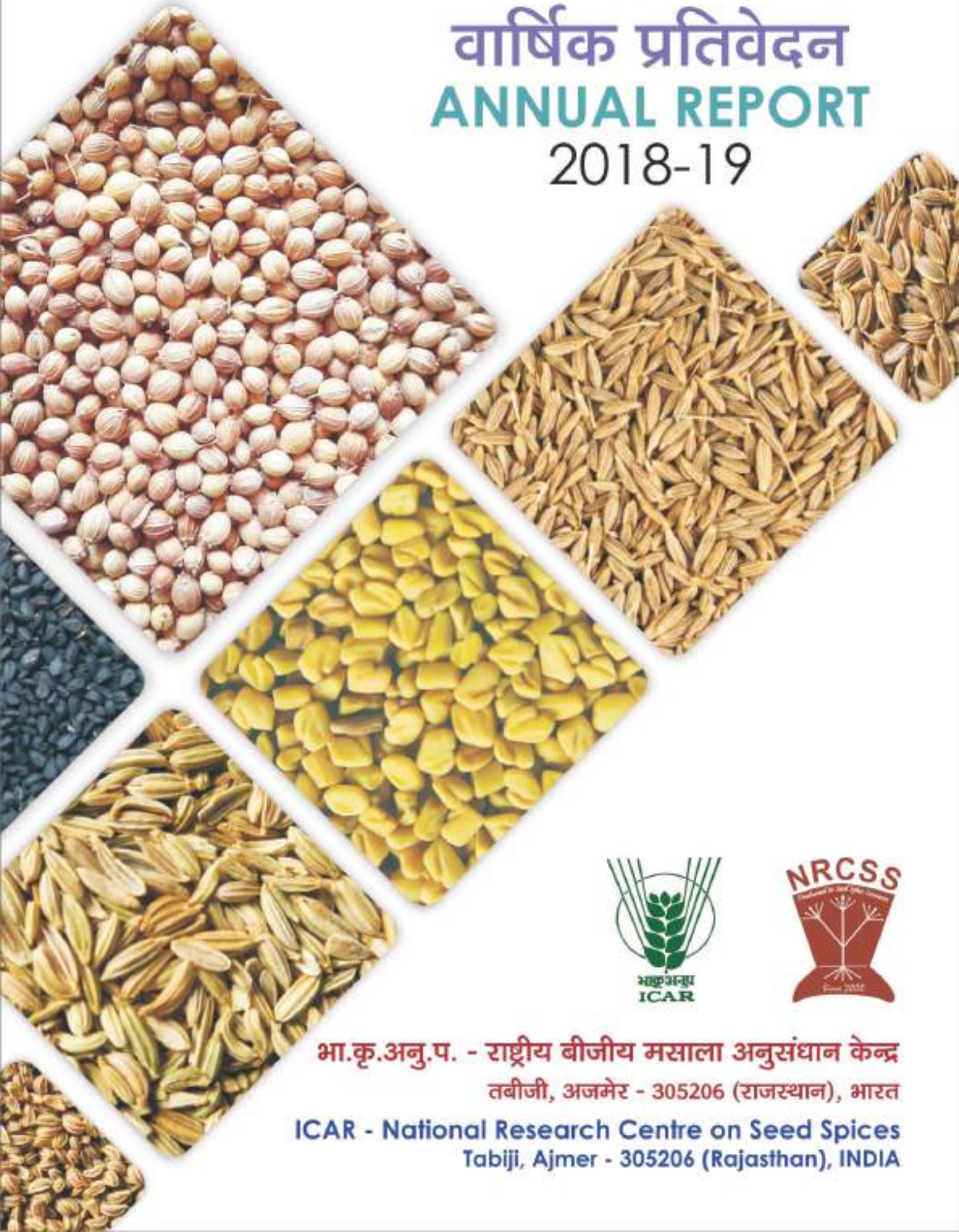


वार्षिक प्रतिवेदन ANNUAL REPORT 2018-19



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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Front : Ajwain, fennel, nigella, fenugreek, coriander, cumin and dill seeds (from bottom to top)
Back : Administrative cum laboratory building, ICAR-NRCSS, Ajmer

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PREFACE



The ICAR-NRC on Seed Spices has been playing a pivotal role for enhancement of area, production, productivity and export of seed spice crops. During the year (2017-18) new records of highest ever seed spice production and productivity has been achieved which is estimated at 1.86 million tonnes with an average productivity of 10.39 q/ha from 1.79 million ha area under cultivation at national level. During the same period seed spices witnessed the export of 2.49 lakh tonnes with a monetary value of Rs 3136.17 crore.

Two new varieties of seed spices namely Ajmer fenugreek-5 and Ajmer Coriander-2 has been notified by Central Varietal Release Committee, Department of Agriculture & Cooperation, Ministry of Agriculture & Farmers Welfare, Govt. of India. One variety of fennel (Ajmer Fennel-3) and one variety of coriander (Ajmer coriander - 3) have been identified in Annual Workshop of All India Coordinated Research Project on Spices held at solan, H.P. during 4 - 6 October, 2018. Two memorandum of understandings (MOUs) has been executed with Farmer Producer Organizations (FPOs) for commercialization of released varieties of coriander, fennel, ajwain, dill and nigella. Extensive research programme for development of organic farming modules, multi-tier cropping of seed spices and intercropping of seed spices in arid orchards has been initiated looking into the future needs of agriculture. Green manuring, on-farm composting of weeds and crop residue and their timely application in NRCSS experimental farm has improved the soil health. The NPK of NRCSS farm soil samples has been found to be in the range of 90-110, 30-52 and 85 kg/ha, NPK respectively, with organic carbon content 0.25-0.32% during 2018. For sustainable and Eco-friendly management of insect pests and diseases several bio-control agents, botanical and bio-fertilizers have been mass-multiplied and their successful field demonstrations have instilled the confidence of seed spice growers for organic inputs.

Effective dissemination of improved varieties, production technologies in existing and new areas, FLDs and farmers training programmes play a crucial role. Under TSP, NEH, SC-SP and MIDH programmes more than 50 farmers training programs were organized in which approximately 2000 farmers directly benefited.

I place on record our gratitude to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR, New Delhi for his guidance, support and encouragement in all endeavours of ICAR-NRCSS, Ajmer. I am grateful to Dr. A.K. Singh, DDG (Horticulture Science), ICAR, New Delhi and Dr. T. Jankiram, ADG (HS-II), ICAR for their keen interest, valuable suggestion and guidance to ICAR-NRCSS, Ajmer. The contribution of various advisory committees (QRT & RAC) in Institute Development are highly appreciated. I also appreciate efforts made by the members of the Annual Report publication committee for compilation, editing and publication. The Annual Report 2018-19 is being placed before the readers for suggestions so as to make it amply informative.

Ajmer

25th June, 2019



(Gopal Lal)

Director, ICAR-NRC on Seed Spices



1. Executive Summary

1.1 Crop Improvement

- ★ Two new varieties of seed spices namely, Ajmer fenugreek-5 (AFg-5) and Ajmer coriander-2 (ACr-2) has been notified by Central Varietal Release Committee (CVRC), Department of Agriculture & Cooperation, Ministry of Agriculture & Farmers Welfare, Govt. of India.
- ★ One variety of Fennel (Ajmer fennel-3) and one variety of coriander (Ajmer coriander - 3) have been identified in Annual Workshop of All India Coordinated Research Project on Spices held at solan, H.P. during 4-6 October, 2018.
- ★ Total 95 germplasm were collected in different seed spices from Uttarakhand, Bihar and Rajasthan state.
- ★ Total of 2220 germplasm lines in different seed spices are maintained at National Active Germplasm Site (NAGS) of ICAR-NRCSS, Ajmer.
- ★ Eight entries of coriander tested for high yield, small seed size and stem gall resistance along with three checks. Entry UD-353 recorded highest seed yield (12.03 q/ha) in station trial over the check variety ACr-1 (8.16 q/ha).
- ★ A trial was conducted with 15 entries of cumin with two checks (GC-4 and RZ-209). The entries GP 3 and GP 39 recorded the higher yield (259.41 kg/ha and 283.45 kg/ha respectively) as compared to check GC-4 (247.01 kg/ha).
- ★ A station trial was conducted with 13 entries of fennel with 3 check varieties (AF-1, AF-2 and RF-125) during the year 2017-18. Entry AF-01-521 recorded highest seed yield (25.92 q/ha) and AF-164 recorded maximum essential oil (1.83 %) content in station trial over the check varieties AF-1 (19.67 q/ha & 1.67%) and AF-2 (21.52 q/ha & 1.50%).
- ★ In screening of fennel genotypes against Ramularia blight, single genotype (AF-87) was recorded lowest disease incidence (PDI-12.33) and considered initially as resistant against Ramularia blight, while three another genotypes Volina, AF-2 and AF0-52 showed moderately resistant reaction to the disease. All other remaining genotypes were recorded susceptible and highly susceptible against the disease.
- ★ A station trial was conducted with 9 entries of fenugreek with one check variety (AFg-3). Entry B5-5-6-1 recorded highest seed yield (9.70 q/ha) compared to check variety AFg-3 (6.61 q/ha).
- ★ A station trial was conducted with 13 advanced lines of dill with two checks varieties (AD-1& AD-2). Three lines (Gene pool, AD-5-1-28 and AD-5-44) were giving the higher yield (2490.1, 2425.5 and 2375.1 kg/ha, respectively) as compared to check varieties AD-1& AD-2 (2277.4 kg/ha and 1952 kg/ha respectively). Lowest (38.4 kg/ha) seed shattering was recorded on genotype AD-5-11 followed by AD-5-45 and AD-5-1-3 (39.4 kg/ha).
- ★ Station trial on ajwain was conducted with 12 test entries and three check varieties Ajmer Ajwain-1, Ajmer Ajwain-2 and GA-1. Higher seed yield (1735 kg/ha) was recorded in AA-3 genotypes as compared to check varieties.
- ★ A trial was conducted with 11 test entries of nigella and two check varieties namely, Ajmer Nigella-20 and Azad Kalongi. Higher yield attributes and yield (1029.66 kg/ha) was recorded in AN-19 genotypes followed by AN-9.
- ★ Entry A-Cel-14-34 recorded highest seed yield (17.08 q/ha) and K-24 recorded maximum essential oil (2.28 %) in station trial on celery over the check variety A-Cel-1 (12.55 q/ha & 1.62%) for yield and essential oil content, respectively.
- ★ Three advanced lines of celery were evaluated with check variety (A-Cel-1) during the year 2017-18. Of the 3 genotypes, entry A-Cel -5 recorded highest seed yield (6.30 q/ha) and essential oil (2.16%). Selected mutants of fennel and cumin were evaluated in their respective generation (M₁, M₂ & M₃) for different traits for which they were selected in M₂ generation. 77 lines in M₁ generation and 40 lines in M₂ generation of fennel showed stability in selected characters and were selected for further evaluation. In cumin M₁ generation successfully raised and 2 mutant lines showing superiority with parent plant (GC-4) with respect to yield per plant were selected.

- ★ Microsatellites were developed using the MISA v1.0 software from transcriptomes. Insilco validation confirmed the SSRs availability at different sizes and distance. Three hundred primers were subjected to wet lab validations which were showing amplification in coriander samples.

1.2 Crop Production

- ★ Two separate field experiments were conducted for evaluation of selected endo-rhizospheric and exo-rhizospheric bacteria for growth and yield of cumin and fenugreek crop plants. The highest seed yield of cumin crop was observed with *Bacillus megaterium* (73.30 g per m²) which was at par with *Pseudomonas fluorescens* (68.55 g per m²) and lowest was recorded with control (15.37 g per m²). The maximum essential oil content was recorded in *Pseudomonas fluorescens* (4.05 %) followed by *Pseudomonas sp.-1* (3.86 %) and the minimum was recorded with *Bacillus sp.* (3.28 %). In fenugreek the highest seed yield was obtained from *Rhizobium*+*B. subtilis* +*B. megaterium* (0.249 kg per m²) which was at par with *Bacillus sp.* + *B. megaterium* (0.242 kg per m²) while the lowest seed yield was recorded with control (0.188 kg per m²).
- ★ Thirty five cumin soil samples were collected from Nagaur, Jodhpur, Jaisalmer and Barmer Districts of Rajasthan. These cumin soil samples assayed for pH and EC which ranged from 7.09 to 8.27 and 0.15 to 1.55 dS/m respectively. Total twelve bacterial isolations made from these samples based on differential growth media for Phosphorus and Zinc solubilizing ability. These bacteria further tested for their ability to grow on different temperatures (35, 40 and 45 °C) and Sodium chloride conc. (1.0, 2.0 and 3.0 percent, w/v).
- ★ Seed germination percentage in celery increased with increase in time from 9 to 16 days. Seed vigour was also improved with the higher concentration of micronutrients except Fe, Zn and B. Based on the germination percentage and seedling vigour, the optimum concentration for seed priming of celery was 500, 250, 250, 1000 and 250 ppm for Fe, Zn, Mn, Cu and B, respectively.
- ★ Seed germination was adversely affected with sodicity and maximum germination was observed at 12 days in coriander fennel and fenugreek, while

in cumin it was maximum at 15 days. More than 50% germination of coriander, cumin fennel and fenugreek was found at RSC 12.0, 8.0, 14.0 and 16.0, respectively. Seedlings vigour reduced with increase in sodicity.

- ★ Standardization of crops for bower system indicated that fenugreek in *rabi* for seed followed by ridge gourd + leafy coriander for vegetable gave maximum fenugreek seed equivalent yield (16176 kg/ha) with maximum gross (Rs. 566173/ha) and net returns (Rs. 361073/ha) and B:C ratio 2.76.
- ★ Intercropping of seed spices with guava recorded highest seed yield in open space followed by with guava association.
- ★ Studies on G × E interaction in cumin through on farm trial (OFT) exhibited the average cumin seed yield 828.0 kg/ha at Bhudhwara (Peesangan), 781.6 kg/ha at Dhorimna (Barmer), 736.5 kg/ha at Mundawa (Nagaur), 443.4 kg/ha at Sarwad and 439.6 kg/ha at Tabiji.

1.3 Crop protection

- ★ In monitoring diseases of seed spice at the Institute farm, fenugreek powdery mildew was initiated in seventh standard week (February 12-18, 2018); downy mildew in second standard week (January 8-14, 2018) and blight in third standard week (January 15-21, 2018); where as increase in cumin *Alternaria* blight first appeared in second standard week (January 7-14, 2018).
- ★ A field experiment on impact of insect pollinators on yield and quality of ajwain and dill was conducted. The results showed that yield of ajwain (1376 kg/ha) obtained in bee pollinated plots (caged) was 62.45 per cent higher than control (without bee pollination-caged with insect proof nylon net), wherein 847 kg/ha yield was recorded.
- ★ Similarly, in dill crop the highest yield of 1447.5 kg/ha was recorded in the plots kept as open pollination and treated with bee attractant (jaggery solution 10%) followed by open pollination plots (1435.2 kg/ha).
- ★ Management of nematodes in field experiments showed that application of soil sterilant Metham sodium and Dazomet gave excellent protection up to the maturity of the crop. Application of granular systemic insecticides/nematicides did not result in

good control of nematodes population in cumin crop. Among nematopathogens, soil application of *Paecilomyces lilacinus* (10^8 CFU/g) + *Trichoderma harzanium* (10^8 CFU/g) + *Pseudomonas fluorescens* (10^8 CFU/g) also gave good control up to 60 days.

- ★ *In-vitro* bio-efficacy of different *Trichoderma* isolates was tested against nigella root rot pathogen and growth inhibition of the pathogen was observed periodically. Data revealed that all *Trichoderma* isolates inhibited the growth (55-60%) of nigella root rot pathogen. Different fungicides were also tested using poison food technique showed growth inhibition of nigella root rot pathogen using mancozeb and chlorothalonil (39-40.5%).
- ★ Field experiments were conducted to evaluate the effective spray scheduling of recommended fungicides against *Alternaria* blight of cumin and to evaluate the effect of different fungicides on diseases of fenugreek. Data revealed that all schedules reduced the cumin blight PDI as compared to control. Comparatively foliar application of Mancozeb/zineb (0.2%) followed by azoxystrobin (0.1%) and difenoconazole (0.05%) starting from 45 days after sowing at 15 days interval was found most effective to manage the disease (77-82%).
- ★ Biological management of *Alternaria* blight in cumin bacterial isolate B1 was found most effective among all tested isolates and showed minimum mycelium growth (10mm) with 90% growth inhibition followed by B8 (14mm) with 87.4% growth inhibition. Other eight biological isolates were also effective against the disease. The maximum mycelium growth was recorded in control (90mm) with no inhibition.
- ★ An experiment was conducted to evaluate the relative efficacy of different IPM modules against aphid. The Maximum per cent reduction in aphid population (94.98%) was recorded on plants treated with IPM module M₁ followed by IPM module M₂ (93.10 %), both the IPM modules were found statistically at par.
- ★ The micro-encapsulation and micro-emulsion formulation of deltamethrin tested @ 0.003%, gave excellent control of aphids at 3 days after spraying which was superior to commercially available

formulation (emulsifiable concentrate) of deltamethrin at same concentration.

- ★ Mixing of synergist @ 5% with synthetic insecticide Thiomethaxam @ 0.0025% and neem oil 2.0% gave good control of aphids on selected crops and was superior to alone application of neem oil 2.0%. Application of botanical formulation, sesamum leaf extract -non polar and sesamum leaf extract -polar at 0.5% concentration showed that non polar formulation gave better result in comparison to polar formulation. Modified neem composition @ 5% tested against aphids also gave good control against aphids in the field. *Verticillium lecanii* (@1.5% SC) was found better than powder formulation.

1.4 Basic science and post-harvest technology

- ★ Modulation of morpho-physiological activities and stress tolerance in cumin by concomitant application of depolymerised plant growth regulators revealed that compared to control, the various treatments showed increase in growth parameters and seed yield particularly BA (@ 0.5 mM), AA (@ 1.5 mM) and Proline (@ 1.5 mM). The maximum total oil content (10.98%) was recorded with BA (@ 0.5 mM) followed by JA and SA (@ 0.5 mM) essential oil/total oil constituents greatly differ with different PGR treatments. Cuminaldehyde was major essential oil content which varies from 27.78% in control to 64.64% in distilled water treatment followed by cymene and gama-terpene.
- ★ Exogenous application of PGRs for improving essential oil content in coriander showed that Benzyl Adenine (@ 1.0 mM and 6- BA (@ 0.2 mM) enhanced essential oil yield (4.8 - 4.23 %) in comparison to control (3.09%).
- ★ Monitoring and evaluation of agro chemical residue in cumin revealed that maximum yield of cumin (9.6 q/ha) was harvested in the soil sterilized with metham sodium, 15 days prior to sowing followed by foliar spray with dimethoate (@ 0.03%) and difenoconazole (@ 0.10%). Residue levels of the molecules used during crop cultivation in the harvested cumin were below detection limit.
- ★ Studies on dissipation kinetics and pre harvest interval of triazoles in fenugreek showed that the fungicides difenoconazole and hexaconazole had dissipated in the harvested seeds completely and

based upon the dissipation kinetics, the pre harvest interval (PHI) for difenoconazole was calculated to be 19 days (@ 0.05%) & 22 days (@ 0.1%) and for hexaconazole as 21 days (@ 0.1%) & 23 days (0.2%).

1.5 Social Science

- For dissemination of seed spices production and post-harvest technology through demonstrations, trainings, workshops and seminars under NEH and TSP project, 231 frontline demonstrations (FLDs) were conducted. FLDs for coriander variety ACr-1 (65), fenugreek-AFg-3 (60), fennel-AF-1 (40), ajwain-AA-1 (35), dill-AD-1 (05) and nigell-AN-1 (26) were conducted on tribal farmers' field at Pratapgarh, Banswara, Dungarpur and Udaipur districts of Rajasthan under Tribal Sub-plan project. Results of the FLDs at different farmers' field revealed that yield of seed spices under demonstration plots was higher in comparison to local checks/practices in the range of 21.54% to 41.39%. Yield was found 33.99 % higher in coriander, 29.65% in fenugreek, and 35.78% in fennel 41.39 % in ajwain, 32.49% in nigella, and 21.54% in dill.
- Assessing approachability and facilities of ICT and effective medium of information dissemination to cumin and coriander growers of Western India, the most effective ICT tool used by farmers to seek information on agriculture was TV, where 74% of the farmers watched agriculture related programmes followed by participation in extension programmes viz; Farmers Fare, Training, Exposure visit, Kisan Sanghasthi etc. Newspaper was also found as most effective tool to seek information by the farmers.
- A study carried out for economic analysis of production and export performance of coriander and cumin in India, revealed that performances of seed spices to total spices in term of area, production and export has improved during study period from 1985 to 2018.

1.6 Externally funded project

- DUS Project (PPV & FRA): Under this project development of DUS test guidelines for major and minor seed spices (20 fennel, 22 fenugreek, 34 coriander, 9 cumin, 9 ajwain, 4 dill, 5 nigella, 3 celery and 2 anise) varieties were undertaken. Observations were recorded for various characters as per standard descriptors.

- Under Network Project on Organic Farming (NPOF) "Standardization of seed spices based organic farming system", performance of crops (fennel, coriander, mung bean and cluster bean) for all parameters was recorded best under 75% organic +25% inorganic treatment followed by state recommendation both in *Kharif* and *Rabi* seasons.
- Among varietal trials for different crops under organic system, the performance of fennel variety GF-12 (3250 kg/ha) and Azad Dania-1 (1653.00 kg/ha) in *Rabi* season, mung bean variety MUM-2 (943.16 kg/ha) and cluster bean variety RGC-1038 (1250 kg/ha) recorded better yield during *Kharif* season.

1.7 Other activities

- Approximately 20,000 visitors including farmers, stakeholders and students visited the ICAR-NRCSS experimental farm, knowledge park and bio-control lab during 2018-19. 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.
- Beej Vitran Pakhwada organized, during 17-30 Sept, 2018, awareness campaigning among the farmers towards the HYV developed by NRCSSS, Ajmer through "Beej Rath Yatra" and vocal means was carried out.
- A State Seminar on "Clean and safe production of Seed Spices for enhancing farmers income" was organized jointly by ICAR - National Research Centre on Seed Spices, Ajmer and DASD, Calicut under MIDH during 27-28 March, 2019 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, 2018 के मध्य मनाया गया। पखवाड़ा का शुभारम्भ 14 सितम्बर 2018 को राजभाषा क्रियान्वयन समिति की बैठक के साथ हुई जिस में केन्द्र के निदेशक डॉ. गोपाल लाल ने अध्यक्षता की।
- दिनांक 19.01.2019 को राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र पर केन्द्र का 20वां 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 aromatic vegetable products of tropical origin and 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 crops covered 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 low volume 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. Rajasthan and Gujarat states are the two largest seed spice growing states, accounting for more than 70 per cent and 80 percent of the total area and production respectively. Seed spices also play important role in the annual export basket of spices of our country. Production of seed spices has critical constraints which need to be tackle on priority basis. 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 issues emerge after making analysis of different constraints affecting production of these crops, which 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 four years from 2014-15 to 2017-18, 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 17.93 lakh ha. More than this,

Spices	2014-15		2015-16		2016-17		2017-18	
	Area ('000 Ha)	Production ('000 MT)	Area ('000 Ha)	Production ('000 MT)	Area ('000 Ha)	Production ('000 MT)	Area ('000 Ha)	Production ('000 MT)
Cumin	890	486	808	503	781	500	780.95	500.38
Coriander	553	462	582	585	672	863	665.19	866.80
Fenugreek	123	131	219	247	220	310	219.72	311.28
Fennel	39	60	76	129	89	148	89.58	148.64
Ajwain	24	16	24	16	34	27	34.50	27.94
Seed Spices	1629	1155	1709	1480	1798	1850	1793.95	1860.55
Total Spices	3317	6108	3474	6988	4031	8610	3969.39	8413.98

(Source: Directorate of Economics and Statistics, DAC &FW for area and production and DGCI&S, Kolkata for export)

production has increased by almost 26 per cent as result of increased productivity of seed spices rather than area. Export of seed spices has also increased from 2607.46 to 3136.17 crore rupees during 2014-15 to 2017-18. During this period highest expansion has been seen under fennel and fenugreek cultivation.

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 spices 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.

2.1 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.

2.2 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.

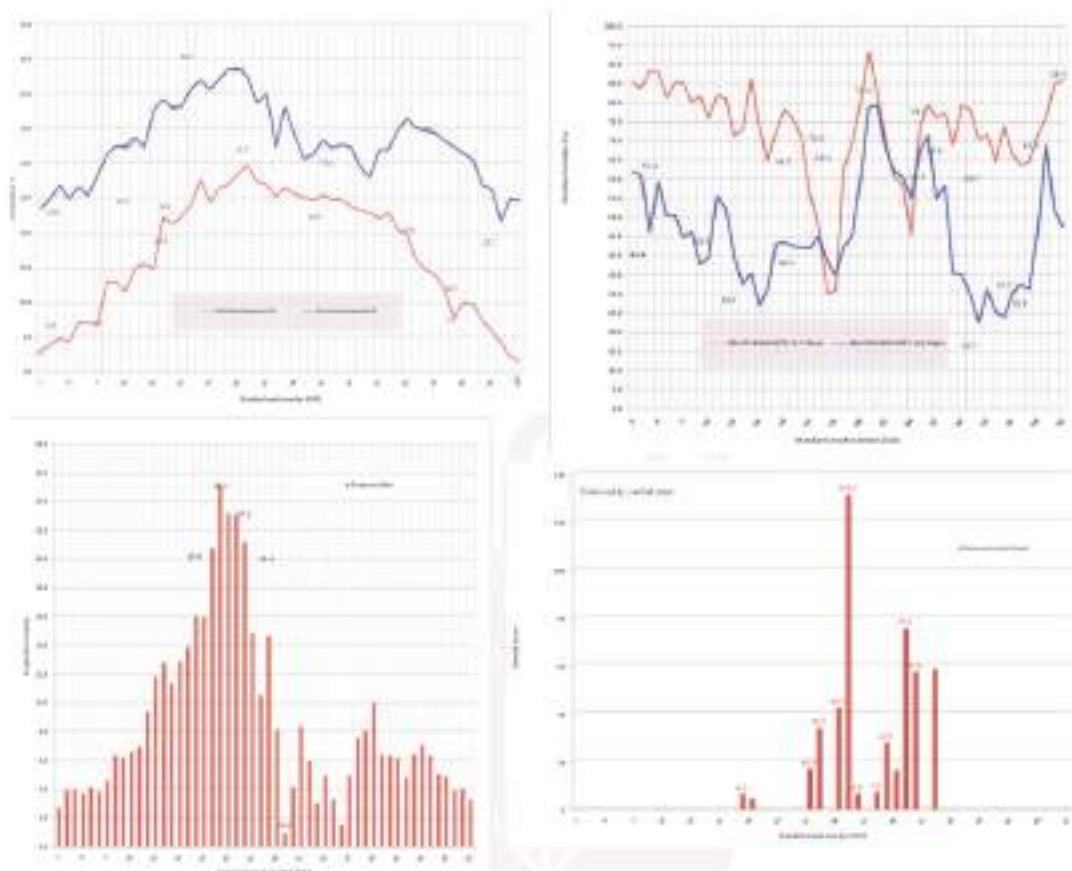
The centre lies on 74° 35' 39" E to 74° 36' 01" longitude and 26° 22' 12" to 26° 22' 31" N latitude at an altitude of 460.17 m above mean sea level. The soil of the research farm is sandy loam, poor in fertility and water holding capacity, having pH 8 to 8.3, EC 0.07 to 0.12 and 0.15 to 0.23% organic carbon, available N 178.5 kg ha⁻¹ (low), P₂O₅ 12 kg ha⁻¹ (medium), K₂O 85 kg/ha-1 (low), Ca 214.7 kg ha⁻¹ (high), Mg 258 kg ha⁻¹ (medium), S 27 kg ha⁻¹ (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 meager. 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%. The agro meteorological data for the cropping year for which the results are presented in this report is given in Table 1.

2.3 Agro meteorological data for the year 20017-18 at ICAR - NRCSS, Tabji, Ajmer

The daily weather data recorded at agro meteorological observatory, ICAR-NRCSS, Ajmer and calculated monthly average data for the cropping year 2017-18 are presented in Annexure 1.

