4) | 9.82 |

Pathogenicity of *A. alternata* on fenugreek leaves

The isolated fungus *A. alternata* was tested for pathogenicity test on fenugreek leaves using detached leaf technique and in pot culture. The inoculated leaves showed leaf spot symptoms in Petriplates on detached leaves and in pots on fenugreek plants. The pathogen was re-isolated and showed similar morphology of *A. alternata* which proved Koch postulates.



Uninoculated



Inoculated

Fig. 4: Pathogenicity test of *A. alternata* on fenugreek leaves

Studies for the appearance and spread of leaf blight of fenugreek

To study the appearance and spread of fenugreek leaf blight under field condition, four varieties viz., AFG-3, AFG-

5, AFG-7 and AFG-8 were sown in three different dates of sowing i.e. 19th October, 3rd November and 18th November. Disease observation and observation for meteorological factors were recorded at weekly interval. The data revealed that leaf blight was appeared during 14-21 January and spread there after by increasing the disease PDI (Fig. 23). The mean disease PDI in D1 ranged from 39.5 to 41.5 in all four varieties, where as it was 32 to 55 in D2 and 51.3 to 63.7 in D3. Mean maximum temperature during the period was 27.5 C (25.1-31.6 C), minimum temperature was 14.9 C (11.8-21.0 C), morning RH was 89.9% (78.2-96.8%) and minimum RH was 31.5% (26.4-41%).

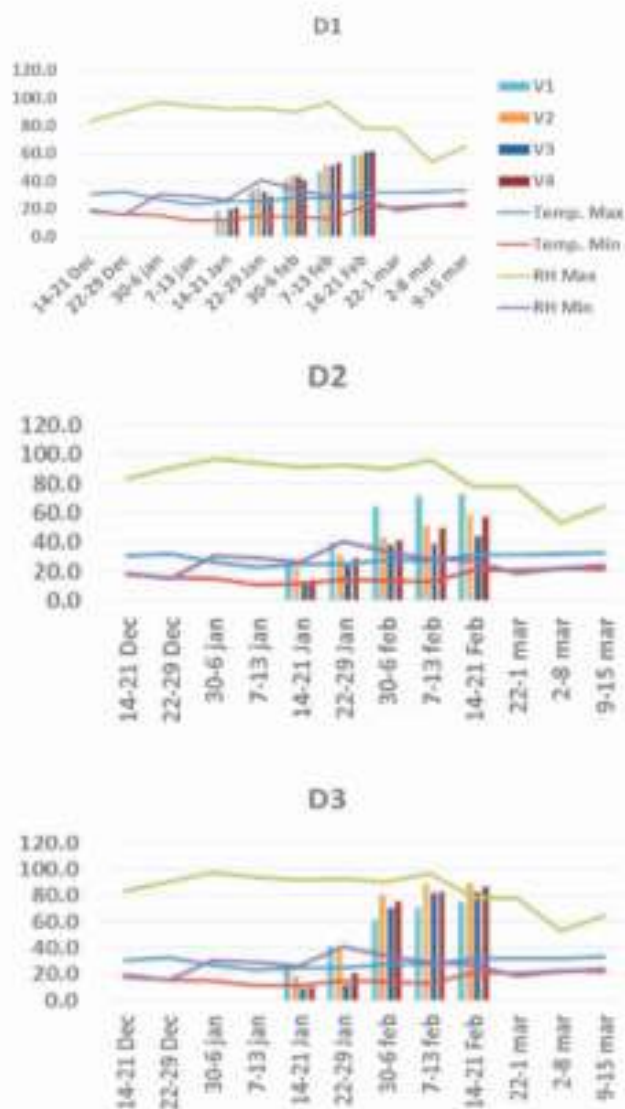


Fig. 23. Appearance and spread of leaf blight of fenugreek



Spray scheduling for the management of fenugreek diseases

Based on the two years results most effective treatments for bioefficacy against different diseases were selected on basis of the time of appearance of different diseases i.e. downy mildew, leaf blight and powdery mildew. Three spray application of different fungicides and organic treatments in schedule applied at 15 days interval and disease PDI was observed. The data revealed that all spray schedule reduced downy mildew, powdery mildew and leaf blight as compared to untreated control. Significant reduction in powdery mildew and leaf blight diseases was observed in the spray schedule of copper oxychloride followed by propiconazole, difenoconazole, chlorothalonil and hexaconazole. Same schedule also recorded higher seed yield as compared to other treatments and untreated control. However, all spray schedules were at par for downy mildew disease PDI.

Screening of fenugreek advanced lines and varieties against diseases of fenugreek:

Nineteen fenugreek lines developed in fenugreek breeding project through mutation and selection for higher seed yield were screened against leaf blight, downy mildew and powdery mildew diseases under natural epiphytotic conditions. The maximum disease PDI of downy mildew (36.3), powdery mildew (46.3) and leaf blight (30.0) with mean PDI of 27.8, 24.4 and 17.3 respectively showed sufficient distribution of disease inoculum in the field (Table 3.39). Data revealed that fenugreek lines A3-23-3, A1-1-2, A2-17-7 and C2-55-4 showed tolerant reaction against leaf blight and C2-55-4, B2-19, A2-17-7, A1-1-2, A3-23-3, AFg-3 and AFg-4 showed tolerant reaction against powdery mildew disease of fenugreek.

Table. 3.39. Screening of fenugreek lines against downy mildew, powdery mildew and leaf blight

| | DM PDI | PM PDI | ALB PDI |
|------|--------|--------|---------|
| Mean | 27.8 | 24.4 | 17.3 |
| Min. | 18.8 | 6.7 | 8.8 |
| Max | 36.3 | 46.3 | 30.0 |

CPT/13.12.1: Sustainable management of insect pests in coriander and cumin (2013-16)

(N.K. Meena, K. Kant and M.A. Khan)

Relative efficacy of botanicals and bio-pesticide against thrips on coriander

An experimental trial was conducted to evaluate the relative efficacy of eleven treatments (including control) viz., extract of *Ker* plant, *Ashwagandha*, *Karanj*, *Datura*, parthenium, castor, custard apple and fruit juice of tumba, garlic, as well as cow urine and untreated check against thrips under open field conditions. The formulations of above listed wild botanical products were prepared manually in the laboratory for field application. The treatments were applied when sufficient populations of thrips built-up on the crop. Observations on thrips population were recorded from five randomly selected and tagged plants per plot. Results showed that all the treatments were found significantly effective for thrips control in comparison to untreated check. Maximum per cent reduction in thrips population (69.04%) was recorded on plants treated with *ker* plant extract @10ml/lit followed by tumba fruit extract @ 10ml/lit (67.00%). The remaining treatments were found middle order of effectiveness against thrips on coriander.

Relative efficacy of botanicals and bio-pesticide against aphid in cumin

An experimental trial was conducted to evaluate the relative efficacy of eleven treatments (including control) viz., *ker* plant extract @ 10ml.lit, *Ashwagandha* leaves extract 10ml/lit, *karanj* leaf extract 10ml/lit, *datura* leaf extract 5ml/lit, *Parthenium* 10ml/lit, castor leaf extract 10ml/lit, custard apple leaf extract 10ml/lit and tumba fruit extract 10ml/lit, garlic extract 5ml/lit and a bio-product: cow urine 10%) and compared with untreated check against aphids on cumin. The formulations of above listed wild botanical products were prepared manually in the laboratory for field application. The treatments were applied when sufficient populations of aphid built-up on the crop. Observations on aphid population were recorded from five randomly selected and tagged plants per plot. Results showed that all the treatments were found significantly superior over control. Maximum per cent reduction in aphid population (67.48%) was



recorded on plant treated with ker plant extract 10ml/lit followed by tumba fruit extract 10ml/lit (66.74%). The remaining treatments were found middle order of effectiveness against the pest.

Evaluation of relative efficacy of botanicals and bio-pesticides against thrips on cumin

An field trial was conducted to evaluate the relative efficacy of eleven treatments (including control) viz., ker plant extract @ 10ml.lit, ashwagandha leaves extract 10ml/lit, karanj leaf extract 10ml/lit, datura leaf extract 5ml/lit, Parthenium 10ml/lit, castor leaf extract 10ml/lit, custard apple leaf extract 10ml/lit and tumba fruit extract 10ml/lit, garlic extract 5ml/lit and a bio-product, cow urine 10% and compared with untreated check against thrips on cumin.

The treatments were applied when sufficient populations of thrips built-up on the crop. Observations on thrips population were recorded from five randomly selected and tagged plants per plot. Results showed that all the treatments were found significantly effective against thrips in comparison to control. Maximum per cent reduction in thrips population (71.00%) was recorded on plants treated with ker plant extract followed by tumba fruit extract (68.77%).

CPT/13.17.1: Impact of pollinators on yield and quality of coriander, fennel, ajwain and dill (2013-2017)

(N.K. Meena and K. Kant)

Impact of insect pollinators on yield and quality of ajwain and dill

A field experiment on Impact of insect pollinators on yield and quality of ajwain was conducted at research farm, ICAR-NRCSS, Tabiji, Ajmer during Rabi season of year 2016-17. Seeds of ajwain (AA-1) and dill (AD-1) were sown in well prepared and statistically laid out field in plots sized of 5x4 meters under specified crop geometry. All required agricultural practices were followed as per package of practices adopted for both the crops at the centre. The below given observations under following parameters were recorded.

Diversity studies of insect pollinators

A field study on diversity and abundance of insect pollinators on both the crops was carried. Result showed

that, the flowers of ajwain were visited by 34 insect species of different orders and families. Among these pollinators, Hymenoptera (13 species), Diptera (8 species), Coleoptera (3 species), Lepidoptera (4 species), Hemiptera (4 species), Neuroptera (01 species) and 01 species of spider were recorded. Similarly, dill flowers were visited by 27 insect species of different orders and families. Among these insect pollinators, Hymenoptera (10 species) and Diptera (8 species), Hemiptera (3 species), Coleoptera (2 species), Neuroptera (01 species) and Lepidoptera (3 species) were recorded on the crop. Three honeybee species i.e. *Apis florea*, *A. mellifera* and *A. dorsata* and syrphid flies, *Episyrphus balteatus* and *Episyrphus* sp. were found most prominent pollinators of ajwain and dill.

Foraging behaviour and abundance of major insect visitors

The foraging behaviour of major floral visitors viz., *Apis dorsata* F., *Apis florea* F., *Apis mellifera* L., *Episyrphus balteatus*, *Episyrphus* sp.-1, *Eristalis* sp. and *Musca* sp.1 was studied on both the crops at hourly interval for 10 calm and clear sunny days by sweep netting of 1 m² area/minute during full bloom. It was found that there was no activity of insect visitors noticed 6.00-8.00 hrs on both crops, however, few floral visitors seen inadequately between 8.00-9.00 hrs and after that their population increased gradually and reached to its maximum between 12.00-14.00 hrs which were ranged from 2.60 to 27.10 and 5.20 to 19.22insects/m² area per minute in ajwain and dill, respectively. The most abundant pollinator was *Apis florea* (27.10 and 19.22 bees/m² /minute) during peak hours. After that the visitor's population declined gradually and recorded negligible by 18.00 hrs.

Effect of different mode of pollination on yield

The impact of insect pollinators on yield and quality of ajwain and dill was studied using insect proof nylon cages and compared with without bee pollination (caged) and other treatments. The result showed that the yield of ajwain 1352.25 kg/ha was obtained from bee pollinated plots (caged) which was 60.63% higher than control (without bee pollination-caged). The yield obtained from the open pollination plots was 1353.87 kg/ha, which was slightly higher than bee pollinated plots but statistically at



par with bee pollination plots. Similarly, the highest yield of dill (1563.7 kg/ha) was recorded from the plots, kept for open pollination and treated with bee attractant (jaggery solution 10%) followed by open pollination (1483.70 kg/ha) and bee pollination-caged with *A. mellifera* (1430.00 kg/ha), which were statistically at par with each other and superior over rest of the treatments. Bee pollination increased the yield of dill by 47.80 percent (Av.) higher than control (without bee pollination-caged). The higher test weight (2.30 g) and essential oil 2.32 per cent (ajwain) as well as the test weight of dill (3.25g) and essential oil (2.16%) were also recorded in the treatment of bee pollination as quality parameters.

CPT/16.4.1 Studies on population diversity and management of nematodes in Cumin (*Cuminum cyminum* L.) (2016-19)

(K. Kant; Co-PI: Y.K. Sharma and S.R. Meena)

Field sampling of nematodes population in cumin crop at Institute farm showed that population of nematodes were present in the fields from time of sowing to the harvest of crop. Nematode species was recorded in sampling was only lesion nematodes *Pratylenchus thorne*. Population of *P. thorne* in cumin soil was fluctuating during the cropping season and two peak population level recorded on the 49th and 7th standard week. Management of nematodes using soil sterient, nematopathogens, plant products and synthetic nematicides showed all treatments were superior over control. However, application of soil sterient Metham sodium and Dazomet gave complete protection up to the maturity of the crop. Leaf extract of Custard apple @ 100 kg/ha (Soil application) and Neem Seed Kernal Powder @ 500 kg/ha (soil application) also showed promising result (Fig.25).

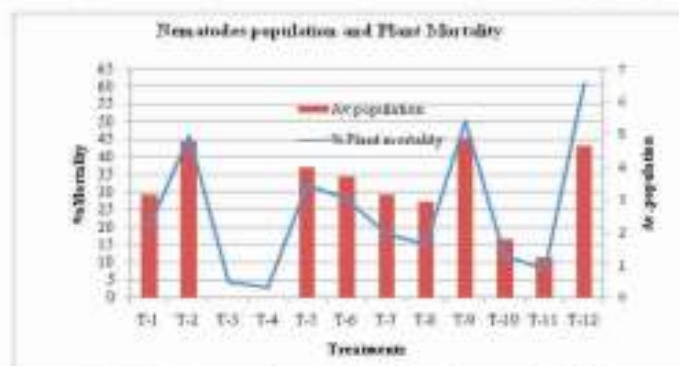


Fig. 24 Nematodes population in cumin field.

Project 5: Development and refinement of post-harvest handling, processing and value addition techniques in seed spices

B5-8: Physiological approaches for enhancing yield and quality in seed spices under abiotic stresses (2012-16)

(PI: S.N. Saxena)

Effect of water stress on morpho-physiological parameters and quality attribute in advance breeding lines of fenugreek

Water stress affects all the morpho-physiological parameters studied. Water stress given at midterm growth stage (60 days) does not affect seed yield in most of the genotypes. Terminal water stress (90 days) affects seed yield significantly. Genotype Afg3 found suitable for all tested environments compared to other genotypes. B5-33-20 is another genotype performed very well under control as well as stressed conditions. Genotypes B5-73-11 were not found suitable showed lowest seed yield under various conditions. None of the genotypes was found stable for all the traits. Most of the genotypes showed increased sapogenin under midterm as well as terminal stress conditions. Under midterm stress condition maximum sapogenin (6.52%) was observed in B4-22-7-2-1 while minimum (5.25%) was recorded in genotype AFG-3 which further reduced under terminal stress conditions up to 4.56%. In general, a decrease in leaf area was recorded under both midterm and terminal stress condition as compare to control (Fig.25). There are significant differences among the genotypes for chlorophyll content which showed diversity among the genotypes for chlorophyll content. Total chlorophyll content decreased significantly in all the genotypes at both the stages due to water stress condition. There was a significant difference among the genotypes for the water potential as well as environment and genotype and environment interaction has its significant effect on the water potential of the genotypes.

In both midterm and terminal water stress conditions oil content was found to reduce. However, genotype AFG-3 showed an increase from 2.8 to 3.23% under midterm stress. In general oil content was reduced due to moisture stress. Under terminal stress condition diosgenin content showed reduction in most of the genotypes except A3-31-2-7-2 and B4-22-7-2-1. Environment-wise analysis of

variance revealed that significant differences existed among genotypes in each environment for all characters indicating that real differences existed among the genotypes (Table 3.40).

Table 3.40: Twig water potential of fenugreek genotypes as affected by water stress at post flowering stages (90 DAS)

| Genotypes | Water Potential (bar) | | |
|-----------------|-----------------------|-------|-------|
| | NS | MS | TS |
| A3-31-2-7-2 | -12.5 | -18.3 | -17.3 |
| B4-22-7-2-1 | -13.3 | -16 | -16.2 |
| B5-33-20 | -14.2 | -20.2 | -18.3 |
| B5-5-6-1 | -13.3 | -19.8 | -20.5 |
| AFG3 | -13.8 | -17.5 | -20.3 |
| C4-23-1 | -12.2 | -17.2 | -21.2 |
| B3-77-8-10 | -11.2 | -16.2 | -17.8 |
| C4-2-14 | -12.8 | -16.3 | -20.8 |
| A3-31-1-17 | -12.5 | -16.3 | -21.3 |
| B5-73-11 | -15.2 | -19.5 | -21.5 |
| CD V (0.05%) | | 3.26 | |
| CDE (0.05%) | | 10.22 | |
| CD Vx E (0.05%) | | 4.16 | |
| CV (%) | | 2.29 | |

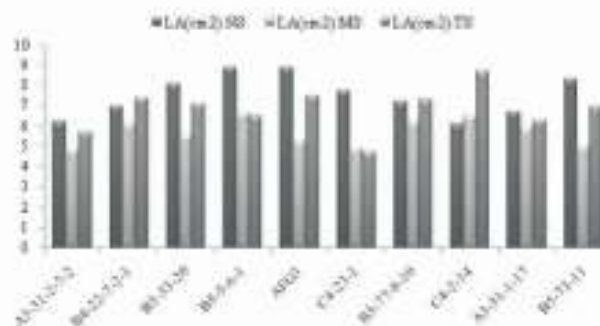


Fig 25. Leaf area of fenugreek genotypes as affected by water stress at post flowering stages (90 DAS)

Plant growth regulators for induction of dwarfism in fennel

The results of exogenous application of two gibberellin synthesis inhibitors (Paclobutrazol and chlormequate chloride) on induction of dwarfism in fennel without affecting seed yield. Paczee 10 ppm when sprayed at 90 DAS gave more yield than control with significant reduction in plant height. (Table 3.41)

Table 3.41: Effect of PGR on induction of dwarfism in fennel genotype AF 1

| Treatment | Plant height (cm) | No. of branch | No. of umbel | Seed yield/plant (g) |
|--|-------------------|---------------|--------------|----------------------|
| T1= Control | 141.3 | 8.1 | 21.6 | 12.8 |
| T2= cutting | 149.1 | 7.2 | 19.9 | 7.7 |
| T16= Paczee 10 PPM (90 days + 105 Days) | 129.0 | 7.7 | 23.3 | 14.7 |
| T17= Paczee 50 PPM (90 days) | 127.5 | 8.0 | 20.3 | 12.6 |
| T20= CCC 100 PPM (105 days + 120 Days) | 115.8 | 5.5 | 11.3 | 11.3 |
| T21= CCC 500 PPM (105 days) | 117.7 | 9.0 | 23.8 | 12.0 |
| T22= CCC 500 PPM (105 days + 120 Days) | 132.5 | 6.0 | 17.5 | 13.1 |
| T23= Paczee 10 PPM (105 Days) | 110.8 | 6.5 | 11.7 | 6.8 |
| T24= Paczee 10 PPM (105 days + 120 Days) | 133.8 | 8.5 | 20.0 | 7.2 |
| T25= Paczee 50 PPM (105 days) | 129.2 | 7.3 | 15.5 | 13.1 |
| T26= Paczee 50 PPM (105 days + 120Days) | 135.8 | 6.5 | 16.3 | 6.5 |
| Mean | 140.9 | 7.5 | 18.7 | 11.4 |
| CD 0.05 | 42.1 | 2.4 | 10.0 | 8.5 |
| CV % | 18.2 | 19.1 | 32.7 | 45.8 |



CPd/13.8.1: Development of value added products from seed spices (2014-17)

(G. Lal and B. K. Mishra)

- Under this project value added products of seed spices were developed with the help of ICAR-CISH, Lucknow. The recipes of the products were standardized.

Products developed

- Fennel – aonla squash
- Dill-aonla squash
- Coriander aonla squash
- Probiotic drink of seed spices
- Fenugreek tea
- Dillprash
- Dill-aonla capsules as functional food
- Fenugreek-QPM biscuits (Sweet, salty & without sugar)

Details of the patents applied

| IPRs | Name of Institute | Application/ Registration No. | Name of Innovation/ Technology/ Product/ Variety | Date of Filing /Registration | Application Granted/ Registered |
|--------|-------------------|-------------------------------|--|------------------------------|---------------------------------|
| Patent | NRCSS & CISH | 2877/DEL/2014 | Anti diabetic fenugreek -QPM biscuits | 09.10.2014 | Published |
| Patent | NRCSS & CISH | 2878/DEL/2014 | Methica (Fenugreek) Tea | 09.10.2014 | Published |
| Patent | NRCSS & CISH | 2879/DEL/2014 | Vitamin C enriched Dill based Herbal Chew | 09.10.2014 | Published |
| Patent | NRCSS & CISH | 2880/DEL/2014 | Coriander based squash & RTS | 09.10.2014 | Published |
| Patent | NRCSS & CISH | 2881/DEL/2014 | Fennel based squash & RTS | 09.10.2014 | Published |
| Patent | NRCSS & CISH | 2882/DEL/2014 | Dill based squash & RTS | 09.10.2014 | Published |
| Patent | NRCSS & CISH | 2877/DEL/2014 | Anti diabetic fenugreek -QPM biscuits | 09.10.2014 | Published |

Products commercialized:

- ❖ Six products of seed spices (03 squashes and 03 RTS made with the use of fennel, dill and coriander) were commercialized to M/s HDN Farmers' Combine, N. Delhi. Rupees 3,00,000.00 (Three lakh) deposited by the firm to ICAR-NRCSS, Ajmer under MOU of commercialization and 03% royalty will also be given on the sale of these products.

BS/14.5.1: Monitoring and evaluation of agro-chemical residues in cumin (*Cuminum cyminum* L.) and coriander (*Coriandrum sativum* L.) from Rajasthan and Gujarat (2014-17)

(P.N. Dubey, S.N. Saxena and K. Kant)

An experiment for the evaluation of the influence of propiconazole foliar sprays on enzymatic activities and microbial biomass in cumin field soil was undertaken with 9 treatments including control for the study. The cumin

- Dill parag
- Dill cider
- Mouth freshener

Products (Squashes, RTS and fenugreek biscuits) developed/ scaled up followed by marketing and selling at different seminars, conferences kisan melas, spice parlor and others trainings so that commercial output of developed value added products can be achieved. during this year more than two thousand packets/bottles of RTS and other valued products has been sold.

Patent filled:

- ❖ Six patents (final after full specifications) for different products which were filed on 09.10.2014 at Indian Patent Office, N. Delhi, has been published.

plant samples were sprayed with Deltamethrin and Propiconazole in single dose, double dose and fivefold dose at the recommended concentration. Soil samples were drawn after third spray at 90 DAS at different time intervals viz. 0 (within 4 hr. after the final spray of the insecticide and pesticides) 1, 3, 5, 7, 9, 15, 30 days and finally at crop harvest time. The results indicate significant decrease in soil MBC for all the three doses of propiconazole as compared to control. The reduction in SD & DD at initial stages and regain later may be due to the effect of fungicide resulting into the killing of the microbes particularly fungi, but bacterial species generally adapt quickly and begin proliferating fast due to reduced microbial competition. The results obtained for V fold dose may be due to strong inhibition of degrading microorganisms or buildup of toxic metabolites. At harvest the soil MBC built up regains at all the doses (Fig.27).



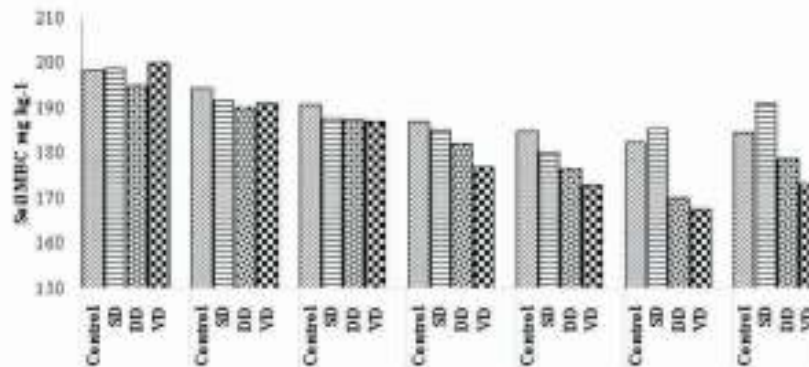


Fig.27: Effect of foliar application of propiconazole on soil microbial biomass carbon content as compared to control

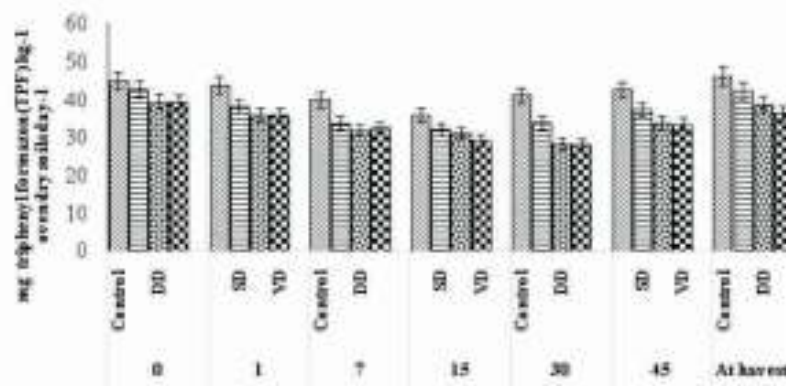


Fig.28: Effect of foliar application of propiconazole on dehydrogenase activity.

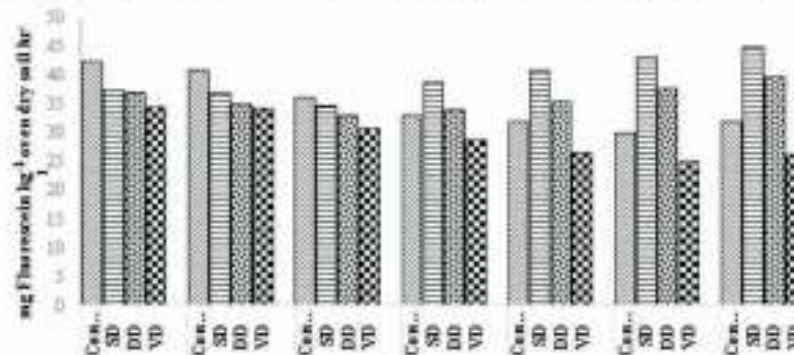


Fig. 29: Effect of foliar application of propiconazole on fluorescein diacetate hydrolase activity.

Dehydrogenase activity (DHA) in soil is an overall indicator of microbial activity. The DHA activity decreased up to 30th day at SD & DD but it continued to fall in VD till harvest. The DHA is most susceptible parameter to pesticide application (Fig.28). Fluorescein diacetate hydrolase activity (FDHA) is also a measure of total microbial activity in soils. This activity decreased up to 15 days at SD & DD but further decreased in VD. This could be due to the inhibitory result of pesticide on synthesis of

enzymes. The FDHA regains fast as compared to control due to built up of microbes after 15-30 days of application (Fig.29). Soil urease activity indicate variability with application rate. It regains after 15 days in SD & DD as compared to VD. This could be explained by the fact that the urea degrading enzyme does not have any role in degradation pathway of fungicides and therefore least affected by fungicide application (Fig.30).

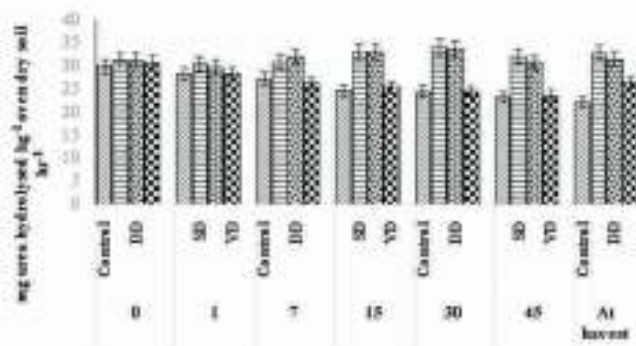


Fig.30: Effect of foliar application of propiconazole on soil urease activity.

Acid phosphatase activity decreased significantly up to 15th day in SD & DD but decreased much more in VD. There was substantial increase in the enzyme activity at later stages, despite the initial inhibition in SD & DD (Fig.31).

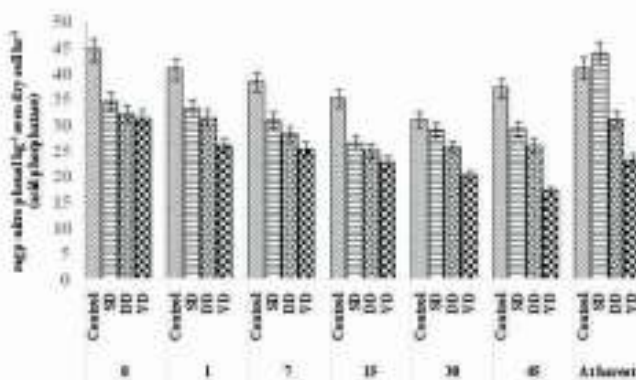


Fig.31: Effect of foliar application of propiconazole on acid phosphatase activity.

Alkaline phosphatase activity showed inconsistency results and SD & DD had no prominent effect. At VD it decreased significantly (Fig.32).

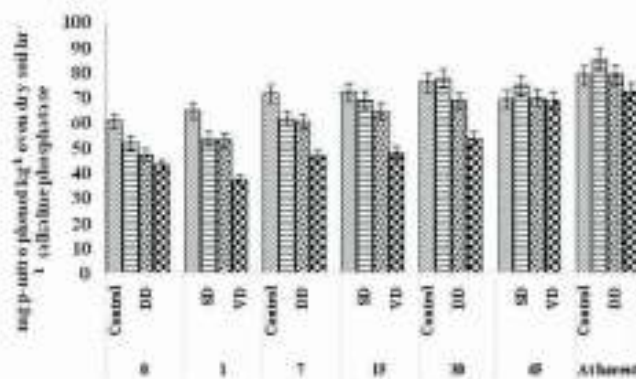


Fig.32: Effect of foliar application of propiconazole on alkaline phosphatase activity.

To generalise the acid phosphatase activity was inhibited, whereas alkaline phosphatase activity remained unaffected at lower doses. The decremental effects on acid phosphatase activity may be due to low organic content in the soil of experimental site. Alkaline phosphatase activity, however was protected at lower doses.

Project 6: Improving knowledge and skill of stakeholders for improving productivity of seed spices

SS/13.16.1: Dissemination of seed spices production and post-harvest technology through demonstrations, trainings, workshops and seminars under NEH and TSP (2014-17)

(G. Lal, R.S. Mehta, R.S. Meena, N.K. Meena and S.P. Maheria)

Performance of FLDs at Pratapgarh

Performance of frontline demonstrations (FLDs) of Seed Spices under TSP Two hundred and three frontline demonstrations (FLDs) of different seed spices were conducted in Tribal Sub-plan area of Rajasthan in collaboration with Krishi Vigyan Kendra, Pratapgarh, Banswara, Dungarpur, and State Department of Agriculture, Jhadol, Udaipur during 2016-17. In total FLDs, fenugreek (66), coriander (62), fennel (30), ajwain (31), nigella (10) and dill (4) were given with quality seeds of improved varieties, recommended dose of fertilizers and package of practices (POP) including seed treatments, line sowing, weed management and plan protection measures were demonstrated on the farmers' fields. The performance of crops under all the frontline demonstrations (FLDs) was observed better in respect to overall growth parameters, yield and yield attributes. Results of the FLDs at different farmers' fields (Table 3.42) revealed that yield of seed spices under demonstration plots was higher in comparison to local checks/practices which were 30.42% higher in coriander, 26.47% in fenugreek, 26.20% in ajwain, 16.44% in nigella, 23.29% in dill and 35.05% in fennel.



Table 3.42: Performance of frontline demonstrations (FLDs) of Seed Spices over local varieties and practices

| S. No. | Crop | Variety | No. of FLDs | Area (ha.) | FLD yield (kg/ha) | | | Yield of local check (kg/ha) | Increase in yield (%) |
|--------|-----------|---------|-------------|------------|-------------------|--------|---------|------------------------------|-----------------------|
| | | | | | Highest | Lowest | Average | | |
| 1. | Coriander | ACr-1 | 22 | 0.25 | 1491 | 1063 | 1264 | 872 | 30.42 |
| 2. | Fenugreek | AFg-3 | 21 | 0.25 | 2220 | 1563 | 1861 | 1360 | 26.47 |
| 3. | Ajwain | AA-1 | 10 | 0.5 | 1185 | 872 | 1054 | 767 | 26.20 |
| 4. | Nigella | AN-1 | 10 | 0.5 | 80 | 640 | 724 | 605 | 16.44 |
| 5. | Dill | AD-1 | 4 | 0.5 | 130 | 1200 | 1258 | 965 | 23.29 |
| 6. | Fennel | AF-1 | 08 | 0.5 | 2280 | 1883 | 2065 | 1465 | 35.05 |

Farmer's workshop on Safe production of seed spices for TSP

Two days Farmer's workshop on Safe production of seed spices for TSP was organized at ICAR-NRCSS, Tabiji, Ajmer during 18-19 September, 2016. Inaugural session of the workshop was conducted with *Bheej Vitaran Kisan Mela - 2016* programme, wherein, Dr. Gurbachan Singh, Chairman, ASRB, Pusa New Delhi was the Chief Guest and Dr. P.S. Rathore, Hon'ble Vice-Chancellor, SKN Agriculture University, Jobner and Dr. M.L. Jat, Coordinator, Asia, CIMMYT, NASC, New Delhi were Guests of Honour in the programme. Dr. Gopal Lal, Director & Organizer of the Kisan mela welcomed the guests and farmers present in the programme. In the inaugural function, Dr. Gurbachan Singh addressed the farmers on the issues related to the soil and crop production and also suggested farmers for soil analysis for efficient utilization of fertilizers and micro-nutrients. The other dignitaries were also interacted with farmers coming over Kisan mela from different corners of Rajasthan, Madhya Pradesh and Gujarat. In two days farmers workshop, 13 lectures on various aspects of seed spices were delivered. Farmers also visited the exhibitions at mela ground and learnt about the technologies displayed in the exhibitions. Total 148 farmers from tribal areas of Pratapgarh, Banswara and Dungarpur along with 07 officials (SMS from KVKs) participated.

Farmers Training at NEH North East Region under TSP

Two days farmers training on "Organic Production Technologies of Seed Spices for Sikkim" were organized

by ICAR-NRCSS in collaboration with ICAR-NOFRI at Tadong, Gangtok, Sikkim on 16-17th December, 2016. In the inaugural session, Dr. R.K. Awasthe, Director, NOFRI was Chief Guest and Dr Gopal Lal Presided over the function. Scientists from NRCSS (Dr. R.S. Mehta, Pr. Scientist, Agronomy, Dr. R.S. Meena, Sr. Scientist, Plant Breeding and Dr. N.K. Meena, Sr. Scientist, Entomology), NOFRI and KVK, Sikkim were also present in the function. In two days farmers training programme, 12 lectures on various aspects of organic production technologies of seed spices, and extension methods were delivered. A practical on method of sowing for coriander and fenugreek was carried out by the farmers themselves at Research farm NOFRI on second day of training programme. fifty five FLDs of coriander and fenugreek for 25 m² area were also given to each farmers for demonstration on their own field for seed as well as leaf purpose. In all 63 farmers and 10 officials from different places of Sikkim participated.

SS/16.6.1: Assessing approachability and facilities of ICT and effective medium of information dissemination to cumin and coriander growers of Western India (2016-18)

(M.K. Vishal, G. Lal, K. Kant, S. Choudhary, A.K. Verma, R.D. Meena, M.A. Khan, S.R. Meena)

The current research work is carried out to know the role of ICT and involvement of modern information dissemination technique and their need to the farmers especially for seed spices in western India. Even to know the literacy, acquaintance and usage of ICT and ICT based



services by farmers. For this, the various facts and details of different information dissemination techniques and other ICT usage secondary data were acquired and then a questionnaire was prepared in Hindi and English targeting the stakeholders like farmers, KVK, GO, NGO etc for survey to investigate the approachability and facilities of ICT and effective medium of information dissemination. A field survey was done for major seed spices growing areas like Barhmer, Jaisalmer, Nagaur, Ajmer, Jodhpur, Sirohi regions farmers for cumin and coriander. Survey was done for assessing different stakeholders of different strata of farmers who visited NRCSS under various exposure as well as learning tours/trainings/visits etc; farmers on their field; farmers in Kissan Mela (farmers' fairs) and farmers on interstate tours. All stakeholders and respondents who were surveyed their physical coordinates were recorded for geo referencing. Meta data and past growing details and cropping patters of farmers were also recorded.

Total 568 farmers were interviewed; in which around 21% were women and 79% were men, aged between 18 to 68 years. The complete demographic profile of the farmers is shown in table 3.42. Literacy rate was main challenge in the arid and semi-arid region. Due to resources scare and backwardness in the region the farmers' literacy was low. There is synergy between literacy rate and the digital literacy rate and thus affecting the use of ICT. Farmers were having large land holding especially due to cumin growers. The cumin growers holds a large land holding. Even marginal farmers have practice to borrow the lands for farming in these regions. This survey also tried to know the status of mobile used by farmers for fetching information. It was observed that ATMA and state visitors trainee were more aware about ICT as compared to field surveyed farmers due to their good economical status, almost all were using the smart phone. Where as more than 90% farmers owns cellphone (basic as well smart) in all groups which were surveyed (fig. 33). In case of messaging system few message were given on major and current issues of pest and diseases except around 4 % of the population on blight in case of cumin. According to study it was found that message dissemination, SMS, may be sent according to crop cycle and need of the farmers based on region climate, date of sowing and cropping

pattern. It is also observed that around 2% of messages were send on only pest management aspect. There were no messages sent for secondary processing of seed spices and promotion of same. This is much needed subject. The major gap in implementation of ICT based e-extension that is training and digital awareness of the farmers. Though many farmers owned their cell phone but none of them received any formal training on ICT and based services for seed spices and other crops in the region.

Table 3.42: Demographic characteristics of the farmers/ stakeholders surveyed

| Demographic characteristics | N (568) | % |
|-----------------------------|---------|----|
| SEX | | |
| Female | 122 | 21 |
| Male | 446 | 79 |
| Age (Years) | | |
| 20-39 | 237 | 42 |
| 40-59 | 242 | 43 |
| >= 60 | 89 | 15 |
| No Answer | 0 | 0 |
| Education | | |
| Illiterate | 29 | 05 |
| Primary School (5th) | 152 | 27 |
| Elementary School (8th) | 134 | 23 |
| High School | 68 | 12 |
| Higher Secondary | 114 | 20 |
| College graduate/University | 71 | 13 |
| No Answer | 0 | 0 |



A group of farmers being surveyed during farmers training programme at NRCSS Ajmer

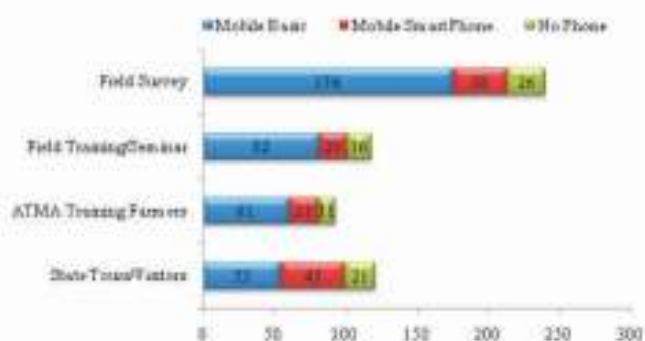




A group of farmers being surveyed during farmers training programme at NRCSS Ajmer



A group of farmers being surveyed near Nagaur, Rajasthan



Mobile Smart Phone



Fig. 33: Mobile phone status of the farmers

External Funded Projects

Net work Project on Protected Horticulture in collaboration with IHR: Standardization of production technologies for seed spice under protected

(Ravindra Singh, Gopal Lal, Hannapa, A., Krishan Kant, R. D. Meena and S. P. Maheria)

a) To protect the crop from frost during winters, different protection structures like, Plastic sheet covered high walk in tunnel, Insect proof net covered high walk in tunnel, vertical plastic sheet wall were erected in the field and compared with open condition in major (Cumin, coriander, fenugreek, fennel) and minor (dill) seed spices. The minimum temperature was -1.0°C in open condition during 11-13 January, 2017, which caused frost injury in all the seed spices. Whereas minimum temperature at fennel, dill, coriander, cumin and fenugreek were higher by $1.99, 1.22, 1.42, 2.36$ and 1.00°C with insect proof net covered walkin tunnels and $1.22, 1.99, 1.00, 3.25$ and 1.33°C with plastic sheet covered walkin tunnels, respectively over open conditions. Whereas the improvement in maximum temperature at fennel, dill,



Production technologies for seed spice under protected



coriander, cumin and fenugreek were higher by 7.99, 7.25, 6.51, 8.55 and 6.62°C with insect proof net covered walkin tunnels and 7.25, 7.99, 9.31, 15.47 and 8.84 oC with plastic sheet covered walkin tunnels, respectively as compared with open conditions. Among the protected structures, maximum seed yield of 1961.4 kg/ha were recorded at plastic sheet vertical wall followed by 1696.6

kg/ha with insect proof net covered walk in tunnels and 1636.5 kg/ha with plastic sheet covered walkin tunnels. Among the crops maximum seed yield of 2589.3 kg/ha were recorded in fennel with vertical wall (Table 3.43). In all the seed spice crops lowest yield were recorded in control treatment due to frost damage, higher incidence of diseases and pest at absolute control and open

Table 3.43: Seed yield (kg/ha) of different seed spices as influenced by different protected structure

| Treatment | Insect proof net | Plastic sheet | Vertical wall (Plastic) | Open condition | Control | Mean A |
|------------------------------|------------------|----------------|-------------------------|----------------|----------------|---------|
| Fennel | 2,367.2 | 2,118.9 | 2,589.3 | 2,089.7 | 1,178.9 | 2,068.8 |
| Dill | 2,283.6 | 2,047.8 | 2,461.8 | 1,990.1 | 1,168.7 | 1,990.4 |
| Coriander | 1,679.2 | 2,067.6 | 2,506.2 | 1,416.0 | 1,303.1 | 1,794.4 |
| Cumin | 784.9 | 657.3 | 545.7 | 503.7 | 341.9 | 566.7 |
| Fenugreek | 1,368.0 | 1,290.7 | 1,704.2 | 1,058.8 | 1,222.2 | 1,328.8 |
| Mean B | 1,696.6 | 1,636.5 | 1,961.4 | 1,411.7 | 1,043.0 | |
| Factors | | C.D. | | SE(d) | | |
| Factor(A) crop | | 98.3 | | 44.7 | | |
| Factor(B)Protected structure | | 53.8 | | 24.4 | | |
| Factor(B)at same level of A | | 126.2 | | 56.3 | | |
| Factor(A)at same level of B | | 124.4 | | 57.1 | | |

Standardization of different Colour Shade Nets for off season cultivation of leafy coriander and fenugreek:

Among the different color tested green and black shad net were more effective for off season leafy coriander and fenugreek production than white and red shad nets during June and July. 90% shading intensity of green shad net or 75% black shad nets were equally effective for

higher leafy biomass production during off season for both coriander and fenugreek. Three crops of coriander were taken from 1 June to 30 September with crop duration of 45 days which gave cumulative yield of 10620, 10139, 9270 kg/ha biomass of green leafy coriander under 90 % Green, 75 % Black and 75 % Green shad net during off season (Table 3.44).

Table 3.44: Leafy coriander yield during off season

| Treatment | Leafy coriander yield (kg/ha) | | |
|------------|-------------------------------|---------|-------|
| | I crop | II crop | Total |
| 90% Green | 5260 | 5360 | 10620 |
| 75% Green | 4680 | 4590 | 9270 |
| 50% Green | 4077 | 3988 | 8065 |
| 75% Black | 4987 | 5152 | 10139 |
| 75% Red | 2268 | 3347 | 5615 |
| 75% White | 3589 | 3896 | 7485 |
| Open | 869 | 967 | 1836 |
| C.D. at 5% | 265 | 289 | 508 |
| SE(m) | 84 | 98 | 153 |

Demonstration of 75% shading green shade net covered walk in tunnels for Off season coriander production at farmers field

A field demonstration was conducted at a progressive farmer's field of Mr. Harkaran Paroda, village of Dang, Saradhana, Ajmer. He underwent training on Off season production of green leafy coriander under shade net condition at ICAR NRCSS, Ajmer. Scientist of ICAR-NRCSS demonstrated the technology at his farm during Off season (April to September, 2017). He cultivated coriander variety AgCr-1 under 75 % green shade net covered walk in tunnel covering an area of 100 m². The seed rate was kept 40.0 kg/ha with random sowing along





with recommended fertilizers. Due to prevalence of high temperature and bright sun shine during March to September in Rajasthan, Open cultivation of coriander for leafy vegetable is hardly possible. Two crop cycles of coriander (45-50 days in one cycle) were taken by the farmer under shad net covered walk in tunnel within 100 days duration during Off season. Total production of 1st crop was 130 kg from 100 m² and sold in the market @ Rs 125.0/kg amounting the total revenue of Rs 16250, whereas the production of second crop was 105 kg and sold in the market @ Rs 85.0/ amounting Rs 8925 and the total revenue of two crop cycles were Rs 25175. The cost of cultivation including the working cost of the tunnel were Rs 6750, hence net profit the farmer got was ₹18425 from 100 m² within 90 to 100 days during the off season when the prices of leafy coriander was very high.

Effect of seed rate on growth, biomass and seed yield of Kassuri/Nagauri methi: Twelve seed rates (10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110 and 120 kg/ha) of kassuri methi were used to see the effect of seed rate on growth and biomass production of kassuri methi. 6 cutting were taken after 35 days of sowing at 8-10 days interval. The crop was allowed to grow and seeds were harvested at



Fig. 33: Effect of seed rate on kassuri methi yield

maturity even after 6 cuttings. Maximum dry biomass (3130 kg/ha) of kassuri methi was recorded at 80 kg seed/ha which was declined gradually with decreasing seed rate and lowest (2564 kg/ha) recorded at 20 kg/ha seed rate. Similarly maximum seed yield (870.5 kg/ha) were recorded at 120 kg/ha seed rate which was lowest (389.8 kg/ha) at 10 kg/ha seed rate (fig. 34).

Effect of number of cuttings on foliage and seed yield in Nagauri Methi (Pann Methi): Nine treatments comprising of 0-8 cuttings at 10-12 days interval were undertaken to see the effect of number of cuttings on growth, dry biomass production and seed yield of Kassuri methi. The total dry biomass production of Kassuri methi ranged from 0 to 4760.8 kg/ha at no cutting (control, without cutting) to 8 cuttings. Seed yield was recorded at harvest and it was observed that maximum seed yield of 1022.0 and 1004.3 kg/ha was recorded after 4 and 5 cuttings. The seed yield was declined drastically due to reduced cuttings (0-3 cuttings) as well as increased number of cuttings (6-8 cuttings).



Photo: effect of different seed rates and number of cuttings on growth of Kassuri methi



DUS Project (PPV & FRA): To develop DUS test guidelines for minor seed spices (ajwain, dill, nigella, celery and anise)

(R.S. Meena and A.K.Verma)

DUS experiment on minor seed spices (ajwain, dill, nigella, celery and anise) was conducted at NRCSS, Ajmer. In the experiment, 6 ajwain, 4 dill, 5 nigella, 3 celery and 2 anise varieties were included to develop DUS guidelines in these crops. Observations were recorded for seedling colour at 25 DAS, seedling crown pigmentation at 25 DAS, height, number of primary and secondary branches per plant, stem: pigmentation, surface and waxiness, number of days to stem elongation, angle of first primary branch, leaflet: spacing of lobes, shape of tips of margin and density of margin incisions, leaf blade: length and lensity between 1st and 2nd pair of leaflet, leaf: size of terminal leaflet, petiole: Length and width, Umbel compactness, main umbel: diameter and number of peduncles, number of umbel/siliqua per plant, number of umbellates per plan, siliqua size, seed: colour, shape, ridges and curvature and weight of 1000 seeds. Based on the results, developing DUS guideline in miner seed spices has been initiated.

Network Project on Organic Farming (NPOF) in collaboration with IIFSR, Modipuram "Standardization of seed spices based organic farming system" (2015-16 to 2019-20)

(G. Lal, N. K. Meena and R.D. Meena)

A Network Project on Organic Farming (NPOF) "Standardization of seed spices based organic, inorganic and integrated production and cropping system" sponsored by ICAR-IIFSR, Modipuram is running at ICAR-NRCSS, Ajmer to develop seed spices based cropping system. In the project, screening of different varieties/cultivars of coriander and fennel under organic management, evaluation of IPM Modules against aphid and thrips infesting coriander, fennel and management of Sclerotium rot of coriander and Ramularia blight of fennel were carried out. During the period reported upon, the following results were obtained:

- The experiments on development of sustainable seed spices based cropping system in Kharif (moong bean and cluster bean) and Rabi (coriander and fennel) were conducted at organic block of research farm,



NRCSS, Ajmer. The results stated that, the performance of 75% organic with 25% inorganic treatment is recorded highest value of all parameters followed by state recommendation both in *Kharif* and *Rabi* season.

- The eight varieties of both coriander and fennel in Rabi and eight varieties of moong bean and cluster bean in Kharif were tested under organic production system. It was found that the fennel variety GF-12 was performed best and given highest yield (1475.83 kg/ha) followed by AF-1 (1466.67 kg/ha) in fennel. In coriander, variety Azad Dania-1 was found best in yield (1702.83 kg/ha) and growth parameters followed by ACr-1(1623.50 kg/ha) in Rabi season. In Kharif season, cluster bean variety RGC-1038 (1485.83 kg/ha) performed best followed by RGC-1055 (1185.67 kg/ha) and in moong bean, best performance was given by cultivar MUM-2 (984.17 kg/ha) followed by RMG-975 (975.67 kg/ha) with respect to growth and yield.
- Among six organic based IPM modules (including control) tested against aphid and thrips on coriander and fennel, IPM module M-3 (garlic extract 10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit + fruit extract of *Citrullus colocynthis* 10ml/lit.) was given best management of aphid (67.10% and 66.40% reduction in coriander and fennel, respectively) and thrips (63.84% and 62.37% reduction in coriander and fennel, respectively).
- In coriander, five organic treatments (including control) viz., soil solarisation (20 days), Trichoderma (8g kg⁻¹ seed as seed treatment + 2.5 kgha⁻¹ as soil application), neem cake (0.5t/ha), caster cake (0.5t/ha) were evaluated. Among the treatments, soil solarization was found most effective (PDI 1.7) followed by neem cake (PDI 4.8) while the disease (*Sclerotium* rot of coriander) was recorded maximum (PDI 8.8) under control plots.
- Among four botanicals tested against *Ramularia* blight disease, the garlic extract (0.5%) was found most effective (PDI-5.2) followed by onion extract (0.5%) whereas in control the disease was reported maximum (PDI-14.0)

. Among them, five masalas i.e. Tea masala, Chana masala, Rajma masala, Gram masala and Sabji masala were evaluated organoleptically and scored from 7.06 to 7.91 out of nine (9-Hedonic ranking test scale). The remaining three masalas were under process. Garam masala, Tea masala, Chana masala, Rajma masala and Raita masalas were also carried out their shelf life storage studies under laboratory. The organic spices (fennel, coriander and fenugreek) were procured from ICAR-NRCSS, Tabiji, Ajmer (Rajasthan) for preparation of above spice premixes.



A B C D

Sabji(RTS) with different organic spice premixes

ICAR-Extramural Project: Pollination Management in cumin and nigella

(N.K. Meena, G. Lal and R.D. Meena)

Diversity of insect pollinators on cumin

A field study on diversity of insect pollinators associated with cumin (*Cuminum cyminum*) was carried out at research farm, NRCSS, Ajmer during Rabi 2016-17. Diversity of floral visitors was studied by sweep-netting the insect visitors throughout the flowering period. Cumin flowers were visited by 19 species of insects belonging to 11 families and 6 orders during entire flowering period. Among these insect visitors, maximum population was noticed from Hymenoptera (7 species) followed by Diptera (4 species), Hemiptera (2 species), Coleoptera (2 species), Neuroptera (1 species) and Lepidoptera (3 species) on the crop. Honeybee species *Apis florea* was recorded as most abundant pollinator (13.33 bee/m² bloom area) followed by *Episyrphus balteatus* (10.00 flies/m² bloom area), *Apis mellifera* (8.66 bee/m²), *A. dorsata* (7.00 bee/m²) and *Musca* sp. 1 (7.00 flies/m²).



Impact of pollinators on yield and quality of cumin

The impact of insect pollinators on yield and quality of cumin was carried out where in the yield of cumin 510.41 kg/ha was obtained in bee pollinated plots (caged) which was 40.03 % higher than control (without bee pollination-caged). Likewise, the highest average test weight (2.12g) and 2.00 per cent essential oil were recorded in the treatment of bee pollination which was significantly higher than the treatment of without insect pollination-WIP, wherein test weight was 1.78 g.

Diversity of insect pollinators on nigella

A similar field study was conducted for nigella to ascertain the diversity of various floral visitors associated with nigella (*Nigella sativa* Linn) crop during *Rabi* season. It was found that nigella flowers were visited by 23 insect species belonging to different order and families' right from initiation of flowering to withering or up to harvesting of crop. Among these insect visitors, maximum

population was noticed from Hymenoptera (9 species) followed by Diptera (5 species), Hemiptera (2 species), Coleoptera (2 species), Neuroptera (1 species) and Lepidoptera (4 species). Honeybee species *Apis florea* was recorded most abundant pollinator (14.00 bee/m² bloom area) followed by *A. mellifera* (12.33 bee/m²), *A. dorsata* (11.00 bee/m²) and *Episyrphus balteatus* (10.00 flies/m² bloom area).

Impact of pollinators on yield and quality of nigella

The impact of insect pollinators on yield and quality of nigella was studied. The yield of nigella 927.50 kg/ha was obtained in bee pollinated plots (caged) which was 45.16 percent higher than control (without bee pollination-caged). Similarly, the highest average test weight (2.49g) and 0.26 per cent essential oil were recorded in the treatment of bee pollination, which was significantly higher than the treatment of without insect pollination-WIP, (test weight .97g).



4. TECHNOLOGY ASSESSMENT AND TRANSFER

4.1 Technology transfer in TSP areas during 2017-18 .

- One day farmers training programmes was organized on "Production and protection technologies of seed spices" at KVK (MPUAT), Banswara on 18th August, 2017. In this training programme, a total of 8 lectures were delivered by the scientists of institute and KVK on different aspects of production and protection technologies of seed spices and also on other related field. Total 50 farmers from Banswara district were benefited. This training programme was organized by ICAR-NRCSS under TSP programme.
- One day farmers training programmes was organized on "Advance agricultural practices for seed spice production under tribal belt of Udaipur" at Phalasia, Udaipur with Agriculture Department, Govt. of Rajasthan on 30th August, 2017. In this training programme, total 50 farmers of Phalasia area participated and benefited. This programme was conducted by NRCSS, Ajmer under TSP scheme.
- One day farmers training programme was organized on "Improved production technology of seed spices" at KVK, Badal Mahal, Dungarpur on 31st August, 2017. In this training programme 8 lectures were delivered on different aspects of seed spices. In this programme, 62 farmers from Dungarpur district participated and got benefitted. Issues on plant protection in seed spices and other local crops of Dungarpur region was discussed.

4.2 Technology transfer in NEH areas during 2017-18 .

- Two days stakeholder capacity building programme was organized on "Production technology of seed spices for Manipur State" at ICAR-Research Complex for NEH Region, Lamphelpat (Imphal), Manipur from 7-8th December, 2017. In this training programme 12 lectures were delivered on different aspects of seed spices production. Sixty Eight farmers from different districts of Manipur participated and got benefited. The programme was organized by ICAR-NRCSS under NEH scheme.

- Two days farmers training programme was organized on "Production technology of seed spices for NEH Region" at College of Agriculture, Tripura, Lembucherra, West Tripura from 27-28th February, 2018. In this training programme 14 lectures were delivered on different aspects of seed spices production. Fifty farmers from different districts of Tripura participated and got benefited. The programme was organized by ICAR-NRCSS under NEH scheme.

4.3 Beej Vitran Pakhwada

"Beej Vitran Pakhwada" was organized, during 14-30 September, 2017 for creating awareness among the farmers towards the HYV developed by NRCSS, Ajmer through "Beej Rath Yatra" and campaigning by vocal means was carried out. Seed sale and distribution of HYV was also done. This programme was organized under the convenorship of Dr. S.S. Meena.

4.4 Krishi unanti mela evam sangosthi (3 March 2018)

Krishi unanti mela evam sangosthi was organized at ICAR-NRCSS on 3rd March 2018. Hon'ble Shri Suresh Rawat, MLA Pushkar and Parliamentary Secretary was the chief guest and Ms. Vandana Nogia and Smt. Madhu Paroda were guest of honour in the inaugural function of the mela in which live web casting of speech of Hon'ble Shri Narendra Modi, Prime Minister of India, was displayed on LED wall to gathering of more than 1200 farmer's from different regions of Rajasthan. Dr. Gopal Lal, Director and other experts had a interaction session with farmers.



4.5 Field Days

Two field days were conducted on "Improved production technologies of fennel" at Sanju (Degana), Nagaur, Udliyawas and Bilada (Jodhpur) under MIDH programme of NRCSS, Ajmer. In the programme total 118 farmers participated and got benefitted by seeing the results of front line demonstrations on fennel variety AF-2 developed by NRCSS, Ajmer.