The maximum monthly rainfall of 161.3 mm was recorded during July, 2017, whereas it was 179.0 mm during July, 2018. The total rainfall was 507.3 and 480.3 mm during 2017 and 2018, respectively. The total rainfall was lower by 4.0% during 2017 and 9.2% during 2018 as compared to the mean annual rainfall of 529.0 mm (for the 100 years) in the area. The minimum temperatures



Weekly weather data during 2018 at NRCSS Farm

(1.0 to 1.5 °C) was recorded on 2nd, 3rd and 25th January, 2018 and a frost event was happened which damaged the seed spices in the area. Whereas, maximum temperature of 43.5 °C were recorded on 8th May, during 2017 and 44.0 - 45.0 °C on several occasions during May, 2018. The lowest relative humidity was 15.5 per cent on 18th April, 2018 while the highest (95%) was recorded on several occasions during the year. The total open pan evaporation during the year 2017 and 2018 were 2646.8 and 3153.8 mm, which was 5.21 and 6.56 times higher than the annual rainfall of respective year. 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 19.0 mm on 3rd June, 2017 and 26.5 mm on 22 and 23 May, 2018, respectively.

2.4 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

2.5 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.)

2.6 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.

2.7 FINANCIAL OUTLAY (Rs in Lakhs)

HEAD	Govt. Grant (2018-19)	
	Budget	Expenditure
Minor works	8.89	8.89
Equipment	11.63	11.63
Information technology	3.77	3.77
furniture and fixture	1.00	1.00
others SCSP capital	5.00	5.00
Salaries	637.39	637.39
Pension	58.00	52.42
Travelling Allowance	12.88	12.88
Research & Operation	83.76	83.76
Administrative Expenses	194.51	194.51
Miscellaneous Expenses	8.81	8.81
TSP	15.48	15.48
NEH	3.00	3.00
SCSP	5.00	5.00
Total	1049.12	1043.54

2.8 STAFF POSITION on 31-03-2019

S.No.	Class of Posts	Total sanctioned posts	Employees in position
1.	Scientific Posts		
a.	Scientist	12	11
b.	Senior Scientist	07	07
c.	Principal Scientist	1	0
d.	Director/RMP Scientist	1	1
	Total	21	19
2.	Technical Posts		
a.	Category I	1	0
b.	Category II	3	3
c.	Category III	4	2
	Total	8	5
3.	Administrative Posts		
a.	Category "A" posts:- AO	01	01
b.	Category "B" posts:- AF&AO/AAO	06	04
c.	Category "C" posts:- UDC/Steno/LDC	04	03
	Total	11	8
4.	Supporting Skilled Staff	2	2
	Grand Total	42	34

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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

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

Germplasm Collection: Total 95 germplasm were collected in different seed spices. Nineteen germplasm lines were collected in collaboration with NBPGR, New Delhi which included coriander (13), fenugreek (1), caraway (4) and fennel (1) from Uttarakhand during 6-27 May 2018. Collected 10 fenugreek, 20 coriander & 4 nigella lines from Kota during 24- 28 April 2018. Twenty three germplasm lines were collected from Bihar state included coriander (12), nigella (9), fenugreek (1) and fennel (1) during 30-31 May 2018. Nineteen Ajwain germplasm lines were collected from Pratapgarh district of Rajasthan during 2-3 Feb. 2018.

Table 3.1: Total germplasm assemblages at NRCSS, Ajmer

Crop	NRCSS Collection			NAGS Holding
	Indigenous	Exotic	Present available	
Cumin	100	7	107	247
Coriander	169	3	176	594
Fenugreek	82	59	135	745
Fennel	118	3	46	299
Ajwain	99	1	91	119
Dill	106	5	108	111
Nigella	21	3	24	37
Celery	36	-	36	36
Anise	18	-	18	18
Caraway	8	2	2	14
Total	790	83	745	2220

Germplasm Evaluation:

- Curators maintained and evaluated germplasm and recorded observations as per descriptors.
- Besides this 230 germplasm lines of fenugreek received from NBPGR were also evaluated under CRP on Biodiversity.

Table 3.2: Variability recorded in celery germplasm.

Character	Mean	Minimum	Maximum	CV %
Leaf Length	11.38	9.5	12.16	34.32
No. of Leaf lets	3.86	3	4.2	10.38
Petiole Length (cm)	8.69	6.962	9.86	9.94
No. of Umbel/Plant	87.98	70	105.2	11.23
No. of Umbellate/Umbel	22.34	14	26.8	19.73
Seed/Umbellate	33.54	28.6	38	10.11
Plant Height (cm)	87.78	80.4	94.4	5.85
Test Weight (g)	0.37	0.251	0.438	16.43
Seed Yield (g)	10.09	1.07	19.4	54.84

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: A.K. Verma; Co-PI: Y.K. Sharma and N.K. Meena; 2015-20)

During the current season (2017-18) one station trial was conducted on dill. The trial consisted 13 advanced lines of dill with two check varieties (AD-1 & AD-2). Data presented in the Table 3.3 revealed that maximum primary branches (7.2) recorded on genotype Genepool, while the maximum (28.3) secondary branches were recorded on AD-5-11 followed by Genepool (27.3). Maximum number of umbel per plant were recorded on AD-5-28 (79.1) followed by Genepool (73.5). Likewise maximum number of umbellate per umbel (45.5) were recorded on Genepool followed by AD-5-28 (42.5). Three lines (Gene pool, AD-5-1-28 and AD-5-44) were giving the higher yield (2490.1, 2425.5 and 2375.1 kg/ha respectively) as compared to check varieties (AD-1 & AD-2, 2277.4 kg/ha and 1952 kg/ha respectively). The maximum oil content (2.7%) was recorded in genotype AD-5-11 followed by AD-5-1-28 (2.69%) and the lowest seed shattering (38.4 kg/ha) was recorded in genotype AD-5-11 followed by AD-5-45 and AD-5-1-3 (39.4kg/ha).

Table 3.3: Ancillary characters of dill genotypes

Genotype	PH	PB	SB	UPP	UPU
AD-S-45	164.4	6.6	23.3	64.1	26.8
AD-S-3-2	163.0	6.8	23.0	64.6	26.8
AD-S-3-8	159.4	6.7	14.6	41.5	23.8
AD-S-1-3	161.3	6.6	15.4	63.7	26.6
AD-S-50	160.0	6.7	24.7	63.3	27.0
AD-S-14	168.3	6.7	23.0	68.2	25.0
AD-S-11	158.3	6.7	28.3	67.4	26.2
AD-S-1-24	168.9	7.0	24.8	64.7	27.1
AD-S-44	169.4	6.9	26.4	68.9	41.7
AD-S-3-35	168.3	7.0	24.2	55.3	26.2
AD-S-1-28	168.9	6.8	27.0	79.1	42.5
AD-67	151.9	6.7	23.6	60.2	25.4
Genepool	155.6	7.2	27.3	73.5	45.5
AD-1	154.7	7.1	25.4	61.9	37.8
AD-2	149.4	6.8	22.0	56.9	25.1
CD(5%)	NS	NS	4.2	12.8	3.9



Average yield of different genotype of dill



Essential oil content in different genotype of dill

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

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

A trial was conducted with 12 test entries and three check varieties namely, Ajmer Ajwain-1, Ajmer Ajwain-2 and GA-1 during the year 2017-18. Observations on

growth parameters such as yield and yield attributing traits were recorded. Higher yield (1735 kg/ha) was recorded in AA-3 genotypes as compared to check varieties. Necessary observations were recorded and data presented in table 3.4 and 3.5 given below.

Table 3.4: Performance of ajwain genotypes in trial

Genotypes	Plant height (cm)	No. of primary branches /plant	No. of secondary branches /plant	No. umbels /plant
AA-1	125.67	17.00	187.00	259.66
AA-2	122.00	17.33	248.33	249.66
AA-84	121.33	15.33	190.00	219.66
AA-51	117.00	16.00	222.66	236.66
AA-45	120.00	13.67	255.67	257.66
AA-96	120.33	14.33	217.67	267.33
AA-74	121.33	15.00	221.66	258.66
AA-43	123.00	16.00	242.66	239.00
AA-27	124.00	16.00	227.67	249.66
GA-1	119.33	14.00	206.6	241.00
AA-85	131.67	18.33	245.66	265.00
AA-100	118.67	15.33	207.33	248.00
AA-44	120.67	16.33	212.66	225.00
AA-3	119.33	15.33	218.00	267.00
AA-61	121.00	16.33	205.00	246.33
SEm ±	2.24	0.85	7.69	7.24
CD(P=0.05)	6.52	2.47	22.41	21.10
CV%	3.19	9.31	6.04	5.04

Table 3.5: Performance of ajwain genotypes in trial

Genotypes	No. of umbellates /umbel	No. of seeds /umbellate	Seed yield (kg/ha)	Test weight (gm)	Essential oil (%)
AA-1	19.30	22.60	1460	1.020	1.8
AA-2	17.10	24.00	693	1.080	1.6
AA-84	16.50	22.10	1158	1.010	1.9
AA-51	16.40	23.60	1430	0.930	2
AA-45	17.70	22.20	1180	1.080	1.8
AA-96	16.40	22.50	1702	0.997	1.9
AA-74	16.80	22.30	680	1.040	1.75
AA-43	16.90	21.50	1620	0.877	1.5
AA-27	19.00	22.50	1710	1.100	1.25
GA-1	17.50	21.10	1280	0.927	2
AA-85	16.30	22.30	1341	0.820	1.6
AA-100	16.66	22.60	752	0.977	1.5
AA-44	17.20	22.20	1505	1.017	1.75
AA-3	17.23	22.20	1735	0.930	1.8
AA-61	17.60	22.00	871	0.907	1.8
SEm ±	0.56	0.35	117.74	0.068	0.07
CD(P=0.05)	1.65	1.01	342.83	N/A	0.21
CV%	5.69	2.70	16.00	11.99	6.42

CI-19: Enhancing genetic variability in cumin

(PI: A.K. Verma; Co-PI: R.S. Meena; 2012-18)

An experiment carried out with 15 entries and two checks (CG-4 and RZ-209). The entries GP 3 and GP 39 recorded the higher yield (259.41kg/ha and 283.45kg/ha respectively) as compared to check GC-4 (247.01kg/ha) (Table 3.6). Likewise in Table 3.7 there were 12 entry with two checks, among the entries, CE-10 (407.6 kg/ha) and CE-13 (448.3kg/ha) were found to be superior to GC-4 (360.5kg/ha) when compared yield per ha basis. Data presented in Table 3.8 revealed that there were 12 entries and two checks. It was found that entry AC-WMT-16-40 and AC-WMT-16-73 were recorded higher yield and resistance/tolerance to wilt as compared to checks varieties. The AC-WMT-16-40 and AC-WMT-16-73 were recorded yield 563.4 kg/ha and 524.6 kg/ha respectively as compared to 368.5kg/ha in GC-4 (Table 3.8).

Table 3.6: Pooled data of ancillary characters of cumin genotypes

Genotype	PH	PB	SB	UPP	SY kg/ha
GP-3	25.6	5.6	12.1	20.8	259.41
GP-6	28.5	5.2	10.5	24.1	209.24
GP-7	27.8	5.7	10.9	22.3	165.04
GP-15	28.2	5.4	11.1	24.6	223.41
GP-17	25.6	5.5	11.6	21.6	237.16
GP-18	27.1	5.7	10.6	23.6	186.58
GP-19	28.2	5.1	9.7	25.9	173.04
GP-21	28.7	5.1	9.4	23.2	147.32
GP-37	28.9	4.8	9.2	24.1	153.96
GP-39	28.1	5.7	11.9	26.1	283.45
GP-41	24.9	5.0	8.9	23.8	193.74
GP-47	26.8	4.7	8.9	23.2	212.68
GP-50	27.1	5.0	9.0	23.2	165.32
GP-58	28.7	5.1	9.0	20.7	225.31
GP-59	29.2	5.2	10.2	20.0	232.17
GC-4	25.9	5.4	9.6	20.8	247.01
RZ-209	25.9	4.9	9.0	17.0	154.90
CD(5%)	NS	NA	1.79	NA	NA
CV(%)	9.2	11.7	10.6	14.4	28.654

Table 3.7: Pooled data of ancillary characters of cumin genotypes

Genotype	PH	PB	SB	UPP	UPU	SY kg/ha
CE-1	29.1	4.9	10.2	23.0	4.1	258.6
CE-2	27.5	5.1	9.4	24.6	4.25	160.3
CE-3	27.8	4.8	9.9	25.7	4.35	180.5
CE-5	26.9	4.6	9.2	21.9	4.1	201.6
CE-6	25.3	4.7	8.9	24.8	4	239.2
CE-7	25.9	4.5	8.0	24.9	4.05	256.1
CE-8	27.5	4.6	8.4	23.6	4.15	131.0
CE-10	26.8	4.7	7.7	22.3	4	407.6
CE-11	25.4	4.7	10.3	25.3	4.2	303.9
CE-13	26.6	5.1	11.9	27.3	4	448.3
CE-14	26.5	4.8	9.7	27.1	4.28	274.7
CE-15	26.6	5.1	12.5	26.3	4.4	494.3
GC-4	27.7	5.2	11.4	22.6	4.4	360.5
RZ-209	27.9	4.7	8.9	18.6	3.95	165.9
CD(5%)	NS	NS	2.56	3.82	NS	183.98
CV(%)	11.7	7.9	18.3	11.01	6.4	30.4

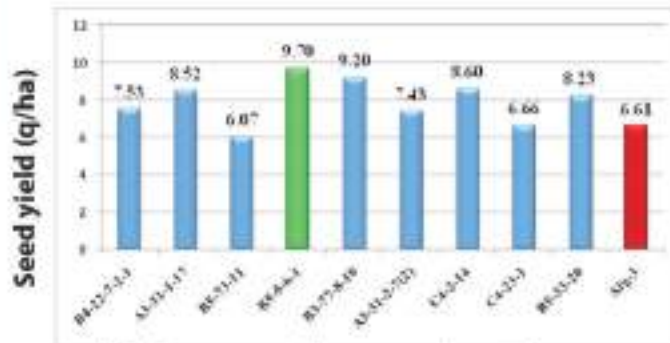
Table 3.8: Pooled data of ancillary characters of cumin genotypes

Genotype	PH	PB	SB	UPP	SY kg/ha
AC-WR-16-1	18.4	4.8	10.6	22.0	241.2
AC-WMR-16-3	20.3	5.2	11.3	25.9	205.4
AC-WT-16-7	19.3	4.8	10.2	26.2	184.0
AC-WT-16-14	21.8	5.0	10.4	28.8	204.9
AC-WT-16-20	19.2	4.7	10.1	26.5	242.6
AC-WMT-16-2	20.4	5.0	10.5	26.9	234.0
AC-WMT-16-3	22.9	4.6	10.2	26.9	300.1
AC-WMT-16-4	19.2	4.8	10.1	27.4	386.8
AC-WMT-16-40	24.1	5.2	12.0	32.5	563.4
AC-WMT-16-73	21.8	4.8	10.9	27.7	524.6
SPS-IS-15	20.6	5.1	11.2	26.3	279.5
SPS-249/13	18.9	4.6	11.4	26.4	222.5
GC-4	22.0	4.8	11.3	25.5	368.5
RZ-209	20.6	4.4	8.9	25.3	209.4
CD(5%)	NS	NS	NS	NS	152.7
CV(%)	9.9		6.7	11.6	27.1

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)

Station Trial-I: A station trial was conducted with 9 entries and one check variety (AFg-3) during the year 2017-18. Entry B5-5-6-1 recorded highest seed yield (9.70 q/ha) over the check variety AFG-3 (6.61 q/ha) (Table 3.9 and 3.10).

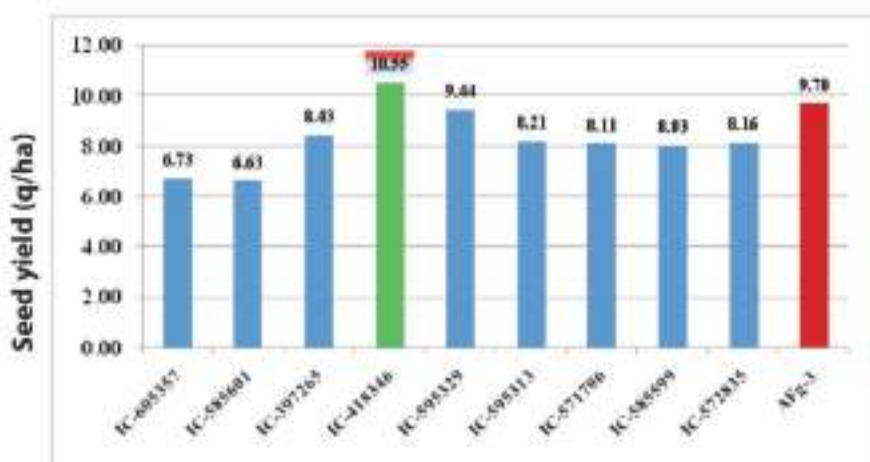


Performance of fenugreek genotypes seed yield (q/ha) during 2017-18 station trial-I

Table 3.9: Performance of fenugreek genotypes for ancillary characters in station trial-I

Genotype	Plant height (cm)	Primary branches	Secondary branches	No. of pod/plant	No. of seed/pod	Test weight (gm)
B4-22-7-2-1	84.40	4.20	7.07	19.73	16.93	12.83
A3-31-1-17	77.20	4.13	6.93	22.73	17.47	13.77
B5-73-11	72.00	4.13	6.20	18.73	16.80	14.33
B5-5-6-1	79.27	4.60	7.53	23.00	16.80	12.93
B3-77-8-10	71.80	5.07	7.47	17.87	17.47	12.27
A3-31-2-7(2)	66.07	4.80	7.07	19.87	16.20	13.13
C4-2-14	76.07	4.00	7.33	21.47	14.60	14.53
C4-23-1	76.93	3.53	6.13	23.73	16.00	13.37
B5-33-20	68.27	3.40	7.27	16.00	15.33	16.93
AFg-3	78.53	5.93	7.60	24.13	17.07	13.50
Mean	75.05	4.38	7.06	20.72	16.47	13.67
SEm±	2.93	0.2	0.2	0.77	0.52	1.9
CD(0.05)	8.69	0.7	0.7	2.28	1.54	3.24
CV(%)	0.67	0.9	0.6	0.64	0.55	1.37

Station Trial-II: A station trial was conducted with nine entries. Entry IC-418346 recorded highest seed yield (10.55 q/ha) over the check variety AFG-3 (9.70 q/ha)



Performance of fenugreek genotypes seed yield (q/ha) during 2017-18 station trial-II

Table 3.10: Performance of fenugreek genotypes for ancillary characters in station trial-II

Genotype	Plant height (cm)	Primary branches	Secondary branches	No. of pod/plant	No. of seed/pod	Test weight (gm)
IC-605357	63.07	4.67	6.47	21.60	18.67	11.27
IC-585601	74.60	5.33	6.33	20.33	17.67	9.83
IC-397265	66.47	4.73	6.40	21.33	16.93	14.50
IC-418346	63.13	5.13	6.93	20.93	17.53	14.17
IC-595329	78.00	4.60	7.40	20.93	18.47	13.23
IC-595313	81.47	4.67	6.53	22.27	18.27	14.77
IC-571706	78.07	4.80	6.67	20.47	17.93	16.33
IC-585599	81.60	4.60	5.93	22.60	17.27	13.10
IC-572835	66.13	4.47	6.67	19.47	18.53	13.93
AFg-3	80.00	5.53	7.40	20.07	17.87	13.70
Mean	73.25	4.85	6.67	21.00	17.91	13.48
SEm±	0.832	0.3	0.2	0.7	0.86	0.55
CD (0.05)	2.47	0.9	0.5	2.09	2.54	1.62
CV (%)	1.97	1.1	4	5.81	8.28	0.7

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

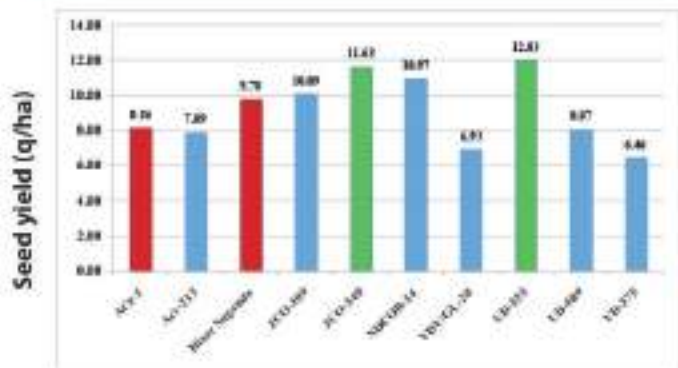
(PI: R.S. Meena; Co-PI: Y.K. Sharma; 2013-18)

Station Trial-I: Eight entries of coriander tested for high

yield, small seed size and stem gall resistance along with three checks (Table 3.11). Entry UD-353 (12.03 q/ha) recorded highest seed yield in station trial-I over the check varieties Acr-1 (8.16 q/ha).

Table 3.11: Performance of coriander genotypes for ancillary characters in station trial-I.

Genotype	Plant height (cm)	Primary branches	Secondary branches	Umbel /plant	Umbellate /umbel	Seed /umbellate	Test weight (g)
ACr-1	115.40	5.80	8.33	17.13	6.73	5.40	11.63
ACr-213	117.07	6.27	8.87	17.53	6.67	5.20	15.80
Hisar Suganda	117.87	5.73	8.40	16.00	6.27	5.13	16.33
JCO-309	119.93	6.53	8.33	19.13	6.60	5.20	18.23
JCO-340	121.73	5.87	8.93	18.87	6.07	5.93	17.53
NDCOR-14	119.00	6.53	8.73	19.47	6.53	5.27	13.47
VDV/GL-20	120.27	6.40	9.27	17.73	6.13	5.20	14.27
UD-353	119.87	6.07	9.07	18.47	6.53	5.47	12.37
UD-589	106.87	6.13	9.00	18.40	6.47	5.07	17.67
VD-375	114.40	6.47	9.13	19.20	6.33	5.40	12.43
Mean	117.24	6.18	8.80	18.19	5.65	5.33	14.97
SEm±	2.479	0.185	0.223	0.984	0.277	0.298	0.301
CD (0.05)	7.37	0.55	0.66	2.92	0.82	0.89	0.89
CV (%)	0.37	0.52	0.44	0.94	0.75	0.97	0.35



Performance of coriander genotypes for in station trial-I

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)

The selected mutants of fennel and cumin were evaluated in their respective generation (M_1 , M_2 & M_3) for different traits for which they were selected in M_1 generation. Total 177 lines (110 M_1 lines and 67 M_2 lines) of fennel were evaluated to know the variability and stability of the characters. 77 lines in M_1 generation and 40 lines in M_2 generation of fennel were showing stability in selected characters and selected for further evaluation. These lines will be advanced in the next generation to know the agronomic characters of the selected mutants. The total morphological variation present in the fennel mutants lines is given below:-

Traits	Minimum	Maximum	Average	Coefficient of variation (%)
Plant height (cm)	65	200	138.6	23.9
Number of primary branch	4	10	7.1	23.1
Number of secondary branch	12	40	24.8	24.7
Number of umbel per plant	10	38	23.7	26.9
Number of seeds per umbel	107.5	992	638.4	39.8
Days to maturity	155	186	165.1	5.9
Seed yield per plant (g)	4	146	65.1	67.5
Test weight (g)	4.33	9.65	7.5	21.9

The plant height ranges from the 65 cm to 200 cm and the coefficient of variation was 23.9% for the plant height. The maturity days varies from 155 days to 186 days. The maximum coefficient of variation was recorded 67.5% for the seed yield per plant followed by number of seed per umbel.



In cumin M_1 generation successfully raised and selected 2 mutant lines that were showing superiority with parent plant (GC-4) with respect to yield per plant. The seeds harvested from both the lines and the evaluation of the selected characters will be done in next generation.



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

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

A trial was conducted with 11 test entries and two check varieties namely, Ajmer Nigella-20 and Azad Kalongi

during the year 2017-18. Observations on growth parameters such as yield and yield attributing traits were recorded. Higher yield attributes and yield (1029.66 kg/ha) was recorded in AN-19 genotype followed by AN-9. All necessary observations were recorded and data presented in table 3.12.

Table 3.12: Performance of nigella genotypes in trial

Genotypes	Plant height (cm)	Primary branch /plant	Secondary branch /plant	No. of capsules /plant	No. of seeds /capsule	Test weight (gm)	Seed yield (kg/ha)
AN-9	63.66	8.20	18.00	32.90	84.067	1.96	1017.00
AN-16	63.00	8.40	22.40	37.86	90.533	1.85	753.00
Azad Kalongi	70.66	9.86	24.66	47.33	93.667	2.18	674.50
AN-20	67.66	9.06	22.66	54.20	94.267	2.34	843.33
SEL-10	67.66	9.86	26.00	74.00	99.000	1.97	830.00
SEL-9	64.66	8.73	25.53	64.00	87.667	1.83	954.00
SEL-5	68.66	8.53	24.66	37.13	81.333	1.85	621.83
SEL-4-1	66.66	9.13	23.60	47.50	88.067	2.17	483.66
SEL-4	67.66	8.06	23.73	35.40	79.400	2.13	500.83
AN-24	57.00	7.00	17.80	26.00	75.933	2.51	663.16
AN-19	61.00	7.53	17.46	26.13	78.267	2.02	1029.66
AN-10	59.33	7.06	15.60	25.80	75.933	2.02	313.50
AN-4	60.33	7.33	16.13	20.00	62.733	2.06	795.00
SEm ±	1.96	0.45	1.62	2.91	3.304	0.10	40.62
CD (P=0.05)	5.76	1.33	4.75	8.55	9.700	0.31	119.27
CV%	5.27	9.40	13.11	12.41	6.819	9.06	9.64



Seed yield (kg/ha) of nigella genotypes

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

(PI: S. Choudhary; Co-PI: Mr. M.K. Vishal (on study leave): 2015-18)

ESTs were developed for the coriander crop using transcriptom sequences of the NRCSS, Ajmer variety (Acr-1). Microsatellites were developed using the MISA v1.0 software from transcriptoms.

Insilco validation confirmed the SSRs availability at difference sizes and distance.

Microsatellites developed from ESTs of Acr-1 and CS-6



**Di-nucleotide: 1812,
Tri nucleotides: 7175,
Tetra nucleotides: 173,
Penta nucleotide: 29 and
Hexa nucleotide: 24**

SSRs generated



Di-nucleotide:1767,
Tri nucleotides: 8114,
Tetra nucleotides: 203,
Penta nucleotide: 31 and
Hexa nucleotide:19

Microsatellites showing amplification



Microsatellites developed using transferability and EST mining from Carrot and Celery RNA seq data

Microsatellites generated



Microsatellites developed using coriander ESTs generated by RNA seq technique in Coriander

Simulated PCR (SPCR3.0) was used to carry out PCR technique computationally. In Silico gel simulation (Simgel) was done computationally.

Sequences of coding SSRs for coriander were grouped in a single text to carry out the annotation analysis. SSR sequences were compared against SwissProt database and sequences with significant matches.

Wet Lab validation of primers

Three hundred primers were subjected to wet lab validations which were showing amplification in coriander samples.

Database development

Database was generated and the data submitted to NCBI. Database section or the tab of SeedSpicesSatDb, is the main analysis page of the database where user can query for microsatellites. This novel approach can be embedded to assist researchers and biologists.

- Three approaches were applied to develop SSRs for coriander
 1. Transferability from other crops (from same family), Carrot and Celery SSRs were transferred.
 2. Mining of ESTs from public domain (Carrot ESTs were mined for 300 primers)
 3. Development of specific ESTs (Coriander ESTs were developed)

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

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

- WRKY33 which is very well characterized in response to pathogen response, coriander transcriptome found WRKY 33 transcription factor is induced in response to pathogen infection.
- Secondary metabolite pathway transcripts expressed differentially and belonged major to Phenylpropanoid biosynthesis pathway a stress induced metabolic pathway and the enzymes associated with this pathway included trans-cinnamate 4-monooxygenase known to involve in development and environmental stress tolerance, coniferyl-aldehyde dehydrogenase, cinnamyl-alcohol dehydrogenase and peroxidase involved in the lignin biosynthesis pathways and involved in disease resistance in plants were highly expressed in the resistant genotype (Acr-1).
- Disease Resistant genes (RPS2, PR1) have been identified in coriander as reported in tobacco and tomato.

Genes used for gene expression in coriander varieties:

Gene	Forward primer	Reverse primer
18S	GTGGGCGATTGTCTGGTT	TGTACAAAGGGCAGGGACGT
CDS-48662	GCGCACATGGATTACTCGGA	TGTGTTCCAAAGCAGGGACC
CDS-12945	AGGGGCATTGACATAGAACGG	AAGCACATCAGAGTCAGAGGC
CDS-12952	CCAAGCTTTTTTCGGTCGCAG	TTGGCGAAAGATGCCTCTCC

CS-6 and Acr-1 samples were analyzed for the CDS-48662, CDS-12945 & CDS-12952 gene expression. Results reveal that sample Acr-1 expressed up regulation on CDS-12952 and down regulation on CDS-48662, CDS-12952 genes respectively over CS-6 sample (Control sample). The 18s gene was used as internal control (Housekeeping gene).