4.6 Interactive Workshop on Seed Spices

One day workshop of World Trade Organization-Standards and Trade development Facility (WTO-STDF) was organized at ICAR-National Research Centre on Seed Spices, Ajmer on 19th May, 2017. In the workshop, Dr. Gopal Lal, Director, NRCSS, Ajmer was the chief guest and Dr. Dharendra Singh, Professor (Plant Breeding) and Dr. Dinesh Arora, Sr. Scientist & Head, KVK, Ajmer were the guest of honour. Dr. P.S.S. Thampi, Deputy Director and programme organizer, Dr. (Mrs.) Shashi Sareen, Ex-Consultant, FAO, were also present in the function and Dr. N.K. Meena, Sr. Scientist, ICAR-NRCSS, Ajmer was convener of the workshop. Dr. Dr. H.A. Vijaya, Deputy Director, Spices Board and Sh. Usman, AD, Spices Board, Jodhpur were present in the programme. In this interactive workshop, the dignitaries presented their work and discussed the issues related to seed spices, production and trade. In the workshop an open house interactive session was also organized, in which farmers from different places of Barmer, Jodhpur, Jhalawar, Baran, Kota, Bundi and Ajmer, interacted with the scientists on various problems faced by them and scientists provided the solutions. In the programme 75 persons participated.

4.7 Seminar on "Sustainable Agricultural Practices for Seed Spices" at ICAR-NRCSS, Ajmer (24-25 Feb, 2018)

A State Seminar on "Sustainable Agricultural Practices for Seed Spices" was organized jointly by ICAR-National Research Centre on Seed Spices, Ajmer and DASD, Calicut under MIDH during 24-25 February, 2018 at Dr. R. S. Paroda Auditorium, ICAR-National Research Centre on Seed Spices, Ajmer. The main aim of the seminar was to discuss the challenges faced by seed spice growers like extreme weather conditions, drought, declining soil fertility and increasing aridity, low availability of high yielding varieties, low seed replacement rate and

emergence of new pests and diseases. The theme areas of the seminar were sustainable agriculture for improving soil health, crop production with sustainable natural resource management, plant health management,





climate resilience technologies, post-harvest handling, processing and value addition for high profitability, marketing & export of seed spices.

In the Inaugural session, Hon'ble Dr. B. S. Chundawat,

Former Vice Chancellor, SDA University, Dantiwara (Gujarat) was the Chief Guest. Dr. I.J. Mathur, Former Director, Extension Education, MPUA&T, Udaipur and Sh. B.L. Meena, Assistant Director, DASD, Calicut were the Guests of Honor and Dr. Dinesh Arora, Sr. Scientist & Head, Krishi Vigyan Kendra, Ajmer was the Special Guest. Dr. Gopal Lal, Director, NRCSS and Chairman Organizing Committee, welcomed the dignitaries, briefed about the achievements and progress made by the institute, about MIDH Programmes being carried out at ICAR-NRCSS and also gave the welcome address. He urged the farmers to come forward and adopt the technologies developed by ICAR-NRCSS, Ajmer. He also informed scientists and farmers about the coriander variety ACr-1 which is resistant to stem gall disease, can be grown in Kota, Baran, Jhalawar as well as adjoining area of Madhya Pradesh and Gujarat, wherein farmers are leaving coriander cultivation due to stem gall problem. He also elaborated the potential of other varieties of cumin, fenugreek, fennel, ajwain, nigella and their value added products. Dr. B.S. Chundawat, Chief Guest of the function address the delegates and farmers participants and appreciated the efforts made by the NRCSS in the field of germplasm collection, variety and technologies development, package of practices for an individual crop and extension activities taking by the institute for the farmers welfare. He also advised the Scientists of institute to develop new varieties of cumin and coriander as per the choice of farmers and market preferences during his field visit at NRCSS, research farm. He highly appreciated the Director and his scientific team for systematically carrying out the experimental trials and keeping their respective experiments and farm neat and clean and well managed. He also shared his vast research experience with delegates present in the event NRCSS, Ajmer from different places and asked them to do something novel in research for the benefit of farmers in era of climate change.

Dr. I.J. Mathur, Guest of Honor in the function addressed the delegates and highlighted the importance of seed spices and for improvement of income of farming community in the country. He advised the scientists to work on value addition and oil extraction from the straw and underutilized produce of seed spices for earning





additional income. Sh. B.L. Meena, Guest of Honor of the function, also addressed the gathering and asked them to spread the spices and seed spices among farming community. He assured to give all possible support to NRCSS, Ajmer for more works on seed spices research and extension activities for the benefit of farmers in Rajasthan and nearby states like Gujarat and Madhya Pradesh. During the inaugural session various publications namely Book of lead papers and abstracts of seminar on "Sustainable Agricultural Practices for Seed Spices, an extension bulletins, International Journal of Seed Spices and NRCSS Profile Document were released by the dignitaries. At the end of the inaugural function, Dr. N. K. Meena, Organizing Secretary, presented the vote of thanks to the guests and staff of ICAR-NRCSS, Ajmer for successful completion of the seminar.

In the seminar, there were four Technical Sessions (Technical Session-I on Crop Improvement and Basic Science, Technical Session-II on Crop Management, Technical Session-III on Plant Health Management and Technical Session-IV on Social Science and TOT) and a Plenary Session were conducted in two days scientific deliberations.

4.8 Front Line demonstrations (FLDs) under Tribal Sub Plan (TSP) :

Total 226 Front Line Demonstrations on coriander, fenugreek, ajwain, fennel and nigella (0.25 ha each) were given to the farmers from tribal regions of Pratapgarh, Banswara, Dungarpur and Udaipur under Tribal Sub Plan (TSP) during Rabi 2017-18. The necessary inputs i.e. seeds, fungicides and POP of particular seed spice were also provided to the farmers for reaping efficient results. All necessary scientific informations were also given to the FLD farmers having through publications, telephone or other means as and when required.

4.9 Front Line demonstrations (FLDs) under MIDH :

- 80 Frontline demonstrations on coriander, cumin and fenugreek (0.5 hectare area each) were carried out at farmer's fields in Ajmer, Jhunjhunu, Nagaur, Sikar Kota, Barmer Jaisalmer and Jalore districts of Rajasthan. The seeds, fertilizers and POP adopted for seed spice production were also provided for the benefit of farmers.
- Two Field Days for FLD on fenugreek variety AFG-3 and fennel (variety AF-2) was conducted at Mohbatsar (Jhunjhunu) and Prempura (Nagaur) on 29.03.2018. During the field day, Director and scientists of ICAR-NRCSS discussed with farmers about the interventions made in FLDs and presented the effect of different interventions of FLDs on the performance fenugreek variety AFG-3 for growth and yield in comparison to local varieties. Dr. G. Lal, Director, ICAR-NRCSS along with his team also organized a field day on fenugreek variety AFG-3 at Prempura (Nagaur) on same day and





A field day on fenugreek at Mohabatsar (Jhunjhunu)

A field day on fennel (AF-2) and Nigella (AN-20) at Premapura (Nagaur)

seen the impact of FLDs and compared with local cultivar for growth and yield of FLDs. In both the programme, 110 farmers including farm women and youths participated.

Farmer's training at Sawai Madhopur, Rajasthan

A two days farmer's training programme on 'Improved Cultivation of Seed Spices' was organized during 12-13 February, 2018 at Assistant Director (Horticulture) office, Sawai Madhopur (Rajasthan). The training programme was inaugurated by Dr. Ram Asarey, Sr. Scientist & Head, Krishi Vigyan Kendra, Sawai Madhopur as Chief Guest and Sh. Ram Raj Meena, Assistant Director (Horticulture), Sawai Madhopur and Dr. B.L. Meena, Assistant Professor (Entomology), Krishi Vigyan Kendra, Sawai Madhopur acted as Guests of Honor in the training programme. Dr. R.S. Meena, Sr. Scientist (Plant Breeding), Dr. N.K. Meena, Sr. Scientist (Agricultural Entomology) and Dr. R.D. Meena, Scientist (Plant Pathology) acted as training Coordinators of the programme. Dr. Ram Asarey delivered his inaugural address to the farmers on possibilities of seed spices cultivation in the region. He emphasized coriander and fennel cultivation with improved varieties and technologies developed by ICAR-NRCSS, Ajmer for





Farmer's participation in training at Sawai Madhopur on 12-13 February, 2018

getting more income per unit area. Sh. Ram Raj Meena also addressed the farmers participants and advised the farmers to do the seed spices as intercropping with fruit orchards. He suggested the farmers to cultivate coriander for green leaf purpose during off season under natural shade of guava and aonla, which is plenty in the region. Dr. R.S. Meena, delivered the talk on improved varieties of seed spices. He advocated adapting improved varieties developed by ICAR-NRCSS, line sowing, seed treatment, timely weeding and other field operations to get the maximum production and profit. In two days deliberations, scientists delivered 12 lectures, covered all aspects of seed spices production like field preparation,

method of sowing specific to crops, seed treatments, irrigation methods, manure and fertilizers, insect-pests and disease management in seed spices. Dr. B.L. Meena, delivered a lecture on pests problem on crops in Sawai Madhopur region and possible control measure. Dr. N K Meena, delivered a lecture on important insect-pests of seed spices and their management. Dr. R.D. Meena delivered lecture on diseases management in seed spices crops with special reference to coriander and fenugreek. In the training programme 70 farmers from nearby villages of Sawai Madhopur district of Rajasthan participated.



The training ended on 13th February, 2018 with farmer's feedback and vote of thanks by Dr. R.S. Meena, Coordinator, ICAR-NRCSS, Ajmer.

4.10 Farmers visit to the ICAR-NRCSS, Ajmer

Farmers and other stakeholders visited the ICAR-NRCSS experimental farm, knowledge park and bio control lab during 2017-18. Various farmers' group from Rajasthan and adjoining states viz., Gujarat, M.P., U.P., Punjab, Haryana and Maharashtra visited the centre during cropping season as well as off season of seed spices. Groups were explained about the ongoing research

activities and various seed spice production technology developed by the centre. Approximately 18, 545 farmers, students and extension workers benefitted from the on-site demo of advanced and innovative seed spices production technologies such as fertigation. Off season production, high yielding varieties, value added products and post harvest management technologies of the centre. During Kisan Mela and different sponsored farmers training programmes, knowledge and skill up gradation of the farmers was the prime aim of the ICAR-NRCSS, Ajmer.

4.11 Training programmes organized at ICAR-NRCSS

| Title of training | Duration | Coordinators | Sponsoring agency | Farmers benefited |
|---|-----------------------|---|---|-------------------|
| <i>Krishak Samvad Karyakram</i> | May 02, 2017 | Er. S.P. Maheria | PD, ATMA, Ajmer | 30 |
| <i>Beejeey masala fasal utpadan ki unnat praudyogikiyan evam katai upraant prasanskan</i> | Aug 01-05, 2017 | Dr. Krishna Kant Dr. R.S. Meena Dr.S.R.Meena | PD, ATMA, Bikaner | 30 |
| Production and protection technologies of seed spices | Aug 18, 2017 | Dr. N. K. Meena | TSP, KVK, Banswara | 50 |
| Production and protection technologies of seed spices | Aug 19, 2017 | Dr. R.S. Meena | TSP, KVK, Pratapgarh | 64 |
| Integrated Nutrient Management, Integrated Pest Management and Innovative Techniques and Sustainable Practices of Cumin Cultivation | Aug 25- 26, 2017 | Dr. P.N. Dubey Dr. R.D. Meena Dr.A.K.Verma | Project Executive, Ambuja Cement Foundation, Mundwa, Nagaur | 30 |
| <i>Beejeey masala fasal utpadan ki valgyanik kheti</i> | Aug 28- Sept 01, 2017 | Dr. S.S. Meena Dr. Shada Choudhary Dr. S.P. Maheria | PD, ATMA, Shivpuri (MP) | 30 |
| Advance agricultural practices for seed spice production under tribal belt of Udaipur | Aug 30, 2017 | Dr. N. K. Meena | TSP, Phalasia, Udaipur | 50 |
| Improved production technology of seed spices | Aug 31, 2017 | Dr. N. K. Meena | TSP, KVK, Badal Mahal, Dungarpur | 62 |
| <i>Beejeey masala fasal utpadan ki unnat praudyogikiyan evam katai upraant prasanskan</i> | Sept 04-08, 2017 | Dr. S.N. Saxena Dr. R.S. Meena Mr. M.A. Khan | PD, ATMA, Nagaur | 30 |
| <i>Beejeey masala fasal utpadan ki unnat praudyogikiyan evam katai upraant prasanskan</i> | Sept 12- 16, 2017 | Dr. N.K. Meena Dr. R.D. Meena Dr. Mukesh K. Vishal | PD, ATMA, Sikar | 30 |



| | | | | |
|---|------------------|--|--------------------------------------|----|
| <i>Beejeey masala fasalan ke utpadan ke unnat praudyogikiyan</i> | Sept 23-27, 2017 | Dr. Y.K. Sharma Dr. P.N. Dubey Dr. Shada Choudhary | SAMI, Rehmankheda, Lucknow | 30 |
| <i>Beejiya Masala Phasalan Ki Unnat Utpadan Takneeki</i> | Oct 03-07, 2017 | Dr. Ravindra Singh Dr. B.K. Mishra Dr. S.R. Meena | PD, ATMA, Bhilwara | 30 |
| <i>Beejeey masala fasal utpadan ki unnat kheti</i> | Oct 09-13, 2017 | Dr. Y.K. Sharma Dr. N.K. Meena Mr. M.K. Vishal | PD, ATMA, Jaipur | 30 |
| <i>Beejiya Masala Phasalan Ki Unnat kheti</i> | Oct 13-17, 2017 | Dr. O.P. Aishwath Dr. P.N. Dubey Dr. A.K. Verma | PD, ATMA, Jaipur | 30 |
| <i>Bijiye Masala Fasal Utpadan ki Unnat Kheti</i> | Nov 25, 2017 | Dr. R.S. Meena Dr. M.D. Meena Dr. R.D. Meena | MIDH, Organized at Piprali, Sikar | 70 |
| Post-harvest Management and Processing for Quality Maintenance of seeds spices | Mar 31, 2018 | Dr. N. K. Meena | TSP, KVK, Pratapgarh | 55 |
| Improved cultivation of seed spices | Feb,12-13, 2018 | Dr. R.S. Meena | MIDH, Sawai Madhopur | 70 |
| Stakeholder capacity building programme on Production technology of seed spices for Manipur state | Dec 7-8, 2017 | Dr. N. K. Meena | NEH, Lamphelpat (Manipur) | 68 |
| International Exposure visit for undergraduates of the University of Arkansas, USA. | Jan 6-7, 2018 | Dr. Sharda Choudhary | University of Arkansas, USA. | - |
| Exposure visit of Farmers | Feb 24-25, 2018 | Dr. R.D. Meena | TSP Farmers, Pratapgarh | 40 |
| Production technology of seed spices for NEH region | Feb 27-28, 2018 | Dr. N. K. Meena | NEH, College of Agriculture, Tripura | 50 |

4.12 Model Training Course (MTC) on "Protected cultivation and precision resource management for horticultural crops and seed spices"

A model training course on "Protected cultivation and precision resource management for horticultural crops and seed spices" sponsored by Directorate of Extension, Ministry of Agriculture, Govt of India was organized during 19th to 26th January, 2018 at ICAR-NRCSS, Ajmer to update the knowledge of the officials from central/state development departments on the recent developments and strategies of protected cultivation, precision resource

management techniques, RCT and micro irrigation for horticultural crops including seed spice production in the country. The objectives of the model training course programme were : (i) To provide advance training to the state agricultural officers and scientists of ICAR/SAUs/KVKs and improve their skills in the area of protected cultivation, RCTs, fertigation management, and time/microclimate management in horticultural crops, (ii) To show the trainees live demonstrations/ experiments on protected structures, precision resource conservation practices, fertigation/ time/ climate



management and micro irrigation and (iii) To provide an opportunity to discuss and exchange ideas/knowledge between the academicians and the experts/resource persons who have made notable contributions in this area. Course consisted of lectures by faculty members, practical, laboratory work, field training, field visits and subject expert guest lectures. Participants were exposed to various aspects of protected cultivation and precision resource management techniques, protected structures, precision input application including micro irrigation and fertigation applied to different horticultural and seed spices crops grown in open field/ protected structures. The course content broadly covered the following topics: (i) Protected cultivation for horticultural crops including fruits, flowers, vegetables and seed spices (ii) Precision resource management in horticultural crops and seed spices (iii) Micro irrigation and fertigation, (iv) Water-Stress-Sensing in Field crops/Fruit Trees for Irrigation Management (v) Resource use efficiency, (vi) Precision farming (vii) Mulching for vegetables and seed spices (viii) Procedures and methodology for protected cultivation of horticultural crops and seed spices etc.

The Model Training Course started on 18th January 2018 after inauguration by Dr A. S. Faroda, Former Chairman, Agricultural Scientist Requirement Board, New Delhi and former Vice Chancellor, Maharana Pratap University of Agriculture and Technology, Udaipur. Dr. T. Janakiram, Assistant Director General (Hort. II), ICAR, New Delhi, Dr. P.L. Saroj, Director, CIAH, Bikaner and Dr. S. K. Singh, Director, ATARI, Jodhpur also witnessed the inaugural programme. Twenty six participants from State Development Agencies, ICAR/SAUs and KVKs from Uttar Pradesh, Madhya Pradesh, Asam and Rajasthan participated and got trained on different aspects of protected cultivation and precision resource management technologies for the horticultural crops and seed spices during the training course. Course director Dr. Ravindra Singh gave brief introduction of model training course, its objective and background of the participants. Course Coordinators Dr. Sharda Choudhary and Dr. A. K. Verma were also present in the program.

4.13 Radio/Television talks

| Name of Scientists | Topic/ Title of the talk | Date and venue |
|--------------------|--|--------------------------------------|
| Dr. G. Lal | Preparations before sowing of seed spices (in Hindi) | AIR, Jaipur, 18 Aug, 2017 |
| Dr. R. Singh | HELLO KISAN: मसालों की खेती | DD Kisan, New Delhi 18 July 2017 |
| | HELLO KISAN: जीवीय मसालों की खेती | DD Kisan, New Delhi 31 Jan, 2018 |
| | Krishi Darshan: Protected Cultivation of Cucumber | DD National, New Delhi 6 April, 2017 |

4.14 Exhibitions conducted/ participated

The research centre is actively involved in spreading the knowledge of advanced package of practices and improved varieties to farmers and other stakeholders. For this purpose NRCSS is regularly participating in farmers fair and demonstrating through stalls at various locations of the country.



Global Rajasthan Agritech Meet (GRAM) -2017, Udaipur, 7-9 Nov., 2017



SKNAU, Jobner Campus, 27 Feb., 2018





माननीय श्री सुरेश रावत जी, विधायक
पुष्कर क्षेत्र एवं संसदीय सचिव,
द्वारा उन्नत किसान मेला, एवं संगोष्ठी,
17 मार्च, 2018 का उद्घाटन

उन्नत किसान मेला, एवं संगोष्ठी, 17 मार्च, 2018
के अवसर पर मंचासीन अतिथीगणों द्वारा
माननीय प्रधानमंत्री के भाषण का लाईव वेबकास्ट
द्वारा अवलोकन



माननीय श्री सुरेश रावत जी, विधायक
पुष्कर क्षेत्र एवं संसदीय सचिव
द्वारा रा. बी. म. अनु. केन्द्र के प्रदर्शनी-स्टाल
का अवलोकन, 17 मार्च, 2018



5. TRAINING AND CAPACITY BUILDING PROGRAMMES

5.1 Education (M.Sc. student guided)

| Name of student | Degree | Thesis title | Guide |
|------------------|--|---|-------------------------------------|
| Dolly Agarwal | Ph.D. Pacific University, Udaipur (Raj.) | Study on genotypic variation in chemical profiling and medicinal properties of seed spices crop, | Dr. S.N. Saxena Major advisor |
| Deepak Vyas | M.Sc. M.J.R.P. University, Jaipur | Effect of moisture stress on seed yield and quality of selected genotypes of fenugreek (<i>Trigonella foenum-gracium</i> L.) | Dr. S.N. Saxena Co-Major advisor |
| Vinod Kumar | M.Sc. M.J.R.P. University, Jaipur | Study on coriander (<i>Coriander sativum</i> L.) based intercropping system for enhancing system productivity | Dr. S.S. Meena |
| Mahendra Parsoya | M.Sc. M.J.R.P. University, Jaipur | Study on Ajwain based intercropping system for enhancing system productivity | Dr. S.S. Meena |

5.2 Training and Capacity Building Programmes Organized

Training programme under Agriculture Skill Council of India (ASCI)

A 21 days (200 hours) training programme on "seed processing" was organized at NRCSS, Ajmer under *Rashtriya Krishi Vikas Yojna* (RKVY). This training was sponsored by Agriculture Skill Council of India (ASCI). The training was conducted during March 5-26, 2018, in which 20 unemployed youth participants were trained on different aspects of seed processing industry. The main aim of this training was to develop skill among the trainees on a particular trade so that they can establish their own business. All the 20 participants have passed successfully and received certificate from ASCI. The programme was organized by the team of Dr. K. Kant, Dr. O.P. Aishwath, Dr. A.K. Verma and Sh. M.A. Khan under leadership of Dr. G. Lal, Director.

5.3 Training and Capacity Building Programme Attended

- Dr. G. Lal attended Executive Development Programme on Leadership Development at NAARM, Hyderabad during 1-7 August, 2017.
- Dr. B.K. Mishra attended "*Sankalp Se Siddhi*" program organized in presence of Hon'ble Shri Radha Mohan

Singh, Minister of Agriculture & Farmers Welfare, at KVK Badgaon, Udaipur on 28-08-2017.

- Dr. B.K. Mishra attended ERP training programme during 8-9 May, 2017 at ICAR-IASRI, Pusa, New Delhi.
- Sh. S.P. Maheria attended one week long Training Program titled "Communication and Scientific Writing for Technical Officers of ICAR" January 3-9, 2018 held at ICAR-National Academy of Agricultural Research Management, Hyderabad 500030, Telangana.
- Sh. S.P. Maheria attended Model Training Course on "Protected cultivation and precision resource management for horticultural crops and seed spices" January 19-26, 2018 held at ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan.
- Sh. M.A. Khan attended 3 days Training Programme on "Seed Processing Worker" during 11-13 December, 2017 at Gwalior, M.P.
- Sh. S.R. Meena attended a training/Short course on "New Frontiers in Biotic Stresses Management for Doubling Farmers Income" during 11-20 September, 2017 at ICAR-National Institute of Biotic Stress Management, Raipur (Chhattisgarh).
- Sh. G.K. Tripathi attended ERP Training (4 Day) during 7-10 May, 2017 at ICAR-IASRI, New Delhi



5.3.2 Conference/ Seminar/ Symposia/ Workshop/ Meetings etc. Attended

| | | |
|---|--|----------------------|
| Dr. G. Lal | • International Conference on "Advances in Potassium Research for Efficient Soil and Crop Management" jointly organised by IPNI, FAI, TAAS, CIMMYT, ICAR and IARI at NASC Complex, New Delhi. | August 28-19, 2017 |
| | • International Seminar on "Horticulture: Priorities and emerging trends" organized by ICAR-IIHR at Bangalore. | September 5-8, 2017 |
| | • International seminar on "Global climate change: Implications for agriculture and water sectors" at Rukmini, Aurangabad, Maharashtra. | December 14-16, 2017 |
| | • International Spice Conference (ISC 2018) organized by World Spice Organization at the Crowne Plaza, Jaipur. | February 4-7, 2018 |
| | • National Seminar (SYMSAC-IX) on Spices for Doubling Farmers' Income at SASRD, Nagaland University, Medziphema, Nagaland. | March 15-17, 2018 |
| | • National Conference on "Technological changes and innovations in Agriculture for Enhancing Farmers' Income" at Junagarh Agricultural University, Junagarh, Gujarat. | May 28-31, 2017 |
| | • Conference on "Advances in Potassium Research for Efficient Soil and Crop Management" at NASC Complex, New Delhi. | August 28-29, 2017 |
| | • State Seminar on Temperate Spices at SKUAST, Srinagar, J&K. | March 20-21, 2018 |
| | • XXVIII Workshop of ICAR-All India Coordinated Project on Spices at Dr. Y.S.R. Horticultural University, Guntur (AP). | October 10-12, 2017 |
| | • Validation Workshop at India International Centre, New Delhi, Spice Board of India, Govt. of India. | June 7, 2017 |
| | • Annual Review Meeting on the Schemes on Spices and Aromatic Plants under MIDH implemented through DASD organized at CCS HAU, Hisar | May 12-13, 2017 |
| | • State Coordination Committee Meeting held under the chairmanship of Dr. U.S. Sharma, Vice Chancellor, MPUAT, Udaipur at Udaipur. | April 5 - 6, 2017 |
| | • Business Meeting of Spice Industry held under the chairmanship of Dr. T. Mohapatra, DG, ICAR at ICAR, New Delhi. | April 13, 2017 |
| | • Interactive meeting with ICAR SMDs/Institutes (Review meeting). The meeting for Horticulture and Agricultural Engineering Divisions held under the Chairmanship of Dr. Mruthyunjaya, Member, ICAR-Review Committee at NIAP, New Delhi. | April 20, 2017 |
| | • Foundation Day Function of CIAH at Bikaner | April 25, 2017. |
| | • E-governance meeting at Pant Krishi Bhawan, Jaipur | April 28, 2017. |
| | • EFC Meeting at ICAR, New Delhi under the Chairmanship of Honorable DG, ICAR, New Delhi. | May 11-12, 2017 |
| | • Global Rajasthan Agritech Meet (GRAM- KOTA 2017), Kota, Rajasthan. | May 24-26, 2017 |
| | • SAP Meeting (Preliminary Meeting for Developing Sustainable Agriculture Practices) for spices at IISR, Calicut, Kerala. | June 16, 2017 |
| | • One day Interface Meeting on "Enhancing the Preparedness for Agricultural Contingencies during Kharif, 2017" at Pant Krishi Bhawan, Jaipur | June 16, 2017 |
| • IDWG Meeting at Krishi Ayuktalya Jaipur (NMAE & Technology). | July 4, 2017 | |
| • Rajasthan Kisan Ayog Meeting a Pant Krishi Bhawan, Jaipur. | July 11, 2017 | |
| • ICAR Foundation Day and Director's Conference at NASC, New Delhi. | July 16-17, 2017 | |
| • Meeting for SAP finalization at IISR, Calicut. | August 23 -24, 2017 | |





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| | <ul style="list-style-type: none"> • Meeting on FAIR at SIAM, Durgapura, Jaipur. | September 8, 2017 |
| | <ul style="list-style-type: none"> • 25th Meeting of Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Horticultural Crops on 17th September, 2017 under the Chairmanship of Honorable DDG (HS) at ICAR, New Delhi | September 17, 2017 |
| | <ul style="list-style-type: none"> • Mid-term Review Meeting of Regional Committee no. IV & Kisan Mela at CAZRI, Jodhpur. | September 22, 2017 |
| | <ul style="list-style-type: none"> • An interview meeting at ASRB, New Delhi | September 27, 2017. |
| | <ul style="list-style-type: none"> • Scientific Advisory Committee Meeting of at KVK (Kota Agriculture University), Anta, Baran. | October 6th, 2017 |
| | <ul style="list-style-type: none"> • State Coordination Committee Meeting at Directorate of Research, MPUAT, Udaipur. | October 23, 2017 |
| | <ul style="list-style-type: none"> • Scientific Advisory Committee Meeting at KVK (MPUAT), Bhilwara, Rajasthan. | December 7, 2017 |
| | <ul style="list-style-type: none"> • Foundation Day of CSWRI, Awikanagar (Tonk, Rajasthan) and visited the institute with Shri R P Singh Member, Governing Body, ICAR. | January 4, 2018 |
| | <ul style="list-style-type: none"> • ICAR-IIWSC, Dehradun and ICAR-DCFR, Bhimtal with Shri R P Singh, Member, Governing Body, ICAR | January 6 - 10 , 2018. |
| | <ul style="list-style-type: none"> • Regional Advisory Group Meeting at NABARD Office, Jaipur. | February 22, 2018 |
| | <ul style="list-style-type: none"> • Directors Conference at NASC, ICAR, New Delhi. | March 08-09, 2018 |
| Dr. Y.K. Sharma | <ul style="list-style-type: none"> • 28th Workshop of AICRP on Spices at Horticultural Research Station, Lam, Guntur | October, 10-12, 2017 |
| | <ul style="list-style-type: none"> • Attended a Meeting of State Pest Surveillance & Advisory Unit at Pant Krishi Bhawan, Jaipur | January 22, 2018 |
| Dr. R. Singh | <ul style="list-style-type: none"> • International seminar on "Global Climate Change: Implications for Agriculture and Water Sectors" held at WALMI Campus Aurangabad, Maharashtra | December 14-16, 2017 |
| | <ul style="list-style-type: none"> • International conference on "Advances in Potassium Research for Efficient Soil and Crop Management" held at NASC complex, New Delhi, Organized by International Potash Limited, Gurgaon | August 28-29, 2017 |
| | <ul style="list-style-type: none"> • XXVIII AICRP Workshop on Spices, held at Guntur, Organized at Dr Y S R Horticultural University, Guntur | October 10-13, 2017 |
| | <ul style="list-style-type: none"> • Workshop on "Increasing Impact of Agricultural Programmes Among Viewers of Doordarshan "Organized by Doordarshan Kendra, Jhalana Dungari, Jaipur | May 11, 2017 |
| Dr. S. S. Meena | <ul style="list-style-type: none"> • 26th National Conference on "Natural Resource Management for Climate Smart Sustainable Agriculture" at Collage of Post Graduate Studies, Barapani, Shillong, Meghalaya India. | September 11-13,2017 |
| | <ul style="list-style-type: none"> • Symposium on "Spices, Medicinal and Aromatic Crops (SYMSAC-IX)" at Nagaland University, Medziphema, Nagaland, India. | March 15-17, 2018 |
| | <ul style="list-style-type: none"> • Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officer of ICAR at NAARM, Hyderabad | February 15-17, 2018 |
| | <ul style="list-style-type: none"> • Regional Workshop on Skill Development in Agriculture at SIAM, Jaipur, Rajasthan. | August 18, 2017 |



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| | <ul style="list-style-type: none"> • 28th Workshop of ICAR-All India Coordinated Research Project on Spices" at Horticultural Research Station, Dr. Y. S. R. Horticultural University, Lam, Guntur, Andhra Pradesh | October 10-12, 2017 |
| Dr. O.P. Aishwath | <ul style="list-style-type: none"> • 26th National Conference on Natural Resource Management for Climate Smart Sustainable Agriculture, SCS-CPGS, CAU (I), Barapani, Meghalaya. • National Seminar on "Developments in Soil Science - 2017" and 82nd Annual Convention of the Indian Society of Soil Science at Amity University, Kolkata. | September 11-13, 2017 December 11-14, 2017 |
| Dr. P.N. Dubey | <ul style="list-style-type: none"> • National Symposium on Spices and Aromatic crops (SYMSAC-IX) "Spices for doubling farmer's income" at SARD, Medziphema, Nagaland. • International Conference on "Recent Trend in Agriculture, Veterinary and Life Sciences"-2017 held at Carmel College for Women, Nuvem, Goa in collaboration with Multi-disciplinary Research Foundation, | March 15-17, 2018 December 28-30, 2017. |
| Dr. B.K. Mishra | <ul style="list-style-type: none"> • 26th National conference on "Natural resource management for climate smart sustainable agriculture" held at PGS-Central Agriculture University campus, Barapani, Umiam (Meghalaya). • Participated and presented a paper in the the International Conference on Recent Trends in Agriculture, Veterinary & Life Sciences-2017 at Carmel college for Women, Nuvem, Goa. | August 11-13, 2017 December 28-30, 2017 |
| Dr. R.S. Meena | <ul style="list-style-type: none"> • 33rd Academic Council Meeting of Bhagwant University at Ajmer. • Attended 5th International Conference on "Agriculture, Horticulture and Plant Science" at Rishikesh, UK, India. • Attended an International Conference on "Doubling the Farmers Income through innovative approaches" at KVK, Baramati, Pune . • 12th review meeting of DUS test centres on 15-17 January, 2018 at Indian Institute of Sugarcane Research, Lucknow. | February 20, 2018 June 24-25, 2017 April 9-11, 2018 Januar 15-17, 2018 |
| Dr. N.K. Meena | <ul style="list-style-type: none"> • XXVIII workshop of All India Coordinated Research Project on Spices at Horticultural Research Station, Dr. Y.S. R. Horticultural University, Lam, Guntur (AP) • International Symposium on Horticulture: Priorities and Emerging Trend organized by ICAR-IIHR, Bengaluru (Karnataka). • IITA 5th International Conference on "Agriculture, horticulture and Plant Science" organized by International Journal of Tropical Agriculture and Serial Publications Pvt. Ltd. New Delhi, held at Anandam Resort, Rishikesh (Uttarakhand). • National conference on Technological Changes and Innovations in Agriculture for Enhancing Farmers' Income" jointly organized by ASM Foundation, JAU and CHAI at JAU, Junagarh • National conference on "Sustainable Development Goals: Preparedness and role of Indian agriculture" organized by Trust for Advancement of Agricultural Sciences (TAAS) and International Food Policy Research Institute (IFPRI) in collaboration with Indian Council Agriculture Research (ICAR) at NASC Complex, New Delhi, India. • Annual Progress Meeting of MIDH, held at CCSHAU, Hisar (Haryana) | October 10-12, 2017 September 5-8, 2017. June 24-25th, 2017. May 28-31, 2017 May 11-12, 2017 May 12-13, 2017. |





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| | <ul style="list-style-type: none"> • Two days training programme on "Stability/combined analysis methodology for NPOF experimental data" at ICAR-IIFSR, Modipuram (UP). | July 25-26, 2017 |
| | <ul style="list-style-type: none"> • 12th Annual Group Meeting of NPOF project at ICAR-IIFSR, Modipuram, Meerut . | December 18-19, 2017 |
| Dr. Sharda Choudhary | <ul style="list-style-type: none"> • IITA Sixth International Conference on "Recent Advances in Agriculture and Horticulture Sciences" at New Delhi. | December 16-17,2017 |
| Dr. M.D. Meena | <ul style="list-style-type: none"> • International Symposium on Horticulture at IIHR, Bengaluru. • Policy dialogue on Innovation in Ensuring Remunerative Prices (MSP) to farmers held at NASC Complex New Delhi. | September 5-8, 2017 March 23, 2018. |
| Dr. A.K. Verma | <ul style="list-style-type: none"> • National conference on Technological Changes and Innovations in Agriculture for Enhancing Farmers' Income" jointly organized by ASM Foundation, JAU and CHAI at JAU, Junagarh | May 28-31, 2017 |
| | <ul style="list-style-type: none"> • Two days training programme on "Stability/combined analysis methodology for NPOF experimental data" at ICAR-IIFSR, Modipuram (UP). | July 25-26, 2017 |
| S.P. Maheria | <ul style="list-style-type: none"> • International conference on "Advances in Potassium Research for Efficient Soil and Crop Management" held at NASC complex, New Delhi, Organized by International Potash Limited, Gurgaon | August 28-29, 2017 |
| | <ul style="list-style-type: none"> • International seminar on Global Climate Change: Implications for Agriculture and Water Sectors at Rukmini, Aurangabad, Maharashtra. | December 14-16, 2017 |
| G. K. Tripathi | <ul style="list-style-type: none"> • International conference on "Advances in Potassium Research for Efficient Soil and Crop Management" held at NASC complex, New Delhi, Organized by International Potash Limited, Gurgaon | August 28-29, 2017 |
| | <ul style="list-style-type: none"> • International seminar on Global Climate Change: Implications for Agriculture and Water Sectors at Rukmini, Aurangabad, Maharashtra. | December 14-16, 2017 |
| | <ul style="list-style-type: none"> • Fourth International Agronomy Congress on "Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to achieve zero hunger challenge", at IARI, Pusa Campus, New Delhi, India | November 21-25, 2017 |
| | <ul style="list-style-type: none"> • International Symposium on Horticulture: Priorities & emerging trends" at IIHR, Bangalore | September 4-8,2017 |
| G. Lal, S.N. Saxena, Y.K. Sharma, O.P. Aiswath, K.Kant R.Singh, S.S. Meena, B.K. Mishra, P.N. Dubey R.S. Meena, N.K. Meena, S.Choudhary, R.D. Meena, A.K. Verma, M.D. Meena, S.P. Maheria, MA Khan, Siyaram Meena, G.K.Tripathi, S.R. Balai, P.K. Agrawal | <ul style="list-style-type: none"> • Seminar on "Sustainable Agriculture Practices for Seed Spices" held at ICAR-NRCSS, Ajmer . | Febuary 24-25, 2018 |



6. AWARDS AND RECOGNITIONS

6.1 Awards

Dr. G. Lal

- Fellow of Indian Society of Spices (FISS) Award-2018, Conferred by Indian Society of Spices, Calicut, Kerala in 2018.
- CHAI-JISL Fellowship-2018, Conferred by Confederation of Horticulture Associations of India in 2018.
- CHAI Fellowship Award-2017, Conferred by Confederation of Horticulture Associations of India in 2017.

Dr. O.P. Aishwath

- Fellow of Indian Society of Spices (FISS) by Indian Society of Spices, Kozhikode, Kerala during inaugural of National Symposium on Spices and Aromatic Crops (SYMSAC-IX) "Spices for doubling farmer's income, held on March 15-17, 2018, at SARD, Medziphema, Nagaland.

Dr. Sharda Choudhary

- "Scientist of the Year Award 2017" in 6th International Conference on Recent Advances in Agriculture and Horticulture Sciences during 16-17 December, 2017 by The Society of Tropical Agriculture held at Delhi.



Dr. G. Lal receiving ISS Fellow Award-2018



Dr. O.P. Aishwath receiving ISS Fellow Award-2018

6.2 Recognitions

Dr. G. Lal

- Chairman, Technical Session-2: Crop Improvement, National Seminar (SYMSAC-IX) on "Spices for doubling farmers' income" during 15-17 March, 2018 at SASRD, Nagaland University, Medziphema, Nagaland, India.
- Co-Chairman, Technical Session-V: Abiotic stress management in: International Seminar on Horticulture: priorities and emerging trends" to be organized by ICAR-IIHR on the occasion on Golden Jubilee of the Institute during September 5-8, 2017.
- Best Poster Presentation Award on "Performance study of coriander varieties (*Coriandrum sativum* L.) in off season for green leaf production" authored by

Lal, G., Singh, R., Mehta, R.S., Meena, N.K. and Choudhary, M.K. 2018. In: Seminar on "Sustainable agricultural practices for seed spices jointly organised by ICAR-NRCSS" at ICAR-NRCSS, Ajmer during 24-25 March, 2018.

Dr. S.N. Saxena

- Co-Chaired technical session-I based on crop improvement in seminar on Seminar on "Sustainable agricultural practices for seed spices" held on 24-25 February, 2018 at ICAR-NRCSS, Ajmer.
- Best poster award (IInd): Agarwal, D. and Saxena, S.N. (2017). Analysis of total phenolics and free radical scavenging capacity in leaf extract of fenugreek (*Trigonella foenum-graecum* L.) genotypes. In: Seminar on "Sustainable agricultural practices for



seed spices" held on 24-25 February 2018 at ICAR-NRCSS, Ajmer. Pp:199

Dr. Y. K. Sharma

- Awarded Certificate of Appreciation for outstanding work and significant contribution in the field of seed spices-Plant Pathology by the Director, ICAR-NRCSS, Ajmer
- Nominated by ASRB, New Delhi as Member in the Committee meeting for assessment of Technical person from T-7/8 to T-9 on November 21, 2017.
- Delivered lecture in Model Training Course on 'Eco-friendly Integrated pest management in arid crops' on February 17, 2018 at ICAR-CAZRI, Jodhpur
- Delivered lecture in Model Training Course (January 19-26, 2018) on Protected Cultivation and Precision Resource Management for Horticultural Crops and Seed Spices at ICAR-NRCSS, Ajmer
- Nominated as Member of AICRP on Spices Monitoring Team by PC, AICRP-Spices, Calicut.

Dr. R. Singh

- "Editorial Excellence Award" presented by Indian Journal of Agricultural Research, ARCC Journals, Karnal.
- Rapporteur in the Inaugural Session of XXVIII AICRP Workshop on Spices, held at Guntur from 10-13 October, 2017 organized at Dr Y S R Horticultural University, Guntur
- Secretary, Indian Society of Seed Spices, Ajmer (Raj.)
- Nominated as Councilor of Indian Journal of Agricultural Research, Karnal.
- Chief Editor of NRCSS Annual Reports 2016-17 (English and Hindi) and News letter of NRCSS and International Journal of Seed Spices published by ISSS.

Dr. S.S. Meena

- Vice President, Indian Society of Seed Spices, Ajmer
- Best Oral Paper Award for paper authored by Ved Kant, N.K. Meena and S.S.Meena (2018). Studies on the effect of date of sowing and comparative effect of weedicides on growth, yield and quality of nigella.

(Nigella Sativa L.) Seminar on "Sustainable Agricultural Practices for Seed Spices" (February 24-25, 2018) ICAR-National Research Centre on Seed Spices, Ajmer (Raj.) India.

Dr. O.P. Aishwath

- Fellow of Gramin va Krishak Vikas Society (FGKVS) by GKV Society, Agra, U.P. during inaugural of National Conference on "Managing soil health for sustainable and nutritional food production" held on 28-29 October, 2017 at JNKVV, Jabalpur, M.P.
- Dr H.S. Mehta Memorial Award for Best Research Paper (Oral Presentation) on Doubling farmers income during Valedictory programme of National Symposium on Spices and Aromatic Crops (SYMSAC-IX) "Spices for doubling farmer's income, held on March 15-17, 2018, at SARD, Medziphema, Nagaland
- Second best poster presentation award for paper authored by Sharma, N., Aishwath O.P. and Lal G.(2018). Effect of Continuous Nitrogen Fertilizers on Available Soil Nutrients of Coriander and Fennel. In: Seminar on Sustainable Agriculture Practices for Seed Spices, held on February 24-25, 2018, at ICAR-NRCSS, Ajmer, Rajasthan.
- Certificate of Honour by the "Bioinfo Publications", for the contribution as 'Associate Editor' of "International Journal of Agriculture Sciences" (ISSN:0975-3710/EISSN:0975-9107) on July 16, 2017.
- Convener' for poster evaluation committee during National Seminar on "Developments in Soil Science - 2017" and "82nd Annual Convention of the Indian Society of Soil Science" held on December 11-14, 2017 at Amity University, Kolkata, W.B.
- 'Rapporteur' in Technical Session II: Crop management. During Seminar on sustainable agriculture practices for seed spices, held on February 24-25, 2018, at ICAR-NRCSS, Ajmer, Rajasthan
- Convener for session III (Abiotic and Biotic Stress Management to Mitigate the Effects of Climate Change) during 26th National Conference on Natural resource management for climate smart sustainable agriculture, September 11-13, 2017, SCSU-CPGS, CAU (I) Barapani, Meghalaya.



Dr. B.K. Mishra

- Chairman of the technical session on Agriculture in the International Conference on Recent trends in agriculture, veterinary & life sciences-2017 during 28-30 December, 2017 at Carmel College for Women, Nuvem, Goa.
- Certificate of Appreciation for outstanding work and significant contribution in the field of seed spices-Agriculture Microbiology by Director, ICAR-NRCSS, Ajmer on occasion of Foundation day function on 19 January, 2018.
- Convener for session IV (Biofertilizers and biocontrol agents for organic agriculture) during 26th National Conference on Natural resource management for climate smart sustainable agriculture, September 11-13, 2017, SCSI-CPGS, CAU (I), Barapani, Meghalaya.
- Editor, 'Masala Surabhi' - Rajbhasha Hindi patrika published by ICAR-NRCSS, Ajmer.
- Editor, Current Horticulture (A research journal published under the aegis of Society for Horticultural Research and Development, Department of Botany, MM (P.G.) College, Modinagar, Ghaziabad, U.P.)
- Member of Academic Council of Bhagwant University, Ajmer and participated in two Academic council meetings during the period under report.
- Treasurer, Indian Society of Seed Spices (ISSS), NRC on Seed Spices, Ajmer-305206 (Raj.)
- Rapporteur in the technical session-II- crop management of seminar on "Sustainable Agricultural Practices for Seed Spices" held during February 24-25, 2018 at ICAR-National Research Center on Seed Spices, Ajmer. Editor of Institute Annual Report 2016-17 of ICAR-NRC on Seed Spices, Tabiji, Ajmer.
- Editor of Institute Annual Report 2016-17 (Hindi-edition) of ICAR-NRC on Seed Spices, Tabiji, Ajmer.
- Editor-NRCSS-e-newsletter – a bimonthly online magazine of ICAR-NRCSS, Ajmer.

Dr. P.N. Dubey

- Member of Flying squad for ICAR's 22nd All India Entrance Examination for admission to U.G. and P.G. degree programs and AICE-SRF-(PGS) [AIEEA-UG/PG

& AICE-SRF-(PGS)-2015] in agriculture and allied science subjects to be held on 21 May 2016.

- Chairman of Technical Session-Life Science and Evaluation of poster presentations in International Conference on Recent trends in agriculture, veterinary & life sciences-2017, 28-30 December, 2017. Nuvem, Goa.
- Member editorial committee-Annual Report of the Institute.
- Editor, 'Masala Surabhi' - Rajbhasha Hindi patrika published by ICAR-NRCSS, Ajmer.

Dr. R.S. Meena

- Co-organizing Secretary of National Seminar on Sustainable Agricultural Practices for Seed Spices during 24-25 February, 2018 at ICAR-NRCSS, Ajmer.
- Rapporteur in the Technical Session on Crop Improvement in Seminar on "Sustainable Agricultural Practices for Seed Spices" during February 24-25, 2018 at ICAR-NRCSS, Ajmer
- Outstanding Scientist Award-2017 in 5th International Conference on "Agriculture, Horticulture and Plant Science" during 24-25 June, 2017 at Rishikesh, U.K., India.
- Certificate of Appreciation for outstanding work and significant contribution in the field of Seed Spices – Plant Breeding and Genetics at ICAR-NRCSS, Ajmer.

Dr. N.K. Meena

- Organizing Secretary of National Seminar on Sustainable Agricultural Practices for Seed Spices during 24-25 February, 2018 at ICAR-NRCSS, Ajmer.
- Outstanding Scientist Award-2017 conferred in 5th International Conference on "Agriculture, Horticulture and Plant Science" organized by International Journal of Tropical Agriculture and Serial Publications Pvt. Ltd. New Delhi, held on 24-25th June, 2017 at Anandam Resort, Rishikesh (Uttarakhand).
- Best oral presentation award on "Diversity of insect pollinators and their potential impact of yield and quality of coriander (*Coriandrum sativum* L.)" In National Conference on Technological Changes and



Innovations in Agriculture for Enhancing Farmers' Income" authored by N.K. Meena *et al.* jointly organized by ASM Foundation, JAU and CHAI during 28-31 May, 2017 at JAU, Junagarh.

- Best poster presentation award on "Performance study of coriander varieties (*Coriandrum sativum* L.) in off season for green leaf production" authored by Lal *et al.* In: Seminar on "Sustainable Agricultural Practices for Seed Spices" held during 24-25 February, 2018 at NRCSS, Ajmer.
- Rapporteur of technical session 'Plant Health Management'. In National level seminar on "Sustainable agricultural practices for seed spices" held during 24-25 February, 2018 at NRCSS, Ajmer

Dr. Sharda Choudhary

- Received Certificate of Appreciation from Director, NRCSS on Foundation Day (19th January, 2018) of NRCSS for Outstanding work and significant contribution in the field of Seed Spices- Plant Biotechnology.

Dr. R.D. Meena

- Rapporteur in Session on Plant Health Management Seminar on "Sustainable agricultural practices for seed spices" held during 24-25 February, 2018 at NRCSS, Ajmer.
- Delivered lecture in Model Training Course (January 19-26, 2018) on problems of horticultural Crops and Seed Spices at ICAR-NRCSS, Ajmer

Dr. A. K. Verma

- Best oral presentation award on "Induction of genetic variability and estimation of gamma ray induced mutants of fennel" authored by Verma, A.K., Choudhary, S., Meena, R.S., Meena, R.D., Sharma, M. and Lal, G. (2017). In: National Conference on "Technological changes and innovations in agriculture for enhancing farmers' income" during 28-31 May, 2017 at Junagadh Agricultural University, Junagadh, Gujarat.
- Best Poster Presentation Award on Estimation of gamma rays induced variation in M₁ generation of fennel (*Foeniculum vulgare* Mill.) authored by Rahul Jatwa, M.K. Vishal, Sharda Choudhary, R.D. Meena, Gopal Lal, R.S. Meena and A.K. Verma. In: Seminar on "Sustainable agricultural practices for seed spices jointly organized during 24-25 March, 2018 ICAR-NRCSS" at ICAR-NRCSS, Ajmer.
- Nominated Presiding Officer for Ajmer Loksabha by-election- 2018 by District Collector, Ajmer.
- Nominated Returning Officer for the ISSS Election- 2018 for different posts in Indian Society for Seed Spices by President, ISSS, Ajmer, Rajasthan.

Sh. S.P. Maheria

- Nodal Officer-Yoga day and organized "Mass Yoga performance of Common Yoga Protocol" on June 21, 2017 at Onkareshwar Mandir Park, Chandravardai Nagar by Staff members of ICAR-NRCSS, Ajmer.



7. LINKAGES AND COLLABORATIONS

Linkages and collaborations are the important tool to enrich and share the knowledge gained by an individual as well as at institute level. This also helps to increase output and share knowledge. ICAR-National Research Centre on Seed Spices, Ajmer has been a key functionary towards collaboration and linkages with various ICAR Institutes, State Agricultural Universities, Central and State government organizations and other govt. and non-government agencies working on the different aspects of seed spices research and development in the country. ICAR-NRCSS has encouraged collaborative research works with parallel institutes or universities. During this period, Institute has established the collaboration and linkages as mentioned below:

All India Coordinated Research Project on Spices (AICRP), Calicut, Kerala.

Central Agricultural University, Campus, Pasighat, Arunachal Pradesh.

Collage of Horticulture and Forestry, Jhalawar, Rajasthan.

Directorate of Arecanut and Spices Development (DASD), Calicut, Kerala.

Farmers, NGOs and Traders.

ICAR-ATARI, Barapani, Meghalaya.

ICAR-ATARI, Jodhpur, Rajasthan.

ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan.

ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.

ICAR-Central Institute of Sub-Tropical Institute (CISH), Lucknow, Uttar Pradesh.

ICAR-Central Institutes of Arid Horticulture (CIAH), Bikaner, Rajasthan.

ICAR-Central Plantation Crop Research Institute, Regional Station, Kahikuchi, Guwahati, Assam.

ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh.

ICAR-Central Sheep and Wool Research Institute, Avikanagar, Tonk, Rajasthan.

ICAR-Central Soil Salinity Research Institute (CSSRI), Karnal, Haryana.

ICAR-CPRI, Regional Station, Upper Shillong, Meghalaya.

ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat.

ICAR-Indian Agricultural Research Institute, Pusa, New Delhi and its regional centres.

ICAR-Indian Institute of Farming Systems Research, Modipuram, Uttar Pradesh.

ICAR-Indian Institute of Horticultural research (IIHR), Bengaluru.

ICAR-Indian Institute of Spices Research (IISR), Calicut, Kerala.

ICAR-National Bureau of Agriculturally Important Micro-organism, Mau, Uttar Pradesh.

ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi.

ICAR-National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur, Maharashtra.

ICAR-National Research Centre on Grapes, Pune, Maharashtra.

ICAR-NRC for Orchids, Pakyong, Sikkim.

ICAR-Protection of Plant Varieties and Farmers Right Authority (PPVFRA), Govt. of India, New Delhi.

ICAR-Spices Board, Cochin, Kerala.

KVKs: Ajmer, Anta, Banswara, Barmer, Bundi, Chomu, Dungarpur, Gudamalani, Jalore, Jhunjhunu, Jhalawar, Kota, Nagaur, Pokhran, Pali & Pratapgarh.

SAU's: i.e. SKRAU, Bikaner; MPUA&T, Udaipur; SKN Agriculture University, Jobner; Kota Agricultural University, Kota; Jodhpur Agricultural University, Jodhpur; SDAU, Dantiwara; CCSHAU, Hisar; PAU, Ludhiana, SKUAT, Sri Nagar; APHU, Hyderabad; UAS, Dharwar and NDUAT, Faizabad.

State Agriculture Department of Rajasthan and Gujarat.



8. PUBLICATIONS

International Journals

1. Agarwal, D., Saxena, S.N., Sharma, L. K. and Lal, G. (2018). Prevalence of essential and fatty oil constituents in 1 fennel (*Foeniculum vulgare* Mill) genotypes grown in semi arid regions of India. *Journal of Essential Oil Bearing Plants*, 21(1): 40-51.
2. Agarwal, D., Saxena, S.N., Vishal, M.K., Sharma, L.K., Dubey, P.N., Lal, G. and Agarwal, A. (2018). Hepatoprotective properties of fennel seeds extract. *MOJ Food Processing & Technology*, 6(1): 00140.
3. Saxena, S. N., Kakani, R.K., Sharma, L.K., Agarwal, D., John, S. and Sharma, Y. (2017). Genetic variation in seed quality and fatty acid composition of fenugreek (*Trigonella foenum-graecum* L.) genotypes grown under limited moisture conditions. *Acta Physiologiae Plantarum*, 39:218. doi :10.1007/s11738-017-2522-6
4. Sharma, R., Sharma, P., Kumar, S., Saxena, S.N., Khandelwal, V. and Rizwan, M. (2017). Heat treatment affects regeneration, protein expression and genetic make-up of *Vigna aconitifolia* (Jacq.) Marechal. *Annals of Agrarian Science*, doi.org/10.1016/j.aasci.2017.12.001
5. Choudhary, S., Jethra, G., Sharma, R.S., Meena, R.S. and Verma, A.K. (2017). Microsatellite in coriander: A cross species amplification within Apiaceae family. *International Journal of Current Microbiology and Applied Sciences*, 6(5): 2714-2721.
6. Choudhary, S., Pareek, D. and Vishal, M.K. (2017). Genetic relationship among coriander genotypes and cluster analysis based on simple sequence repeats (SSR). *International Journal of Tropical Agriculture*, 35(4): 1209-1216.
7. Choudhary, S., Pereira, A., Basu, S. and Verma, A.K. (2017). Differential antioxidant composition and potential of some commonly used Indian spices. *Journal of Agri-Search*, 4(3): 160-166.
8. Choudhary, S., Sharma, R.S., Meena, R.S. and Verma, A.K. (2018). Molecular diversity analysis in fennel (*Foeniculum vulgare* Mill) genotypes and its implications for conservation and crop breeding. *International Journal of Current Microbiology and Applied Sciences*, 7(3): 794-809.

National Journals

1. Agarwal, D., Sharma, L.K. and Saxena, S.N. (2017). Anti-microbial properties of fennel (*Foeniculum vulgare* Mill.) seed extracts. *Journal of Pharmacognosy and Phytochemistry*, 6(4): 479-482.
2. Aishwath, O.P. (2017). Nutrients uptake pattern in some important cultivars of fennel under Typic Haplustepts for their management precisely and farmgate budgeting. *International Journal of Seed Spices*, 7(2): 19-25.
3. Aishwath, O.P., Lal, G., Naimuddin and Singh, B. (2017). Evaluation of nutritional quality of manures: Impact on yield and uptake of nutrients in fenugreek (*Trigonella foenum-graecum*) and soil properties under Typic Haplustepts. *Indian Journal of Agricultural Sciences*, 87(9): 52-58.
4. Barnwal, P., Singh, K.K., Kumar, P. and Saxena, S.N. (2017). Some design parametric considerations of cryogenic pre-cooler for spices grinding. *International Journal of Seed Spices*, 7(1): 12-18.
5. Choudhary, S., Jethra, G., Sharma, R.S., Meena, R.S. and Verma, A.K. (2017). Microsatellite in coriander: A cross species amplification within Apiaceae family. *International Journal of Current Microbiology and Applied Sciences*, 6(5): 2714-2721.
6. Choudhary, S., Pareek, D. and Vishal, M.K. (2017). Genetic relationship among coriander genotypes and cluster analysis based on simple sequence repeats (SSR). *International Journal of Tropical Agriculture*, 35(4): 1209-1216.
7. Choudhary, S., Pereira, A., Basu, S. and Verma, A.K. (2017). Differential antioxidant composition and potential of some commonly used Indian spices. *Journal of Agri-Search*, 4(3): 160-166.
8. Choudhary, S., Sharma, R.S., Meena, R.S. and Verma, A.K. (2018). Molecular diversity analysis in fennel (*Foeniculum vulgare* Mill) genotypes and its implications for conservation and crop breeding. *International Journal of Current Microbiology and Applied Sciences*, 7(3): 794-809.
9. Dubey, P.N., Saha, A, Kant, K., Sharma, Y.K., Saxena, S.N., Mishra, B.K. and Lal, G. (2017). Persistence of azoxystrobin in cumin crop cultivated on sandy loam soils of Rajasthan, India. *International Journal of Seed Spices*, 7(1): 19-22.
10. Dubey, P.N., Saxena, S.N. and Mishra, B.K. (2017). Status of some enzymatic activities in cumin field soil under the influence of propiconazole. *International Journal of Seed Spices*, 7(2): 62-65.
11. Godara, A.S., Singh, R. and Chouhan, G.S. (2017). Response of fenugreek (*Trigonella foenum-graecum* L.) to fertility levels, biofertilizers and brassinosteroid under semi-arid eastern plains zone conditions of Rajasthan. *Indian Journal Agronomy*, (62): 94-99.
12. Godara, A.S., Singh, R., Chouhan, G.S. and Nepalia, V. (2018). Fenugreek productivity and N and P balance sheet with varying fertilizer levels, biofertilizers and



- brassinosteroid in Typic Haplustepts. *Legume Research*: doi:10.18805/LR-3758.
13. Harisha, C.B., Asangi, H. and Singh, R. (2017). Impact of drip irrigation and fertigation on residual soil nutrient status, nutrient uptake and nutrient use efficiency of fenugreek under semi arid conditions. *International Journal of Pure & Applied Bioscience*, (5): 661-667.
 14. Harisha, C.B., Asangi, H., Singh, R., Meena, N.K. and Lal, G. (2017). Irrigation management for higher productivity in seed spices-A review. *International Journal of Current Microbiology and Applied Sciences*, (6): 2334-2345.
 15. Harisha, C.B., Diwakar, Y., Aishwath, O.P., Singh, R. and Asangi H. (2017) Response of *Cuminum cyminum* for various modes of micronutrients application including uptake and their availability in soil. *International Journal of Seed Spices*, 7(1): 48-51.
 16. Kant, K., Meena, N.K., Meena, S.R., Mishra, B.K., Lal, G., Vishal, M.K. and Singh, D.P. (2017). Population dynamics of insect pests, natural enemies and pollinators of fenugreek (*Trigonella foenum-graecum* L.). *International Journal of Seed Spices*, 7(1): 56-59.
 17. Kant, K., Singh, B., Sharma, Y.K., Meena, S.R., Solanki, R.K., Mishra, B.K., Meena, N.K. and Siddiqui, A.U. (2017). Diversity of nematodes population in cumin (*Cuminum cyminum*) crop. *Indian Journal of Agricultural Sciences*, 87 (12): 1664-1667.
 18. Khare, M.N., Tiwari, S.P. and Sharma, Y.K. (2017). Disease problems in the cultivation of coriander (*Coriandrum sativum* L.) and their management leading to production of high quality pathogen free seed. *International Journal of Seed Spices*, 7(1): 1-7.
 19. Khorajiya, M., Shiyani, R., Ardesna, N., Swaminathan, B. and Meena, M.D. (2018). Export competitiveness and performance of Indian livestock export: A balance panel data analysis. *International Journal of Livestock Research*, 8(3): 140-156.
 20. Lal, G., Metha, R.S., Singh, R., Choudhary, M.K. and Maheria, S.P. (2017). Effects of sowing date on plant growth and seed yield of Ajmer Green Coriander-1 in winter season. *International Journal of Seed Spices*, 7(2): 8-13.
 21. Lal, G., Singh, R., Mehta, R.S., Sharma, Y.K., Kant, K. and Maheria, S.P. (2017). Standardization of organic module for sustainable production of fenugreek (*Trigonella foenum-graecum* L.). *Legume Research*, 40(1): 144-149.
 22. Meena, N.K., Lal, G., Meena, R.S., Harisha, C.B. and Meena, S.R. (2017). Pest scenario of coriander (*Coriandrum sativum* L.) and population dynamics in semi-arid region of Rajasthan. *International Journal of Tropical Agriculture*, 35 (4): 779-783.
 23. Meena, N.K., Ram Pal, Barman, D. and Pant, R.P. (2018). Indigenous approaches of orchid pest management in North East India. *Indian Journal of Traditional Knowledge*, 17(1): 209-214.
 24. Meena, R.D., Singh, R., Lal, G., Sharma, Y.K., Kumar, N., Meena, N.K., Meena, S.S., Meena, N.L., Choudhary, S. and Verma, A. K. (2017). Effect of weed invasion on *Ramularia* blight disease incidence in fennel (*Foeniculum vulgare* Mill.). *International Journal of Seed Spices*, 7(1):65-67.
 25. Meena, S.S, Lal, G., Mehta, R.S., Meena, R.D., Kumar, N. and Tripathi, G.K. (2017). Comparative study for yield and economics of seed spices based cropping system with fruit and vegetable crops. *International Journal of Seed Spices*, 7(1): 35-39.
 26. Mehta, R.S., Meena S.S. and Lal, G. (2017). Effect of intercropping seed spices with vegetable for enhancing system profitability. *International Journal of Seed Spices*, 7(2): 33-39.
 27. Mishra, B.K., Dubey, P.N., Aishwath, O.P., Kant, K., Sharma, Y.K. and Vishal, M.K. (2017). Effect of plant growth promoting rhizobacteria on coriander (*Coriandrum sativum*) growth and yield under semi-arid condition of India). *Indian Journal Agricultural Sciences*, 87 (5): 607-612.
 28. Mishra, B.K., Dubey, P.N., Sharma, Y.K. and Kant, K. (2017). Rhizosphere effect in seed spices plants grown under semi-arid conditions. *International Journal of Seed Spices*, 7(2): 40-44.