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

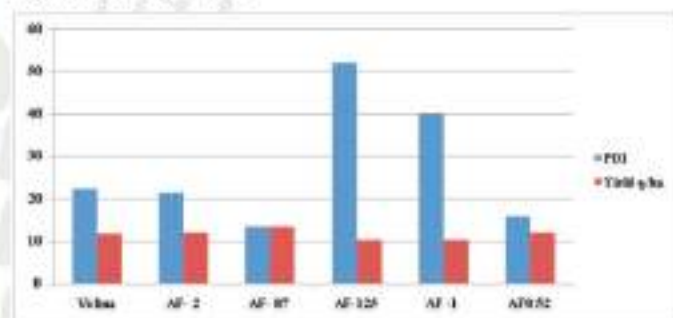
(PI:R. S. Meena; Co-PI: R. D. Meena, S. Choudhary, N. K. Meena, S.N.Sexaria; 2016-21)

Breeding for dwarfism: Seed set was harvested from F₁ generation in 71 crosses. All crosses were sown this year. Main umbel of F₂ was selfed and segregant plants were discarded and seed was harvested separately and F₂ will be sown in coming season



Dwarf fennel line used for making crosses

Screening of fennel varieties against *Ramularia* blight: Only a single genotype (AF-87) was recorded lowest disease incidence and considered initially as resistant against *Ramularia* blight (PDI-12.33), while another three genotypes Volina, AF- 2 and AF0 52 showed moderate resistance to the disease. Other genotypes were susceptible and highly susceptible against the disease.



Performance of fennel genotypes against *Ramularia* blight

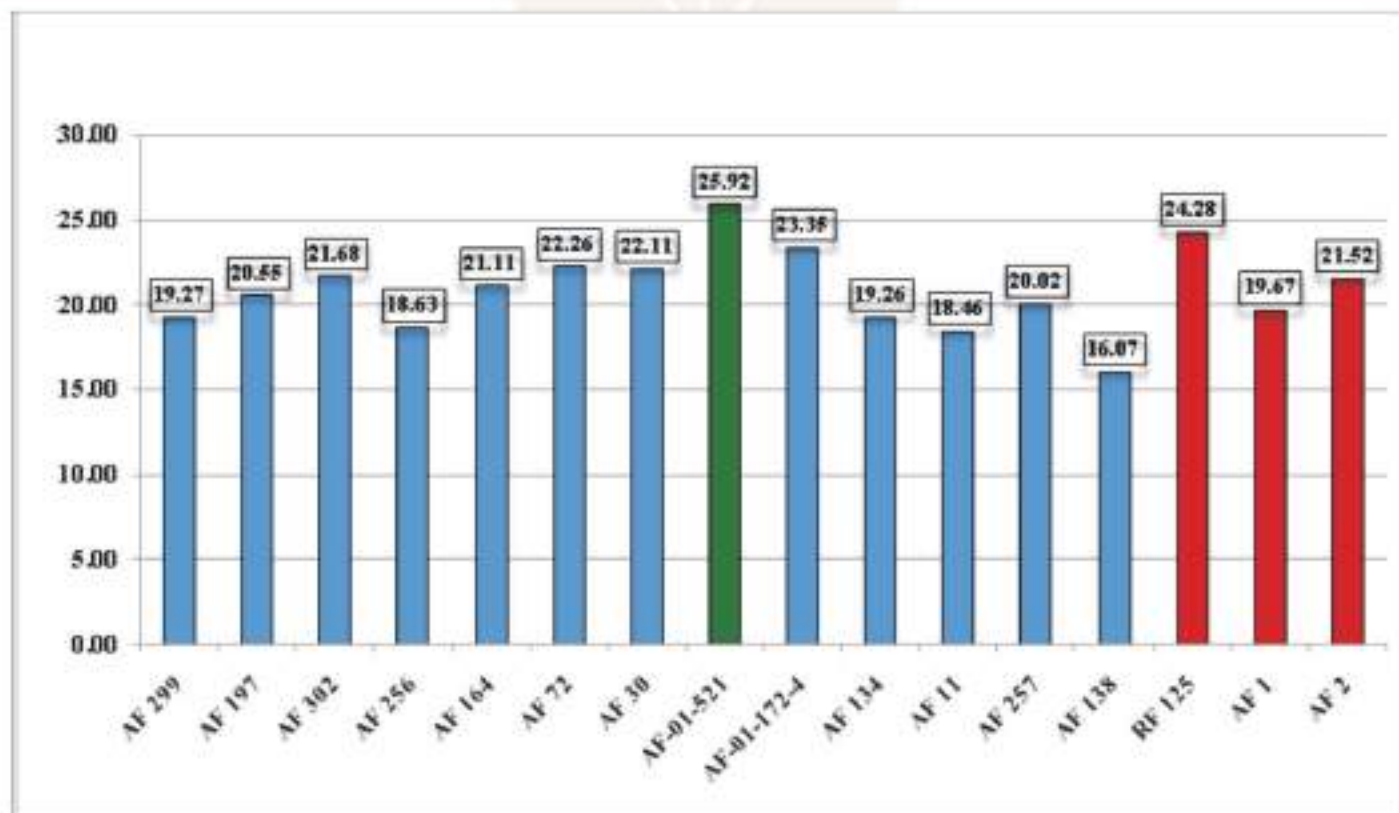
Station Trial: A station trial was conducted with 13 entries and 3 check varieties (AF-1, AF-2 and RF-125) during the year 2017-18. Entry AF-01-521 recorded highest seed yield (25.92 q/ha) and AF-164 recorded maximum essential oil (1.83 %) in station trial over the check varieties AF-1 (19.67 q/ha & 1.67%) and AF-2 (21.52 q/ha & 1.50%, respectively) (Table 3.13).

Screening of fennel varieties against *Ramularia* blight (2017-18)

S. No.	Fennel varieties	Ramularia blight PDI	Disease reaction	Seed yield (q/ha)
1	Volina	21.67	MR	11.9
2	AF-2	21.33	MR	11.1
3	AF-87	12.33	R	12.4
4	AF-125	52.00	HS	10.7
5	AF-1	40.67	S	10.8
6	AF052	16.67	MR	11.0
	SEm±	2.35		0.04
	CD 0.5%	7.8		0.08
	CV	13.8		1.16

Table 3.13: Performance of fennel genotypes for ancillary characters in station trial.

Genotype	Plant Height (cm)	Primary Branches	Secondary Branches	Umbel /Plant	Umbellate /Umbel	Seed /Umbellate	Essential oil%	Test weight (g)
AF-256	153.07	8.47	19.60	43.87	29.60	24.20	1.60	7.04
AF-30	156.47	8.33	18.73	36.13	26.87	25.73	1.50	7.55
AF-197	152.67	9.73	18.00	38.27	29.00	25.93	1.33	7.52
AF-138	166.73	7.47	20.33	41.60	27.73	28.07	1.46	7.31
AF-302	170.60	8.33	18.80	38.47	29.87	29.93	0.93	7.48
AF-11	160.80	8.13	19.93	41.07	29.40	27.47	1.50	7.08
AF-01-521	182.40	9.13	18.60	40.73	28.07	28.73	1.33	7.97
AF-71	158.00	9.67	21.47	48.67	30.60	28.60	1.80	6.94
AF-134	154.07	8.80	17.93	49.93	30.87	26.00	1.13	7.19
AF-01-172-4	99.27	5.60	11.60	72.20	14.93	16.13	1.46	7.42
AF-299	161.67	8.73	16.93	38.13	26.93	27.67	1.40	7.13
AF-164	166.93	9.07	19.80	40.53	31.07	23.93	1.83	7.00
AF-257	147.93	9.53	21.13	40.60	28.73	26.47	1.40	9.30
RF-125	165.13	8.20	20.20	38.60	27.27	26.07	1.33	8.39
AF-1	154.73	7.73	19.27	37.20	29.13	28.93	1.67	6.68
AF-2	178.47	8.47	21.60	49.00	30.87	27.80	1.50	6.86
SEm±	0.536	0.268	0.686	0.238	0.204	0.217	0.026	0.118
CD (0.05)	1.55	0.77	0.236	0.692	0.592	0.629	0.076	0.344
CV (%)	0.587	5.49	2.155	0.950	1.253	1.424	3.139	2.760

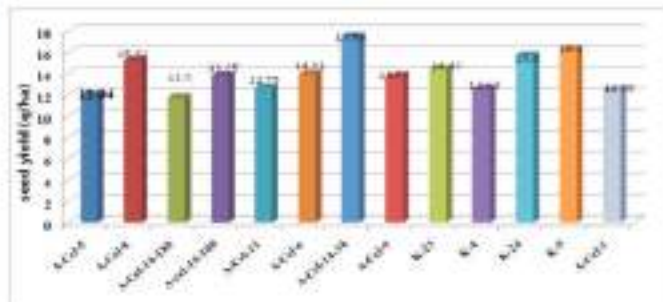


Performance of fennel genotypes for seed yield (q/ha) in station trial

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, R. D. Meena; 2016-21)

Station Trial: Entry A-Cel-14-34 (17.08 q/ha) exhibited highest seed yield and K-24 (2.28 %) gave maximum essential oil (Table 3.14) in station trial over the check variety A-Cel-1 (12.55 q/ha & 1.62%, respectively).



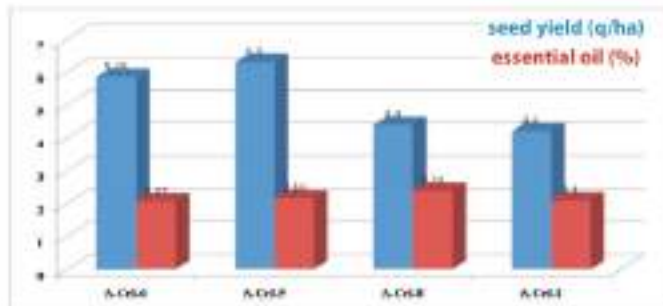
Performance of celery genotypes for seed yield (q/ha)

Table 3.14: Performance of celery genotypes in station trial at NRCSS

Entries	Plant Height (Cm)	Primary Branches	Secondary Branches	Umbel /Plant	Umbellate /Umbel	Seed /Umbellate	Test Weight (G)	Essential Oil (%)
A-Cel-5	164.20	10.04	31.2	234.20	22.52	35.88	0.40	1.39
A-Cel-8	150.35	14.14	32.88	299.85	26.32	31.32	0.38	0.43
A-Cel-7	149.42	11.15	27.32	296.42	25.51	39.03	0.36	0.51
A-Ecel-8	143.10	10.05	30.45	291.71	24.39	44.06	0.44	1.90
A-Cel-14-104	148.41	11.25	26.87	253.52	26.21	38.31	0.48	1.79
K-25	149.63	10.35	29.03	267.20	24.62	3.33	0.38	2.09
A-Cel-14-101	140.41	14.32	30.05	283.52	26.80	37.47	0.40	1.71
A-Cel-14-188	140.52	11.00	28.54	292.31	29.01	35.73	0.43	1.73
A-cel-14-100	142.53	11.09	28.04	320.25	23.84	40.27	0.39	1.80
A-Cel-4	132.32	12.00	29.41	303.31	24.03	37.67	0.38	1.90
A-Cel-11	134.02	11.88	30.87	290.51	22.42	37.60	0.40	1.73
A-Cel-6	127.53	12.50	31.62	280.62	22.25	36.73	0.36	2.13
A-Cel-14-34	119.32	11.98	30.04	297.60	26.01	35.33	0.40	1.70
A-Cel-9	122.42	13.02	29.72	280.31	40.21	34.80	0.46	1.83
K-23	124.20	12.06	31.06	280.82	22.51	34.40	0.43	1.88
K-4	133.52	11.78	28.73	286.71	22.32	36.33	0.41	2.10
K-24	143.72	12.74	28.47	296.31	24.22	40.47	0.47	2.28
K-5	144.21	12.42	32.75	260.00	22.31	36.87	0.58	2.20
A-Cel-1	128.41	12.40	31.5	306.54	24.98	38.53	0.43	1.62
Mean	138.85	11.90	29.92	285.32	25.28	35.48	0.42	1.72
SEm±	4.90	1.32	1.59	18.90	4.19	2.80	0.07	0.013
CD(0.05)	13.65	3.70	4.69	53.81	12.13	7.89	0.20	0.04
CV (%)	0.36	0.94	0.50	0.64	1.49	0.70	1.39	0.07

Celery station trial at ATC Ajmer (Rajasthan) in 2017-18

A trial was conducted with 3 entries with one check variety (A-Cel-1) during the year 2017-18. Yield was recorded 6.30 q/ha in A-Cel-5 which was highest among all the genotypes. Essential oil was also estimated to be 2.16%.



Performance of celery genotypes for seed yield (q/ha) & at ATC Ajmer

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

CPd/15.3.1: Isolation and characterization of endophytic micro-organisms from cumin and fenugreek

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

During 2017-18 two separate field experiments were conducted for evaluation of selected endo-rhizospheric and exo-rhizospheric bacteria for growth and yield of cumin and fenugreek plants. To evaluate the effect of previously isolated native *Bacillus* sp. strains on cumin growth and yield, a field experiment comprising of 07 treatments with 03 replicates in RBD 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 was conducted at experimental field of ICAR-NRCSS, Ajmer. Cumin seeds were inoculated with fresh prepared talc powder based *Bacillus* sp. and *Pseudomonas* sp. cultures having at least 5×10^7 cfu/g of carrier material. Treated seeds were sown in line on already prepared field. Plant to plant spacing of 10-12 cm was maintained after germination of cumin seeds. Besides seed treated with bacterial cultures, soil was treated with *Trichoderma* sp. talc based formulations through soil application @ 5 g per square meter. The crop was sowed on 9th November, 2017 and harvested on 16th March 2018. The cumin seedling germination was highest with *Pseudomonas* sp.-I & *Bacillus* sp. (85 %) and lowest was recorded with control (75 %) at 20 days after sowing (DAS) (Table 3.15). There were significant differences among treatments for various plant growth parameters at 45 and 90 DAS. The highest shoot/root weight ratio was recorded with *Pseudomonas*

Table 3.15: Cumin plant biometric data at 20 DAS

Treatment	Germination (%)	Fresh weight of pl. (g)	Shoot weight (g)	Root weight (g)
T1- <i>Bacillus subtilis</i> NRCSS-1	78.33	0.059	0.039	0.016
T2- <i>Bacillus megaterium</i>	81.66	0.045	0.027	0.015
T3- <i>Pseudomonas fluorescens</i>	85.00	0.054	0.034	0.017
T4- <i>Pseudomonas</i> sp.-I	75.00	0.052	0.038	0.015
T5- <i>Bacillus</i> sp.	85.00	0.046	0.035	0.013
T6- <i>Bacillus</i> sp. W1	77.50	0.047	0.030	0.014
T7- Control	75.00	0.046	0.028	0.016
CD@0.05	6.50	NS	0.014	NS

sp.-I (7.02) followed by *P. fluorescens* (6.75) and lowest was recorded with *B. subtilis* NRCSS-1 (5.67). The maximum shoot length was recorded with control (28.90 cm) which was at par with *Bacillus* sp. W1 at 90 DAS of cumin crop. At maturity stage of cumin crop, significant difference was recorded for yield attributing traits such as number of secondary branches per plant (ranged from 22.80 to 32.00), number of umbels per plant (ranged from 32.33 to 47.30) and number of seeds per umbellete (ranged from 6.60 to 8.30). The highest seed yield of cumin crop was observed with *B. megaterium* (73.30 g per m²) which was at par with *P. fluorescens* (68.55 g per m²) and lowest was recorded with control (15.37 g per m²) (Table 3.16). The maximum essential oil content was recorded in *P. fluorescens* (4.05 %) followed by *Pseudomonas* sp.-I (3.86 %) and the minimum was recorded with *Bacillus* sp. (3.28 %).

Table 3.16: Cumin crop morphological data at maturity

Treatment	Primary branches	Secondary branches	No. of umbels per plant	No. of umbelletes per umbel	No. of seed per umbellete	Seed yield (g per m ²)
T1- <i>Bacillus subtilis</i> NRCSS-1	9.66	23.00	43.00	5.33	6.60	61.47
T2- <i>Bacillus megaterium</i>	9.00	27.20	43.33	5.00	7.00	73.30
T3- <i>Pseudomonas fluorescens</i>	11.00	28.33	47.30	5.60	8.30	68.55
T4- <i>Pseudomonas</i> sp.-I	8.66	28.66	43.60	5.00	7.00	61.86
T5- <i>Bacillus</i> sp.	9.20	30.00	35.00	5.40	6.60	44.80
T6- <i>Bacillus</i> sp. W1	9.00	32.00	36.00	5.60	7.40	45.16
T7- Control	9.66	22.80	32.33	5.20	6.60	15.37
CD@0.05	NS	2.40	3.18	NS	1.10	9.04

Under experiment for endorhizobacteria isolation from fenugreek plant roots, 26 new *Rhizobium* sp. cultures collected from roots nodules during 2017-18. These *Rhizobium* isolates further assayed for bio-chemical screening using HI-media test kits for gram negative bacteria. Majority of these *Rhizobium* cultures were positive for glucose and mannitol utilization. For evaluation of microbial consortia for growth and yield of fenugreek a field trial comprising of 9 treatments with 3 replications was conducted in RBD in a plot size of 3x3 m for each. The fenugreek seeds were inoculated with consortium of *Rhizobium* and *Bacillus* sp. strains in various combinations. The highest seedling vigour index (7850) was recorded with *Rhizobium*+*B. subtilis* +*B. megaterium* followed by *Rhizobium* +*B. megaterium*

(7835) and lowest seedling vigour index (6220) was recorded with control at 15 days after sowing (Table 3.17). At 35 DAS there was non-significant effect of bioinoculant on number of root nodules per plant but at 70 and 105 DAS there were significant difference among treatment for root nodulation in fenugreek plants. The maximum nodules per plant was recorded with *Bacillus*. sp. + *B. megaterium* (29.60) which was at par with *Bacillus*. sp. & *Bacillus subtilis* where as the minimum nodules per plant was recorded with control (23.33) which at par with *Rhizobium* +*B. megaterium*. The highest seed yield was obtained from *Rhizobium*+*B. subtilis* +*B. megaterium* (0.249 kg per m²) which was at par with *Bacillus*. sp. + *B. megaterium* (0.242 kg per m²) while the lowest seed yield was recorded with control (0.188 kg per m²) (Table 3.18).

Table 3.17: Effect of microbes on fenugreek Seedling vigour index at 15 DAS

Treatment	Germination (%)	Seedling vigour index	Seedling dry weight (g)
T1- <i>Rhizobium</i> + <i>B. subtilis</i>	94.0	6657	0.105
T2- <i>Rhizobium</i> + <i>B. megaterium</i>	96.0	7835	0.104
T3- <i>Rhizobium</i> + <i>Bacillus</i> sp. + <i>B. subtilis</i>	92.0	6850	0.084
T4- <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	98.0	7850	0.123
T5- <i>Bacillus</i> . sp. + <i>B. megaterium</i>	97.0	7520	0.084
T6- <i>Bacillus</i> sp.	92.0	6450	0.091
T7- <i>Bacillus subtilis</i>	95.0	7120	0.117
T8- <i>Rhizobium</i>	96.0	7650	0.890
T9-Control	95.0	6220	0.090
CD@0.05	NS	146	0.016

Table 3.18: Plant biometric data at maturity of fenugreek plants

Treatment	No. of primary branches /plant	No. of pods/plant	No. of seeds/pod	Seed yield (Kg / m ²)
T1- <i>Rhizobium</i> + <i>B. subtilis</i>	7.30	28.66	18.00	0.239
T2- <i>Rhizobium</i> + <i>B. megaterium</i>	5.60	40.33	17.40	0.218
T3- <i>Rhizobium</i> + <i>Bacillus</i> sp. + <i>B. subtilis</i>	5.60	33.33	18.20	0.234
T4- <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	6.60	39.33	18.40	0.249
T5- <i>Bacillus</i> . sp. + <i>B. megaterium</i>	5.30	26.66	17.60	0.242
T6- <i>Bacillus</i> sp.	5.60	35.66	16.60	0.221
T7- <i>Bacillus subtilis</i>	5.30	30.66	17.00	0.209
T8- <i>Rhizobium</i>	5.0	28.66	15.40	0.218
T9-Control	5.0	26.66	14.60	0.188
CD@0.05	NS	2.65	0.42	0.42

CPd/16.3.2: Standardization of two tier system of production technology in seed spices with vine vegetables using bower

(PI: R. Singh; Co-PI: S. S. Meena, S. Choudhary, S. P. Maheria; 2016-19)

Standardization of crops for bower system during rabi season

Fenugreek and coriander varieties AFg-1 and ACr-1 were raised as sub plot crop during the rabi season in the relay cropping system with vine vegetables. The main plot crops were sown in the standing crop of coriander and fenugreek during February. Vine vegetables namely bottle gourd (Pusa Naveen), bitter gourd (Pusa Aushadhi) and ridge gourd (Pusa Nutan) were sown as relay crop. The fenugreek and coriander were harvested during March/April. The seed yield of fenugreek was 2545 kg/ha and gave net returns of Rs 37843/ha with B:C ratio of 0.74, whereas it was 1255 kg/ha in coriander with the net returns Rs 17317/ha along with the B:C ratio of 0.34 (Table 3.19). The effect of vine vegetables on the seed yield, net returns and B:C ratio were non-significant but maximum value (were recorded with the bitter



Preparation of beds for vine vegetables and bloom stage in rabi (coriander and fenugreek) crop in February

Table 3.19: Seed yield, net returns and B:C ratio of fenugreek and coriander under different vine vegetables

Treatment	Seed yield (kg/ha)				Net returns (Rs/ha)				B:C ratio			
	Bottle Gourd	Bitter Gourd	Ridge Gourd	Mean A	Bottle Gourd	Bitter Gourd	Ridge Gourd	Mean A	Bottle Gourd	Bitter Gourd	Ridge Gourd	Mean A
Fenugreek	2,127	2,751	2,756	2,545	23,226	45,078	45,224	37,843	0.46	0.88	0.89	0.74
Coriander	1,258	1,267	1,240	1,255	17,513	18,043	16,558	17,371	0.34	0.35	0.32	0.34
Mean B	1,692	2,009	1,998		20,370	31,560	30,891		0.40	0.62	0.60	
Factors	C.D.	SE(d)	SE(m)		C.D.	SE(d)	SE(m)		C.D.	SE(d)	SE(m)	
Factor(A)	271	126	89		10,870	5,054	3,574		0.21	0.10	0.07	
Factor(B)	N/A	154	109		N/A	6,190	4,377		N/A	0.12	0.09	
Factor(A X B)	N/A	218	154		N/A	8,753	6,190		N/A	0.17	0.12	

Standardization of crops for bower system

The main plot crops (bottle gourd, bitter gourd and ridge gourd), were trailed with support of net on the bower. After fully canopy coverage (75-90 days after sowing) by the vine vegetables, fenugreek, coriander, spinach and amaranths were sown as sub plot crops in field below the canopy of the vine vegetables in two tier system. The vine vegetables namely bottle gourd taken 17-18 days in germination, ridge guard germinated 18-20 days whereas bitter gourd taken 22-25 days. The yield of ridge gourd, bottle gourd and bitter gourd were

11396, 26307 and 3910 kg/ha as tier 2 crop (Table 3.20). Whereas the yield of leafy vegetables namely fenugreek, coriander, spinach and amaranths were 3879, 4590, 2872 and 5786 kg/ha which were raised in soil as tier 1 crop in the bower system. Fenugreek in rabi for seed followed by ridge gourd + leafy coriander for vegetable gave maximum fenugreek seed equivalent yield (FSEY) i.e. 16176 kg/ha with maximum gross (Rs 566173/ha) and net returns (Rs 361073/ha) with B:C ratio 2.76 (Table 3.21).

Table 3.20: Vine vegetable yield (kg/ha) under different treatments

Treatment	Coriander	Fenugreek	Spinach	Amaranthus	Mean A
Bottle gourd	26,600	25,834	26,184	26,611	26,307
Ridge gourd	11,440	11,558	11,129	11,456	11,396
Bitter gourd	3,936	4,010	3,797	3,898	3,910
Mean B	13,992	13,801	13,703	13,988	
Factors		C.D.	SE(d)	SE(m)	
Factor(A)		529	212	150	
Factor(B)		N/A	365	258	
Factor(B)at same level of A		N/A	632	300	
Factor(A)at same level of B		N/A	587	415	



Bottle gourd on beds and leafy vegetable in flat beds below the bower

Table 3.21:Fenugreek seed equivalent yield (kg/ha) and gross returns of the seed spices –vegetable based cropping system

Crop I	Crop II	Crop III	System yield (kg/ha)	System cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Fenugreek	1.Bottle gourd	Coriander	12301	213100	430539	217439	2.02
		Fenugreek	9598	206100	335938	129838	1.63
		Spinach	8623	213100	301809	88709	1.42
		Amaranthus	9756	208100	341464	133364	1.64
Coriander	2.Ridge gourd	Coriander	16176	205100	566173	361073	2.76
		Fenugreek	13019	215100	455661	240561	2.12
		Spinach	10978	206550	384245	177695	1.86
		Amaranthus	11318	203550	396127	192577	1.95
	3.Bitter gourd	Coriander	9931	213550	347570	134020	1.63
		Fenugreek	7131	213550	249578	36028	1.17
		Spinach	5521	206550	193251	-13299	0.94
		Amaranthus	6126	203550	214422	10872	1.05



Canopy of vine vegetables developed (as tier 2 crops) and leafy vegetables (as tier 1 crops)

CPd/16.3.3: Seed spice based inter cropping with remunerative fruit crops

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

Intercropping of seed spices with guava

The highest seed yield of seed spices was obtained in

open space followed by with 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 highest seed yield (1763.89 kg/ha) followed by ajwain (Table 3.22).

Table 3.22: Performances of seed spices based intercropping system with guava

Treatments	Plant height	No of primary branch /plant	No of secondary branch/plant	Pod /umbel /plant	Umbellate /umbel	Seeds /umbellate	Seed Yield (kg/ha)	Test Weight (gm)
Fenugreek + Guava	78.40	5.80	8.10	31.30	-	17.70	959.72	21.80
Coriander + Guava	104.10	12.30	44.80	52.30	40.13	50.00	694.03	7.58
Nigella + Guava	66.40	9.50	22.80	39.30	-	81.90	332.64	2.22
Anise + Guava	73.80	7.60	18.60	31.40	14.60	19.10	114.58	3.90
Ajwain + Guava	128.10	17.10	187.10	270.20	18.40	22.96	772.22	1.09
Sole Fenugreek	73.60	5.90	8.00	25.20	-	18.00	1763.89	22.18
Sole Coriander	96.90	12.60	39.70	50.10	44.200	50.40	799.31	7.45
Sole Nigella	67.30	8.50	24.80	35.60	-	94.20	538.89	2.18
Sole Anise	67.60	8.43	16.10	31.40	16.967	18.10	126.25	3.19
Sole Ajwain	121.40	17.90	228.00	237.40	16.233	23.20	1225.69	1.11
SEm ±	2.45	0.41	5.18	2.99	0.934	1.26	29.10	0.24
CD (P=0.05)	7.35	1.23	1.73	8.95	2.796	3.77	86.45	0.73
CV%	4.84	6.76	5.01	6.44	10.743	5.52	6.88	5.86



Guava+seed spices



Pomegranate+seed spices



Pomegranate+seed spices

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 over other seed spices followed by ajwain (Table 3.22a).

Table 3.22a: Performances of seed spices based intercropping system with pomegranate

Treatments	Plant height	No of primary branch /plant	No of secondary branch/plant	Pod /umbel /plant	Umbellate /umbel	Seeds /umbellate	Seed Yield (kg/ha)	Test Weight (gm)
Fenugreek + Pomegranate	75.20	5.50	8.30	26.50	-	17.20	990.20	21.23
Coriander + Pomegranate	109.70	13.70	47.00	51.80	37.93	49.20	553.12	7.16
Nigella + Pomegranate	67.30	8.60	25.10	61.00	-	93.90	327.29	2.23
Anise + Pomegranate	66.80	7.70	16.86	31.50	16.90	19.00	791.87	4.20
Ajwain + Pomegranate	128.20	14.90	193.60	260.20	16.86	21.86	842.91	1.13
Sole Fenugreek	73.60	5.90	8.00	25.20	-	18.00	1656.25	22.20
Sole Coriander	96.90	12.60	39.70	50.10	44.20	50.40	613.75	7.46
Sole Nigella	67.30	8.50	24.80	35.60	-	94.20	233.54	2.20
Sole Anise	67.60	8.43	16.10	31.40	16.97	18.10	706.25	3.20
Sole Ajwain	121.40	17.90	228.00	237.40	16.23	23.20	652.08	1.13
SEm ±	2.59	0.61	1.87	3.83	0.50	1.27	57.71	0.30
CD (P=0.05)	7.76	1.85	5.61	11.47	1.49	3.82	172.79	0.91
CV%	5.14	10.32	5.34	8.19	5.80	5.46	13.56	7.29

CPd/17.3.1: Bioprospecting multitrait bacteria with abiotic stress tolerance from cumin and coriander soil.