29. Panwar, A., Sharma, Y.K., Meena, R.S., Solanki, R.K., Aishwath, O.P., Singh, R. and Choudhary, S. (2017). Genetic variability, association studies and genetic divergence in indian fenugreek (*Trigonella foenum-graecum* L.) varieties. *Legume Research*, doi: 10.18805/LR-3803.
30. Patel, A., Verma, P., Choudhary, S. and Verma, A.K. (2017). Lethal dose (LD₅₀) fixation and sensitivity of fenugreek (*Trigonella foenum-graecum* L.) to gamma radiation for induction of mutation. *Journal of AgriSearch*, 4(4): 237-241.
31. Saxena, S.N., Kakani, R.K., Sharma, L.K., Agarwal, D., John, S. and Sharma, Y. (2017). Effect of water stress on morpho-physiological parameters of fenugreek (*Trigonella foenum-graecum* L.) genotypes. *Legume Research*. doi:10.18805/LR3830.
32. Verma, A.K., Dharsekar, P., Choudhary, S., Meena, R.D. and Lal, G. (2018). Estimation of induced variability in M₁ generation of fennel (*Foeniculum vulgare* Mill.). *Journal of Pharmacognosy and Phytochemistry*, 7(1): 430-436.
33. Verma, A.K., Kakani, R.K., Solanki, R.K. and Meena, R.D. (2017). Improvement in yield attributing traits of cumin (*Cuminum cyminum*) through acute exposure of gamma ray. *International Journal of Pure & Applied Bioscience*, 5(2): 312-318.
34. Verma, A.K., Reddy, K.S., Dharsekar, P. and Singh, B. (2017). Effect of acute gamma radiation exposure on seed germination, survivability and seedling growth in cumin cv. Gujarat Cumin-4. *International Journal of Seed Spices*, 7(1): 23-28.
35. Verma, A.K., Sharma, S., Kakani, R.K., Meena, R.D. and Choudhary, S. (2017). Gamma radiation effects seed germination, plant growth and yield attributing characters of fennel (*Foeniculum vulgare* Mill.). *International Journal of Current Microbiology and Applied Sciences*, 6(5): 2448-2458.
36. Verma, A.K., Sindhu, S.S., Anand, P., Singh, A., Chauhan, V.B.S. and Verma, S.K. (2018). Vermi products and biodegradable superabsorbent polymer improve physiological activities and leaf nutrient contents of gerbera. *Research Journal of Biotechnology*, 13 (3): 8-18.
37. Verma, S.S., Verma, R.S., Verma, S.K., Yadav, A.L. and Verma, A.K. (2018). Impact of salt stress on plant establishment, chlorophyll and total free amino acid content of ber (*Zizyphus mauritiana* Lamk.) cultivars. *Journal of Pharmacognosy and Phytochemistry*, 7(2): 556-559.
38. Vyas, D., Kakani, R.K., Agarwal, D., Dubey, P.N. and Saxena, S.N. (2017). Variability in morpho-physiological parameters of fenugreek genotypes. *International Journal of Seed Spices*, 7(2): 1-7.

Other Research Papers

1. Meena, M.D. (2017). Economics and efficiency in groundnut vis-à-vis cotton cultivation A DEA approach. *Journal of Oilseeds Research*, 34(3): 154-160.
2. Meena, M.D., Khunt, K.A. and Khorajia, H. (2018). Sources of growth to Indian groundnut: A state-wise decomposition analysis. *Indian Journal Of Agricultural Research*, 52 (1): 1-8.

Books/ Compendium/ Manuals/ Bulletins

1. Aishwath, O.P. and Lal, G. (2018). Horticultural Crops for Expanding Agriculture in Degraded Land. Pub. Director, ICAR-National Research Centre on Seed Spices, Tabiji-305 206, Ajmer, Rajasthan (Technical Bulletin-2, 2018), pp. 1- 28.
2. Choudhary, S. and Pareek, D. (2017). Cross species amplification of microsatellites in coriander. Lambert Academy Publishing. ISBN: 978-620-2-01871-5, p. -81.
3. Dubey, P.N., Bhaskar, B.P., Chandran, P., Singh, B. and Mishra, B.K. (2017). Major and trace element geochemistry in ferruginous soils developed under hot humid Malabar region, India. In: Sustainable Management of Land Resources-An Indian Perspective (G.P. Obi Reddy, N. G. Patil and Arun Chaturvedi Eds.), Apple Academic Press Inc., Oakville, Canada, pp. 240-269.
4. Kant, K., Lal, G. and Meena, S.R. (2018). Field and Storage insect pests of seed spices and their management. Technical manual published by NRCSS, Ajmer. pp 1-30.



5. Kant, K., Mishra, B.K. and Meena, S.R. (2018). NRCSS Microbial Agents. Folder developed for ICAR-NRCSS Profile. Published by NRCSS, Ajmer.
 6. Lal, G., Cheriyan, Homey, Sharma, Y.K., Meena, N.K., Meena, R.S., Choudhary, S. and Meena, M.D. (2018). Sustainable Agricultural Practices for Seed Spices. Abstract book, published in seminar by Director, ICAR-NRCSS, Ajmer & DASD, Calicut, pp, 1-296.
 7. Lal, G., Meena, R.S., Meena, N.K. and Meena, R.D. (2017). *Bijiye Masalon Ki Unnat Kheti*, published by Director, ICAR-NRCSS, Ajmer (Rajasthan), pp 1-136.
 8. Lal, G., Mehta, R.S., Meena, S.S., Mishra, B.K., Dubey, P.N., Meena, N.K., Verma, A.K., Khan, M.A. and Meena, S.R. (2017). *Bijiye Masala Phasalon ke Utpadan ki Unnat Prodhogikiya*, Farmers Training Manual, Published by Director, ICAR-NRCSS, Ajmer (Raj), pp, 1-94.
 9. Meena, R.S., Lal, G. and Meena, N.K. (2018). *Syah Jeera ki Naveentam Utpadan Prodhogiki*, published by ICAR NRCSS, Ajmer, Rajasthan, pp, 1-6.
 10. Meena, R.S., Lal, G., Choudhary, S. and Meena, N.K. (2018). *Celery ki Naveentam Utpadan Prodhogiki*, published by Director, ICAR-NRCSS, Ajmer (Rajasthan), pp 1-10.
 11. Meena, R.S., Lal, G., Meena, N.K., Verma, A.K. and Meena, R.D. (2018). *Jeere ki Naveentam Utpadan Prodhogiki*, ICAR NRCSS, Ajmer, Rajasthan, pp 1-16.
 12. Singh, R., Choudhary, S., Verma, A.K. and Lal, G. (2018). Training Manual of Model Training Course on "Protected cultivation and precision resource management for horticultural crops and seed spices". ICAR-NRCSS, Ajmer, Rajasthan, pp 1-145.
 13. Singh, R., Meena, R.S., Meena, N.K., Choudhary, S. and Lal, G. (2017). *Bijiye Masalon Avam Dhaniya ka Katai Purva Avam Pashachyat Prabandhan tatha Prasansakaran*, Farmers Training Manual, Published by Director, ICAR-NRCSS, Ajmer (Raj), pp 1-90.
 14. लाल, जी., मीणा, एन.के., मीणा, एस.एस. एवं वर्मा, ए.के. (2017)। बीजीय मसाला फसलोत्पादन। प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर एवं अध्यक्ष, भारतीय बीजीय मसाला समिति, अजमेर, राजस्थान। (आई.एस.पी.एन. नं. 978-93-84189-53-2) पृ. सं. 1-210.
 15. मीणा, एस.एस., चौधरी, एस., महेरिया, एस.पी., लाल, जी. एवं सिंह, आर. (2017)। "बीजीय मसाला फसलों की वैज्ञानिक खेती। कृषक प्रशिक्षण मैनुअल। भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर (राज.) पृ. सं. 1-108.
- E-books/ News letter/ E-news letter**
1. Krishnakant and Meena, S.R. (2017). Production of Entomopathogenic Nematodes (EPN) in Biocontrol Laboratory. Seed Spices-E-Newsletter- Vol. 10(2) :3.
 2. Lal, G., Aishwath, O.P., Mishra, B.K., Meena, N.K. and Khan, M.A. (2017). Bi-monthly E-newsletter Vol. 9(2) March-April, 2017; Vol. 9(3) May-June, 2017; Vol. 9(4) July-August, 2017; Vol. 9(5) Sept-Oct., 2017 and Vol. 9(6) November-December, 2017.
- Extension bulletins/ folders**
1. मीणा, एस.एस., मीणा, आर.एस., मिश्र, बी.के., मीणा, एम.डी. एवं शर्मा, आर (2018)। "जीरा उत्पादन की उन्नत प्रौद्योगिकी" रा.बी.म.अनु.के.-प्रसार पत्रक-1 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 2. मीणा, एस.एस., मीणा, आर.एस., मिश्र, बी.के., मीणा, एम.डी. एवं शर्मा, आर (2018)। "धनिया उत्पादन की उन्नत प्रौद्योगिकी" रा.बी.म.अनु.के.-प्रसार पत्रक-2 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 3. मीणा, एस.एस., मीणा, आर.एस., मिश्र, बी.के., मीणा, एम.डी. एवं शर्मा, आर (2018)। "मेथी उत्पादन की उन्नत प्रौद्योगिकी" रा.बी.म.अनु.के.-प्रसार पत्रक-3 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 4. मीणा, एस.एस., मीणा, आर.एस., मिश्र, बी.के., मीणा, एम.डी. एवं शर्मा, आर (2018)। "सीफ उत्पादन की उन्नत प्रौद्योगिकी" रा.बी.म.अनु.के.-प्रसार पत्रक-4 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 5. मीणा, एस.एस., मीणा, आर.एस., मिश्र, बी.के., मीणा, एम.डी. एवं शर्मा, आर (2018)। "अजवाइन उत्पादन की उन्नत प्रौद्योगिकी" रा.बी.म.अनु.के.-प्रसार पत्रक-5 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।



6. Kant, K., Mishra, B.K. and Meena, S.R. (2018). Technology Folder:-NRCSS Biocotnrol Agents. Published by ICAR-NRC on Seed Spices, Ajmer, India.
7. Lal, G. 2018. Value added products developed from seed spices. Published by Director, ICAR-NRC on Seed Spices, Ajmer, India.
8. Mishra, B.K. and Dubey, P.N. (2018). ICAR-NRCSS A Profile:- ICAR- NRCSS a profile. Published by Director, NRC on See Spices, Ajmer, India.
9. Mishra, B.K. (2018). Technology Folder:-Plant growth Promoting Rhizobacteria. Published by ICAR-NRC on Seed Spices, Ajmer, India.
10. Saxena, S.N. and Dubey, P.N. (2017). Folder on technologies generated from Basic Science Unit of ICAR-NRCSS, Ajmer.

Chapters in books/ manuals/ compendium

1. Aishwath, O.P. (2017). Advances in precise nutrient management in seed spices through integrated approach. In compendium of winter school: "Recent advances in Production, Protection and Processing (PPP) technologies of underutilized and exotic horticultural crops (during 1st to 21st November, 2017 at SKN Agricultural University, Jobner). pp 1-18.
2. Aishwath, O.P. (2017). Doubling the production of seed spices by stretch out cultivation with saline/alkali soils and water in arid and semi-arid regions. In compendium of winter school on "Doubling Income through Advance Approaches for Fruit and Vegetables in the Arid Region" (during 28th October, 2017 to 17th November, 2017 at ICAR-CIAH, Bikaner). p 28-37.
3. Aishwath, O.P. (2017). Spices, medicinal and aromatic plants: An option beyond doubling yield in degraded arid and semi-arid ecosystem. In: Compendium of winter school: "Doubling Income through Advance Approaches for Fruit and Vegetables in the Arid Region" (during 28th October, 2017 to 17th November, 2017 at ICAR-CIAH, Bikaner). pp 15-27.
4. Aishwath, O.P. (2017). Underutilized horticultural crops for degraded lands. In: compendium of winter school: "Recent advances in Production, Protection and Processing (PPP) technologies of underutilized and exotic horticultural crops (during 28th October, 2017 to 17th November, 2017 at SKN Agricultural University, Jobner). pp 1-11.
5. Aishwath, O.P. (2018). Adaptability of seed spices in salt affected environment: An under explored option for curving the problem towards opportunity. In: Compendium of winter school: "Advance technologies for improving the soil health and livelihood in degraded land" (During 30th January to 19th February, 2018 at RVSKVV, Gwalior, M.P.). pp 1-11.
6. Aishwath, O.P. (2018). Adaptation of seed spices for problematic soil and water. In: Souvenir of Seminar on Sustainable Agriculture Practices for Seed Spices, held on February 24-25, 2018, at ICAR-NRCSS, Ajmer, Rajasthan, pp 122-83.
7. Aishwath, O.P. (2018). Ecophysiology of medicinal and aromatic plants makes a bonzer option for mending and utilizing degraded lands and soil ill-health. In: Compendium of winter school: "Advance technologies for improving the soil health and livelihood in degraded land" (30 January to 19 February, 2018) at RVSKVV, Gwalior, M.P.), pp 1-12.
8. Aishwath, O.P. (2018). Soil health under protected cultivation: A legacy under changing environment vis-à-vis natural. In: training manual: Model Training Course on "Protected cultivation and precision resource management for horticultural crops and seed spices" (19 - 26 Jan., 2018), pp 46-49.
9. Aishwath, O.P., Chadha, K.L. and Singh, V. (2017). Horticulture for soil ill health vis-a-vis sustainable use of degraded lands. In: Souvenir of National Conference on "Managing Soil Health for Sustainable and Nutritional Food Production" held during 28-29 October, 2017 at JNKVV, Jabalpur, pp 30-49.
10. Choudhary, S., Jain, D., Meena, M.R., Verma, A.K. and Sharma, R. (2018). Gene silencing in horticultural transgenic crops. In: Rout, G.R., Peter, K.V. (Eds.), Genetic Engineering of Horticultural Crops. Academic Press, Elsevier pp. 47-61. ISBN: 9780128104392.



11. Choudhary, S., Meena, R.S. and Verma, A.K. (2018). Biotechnology and its uses for betterment of horticultural crops. In: Training Manual of Model Training Course on "Protected cultivation and precision resource management for horticultural crops and seed spices" (19-26 January, 2018) at ICAR-NRCSS, Ajmer, pp 91-96.
12. Harisha, C.B., Aishwath, O.P., Singh, R., Meena, N.K. and Honnappa, A. (2018). Importance and scope of micronutrient management in seed spices cultivation. In: Souvenir of Seminar on Sustainable Agriculture Practices for Seed Spices, held on February 24-25, 2018, at ICAR-NRCSS, Ajmer, Rajasthan, pp 77-83.
13. Janakiram, T. and Lal, G. (2018). Recent advances in research and development of seed spices in India. In: Training Manual of Model Training Course (Eds. By Singh *et al.*, 2018). Director, ICAR-NRCSS, Ajmer, pp 01-09.
14. Kakani, R.K., Meena, R.S. and Solanki, R.K. (2017/3) "Improved varieties of seed spice crops" ICAR-NRCSS, Ajmer, PP 5-7.
15. Lal G. and Verma A.K. (2017). Preparation and processing of underutilized seed spices. In: Compendium of Winter School Recent advances in Production, Protection and Processing (PPP) technologies of underutilized and exotic horticultural crops (during 28th October, 2017 to 17th November, 2017 at SKN Agricultural University, Jobner). Dean, SKNCOA (SKNAU), Jobner
16. Lal G. and Verma A.K. (2017). Recent developments in production technology of minor seed spices. In: Compendium of Winter School Recent advances in Production, Protection and Processing (PPP) technologies of underutilized and exotic horticultural crops (during 28th October, 2017 to 17th November, 2017 at SKN Agricultural University, Jobner). Dean, SKNCOA (SKNAU), Jobner
17. Lal, G. (2017). Status and challenges of seed spice research development in India. In: Souvenir of International Symposium on Horticulture: Priorities and Emerging Trends" jointly organized by ICAR, IIHR, SPH & ISHS on the occasion on Golden Jubilee of the IIHR during September 5-8, 2017. Director, ICAR-IIHR, Bengaluru, pp166-174.
18. Lal, G. (2017). High value spices for better profitability- doubling farmer's income. In: Compendium of Winter School on "Doubling income through advance approaches for fruits and vegetables in arid region". Director, CIAH, Bikaner
19. Lal, G. (2017). Organic farming scope and prospects and practices in seed spices. In: Summer School on "Modern Concepts and Practices of Organic Farming for safe, secured and sustainable food production" to be held during 14 July to 03 August 2017 at ICAR-IIFSR, Modipuram. Director, ICAR-IIFSR, Modipuram.
20. Lal, G. (2018). Doubling of farmer's income through seed spices diversification. In: Souvenir & Abstract Book of Seminar on Sustainable Agricultural practices for Seed Spices (Eds. By G. Lal *et al.*, 2018). Director, ICAR-NRCSS, Ajmer & Director, DASD, Calicut, pp 1-8.
21. Lal, G. (2018). Organic farming scope, prospects and practices in seed spices. In: Compendium of Winter School on "Enhancing the productivity of Rainfed Agro-ecosystem through Suitable Interventions". (Eds by Kothari *et al.*, 2018). Chief Scientist, Dryland Farming Research Station (MPUAT), Bhilwara, Rajasthan, pp 78-85.
22. Lal, G. (2018). Postharvest management and value addition in seed spices. In: Training Manual of Model Training Course (Eds. By Singh *et al.*, 2018). Director, ICAR-NRCSS, Ajmer. Pp 21-24.
23. Lal, G. (2018). Scope and opportunities of seed spices cultivation for livelihood improvement. In: Souvenir & Abstracts Book of National Symposium on Spices and Aromatic Crops (SYMSAC-IX): Spices for doubling farmers' income. SASRD, Nagaland University, Medziphema, Nagaland and ISS, IISR, Calicut, pp 29-35.
24. Lal, G., Mishra, B.K. and Maheria, S.P. (2017). Influence of climate change on biotic and abiotic stresses of seed spices. In: Proceedings and Book of Abstracts, International seminar on Global Climate



- Change: Implications for Agriculture and Water Sector. Director of Research, VNMKV, Prabhani, Maharashtra, pp23-25.
25. Meena, R.S., Choudhary, S., Meena, R.D., Solanki, R.K., Kakani, R.K. and Panwar, A. (2/2016) on "Beejiya Masala Phaslo ke Utpadan ke Beej Utpadan ki Adhunik Prodhogiki". ICAR- NRCSS, Ajmer, Rajasthan, India, pp 7-11.
26. Meena, R.S., Lal, G. and Choudhary, S. (2018). "Improved varieties of seed spice crops suitable for limited moisture condition". In: Training Manual of Model Training Course on "Protected cultivation and precision resource management for horticultural crops and seed spices" (19-26 January, 2018) at ICAR-NRCSS, Ajmer, pp 102-106.
27. Meena, S.S. and Meena, R.D. (2018). Advance production technologies for minor seed spices in resilience climate change. In: Training Manual on "protected cultivation and precision resource management for horticultural crops and seed spices at ICAR-NRCSS, Ajmer, pp 80-84.
28. Mishra, B.K. (2017). Microbial safety of horticultural crops for getting higher profitability. In: ICAR sponsored winter school on "doubling income through advance approaches for fruit and vegetables in the arid region", on 09-11-2017, at ICAR-CIAH, Bikaner (Raj.).
29. Mishra, B.K. (2017). Microbial quality aspect in spices processing. In: ICAR sponsored winter school on "recent advances in production, protection and processing technologies for under-utilized and exotic horticultural crops" on 20-11-2017 at SKN college of Agriculture, Jobner (Raj.).
30. Mishra, B.K. (2017). Techniques to enhance biogas production during winter season and Biotechnological innovations for effective anaerobic digestion. In: ICAR sponsored winter school on "Production of Bio-CNG and organic manure through anaerobic agro-waste decomposition techniques", on 14-08-2017, at Dryland Farming Research Station, MPUAT, Arjia, Bhilwara (Raj.).
31. Mishra, B.K. (2018). Bijiye masala faslon hetu jaiv urvark. In: Book of lead papers and abstracts for National seminar on "sustianable agricultural practices for seed spices" held during February-24-25, 2018 at ICAR-National Research Center on Seed Spices, Ajmer, pp 125.
32. Saxena, S.N. (2018). Role of plant growth regulators in improving abiotic stress tolerance and essential oil content in seed spices. In: book of lead papers and abstract published during seminar on sustainable agricultural practices for seed spices at ICAR-NRCSS, Ajmer on 24-25 February, 2018.
33. Saxena, S.N. and Dubey, P.N. (2018). Prevalence of bioactive compounds in seed spices and their medicinal uses. In: Training Manual of model training course on "Protected cultivation and precision resource management for horticultural crops and seed spices" held at ICAR-NRCSS, Ajmer on 19-26 January, 2018.
34. Sharma, Y.K. 2018. बीजीय मसालों के प्रमुख रोग एवं उनका प्रबन्धन. Lead paper presented in National Seminar on Sustainable Agricultural Practices for Seed Spices, February 24-25, 2018 at ICAR-NRCSS, Ajmer.
35. Singh, R., Choudhary, S. and Verma, A.K. (2018). Protection technologies for seed spices in semi-arid conditions for Rajasthan and Gujarat. In: Training Manual of Model Training Course on "Protected cultivation and precision resource management for horticultural crops and seed spices" ICAR-NRCSS, Ajmer, Rajasthan, India. pp 16-20.
36. Solanki, R.K., Sharma, Y.K., Meena, R.S., Dubey, P.N. and Singh, B. (2017). Cumin In: Breeding of Horticulture Crops Vol. 1 (Part-A) Spices and Plantation Crops (V. A. Parthasarathy, C. Aswath, K. Nirmal Babu, R. Senthil Kumar Eds.). Today & Tomorrow;s Printers & Publishers, Daryaganj, New Delhi, India. pp, 393-408.

Popular article/ technical article

Hindi

1. Choudhary, S., Meena, R.S. and Verma, A.K. (2018). "Jaiv prodhogiki ka beejiya masalo ke sudhar ke liye



- upyog" (in Hindi). In Book of Lead paper & Abstracts for Seminar on "Sustainable Agricultural Practices for Seed Spices. Published by ICAR-NRCSS and DASD, Calicut (Kerala). Pp. 141-145.
2. Choudhary, S., Meena, R.S. and Verma, A.K. (2017). "Beejiya Masalo ke beej utpadan ki aadhunik prodhyogiki" In: Farmers training manual 1/2017 on "Beejiya Masala Fasalo ki vaigyanik kheti". Published by ICAR-NRCSS, Ajmer, Rajasthan, India. Pp: 32-35.
 3. Lal, G. and Singh, R. (2017). "Adhik Utpadakta evam uchch gunvatata hetu Beejiya Masala Fasalo ki Vaigyanik Kheti" In: Farmers training manual 1/2017 on "Beejiya Masala Fasalo ki vaigyanik kheti". Published by ICAR-NRCSS, Ajmer, Rajasthan, India, pp1-6.
 4. Lal, G., Singh, R., Godara, A.S. and Agrawal, P.K. (2017). "Vegyanik vidhi se beejiya masala fasalo ka utpadan" In: Farmers training manual 1/2017 on "Beejiya Masala Fasalo ki vaigyanik kheti". Published by ICAR-NRCSS, Ajmer, Rajasthan, pp22-25.
 5. Lal, G., Meena, S.S., Singh, R., Meena, M.D. and Agrawal, P.K. (2017). "Beejiya Masala Fasale: Jaivik Kheti" In: Farmers training manual 1/2017 on "Beejiya Masala Fasalo ki vaigyanik kheti". Published by ICAR-NRCSS, Ajmer, Rajasthan, pp 75-79.
 6. Meena, M.D. and Meena, R.S. (2018). *Bharat me masala faslo ki kheti our arthik vishleshan*. In: Book of lead papers and abstracts for seminar on Sustainable Agricultural Practices for seed spices. (Lal, G. et.al.,eds.). Published by Director, ICAR-NRCSS, Ajmer and Director, DASD, Calicut: pp. 70-76.
 7. Meena, M.D., Khan, M.A. and Tripathi, G.K. (2017). *Adhik aamdani ke liye bijiya masala fasle ek behtrin vikalp*. In: Bijiyee masala faslo ki vegyani kheti, krushak prashiksan manual 1/2017 (Meena S.S. et.al.,eds.): pp. 67-69.
 8. Mishra, B.K. (2017). *Jai urvark: tikau kirshi ke liye aavashyak*. *Krishi expert feature article July 2017*. (www.krishiexpert.com/articles/).
 9. Verma, A.K. and Choudhary, S. (2018). *Beejiya masalo me utparivartan prajanan*. In: Book of Lead paper and Abstracts for Seminar on "Sustainable Agricultural Practices for Seed Spices. Published by ICAR-NRCSS and DASD, Calicut (Kerala). Pp.164-168.4.
 10. लाल, जी. एवं विशाल, एम.के. (2017)। बीजीय मसालों का भारतीय अर्थव्यवस्था में महत्व। पुस्तक: बीजीय मसाला फसलों के उत्पादन की उन्नत प्रौद्योगिकियों। कृषक प्रशिक्षण मैनुअल- 2017/1। (सम्पादक: जी.लाल, आर.एस. मेहता, एस.एस.मीणा, वी.के.मिश्र, पी.एन.दुबे, एन.के.मीणा, ए.के. वर्मा, एम.ए. खान एवं एस.आर.मीणा) प्रकाशक: निदेशक, भा.कृ.अनु.प-रा.बी.म.अनु.के., अजमेर। पृ.सं 1-5।
 11. लाल, जी., मीणा, एन.के., वर्मा, ए.के., चौधरी, एम.के. एवं शेखावत, एन. (2017)। जैविक खेती अन्तर्गत धनियाे की विभिन्न किस्मों का मूल्यांकन मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान। (2):10-12
 12. लाल, जी., त्रिपाठी, जी.के. एवं चौहान, पी. (2017)। फसल अवशेषों का उचित प्रबंधन एवं पर्यावरण सुरक्षा मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान, (2):22-25.
 13. लाल, जी., शेखावत, एन. एवं चौधरी, एम.के. (2017)। मेथी की उन्नत खेती एवं मूल्य संवर्धन मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान, (2):43-45.
 14. लाल, जी., विशाल एम.के. एवं मीणा, एम. (2017)। बीजीय मसाला: भारतीय मसालों का गौरव, मसाला, सुरभि भा.कृ. अनु.प-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर (राजस्थान), (1):8-9.
 15. लाल जी., एवं शेखावत, एन. (2017)। सोवा का खाद्य प्रसंस्करण एवं मूल्य संवर्धन, मसाला सुरभि भा.कृ.अनु. प-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर (राजस्थान), (1):17-18.
 16. लाल, जी. (2017)। जीरा लोकगीत, मसाला सुरभि भा.कृ. अनु.प-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर (राजस्थान), (1):21.
 17. कृष्णकांत एवं मीणा, एस.आर. (2017)। भंडारण कीटों से बीजीय मसाला फसलों की सुरक्षा। मसाला सुरभि, द्वितीय अंक भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान, पृ. सं. 26-28.