(PI: B.K. Mishra; 2017-20)

During 2017-18 thirty five cumin soil samples collected from Nagaur, Jodhpur, Jaisalmer and Barmer Districts of

Rajasthan. These cumin soil samples assayed for pH and EC which ranged from 7.09 to 8.27 and 0.15 to 1.55 dS respectively. Total twelve bacterial isolations made from these samples based on differential growth media for Phosphorus and Zinc solubilizing ability. These bacteria further tested for their ability to grow on different

temperatures viz; 35, 40 and 45 °C (Table 3.23) and Sodium chloride conc. viz; 1.0, 2.0 and 3.0 per cent (Table 3.24).

Table 3.23: Screening for temperature tolerance of bacterial isolates from cumin soil.

Bacterial cultures	Temperature		
	35 °C	40 °C	45 °C
Cu-2018/1	+++	++	+
Cu-2018/2	+++	+++	+
Cu-2018/3	+++	+++	+
Cu-2018/3	+++	+++	+
Cu-2018/4	+++	++	-
Cu-2018/5	+++	++	+
Cu-2018/6	+++	+++	+
Cu-2018/7	+++	+++	+
Cu-2018/8	+++	++	+
Cu-2018/9	+++	+++	+
Cu-2018/10	+++	++	-
Cu-2018/11	+++	++	+
Cu-2018/12	+++	+++	+

Very good growth= +++, Good growth = ++, Poor growth=+, No growth=-

Table 3.24: Screening for Sodium Chloride tolerance of bacterial isolates from cumin soil.

Bacterial cultures	Sodium Chloride (w/v)		
	1 %	2 %	3 %
Cu-2018/1	+++	++	-
Cu-2018/2	+++	+++	-
Cu-2018/3	+++	+++	-
Cu-2018/3	+++	+++	+
Cu-2018/4	+++	++	-
Cu-2018/5	+++	++	+
Cu-2018/6	+++	+++	-
Cu-2018/7	+++	+++	-
Cu-2018/8	+++	++	-
Cu-2018/9	+++	+++	-
Cu-2018/10	+++	++	-
Cu-2018/11	+++	++	+
Cu-2018/12	+++	+++	-

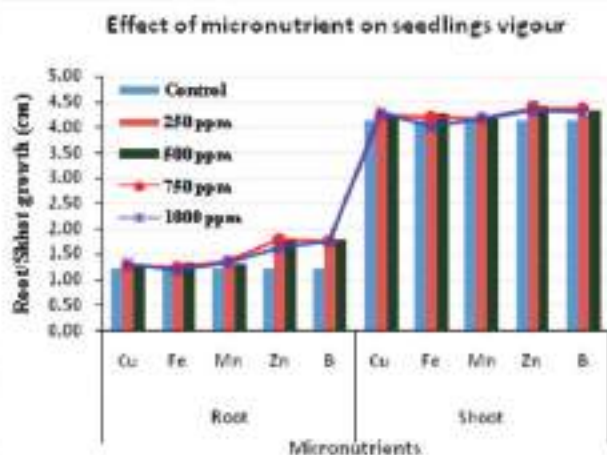
Very good growth= +++, Good growth = ++, Poor growth=+, No growth=-

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)

Seed germination study of celery (Ajm. Cel-1) primed with micronutrients

Seed germination of celery decreased with increase in iron concentration in given treatments at various days interval. Seed germination percentage increased with increase in time from 9 to 16 days. Seed vigour was also improved with the higher concentration of micronutrients except Fe, Zn and B. Based on the germination percentage and seedling vigour, the optimum concentration for seed priming of celery was 500, 250, 250, 1000 and 250 ppm for Fe, Zn, Mn, Cu and B, respectively.



Effect of micronutrients concentrations on seedlings vigour of celery

Thresh hold level of N requirement of celery (Ajm. Cel-1) on soil test basis

All the growth parameters- plant height, number of primary and secondary branches, number of umbel and umbellates per plant and stover yield was more with increase doses of N. However, number of seeds per umbellates and seed yield was not influenced by applied N. Overall yield was lower (Table 3.25) than usual might be due to late sowing (29-11-2017). Uptake of macro and micronutrients also improved with applied N, however uptake of Na was substantially higher in comparison to macronutrients.

Table 3.25. Effect of N levels on performance of celery

Treatment	Plant height (cm)	No. of primary branches	Secondary branches	No. of umbel /pl.	No. of umbellate /umbel	No. of seed umbellate	Seed yield (q/ha)	Stover yield (q/ha)
Control	41.5	6.7	11.2	39.2	14.1	32.1	0.54	4.5
N0	42.1	6.9	11.3	39.9	14.7	32.5	0.55	4.6
N20	42.4	7.0	11.2	40.0	14.9	33.0	0.56	5.0
N40	43.1	7.1	11.5	40.8	15.0	33.2	0.56	5.1
N60	44.3	7.4	12.4	42.0	15.1	33.6	0.56	5.3
N80	44.4	7.5	12.5	43.3	15.8	33.7	0.57	5.3
N100	45.6	7.9	12.7	43.6	16.7	33.9	0.58	5.4
CD at 5%	1.8	0.4	0.6	2.2	1.4	NS	NS	0.5

Threshold level of P requirement of celery (Ajm. Cel-1) on soil test basis

All the growth parameters- plant height, number of primary and secondary branches, number of umbel and umbellates per plant was more with increase doses of N. However, number of seeds per umbellates and yields

were not influenced by applied N. Overall yield was lower (Table 3.26) than usual might be due to late sowing (29-11-2017). Uptake of macro and micronutrients also improved with applied N, however uptake of Na was substantially higher in comparison to macronutrients.

Table 3.26. Effect of P levels on performance of celery

Treatment	Plant Height (cm)	No of Primary Branches	Secondary Branches	No of Umbel /pl.	No of Umbellate /Umbel	No of Seed Umbellate	Seed Yield (q/ha)	Stover Yield (q/ha)
Control	41.5	6.8	11.2	38.1	13.6	32.8	0.52	4.4
P0	43.5	6.9	11.3	39.8	13.7	31.6	0.53	4.6
P20	43.6	7.0	11.6	40.0	13.8	30.3	0.54	4.9
P30	44.3	7.1	11.7	40.4	14.4	32.0	0.54	4.9
P40	45.5	7.6	12.4	41.8	15.0	33.4	0.54	5.3
P50	45.6	7.8	12.5	41.2	15.0	32.8	0.55	5.2
P60	46.7	8.0	12.5	42.7	16.3	33.4	0.56	5.4
CD at 5%	2.0	0.4	0.6	1.6	1.4	NS	NS	NS

CPd/17.3.3: Surveying major growing area of cumin and coriander for soil parameters

{PI: O P Aishwath; Co-PI: M. D. Meena and Ravi Y.; 2017-22}

Benchmark survey for cumin in north-western Rajasthan

During the survey, several villages were covered for soil, plant and water parameters. These are Butati, Punjia, Koompras, Roon, Janana, Nil kiNardi, yendesar road, Vamansar, Parwa, Nalbadi, Kolayat (Shankhalphatak),

Nayagaon, Khirva, Balar (Magra), Ekachauraha, Ram devrapir, Panchpipapli, Dadu, Matolsak (Dadu), Kolu, Dechu, Siyaria, Dhirpura, Tejanagar, Malavas, Barunda, Indavad where farmers had grown the cumin, coriander and other crops. Cumin performance was quite better where there is a crop of weed residue incorporated in soil. Most of the soils were lower in nutrients and their range is given in Table 3.27. However, pH of irrigation water was in neutral range while some of the samples were saline in nature (Table 3.28).

Table 3.27. Soil parameters of northwestern cumin growing areas of Rajasthan

SP	Values of soil parameters (SP)		Places	
	Lowest	Highest	Lowest	Highest
N	67.7	293.5	Matolsak (Dadu)	Koompras
P	8.0	13.1	PunjiaMerta	Matolsak (Dadu)
K	121.70	359.7	Matolsak (Dadu)	Butati
Na	219.1	677.4	Matolsak (Dadu)	Panchpipapli
Fe	4.9	9.4	Roon	Matolsak (Dadu)
Zn	1.5	4.6	Balar (Magra)	Punjia
Mn	2.4	27.4	Kolu (Dahechu)	Koompras
Cu	2.6	7.1	Parwa, Nokha	Ramdevrapir
SOC	0.211	0.474	Matolsak (Dadu)	PunjiaMerta
pH	7.3	8.7	ButatiMerta	DaduRamdevrapir
EC	0.1	0.9	Parwa, Nokha	DhirpuraBalesar

Table 3.28. EC and pH range of underground water used for cumin irrigation

Water parameters	Values of parameters		Places traversed	
	Lower	Higher	Lower	Higher
pH	7.03	7.61	Ekachauraha, Falodi	Nokha
EC	0.60	5.40	Merta	Parwa, Nokha

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)

Nine released varieties of cumin GC-1, GC-2, GC-3, GC-4, RZ-19, RZ-209, RZ-223, RZ-341, RZ-345 were sown at five locations i.e. Nagaur (Mundawa), Barmer (Dhorimana), Ajmer (Tabiji, Bhudhwada, Sarwad) in RBD plot design with 3 replications keeping the plot size 3x3=9 m² at

farmers field. Observations related to weather parameters (Temperature and rainfall) recorded of the selected locations (Table 3.29). Out of nine varieties 3 varieties were not germinated/ survived at some locations. The average cumin seed yield was 828.0 kg/ ha at Bhudhwara, 781.6 kg/ ha at Dhorimna, 736.5 kg/ ha at Mundawa, 443.4 kg/ ha at Sarwad and 439.6 kg/ ha at Tabiji were recorded (Table 3.30, 3.31, 3.32, 3.33 & 3.34).

Table 3.29: Average temperature and total rainfall at different locations during growing season

Location	Maximum temperature	Minimum temperature	Total rainfall (mm)
	°C	°C	
Mundawa	28.23	12.19	4.00
Sarwad	26.93	12.52	7.00
Peesangan	28.93	12.64	1.00
Tabiji	26.93	12.52	7.00
Dhorimana	28.11	12.38	5.00

Table 3.30: Performance of cumin varieties at Mundawa (Nagaur)

Treatment	Plant height (cm)	No. primary branch	No. secondary branch	Umbel /plant	Umbellate per umbel	Seed /umbellate	Yield (kg/ha)
GC-1	28.8	11.8	20.3	31.9	4.8	5.8	649.5
GC-3	27.7	11.4	20.5	37.5	5.5	5.6	647.2
GC-4	29.5	12.3	19.6	34.5	5.2	6.0	853.9
RZ-19	29.8	12.5	23.5	43.2	5.3	5.4	972.7
RZ-341	28.2	12.0	19.8	34.7	5.4	5.6	782.3
RZ-345	25.9	11.1	20.3	25.7	5.0	5.7	513.3

Table 3.31: Performance of cumin varieties at Dhorimana (Barmar)

Treatment	Plant height (cm)	No. primary branch	No. secondary branch	Umbel /plant	Umbellate per umbel	Seed /umbellat	Yield (kg/ha)
GC-1	27.8	10.0	15.6	29.1	5.2	5.7	601.2
GC-3	27.5	10.1	16.4	32.3	5.4	5.8	786.5
GC-4	29.3	10.8	16.0	30.4	5.4	5.9	723.8
RZ-19	30.2	10.9	18.5	36.0	5.5	5.4	967.5
RZ-341	28.3	10.4	16.4	31.1	5.5	5.6	850.2
RZ-345	26.6	9.8	16.2	26.4	5.2	5.8	760.2

Table 3.32: Performance of cumin varieties at Sarwad (Ajmer)

Treatment	Plant height (cm)	No. primary branch	No. secondary branch	Umbel /plant	Umbellate per umbel	Seed /umbellate	Yield (kg/ha)
GC-1	26.8	8.1	10.9	26.3	5.5	5.5	441.4
GC-3	27.3	8.8	12.3	27.1	5.3	5.9	481.3
GC-4	29.0	9.3	12.3	26.2	5.5	5.7	505.8
RZ-19	30.5	9.4	13.4	28.7	5.7	5.3	368.6
RZ-341	28.4	8.9	13.0	27.5	5.6	5.6	527.0
RZ-345	27.2	8.5	12.1	27.1	5.3	6.0	336.1

Table 3.33: Performance of cumin varieties at Peesangan (Ajmer)

Treatment	Plant height (cm)	No. primary branch	No. secondary branch	Umbel/plant	Umbellate per umbel	Seed/umbellat	Yield (kg/ha)
GC-1	30.8	11.6	20.3	32.5	5.1	5.8	656.9
GC-2	29.4	13.4	23.6	38.7	4.9	5.8	786.5
GC-3	26.4	10.7	20.5	37.5	5.5	5.6	883.3
GC-4	28.5	12.3	19.6	34.9	5.2	6.0	1020.6
RZ-19	26.9	12.5	23.5	43.2	5.0	5.4	1264.4
RZ-209	27.4	12.3	21.8	31.7	5.4	5.3	539.0
RZ-223	29.9	12.1	20.9	37.0	5.5	5.5	700.5
RZ-341	27.5	12.0	19.8	34.7	5.4	5.6	865.6
RZ-345	26.6	10.8	20.3	27.4	5.4	5.7	735.5

Table 3.34: Performance of cumin varieties at Tabiji (Ajmer)

Treatment	Plant height (cm)	No. primary branch	No. secondary branch	Umbel /plant	Umbellate per umbel	Seed /umbellat	Yield (kg/ha)
GC-1	27.2	8.2	11.1	27.0	5.4	5.5	531.6
GC-3	27.3	8.8	12.3	27.1	5.3	5.9	481.3
GC-4	29.2	9.9	13.0	26.3	5.5	5.7	485.0
RZ-19	29.9	9.4	13.4	28.7	5.7	5.3	368.6
RZ-209	28.3	9.1	11.9	26.4	5.8	5.7	433.2
RZ-341	29.5	8.8	13.0	27.5	5.7	5.6	521.4
RZ-345	27.4	8.5	11.7	26.7	5.4	5.9	255.9

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

(PI: R.D. Meena; Co-PI: Y.K. Sharma, M.K. Vishal[on study leave]; 2012-18)

Field survey was conducted in major seed spices growing areas of Rajasthan to observe the prevalence of diseases on farmer's fields. In cumin yellowing (2-8%), *Alternaria* blight (0-10%); in fenugreek downy mildew (0-6.5%), blight (0-4.8%) powdery mildew (6-5%); in coriander stem gall (0.5%) and *Sclerotium* rot (0-3.6%) and in fennel *Ramularia* blight (0-0.4%) were observed at different locations of major growing areas of seed spices in Rajasthan (Table 3.35 and 3.36).

In monitoring of seed spices diseases at the Institute farm, in fenugreek powdery mildew was initiated in seventh standard week (February 12-18, 2018); downy mildew was observed in second standard week (January 8-14, 2018) and blight in third standard week (January 15-21, 2018) and in cumin *Alternaria* blight first appeared (54 DAS) in second standard week.

Seed spices diseases were correlated with the environmental factors namely temperature ($^{\circ}\text{C}$), relative humidity (RH %) and rainfall (mm). Diseases responded well towards these environmental factors and disease initiation was positively affected by these factors alone or in cumulative manner.

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

S.No.	Disease	Intensity%
1.	Stem gall of coriander	0-0.5
2.	Sclerotium rot of coriander	0-3.6
3.	Yellowing in cumin	2-8.0
4.	Wilt of cumin	0-5.6
5.	<i>Alternaria</i> blight of cumin	0-10.0
6.	Powdery mildew of fenugreek	0-6.5
7.	Blight of fenugreek	0-4.8
8.	Downy mildew of fenugreek	0-6.5
9.	<i>Ramularia</i> blight	0-0.4
10	Root rot of fennel	0-2.0



Sclerotium rot of coriander at Pratapgarh



Powdery mildew of fenugreek at Chittorgarh



ICAR - NRCSS experimental field for disease monitoring

Table 3.36: Interrelationship between environmental conditions and disease initiation

Std. Week No	Calander time	Environmental factors			Disease severity %				
		Temp. (°C)	RH (%)	Rain (mm)	Cumin Blight	Coriander PM	Ramularia Blight (Fennel)	Fenugreek Blight	DM
49	03 Dec - 09 Dec	16.4	65.5	0.0	0.0	0.0	0.0	0.0	0.0
50	10 Dec - 16 Dec	14.6	79.3	7.2	0.0	0.0	0.0	0.0	0.0
51	17 Dec - 23 Dec	15.7	80.6	0.0	0.0	0.0	0.0	0.0	0.0
52	24 Dec - 31 Dec	15.2	72	0.0	0.0	0.0	0.0	0.0	0.0
1	01 Jan - 07 Jan	13.3	73.7	0.0	0.0	0.0	0.0	0.0	0.0
2	08 Jan - 14 Jan	14.4	72.7	0.0	0.1	0.0	0.0	0.0	2.0
3	15 Jan - 21 Jan	15.9	67.4	0.0	0.6	0.0	0.0	0.2	2.9
4	22 Jan - 28 Jan	14.6	73.6	0.0	2.0	0.0	0.0	1.3	3.7
5	29 Jan - 04 Feb	16.8	66.1	0.0	3.2	0.0	0.10	2.0	4.5
6	05 Feb - 11 Feb	16.1	67.9	0.0	6.1	0.0	0.13	2.4	5.4
7	12 Feb - 18 Feb	17.5	65.1	0.0	8.8	0.5	0.14	3.2	6.6
8	19 Feb - 25 Feb	22.2	63.3	0.0	11.2	1.5	0.18	3.8	6.7
9	26 Feb - 04 Mar	22.7	59.8	0.0	14.3	2.2	0.20	4.0	6.9
10	05 Mar - 11 Mar	22	57.7	0.0	17.2	2.8	0.22	4.2	7.2
11	12 Mar - 18 Mar	24.3	68.8	0.0	20.6	3.1	0.24	4.8	7.6

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

(PI: N.K. Meena; Co-PI: K. Kant; 2013-18)

Impact of insect pollinators on yield and quality of ajwain

A field experiment on Impact of insect pollinators on yield and quality of ajwain and dill was conducted during Rabi season of year 2017-18 at research farm, ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer. Seeds of ajwain variety AA-1 were sown in well prepared and statistically laid out field in plots sized of 5x4.5 meters under specified crop geometry. All required agricultural practices were followed as per package of practices adopted for ajwain crop at the centre.

Diversity studies of insect pollinators on ajwain crop

Data showed that the flowers of ajwain crop were visited by 34 insect species of different orders and families. Among these floral visitors, Hymenoptera (13 species) and Diptera (8 species) contributed more than 80 per cent floral visitors. The remaining floral visitors were from Coleoptera (3 species), Lepidoptera (4 species), Hemiptera (4 species) and Neuroptera (01 species) and

01 species of spider during the entire flowering. Three honeybee species i.e. *Apis florea*, *A. mellifera* and *A. dorsata* and two species of syrphid flies, *Episyrphus balteatus* and *Episyrphus* sp. were found most prominent pollinators on ajwain crop during cropping season in semi-arid region of Rajasthan. The specimen of insect pollinators were collected by sweep netting during full booming period and preserved them for identification and documentation.

Effect of different mode of pollination on yield of ajwain

The result showed that yield of ajwain 1376 kg/ha was obtained in bee pollinated plots (caged) which was 62.45 per cent higher than control (without bee pollination-caged with insect proof nylon net), wherein yield of 847 kg/ha was recorded. The yield obtained from the open pollination plots was 1378.70 kg/ha, which was slightly higher than bee pollinated plots but statistically at par with bee pollination plots.

The data on weight of 1000 seeds (test weight) of ajwain variety AA-1 was also recorded and revealed that the average test weight (2.33g) and 2.31 per cent essential oil recorded in the treatment of bee pollination, wherein

plants caged with insect proof nylon net for bee pollination with *A. mellifera* which was higher than the treatment of without insect pollination-WIP, wherein test weight was 2.0g and 1.44 per cent essential oil were recorded. It was proved that bee pollination increased the production and quality of ajwain in comparison to control.

Diversity studies of insect pollinators in dill

A field study on diversity of insect pollinators on dill crop was carried out at research farm, National Research Centre on Seed Spices, Tabiji, Ajmer under open field conditions. The visual observations were recorded on randomly selected and tagged plants right from initiation of flowering to withering of flowers.

Dill flowers were visited by nearly 27 insect species of different orders and families. Among these insect visitors, Hymenoptera (10 species) and Diptera (8 species) were noticed as prominent pollinators. Remaining floral visitors were from Hemiptera (3 species), Coleoptera (2 species), Neuroptera (01 species) and Lepidoptera (3 species) were noticed on the crop. Three honeybee species (*Apis florea*, *Apis mellifera* and *Apis dorsata*) were the most prominent pollinators of crop during cropping season in semi-arid region of Rajasthan. Among honeybees, *A. florea* was most prominent followed by *A. mellifera* and *A. dorsata*. Beside honeybees, syrphid flies, *Episyrphus balteatus*, *Episyrphus sp.* (Diptera: *Episyrphidae*), *Eristalis sp. 1*, *unidentified hymenoptera sp. 2* and *Musca sp. 2* were noticed as most frequent pollinators during the flowering period reported upon. The specimen of insect pollinators were collected by insect collecting net, identified, categorized and preserved for documentation.

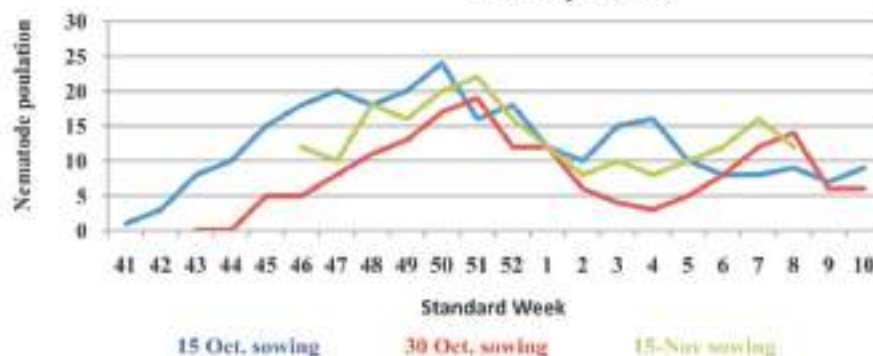
Effect of different mode of pollination on yield of dill

The data on effect of different mode of pollinations (without insect pollination-WIP, open pollination, bee pollination, sugar solution 10% and jaggery solution 10%) on yield of dill variety AD-1 was recorded and showed the highest yield of 1447.5 kg/ha was recorded in the plots kept open pollination treated with bee attractant (jaggery solution 10%) followed by open pollination plots (1435.2 kg/ha) and the plots caged with *A. mellifera* colony for bee pollination (1435.00 kg/ha), which were statistically at par with each other and superior over rest of the treatments. The lowest yield of 950.0 kg/ha was obtained in without insect pollination (WIP) plots with no input of flower visitors caged plots. Bee pollination also increased the yield of dill by 51.0 per cent (Av.) higher than control (without bee pollination-caged) with essential oil (2.17%) and test weight (3.27g) as quality parameters. The studies on coriander and fennel completed earlier.

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, S.R. Meena; 2016-19)

The population of nematodes (*Pratylenchus thomii*) observed in different dates of sowing on cumin crop showed that at all dates of sowing nematodes were present in the soil and cause infestation in cumin roots. However, population of nematodes were higher in the crops at early date of sowing i.e., 15th October and minimum recorded on 30th October. Population of nematodes peaked up to 50th and 51st standard week during December month. The population of nematodes declined thereafter and last recorded in 10th standard week. There were two peak population recorded, first during December month and second during and February month.



Population of nematodes at different dates of sowing

Management of nematodes in field experiments showed that application of soil sterlert Metham sodium and Dazomet gave excellent protection up to the maturity of the crop up to 90 days. Application of granular systemic insecticides/nematicides did not yield good control of nematodes population in cumin crop. Among nematopathogens soil application of *Paecilomyces lilacinus* (10^8 CFU/g) + *Trichoderma harzanium* (10^8 CFU/g) + *Pseudomonas fluorescens* (10^8 CFU/g) also gave good control up to 60 days. Leaf extract of Custard apple @ 100 kg/ha (soil application) and Neem Seed Kernal Powder @ 500 kg/ha (soil application) also showed promising result.



Nigella root rot symptoms

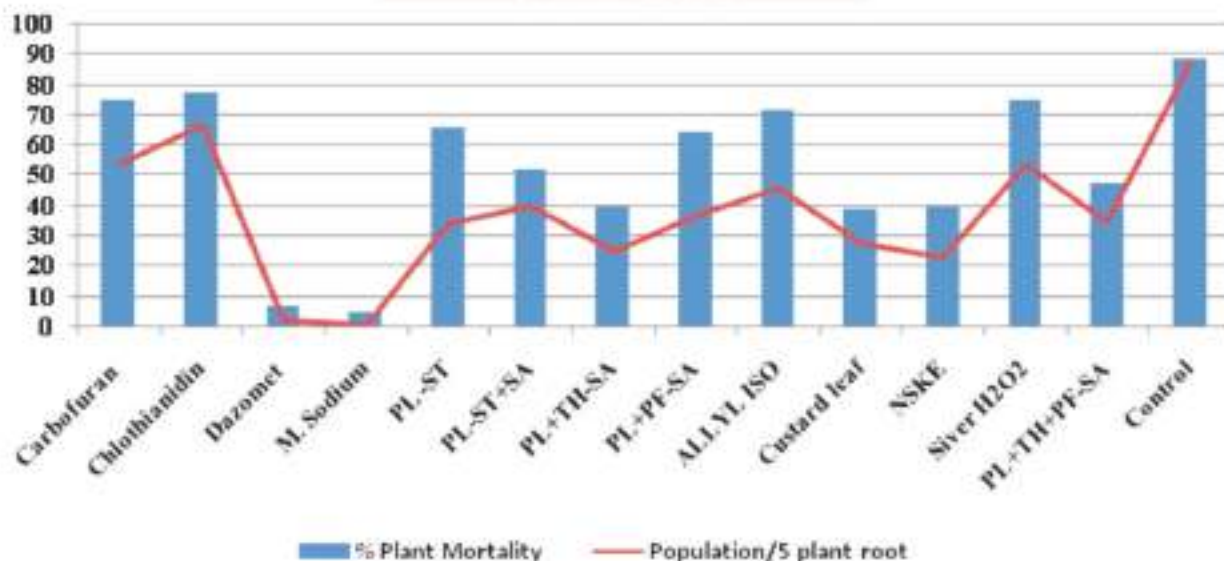
CPT/17.4.1: Epidemiology and management of root rot disease of ajwain and nigella

(PI: Y.K. Sharma; Co-PI: K. Kant; 2017-21)

Root rot infected disease samples of nigella and ajwain were collected and pathogen was isolated, purified and used for bioefficacy test.

In vitro bioefficacy of different *Trichoderma* isolates was tested against nigella root rot pathogen and growth inhibition of the pathogen was observed periodically. Data revealed that all *Trichoderma* isolates inhibited the growth (55-60%) of nigella root rot pathogen. Different fungicides were also tested using poison food technique showed growth inhibition of nigella root rot pathogen using mancozeb and chlorothalonil (39-40.5%).

More than 60% growth inhibition of ajwain root rot pathogen was observed by *Trichoderma* isolates. Among the fungicides 40 to 55% growth inhibition of ajwain root rot pathogen was observed using copper oxychloride, mancozeb and chlorothalonil. The growth inhibition was increased with increase in concentration from 100 ppm to 500 ppm.