18. मीणा, एन.के., मीणा, आर.एस. एवं लाल, जी. (2017)। धनिया की उन्नत उत्पादन तकनीकी, राजस्थान खेती प्रताप, निदेशक, प्रसार शिक्षा, एम.पी.यू.ए.टी., उदयपुर, अक्टूबर, 2017, पृ.सं. 10-11.
19. मीणा, एन.के., लाल, जी. एवं मीणा, एस.एस. (2017)। बीजीय मसाला फसलों में मधुमक्खियों द्वारा परागण का महत्व। मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, पृ. सं. 31-32.
20. मीणा, एस.एस., लाल, जी. एवं अग्रवाल, पी.के. (2017)। फलदार वृक्षों के साथ बीजीय मसाला फसलों की खेती, मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, (1):13-16.
21. मीणा, एस.एस. एवं अग्रवाल, पी.के. (2017)। अजवाइन: खरीफ मौसम के लिए एक लाभदायक बीजीय मसाला फसल, मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, (1):12-16.
22. मीणा, एस.एस., शर्मा, वाय.के., मीणा, आर.एस. एवं मीणा, आर.एस. (2017)। बीजीय मसालों का भण्डारण एवं प्रबंधन। बीजीय मसाला फसलों की वैज्ञानिक खेती, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, (1):20-21.
23. मीणा, एस.एस. एवं अग्रवाल, पी.के. (2017)। आधुनिक उन्नत प्रौद्योगिकी द्वारा गीणीय बीजीय मसाला फसलों की खेती। बीजीय मसाला फसलों की वैज्ञानिक खेती, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, (1):43-47.
24. मीना, आर.डी. एवं शर्मा, वाय.के. (2017)। प्रमुख बीजीय मसाला फसलों की व्याधियां तथा प्रबंधन। "मसाला सुरभि" राजभाषा हिन्दी पत्रिका, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर, पृ. सं. 22-24.
25. मीना, आर.डी. एवं शर्मा, वाय.के. (2017)। जीरे की उमरती हुई प्रमुख बीमारियां एवं विकार। "मसाला सुरभि" राजभाषा हिन्दी पत्रिका, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर, पृ. सं. 58.
26. सिंह, आर., लाल, जी., मीणा, एस.एस., चौधरी, एस. एवं महेरिया, एस.पी. (2017)। जीरा उत्पादन की आधुनिक प्रौद्योगिकी। मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, पृ. सं. 3-7।
27. सिंह, आर., लाल, जी., चौधरी, एस. एवं अग्रवाल, पी. (2017)। बूंद-बूंद प्रणाली द्वारा बीजीय मसाला फसलों में परिशुद्ध जल एवं उर्वरक प्रबंधन। प्रशिक्षण मैनुअल 1/2017- बीजीय मसाला फसलों की वैज्ञानिक खेती, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, पृ. सं. 7-10।
28. सिंह, आर., लाल, जी., ऐश्वथ, ओ.पी., मीणा, एस.एस. एवं अग्रवाल, पी.के. (2017)। बीजीय मसाला फसलों में समन्वित पोशक तत्वों द्वारा प्रबंधन। प्रशिक्षण मैनुअल 1/2017- बीजीय मसाला फसलों की वैज्ञानिक खेती, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर राजस्थान, पृ. सं. 40-42।
29. गोदारा, ए.एस., सिंह, आर. एवं लाल, जी. (2017)। गेहूँ की उन्नत शस्य क्रियाएँ। प्रशिक्षण मैनुअल 1/2017- बीजीय मसाला फसलों की वैज्ञानिक खेती, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, पृ. सं. 91-95।
30. दुबे, पी.एन. एवं सक्सेना, एस.एन. (2017)। कृषि में कीटनाशकों का सुरक्षित उपयोग। मसाला सुरभि, राजभाषा पत्रिका प्रथम अंक। प्रकाशक- निदेशक, भा.कृ. अनु.प.-रा. बी.म.अनु.केंद्र, अजमेर, पृ. सं. 40-44।
31. जाट, एम.के., दुबे, पी.एन., मीणा, एन.के. और तैतरवाल, ए. एस. (2017)। राजस्थान में मुधमक्खी पालन एवं प्रबंधन। मसाला सुरभि, राजभाषा पत्रिका द्वितीय अंक। प्रकाशक- निदेशक, भा.कृ. अनु.प.-रा.बी.म.अनु.केंद्र, अजमेर, पृ. सं. 46-50।
32. ऐश्वथ, ओ.पी., मिश्र, बी.के., दुबे, पी.एन., विशाल, एम.के. एवं लाल, जी. (2017)। लयणीय एवं क्षारीय जल एवं मृदाओं के लिए मुख्य बीजीय मसालें। मसाला सुरभि, प्रथम अंक, भा.कृ. अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, पृ. सं. 20-21।
33. विशाल, एम.के., कुमार, एन., रेड्डी, जी.ओ.बी.पी., सिंह, आर. एवं ऐश्वथ, ओ.पी. (2017)। भारत में जीरा उत्पादन। मसाला सुरभि, द्वितीय अंक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान, पृ. सं. 42-68।
34. ऐश्वथ, ओ.पी. (2017)। मृदा उर्वरता को प्रभावित करने वाले मुख्य कारक एवं प्रबंधन। मसाला सुरभि, द्वितीय अंक, भा.कृ. अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी, अजमेर, राजस्थान,
35. चौधरी, एस., सिंह, आर., महेरिया, एस.पी., खान, एम.ए. एवं मिश्रा, जे. (2017)। स्वास्थ्य हेतु बीजीय मसालों में अंतर्निहित औषधीय गुण। मसाला सुरभि, द्वितीय अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, तबीजी अजमेर।

36. खान, एम.ए. (2017)। जीरा खाने से लाभ। मसाला सुरभि, द्वितीय अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजिय मसाला अनुसन्धान केंद्र, तबीजी अजमेर, पृ. सं. 66।
37. वर्मा, ए.के. (2017)। जलवायु परिवर्तन के युग में बीजिय मसाला फसलों की खेती, मसाला सुरभि, द्वितीय अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजिय मसाला अनुसन्धान केंद्र, तबीजी अजमेर, पृ. सं. 31-33।
38. मिश्र, ए. एवं मिश्र, बी.के. (2017)। राजभाषा हिन्दी की प्रति गांधी जी के विचारों का संकलन। मसाला सुरभि, प्रथम अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजिय मसाला अनुसन्धान केंद्र, तबीजी अजमेर, पृ. सं. 33।
39. देवी, डी. एवं मिश्र, बी.के. (2017)। जीव उर्वरकों का कृषि में महत्व। मसाला सुरभि, द्वितीय अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजिय मसाला अनुसन्धान केंद्र, तबीजी अजमेर, पृ. सं. 34-37।
40. मिश्रा, बी.के. (2017)। बीजिय मसाला फसलों में जैविक खाद का सफल प्रयोग। मसाला सुरभि, प्रथम अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजिय मसाला अनुसन्धान केंद्र, तबीजी अजमेर, पृ. सं. 45-46।
41. सक्सेना, एस.एन. एवं दुबे, पी.एन. (2017)। जीरे की भौतिक एवं रसायनिक संरचना। मसाला सुरभि, द्वितीय अंक, प्रकाशक - निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजिय मसाला अनुसन्धान केंद्र, तबीजी अजमेर, पृ. सं. 64-65।
42. नीगा, एस.आर., त्रिपाठी, जी.के., बलाई, एस.आर. एवं चौहान, पी. (2017)। स्वास्थ्य कर्क अजवाइन, मसाला सुरभि राजभाषा हिन्दी पत्रिका, रा.बी.म.अनु.केंद्र, अंक द्वितीय, पृ. सं. 56-57।
43. नीगा, एस.आर., त्रिपाठी, जी.के., अग्रवाल, पी.के., बलाई, एस.आर. एवं चौहान, पी. (2017)। मसालेदार सौंफ शर्बत, मसाला सुरभि राजभाषा हिन्दी पत्रिका, अंक प्रथम, रा.बी.म. अनु.केंद्र, पृ. सं. 36।
- “Protected cultivation and precision resource management for horticultural crops and seed spices”. Published by ICAR-NRCSS, Ajmer, Rajasthan pp 10-15.
3. Lal, G., Meena, R.S., Choudhary, S. and Verma, A.K. (2017). Coriander at a glance. Indian Horticulture (September- October)- Hort Facts Sheet-Cover-III.
4. Meena M.D. (2018). An economic analysis of protected cultivation technologies. In: Protected cultivation, Training manual 1/2018 (Singh, R. et.al., eds.). Published by Director, ICAR-NRCSS, Ajmer.
5. Mishra, B.K. (2018). Application of microbial inoculants for better yield and quality In: Training manual of Model Training course on “Protected cultivation and precision resource management for horticultural crops and seed spices” (Singh, R., Choudhary, S., Verma A.K. and Lal G., Eds.), ICAR-NRC on Seed Spices, Ajmer, pp 109-114.
6. Saxena, S.N. and Dubey, P N. (2018). Technologies generated from basic science unit of ICAR-NRCSS, Ajmer. Published by Director, ICAR-NRCSS, Ajmer.
7. Saxena, S.N., Dubey, P.N. and Lal, G. (2018). Technical bulletin on essential oil extraction technology from seed spices crop residues. Published by Director, ICAR-NRCSS, Ajmer, pp 1-14.
8. Verma, A.K. and Singh, R. (2018). Techniques of soilless culture for horticultural crops. In: Training Manual of Model Training Course on “Protected cultivation and precision resource management for horticultural crops and seed spices”. Published by ICAR-NRCSS, Ajmer, Rajasthan, pp 73-79.
9. Verma, A.K., Singh, R., Choudhary, S. and Lal, G. (2018). Cultivation of dollar earning cumin crop for higher income. Acta Scientific Agriculture, 2(3): 46-48.

English

1. Choudhary, S., Meena, R.S. and Verma, A.K. (2018). Biotechnology and its uses for betterment of horticultural crops. In: Training Manual of Model Training Course on “Protected cultivation and precision resource management for horticultural crops and seed spices”. Published by ICAR-NRCSS, Ajmer, Rajasthan, pp 91-96.
2. Janakiram, T. and Verma, A.K. (2018). Prospects of protected cultivation in ornamental horticulture. In: Training Manual of Model Training Course on

Paper presentation in Conference/ Symposia/ Seminar (page no. each abstract)

1. Agarwal, D. and Saxena, S.N. (2017). Analysis of total phenolics and free radical scavenging capacity in leaf extract of fenugreek (*Trigonella foenum-graecum* L.) genotypes. In: Seminar on “Sustainable agricultural



- practices for seed spices" held on 24-25 February 2018 at ICAR-NRCSS, Ajmer. Pp:199.
2. Agarwal, D., John, S. and Saxena, S.N. (2017). Physico-chemical characterization of coriander, cumin, fennel and fenugreek seed extracts. In: Seminar on "Sustainable agricultural practices for seed spices" held on 24-25 February 2018 at ICAR-NRCSS, Ajmer. Pp:200.
 3. Aishwath, O.P. (2018). Adaptation of seed spices for problematic soil and water. In Proc. Seminar on Sustainable Agriculture Practices for Seed Spices, held on February 24-25, 2018, at ICAR-NRCSS, Ajmer, Rajasthan. pp. 122-83.
 4. Aishwath, O.P., Dubey, P.N., Yadav, R.K., Meena R.L. and Jha, B.K. (2017). Abiotic and edaphic stresses: proving causes of reddening and non-pathogenic mortality in cumin seedlings. In Proc. 26th National Conference on Natural Resource Management for Climate Smart Sustainable Agriculture, September 11-13, 2017, SCSU-CPGS, CAU (I), Barapani, Meghalaya. pp. 72.
 5. Aishwath, O.P., Dubey, P.N., Yadav, R.K., Meena, R.L. and Jha, B.K. (2017). Performance of dill (*Anethum graveolens*) with sodic irrigation water in Typic Haplustepts. In Proc. National Seminar on "Developments in Soil Science - 2017" and 82nd Annual Convention of the Indian Society of Soil Science held on December 11-14, 2017 at Amity University, Kolkata, W.B. pp. 10.
 6. Aishwath, O.P., Mehta, R.S. and Lal, G. (2017). Response of coriander (*Coriandrum sativum*) to vermi-compost prepared from seed spices crop residues including nutritional parameters of soil and plant. In: Proc. National Conference on "Managing Soil Health for Sustainable and Nutritional Food Production" held during 28-29 October, 2017 at JNKVV, Jabalpur, M.P. pp. 10-11.
 7. Aishwath, O.P., Singh, R. and Jha, B.K. (2017). Liming influence on yield and uptake of nutrients by coriander and soil available nutrients under Typic Haplustalfs. In Proc. National Symposium on Spices and Aromatic Crops (SYMSAC-IX) "Spices for doubling farmer's income, held on March 15-17, 2018, at SARD, Medziphema, Nagaland. pp. 72.
 8. Choudhary, S. (2017). Genetic relationship among coriander genotypes and cluster analysis based on simple sequence repeats (SSR) In: 6th International Conference on Recent Advances in Agriculture and Horticulture Sciences held at New Delhi, from 16-17 December, 2017.
 9. Choudhary, S. (2018). Use of biotechnology in improvement of Seed Spices. In: Seminar on "Sustainable Agricultural Practices for Seed Spices". Organized by ICAR-NRCSS and DASD, Calicut (Kerala). At ICAR-NRC on Seed Spices, Ajmer in technical session-I.
 10. Choudhary, S., Pareek, D., Vishal, M.K. (2017). Genetic relationship among coriander genotypes and cluster analysis based on simple sequence repeats (SSR)". In 6th ICRAAHS at New Delhi, India. Organized by The Society of Tropical Agriculture, from 16-17 December, 2017. pp. 209-1216.
 11. Dhakar, L., Jat, S. and Meena R.S. (2018). Genetic divergence in fennel (*Foeniculum vulgare* Mill.) genotypes In: Book of Lead paper and Abstracts for Seminar on Sustainable Agricultural Practices for Seed Spices held during 24-25 March 2018 at ICAR-NRCSS, Ajmer.
 12. Jatwa, R. Vishal, M.K., Choudhary, S., Meena, R.D., Lal, G., Meena, R.S. and Verma, A.K. (2018). Estimation of gamma rays induced variation in M2 generation of fennel (*Foeniculum vulgare* Mill.). In: Seminar on "Sustainable Agricultural Practices for Seed Spices jointly organised by ICAR-NRCSS" at ICAR-NRCSS, Ajmer during 24-25 March 2018. Pp. 194.
 13. Kant, V., Meena, N.K. and Meena, S.S. (2018). Studies on the effect of date of sowing and comparative effect of weedicides on growth, yield and quality of nigella. (*Nigella Sativa* L.) Seminar on "Sustainable Agricultural Practices for Seed Spices" (February 24-25, 2018) ICAR-National Research Centre on Seed Spices, Ajmer (Raj.), India. Pp. 232.



14. Kant K. (2017). Storage insect pests and their management in seed spice crops. In: Winter school "Recent advance in production, protection and processing (PPP) technologies of underutilized and exotic horticultural crops (1st to 21st November, 2017) at SKNAU, Jobner (Raj.).
15. Kant K. (2017). Seed spice pest. and their management. In: Winter school "Recent advance in production, protection and processing (PPP) technologies of underutilized and exotic horticultural crops (1st to 21st November, 2017) at SKNAU, Jobner (Raj.).
16. Kant K. (2018). IPM in seed spices. In: Model Training Course on "Ecofriendly Integrated Pest Management in Arid Crops" at CAZRI, on 17th February, 2018.
17. Kant K., Meena, S.R. and Meena, N.K. (2018). बीजीय मसाला पारिस्थितिकीय तंत्र में हानिकारक कीट और उनका प्रबंधन। In: National Seminar on Sustainable Agricultural Practices for Seed Spices, during 24-25 February, 2018, at Ajmer, India, pp.106-115.
18. Lal, G. (2017). Status and challenges of seed spice research development in India. In: International Seminar on Horticulture: Priorities and emerging Trends" organized by ICAR-IIHR on the occasion on Golden Jubilee of the Institute during September 5-8, 2017 at Bangalore.
19. Lal, G. (2018). Doubling of farmer's income through seed spices diversification. In: Seminar on "Sustainable Agricultural practices for Seed Spices" during 24-25 March, 2018 at ICAR-NRCSS, Ajmer .
20. Lal, G. (2018). Scope and opportunities of seed spices cultivation for livelihood improvement. In: National Seminar (SYMSAC-IX) on "Spices for doubling farmers' income" during 15-17 March 2018 at SASRD, Nagaland University, Medziphema, Nagaland, India.
21. Lal, G., Meena, N.K., Choudhary, M.K. and Shekhawat, N. (2018). Evaluation of green gram cultivars for their suitability under organic production system. In: Book of Lead paper and Abstracts for Seminar on "Sustainable Agricultural Practices for Seed Spices held during 24-25 March 2018 at ICAR-NRCSS, Ajmer, pp.250.
22. Lal, G., Mishra, B.K. and Maheria, S.P. (2017). Influence of climate change on biotic and abiotic stresses of seed spices. In: International Seminar on Global Climate Change: Implications for Agriculture and Water Sector held during December 14-16, 2017 by VNMKV, Prabhani, at Aurangabad, Maharashtra.
23. Lal, G., Singh, Ravindra., Mehta, R.S., Meena, N.K. and Choudhary, M.K. (2018). Performance study of coriander varieties (*Coriandrum sativum* L.) in off season for green leaf production In: Book of Lead paper and Abstracts for Seminar on Sustainable Agricultural Practices for Seed Spices held during 24-25 March 2018 at ICAR-NRCSS, Ajmer, pp. 249.
24. Meena, N.K., Lal, G., Meena, R.S., Meena, S.S. and Harisha, C.B. (2017). Diversity of insect pollinators and their potential impact on yield and quality of coriander (*Coriandrum sativum* L.). In National Conference on Technological Changes and Innovations in Agriculture for Enhancing Farmers' Income held during 28-31 May, 2017 at JAU, Junagarh, pp.147-148.
25. Meena, R.S. (2018). Improved varieties for increasing productivity and quality of seed spices. In: Book of Lead paper and Abstracts for Seminar on Sustainable Agricultural Practices for Seed Spices held during 24-25 March 2018 at ICAR-NRCSS, Ajmer.
26. Meena, R.S. (2018). Quantitative Genetic Analysis in some genotypes of cumin (*Cuminum cyminum* L.)" in 5th International Conference on "Agriculture, Horticulture and Plant Science" at Rishikesh, U.K., India during 24-25 June, 2017.
27. Meena, S.R., Kant, K. and Meena, N.K. (2018). Storage insect pests of seed spice and their management In: National Seminar on Sustainable Agricultural Practices for Seed Spices.", Souvenir & Abstract Book, pp. 169-179 during 24-25 February, 2018 jointly Organised by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.



28. Meena, S.S., Lal, G., Meena, M.D. and Sharma, D.K. (2018). Effect of weed management practices on quality and seed yield of nigella (*Nigella sativa* L.) National Symposium on "Spices, Medicinal and Aromatic Crops SYMSAC-IX Spices for doubling farmer's income" (15-17 March, 2018), School of Agricultural Science & Rural Development, Nagaland University, Medziphema, Nagaland Pp.189.
29. Meena, S.S., Lal, G., Mehta, R.S. and Agrawal, P.K. (2018). Intercropping of seed spices with fruit trees and vegetables: a profitable enterprise. A Seminar on "Sustainable Agricultural Practices for Seed Spices" (February 24-25, 2018) ICAR-National Research Centre on Seed Spices, Ajmer (Raj.), pp. 116-221.
30. Meena, S.S., Lal, G., Mehta, R.S. and Nanoma, R. (2017). Response of spacing and fertilizer levels on different genotypes of ajwain (*Trachyspermum ammi* L.). In: 26th National Conference on "Natural Resource Management for Climate Smart Sustainable Agriculture"(11-13 September, 2017). College of Post Graduate Studies, CAU (I), Barapani, Shillong, Meghalaya, pp. 79.
31. Mishra, B.K. (2017). Effect of plant growth promoting rhizobacteria on growth and yield characteristics of coriander (*Coriandrum sativum* L.). In: Book of lead papers and abstracts for international conference on recent trends in agriculture, veterinary & life sciences-2017 held during 28-30 December, 2017 at Carmel college for women, Nuvem, Goa , pp53.
32. Mishra, B.K. and Sharma, Y.K. (2017). Role of endophytes in plant health management of seed spices. In: Sanjay Swami, Sanjay Arora, N.B. Singh and Suraj Bhan (Eds.) Abstracts, 26th National conference on natural resource management for climate smart sustainable agriculture, September 11-13, 2017, SCSI-CPGS, CAU, Barapani, Meghalaya, pp.91.
33. N.K. Meena, G. Lal, R.S. Meena, Harisha C.B., and S.R. Meena. (2017). Pests scenario of coriander (*Coriandrum sativum* L.) and their population dynamics in semi-arid region of Rajasthan. Oral paper presented In UTA 5th International Conference on "Agriculture, Horticulture and Plant Science" organized by International Journal of Tropical Agriculture and Serial Publications Pvt. Ltd. New Delhi, held during 24-25th June, 2017 at Anandam Resort, Rishikesh (Uttarakhand).
34. N.K. Meena (2018). Pollinators of seed spices and their impact on enhancement of yield and quality. In: technical session 'Plant Health Management' of National Seminar on "Sustainable Agricultural Practices for Seed Spices" held during 24-25 February, 2018 at NRCSS, Ajmer .
35. Sharma, M., Choudhary, S., Meena, R.D., Meena, R.S., Lal, G. and Verma, A.K. (2018). Morphological and molecular characterization of fennel mutants. In: National Seminar on "Sustainable Agricultural Practices for Seed Spices" held during 24-25 February, 2018 at NRCSS, Ajmer ,pp 195.
36. Sharma, M., Choudhary, S., Meena, R.S., Meena, R.D., Lal, G. and Verma, A.K. (2017). Characterization of gamma ray induced mutants of fennel (*Foeniculum vulgare* Mill.) using morphological characters. In: International Symposium on Horticulture: Priorities & Emerging Trends held during 5-8 Sept 2017 at ICAR-Indian Institute of Horticultural Research, Bengaluru, pp 303-304.
37. Sharma, N., Aishwath, O.P. and Lal, G. (2017). Seasonal and long term effect on soil available nutrients under continues use of nitrogen fertilizer in coriander and fennel. In: Proc. National Conference on "Managing Soil Health for Sustainable and Nutritional Food Production" held during 28-29 October, 2017 at JNKVV, Jabalpur, pp 10-11.
38. Singh, R., Lal, G. and Maheria, S.P. (2018). Precision resource management technologies for seed spice crops for enhancing yield and quality In: Book of lead paper and abstracts for seminar on "Sustainable agricultural practices for seed spices" held during 24-25 March 2018 at ICAR-NRCSS, Ajmer, pp 201-202.
39. Verma, A.K., Choudhary, S., Meena, R.S., Meena, R.D., Sharma, M. and Lal, G. (2017). Induction of genetic variability and estimation of gamma ray



- induced mutants of fennel. In: National conference on "Technological changes and innovations in agriculture for enhancing farmers' income" during 28- 31 May, 2017 at Junagadh Agricultural University, Junagadh, pp 31.
40. Vyas, D., Kakani, R.K. and Saxena, S.N. (2018). Effect of water stress on sapogenin and diosgenin content in fenugreek (*Trigonella foenum-graecum* L.) genotypes. In: Seminar on "Sustainable agricultural practices for seed spices" held on 24-25 February 2018 at ICAR-NRCSS, Ajmer. Pp. 197.
41. Vyas, D., Kakani, R.K. and Saxena, S.N. (2018). Effect of water stress on total oil content in fenugreek (*Trigonella foenum-graecum* L.) genotypes. In: Seminar on "Sustainable agricultural practices for seed spices" held on 24-25 February 2018 at ICAR-NRCSS, Ajmer. Pp. 198.



9. RAC, IRC, IMC AND QRT MEETINGS

9.1 17th Institute Research Council Meeting

The XVII Institute Research Council (IRC) meeting of ICAR- NRCSS held under the chairmanship of Dr. Gopal Lal, Director, ICAR- NRCSS on 13th July 2017; 20-21 & 25th September, 2017 and 18th November 2017 to discuss and recommend action points as per the recommendation made by V-RAC (3rd meeting) held on 7-8 April, 2017 to review the progress of ongoing in-house (Institutional) research projects at ICAR-NRCSS, Ajmer. In the meeting, new project proposals were also discussed thoroughly and were formally approved by the house. All scientists and technical officers of ICAR-NRC on Seed Spices participated in the meetings.

In XVII (I) IRC meeting, the Chairman, Dr. Gopal Lal in his opening remarks appreciated the performance of the research experiments conducted during the rabi season 2016-17. Dr Y.K. Sharma, I/c PME Cell presented the recommendations made by V-RAC (3rd meeting) and detailed discussions were held in the house for incorporating all the suggestions/ recommendations made by RAC in the research programmes.

XVII (II) IRC meeting was held on 20-21 & 25th September, 2017. I/c PME Cell, Dr Y. K. Sharma welcomed the Chairman and other members of IRC. Chairman Dr. Gopal Lal briefed about the ongoing research and development activities at ICAR-NRC on Seed Spices, Ajmer. The action taken report of XVI (2) IRC was presented by I/c PME Cell. The same was discussed in the house. During the meeting the progress of the ongoing sub-projects were presented by individual scientist working in different sections i.e., Crop Improvement, Crop Production, Crop Protection, Basic Sciences and Social Sciences. The progress of each projects were reviewed and thoroughly discussed in the house. The meeting ended with vote of thanks to the chair and members.

The supplementary meeting of XVII (2) Institute Research Council (IRC of ICAR-NRCSS, Ajmer) was held on 18th November, 2017 to discuss research results of concluded projects and new sub-project proposals.

During the meeting the progress of five ongoing sub-projects were presented by individual scientist. The progress of each projects were reviewed and thoroughly discussed in the house. The meetings ended with formal vote of thanks proposed by I/c PME Cell to the chair and members.

9.2 Institute Management Committee Meetings

XVI-Institute Management Committee meeting was held on 20.01.2018 at ICAR-NRCSS, Ajmer. The meeting was chaired by Dr. Gopal Lal, Director and attended by Dr. T. Janakiram, ADG (HS-II), ICAR, New Delhi, Dr. Anil Khar, Principal Scientist (Horticulture), IARI, New Delhi, Dr. B.D. Sharma, Head, Div. of Crop Production, CIAH Bikaner, Dr. S. Vennila, PS, NCIPM, New Delhi, Dr. Krishna Kant, Principal Scientist, NRCSS and Sh. Sumit Singh, AO, NRCSS, Ajmer as Member Secretary.

9.3 III QRT Meeting of ICAR-NRCSS, Ajmer

3rd QRT report (1 June, 2011 to 31 May, 2016) for National Research Centre on Seed Spices, Ajmer was submitted to the Secretary (DARE) & Director General, Indian Council of Agriculture Research.

Composition of 3rd QRT: The Director General, Indian Council of Agricultural Research, New Delhi, constituted the 3rd QRT vide letter No. 1(2)2015.1A-IV dated 8 August, 2016 to review the performance of ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer and nominated Dr. A.R. Pathak, Vice-Chancellor, Junagadh Agriculture University,



QRT Meeting



Junagadh as Chairman. The other members were Dr. K.B. Kathiria, Director of Research, Anand Agriculture University, Anand; Dr. N.L. Joshi, Agronomist (Retd.), ICAR-Central Arid Zone Research Institute, Jodhpur; Dr. M. Anandaraj, Former Director, ICAR- Indian Institute of Spice Research, Calicut and Dr. K.K. Bora, Former Dean, College of Agriculture, Mandore, Jodhpur. Dr. Ravindra Singh, Principal Scientist (Agronomy), NRC on Seed Spices, Tabiji, Ajmer, was nominated as Member Secretary.