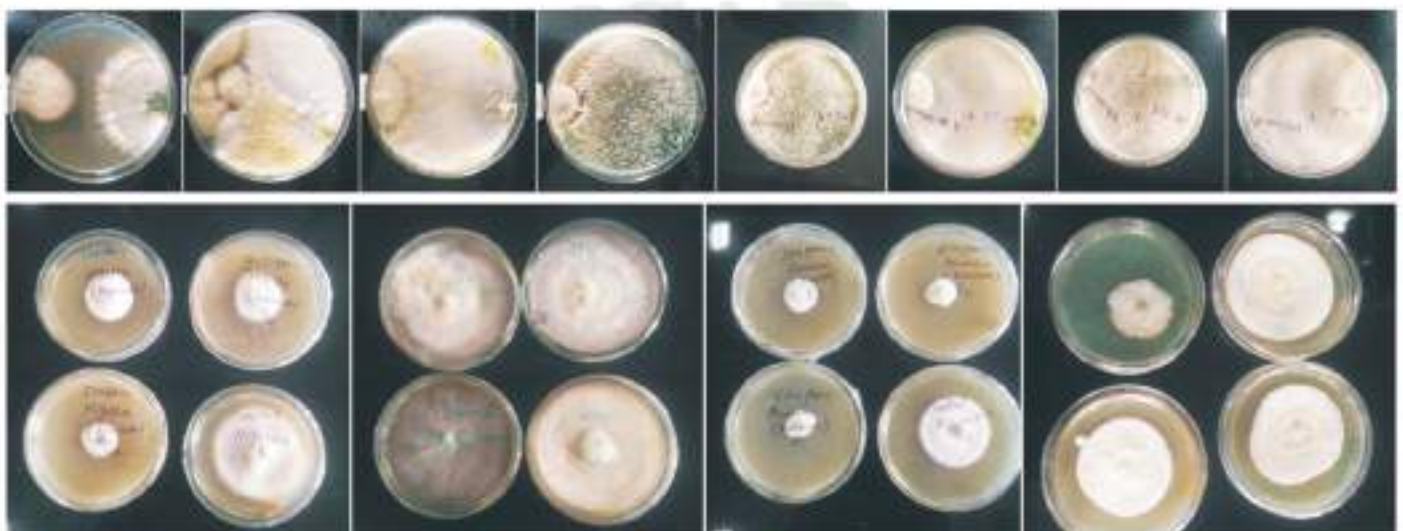
Impact of different treatments against control of P thorni at 90 days



Ajwain root rot symptoms



Isolated cultures of root rot pathogens of nigella and ajwain



Bioefficacy of Trichoderma isolates and fungicides against root rot pathogens of nigella and ajwain

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)

Field experiments were conducted to evaluate the effective spray scheduling of recommended fungicides against *Alternaria* blight of cumin and to evaluate the effect of different fungicides on diseases of fenugreek. One year data revealed that all schedules reduced the cumin blight PDI as compared to control. Comparatively foliar application of Mancozeb/zineb (0.2%) followed by azoxystrobin (0.1%) and difenoconazole (0.05%) starting from 45 days after sowing at 15 days interval was found most effective to manage the disease (77-82%).

Foliar application of different fungicides reduced the disease PDI of downy mildew and leaf blight of fenugreek as compared to untreated control. Comparatively foliar application of difenaconazole (0.05%) and tebuconazole + trifloxystrobin (0.05%) found effective against leaf blight of fenugreek.

CPT/17.4.3: Biological management of *Alternaria* blight in cumin (*Cuminum cyminum*):

(PI: R.D. Meena; Co-PI: B.K. Mishra, 2017-20)

Ten isolates collected from foliar canopy and rhizosphere (root zone) from different cumin growing areas were maintained and screened *in vitro* against the cumin blight pathogen (*Alternaria burnsii*). Bacterial isolate B1 was found most effective among all tested isolates and showed minimum mycelium growth (10 mm) with 90% growth inhibition followed by B8 (14 mm) with 87.4% growth inhibition. Other eight bacterial isolates were also effective against the disease. The maximum mycelium growth was recorded in control (90 mm) with no inhibition.

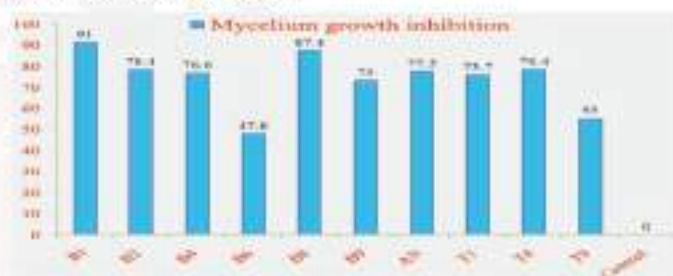


Fig.1 : Growth inhibition of *Alternaria burnsii* using different bio agents



Fig. 3. In vitro screening of biocontrol agents against cumin blight disease pathogen

CPt/17.4.4: Development of IPM modules to combat aphids and thrips in coriander and cumin

(PI:N. K. Meena; Co-PI: Ravindra Singh, Murlidhar Meena : 2017-21)

Evaluation of different IPM modules against aphids on coriander under field conditions.

An experimental trial was conducted to evaluate the relative efficacy of different IPM modules (including control) consisted by M₁-Cultural method + yellow sticky trap @25 traps/Acre + ker plant extract 10ml/lit. + acetamiprid 0.025%; M₂-Neem cake (Soil application) @500kg/ha + cultural method+ NSKE (5%) + fipronil 5% SC @ 0.035%; M₃- Cultural method+ azadirachtin 0.03 EC 3ml/lit. + tumba fruit extract 10 ml/lit. + thiacloprid 0.025% ; M₄-Neem oil 5 ml/lit. + yellow sticky trap 25/Acre + imidacloprid 17.8 SL @ 0.003% + *Coccinella* larvae @5000/Acre ; M₅-Imidacloprid 600FS 3ml/kg seed (ST) + Ker plant extract 10ml/lit. + *Verticillium lecani* (1x10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035% ; M₆-Yellow sticky trap 25/Acre + *Coccinella* larvae @ 5000/Acre + *Beaveria bassiana* 6g/lit. + fipronil 5%SC @ 0.035%; M₇-Thiomethoxam 5g/kg seed (Seed Treatment) + *Azadirachtin* 0.03EC @ 5ml/lit. + *Metarrhizium anisopliae* @ 6g/lit. + acetamiprid 0.025% and M₈ untreated check against aphids under open field conditions.

Results showed that all the IPM modules were found significantly superior in reduction of aphid population over untreated check. The Maximum per cent reduction in aphid population (94.98%) was recorded on plants treated with IPM M₁, followed by IPM Module M₂ (93.10 %), both the IPM modules were found statistically at par. The IPM module M₇ was found least effective against aphid (72.96% reduction) whereas, the remaining modules were found middle order of effectiveness against aphids on coriander under field conditions.

Evaluation of different IPM modules against thrips on coriander under field conditions.

An another field experimental trial was conducted to evaluate the relative efficacy of different IPM modules (including control) as describe above.

Observations on thrips population were recorded from five randomly selected and tagged plants per plot. Data showed that all the IPM modules were found significantly superior over untreated check in reduction of thrips population. The highest per cent reduction in thrips population (92.63%) was recorded on coriander plants treated with IPM module M₂ and this IPM module was found significantly superior to rest of the IMP modules. The IPM modules M₁ (89.26 %) and M₃ (87.96%) were also found equally effective in reduction

Treatment details of different IPM modules against aphids and thrips

Modules	Treatment details
M ₁	- Cultural method + yellow sticky trap @25 traps/Acre + ker plant extract 10ml/lit. +acetamiprid 0.025%;
M ₂	- Neem cake (Soil application) @500kg/ha + cultural method+ NSKE (5%) + fipronil 5% SC @ 0.035%;
M ₃	- Cultural method+ azadirachtin 0.03 EC 3ml/lit. + tumba fruit extract 10 ml/lit. + thiacloprid 0.025% ;
M ₄	- Neem oil 5 ml/lit. + yellow sticky trap 25/Acre + imidacloprid 17.8 SL @ 0.003% + <i>Coccinella</i> larvae @5000/Acre ;
M ₅	- Imidacloprid 600FS 3ml/kg seed (ST) + Ker plant extract 10ml/lit. + <i>V. lecani</i> (1x10 ⁸ cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035% ;
M ₆	- Yellow sticky trap 25/Acre + <i>Coccinella</i> larvae @ 5000/Acre + <i>Beaveria bassiana</i> 6g/lit. + fipronil 5%SC @ 0.035%;
M ₇	- Thiomethoxam 5g/kg seed (Seed Treatment) + <i>Azadirachtin</i> 0.03EC @ 5ml/lit. + <i>Metarrhizium anisopliae</i> @ 6g/lit. + acetamiprid 0.025% and
M ₈	- Untreated check

of thrips population and were found statistically at par with each other. The IPM module M₁ was found least effective against thrips which reduced 73.63 per cent population on coriander.

Evaluation of different IPM modules against aphids on cumin

A field trial was conducted to evaluate the different IPM modules as above including untreated control.

The Maximum per cent reduction in aphid population (91.10%) was recorded on plants treated with IPM module M₅ followed by IPM module M₇ (90.33 %), M₃ (89.3%) and M₆ (89.26%). These IPM modules were found statistically at par with each other.

Evaluation of different IPM modules against thrips on cumin under field conditions.

An experimental trial was conducted to evaluate the relative efficacy of different IPM modules (including control) as describe above. consisted by M₁-Cultural method + yellow sticky trap @25 traps/Acre + ker plant extract 10ml/lit. + acetamiprid 0.025%; M₂-Neem cake (Soil application) @500kg/ha + cultural method+ NSKE (5%) + fipronil 5% SC @ 0.035%; M₃- Cultural method+ azadirachtin 0.03 EC 3ml/lit. + tumba fruit extract 10 ml/lit. + thiacloprid 0.025% ; M₄-Neem oil 5 ml/lit. + yellow sticky trap 25/Acre + imidacloprid 17.8 SL @ 0.003% + *Coccinella* larvae @5000/Acre ; M₅- Imidacloprid 600FS 3ml/kg seed (ST) + Ker plant extract 10ml/lit. + *Verticillium lecanii* (1x10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035% ; M₆-Yellow sticky trap 25/Acre + *Coccinella* larvae @ 5000/Acre + *Beauveria bassiana* 6g/lit. + fipronil 5%SC @ 0.035%; M₇-Thiomethoxam 5g/kg seed (Seed Treatment) + *Azadirachtin* 0.03EC @ 5ml/lit. + *Metarrhizium anisopliae* @6g/lit. + acetamiprid 0.025% and M₈-untreated check against thrips.

The highest per cent reduction in thrips population (91.3%) was recorded on cumin plants treated with IPM module 5 followed by IPM modules M₇ and M₃ reduced 90.66 and 89.0 per cent thrips population. These modules were statistically at par in their efficacy. The IPM module M₁ was found least effective against thrips, reduced 71.12 per cent population on cumin.

Influence of IPM modules on the population of natural enemies

The observations on the activities of different natural enemies were also recorded to find the effect of various IPM modules. The natural enemies i.e. coccinellid predators (*Coccinella septempunctata*, *Menochilus sexmaculata* Feb., *Scymnus* sp., *Brumoides saturalis*, *Hippodamia variegata* Goeze), aphid parasitoids, *Aphidius* sp., and syrphid flies (*Episyrphus balteatus* DeGee, *Ischiodon scutellaris* (Fab.) and *Eristalis* sp., were recorded on both crops at different crop growth stages. It was found that the activities of these natural enemies were not significantly affected under all IPM modules but lesser in number as compared to control plots.

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)

New formulations of different insecticides, botanicals and entomopathogenes were tested in the field against aphids in the crops of cumin (Table-3.37), coriander (Table-3.38) and fenugreek (Table-3.39) during 2017-18. The micro encapsulation and micro emulsion formulation of deltamethrin tested @ 0.003% gave excellent control of aphids at 3 days after spraying which was superior to commercially available formulation (emulsifiable concentrate) of deltamethrin at same concentration. Mixing of synergist @ 5% with synthetic insecticide Thiomethaxam @ 0.0025% and neem oil 2.0% gave good control of aphids on selected crops and was superior to alone application of neem oil 2.0%. Application of botanical formulation, sesamum leaf extract –Non polar and sesamum leaf extract –polar at 0.5% concentration showed that non polar formulation yields better result in comparison to polar formulation. Modified neem composition @ 5% tested against aphids also gave good control against aphids in the field. *Verticillium lecanii* 1.5 %SC was found better than powder formulation.

Table3.37: Efficacy of different formulation on cumin aphids

Treatments	Population/umbel		Population after spray	
	before spray	3 day	6 day	9 day
Deltamethrin - 0.003% Micro encapsulation	62.67	2.67	1.33	3.00
Deltamethrin - 0.003% Micro emulsion	60.67	3.67	1.00	0.33
Thiomethoxam-0.025% + Synergist 5%	101.00	0.33	0.67	0.33
Neem oil -2% +Synergist 5%	82.33	5.50	2.21	2.99
Sesamum leaf extract- Polar- 0.5%	95.33	31.33	27.33	20.33
Sesamum leaf extract- Non Polar- 0.5%	101.67	4.17	5.83	7.99
Verticillium lecanii1.5%SC	70.00	58.00	35.08	21.00
Modified Neem Composition -5%	68.00	23.00	19.33	15.33
Deltamethrin -0.003%	97.00	4.33	6.00	7.99
Thiomethoxam -0.025%	83.33	2.17	2.50	4.50
Neem oil-2%	116.00	55.99	14.33	15.00
Verticillium lecani	120.00	87.00	56.00	39.99
Control	108.33	155.00	126.00	142.00
CD@ 5%		5.25	3.61	4.03

Table3.38: Efficacy of different formulation on coriander aphids

Treatments	Population/umbel		Population after spray	
	before spray	3 day	6 day	9 day
Deltamethrin - 0.003% Micro encapsulation	369.00	0.00	1.33	0.00
Deltamethrin - 0.003% Micro emulsion	427.33	0.00	4.00	0.00
Thiomethoxam-0.025% + Synergist 5%	681.00	3.33	0.00	0.00
Neem oil -2% +Synergist 5%	768.33	20.33	12.00	3.33
Sesamum leaf extract- Polar- 0.5%	666.00	109.33	44.67	0.00
Sesamum leaf extract- Non Polar- 0.5%	252.33	0.00	0.00	0.00
Verticillium lecanii1.5%SC	600.00	545.00	375.00	71.00
Modified Neem Composition -5%	759.33	280.33	87.33	23.00
Deltamethrin -0.003%	351.33	9.33	0.00	0.00
Thiomethoxam -0.025%	759.33	20.00	10.00	0.00
Neem oil-2%	904.33	313.00	147.00	46.33
Verticillium lecani	355.00	254.00	203.33	167.33
Control	633.00	733.33	687.00	483.00
CD@ 5%		27.9	22.14	13.64

Table 3.39: Efficacy of different formulation on fenugreek aphids

Treatments	Population/5 cm twig (before spray)	Population after spray		
		3 day	6 day	9 day
Deltamethrin - 0.003% Micro encapsulation	37.56	0.33	0.33	0.33
Deltamethrin - 0.003% Micro emulsion	36.89	0.33	3.67	0.78
Thiomethoxam-0.025% + Synergist 5%	49.33	2.56	0.67	0.33
Neem oil -2%+Synergist 5%	24.33	4.00	2.67	5.00
Sesamum leaf extract- Polar- 0.5%	14.56	8.33	4.89	1.67
Sesamum leaf extract- Non Polar- 0.5%	19.67	5.00	5.33	0.33
<i>Verticillium lecanii</i> 1.5%SC	19.33	16.00	10.33	9.33
Modified Neem Composition -5%	12.33	1.67	2.00	3.00
Deltamethrin -0.003%	22.89	0.33	0.33	0.33
Thiomethoxam -0.025%	24.89	1.00	0.33	0.33
Neem oil-2%	35.00	16.33	3.00	2.00
<i>Verticillium lecani</i>	51.33	25.33	18.67	13.00
Control	39.67	48.00	55.00	39.00
CD@ 5%		1.58	1.53	1.07

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

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, K. Kant; 2014-19)

Foliar spray schedule for cumin included three sprays each of Thiamethoxam (0.005%), Acetamiprid (0.003%), Dimethoate (0.03%) Mancozeb, (0.2%) and Difenocoazole (0.1%) and for coriander included three sprays each of Thiamethoxam (0.005%), Acetamiprid (0.003%), Dinocap (0.1%), Difenocoazole (0.1%) and Mancozeb, (0.2%) at 45, 60 and 90 days after sowing (DAS) with all the selected molecules. Soil sterilization with metham sodium was also evaluated for soil pre treatment before 15 days of sowing. Mature plant samples were collected as per schedule at harvest and stored in well labelled polythene bags at -15°C till further processing for analysis. The samples were processed and analysed for quantification of insecticide and fungicide residues at ICAR-NRC on Grapes, Pune following the standard protocols. The yield data and residue status of the pesticides used for cumin and coriander cultivation is given in table 3.40 & 3.41.

Table 3.40. Cumin seed yield at harvest using fungicides and insecticides.

S. No.	Treatment and spray DAS	Seed yield (q/ha.)
1	Dimethoate & Mancozeb (T ₁)	6.9
2	Metham sodium (soil sterilizer), Dimethoate & Difenocoazole (T ₂)	9.6
3	Dimethoate & Difenocoazole (T ₃)	4.9
4	Thiamethoxam & Mancozeb (T ₄)	4.1
5	Thiamethoxam & Difenocoazole (T ₅)	7.9
6	Acetamiprid & Mancozeb (T ₆)	8.3
7	Control (T ₇)	3.9
	CD (0.05)	1.02
	S.E.m	± 0.33

The results obtained for yield of cumin (q/ha) followed the trend T₅ > T₆ > T₂ > T₁ > T₃ > T₄ > T₇ (control). Maximum yield of cumin was harvested in the soil sterilized with metham sodium 15 days prior to sowing followed by foliar spray with dimethoate and difenoconazole. Residue levels of the molecules used during crop cultivation in the harvested cumin were below detection limit after crop harvest, determined with GC MS-MS and confirmed with LC MS-MS at ICAR-NRC on Grapes, Pune. The absence of pesticide residues in crops after harvest shows, that these pesticides can be safely used for cumin cultivation.

Table 3.41. Coriander seed yield at harvest using fungicides and insecticides

S. No.	Treatment and spray DAS	Seed yield (q/ha.)
1	Thiamethoxam + Karathane (Dinocap) (T ₁)	13.87
2	Thiamethoxam + Mancozeb (T ₂)	16.05
3	Thiamethoxam + Difenconazole (T ₃)	16.94
4	Acetamiprid + Mancozeb (T ₄)	15.53
5	Acetamiprid + Difenconazole (T ₅)	14.13
6	Acetamiprid + Karathane (Dinocap) (T ₆)	12.3
7	Control	9.21
	CD (0.05)	2.84
	S.Em	±0.91

The results obtained for yield of coriander (q/ha) followed the trend T₃ > T₂ > T₁ > T₅ > T₄ > T₆ > T₇ (control). Maximum yield of coriander was harvested in the treatment Thiamethoxam + Difenconazole (T₃). Residue levels of the molecules used during crop

cultivation in the harvested coriander were below detection limit after crop harvest determined with GC MS-MS and confirmed with LC MS-MS at ICAR-NRC on Grapes, Pune. The absence of pesticide residues in crops after harvest shows, that these pesticides can be safely used for coriander cultivation. Efficacy of pesticides used was justified with the yield obtained for both the crops after controlling the insect and pest issues under various treatments. Estimation of pesticide residues of the selected insecticides and fungicides in cumin and coriander seeds at harvest revealed that a PHI of approximately 29 to 34 days must be observed after the last spray of pesticides on the crops.

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)

As compared to control, treatments showed increase in growth parameters and seed yield particularly with BA, AA and Proline (Table 3.42).

Table 3.42. Growth parameters affected by exogenous application of PGRs

Treatment	SWt	RWT	SLen	Rlen	No. of Branch	Seeds/plant (g)
SA-0.5 mM	3.43	0.31	28.24	11.61	5.40	1.66
SA-1.0 mM	3.01	0.19	23.39	9.87	5.27	0.88
SA-1.5 mM	3.85	0.21	25.30	10.57	5.67	1.57
BA-0.5 mM	5.28	0.26	28.73	13.44	5.40	2.27
BA-1.0 mM	1.74	0.18	23.76	10.01	5.07	0.80
BA-1.5 mM	4.76	0.29	26.59	11.38	5.67	1.17
AA-0.5 mM	3.20	0.26	25.36	11.93	6.47	1.15
AA-1.0 mM	3.67	0.24	23.72	9.95	4.93	0.75
AA-1.5 mM	4.13	0.24	22.11	10.13	4.43	1.12
Proline-0.5 mM	3.41	0.19	23.47	10.03	4.73	1.19
Proline-1.0 mM	3.05	0.28	20.82	9.75	5.33	1.00
Proline-1.5 mM	4.34	0.26	26.36	12.05	7.20	1.79
JA-0.2 mM	3.72	0.21	23.57	9.80	4.67	1.44
JA-0.4 nM	2.70	0.15	25.18	8.61	4.69	1.14
JA-0.6 mM	3.73	0.28	21.80	10.62	5.00	1.22
D/W	2.46	0.45	22.71	9.97	6.33	0.71
Control	2.17	0.17	19.91	8.80	7.00	0.55
Mean	3.45	0.24	24.18	10.50	5.49	1.20
CD 0.05	0.96	0.10	6.06	3.02	1.22	0.47
CV%	16.68	24.66	15.07	17.28	13.37	23.77

Total oil content was also more in treatments of SA, BA and JA. However, EO content was more in SA and AA (Table 3.43). Essential oil/total oil constituents greatly differ with different PGR treatments. Cuminaldehyde was major essential oil content which varied from 27.78

in control treatment to 64.64% in distilled water treatment followed by cymene and γ -terpinene. Among fatty oils, oleic acid was major contributor followed by linolenic and palmitic acid.

Table 3.43. Effect of PGRs on essential and total content oil of cumin var. GC-4

Treatment	Total oil(%)	Essential oil(%)	Treatment	Total oil(%)	Essential oil (%)
SA-0.5 mM	8.45	5.28	Proline-0.5 mM	7.02	4.77
SA-1.0 mM	8.21	3.68	Proline-1.0 mM	5.06	4.73
SA-1.5 mM	7.54	4.27	Proline-1.5 mM	7.86	4.32
BA-0.5 mM	10.98	4.20	JA-0.2 mM	8.85	2.54
BA-1.0 mM	8.14	2.89	JA-0.4 mM	10.84	2.21
BA-1.5 mM	6.03	3.18	JA-0.6 mM	7.93	4.37
AA-0.5 mM	7.90	4.55	D/W	5.80	4.49
AA-1.0 mM	5.54	4.80	Control	6.04	3.76
AA-1.5 mM	5.73	5.41	Mean		4.09

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)

Plant growth regulators or plant hormones are among other factors influencing essential oil production. Endogenous as well exogenous application could affect essential oil production and chemical composition. Seven PGRs including Salicylic acid, Ascorbic acid, BA, 6-

BA, NAA, thiourea and GA₃ were used as foliar spray. PGRs were not effective on seed yield, however, total oil yield was found to increase in many PGR treatment viz., salicylic acid, BA, 6-BA, NAA, thiourea and GA₃. Benzyl Adenine and 6- BA were found to enhance essential oil yield (Table 3.44). Treatment of Ascorbic Acid and GA₃ was found to modify the oil constituents by increasing linalool concentration (Table 3.45).

Table 3.44. Effect of exogenous application of plant growth regulators on essential and total oil yield

PGRs	Essential oil (%)	Total oil (%)	PGRs	Essential oil (%)	Total oil (%)
SA-0.5 mM	0.19	3.30	NAA-0.1 mM	0.05	4.20
SA-1.0 mM	0.12	4.01	NAA-0.2 mM	0.04	3.80
SA-1.5 mM	0.04	2.61	NAA-0.3 mM	0.07	5.32
BA-0.5 mM	0.10	2.74	GA ₃ -0.1 mM	0.09	5.06
BA-1.0 mM	0.20	4.89	GA ₃ -0.2 mM	0.05	1.61
BA-1.5 mM	0.15	3.98	GA ₃ -0.3 mM	0.10	2.88
AA-0.5 mM	0.15	2.11	D/W	0.19	2.63
AA-1.0 mM	0.12	2.72	Control	0.09	3.09
AA-1.5 mM	0.07	3.47	TU-0.5 mM	0.06	5.42
6-BA-0.1 mM	0.05	3.24	TU-1.0 mM	0.06	2.85
6-BA-0.2 mM	0.13	4.23	TU-1.5 mM	0.15	4.48
6-BA-0.3 mM	0.20	1.95			

Table 3.45. Effect of exogenous application of plant growth regulators on essential constituents

PGRs	α -Pinene	β -Pinene	Myrcene	Cymene	Gama Terpene	Linalool	Geraniol	Anethol+ estragol	Geranyl Acetate
SA-0.5 mM	2.94	1.82	0.43	3.19	12.40	63.98	2.47	0.82	11.11
SA-1.0 mM	4.05	1.74	0.29	2.00	8.90	73.24	2.22	0.39	6.40
SA-1.5 mM	3.72	1.62	0.43	4.51	11.74	62.99	0.77	1.42	12.02
BA-0.5 mM	3.70	1.26	0.39	3.29	10.10	66.13	2.46	0.19	11.52
BA-1.0 mM	3.31	1.10	0.35	6.03	12.71	53.11	1.78	14.02	6.95
BA-1.5 mM	3.49	1.44	0.34	3.82	7.85	69.58	2.44	0.83	9.35
AA-0.5 mM	1.31	0.84	0.14	2.23	4.44	83.21	1.57	0.12	5.11
AA-1.0 mM	5.82	1.22	0.07	3.69	7.87	69.98	1.49	2.73	4.35
AA-1.5 mM	0.06	2.34	0.04	7.96	2.16	70.01	7.47	7.75	0.06
6-BA-0.1 mM	4.72	0.54	0.37	2.34	9.26	71.65	1.05	0.16	8.78
6-BA-0.2 mM	9.19	0.81	0.35	2.62	7.68	68.06	2.68	0.38	6.99
6-BA-0.3 mM	8.21	1.63	0.48	2.27	9.68	66.45	1.60	1.33	7.34
NAA-0.1 mM	9.04	0.99	0.51	3.60	11.60	62.89	1.65	0.23	8.23
NAA-0.2 mM	8.28	0.49	0.46	2.42	9.80	67.53	1.92	0.44	7.79
NAA-0.3 mM	8.22	0.87	0.53	3.66	10.42	64.33	1.64	0.20	8.99
GA3-0.1 mM	4.48	0.41	0.19	1.69	5.51	81.77	2.78	0.06	2.24
GA3-0.2 mM	2.34	0.28	0.08	1.67	5.34	82.32	2.22	0.19	4.48
GA3-0.3 mM	9.85	0.91	0.35	1.57	7.11	68.56	1.56	1.51	6.58
D/W	2.17	0.95	0.67	4.47	5.33	75.40	2.46	0.39	6.63
Control	5.46	0.44	0.25	2.14	7.57	75.13	1.54	0.17	6.28
TU-0.5 mM	5.12	0.46	0.37	2.04	9.24	69.15	2.39	1.21	8.40
TU-1.0 mM	5.91	1.08	0.85	4.84	6.05	68.00	3.74	0.22	7.00
TU-1.5 mM	3.67	0.32	1.55	1.35	7.36	71.32	2.48	0.98	9.82

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)

Fenugreek variety AFG-3 was sown during rabi season, 2017-18 and below mentioned pesticides were evaluated for their efficacy in insect-pest and disease management. Residue status in the produce after harvest, dissipation kinetics and pre harvest intervals was determined.

Three foliar sprays of Propiconazole [1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1,2,4-triazole), Hexaconazole 2-(2,4-Dichlorophenyl)-1-(1H-1,2,4-triazol-1-yl)hexan-2-ol and Copper oxychloride (Cu₂(OH)₂Cl₂) @ recommended doses at 45, 60 and 90 days after sowing (DAS) was carried out in single and double doses for the assessment of set experiment targets. Mature plant samples were

collected as per schedule at harvest and stored in well labelled polythene bags at -15°C till further processing for analysis. The samples were processed and analysed for quantification of insecticides and fungicides residues at ICAR-NRC on Grapes, Pune following the standard protocols. The yield data given in Table 3.46.