Overall Assessment of NRCSS by 3rd QRT

After critically examining the progress of NRCSS with regards to mandate, research programmes and projects, research output and publications, structure and organization, management practices, collaboration with international organizations, SAUs, KVKs and ICAR institutes, linkages with clients and end users, human, physical and financial resources, the QRT is of the opinion that this centre is rated as "Excellent".

Consolidated Recommendations

After critical review, QRT suggested 31 recommendations on three aspects viz; recommendation on research and extension (24); on infrastructure (4) and on policy matters (3). The details are given in report, however salient recommendations are given here.

Recommendations on research and extension

1. Among all the seed spices, cumin occupies nearly half of the area. However, only GC-4 variety is being extensively grown, hence there is need of more improved varieties in the basket of farmers.



Therefore, tangible efforts are needed for diversifying genetic base and variability by introducing germplasm from Mediterranean region/cumin growing countries and use of unconventional breeding technologies.

2. Attempt should be made to develop trait specific varieties viz., blight resistance in cumin, high essential oil in coriander and dwarfness cum earliness in fennel through conventional and unconventional approaches.
3. In view of the changing climatic scenario and related biotic and abiotic stresses, breeding programme should be directed to address these stresses besides higher yield and quality.
4. In view of the concerns raised by traders, exporters and processors about higher essential oil and low fiber contents in coriander, it is suggested that NRCSS should strengthen the breeding programme accordingly.
5. Modern tools of biotechnology need to be used for addressing major production constraints. Whole genome sequencing and annotation of seed spices especially, cumin and coriander should be taken up on priority. Development of strong molecular marker database and mapping population of major seed spices for tagging QTL for important yield and quality traits is needed to develop desired varieties.
6. The technology developed on efficient cropping system, intercropping, nursery raising, organic farming and raised bed sowing should be passed to farmers through front line demonstrations and other extension tools. Seed spices are also known for their therapeutic values therefore, NRCSS should explore possibilities of clinical trials for use of seed spices in curing various health problems in collaboration with related institutions.
7. There is need to give more focus on pragmatic resource utilization. Therefore, research in development of production technology should revolve around precise nutrient, water and space management. Technology for precision farming need to be developed in conjunction with using sensor based technology and other resource conservation techniques.



8. Work on mechanization and protected cultivation practices for enhancing resource use efficiency need to be strengthened. Protected cultivation may be a solution to increase the productivity levels of seed spices especially coriander and fenugreek for ensuring better crop with low damage and enhanced utilization of inputs.
9. Future of organic cultivation is very bright for adding up a value tag to seed spices and also for human health. Standardization of organic crop production modules needs to be developed keeping in view the sustainability and viability of farming system. Organic production of spices is to be strengthened to promote production of quality spices for enhancement of export.
10. Intensify research for problematic soils and poor quality waters to generate technologies for adverse abiotic stress conditions. There is need to determine allelopathy effect of one crop/tree on next crop for ensuring sustainability of the system.
11. PGPR isolates developed and tested through AICRPS, IISR, Calicut and other institutions may be popularized and microbial isolates identified and evaluated at NRCSS be made available to the farmers.
12. In survey and surveillance programme, proper collaboration should be established with line departments, KVKs, SAUs and ICAR institutes. Priority needs to be given to develop forecasting models for prevailing pests and diseases.
13. In order to address pesticide residue problem in cumin, it is necessary that rotational application of fungicide should be done to manage blight in cumin. Quantity and timing of spray schedule should be regulated. Simultaneously, alternate pesticide molecules registered with Central Insecticides Board (CIB) need to be identified for addressing the pesticide residue problems.
14. Water potential and evapo-transpiration parameters should be studied along with other physiological parameters for understanding morphological, physiological and biochemical responses to temporal variations in abiotic stresses in seed spices.
15. Studies should be initiated on the role of multi plant protectants to mitigate biotic and abiotic stresses for seed spices and to identify physiological and biochemical traits towards abiotic stress tolerance as marker traits.
16. Seed priming of seed spices should be done for better germination and consequent reduction in seed rate. Seed priming and pelleting with different bio-formulations, such as plant growth promoting rhizobacteria, bio-fertilizers and phyto-chemicals, need to be done to ensure early germination and protection against various biotic and abiotic stresses in the scenario of changing climate.
17. Presently, seed spice growers are getting low price for their produce, because of lack of proper post harvest management, grading facilities, processing and value addition. The NRCSS should take appropriate steps for improving value chain in seed spices.
18. Seed replacement rate of seed spices is nearly 15% which needs to be enhanced. It is necessary to give more attention on seed production and multiplication based on seed village concept to meet the farmers demand. Indian youths can be encouraged for taking large scale quality seed production programmes in self employment generation mode.
19. Intensive capacity building program including other means of TOT should be strengthened on various scientific cultivation practices including improved varieties, GAP, IPM, IDM, mechanization etc. The technology developed should be disseminated among the farmers through extension tools.
20. Value added seed spices market offers tremendous scope to the youth who could be trained to start enterprises dealing with cryo-grinding and packaging of seed spices, developing novel seed spice value added products, beverages, confectionary/bakery items etc., to gain profit.
21. Bioinformatics work at NRCSS needs to be initiated on seed spices in collaboration with National Agricultural Bioinformatics Grid (NABG). The NRCSS need to set up a bioinformatics hub on seed spices for genomics and proteomics research.



22. For promotion of export of spices, Indian standards should be at par with International Standards.
23. Seed spices are also known for their therapeutic values therefore, NRCSS should explore possibilities of clinical trials for use of seed spices in curing various health problems in collaboration with related institutions.
24. The process of technology generation in institutes of ICAR is already monitored and regulated by a fool-proof and rigid system of regulation viz., IRC, RAC and QRT. Therefore, technology generated should be directly included in package of practices after discussion in ZREAC and should not be re-tested at ATC, which delays the process of technology transfer to farmers.

Recommendations on infrastructure

25. In seed spices, pesticides residue is a major challenge hence there is a need to establish Referral laboratory for pesticide residue and agrochemical analysis.
26. As many farmers are visiting the centre seeking knowledge of seed spices, a Farmers Training Hostel is essential.
27. First phase of Scientist Training Hostel is already completed, hence fund required to be allocated for second phase in order to create better facility.
28. The centre has done excellent work on ToT, however felt handicapped for want of transport facility. Hence, QRT is of the view that the centre should be equipped at least with a mini bus.

Recommendations on policy matters

29. The NRCSS has made a very good progress in seed spices research and helping in solving the problems of farming community. This is a unique centre with respect to seed spices working since the year 2000. Seed spices forms a means of livelihood security of marginal and small farmers of arid and semi-arid regions. Moreover, seed spices are major source of foreign exchange. The services of the centre are required for the farmers of arid and semi-arid regions and there is a felt need of regional stations. Therefore, the QRT is of the opinion to upgrade the centre as an "Institute".
30. Currently, the coordinated experiments concerning "Seed Spices" are also managed from IISR, Calicut. To impart greater efficiency and effectiveness in management, it is imperative that work of coordination related to "Seed Spices" be brought under the umbrella of Institute at Ajmer. Thus, a separate AICRP on "Seed Spices" is strongly recommended with the Director, NRCSS (or the proposed Institute) functioning as Project Coordinator. This will not have any additional financial burden on the Council.
31. The QRT observed that there is skewed proportion of scientific and technical staff (1: 0.4), instead of prevailing norms of 1:1.5. So, the QRT recommended providing the required technical staff as per norms.



10. DISTINGUISHED VISITORS

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|----|-------------------------|---|----------------|---|
| 1 | Dr. B.B. Vashishtha | Ex-Director, ICAR-NRCSS, Ajmer | 7-8 April,2017 | III Meeting of V RAC |
| 2 | Dr. E.V. D. Sastry | Prof. and Plant Breeder (Spices), Rajasthan Agriculture Research Institute, Jaipur | 7-8 April,2017 | III Meeting of V RAC |
| 3 | Dr. A.N. Maurya | Retd. Director, Institute of Agriculture Science, BHU, Varanasi | 7-8 April,2017 | III Meeting of V RAC |
| 4 | Dr. M. Anandraj | Director, IISR, Calicut | 7-8 April,2017 | III Meeting of V RAC |
| 5 | Dr. Jitendra Kumar | Director, DMAPR, Anand | 7-8 April,2017 | III Meeting of V RAC |
| 6 | Dr. D.A. Patel | Cumin Processor, Unjha Market, Gujarat | 7-8 April,2017 | III Meeting of V RAC |
| 7 | Dr. T. Janakiram | ADG (HS-II) ICAR | 7-8 April,2017 | III Meeting of V RAC |
| 8 | Dr. S.R. Maloo | Ex. Dean, RCA (MPUAT), Udaipur, (Raj.) | 10 April,2017 | DPC Meeting |
| 9 | Dr. Dharendra Singh | Professor (PBG), SKN Agril. University, Jobner | 10 April,2017 | DPC Meeting |
| 10 | Dr. Ramavtar Sharma | Pr. Scientist (PBG), CAZRI, Jodhpur | 10 April,2017 | DPC Meeting |
| 11 | Prof. Sanwar Lal Jat | Union Minister of State, Water Resources | 2 May, 2017 | कृषक संवाद कार्यक्रम |
| 12 | Sh. Dilip Pachar | Pradhan, Panchayat Samiti, Pisangan, Ajmer | 2 May, 2017 | कृषक संवाद कार्यक्रम |
| 13 | Sh. J.S. Sandhu | Joint Director, State Agriculture Department | 2 May, 2017 | कृषक संवाद कार्यक्रम |
| 14 | Dr. PSS Thampi | Deputy Director, Spices Board India, Guntur (AP) | 19 May,2017 | WTO STDF Interactive Workshop on Capacity Building in Sanitary and Phytosanitary in Seed Spices |
| 15 | Sh. H.A. Vijaya | Deputy Director, Spices Board India, Jodhpur | 19 May, 2017 | WTO STDF Interactive Workshop on Capacity Building in Sanitary and Phytosanitary in Seed Spices |
| 16 | Dr. (Mrs) Shashi Sareen | Ex-Consultant, FAO | 19 May, 2017 | WTO STDF Interactive Workshop on Capacity Building in Sanitary and Phytosanitary in Seed Spices |
| 17 | Dr. Dharendra Singh | Prof. PBG, SKN Agril. University, Jobner | 19 May, 2017 | WTO STDF Interactive Workshop on Capacity Building in Sanitary and Phytosanitary in Seed Spices |

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| 18 | Dr. T.S. Rajpurohit | Farmer Consultant, Jodhpur | 19 May, 2017 | WTO STDF Interactive Workshop on Capacity Building in Sanitary and Phytosanitary in Seed Spices |
| 19 | Dr. Dinesh Arora | Sr. Scientist & Head KVK, Ajmer | 19 May, 2017 | WTO STDF Interactive Workshop on Capacity Building in Sanitary and Phytosanitary in Seed Spices |
| 20 | Sh. Vasudev Devnani | State Education Minister, Ajmer, Raj | 07 July, 2017 | राष्ट्रीय युवा स्वयं सेवक प्रशिक्षण शिविर 07.07.2017 (उद्घाटन सत्र) |
| 21 | Dr. A.R. Pathak | Vice-Chancellor, Junagarh Agriculture University, Junagarh, Gujarat | 11-13 Aug, 2017 | III QRT Meeting |
| 22 | Dr. K.B. Kathiria | Director of Research, Anand Agriculture University Anand-Gujarat | 11-13 Aug, 2017 | III QRT Meeting |
| 23 | Dr. N.L. Joshi | Ex-Agronomist, ICAR- Central Arid Zone Research Institute, Jodhpur | 11-13 Aug, 2017 | III QRT Meeting |
| 24 | Dr. M. Anandraj | Ex-Director, ICAR-IISR, Calicut (Kerala) | 11-13 Aug, 2017 | III QRT Meeting |
| 25 | Dr. K.K. Bora | Ex-Dean, College of Agriculture, Mandore, Jodhpur (Rajasthan) | 11-13 Aug, 2017 | III QRT Meeting |
| 26 | Dr. Dinesh Arora | Scientist KVK, Ajmer | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 27 | Sh. V.K. Sharma | Deputy Director Agriculture Extension, Ajmer | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 28 | Sh. Dilip Pachar | Pradhan Pisangan Samiti, Ajmer | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 29 | Miss Vandana Nogia | Jila Pramukh, Ajmer | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 30 | Sh. Shiv Shanker Heda | Chairman ADA, Ajmer | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 31 | Sh. Bhupendra Yadav | Member of Parliament (Rajya Sabha) | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 32 | Dr. S.K. Sharma | Prof. KVK, Ajmer | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |
| 33 | Sh. Ramchandra Choudhary | Ajmer Dairy Chairman | 1 Sept, 2017 | New India Manthan: Sankalp se Siddhi™ |





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| 34 | Sh. Chhabilendra Roul | Additional Secretary (DARE) & Secretary ICAR, New Delhi | 16 Oct, 2017 | Spice Parlor Inauguration |
| 35 | Smt Anita Bhadel | Minister of Women and Child Development, Govt. of Rajasthan | 21 Nov, 2017 | For Farm visit at NRCSS, Ajmer |
| 36 | Dr. Arun Tomar | Director, CSWRI, Avikanagar, Rajasthan | 21 Nov, 2017 | To attend Assessment meeting of Sh M A Khan |
| 37 | Dr. V.S. Korikanthimath | Ex-Director ICAR- CCARI, Goa | 21 Nov, 2017 | To attend Assessment meeting of Sh M A Khan |
| 38 | Dr. Laxmi Kant Ji | Principal, DAV College, Ajmer | 03 Dec, 2017 | Agriculture Education Day |
| 39 | Dr. B.L. Chauhdary | Chairman, Board of Secondary Education Ajmer, Rajasthan | 05 Dec, 2017 | World Soil Day |
| 40 | Prof. C.B. Gena | Former Vice Chancellor Ganga Singh University, Bikaner | 05 Dec, 2017 | World Soil Day |
| 41 | Sh. R.P. Singh | Member Governing Body, ICAR, New Delhi | 05 Jan, 2018 | Visit of ICAR-NRCSS, Ajmer |
| 42 | Dr. KML Pathak | Vice Chancellor, DUVASU, Mathura Ex-DDG (Animal Science), ICAR New Delhi. | 12 Jan, 2018 | NRCSS, Ajmer |
| 43 | Dr. A.S. Faroda | Ex-Chairman, ASRB, Vice Chancellor, MPU&AT, Udaipur | 19 Jan, 2018 | Foundation Day 2018 |
| 44 | Dr. T. Janakiram | ADG, HS-II, ICAR-New Delhi | 19 Jan, 2018 | Foundation Day 2018 |
| 45 | Dr. S.K. Singh | Director, ATARI, Jodhpur | 19 Jan, 2018 | Foundation Day 2018 |
| 46 | Dr. P.L. Saroj | Director, CIAH, Bikaner | 19 Jan, 2018 | Foundation Day 2018 |
| 47 | Dr. B.S. Chundawat | Former Vice Chancellor, SDAU, Dantiwara | 24-25 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |
| 48 | Dr. I.J. Mathur | Ex Director Extension Education, MPUA&T, Udaipur | 24-25 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |
| 49 | Dr. S.K. Singh | Director, ATARI, Jodhpur | 24-25 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |
| 50 | Dr. Ashok Kumar Ahlawat | Ex Prof. & Head Department of Entomology, RCA, Udaipur | 24-25 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |
| 51 | Dr. Dharendra Singh | Prof. & Head SKNCOA, Jobner | 24-5 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |



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| 52. Sh. Rakesh Patri | Deputy Director (Ag.), Jaipur | 24-5 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |
| 53. Dr. Dinesh Arora | Sr. Scientist & Head KVK, Ajmer | 24-5 Feb, 2018 | National Seminar on "Sustainable Agricultural Practices for Seed Spices" |
| 54. Sh. Suresh Singh Rawat | Parliamentary Secretary & MLA Pushkar | 17 Mar, 2018 | Krishi Unnati Mela 2018 |
| 55. Ms. Vandana Nogia | Jila Pramukh, Ajmer | 17 Mar, 2018 | Krishi Unnati Mela 2018 |
| 56. Sh. J.S. Sandhu | Joint Director Agriculture, Jaipur | 17 Mar, 2018 | Krishi Unnati Mela 2018 |



11. WOMEN EMPOWERMENT

"International Women's Day" programme was organized on 8 March 2018 at ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer (Rajasthan). Chief guest of the function was Dr. Dinesh Arora, PC, KVK, Ajmer, Programme was chaired by Dr. S.N. Saxena, Principal Scientist, NRCSS, Ajmer. The programme was organized by Dr. Sharda Choudhary, Nodal officer, Women Complaint Cell. Dr. Arora delivered lecture on "Women Empowerment and role of women in farming." Dr. Arora told that Women empowerment refers to increasing and improving the social, economic, political and legal

strength of the women, to ensure equal-right to women and to make them confident enough to claim their rights. To encourage the women employees of NRCSS a quiz programme was also organized and the winners were awarded with prizes.

More than 500 farm women participated in kisan and beej vitran mela at ICAR-NRCSS campus. During many important events at ICAR-NRCSS women guests visited the institute and interacted with farm labourers and women farmers of Ajmer and nearby districts.



Dr. Dinesh Arora delivering lecture on "Women Empowerment and role of women in farming"



Dr. Sharda Choudhary organizing the Quiz for Women Empowerment



Dr. S.N. Saxena giving prizes to the winners of Quiz for Women Empowerment



12. INFRASTRUCTURE DEVELOPMENT

Works: Plan Completed

- Work titled "Construction of Climate Control Glass House" was taken up during the period under report and completed satisfactorily through CPWD at a cost of Rs.16,87,800/-. The work included provision of cooling pads and water circulation system for temperature control besides designer platforms for raising crops and roof mounted fogger system for controlling the inside humidity.
- Work titled "Construction of Green House at NRCSS Ajmer" was taken up during the period under report and completed satisfactorily through CPWD at a cost of Rs. 5,18,500/-. The work included provision UV Stabilized fibre glass roofing, cooling pads and water circulation system for temperature control besides designer platforms for raising crops and roof mounted fogger system for controlling the inside humidity.

Works: Project based

- Work titled "Construction of Seed Processing and Storage Infrastructure at NRCSS Ajmer" under MIDH Research Project was taken up and completed satisfactorily through CPWD at a cost of Rs. 9,26,400/-. The work included provision of covered space for seed handling, weighing and packaging. This structure was integrated with the existing seed handling and storage units.

Works: Initiated under Non Plan

- The Work titled "Renovation of Wall panelling in Director's Room & Knowledge Park Room at NRCSS

Ajmer" was taken up during the period under report through CPWD at a cost of Rs. 11,59,400/-.

- The Work titled "Improvement of Boundary Wall at NRCSS Farm/Campus Ajmer" was initiated after obtaining vetting from Director (Works) during the period under report through CPWD at a cost of Rs. 36,58,100/-.
- The Work titled "Renovation of Main Laboratory Building Roof at NRCSS Ajmer" was initiated after obtaining vetting from Director (Works) during the period under report through CPWD at a cost of Rs. 32,51,100/-.
- The Work titled "Renovation of North-South Road at NRCSS Farm Ajmer" was initiated after obtaining vetting from Director (Works) during the period under report through CPWD at a cost of Rs. 23,11,400/-.
- The Work titled "General Repair & Maintenance of Floors, drainage systems, Toilets and bathrooms in Main Building and Scientist Training Hostel at NRCSS Ajmer" was initiated during the period under report through CPWD at a cost of Rs. 9,50,400/-.
- The Work titled "Renovation of Administrative Office Room at Main Laboratory Building at NRCSS Ajmer" was initiated during the period under report through CPWD at a cost of Rs. 9,43,200/-.
- The Work titled "Specialized Repair of Main Laboratory and Hostel Building at NRCSS Ajmer" was initiated during the period under report through CPWD at a cost of Rs. 9,43,200/-.





13. PERSONNEL

S.No SCIENTISTS

- 1 Dr. Gopal Lal, Director
- 2 Dr. S.N. Saxena, Principal Scientist (Plant Physiology)
- 3 Dr. Y.K. Sharma, Principal Scientist (Plant Pathology)
- 4 Dr. O.P. Aishwath, Principal Scientist (Soil Science)
- 5 Dr. Ravindra Singh, Principal Scientist (Agronomy)
- 6 Dr. Krishna Kant, Principal Scientist (Entomology)
- 7 Dr. S.S. Meena, Principal Scientist (Vegetable Science)
- 8 Dr. B.K. Mishra, Principal Scientist (Agricultural Microbiology)
- 9 Dr. P.N. Dubey, Senior Scientist (Agriculture Chemistry)
- 10 Dr. R.S. Meena, Senior Scientist (Plant Breeding)
- 11 Dr. N.K. Meena, Senior Scientist with RGP 8K (Entomology)
- 12 Dr. Sharda Choudhary, Scientist with RGP 7K (Biotechnology)
- 13 Dr. R.D. Meena, Scientist with RGP 7K (Plant Pathology)
- 14 Sh. Mukesh Kumar Vishal, Scientist (Agriculture Statistics)
- 15 Dr. Arvind Kumar Verma, Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
- 16 Dr. Murlidhar Meena, Scientist (Agricultural Economics)
- 17 Sh. Honnappa Asangi, Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
- 18 Sh. Ravi Y., Scientist (Spices, Plantation, Medicinal & Aromatic Plants)

TECHNICAL STAFF

- 19 Sh. S.P. Maheria, CTO
- 20 Sh. M.A. Khan, CTO
- 21 Sh. S.R. Meena, STO
- 22 Sh. G.K. Tripathi, Senior Technical Assistant
- 23 Sh. P.K. Agarwal, Senior Technician
- 24 Sh. S.R. Balai, Senior Technician

ADMINISTRATIVE STAFF

- 25 Sh. Sumit Singh, AO
- 26 Sh. Bhim Singh, AAO
- 27 Sh. Sunil Kumar Agrawal, AF&AO
- 28 Sh. Sanjeev Sharma, Assistant
- 29 Sh. Suresh Kumar, Assistant
- 30 Sh. Pradeep Kulhari, Assistant
- 31 Sh. R.K. Kanwaria, UDC
- 32 Sh. Amit Kumar Gupta, LDC
- 33 Sh. Mukesh Kandari, LDC

SKILLED SUPPORTING STAFF

- 34 Smt. Sarla Devi, SSS
- 35 Sh. Pukhraj Paroda, SSS

On Study Leave

- 1. Sh. Honnappa Asangi, Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
- 2. Sh. Mukesh Kumar Vishal, Scientist (Agriculture Statistics)

New Joining:

- 1. Dr. Murlidhar Meena, Scientist (Joined on 10.07.2017)
- 2. Mr. Ravi Y., Scientist (Joined on 16.10.2017)
- 3. Mr. Suresh Kumar, Assistant (Joined on 28.07.2017)
- 4. Mr. Pradeep Kulhari, Assistant (Joined on 29.07.2017)

Transfer & posting:

- 1. Sh. Harisha C.B., Scientist (Transferred to NIASM, Baramati (w.e.f. 07.06.2017)

Promotions:

- 1. Dr. O.P. Aishwath, Principal Scientist (w.e.f. 03.10.2012)
- 2. Dr. B.K. Mishra, Principal Scientist (w.e.f. 10.02.2017)
- 3. Dr. Ram Swaroop Meena, Senior Scientist with RGP 9000 (w.e.f. 16.04.2016)
- 4. Sh. M.A. Khan, Chief Technical Officer (w.e.f. 01.07.2016)



14. ON GOING RESEARCH PROJECTS

Ongoing Projects

Project 1: Conservation characterization and utilization of genetic resources in seed spices.

CI-1: Management of plant genetic resources of seed spices

(PI: R.S. Meena; Co-PI: S.S. Meena, S. Choudhary, A.K. Verma, Harisha C.B. and Honappa Asangi (on study leave); 20014-19)

Project 2: Genetic improvement of seed spices for improving productivity, quality and tolerance to biotic and abiotic stresses.

CI-8: Breeding for high yield and quality in dill

(PI: R.S. Meena; Co-PI: Y.K. Sharma and N.K. Meena; 2015-20)

CI-9: Breeding for high yield and improved quality in ajwain:

(PI: S.S. Meena; 2015-20)

CI-15: Genetic enhancement of anise for yield and yield contributing traits

(PI: A.K. Verma; Co-PI: O.P. Aishwath 2011-17)

CI-19: Enhancing genetic variability in cumin

(PI: A.K. Verma; Co-PI: R.S. Meena and H. S. Mahla; 2012-17)

CI/13.2.1: Breeding for high yield, powdery mildew resistance and suitability to limited moisture condition in fenugreek

(PI: R.S. Meena; Co-PI: S.N. Saxena and Y.K. Sharma; 2013-18)

CI/13.2.2: Breeding for high yield, small seed size and stem gall resistance in coriander

(PI: R.S. Meena; Co-PI: Y.K. Sharma; 2013-18)

CI/14.2.1: Induction of genetic variability in cumin and fennel through gamma radiation

(PI: A.K. Verma; Co-PI: S. Choudhary and R.D. Meena; 2014-19)

CI/15.2.1: Breeding in *Nigella sativa* L. for higher yield and improve quality

(PI: S.S. Meena; Co-PI: S.N. Saxena; 2015-20)

CI/15.2.2: Development of microsatellites (SSRs) markers for coriander

(PI: S. Choudhary; Co-PI: M.K. Vishal; 2015-18)

CI/15.2.3: Identification of molecular marker associated with stem gall in coriander

(PI: S. Choudhary; Co-PI: R.D. Meena; 2015-20)

CI/16.2.1: Breeding for dwarfism and *Ramularia* blight resistance /tolerance in fennel

(PI: R.S. Meena; Co-PI: R.D. Meena, S. Choudhary, N.K. Meena and S.N. Saxena; 2016-21)

CI/16.2.2: Breeding for yield and quality in celery

(PI: R.S. Meena; Co-PI: S. Choudhary, N.K. Meena, A.K. Verma and R.D. Meena; 2016-21)

Project 3: Development and refinement of efficient crop production technologies of seed spices.

CPd-24: Fertigation scheduling for efficient nutrient and water management in major and minor seed spices

(PI: R. Singh; Co-PI: G. Lal, Honappa Asangi (on study leave) and S.P. Maheria; 2012-17)

CPd-25: Nutrient management for sustainable seed spices production (coriander and fennel)

(PI: O.P. Aishwath; Co-PI: P.N. Dubey and Harisha C.B.; 2012-17)

CPd-26: Evaluation of seed spices for edaphic stress (Coriander, Cumin, Fennel, Fenugreek, Anise, Nigella and Celery)

(PI: O.P. Aishwath; Co-PI: P.N. Dubey, R.K. Yadav, R.L. Meena and B.K. Jha; 2012-17)

CPd/13.6.1: Off Season production of coriander and fenugreek for green leaf

(PI: G. Lal; Co-PI: R. Singh, N.K. Meena and S.P. Maheria; 2014-17)



14.3.1: Micronutrient management in cumin (*Cuminum cyminum* L.) and fennel (*Foeniculum vulgare* L.) for higher yield and quality

(PI: Harisha, C.B.; Co-PI: R. Singh and O.P. Aishwath; 2014-17)

15.3.1: Isolation and characterization of endophytic fungi from cumin and fenugreek

(PI: N.K. Mishra; Co-PI: Y.K. Sharma; 2015-20)

15.3.2: Effect of drip irrigation regimes and mulch levels on growth, yield and quality of coriander and fenugreek

(PI: J. Asangi (On study leave) project handle by Harisha (On study leave) (w.e.f. February 2016); Co-PI: R. Singh and Harisha (On study leave); 2014-17)

16.3.1: Inter-cropping of seed spices with vegetables for higher productivity and resource use efficiency

(PI: S.S. Meena; Co-PI: G.Lal, R. Singh, O.P. Aishwath, N.K. Meena, R.D. Meena, S.P. Maheria and A.S. Godara; 2016-17)

16.3.2: Standardization of two tier system of production technology in seed spices with vine vegetables and cover crop

(PI: R. Singh; Co-PI: G. Lal, S.S. Meena, S. Choudhary, Harisha C.B., S.P. Maheria and A.S. Godara; 2016-19)

16.3.3: Seed spice based inter cropping with cover crop and other fruit crops

(PI: S.S. Meena; Co-PI: G. Lal, O.P. Aishwath, N.K. Meena, R.D. Meena; 2016-19)

Project 4: Development and refinement of efficient crop production technologies for production of safe seed spices.

13.13.1: Survey and surveillance of existing and emerging diseases of seed spices

(PI: R.D. Meena; Co-PI: Y.K. Sharma and M.K. Vishal; 2012-17)

13.13.1: Management studies on emerging problems in cumin and fenugreek

(PI: N.K. Sharma; Co-PI: R.D. Meena and B.S. Shekhawat; 2013-17)

CPT/13.12.1: Sustainable management of insect pests in coriander and cumin

(PI: N.K. Meena; Co-PI: K. Kant, Rita Jain and M.A. Khan; 2013-17)

CPT/13.17.1: Impact of pollinators on yield and quality of coriander, fennel, ajwain & dill

(PI: N.K. Meena; Co-PI: K. Kant; 2013-17)

CPT/16.4.1: Studies on population diversity and management of nematodes in cumin (*Cuminum cyminum* L.)

(PI: K. Kant; Co-PI: Y.K. Sharma and S.R. Meena; 2016-19)

Project 5: Development and refinement of post-harvest handling, processing and value addition techniques in seed spices.