Table 3.46. Fenugreek seed yield at harvest using different fungicides

S. No.	Treatment and spray DAS	Seed yield (q/ha.)
1	Copper Oxychloride (SD) (T1)	14.45
2	Copper Oxychloride (DD) (T2)	14.0
3	Hexaconazole (SD) (T3)	20.33
4	Hexaconazole (DD) (T4)	19.53
5	Propiconazole (SD) (T5)	18.07
6	Propiconazole (DD) (T6)	19.4
7	Control (T7)	13.23
	CD (0.05)	2.84
	S.Em	±0.91

The results obtained for yield (q/ha) in fenugreek followed the trend $T_1 > T_4 > T_2 > T_3 > T_5 > T_6 > T_7$ (control) with maximum yield in treatment T_4 . Residue levels of the fungicide molecules used during crop cultivation in the harvested fenugreek were below detection limit after crop harvest as determined with GC MS-MS and confirmed with LC MS-MS at ICAR-NRC on Grapes, Pune. The absence of pesticide residues in crop after harvest shows, that these pesticides can be safely used for

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, S.P. Maheria; 2014-18)

231 frontline demonstrations (FLDs) for coriander variety ACr-1 (65), fenugreek-AFg-3 (60), fennel-AF-1 (40), ajwain-AA-1 (35), dill-AD-1 (05) and nigella-AN-1 (26) were conducted in tribal farmers field at Pratapgarh,

Banswara, Dungarpur and Pratapgarh districts of Rajasthan under Tribal Sub-plan project of ICAR-NRCSS, Ajmer during 2017-18. These FLDs were organized in collaboration with Krishi Vigyan Kendra, Pratapgarh, KVK, Banswara, KVK, Dungarpur, and State Department of Agriculture, Phalasia, Udaipur during Rabi 2017-18. In the FLDs, improved varieties and recommended package of practices (POP) consisting of seed treatments, line sowing, weed management, nutrient management and plant protection measures were demonstrated on the farmers' fields. In plant protection measures, foliar treatment of imidacloprid 0.03ml/lit and botanicals (Ker plant extract 10ml/lit., and azadirachtin 0.03EC 5ml/lit.) were used. The performance of crops under all the frontline demonstrations (FLDs) was observed to be better in respect to overall growth parameters, yield and yield attributes. Results of the FLDs at different farmers fields revealed that yield of seed spices under demonstration plots was higher in comparison to local checks/practices which ranged from 21.54 to 41.39 percent. It was found to be 33.99 % higher in coriander, 29.65% in fenugreek, 35.78% in fennel, 41.39% in ajwain, 32.49% in nigella, and 21.54 % in dill (Table 3.47).

Table 3.47. Average performance of FLDs of seed spices in Tribal districts of Rajasthan in 2017-18.

Sl. No.	Crop	Technology Demonstrated	Variety	No. of FLDs	Area (ha.)	Demo. Yield q/ha			Yield of local Check (q/ha)	Increase in yield (%)
						H	L	A		
1.	Coriander	Crop	ACr-1	65	16.25	13.25	10.48	11.79	8.14	33.99
2.	Fenugreek	Production and	AFg-3	60	15.00	20.55	16.18	17.90	13.86	29.65
3.	Ajwain	crop protection	AA-1	35	8.75	9.85	7.25	8.79	6.14	41.39
4.	Nigella	technologies	AN-1	26	6.50	5.43	4.70	5.23	4.36	32.49
5.	Dill		AD-1	05	1.25	12.4	10.8	11.4	9.38	21.54
6.	Fennel		AF-1	40	10.00	16.50	12.63	14.83	10.92	35.78
Total					231	57.75				

Farmer Trainings organized under TSP during 2018-19: During the reporting period farmer's trainings were conducted and details are giving below-

One day farmer's training on "Improved production and protection technologies of seed spices" was organized at KVK (MPUA&T), Banswara on 21st August, 2018. In this training, a total of 7 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Banswara on various aspects of production, protection technologies in seed spices and other related field. A total of 50

farmers from different villages participated in the training programme organized by NRCSS under TSP project.

One day farmer's training on "Improved production technologies of seed spices" was organized at KVK (MPUA&T), Pratapgarh on 22nd August, 2018. In this training, a total of 6 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Pratapgarh on various aspects of production and protection

technologies in seed spices and other related field. A total of 60 farmers from different tribal villages of Pratapgarh district participated in the training programme organized by NRCSS under TSP project.

One day farmer's training on "Improved production and protection technologies of seed spices" was organized at KVK (MPUA&T), Badal Mahal, Dungarpur on 11th September, 2018. In this training, 7 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Dungarpur on various aspects of production and protection technologies in seed spices and other related field. 66 farmers from different villages participated in the training programme organized by NRCSS under TSP project.

Similarly, one day farmer's training programme on improved production technologies of seed spices was organized at Agriculture Department, Govt. of Rajasthan, Phalasia (Udaipur) on 12th September, 2018. In this training, a total of 6 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and Agriculture Department, Jhadol Panchyat Samiti, (Phalasia) Udaipur, on different aspects of production and protection technologies in seed spices and other related field. A total of 54 farmers from different villages participated in the training programme organized by NRCSS under TSP project.

One day farmer's training programme on post-harvest management of seed spices was organized at KVK (MPUA&T), Vallabhnagar (Udaipur) on 28th February, 2019. In this training, a total of 5 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Vallabhnagar on various aspects of post harvest management in seed spices and other related field. A total of 50 farmers from different villages of Mavali tehsil participated in the training programme organized by NRCSS under TSP project.

One day farmer's training on post-harvest management of seed spices was organized at KVK (MPUA&T), Badal Mahal, Dungarpur on 19th March, 2019. In this training, a total of 6 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Dungarpur on various aspects of post harvest management in seed spices and other related field. A total of 66 farmers from different villages participated in the training programme organized by

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

Primary survey of 458 seed spice grower from major growing areas of Rajasthan and Gujarat was conducted, using questionnaire developed by ICAR-NRCSS, Ajmer during 2017-18 to access the approachability of ICT by seed spice growers. Major coriander and cumin growing districts in Rajasthan and Gujarat (150 farmers from each state) namely Kota, Baran, Jhalawad, Jodhpur, Barmer, Jaisalmer, Nagaur districts of Rajasthan and Banaskhanta, Mehsana and Patan Districts of Gujarat were covered. Other than this, 158 farmers that visited ICAR-NRCSS, Ajmer were also interviewed to seek their opinion on use of ICT and social media in agriculture.

Out of 458 seed spice growers surveyed, 66 percent of the farmers were small and marginal farmers having average land holding of 1.02 hectare followed by semi medium and medium farmers with average land holding of 2.69 and 5.92 hectare respectively. Only 6 farmers had land holding more than 10 hectare. Most of the surveyed farmers were under the age group of 40 to 60 years followed by young farmers of age less than 40 years. Education level was high (>12th Class) in farmers who attended training at NRCSS compared to farmers surveyed. There was inverse relationship in age and land holding. Low education level affected the digital literacy adversely resulting in hindrance the use of ICT and social media as a source of information in agriculture (Table :3.48).

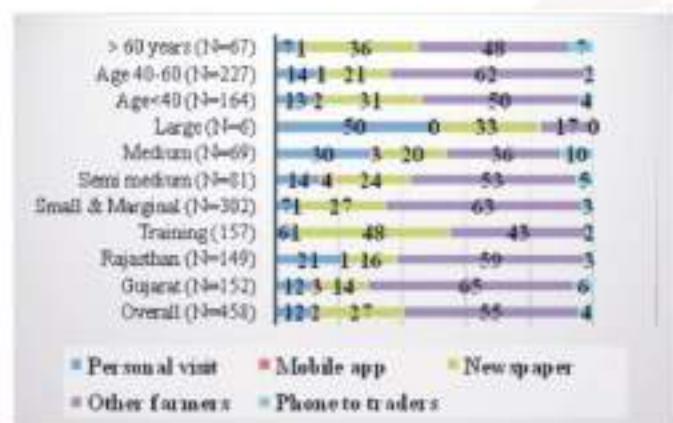
Table 3.48: Source of information on agriculture (in

Particulars	Overall (%)	Gujarat (%)	Rajasthan (%)	Training (%)
Agri. Dept.	4	9	2	1
Ext. Officer	2	4	1	0
KVK	25	2	9	62
Other farmers	2	1	7	0
Input dealers	66	84	81	34
T.V.	1	1	0	3

The survey results showed that farmers heavily depend on input dealers to seek information related to agriculture. Only 29 per cent of the farmers, most of them are trained farmers approaches KVK and agriculture experts to seeks information, followed by information from the other progressive farmers in the villages. The results calls for use of ICT and Social media tool which can help the seed spice grower to get information related to their problems. The most effective ICT tool used by farmers to seek information on agriculture was found to be TV, where 74% of the farmers watch agriculture related programmes on televisoin followed by participation in extension programmes viz; Famers Fare, Training, Exposure visit, Kisan Sangosti etc. Newspaper was also found as most effective tool to seek inforamtion by the farmers. Radio was found to be least used by seed spice farmers in today's scenario. Market related information mostly about prices is gathered from other farmers who has recently visited the APMC yard, 27% of the farmers get market informations from newspaper followed by personal visit to yard. Some of the farmers have direct contacts with the input dealers (4%) who get information about prices over phone calls from traders. Very few, only 7 farmers out of 458 used mobile phone app to get market prices.



Photo: Seeking opinion of seed spice grower on approachability and accessibility of effective medium of information dissemination.



Source of information on market prices for seed spice grower (in %)

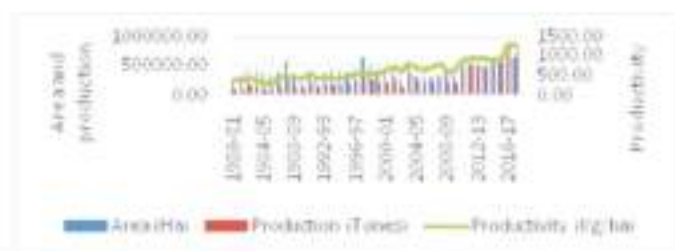
Findings of the study suggest that there is need to give more emphasis on use of ICT tools especial social media via mobile phone for better dissemination and wider coverage of seed spice grower in timely and cost effective manner.

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. Visal and M.A. Khan, 2017-20)

To develop database on area, production, productivity and export (in quantity and value term) of cumin and coriander, information was collected for the period 1985-86 to 2017-18 from various sources namely DASD, Calicut; Directorate of Economics & Statistics, DAC & FW and Spice Board. Compound Growth Rate and instability during different sub-periods (1985-86 to 94-95, 1995-96 to 2004-05 and 2005-06 to 2017-18) was calculated. From triennial ending 1985 to triennial ending 2018 area under cumin increased by 627 percent from 108650.00 to 790033.33 hectare and production increased by 745 percent from 59336.67 to 501333.33 tones. Similarly area under coriander enhanced by 63 percent growth from 401966.67 to 654243.33 hectare and 47 increased

by 475 percent from 133500.00 to 767743.33 tones. Further exponentially increase in production since 2006-07 shows the significant impact of ICAR-NRCSS technologies for yield enhancement of coriander



Area, production and productivity of coriander cultivation in India from 1980 to 2018

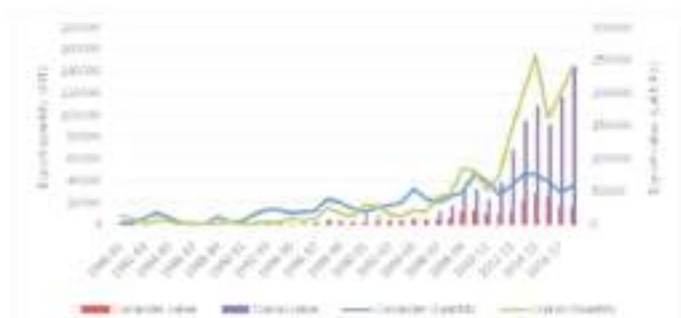
Similar trend was observed in cumin where production increased continuously showing the efforts of this centre. From the figure 2, it can be seen that productivity of cumin in the country showed downward trend till 2000. Since establishment of ICAR-NRCSS this downward trend for year 2000 was corrected and was set to positive trend onward. Jodhpur, Barmer, Jalore, Nagaur and Jaisalmer were identified as major cumin growing districts in Rajasthan with 31, 27, 19, 11 and 7 per cent area share respectively, to state's total acreage during TE 2016. Jhalawar, Kota and Baran were identified as major coriander growing districts of Rajasthan and jointly contributed 86.4 percent acreage share to the state during TE 2016 (Table 3.49).



Area, production and productivity of cumin cultivation in India from 1980 to 2018

During 1985-86 to 2017-18 coriander export increased by 432 and 8495 per cent in quantity and value term respectively. In the same period cumin export has increased by 3939 and 42120 per cent in quantity and value term respectively. Coriander and cumin export has increased very rapidly since 2004-05, with increasing

contribution to Indian economy through increasing export earnings.



Export of cumin and coriander in quantity and value term from 1980 to 2018

An assessment of cost of cultivation and technical efficiency of coriander and cumin cultivation in major growing areas of Rajasthan, Gujarat and Madhya Pradesh was carried out using a pretested questionnaire through stratified random sampling method. A primary survey of 300 cumin and coriander growers (150 each) was conducted through personnel interview method to measure technical efficiency of cumin and coriander growers. In coriander Kota, Baran, Jhalawad of Rajasthan and Guna districts of M.P. were surveyed. In case of cumin Barmer, Nagore, Jodhpur and Jaisalmer districts of Rajasthan were covered.

Table 3.49: Technical efficiency of coriander and cumin growers

Technical efficiency Range	Coriander		Cumin	
	Mean TE	Percent farmers	Percent farmers	Mean TE
< 70%	59.03	30.43	0	
70 to 80%	74.48	30.43	2.04	76.49
80-90%	85.06	24.64	36.73	86.29
>90%	94.16	14.49	61.22	95.82
Overall	75.24	100	100	91.92

Data revealed that performances of seed spices to total spices in term of area, production and export has improved during study period from 1985 to 2018 but export of seed spices was found more volatile than total spices. Existing inefficiencies was found high in case of coriander crop which need to be taken care through efficient utilization of resources.



Photo: Primary survey of cumin and coriander grower

Externally Funded Project

DUS Project (PPV & FRA): To develop DUS test guidelines for major seed species (fennel, fenugreek, coriander and cumin)

(R.S. Meena and Sharda Choudhary)

DUS experiment on major seed species (fennel, fenugreek, coriander and cumin) was conducted at NRCSS, Ajmer. In the experiment, 20 fennel, 22 fenugreek, 34 coriander, and 9 cumin varieties were included to develop DUS guidelines for 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, branches at base, plant growth pattern, pod length, pod curvature, apex shape of leaf blade on first pod axis, stem: pigmentation, surface and waxiness, number of days to stem elongation, angle of primary branch, fully bloom leaf foliage density; leaflet: spacing of lobes, shape of tips of margin and density of margin incision, leaf blade: length and lensity between 1" and 2" pair of leaflet, leaf: size of terminal leaflet; petiole: Length and width, Umbel compactness, number of umbel/siliqua per plant, number of umbellate per plant, siliqua size, seed: colour, shape, ridges and curvature and weight of 1000 seeds. Based on the results, developing DUS guideline in major seed spices has been initiated.

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

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

DUS experiment on minor seed species (ajwain, dill, nigella, celery and anise) was conducted at NRCSS,

Ajmer. In the experiment, 9 ajwain, 4 dill, 5 nigella, 3 celery and 2 anise varieties were included to develop DUS guidelines for 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 primary branch; leaflet: spacing of lobes, shape of tips of margin and density of margin incision, leaf blade: length and lensity between 1" and 2" pair of leaflet, leaf: size of terminal leaflet; petiole: Length and width, Umbel compactness, number of umbel/siliqua per plant, number of umbellate per plant, siliqua size; seed: colour, shape, ridges and curvature and weight of 1000 seeds. Based on the results, developing DUS guideline in minor seed spices has been initiated.

Network Project on Organic Farming (NPOF) in collaboration with IIFSR, Modipuram "Standardization of seed spices based organic farming system" Duration (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 seed spices cultivars 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 and 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 show that, the performance of crops for all parameters was recorded best under 75% organic with 25% inorganic treatment followed by state recommendation both in *Kharif* and *Rabi* seasons.

Eight varieties both of 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 performance of GF-12 recorded highest value (3250.00 kg/ha yield) followed by AF-1 (3218.33 kg/ha yield) in fennel. In coriander, variety Azad Dhania-1 was found best in yield (1653.00 kg/ha) and growth parameters followed by ACr-1(1618.67 kg/ha) in *Rabi* and in *Kharif* season, cluster bean variety RGC-1038 (1250.00 kg/ha) performed best followed by RGC-1055 (1063.33 kg/ha) and in moong bean superior performance was given by cultivar MUM-2 (943.16 kg/ha) followed by RMG-975 (936.66 kg/ha) with respect to growth and yield aspects.



Preparation of different spice premixes

Six organic based IPM modules (including control) were tested against aphid and thrips on coriander and fennel under field conditions. It was found that, the IPM module M₂ (garlic extract 10 ml/lit + azadirachtin 0.03 % EC @ 5ml/lit + fruit extract of *Citrullus colocynthis* 10ml/lit.) was found most effective against aphid (71.40 & 73.00 % insect population reduction in comparison to control) and thrips (62.10 & 64.05 % insect population reduction in comparison to control) both on coriander and fennel, respectively.

In coriander, five different organic treatments consisted of soil solarization (20 days), *Trichoderma* (8g kg⁻¹ seed as seed treatment + 2.5 kg/ha as soil application), neem cake (0.5t/ha), castor cake (0.5t/ha) and control which were evaluated. Among the treatments, soil solarization was found most effective (PDI 1.2) followed by neem cake (PDI 4.2) and *Trichoderma* (PDI 5.3) while the disease (*Sclerotium* rot of coriander) was recorded maximum (PDI 8.8) under control plots.

In the same project, the work on spice premixes was initiated based on organoleptic evaluation. The spice premixes pavbhaji masala and sambar masala were prepared, standardized and evaluated organoleptically. Scored from 7.8 to 8.6 out of nine (9-Hedonic ranking test scale). Garam masala, Tea masala, Chana masala, Rajma masala, Sabji masala, Pavbhaji masala and Sambarmasala were also studied for their shelf life storage under laboratory. The organic seed spices (fennel, coriander, cumin and fenugreek) were procured from ICAR-NRCSS, Tabiji, Ajmer (Rajasthan) for preparation above spice premixes.



4. Technology Assessment and Transfer

One of the prime activities of this research centre to benefit the farmers, stake holders and processing industry is, transfer of the established technologies and acquired knowledge through training programmes, demonstration of new varieties, production technologies, organizing kisan mela, seed distribution mela, participation in exhibition, in campus and off campus organizing of field day etc. These activities were conducted along with KVKs, State Department of Agriculture/Horticulture/extension agencies/ NGOs and line departments. During the reported period following activities were conducted.

4.1 Transfer of Technology under Mission for Integrated Development of Horticulture (MIDH)

4.1.1 MIDH 2018-19

1. Organised one day farmers training programme on "Good Agricultural Practices in Seed Spices" on 17th November, 2018 held at ICAR-NRCSS, Ajmer. 75 farmers participated in the training programme.
2. Organised one day farmers training programme on "Good Agricultural Practices in Seed Spices" 24th December, 2018 held at Agric. Dept. (ATMA), Govt. of Rajasthan, Nagaur. 81 farmers participated in the training programme
3. Organised two days district level seminar on "Improved cultivation of seed spices under climate change regime" from 26 to 27th December, 2018 held at Agric. Dept., Govt of Rajasthan, Jaisalmer. 128 farmers participated in the seminar.

Front Line Demonstrations (FLDs) distributed.

Place	No. of FLDs	Crop	Variety
Jaisalmer	7	Cumin	GC 4
Jalore	6	Cumin	GC 4
Gudamalani, Barmer	6	Cumin	GC 4
Danta, Barmer	7	Cumin	GC 4
Jodhpur	6	Fennel	AF 2
Jhunjhunu	5	Fenugreek	AFg 3
Sikar	3	Fenugreek	AFg 3
Bharatpur	4	Fennel	AF 2

Technology Assessment and Transfer

TOT Programme Conducted in NEH region during 2018-19

4.1.2 CAPACITY BUILDING PROGRAMME

One day Capacity Building Programme on "Organic Production Technology of Seed Spices for NEH Region" was organized in collaboration with KVK, Namsai Longding, ICAR Res. Complex for NEH Region, AP Centre at Namsai on 22nd September, 2018. In inaugural session, Sh. Chowna Mein, Hon'ble Deputy Chief Minister of Arunachal Pradesh was Chief Guest and Sh. Chow Tewa Mein, MLA Chowkham and Sh. Chow Zingnu Namchoom, MLA, Namsai acted as Guests of Honor. Dr. Tapasya Raghav, IAS Deputy Commissioner, Namsai and Sh Akhil Kumar Singh, Superintendent of Police, Namsai were Special Guests and Dr. Gopal Lal, Director, ICAR-NRCSS presided over the function. Dr. N.K. Meena, Sr. Scientist coordinated the programme. In this



programme, Dr. Lal presented overall scenario of seed spices in the country and future prospect in his welcome address. He emphasized the importance and possibilities of coriander, fenugreek and fennel cultivation in Arunachal Pradesh. Dignitaries also addressed the farmers gathering and expressed their views for the benefit of farmers through seed spices cultivation. Hon'ble Chief Guest appreciated for organizing such a potential programme on seed spices in Arunachal Pradesh. He advised the farmers to come forward for the cultivation of coriander and fenugreek for seeds as well as leaf purpose for obtaining more income per unit area. Six lectures on different aspect of

seed spices were delivered by the resources persons. 110 farmers, stakeholder, scientists and officers from state agricultural department participated in this programme. In addition, 110 FLDs (55 each for coriander and fenugreek) for 25 sq. meter area were also given to the farmers.



4.1.3 Farmers Training Programme

To promote seed spice cultivation in non-traditional areas of the country an One Day Farmers' Training Programme on "Advanced Production and Protection Technologies of Seed Spice for NEH Regions" was organized on 29th January, 2019 by ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer in collaboration with Agricultural Technology Application Research Institute, Zone VI, Guwahati, Assam & KVK, Morigaon at Krishi Vigyan Kendra, Morigaon. A total of



74 farmers/official participated/attended this training programme. The training was coordinated/organized by Dr Shiv Lal, Scientist, Horticulture along with Dr. R.D Meena, Scientist-Pl. Pathology, Dr. M.D. Meena, Scientist-Agrl. Eco., Sh. G K Tripathi, Technical officer and Mr. Sunil Agarwal, AFAO from ICAR-NRCSS. Dr. R. Bordoloi, Pr. Sci., ICAR-ATARI, ZONE-VI, Guwahati & Dr. (Mrs.) R. S. Deka, Senior Scientist & Head, KVK Morigaon were the local organizers. Various lectures were delivered by different subject matter specialist of ICAR-NRCSS, ATARI, Guwahati and KVK, Morigaon. In this training village sarpanch, farmers' producer organization (FPO) representatives also participated. During the training programme plastic crates for carrying/handling fresh vegetable and spices were also distributed to the all participants.

4.1.4 Technology transfer under Scheduled Caste Sub Plan (SCSP) 2018-2019

For capacity building and distribution of agricultural inputs like quality seeds and other items to the beneficiaries belonging to scheduled caste under SCSP, 3 different training programmes were organized at different location of the state by Dr. Shiv Lal (Nodal Officer) as mentioned below:

The first programme was conducted on the topic "Organic production technologies for seed spices" on 18 February 2019 at ICAR-NRCSS, Ajmer. In this training a total of 47 farmers from Tabiji, Doomara, Dang, Jethana, Budhwara and Datra villages participated. During training programme. A total of six lectures were delivered by scientist of ICAR-NRCSS, Ajmer on different aspects of organic seed spices production. To protect their crops through application of bio-pesticides, a hand operated spray machines were distributed in addition to seeds of coriander variety ACr-1 to all the beneficiaries. The programme was organized by Dr. Gopal Lal, Director, Dr. Shiv Lal, Scientist and Dr. N. Chaudhary, Scientist.



Second training programme was exclusively organized for SC women on the topic "Off-season cultivation of seed spices for higher income" on 15th March, 2019 at ICAR-NRCSS, Ajmer. In this training programme a total of 61 women participated from

nearby villages viz. Tabiji, Saradhana, Daurai, Budhwara and Doomara. During the training six lectures were delivered by scientist of ICAR-NRCSS, Ajmer on different aspects for off season seed spices production. To cultivate off-season coriander for leaf purpose, seeds of coriander variety ACr-1 and green shed net was distributed in addition to milk cans for carrying the milk etc. to all the beneficiaries. The programme was organized by Dr. Gopal Lal, Director, Dr. R.S Meena, Senior Scientist and Dr. Shiv Lal, Scientist.

Third one day farmers training on "Advanced Production Technologies of Seed Spice and Horticultural Crops under SCSP" was organized on 18th March, 2019 in collaboration with Krishi Vigyan Kendra, Rajsamand at KVK, Rajsamand. In this training programme 59 farmers (male & female) from SC community of different villages (Rajiyawas, Pirada, Mohi, Bagol, Kucholi, Kumariyo Ka Khera and Emdi) of Rajsamand participated in the programme. In this training programme a kit constituting of seeds of coriander variety ACr-1, hand sprayer, bag, pen and pad was also distributed

to each participant. During training programme five lectures on various aspects of advanced production technologies of seed spice and horticultural crops were delivered by officials of ICAR-NRCSS and KVK, Rajsamand. Scientist and farmers also interacted on issues related to horticultural crop production in the areas. The programme was organized by Dr. Dr. S.S Meena, Pr. Scientist, Dr. B.K. Mishra, Pr. Scientist, Shiv Lal, Scientist) and Dr. N. Chaudhary, Scientist from ICAR-NRCSS in collaboration with Dr. R.S Patodiya, Senior Scientist & Head, KVK, Rajsamand and Dr. P.C. Regar, Scientist, Animal Sciences).



4.2 Technology transfer through FLDs under MIDH (2018-19)

1. Distributed cumin (GC-4), coriander (ACr-1), fennel (AF-2) and fenugreek (AFg-3) seeds.
2. Seeds and fertilizers to the farmers of different location of Rajasthan under MIDH were distributed
3. Distributed pesticides to the farmers beneficiaries under MIDH.
4. Monitored the fennel FLDs plots at farmers field, Bharatpur under MIDH.
5. Monitored the fenugreek FLDs plots at farmers field, Jhunjhunu and Sikar district under MIDH.
6. Monitored the cumin FLDs plots at farmers field, in Jalore, Barmer and Jaisalmer under MIDH.
7. Monitored fennel, coriander and nigella FLDs in Pratapgarh, Dungarpur, Banswara and Phalasia

districts of Rajasthan under TSP programme. The programme was coordinated by Dr. Narendra Chaudhary, Scientist, NRCSS, Ajmer.

4.3 Rashtriya Beej Vitran Kisam Mela and Beej Vitran Pakhwara

NRCSS Organized "Masala beej Vitran Pakhawara" during 17-30th September, 2018

To promote the supply of quality seeds to seed spice growers of Rajasthan, ICAR-National Research Centre on Seed Spices, Ajmer organized *Masala Beej Vitran Pakhwara* during 17-30 September 2018. As an innovative activity NRCSS planned to supply quality seeds of seed spice crops at doorsteps of farmers by sending 'Beej Rath' to seed spice growing areas of Rajasthan and parts of Madhya Pradesh. This *Rath* had sufficient seeds of all seed spice crops for sale at reasonable price and stayed at each district for one day. Four teams comprising of scientists and Technical officers were constituted to cover the districts of Bundi, Kota, Jhalawar, Sikar, Nagaure, Jhunjhunu, Banswara, Udaipur, Pratapgarh, Neemuch and Mandsoore in 3-4 days. The officers from Agriculture department, Govt. of Rajasthan cooperated in this farmer welfare scheme of ICAR-NRCSS, Ajmer for ensuring quality seeds to the growers thus, enhancing the production and productivity of seed spice crops. Appreciable quantity of seeds of improved varieties of cumin, coriander, fennel and fenugreek were distributed among farmers. Dr. Ravindra Singh, Dr. N.K.Meena, Dr. Arvind Verma and Dr. Murlidhar Meena were the team leaders with Sh. M. A. Khan, Sh. S.R. Meena and Sh. Sriram Balal as associate with respective teams. Dr. S. N. Saxena coordinated the entire programme under patronage of Dr. Gopal Lal, Director, NRCSS, Ajmer.

Live telecast of PM - KISAN SAMMAN NIDHI SCHEME LAUNCHING

ICAR - NRCSS, Ajmer live telecasted the launching of PM KISAN SAMMAN NIDHI SCHEME on 24th Feb., 2019. Live broadcast of this programme was viewed by 323 farmers of Rajasthan State. 15 dignitaries (including two MLAs, District Collector, Jila Pramukh and staff of NRCSS, KVK Ajmer, State Agriculture Department) and public representative were participated in this programme.



4.4 Farmers visit to the Centre

Farmers and stakeholders visited the ICAR-NRCSS Experimental farm, Institute Technology Management Unit and bio control lab during 2018-19. Various farmers' groups from Rajasthan and adjoining states viz., Gujarat, M.P., U.P., Punjab, Haryana and Maharashtra etc. visited the centre during cropping season as well as during off season of seed spices. Visiting groups were explained about the ongoing research activities and various seed spice production technologies developed by this centre. Approximately 18, 545 farmers, students and extension

workers were benefitted from the on-site demonstration 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 organized 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. The knowledge acquired through research was disseminated to various stake holders through this venture.

4.5 Training programme organized at ICAR-NRCSS (farmers)

Sr. No.	Title of training	Duration	Coordinators	Sponsoring agency	Farmers benefited
1.	सौंफ की खेती पर तीन दिवसीय कृषक प्रशिक्षण कार्यक्रम	18-20 July, 2018	Dr. A.K. Verma, Dr. Ravi Y. and S.R. Meena	ATMA Burhanpur (MP)	10
2.	बीजीय मसाला उत्पादन की उन्नत खेती	20-24 August, 2018	Dr. O.P. Aishwat, Dr. Sharda Choudary, Dr. M.D. Meena	ATMA, Jothwada Jaipur, Raj.	30
3.	उन्नत उत्पादन तकनीक द्वारा बीजीय मसाला फसलों की खेती	27-31 August, 2018	Dr. Ravindra Singh, Dr. B. K. Mishra, Dr. R.D. Meena	ATMA, Jothwada Jaipur, Raj.	30
4.	Improved production and protection technologies for seed spices	10-14 Sept., 2018	Dr. K. Kant, Dr. N.K. Meena and Dr. Shivalal	ATMA, Shivpuri, M.P.	40
5.	बीजीय मसाला फसलों की उन्नत उत्पादन तकनीकियाँ	24 to 28 Sept., 2018	Dr. S.N. Saxena, Dr. R.S. Meena and Dr. Ravi	ATMA, Nagaur, Raj.	30

7.	बीजीय मसाला उत्पादन की उन्नत प्रौद्योगिकियाँ	22-26 Oct., 2018	Dr. N.K. Meena and Dr. M.D. Meena	ATMA, Jodhpur, Raj.	24
8.	बीजीय मसाला उत्पादन की उन्नत कृषि पद्धतियाँ	13-17 Nov., 2018	Dr. P.N. Dubey, Dr. R.D. Meena, Sh. G.K. Tripathi	ATMA, Tonk, Raj.	27
9.	बीजीय मसाला उत्पादन की उन्नत कृषि पद्धतियाँ	26-30 Nov., 2018	Dr. S.S. Meena, Dr. M.D. Meena and P.K. Agrawal	ATMA, Tonk, Raj.	25
10.	बीजीय मसालों फसलों की वैज्ञानिक खेती	11-15 Dec., 2018	Dr. R. S. Meena Dr. Narendra Chaudhary	ATMA, Jhalawad	30
11.	बीजीय मसालों फसलों की उन्नत खेती कृषि क्रियाएँ	24 Dec., 2018,	Dr. S. S. Meena Dr. N. Chaudhary	MIDH	81
12.	Present status and future prospectus of seed spices research and development in India	27 Dec. - 2 Jan., 2019	Dr. Gopal Lal Dr. M.D. Meena Dr. A.K. Verma	BHU Students 1 week interaction programme	20
13.	बीजीय मसालों एवं उद्योगिकी फसलोत्पादन की नवीनतम तकनीकियाँ	7-11 Jan. 2019	Dr. B.K. Mishra Dr. Shiv Lal	ATMA, Rajsamand, Raj.	30
14.	मध्य प्रदेश राज्य में मसालों की उन्नत उत्पादन तकनीकी तथा सस्योत्तर क्रियाएँ	21-30 Jan., 2019	Dr. S.S. Meena Dr. P.N. Dubey Dr. M.D. Meena	Hort. Commissioner Bhopal	20
15.	Advanced Production and Protection Technologies of Seed Spice for NEH Regions	29 Jan., 2019	Dr. Shiv Lal Dr. M.D. Meena Dr. R.D. Meena	NEH	74
16.	Organic production technologies for seed spices	18 Feb., 2019	Dr. Shiv Lal Dr. N. Chaudhary,	SCSP	47
17.	Off-season cultivation of seed spices for higher income	15 March, 2019	Dr. R. S. Meena Dr. Shiv Lal	SCSP	61
18.	Advanced Production Technologies of Seed Spice and Horticultural Crops	18 March, 2019	Dr. S.S. Meena, Dr. B.K. Mishra, Dr. Shiv Lal, Dr. N. Chaudhary, Dr. R.S. Patodiya, and Dr. P.C. Regar (KVK, Rajsamand)	SCSP	59
19.	Advanced production technology in vegetable crops	7 March, 2019	Dr. Shiv Lal Mr. Ravi Y.	Indian Farm forestry development cooperative Ltd (IFFDC)	40

20.	बीजीय मसाला उत्पादन	26-30 March, 2019	Dr. Y.K. Sharma, Dr. Arvind and Dr. Narendra Chaudary	ATMA, Naugore, Raj.	30
21.	बीजीय मसाला उत्पादन की उन्नत उत्पादन तकनीकियाँ	26-30 March 2019	Dr. S.S. Meena Dr. M.D. Meena G. K. Tripathi P.K. Agrwal	ATMA, Tonk, Raj. ATMA, Nagaur, Raj.	30 30
22.	Woman empowerment through seed spice cultivation	30 March, 2019	Dr. S.S. Meena Dr. Shiv Lal Dr. N. Chaudhary	MIDH	121

4.6 Radio/Television talks

Name of Scientists	Topic/Title of the talk	Date and venue
Dr. G. Lal	Live Talk (Phone in Programme) Radio Talk	DD, New Delhi on 24 July, 2018 AIR, Jaipur on 20.02.2019
Dr. A.K. Verma	"Phoolon ki kheti se adhik aamdani"	AIR on 26 August, 2018

4.7 Exhibitions conducted/ participated

Exhibitions conducted/Participated

This centre is actively involved in exhibiting the technologies generated at NRCSS for the benefit of stakeholders in seed spices chains through participation in farmers fair and other activities organised in the country by various organisations. The visiting farmers and other stake holders were provided with first-hand

knowledge on advance package of practices and improved varieties. In the year 2018-19, ICAR-NRCSS had participated in many farmers fair organised at different places by different organisation where twenty five thousand farmers and other stakeholders including industrialist, NGOs, traders, students etc. were benefited. During 2018-19 NRCSS has participated in following programmes as mentioned below:

Sr. No.	Name of exhibition/fair	Duration	Organised by	Name of exhibitors
1	Foundation day cum farmers fair, Bikaner	05 July, 2018	ICAR-NRC on Camel Jorbeer, Bikaner (Rajasthan).	Dr. Murlidhar Meena and Sh. G.K. Tripathi
2	Stale level farmers fair, Jodhpur	13-15 Sept., 2018	ICAR- CAZRI Jodhpur (Rajasthan).	Dr. Murlidhar Meena and Sh. S.R. Meena
3	Stale level farmers fair, Avikanagar	29 Sept., 2018	ICAR-CSWRI, Avikanagar (Rajasthan)	Dr. Murlidhar Meena and Sh G.K. Tripathi
4	Kisan Mela, Bikaner	02 Oct., 2018	ICAR-NRC on Camel Jorbeer, Bikaner	Dr. Murlidhar Meena Sh M.K. Choudhary
5	Pushkar Mela, 2018, Pushkar	15-23 Nov., 2018	Animal Husbandry Dept. Govt. of Rajasthan	Dr. P.N. Dubey, Dr. Murlidhar Meena, Sh. M.A. Khan
6	Spices buyer-sellers meet, Nagaur	24 Jan., 2019	Spice board of India and Agriculture university Jodhpur	Dr. Murlidhar Meena and Dr. S.S. Meena
7	XIV Agricultural Science Congress, New Delhi	20-23 Feb., 2019	NAAS and IARI New Delhi	Dr. Murlidhar Meena, Dr. S.S. Meena, Dr. Shiv Lal and Sh. S.R. Balai



Sh. Radhamohan Singh, Union Minister for Agriculture & Farmers Welfare, GOI, visiting NRCSS stall at Avikanagar



Sh. Arjun Ram Meghwal, Union Minister of State for Ministry of Water Resources, River Development & Ganga Rejuvenation, GOI and Dr. T. Mahapatra, DG ICAR visiting NRCSS stall, Bikaner



Dr. T. Mahapatra, DG ICAR and President NAAS Dr. Panjab Singh visiting NRCSS stall at New Delhi



Sh. Arun Garg, CEO Zila Parishad, Ajmer visiting NRCSS stall at Pushkar Mela 2018



Researchers from other organisations visiting NRCSS stall, New Delhi



Farmers visiting NRCSS stall at Pushkar Mela 2018



Farmers visiting NRCSS stall at State level farmers fair, Jodhpur



Students visiting NRCSS stall, State level farmers fair, Avikanagar

5. Training and Capacity Building Programmes

5.1 Education (M.Sc. Student guided)

Name of the student	Degree	Title of thesis	Guide
Ms. Kavita Kumari Sharma	M.Sc.	Standardization of production technology of fenugreek (<i>Trigonella foenum-graecum</i> L.) under protected condition, Department of Agronomy, College of Agriculture at MJRP University, Jaipur	Dr. R. Singh
Ms. Geetika Jethara	Ph.D.	Computational analyses and database development of simple sequence repeats from seed spices species of Apiaceae family	Dr. S. Choudhary

5.2 Training and Capacity Building Programmes Organised

5.2.1 State level Seminar

A State Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" was organized jointly by ICAR-National Research Centre on Seed Spices, Ajmer and DASD, Calicut under MIDH during 27-28 March, 2019 at ICAR-National Research Centre on Seed Spices, Ajmer. Theme areas of seminar were: Plant genetic resources and crop improvement, natural resource management and hi-tech horticulture, crop health management, organic production of seed spices,

post-harvest management and value addition, innovations for technology dissemination.

Four Technical Sessions (Technical Session-I: Plant Genetic Resources and Crop Improvement, Technical Session-II: Crop Production Management and Organic Production of Seed Spices, Technical Session-III: Crop Health Management and Technical Session-IV: Post Harvest Management and Transfer of Technology) and a Plenary Session were conducted in two consecutive days.

Scientists-farmers interaction session was also conducted, in which scientists answered the queries of farmers in relation to the seed spices cultivation.



State Seminar organized at ICAR-NRCSS, Ajmer (27-28 March, 2019)

5.3 Capacity Building Programme attended

5.3.1 Training attended

- Dr. P.N. Dubey attended two days workshop and training on "Bhartiya Krishi Anusandhan Parishad Mein Rajbhasha Ki Nai Dishayen" on 24-25 April, 2018, organised by ICAR-Rajbhasha Dept, New Delhi at CRIDA, Hyderabad.
- Dr. A.K. Verma attended 10 day short course on "Genomics assisted pre-breeding in vegetable crops" from 25 June to 04 July 2018 at ICAR-Indian Agricultural Research Institute, New Delhi- 110012.
- Dr. Y.K. Sharma attended Training Workshop for Vigilance Officers of ICAR Institutes at NAARM, Hyderabad on 31st October to 1st November 2018.
- Dr. R. Singh attend training programme on "MDP on Leadership Development Programme (a Pre-RMP Programme)" organized by NAARM, Hyderabad on 18-29 December, 2018.
- Dr. A.K. Verma attended two days training/workshop on "Soft Skills for Personality Development" from 28 Feb. to 1 March, 2019 at Krishi Vigyan Kendra, Ajmer-305206, Rajasthan.

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

G. Lal

- | | |
|---|--|
| ❖ Meeting and Monitoring of PDDUUKSY at Sikar and Kotputli (Rajasthan) & State level workshop to decide contingency plan against drought for states four vulnerable districts (Ajmer, Nagaur, Churu and Jaisalmer), organized by ministry of agriculture and farmer welfare, Govt. of India with the collaboration of CRIDA, Hyderabad at Pant Krishi Bhawan, Jaipur. | May 02, 2018 |
| ❖ 36 th Group Meeting of AICRP on Vegetable crops organized by IIVR, Varanasi and SKNAU, Jobner at RARI, Durgapura, Jaipur. | May 10, 2018 |
| ❖ National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development at Samastipur, Bihar and also conduct an exploration for seed spices germplasm in adjoining areas of Bihar state (Samastipur, Bihar). | May 18-21, 2018
May 27 - June 02, 2018. |
| ❖ Annual Zonal Workshop including 62 KVKs organized by ATARI, Jodhpur at SKRAU, Bikaner. | June 10, 2018. |
| ❖ Meeting on the use of Nano Technology in Agriculture at Krishi Bhawan, Jaipur. | June 25, 2018 |
| ❖ 12 th Annual Review Meeting for MIDH activities carried out by DASD, Calicut at I.G. Agriculture University (IGKV), Raipur, Chhattisgarh. | June 26 -27, 2018 |
| ❖ Foundation Day Function of NRC on Camel at Bikaner | July 05, 2018 |
| ❖ Directors' & Vice-Chancellors' Conference at New Delhi. | July 15-18, 2018 |
| ❖ ICAR Foundation Day at AP Sindhe Auditorium, NASC, complex N. Delhi. | July 16, 2018 |
| ❖ International Horticultural Congress-2018 (IHC-2018), organized by ISHS at Istanbul, Turkey. | August 12-18, 2018 |
| ❖ Assessment (DPC) Meeting at ASRB, New Delhi | August 23-24, 2018 |
| ❖ Regional Conference on Motivating & Attracting Youth in Agriculture at NASC, N. Delhi organizes by Trust for Advancement of Agricultural Sciences (TAAS). | August 29-30, 2018 |
| ❖ National Animal Science Fair (as Guest of Honour) at CSWRI, Avikanagar (Tonk). | September 29, 2018 |

❖ Foundation Day Function of CAZRI at Jodhpur.	October 01, 2018
❖ AICRP Spices, Workshop, held at YSPUHF, Solan (Shimla), H.P.	October 4-6, 2018
❖ QRT Meeting of ICAR-IIFSR, Modipuram (Including AICRP on IFS and NPOF) at RARI, Durgapura, Jaipur	October 10-11, 2018
❖ National Workshop on Vertical Farming: Status, Researchable Issues and Way Forward at New Delhi organized by Indian Council of Agricultural Research, Krishi Anusandhan Bhawan-II, Pusa, New Delhi - 110012 Amity University (UP), Sector 125, Noida - 201313.	October 18, 2018.
❖ National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment organized by Indian Society for arid horticulture at CIAH, Bikaner.	October 27-29, 2018
❖ Central Varietal Release and Notification Committee meeting under the Chairmanship of Hon'ble Dr. A.K. Singh, DDG (HS) held at Krishi Bhawan New Delhi.	November 5, 2018
❖ NPOF workshop at TNAU, Coimbatore.	November 26-29, 2018
❖ Second Shadow committee meeting for the 4th session of Codex Committee on Spices and Culinary Herbs (CCSCH4), at the Administrative Building, MEPZ Special Economic Zone, GST Road, Tambaram, Chennai, Tamil Nadu, India.	December 3, 2018
❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer	December 20-22, 2018
❖ National Conference on "Ornamental Horticulture to Uplift Rural" at MPUAT, Udaipur.	January 11-13, 2019
❖ 8 th Indian Horticulture Congress-Shaping Future of Indian Horticulture at IGKV, Raipur, Chattishgarh, organized by Horticulture Society of India, New Delhi.	January 17-21, 2019
❖ Codex committee meeting on spices and culinary herbs "4th session of Codex Committee on Spices and Culinary Herbs (CCSCH4)", held at Trivananthapuram.	January 21-25, 2019
❖ Ber Day celebration at CIAH, Bikaner, Rajasthan	January 27, 2019
❖ International Spice Conference 2019, at Novotel, Hyderabad Convention Centre, Hyderabad, India.	January 28- 31, 2019
❖ Directors' Conference on "Challenges of Change Redefining the Value Chain".	Jan. 31 - Feb., 1 2019.
❖ XXV Meeting of ICAR Regional Committee No. VI comprising the state of Rajasthan, Gujarat, UT of Dadara & Nagar Haveli & Daman & Div at Anand Agricultural University, Anand, Gujarat (India).	February 4-5, 2019
❖ 13 th International Conference on Development of Drylands "Converting Dryland Areas from Grey into Green" at CAZRI, Jodhpur, India.	February 11- 14, 2019
❖ Visit & Monitoring of Seed Spices, AICRP Centre at Jagudan (SDAU) Gujrat	February 26-27, 2019
❖ Visit & Monitoring of Seed Spices, AICRP Centre at Jobner, Sikar and Hisar	March 01-03, 2019.

	❖ Visit & Monitoring of Seed Spices, AICRP Centre at Raipur, Dholi, Kumarganj	March 8-14, 2019
	❖ National Seminar cum Interactive Workshop on "Noni and Medicinal Plants in Human Wellness at Noni, Chennai.	March 23-24, 2019
	❖ State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held at ICAR-NRC on Seed Spices, Ajmer.	March 27-28, 2019
S.N. Saxena		
	❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer	December 20-22, 2018
	❖ State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held at ICAR-NRC on Seed Spices, Ajmer.	March 27-28, 2019
Y.K. Sharma		
	❖ 29th Workshop of ICAR-AICRP on Spices at YSPUHF, Nauni, Solan	October 03-06, 2018
	International Conference on Microbiome Research-2018 Organized by NCMR, NCCS, Pune, India.	November 19-22, 2018
	❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer.	December 20-22, 2018
	❖ Conference organized by NHB in collaboration with ICAR Institutions, SAU/SHU/CAU and Horticulture Training Institutes at NAS Complex, Pusa, New Delhi.	February 5-6, 2019
	❖ State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held at ICAR-NRC on Seed Spices, Ajmer.	March 27-28, 2019
K.Kant		
	❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer	December 20-22, 2018
	❖ 8 th Indian Horticulture Congress-2019 at Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chattisgarh	January 17-21, 2019
	❖ State Level Seminar on Production of seed Spices for enhancing farmers income at ICAR-NRCSS	March 27-28, 2019
O.P. Aishwath		
	❖ National Conference on 'Sustainable management of soil and water resources for doubling farmers' income' at Assam Agricultural University, Jorhat, Assam.	October 25-27, 2018
	❖ Annual Convention of 'Indian Society of Soil Science' at Anand Agricultural University, Anand.	November 27-30, 2018
	❖ 1 st International Conference on "Climate change and Adaptive crop protection for Sustainable Agri-horticulture Land Landscape" at ICAR-NRCSS, Ajmer, Rajasthan.	December 20-22, 2018
	❖ National Conference on "Farmers friendly soil and water conservation technologies for mitigating climate change impact" at ICAR-IISWC, Regional Centre, Udhagamandalam, Tamil Nadu.	Jan., 31 to Feb. 2, 2019
	❖ State level seminar on "Clean and safe production of seed spices for enhancing farmers' income" at ICAR-NRCSS, Ajmer, Rajasthan.	March 27-28, 2019

R. Singh

- ❖ XXIX AICRP on Spices, Annual Workshop held at Dr Y S Parmar University of Horticultural and Forestry, Nauni, Solan, Himachal Pradesh. October 4-6, 2018
- ❖ XXI Biennial National Symposium of Indian Society of Agronomy on "Doubling Farmers' Income Through Agronomic Interventions Under Changing Scenario" held at RCA, MPUAT, Udaipur. October 23-26, 2018
- ❖ State level Seminar on "Clean and safe production of Seed Spices for enhancing Farmers income", at ICAR-NRCSS, Ajmer. March 27-28, 2019

S.S. Meena

- ❖ "National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development" at DRPCA, Pusa (Samastipur), Bihar, India. May 28-31, 2018,
- ❖ 90th ICAR Foundatin Day and ICAR Award Ceremony at ICAR-NAAS Complex, New Delhi. July 16, 2018
- ❖ AICRP Workshop on Spices at Dr.Y.S.P. Univ., Solan. October 2-6, 2018
- ❖ National Workshop on Vertical Farming at ICAR-NAAS Complex, New Delhi October 18, 2018
- ❖ "National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment" at ICAR-CIAH, Bikaner (Raj.) October 27-29, 2018
- ❖ 9th National Extension Education Congress on "Climate Smart Agriculture Technologies: Innovations and Interventions" at CAEPHT, Ranipool, Sikkim (CAU, Imphal. November 15-17, 2018
- ❖ 1st International Conference on "Climate Change and Adaptave Crops Protection for Sustainable Agri-horticulture Land Scape" at ICAR-NRCSS, Ajmer (Raj.), India. December 20-22, 2018
- ❖ Spices buyer sellers meet organized by Spices Board India at Agriculture College, Nagaur. January 24, 2019
- ❖ "8th Indian Horticultur Congress-2019 at IGKV, Raipur, Chhathishgarh. February 17-21, 2019
- ❖ "16th Agricultural Science Congress" at NASC Complex, New Delhi. February 20-23, 2019

B.K. Mishra

- ❖ International Conference on "climate change and adaptive crop protection for sustainable agri-horticulture land scape" at ICAR-NRCSS, Tabiji, Ajmer, Rajasthan. December 20-22, 2018
- ❖ National conference on "strategies & challenges in doubling farmers' income through horticultural technologies in subtropics" at ICAR-CISH, Rehmankhara, Lucknow (U.P). June 21-22, 2018
- ❖ 37th Academic Council Meeting of Bhagwant University on at Conference Hall, Bhagwant University, Ajmer. February 16, 2019
- ❖ National conference on "sustainable agriculture and recent trends in science & technology" at Bhagwant University, Ajmer (Raj.). February 22-23, 2019
- ❖ State level seminar on "clean and safe production of seed spices for enhancing farmers' income" at ICAR-NRCSS, Ajmer (Raj.). March 27-28, 2019

P.N. Dubey

- ❖ National conference on "strategies & challenges in doubling farmers' income through horticultural technologies in subtropics" at ICAR-CISH, June 21-22, 2018

	Rehmankhhera, Lucknow (U.P.).	
	❖ 9 th National Extension Education Congress on "Climate Smart Agriculture Technologies: Innovations and Interventions" at CAEPHT, Ranipool, Sikkim (CAU, Imphal).	November 15-17, 2018
R.S. Meena		
	❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer	December 20-22, 2018
	❖ State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held at ICAR-NRC on Seed Spices, Ajmer.	March 27-28, 2019
N.K. Meena		
	❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer	December 20-22, 2018
	❖ State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held at ICAR-NRC on Seed Spices, Ajmer.	March 27-28, 2019
S. Choudhary		
	❖ International conference on "climate change and adaptive crop protection for sustainable agri-horticulture land landscape" at ICAR-NRCSS, Tabiji, Ajmer, Rajasthan.	December 20-22, 2018
	❖ State level seminar on "clean and safe production of seed spices for enhancing farmers' income" at ICAR-NRCSS, Ajmer (Raj.).	March 27-28, 2019
M.D. Meena		
	❖ National conference on "enhancing productivity of oil seeds in changing climate scenario", organised by Indian Society of Oilseed Research Hyderabad at ICAR-DGR Junagadh.	April 7-9 2018
	❖ 9 th National extension education congress on "climate smart agriculture technologies: Innovations and Interventions" at CAEPHT, Ranipool, Sikkim.	November 15-17, 2018
	❖ 1 st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape held at ICAR-NRC on Seed Spices, Ajmer	December 20-22, 2018
	❖ State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held at ICAR-NRC on Seed Spices, Ajmer.	March 27-28, 2019
R.D. Meena		
	❖ 8th Horticulture Congress, "Impact of soil solarization on weed infestation and productivity of cumin" at IGKV, Raipur	January 17-21, 2019
A.K. Verma		
	❖ National Conference on "Intensification and Diversification in Agriculture for Livelihood and Rural Development" at DRPCA, Pusa (Samastipur), Bihar.	May 28-31, 2018
	❖ International Conference on "Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and	Oct. 30 - Nov. 01, 2018

	Allied Enterprises (RLSIAAe)" at Birla Institute of Technology, Patna.	
	❖ 1 st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture land scape" at ICAR-NRC Seed Spices, Ajmer, Rajasthan.	December 20-22, 2018
	❖ State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" at ICAR-NRCSS Ajmer, Rajasthan	March 27-28, 2019
Ravi Y.		
	❖ 1 st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture land scape" at ICAR-NRC Seed Spices, Ajmer, Rajasthan.	December 20-22, 2018
	❖ State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" at ICAR-NRCSS Ajmer, Rajasthan	March 27-28, 2019
Dr. Shiv Lal		
	❖ 8 th Indian Horticulture Congress-Shaping Future of Indian Horticulture at IGKV, Raipur, Chattishgarh, organized by Horticulture Society of India, New Delhi.	January 17-21, 2019
	❖ National Workshop on Vertical Farming: Status, Researchable Issues and Way Forward at New Delhi organized by Indian Council of Agricultural Research, Krishi Anusandhan Bhawan-II, Pusa, New Delhi - 110012 Amity University Uttar Pradesh, Sector 125, Noida - 201313	February 20-23, 2019,
	❖ XIV Agricultural Science Congress, NASC, Pusa, New Delhi, India जलवायु परिवर्तन के परिप्रेक्ष्य में बीजीय मसालों की उन्नत खेती जिला स्तरीय संगोष्ठी, आयोजनकर्ता- भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर, आयोजन- जैसलमेर	दिसंबर, 26-27, 2018
Dr. N. Choudhary		
	❖ 1 st International Conference on "Climate Change and Adaptave Crops Protection for Sustainable Agri-horticulture Land Scape" at ICAR-NRCSS, Ajmer (Raj.), India	December 20-22, 2018
	❖ Training/workshop on "Soft Skills for Personality Development" at KVK, Ajmer.	Feb. 28 - March 1, 2019
All NRCSS staff		
	❖ 1 st International Conference on "Climate Change and Adaptave Crops Protection for Sustainable Agri-horticulture Land Scape" at ICAR-NRCSS, Ajmer (Raj.), India	December 20-22, 2018
All NRCSS staff		
	❖ State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" at ICAR-NRCSS Ajmer, Rajasthan	March 27-28, 2019

6. Awards and Recognitions

6.1 Awards

Dr. G. Lal

- ▲ Late Dr. S.K. Kushwaha Memorial Award-2018. In: 1st International Conference on Climate change and adaptive crops protection for sustainable Agri-horticulture landscape. Jointly organized by ISSS, Ajmer and SPPS, New Delhi during 20 - 22 December 2018 at ICAR-NRCSS, Ajmer.
- ▲ Dr. R.S. Paroda Award-2018 conferred by CHAI, New Delhi. In: 10th Swadesh Prem Jagruti Sangosthi-National Conference on "Intensification and Diversification in Agriculture for Livelihood and Rural Development" organized at CAU, PUSA, Samastipur, Bihar, during 28-31 May, 2018.
- ▲ Fellowship: Horticulture Society of India (HSI), New Delhi, 2018.
- ▲ JISL-CHAI Fellowship, New Delhi, 2018 Int. Horticultural Congress, held at Istanbul during August 12-18, 2018 by Confederation of Horticultural Associations of India (CHAI).

Dr. O.P. Aishwath

- ▲ मौलिक शोधपत्र हेतु कृषि विज्ञान गौरव की मानद उपाधि से अलंकृत, जून, 2018, द्वारा भारतीय कृषि अनुसंधान समिति तथा कृषि अनुसंधान संचार केन्द्र, करनाल।
- ▲ Gold Medal for the dedicated effort and contribution in the field of Soil and water conservation, awarded by the Soil Conservation, Society of India on the occasion of 28th National Conference on "Farmers friendly soil and water conservation technologies for mitigating climate change impact" held during January, 31st to February 2nd 2019 at ICAR-IISWC, Regional Centre, Udthagamandalam, Tamil Nadu.

6.2 Recognitions

Dr. G. Lal

- ▲ President of Indian Society of Seed Spices, ICAR-NRCSS, Ajmer, Rajasthan, India.
- ▲ Chairperson, Technical Session on Crop Production Management in AICRP-Spices Workshop held at

YSPUHF, Solan (Shimla), H.P. during October 4-6 2018.