BS-8: Physiological approaches for enhancing yield and quality in seed spices under abiotic stresses: (PI: S.N. Saxena; 2012-17)

CPd/13.8.1: Development of value added products from seed spices

(PI: G. Lal; Co-PI: B.K. Mishra; 2014-17)

BS/14.5.1: Monitoring and evaluation of agro-chemical residues in cumin (*Cuminum cyminum* L.) and coriander (*Coriandrum sativum* L.) growing areas of Rajasthan and Gujarat

(PI: P.N. Dubey; Co-PI: S.N. Saxena and K. Kant; 2014-17)

Project 6: Improving knowledge and skill of stakeholders for improving productivity of seed spices.

SS/13.16.1: Dissemination of seed spices production and post-harvest technology through demonstrations, trainings, workshops and seminars under NEH and TSP;

(PI: G. Lal; Co-PI: R.S. Meena, N.K. Meena and S.P. Maheria; 2014-17)

SS/16.6.1: Assessing approachability and facilities of ICT and effective medium of information dissemination to cumin and coriander growers of Western India

(PI: M.K. Vishal; Co PI: G. Lal, K. Kant, S. Choudhary, A. K. Verma, R.D. Meena, M.A. Khan and S.R. Meena; 2016-18)



New Sub-Project

1. CPd/17.3.1: Bioprospecting multitrait bacteria with abiotic stress tolerance from cumin and coriander soil (PI: B.K. Mishra; 2017-20)
2. CPd/17.3.2: Nutrient requirement of minor seed spices (Celery and Ajwain) and their management (PI: O.P. Aishwath; Co-PI: S.N. Saxena and Ravindra Singh; 2017-22)
3. CPd/17.3.3: Surveying major growing area of cumin and coriander for soil parameters (PI: O.P. Aishwath; Co-PI: M.K. Vishal, M.D. Meena and Ravi Y.; 2017-22)
4. CPd/17.3.4: Studies on G × E interaction in cumin through on farm trial (OFT) (PI: Ravindra Singh; Co-PI: R.S. Meena; 2017-19)
5. CPt/17.4.1 : Epidemiology and management of root rot disease of ajwain and nigella (PI: Y.K. Sharma; Co-PI: K. Kant; 2017-21)
6. CPt/17.4.2: Bioefficacy of new molecules of fungicides for the management of *Alternaria* blight disease of cumin and fenugreek. (PI: Y.K. Sharma; Co-PI: P.N. Dubey; 2017-20)
7. CPt/17.4.3 : Biological management of *Alternaria blight* in cumin (*Cuminum cyminum*) (PI: R.D. Meena; Co-PI: B.K. Mishra; 2017-20)
8. CPt/17.4.4 : Development of IPM modules to combat aphids and thrips in coriander and cumin (PI: N.K. Meena; Co-PI: R. Singh and Murlidhar Meena; 2017-21)
9. CPt/17.4.5 : Evaluation of novel pesticide formulations for better efficacy and lower residues in major seed spices (PI: Krishna Kant; Co-PI: B.K. Mishra and P.N. Dubey; 2017-20)
10. BS/17.5.1: Modulation of morpho-physiological activities and stress tolerance in cumin by concomitant application of depolymerised plant growth regulators (PI: S.N. Saxena; Co-PI: Y.K. Sharma and P.N. Dubey; 2017-19)
11. BS/17.5.2: Exogenous application of PGRs for improving essential oil content in coriander (*Coriandrum sativum* L.) (PI: S.N. Saxena; Co-PI: P.N. Dubey; 2017-19)
12. BS/17.5.3: Studies on dissipation kinetics and pre harvest interval of triazoles in fenugreek (PI: P.N. Dubey; Co-PI: S.N. Saxena, Y.K. Sharma and K. Kant; 2017-19)
13. SS/17.6.1 : Economic analysis of production and export performance of coriander and cumin in India (PI: M.D. Meena; Co-PI: M.K. Vishal and M.A. Khan; 2017-20)

ICAR-Network/Platform Research Projects

| S.No. | Title |
|-------|--|
| 1. | Network Project on Organic farming. (PI: Dr. G. Lal) |

External Funded Projects

| S.No. | Title |
|-------|---|
| 1. | DUS testing guideline in seed spices crops (PI: Dr. R.S. Meena) |
| 2. | Centrally Sponsored Scheme -MIDH Development programme on Seed Spices (PI: Dr. Y.K. Sharma) |
| 3. | DUS test guidelines in minor seed spice crops (PI: Dr. R.S. Meena) |



15. OTHER INFORMATION

Swatch Bharat Mission

1. Under "Swatch Bharat Mission" awareness activities for cleanness and hygiene were done at 'Dang' village, Ajmer (27th May, 2017).



भा. कृ. अनु. प. - राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर में राजभाषा हिन्दी पखवाड़ा (14- 30 सितम्बर, 2017) मनाया गया

भा. कृ. अनु. प. - राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर (राजस्थान), पर राजभाषा हिन्दी पखवाड़ा 14-30 सितम्बर, 2017 के मध्य मनाया गया। पखवाड़ा का शुभारम्भ 14 सितम्बर 2017 को राजभाषा क्रियान्वयन समिति की बैठक के साथ हुई जिसमें में केन्द्र के निदेशक डॉ. गोपाल लाल ने अध्यक्षता की। इस राजभाषा हिन्दी पखवाड़ा में कार्यालय में हिन्दी के और अधिक प्रयोग पर सभी लोगों को ज्यादा ध्यान देने की आवश्यकता पर जोर दिया गया। राजभाषा हिन्दी-पखवाड़ा 2017 के

उद्घाटन कार्यक्रम में राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र पर राजभाषा हिन्दी के प्रगामी प्रयोग हेतु अनेक सुझावों पर चर्चा की गयी। 21 सितम्बर, 2017 को संस्थान में कार्यरत वैज्ञानिकों, अधिकारियों तथा कर्मचारियों के मध्य अनेक प्रतियोगिता का जैसे वाद-विवाद, तत्काल/आशु भाषण एवं टिप्पणी-लेखन का आयोजन किया गया। दिनांक 23 सितम्बर 2017 को बच्चों की हिन्दी में अभिरुचि हेतु बाल प्रतियोगिता का आयोजन हुआ जिसमें हिन्दी काव्य पाठ तथा प्रश्नोत्तरी प्रतियोगिता हुई एवं इसी दिन सफल बाल प्रतिभागियों को पुरस्कार वितरण किया गया। हिन्दी पखवाड़े के दौरान दिनांक 23 सितम्बर 2017 को हिन्दी ज्ञान प्रश्न मंच तथा काव्य पाठ प्रतियोगिता का आयोजन किया गया। इन प्रतियोगिताओं में संस्थान में कार्यरत वैज्ञानिक, अधिकारी, कर्मचारी, एवं अनुसंधान अभ्येयता वर्ग के लोगो ने अधिक संख्या में हिस्सा लिया। डॉ. गोपाल लाल, निदेशक रा. बी. म. अनु. केंद्र ने संस्थान के सभी लोगो को हिन्दी में कार्य करने के लिए विशेष तौर पर प्रेरित किया तथा मानक वर्तनी के प्रयोग को वैज्ञानिक लेखों में बढ़ावा देने पर बल दिया। डॉ. वृजेश कुमार मिश्र, वरिष्ठ वैज्ञानिक एवं प्रभारी राजभाषा अधिकारी ने विभिन्न कार्यक्रमों के सफल आयोजन हेतु केन्द्र के निदेशक डा. गोपाल लाल के मार्गदर्शन को रेखांकित करते हुए निर्णायक मण्डल के सदस्यों डॉ. युगल किशोर शर्मा, डॉ. शारदा चौधरी तथा श्री एस. पी. महेरिया का विशेष आभार व्यक्त किया। सफल प्रतिभागियों को पुरस्कार प्रदान किये गये और समस्त वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को इस हिन्दी पखवाड़ा कार्यक्रम को सफल बनाने के लिए धन्यवाद ज्ञापन किया गया। दिनांक 3 अक्टूबर 2017 को हिन्दी पखवाड़ा कार्यक्रम के विभिन्न प्रतियोगिताओं में सफल प्रतिभागियों को नकद पुरस्कार राशी का वितरण डा. गोपाल लाल निदेशक भा.कृ.अनु.प. - राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर द्वारा किया गया। विभिन्न प्रतियोगिताओं में सफल प्रतिभागियों की सूची निम्नवत हैं।



| क्र. स. | कार्यक्रम | विजेता प्रतिभागी का नाम |
|---------|--|--|
| 1 | वाद-विवाद प्रतियोगिता-पक्ष एवं विपक्ष (सभी वर्गों के लिए) | प्रथम-शारदा चौधरी / एस.एन. सक्सेना द्वितीय-सुरेश कुमार/सुनील कुमार अग्रवाल तृतीय-एस.एस. मीणा /भीम सिंह |
| 2 | तत्काल / आज्ञा भाषण प्रतियोगिता (सभी वर्गों के लिए) | प्रथम-भीम सिंह द्वितीय-एस.एन. सक्सेना तृतीय-सुनील कुमार अग्रवाल |
| 3 | टिपण्णी लेखन प्रतियोगिता (सभी वर्गों के लिए) | प्रथम-एम.के. विशाल द्वितीय-भीम सिंह तृतीय-एस.एन. सक्सेना |
| 4 | प्रश्न मंच प्रतियोगिता (टीम आधार पर तथा प्रत्येक टीम में 3 सदस्य) | प्रथम-भीम सिंह, एस.एस. मीणा एवं जी.के. त्रिपाठी द्वितीय-रविन्द्र सिंह, शारदा चौधरी एवं सरला देवी तृतीय-सुनील कुमार अग्रवाल, अमित गुप्ता एवं मुकेश कंडारी |
| 5 | हिंदी काव्य पाठ (सभी वर्गों के लिए) | प्रथम-शारदा चौधरी द्वितीय-एस.एन. सक्सेना तृतीय-प्रमोद कुमार अग्रवाल |
| 6 | निर्णायक मण्डल सदस्य | डॉ. गोपाल लाल, निदेशक डॉ. वाई.के. शर्मा, प्रधान वैज्ञानिक डॉ. बी.के. मिश्र, वरिष्ठ वैज्ञानिक श्री एस.पी. महेरिया, मुख्य तकनीकी अधिकारी |





राजभाषा क्रियान्वयन समिति की बैठक- राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर में राजभाषा समिति की त्रिमाही समीक्षा हेतु बैठकों का आयोजन 1 जून 2017, 26 जुलाई 2017 तथा 15 सितम्बर 2017, 27 मार्च 2018 को डॉ. गोपाल लाल, निदेशक की अध्यक्षता में हुआ। इन बैठकों में हिन्दी के प्रगामी प्रयोग एवं प्रकाशन पर विशेष बल दिया गया। इस अवधि में राजभाषा कार्यान्वयन को कारगर ढंग से लागू करने के लिए दो बार राजभाषा हिन्दी कार्यशाला का आयोजन दिनांक 26-07-2017 तथा 28-03-2018 को किया गया।

राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र के हिन्दी प्रकाशन

1. भा. कृ. अनु. प. - राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर (राजस्थान) द्वारा अर्ध-वार्षिक राजभाषा पत्रिका-मसाला सुरभि का प्रकाशन प्रारम्भ किया गया है। इस पत्रिका का प्रथम अंक का सफल प्रकाशन जुलाई 2017 में किया गया। इस पत्रिका के अगले अंक (दिसम्बर, 2017) को भी प्रकाशित किया जा चुका है। मसाला सुरभि पत्रिका का प्रकाशन डॉ. गोपाल लाल, निदेशक के मार्गदर्शन में डॉ. बृजेश कुमार मिश्र एवं अन्य वैज्ञानिकों द्वारा किया जा रहा है।

2. बीजीय मसाला फसलों की वैज्ञानिक खेती -कृषक प्रशिक्षण मैनुअल -2017/1

13. राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र -वार्षिक कैलेंडर (द्विभाषीय) - 2016

4. वार्षिक प्रतिवेदन-2016-17 राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर।

राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर में विश्व मृदा दिवस का आयोजन

दिनांक 05.12.2017 को राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर एवं कृषि विज्ञान केन्द्र तबीजी, अजमेर के सह-संयोजन में विश्व मृदा दिवस मनाया गया। इस अवसर पर

डॉ. बी. एल. चौधरी, अध्यक्ष, राजस्थान माध्यमिक शिक्षा बोर्ड, अजमेर मुख्य अतिथि, प्रो. सी.बी. गेना, पूर्व कुलपति, महाराजा गंगा सिंह विश्व विद्यालय, बीकानेर, एवं ओ.पी. शर्मा, उप निदेशक, आत्मा, अजमेर विशिष्ट अतिथि, डॉ. एस.के. शर्मा, प्रमुख वैज्ञानिक, के.बी.के. अजमेर, उपस्थित थे। इस कार्यक्रम की अध्यक्षता डॉ. गोपाल लाल, निदेशक, राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र द्वारा किया गया। सभा में उपस्थित गणमान्य अतिथियों, वैज्ञानिकों, एनजीओ के अधिकारियों, प्रगतिशील किसानों एवं कृषक महिलायें, प्रेस एवं मीडिया के कार्यकर्ताओं का स्वागत करते हुए डॉ. गोपाल लाल ने मनाये जा रहे विश्व मृदा दिवस के महत्व को प्रस्तुत करते हुए मनुष्यों एवं पशुओं के जीवन पर मृदा के महत्व को बताया। उन्होंने स्वस्थ मृदा से स्वस्थ जीवन प्राप्ति के उपायों पर बल दिया।

इस अवसर पर प्रधानमंत्री के मन की बात कार्यक्रम का चलचित्र ओताओं को दिखाया गया, जिसमें मिट्टी के मृदा स्वास्थ्य कार्ड में दर्शाये गये पोषण आकड़ों को फसल के लिए मानक अनुसार खाद प्रदान करने पर बल दिया। हिमाचल प्रदेश के एक गाँव में इस कार्ड की सफलता पूर्वक उपयोग का उदाहरण भी प्रस्तुत किया। हमारे देश के कृषि मंत्री श्री राघवमोहन सिंह जी द्वारा दिये गये उद्बोधन को भी चलचित्र में प्रस्तुत किया गया। 10 करोड़ मृदा स्वास्थ्य कार्ड के वितरण की उपलब्धी को भी समझ रखा गया। कई तरह के चलचित्रों के प्रदर्शन द्वारा मृदा स्वास्थ्य की आवश्यकता को उपस्थित दर्शकों के समझ रखकर इसकी महत्ता को प्रतिपादित किया गया। छत्तीसगढ़ के किसानों की इस कार्ड के उपयोग से प्राप्त उत्पादन वृद्धि को भी प्रस्तुत किया। इस अवसर पर प्रो. सी.बी. गेना, ओ.पी. शर्मा एवं डॉ. एस. के. शर्मा ने भी मृदा को स्वस्थ रखने के उपायों पर, वर्मीकम्पोस्ट इत्यादि के द्वारा इसे पोषित करने का सुझाव दिया। डॉ. बी.एल. चौधरी ने उनके द्वारा कृषि के अंतर्गत उपस्थित समस्याओं के खट्टे-मीठे अनुभवों को बताकर इस अमूल्य निधि को बचाकर रखते हुए इसके स्वास्थ्य को बरकरार रखने पर जोर दिया। उन्होंने यह भी कहा की सरकार का भी पूर्ण समन्वय किसानों के साथ होना चाहिए। कम लागत तकनीकीयों का प्रचार प्रसार एवं उत्पाद के सार्थक मूल्य का निर्धारण स्थान एवं परिस्थिती के अनुसार किया जाना चाहिए। सभा को यह सूचित किया गया कि अबतक सम्पूर्ण देश में लगभग 10 करोड़ मृदा स्वास्थ्य कार्ड बाँटे जा चुके हैं। समुचित कृषि प्रबंधन का दायित्व वैज्ञानिकों एवं सरकार को साथ-साथ करना चाहिए। रसायनिक उर्वरक एवं कीट नाशकों का समुचित एवं यथाउचित उपयोग किया जाना अतिआवश्यक है जिससे मृदा, जल, वायु एवं पृथ्वी के समस्त जीवों को होनी वाली हानी से बचाया जा सके। जैव नियंत्रकों एवं जैविक उर्वरकों (ट्राइकोडर्मा) के उपयोग को बढ़ावा देना आवश्यक है। इस कार्यक्रम में यह भी बताया गया की कृषि विज्ञान केन्द्रों पर समय-समय पर होने वाले कार्यक्रमों का लाभ किसानों को उठाना चाहिए। इसी कार्यक्रम के दौरान नदी, आंबा, मसीनिया, मायापुर, सराधना, केंसरपुरा एवं गंगवाना के किसानों को के.पी.के. अजमेर द्वारा बनाये गये मृदा स्वास्थ्य कार्डों का वितरण अतिथियों के द्वारा किया गया।



इस अवसर पर आमंत्रित प्रगतिशील किसानों, किसान महिलाओं, कृषि विभाग के कर्मचारी एवं कृषि विकास संस्था के निदेशक श्री जितेन्द्र चतुर्वेदी जी को स्मृति चिन्ह प्रदान कर सम्मानित किया गया। इस अवसर पर समस्त अतिथियों का कार्यक्रम के समन्वयक डा. रविन्द्र सिंह, प्रधान वैज्ञानिक ने धन्यवाद व्यक्त किया।

राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर का 19वां स्थापना दिवस मनाया गया

दिनांक 19.01.2018 को राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र पर केन्द्र का 19वां स्थापना दिवस मनाया गया। इस अवसर पर डॉ. अमर सिंह फरोदा, पूर्व ए.एस.आर.बी., अध्यक्ष एवं कुलपति, एम.पी.यू.ए.टी., उदयपुर, मुख्य अतिथि, डॉ. टी. जानकीराम, सहायक महानिदेशक (उद्यानिकी-), भा.कृ.अनु.प., नई दिल्ली, कार्यक्रम अध्यक्ष, डॉ. एस. के. सिंह, निदेशक, अटारी, जोधपुर एवं डॉ. पी. एल. सरोज, निदेशक, सी. आई.ए.एच., बीकानेर, विशिष्ट अतिथि के रूप में उपस्थित थे। कार्यक्रम के प्रारंभ में डॉ. गोपाल लाल, निदेशक, भा.कृ.अनु.प.-रा. बी.म.अनु. केन्द्र, तबीजी, अजमेर ने मंचासीन अतिथियों एवं सभागार में उपस्थित सभी आमंत्रितों का स्वागत करते हुए इस संस्थान के स्थापना के पश्चात् आज तक की यात्रा की एक समुचित रूपरेखा, अनुसंधान एवं अन्य विधाओं पर प्रकाश डालते हुए वर्तमान में चल रही सभी गतिविधियों से अवगत करवाया। इस कार्यक्रम के पूर्व सभी अतिथियों के द्वारा प्रक्षेत्र भ्रमण का कार्यक्रम आयोजित किया गया था जिसमें केन्द्र पर चल रहे सभी अनुसंधान कार्यक्रमों, विभिन्न प्रयोगशालाओं के अंतर्गत क्रियाशील कार्यक्रमों एवं अनुदेशित फसलों की पूर्ण वैज्ञानिक परिचर्चा की गई। प्रधानमंत्री महोदय द्वारा चलाये जा रहे स्वच्छता अभियान का पूर्ण रूपेण क्रियान्वयन इस केन्द्र पर उपस्थित पा कर सभी अतिथियों ने भूरीभूरी प्रशंसा की। जैसा की ज्ञात है, इस केन्द्र की स्थापना वर्ष 1999 में डॉ. राजेन्द्र सिंह परोदा के कुशल नेतृत्व एवं परिकल्पना में क्षेत्र की फसलों एवं किसानों की आवश्यकताओं को मद्दे नजर रखते हुए की गई थी। जीरा, धनिया, सौंफ, मेथी, अजवायन, कलौंजी, सेलरी आदि बीजीय मसालों पर बिगत 18 वर्षों से यह संस्थान अनुसंधान एवं विकास के साथ-साथ किसानों के हितार्थ प्रचार-प्रसार में लगा हुआ है।

डॉ. एस.के. सिंह, निदेशक, अटारी, जोधपुर ने संस्थान के 19वें स्थापना दिवस पर सभी वैज्ञानिक, कर्मचारियों एवं मसाला उत्पादक किसानों को बधाई देते हुए संस्थान की उपलब्धियों की सराहना की। उन्होंने कहा कि बीजीय मसालों के मूल्य अर्जन क्षमता द्वारा भारत सरकार के 2022 तक किसानों की आय दोगुनी करने के लक्ष्य में यह एक अहम भूमिका निभा सकता है। डॉ. टी. जानकीराम, सहायक महानिदेशक, नई दिल्ली ने इस अवसर पर स्थापना दिवस व्याख्यान प्रस्तुत करते हुए कहा कि आज हम आने वाले समस्याओं के प्रति कितने तैयार हैं, इस बात की परिचर्चा आवश्यक है। उन्होंने इसी दौरान प्रारंभ हो रहे मॉडल प्रशिक्षण कार्यक्रम के प्रशिक्षणार्थियों एवं उपस्थित आगंतुकों को बताया कि भारत में कृषि की विविधता का सही से उपयोग करते हुए हमें देश को कृषि उन्नति के पथ पर ले जाना है। किसानों तथा वैज्ञानिकों के अथक प्रयासों एवं विज्ञान के

प्रति निष्ठा की सराहना करते हुए कहा कि बागवानी उत्पादन में देश अग्रणी हो रहा है। खाद्यन्न उत्पादन में बायोफोर्टिफाइड किस्मों के विकास द्वारा खाद्यन्न एवं पोषण सुरक्षा सुनिश्चित की जा रही है। इन्होंने संस्थान द्वारा इस अवधि में विकसित बीजीय मसालों की नवीनतम किस्मों एवं प्रौद्योगिकियों के महत्व को प्रतिपादित करते हुए किसानों को इसके भरपूर उपयोग एवं लाभ के लिए प्रोत्साहित किया। इस अवसर पर राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र के कृषि महत्व को देखते हुए इसके अपग्रेडेशन (उच्चीकरण) की आवश्यकता बताई तथा डॉ. फरोदा ने इस केन्द्र को संस्थान बनाने की संस्तुति भी की। बीजीय मसाले इस शुष्क एवं अर्द्ध शुष्क क्षेत्रों के किसानों के लिए सोना है। ब्रांड के साथ-साथ गुणवत्ता एवं न्यूनतम रसायनिक अवशेषों के साथ बीजीय मसालों का विपणन एवं निर्यात और अधिक बढ़ाया जा सकता है।

डॉ. पी. एल. सरोज, निदेशक, सीआईएच, बीकानेर ने इस संस्थान के स्थापना पूर्व दिनों को याद करते हुए उनके महत्वपूर्ण योगदान का स्मरण किया तथा इस संस्थान के साथ हृदय से जुड़ाव को व्यक्त किया।

स्थापना दिवस के अवसर पर संस्थान द्वारा प्रमोद कुमार अग्रवाल, सुनील कुमार अग्रवाल, भीम सिंह, डॉ. शारदा चौधरी, डॉ. आर.एस. मीणा, डॉ. बी.के. मिश्र एवं डॉ. चाई.के. शर्मा को उत्कृष्ट कार्य हेतु प्रोत्साहन पुरस्कार प्रदान किये गये। इसी दौरान संस्थान द्वारा प्रकाशित राजभाषा हिन्दी के पत्रिका "मसाला सुरभि" एवं बीजीय मसालों के अंतर्राष्ट्रीय जर्नल का विमोचन भी किया गया। अंत में कार्यक्रम के समन्वयक डा. रविन्द्र सिंह, प्रधान वैज्ञानिक ने सभी अतिथियों का धन्यवाद व्यक्त किया।

Agricultural Education Day

Organised Agricultural Education Day, on 3rd December, 2017. Program was conducted for Agricultural Education Day, on 3rd December, 2017. Dignitaries, farmers and students were invited for the function and a successful program was conducted with emphasis on agriculture education among the students and society.

Seed Spices Info mobile App developed

There was an urgent need to develop a mobile app of ICAR-NRCSS for the benefit of farmers, traders and scientist. To fulfil this, a "Seed Spices Info App" was developed. It is bi-lingual and has all the information of about the institute, seed spices crops, value addition of seed spices, news and transfer of technology. It is an interactive mobile application in which farmers can ask questions regarding seed spices through app and our experts will give the reply.

Seed Spices Info App can be downloaded to smart phone and android phone through Google play store free of cost.



Web page corner for SAIF Developed

Sophisticated Instruments Analytical Facilities (SAIF) was developed by AKMU team (Dr. B.K. Mishra and Sh. M.A. Khan) of NRCSS. A webpage corner of SAIF has been created on our institute's website: www.nrcss.res.in. All the information related to important instruments in working condition at the centre along with user charges and photographs of the equipments was also uploaded on ICAR website's KM portal. The main aim of uploading these type of instruments on web is to make these easily available to the other researchers and students as per the directives of ICAR.

Yoga Day

NRCSS, Ajmer organized 10 day's Yoga Practice morning sessions (5.30-7.00 AM) during 11-20 June, 2017 under the guidance of Yoga instructor and demonstrators from Vivekanand Kendra, Kanyakumari, Branch Ajmer. The training sessions held at Onkareshwar Mandir Park, Ajmer were attended by majority of ICAR-NRCSS Staff and their family members besides the residents of the area.

Participation in ICAR tournament at CAZRI, Jodhpur

The NRCSS staff contingent comprising of scientists, technical officers and administrative personnel participated in ICAR zonal sports meet at CAZRI, Jodhpur during 16-20 January, 2018. Sh. Pradeep Kulhari, Assistant, NRCSS, Ajmer won several medals in the ICAR Zonal and inter-zonal tournament as given below:

(a) At ICAR Zonal tournament, CAZRI Jodhpur (16-20 January, 2018)

- (i) Gold medal in 800 meter men's race
- (ii) Silver medal in High jump
- (iii) Silver medal in Discus throw
- (iv) Silver medal in Shot put throw

(b) At ICAR Inter-Zonal tournament, NAARM, Hyderabad (21-25 February, 2018)

- (i) Gold medal in 800 meter men's race



ANNEXURES

Table 1 : Monthly mean temperature, relative humidity, evaporation and rainfall during 2016

| Year 2016 | Mean Temperature (0C) | | Relative humidity (%) | | Evaporation mm/day | Total rainfall (mm) |
|-----------|-----------------------|---------|-----------------------|---------|-----------------------|------------------------|
| | Month | Minimum | Maximum | 7.40 am | | |
| January | 7.0 | 25.2 | 91.8 | 53.5 | 2.9 | |
| February | 9.4 | 26.9 | 90.4 | 49.3 | 3.9 | |
| March | 17.1 | 32.5 | 87.8 | 41.9 | 5.7 | |
| April | 22.4 | 37.7 | 67.8 | 31.0 | 9.4 | |
| May | 27.1 | 40.9 | 62.1 | 38.7 | 14.2 | |
| June | 27.9 | 39.8 | 75.8 | 51.5 | 13.5 | 85.0 |
| July | 26.0 | 33.3 | 91.3 | 77.5 | 6.5 | 173.0 |
| August | 24.5 | 30.2 | 94.4 | 89.5 | 4.8 | 279.6 |
| September | 23.9 | 33.7 | 90.8 | 66.7 | 5.8 | |
| October | 19.7 | 32.9 | 86.8 | 53.8 | 7.0 | 136.8 |
| November | 9.2 | 30.6 | 91.8 | 38.7 | 3.7 | |
| December | 8.0 | 27.7 | 92.9 | 49.4 | 3.3 | |
| Average | 18.5 | 32.6 | 85.3 | 53.5 | 6.7 | 674.4 |

Table 2: Monthly mean temperature, relative humidity, evaporation and rainfall during 2017

| Year 2017 | Mean Temperature (0C) | | Relative humidity (%) | | Evaporation mm/day | Total rainfall (mm) |
|-----------|-----------------------|---------|-----------------------|---------|-----------------------|------------------------|
| | Month | Minimum | Maximum | 7.40 am | | |
| January | 6.8 | 22.2 | 92.4 | 59.1 | 3.2 | 24.3 |
| February | 7.6 | 26.9 | 92.1 | 53.4 | 4.0 | |
| March | 13.2 | 32.3 | 90.8 | 41.7 | 5.8 | |
| April | 21.6 | 38.2 | 87.4 | 38.7 | 12.1 | |
| May | 26.0 | 40.6 | 81.6 | 36.8 | 15.9 | 40.8 |
| June | 27.2 | 37.4 | 83.8 | 56.2 | 12.4 | 107.2 |
| July | 25.9 | 32.6 | 91.0 | 77.4 | 5.4 | 161.3 |
| August | 24.2 | 31.4 | 92.4 | 78.2 | 4.9 | 117.7 |
| September | 23.4 | 34.2 | 90.2 | 63.4 | 7.4 | 48.8 |
| October | 16.1 | 36.1 | 73.5 | 36.4 | 7.1 | |
| November | 9.7 | 29.4 | 69.7 | 49.9 | 5.2 | |
| December | 6.6 | 24.7 | 79.3 | 69.4 | 3.6 | 7.2 |
| Average | 17.4 | 32.2 | 85.3 | 55.1 | 7.2 | 507.3 |



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