- ▲ Chairman in Technical Session IV (Sustainable production of spices, medicinal and aromatic plants on 21 December, 2018). In: 1st International Conference on Climate changes and adaptive crops protection for sustainable Agri horticulture landscape 20 - 22 December, 2018 at ICAR-NRCSS Ajmer, jointly organized by ISSS Ajmer and SPPS, New Delhi.
- ▲ Chief Guest in plenary session on 22 December, 2018. In: 1st International Conference on Climate change and adaptive crops protection for sustainable Agri horticulture landscape from 20 to 22 December 2018 at ICAR-NRCSS Ajmer. Jointly organized by ISSS, Ajmer and SPPS, New Delhi.
- ▲ Co-Chairman in Technical Session VI (Vegetable production). In: 36th Group Meeting of All India Coordinated Research Project on Vegetable crops organized by IIVR, Varansi and SKNAU, Jobner during 18-21 May, 2018 at RARI, Durgapura, Jaipur.
- ▲ Co-Chairman technical session-I (Paradigms in intensification and diversification of agriculture for Livelihood and Rural Development). In: National Conference on "Intensification and Diversification in Agriculture for Livelihood and Rural Development" at Samastipur, Bihar, during 28-31 May, 2018.
- ▲ Chief Guest in Farmers training programme under PDDUY and delivered a lecture on 'Cultivation of Horticultural Crops Organically' on 22 June, 2018 at Keeratpura (Kotputali) Jaipur.
- ▲ Guest of Honour. In: 12th Annual Review Meeting for MIDH/NHM activities carried out by DSSD, Calicut during 26th -27th June, 2018 at I.G. Agriculture University (IGKV), Raipur, Chhattisgarh.
- ▲ Panelist for Technical session II (Genetic Resources Management, improvement and biotechnological Intervention). In: National Conference on arid horticulture Enhancing Productivity and Economic Empowerment organized by Indian Society for arid

horticulture at CIAH, Bikaner during 27 to 29 October 2018.

- ▲ Co-chairman in technical session VI –B (Production Technology-Conventional Horticulture) on 19 January 2019. In: 8th Indian Horticulture Congress-2019 at Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhatisgarh, during 17-21 January, 2019.
- ▲ Best oral presentation award on "Exploring genetic diversity in seed spices through induced mutagenesis" authored by Verma, A.K., Choudhary, S., Dhanasekar, P., Meena, R.S., Meena R.D. and Lal, G. (2018). In: International Conference on "Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Enterprises (RLSIAAe)" during 30th October to 01st November, 2018 at Birla Institute of Technology, Patna. pp.91.
- ▲ Best oral presentation award for research paper entitled "Evaluation of relative efficacy of Imidacloprid 600 FS as seed treatment against sucking pests on cumin (*Cuminum cyminum* L.) under field conditions" authored by Meena, N.K., Lal, G., Meena, R.D. and Meena, R.S. 2019. In: 1st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture land scape", jointly organized by SPPS, ICAR-NCIPM, New Delhi & ISSS during 20-22 December, 2018 held at ICAR-NRCSS, Ajmer (Rajasthan).

Dr. S.N. Saxena

- ▲ Co-Chaired technical session on post harvest management and technology transfer in Seminar on "Clean and safe production of seed spices for enhancing farmers' income during 27-28, March, 2019 at ICAR-National Research Centre on Seed Spices, Tabiji – 305 206, Ajmer (Rajasthan).

Dr. Y.K. Sharma

- ▲ SPPS-Best Oral Presentation Award in the 1st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape, 20-22, December, 2018.
- ▲ Honoured as Editor, International Journal of seed spices.

- ▲ Honoured as Chairperson in Crop Protection Session during 29th Workshop of ICAR-AICRP on Spices held at YSPUHF, Nauni, Solan.
- ▲ Recognized as Reviewer for International Journal of Seed Spices.
- ▲ Recognized as Reviewer for Journal of spices and aromatic crops.
- ▲ Appointed as an examiner for evaluation of the thesis for M.Sc. Ag. (Plant Pathology) by MPUAT, Udaipur.
- ▲ Appointed as paper setter and examiner for evaluation of answer books for B. Sc. Ag. (Hons.) by Agricultural University, Jodhpur for the course Seed Pathology.
- ▲ Nominated as Member of Monitoring Team in Farmers Participatory Seed Production Programme.

Dr. K.Kant

- ▲ SPSS- Best Oral Presentation Award on the paper entitled "Sucking Pests Management in Major Seed Spice Crops" presented during 1st International Conference on "Climate Change and Adaptive Crop Protection for Sustainable Agri-Horticulture Land Landscape", at ICAR-NRCSS, Ajmer (Rajasthan) during December 20-22, 2018.

Dr. O.P. Aishwath

- ▲ Best Oral Presentation Award for the paper entitled "Performance of Nigella (*Nigella sativa*) with sodic irrigation water in Typic Haplustepts presented in 28th National Conference on "Farmers friendly soil and water conservation technologies for mitigating climate change impact" held during 31 January - 2 February, 2019 at ICAR-IISWC, Regional Centre, Udhagamandalam, Tamil Nadu.



Receiving gold medal and plaque during national conference.

- ▲ Elected as a vice president of 'Soil conservation Society of India', during February, 2019.
 - ▲ Editor-in-Chief of *Global Journal of Biology Agriculture & Health Sciences*: Re-appointed by Global Institute for Research and Education during 2018.
 - ▲ Member of Jury and arbitrator for adjudicating 'the best oral presentations' in various sessions for award of best oral presentations and lead speaker during 27th National Conference on "Sustainable Management of soil and water resources for doubling farmer's income" held during 25-27 October 2018 at AAU, Jorhat, Assam, India
 - ▲ 'Rapporteur' in the session - I (Soil fertility-I) of 83rd Annual convention of Indian Society of Soil Science' and National Seminar on 'Development in Soil Science' held at Anand, Gujarat during 27-30 Nov., 2018.
 - ▲ Rapporteur in Session-II, Crop production: In State level seminar on Clean and Safe Production of Seed Spices for enhancing farmers income" held on 27-28 March, 2019 at ICAR-NRCSS, Ajmer.
 - ▲ Examiner for Oral Comprehensive Examination for PhD: Appointed by Dean Faculty of Agriculture, Banaras Hindu University, Varanasi and conducted the exam on 02.04.2018 at Division of Soil Science and Agricultural Chemistry, BHU, Varanasi.
 - ▲ External examiner for Viva voce: Nominated by Vice chancellor of MDSU, Ajmer for Viva voce of Long-term Projects of MSc (Microbiology) Students and conducted viva voce on 7 July, 2018.
 - ▲ Lead speaker in national conference: Invited as lead speaker and delivered lecture on "Spices, medicinal and aromatic plants for sustenance of soil health and water quality in semi-arid regions" during national conference on "Managing Natural Resources for Sustainable Agriculture" held during December 8 - 9, 2018, Agra, UP.
 - ▲ Resource person in orientation course: Invited as a resource person and delivered lecture on 'Carbon management in soils of arid and semi-arid regions with special reference to Indian subcontinent' in orientation course on 11 June - 1 July, 2018 at Agricultural University, Jodhpur.
 - ▲ Invited as a resource person in winter school on "Role of precision farming in urban and peri-urban horticulture in the era of urbanization" organized by SKN College of Agriculture, SKN Agricultural University (SKNAU), Jobner (Jaipur) from 4 - 24 January, 2019.
- Dr. R. Singh**
- ▲ Krishi Vigyan Gaurav 2018, awarded by Bhartiya Krishi Anusandhan Samiti and ARCC, Karnal for publishing the research paper in Hindi रबीन्द्र सिंह, राधेश्याम मेहता, ओम प्रकाश ऐश्वर्य, शारदा चौधरी एवं गोपाल लाल-2018, खरपतवार प्रतिस्पर्धा के लिए क्रांतिक अवस्था को पहचान एवं इनका अजवाइन की वृद्धि एवं उपज पर प्रभाव, भारतीय कृषि अनुसंधान पत्रिका, 33(2): 80-87.
 - ▲ Member Secretary, 3rd QRT (1 June, 2011 to 31 May, 2016), submitted the action taken report for 2nd QRT (1 April, 2005 to 31 May, 2011) and agenda items to SMD/ICAR for discussion in GB at ICAR during 2018-19.
 - ▲ Secretary, Indian Society of Seed Spices, Tabiji Ajmer.
 - ▲ Editor for Seed Spices News letter of NRCSS, Ajmer.
 - ▲ Reviewer for Journal of Spices and Aromatic Crops published by ISS, Kozhikode, Kerala.
 - ▲ Reviewer for "Agricultural Science Digest" ARCCSS, Karnal.
 - ▲ Reviewer for Legume Research published by ARCC, Karnal.
 - ▲ Reviewer for Indian Journal of Agricultural Sciences, published by ICAR, New Delhi.
- Dr. S.S. Meena**
- ▲ Organising Secretary for MIDH two days District Seminar entitled "Improved Cultivation of Seed Spices under Climate Change Scenario", organised on 26-27 December, 2018 at Jaisalmer by ICAR-NRCSS, Ajmer and sponsored by DASD, Calicut.
 - ▲ As a Course Coordinator of Ten days Model Training Course programme for M. P. Govt. Officers on "Advanced Production Technology and Post Harvest Operations for spices in MP State" organized during 18th-27th February, 2019 at ICAR-NRCSS, Tabiji, Ajmer.
 - ▲ Training Co-Convener for one day Training

programme under TSP entitled "Beejeey Masalaon ki unnat utpadan avm suraksha tacnik", held on August, 21st, 2018 at KVK, Banswara (Rajasthan) organised by ICAR-NRCSS, Ajmer.

- ▲ Training Convener for one day Training programme under TSP on "Beejeey Masalaon ki unnat utpadan evam surakshit tacnik" held on August, 22nd, 2018 at KVK, Pratapgarh (Rajasthan) organised by ICAR-NRCSS, Ajmer.
- ▲ Training Convener for one day Training programme under MIDH on "Beejeey Masala phaslon ki unnat krishi kriyaen" held on December, 24th, 2018 at Agriculture department, Govt. of Rajasthan, Nagaur. (Rajasthan) organised by ICAR-NRCSS, Ajmer and sponsored by DASD, Calicut.

Dr. B.K. Mishra

- ▲ 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.)
- ▲ Guest of Honour in the valedictory function of national conference on "Sustainable Agriculture and Recent Trends in Science & Technology" held during 22-23 Feb, 2019 at Bhagwant University, Ajmer (Raj.)
- ▲ Chief Editor of Annual Report (English and Hindi separately) 2017-18 of ICAR-NRC on Seed Spices, Tabiji, Ajmer.
- ▲ Editor, 'Masala Surabhi' - Rajbhasha Hindi patrika published by ICAR-NRCSS, Ajmer.
- ▲ Member of Academic Council of Bhagwant University, Ajmer and participated in Academic council meeting during the period under report.

Dr. P.N. Dubey

- Training Coordinator for 5 days training program on 'Beejeey Masala Utpadan Ki Unnat Krishi Padhatiyen' organised during 13 to 17 November, 2018 at ICAR-NRCSS, Ajmer, sponsored by ATMA, Tonk, Rajasthan.
- Training Coordinator for one day training program under MIDH on 'Beejeey Masala Phaslon Ki Unnat Krishi Kriyaen' organised on 24th December, 2018 at Agriculture Dept., Govt. of Rajasthan, Nagaur,

organised by ICAR-NRCSS, Ajmer and sponsored by DASD, Calicut.

- ▲ Training Coordinator for 10 day model training program for M. P. Govt. officers on 'Advanced Production Technology and Post Harvest Operations for Seed Spices in M. P. State' organised during 18-27 February, 2019 at ICAR-NRCSS, Ajmer.
- ▲ Organizer for one day "Scientists-stake holders Interface for commercialization of Technologies" organised for the stake holders from different parts of India on December 17, 2018.
- ▲ Nodal Officer, ITMU: Varieties of seed spices were commercialized to two FPOs from Rajasthan.
- ▲ Editor : International Journal of Seed Spices, ISSS, Ajmer.

Dr. S. Choudhary

- ▲ Krishi Vigyan Gaurav award from Bhartiya Krishi Anusandhan Patrika.
- ▲ Excellence award as a reviewer of Indian Journal of Agricultural Research from ARCC journals.
- ▲ Excellence award as a reviewer of Legume Research from ARCC journals.
- ▲ Best oral presentation award on "Exploring genetic diversity in seed spices through induced mutagenesis" authored by Verma, A.K., Sharda Choudhary, Dhanasekar, P., Meena, R.S., Meena R.D. and Lal, G. (2018). In: International Conference on "Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Enterprises (RLSIAAe)" during 30th October to 01st November, 2018 at Birla Institute of Technology, Patna.

Dr. R.D. Meena

- ▲ Rapporteur (Session 3rd Crop Health Management) in the State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income", held at ICAR-NRC on Seed Spices, Ajmer during 27-28 March, 2019.
- ▲ Best presentation award was conferred to R.D. Meena, R.S. Meena, Y.K. Sharma, S.S Meena and N.L. Meena for the paper entitled "Characterization of cumin (*Cuminum cyminum* L.) cultivars against various diseases under natural conditions. In International Conference on Climate Change and

Adaptive Crop Production for sustainable Agri-Horticulture Land scape" during 20-22 December, 2018 at ICAR, NRC on seed spices, Ajmer.

- ▲ Appointed as an external examiner of B.Sc. (Ag.) 1st year (plant Pathology) during June 11-12, 2018 at DAV College of Agriculture, Ajmer (Rajasthan).
- ▲ Appointed as an invigilator during All India Undergraduate Examination (AIEEA) conducted by ICAR on 19 August, 2018.

Dr. A.K. Verma

- ▲ Awarded Fellow of Confederation of Horticulture Associations of India (CHAI), New Delhi, 2018.
- ▲ Second Best oral presentation award on "Exploring genetic diversity in seed spices through induced mutagenesis" authored by Verma, A.K., Choudhary, S., Dhanasekar, P., Meena, R.S., Meena R.D. and Lal, G. (2018). In: International Conference on "Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Enterprises (RLSIAAe)" during 30th October to 01st November, 2018 at Birla Institute of Technology, Patna. Pp. 91.
- ▲ Co-convenor of Bijiye Masala Kisan Mela - 2019 organised at ICAR-NRCSS, Ajmer from 8-9 Feb., 2019.

Dr. Shiv Lal

- ▲ Best poster award for paper authored S. Lal, D.B. Singh, O.C. Sharma, J.I. Mir, W.H. Raja and Anil Sharma entitled "Characterization of strawberry (*Fragaria x ananassa* Duch.) genotypes for flowering, fruiting and fruit physico-chemical attributes under temperate condition". In: Kalia P., Sharma, R.M., Singh, K.P., Behera T.K. and Sharma, R.R. (Ed.). Abstract (poster papers). 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019.

- ▲ Rapporteur in the technical session IV: Post-harvest management and transfer of technology during State Level Seminar on "Clean and Safe Production of seed spices for enhancing farmers, Income" held on 27-28th March, 2019 at ICAR-NRCSS, Ajmer, Rajasthan (India).
- ▲ Co-convenor of Beejiya Masala Kisan Mela Evam Sangosthi organized during 8th -9th Feb., 2019 at ICAR-NRCSS, Ajmer (Rajasthan).
- ▲ Co-organizing secretary for two days state level seminar on clean and safe production of seed spices for higher farmer's income organized during 27-28th March, 2019 at ICAR-NRCSS, Ajmer.
- ▲ Organizing Secretary for two days District seminar on "advanced production technologies of seed spices under climate change scenario" under MIDH at held at during 26th-27th December 2018 organized at Agriculture Department, Govt. of Rajasthan, Jaisalmer organized by ICAR-NRCSS, Ajmer.
- ▲ Nodal officer for organizing Birth Anniversary of Sardar Vallabhbhai Patel as Rashtriya Ekta Diwas (National unity day) on 31 October 2018 at ICAR-NRCSS, Ajmer

Dr. N. Chaudhary

- ▲ Seminar secretary for two days District seminar on "Jalvau parivartan ke paripekshya me beejiye masalon ki unnat kheti" under MIDH held at Agric. Dept., Govt. of Rajasthan, Jaisalmer (Raj.) on 26-27 December, 2018.
- ▲ Co-organizing Secretary in State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers' Income held on 27-28 March, 2019 at ICAR-NRCSS, Ajmer under MIDH.



7. Linkages and Collaborations

Linkages and collaborations are the vital tools to enrich and share the knowledge acquired by an individual as well as at Institute level. This also helps to increase output through sharing of 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, other govt. and non-government agencies working on the different aspects of seed spices research and development in the country. ICAR-NRCSS has always encouraged collaborative research works with parallel Institutes or universities. During the period under report, Institute has established collaboration and linkages with various Institutions 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 and its regional centres.

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, Srinagar; APHU, Hyderabad; UAS, Dharwar and NDUAT, Faizabad.

State Agriculture Department of Rajasthan and Gujarat.

8. Publications

International Journals

1. Lal, G. (2018). Scenario, importance and prospects of seed spices: A review. *Current Investigations in Agriculture and Current research* 4(2): 491-498. (Thomas Reuters/ International impact factor 0.654).
2. Lal, G. and Meena, S.S. (2018) Medicinal and Therapeutic Potential of Seed Spices. *Biomedical Journal of Scientific & Technical Research* 5(4):1-21.
3. Saxena, S.N., Barnwal, P., Balasubramanian, S., Yadav, D.N., Lal, G. and Singh, K.K. (2018). Cryogenic grinding for better aroma retention and improved quality of Indian spices and herbs: A review. *J. Food Process Eng.* E12826. <https://doi.org/10.1111/jfpe.12826>

National Journals

1. Aishwath, O.P., Meena, R.D., Jain, D., P.N. Dubey, Harisha, C.B., Mishra, B.K. and Ganeshamurthy, A.N. (2018) Role of micronutrients on morpho-physiological and nutritional parameters including diseases suppression of fenugreek. *International J. Seed Spices* 8(2):41-47.
2. Aishwath, O.P., Mehta, R.S. and Lal, G. (2018) Effects of on-farm composted seed spices residues on coriander, nutritional parameters and seasonal carbon offset by the crop and soil. *International J. Seed Spices* 9(1):91-99.
3. Barnwal, P., Singh, K.K., Sharma, A., Yadav, D.N. and Saxena, S.N. (2018). Performance evaluation of cryogenic spice grinding system for fenugreek powder production. *Inter. J. Seed Spices* 8(2), 6-11.
4. Barnwal, P., Singh, K.K., Sharma, A., Yadav, D.N. and Saxena, S.N., (2017). Grinding performance of cryogenic spice grinding system for coriander. *Inter. J. Seed Spices* 8(1): 1-6.
5. Barnwal, P., Singh, K.K., Sharma, A., Yadav, D.N., Zachariah, T.J. and Saxena, S.N. (2019). An experimental study on cryogenic spice grinding system for black pepper grinding. *Inter. J. Seed Spices* 9(1):27-33.

6. Choudhary, S., Naika, M.B.N., Sharma, R., Meena, R.D., Singh, R. and Lal, G. (2019). Transcriptome profiling of coriander: a dual purpose crop unravels stem gall resistance genes. *Journal of Genetics* 98:19.
7. Dhakar, L., Meena, R.S., Jat, S. and Yadav, T.C. (2018). Genetic Divergence Analysis in Fennel Genotypes. *Int.J.Curr.microbial.App.Sci* 7(7):403-408.
8. Dubey, P.N., Saxena, S.N., Lal, G., K. Kant, Mishra, B. K., Agarwal, D., John, S. and Sharma, L.K. (2018). Essential oil constituents and unsaturated fatty acids in Indian *Cuminum cyminum* L. seed oil under varying agro climatic environments. *International Journal of Seed Spices* 8(1):7-14.
9. Godara, A., 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 Haplusteps. *Legume Research* 41(4):598-601.
10. Godara, A.S., Singh, R. and Chouhan, G.S. (2018). Soil Fertility, Growth and Productivity of Fenugreek (*Trigonella foenum-graecum* L.) as Influence by Fertilizer Levels, Biofertilizers and Brassinosteroid *International Journal of Current Microbiology and Applied Sciences* 7(9):462-468.
11. Jethra, G., Choudhary, S. and Sharma, V. (2018). Development and characterization of novel set of polymorphic SSR markers for Dill (*Anethum graveolens* L.). *Annals of Plant Sciences* 7(6): 2347-2351.
12. Jethra, G., Choudhary, S. and Sharma, V. (2018). Identification and characterization of microsatellite markers in Fenugreek: An inter-family amplification. *Legume Research*. DOI:10.18805/LR-4024.
13. Kant, K., Lal, G., Meena, S.R., Sharma, Y.K., Mishra, B.K., Saxena, S.N., Dubey, P.N. and Cherian, H. (2018). Popularization of bio-control agents, botanicals and PSB for seed spices and other horticultural crops in Rajasthan. *International Journal of Seed Spices* 8(1):84-89.

14. Kant, K., Meena, S.R., Sharma, Y.K., Meena, N.K., Vishal, M.K., Saxena, S.N. and Mishra, B.K. (2019). Development of aphids *Hyadaphis coriandri* (Das), its natural enemies and pollinators on coriander (*Coriandrum sativum* L.). *Int. J. Seed Spices* 8(1):84.
15. Kant, V., Meena, S.S., Meena, N.K. and Lal, G. (2018). Influence of Different Dates of Sowing, Fertilizers Level and Weedicides on Growth and Yield of Nigella (*Nigella Sativa* L.) under Semi-Arid Conditions. *International Journal of Current Microbiology and Applied Science* 7(9): 1156-1167.
16. Kanwar, K., Harisha, C.B., Singh, R. and Aadityendra (2018) Growth, Seed Yield, Protein Content and Water Use Efficiency of Fenugreek (*Trigonella foenum – graecum* L.) as Influenced by Drip Irrigation Regimes and Fertigation Levels. *International Journal of Current Microbiology and Applied Science* 7(8): 997-1003
17. Kumar, V., Mehta, R.S., Meena, S.S., Parsoya, M., Rajveer and Chokh, N. S. (2018). Study on Coriander (*Coriandarum sativam* L.) Based Intercropping System for Enhancing System Productivity. *International Journal of Current Microbiology and Applied Science* 7(6): 3509-3514.
18. Lal, G., Meena, N.K., Chaudhary, N. and Choudhary M.K. (2019). Performance of fennel varieties under organic production system *Int. J. Seed Spice* 9(1): 21-26.
19. Lal, G., Meena, R.S. and Choudhary, M.K. (2018). Evaluation of coriander varieties for green leaf yield in off season under shade net condition, *Int. J. Seed Spice*, 8(2):12-16.
20. Lal, G., Meena, S.S., Meena, N.K. and Meena, R.D. (2018). Stem gall occurrences on coriander, symptomatology and management strategies. *Indian Journal of Arecanut, Spices & Medicinal Plants* 20(2):10-15.
21. Meena, M.D., Lal, G., Meena, S.S. and Meena, N.K. (2018). Production and export performances of major seed spices in India during pre and post –WTO period. *International Journal of Seed Spice* 8(1):21-30.
22. Meena, N.K., Lal, G., Kant, K., Meena, R.S. and Meena, S.R. (2018). Pest scenario of cumin (*Cuminum cyminum* L.) and population dynamics in semi-arid region of Rajasthan . *Int. J. Seed Spices* 8(1):80-83.
23. Meena, N.K., Lal, G., Meena, R.S., Meena, B.M. and Meena, R.D. (2018). Pollinator's diversity and abundance on cumin (*Cuminum cyminum* L.) and their impact on yield enhancement at semi-arid regions. *Journal of Entomology and Zoology Studies* 6(4): 1017-1021.
24. Meena, N.K., Meena, S.S., Gupta, S. and Lal, G. (2018). Influence of Different Dates of Sowing, Fertilizers Level and Weedicides on Growth and Yield of Fenugreek(*Trigonella foenum-graecum* L.) under Semi-Arid Conditions. *International Journal of Current Microbiology and Applied Science* 7(8): 1844-1854.
25. Meena, R.D., Lal, G., Mehta, P., sharma, Y.K., Meena, S.S, Meena, R.S., Meena, N.K., Mishra, B.K., Meena, R.L., Meena, N.L. and Tripathi, G.K. (2018) Efficacy of soil solarization on growth and yield of cumin (*Cuminum cyminum*) under arid conditions. *International Journal of Seed Spice* 8(1):74-79.
26. Meena, R.D., Lal, G., Mehta, P., sharma, Y.K., Meena, S.S and Meena, N.L. (2018) Impact of soil solarization on weed infestation and productivity of cumin (*Cuminum cyminum*L.). *International Journal of Seed Spice* 8(2):54-57.
27. Meena, R.S., Choudhary, S., Verma, A.K., Meena, N.K. and Mali, S.C. (2018) Estimates of genetic variability, divergence, correlation and path coefficient for morphological traits in fenugreek (*Trigonella foenum-graecum* L.) genotypes. *Legume research* 1-6.
28. Meena, R.S., Lal, G. and Meena, N.K. (2018) Effect of promising Indian varieties of fenugreek (*Trigonella foenum-graecum* L.) on yield attributed, yield and its economics. *Bhartiya Krishi Anushandhan Patrika*, 33(3):206-208.
29. Meena, R.S., Lal, G. and Meena, N.K. (2018) Estimates of genetic diversity for morphological and yield contributing traits in coriander genotypes. *Indian J. Hort.* 75(3): 446-450.
30. Meena, S.S., Lal, G. and Meena, R.D. (2018) Multidimensional therapeutic uses of ajwain (*Trachyspermum ammi* L.). *International Journal of Seed Spice* 8(2):1-5.

31. Mishra, B.K., Lal, G., Sharma, Y.K., Kant, K., Aishwath, O.P. and Dubey, P.N. (2018). Assessment of benign bacterial isolates for plant growth promotion of coriander (*Coriandrum sativum*) crop. *International J. Seed Spices* 8(1):65-69.
32. Mishra, B.K., Lal, G., Sharma, Y.K., Kant, K., Saxena, S.N. and Dubey, P.N. (2019). Effect of microbial inoculants on cumin (*Cuminum cyminum* Linn.) growth and yield. *International J. Seed Spices* 9(1):53-56.
33. Panwar, A., Sharma, Y.K., Meena, R.S., Solanki, R.K., Aishwath, O.P., Singh, R. and Choudhary, S. (2018). Genetic variability, association studies and genetic divergence in Indian fenugreek (*Trigonella foenum-graecum* L.) varieties. *Legume Research* 41(6):816-821.
34. Parsoya, M., Mehta, R.S., Meena, S.S., Kumar, Vinod and Rajveer (2018). Study on AJWAIN (*Trachyspermum ammisprage*) Based Intercropping System for Enhancing System Productivity. *International Journal of Current Microbiology and Applied Science* 7(6): 3490-3496.
35. Ravi, Y, Meena, N.K and Lal, G. (2019). Spices: A novel source for insect-pest management. *Journal of Entomology and Zoology Studies* 7(2): 684-689.
36. Saxena S.N. and Agarwal D. (2019). Pharmacognosy and phytochemistry of coriander (*Coriandrum sativum* L.) *Inter. J. Seed Spices* 9(1): 1-13.
37. Saxena, S.N., Agarwal, D., John, S., Dubey, P.N. and Lal, G. (2018). Analysis of fennel (*Foeniculum vulgare*) essential oil extracted from green leaves, seeds and dry straw. *International Journal of Seed Spices*, 8(1):60-64.
38. Saxena, S.N., Kakani, R.K., Sharma, L.K., Agarwal, D., John, S. and Sharma Y. (2019). Effect of water stress on morpho-physiological parameters of fenugreek (*Trigonella foenum-graecum* L.) genotypes. *Legume Research* 42(1):60-65
39. Sharma, N. and Aishwath, O.P. (2018) Growth kinetics of fennel with nitrogen application in TypicHaplusteps. *Annals of Plant and Soil Research* 20:1-9.
40. Sharma, S.S., Rao, S.S., Singh, R.S., Sharma, R.P. and Dubey, P. N. (2018). Evaluation of potential cumin growing area in hot arid region of Jaisalmer district. *International Journal of Seed Spices* 8 (1):50-55.
41. Sharma, Y., Saxena, S.N. and Shrivatsava, P. (2019). Analysis of total phenolics and antioxidant activity in seed extracts of coriander (*Coriandrum sativum* L.) genotypes. *Inter. J. Seed Spices* 9(1): 55-61.
42. Sharma, Y.K., Solanki, R.K. and Meena, R.D. (2019). Effect of foliage trimming and planting time on downy mildew, leaf blight, powdery mildew and canopy micro climate in fenugreek. *International Journal of Seed Spices* 9(1):99-102.
43. Singh, D.K., Gautam, K.M., Khan, M.A., Khandelwal, S. Singh, D., Choudhary, D., Verma, T.C. and Kumar, S. (2019). Evaluation of garlic based seed spices intercropping system in Baran District of Rajasthan *Int. J. Seed Spices* 9(1):76-78.
44. Singh, D.K., Verma, T.C., Khan, M.A. and Gautam, K.M. (2018). Response of coriander based intercropping with garlic on productivity and profitability in Haroti region of Rajasthan. *International J. Seed Spices* 8(2):58-60
45. Yadav, T.C., Meena, R.S. and Dhakar, Lad (2018). Genetic Variability Analysis in Fenugreek (*Trigonella foenum-graecum* L.) *Genotypes Int. J. Curr. Microbiol. App. Sci* (2018) 7(10): 2998-2003.

Other Research Publication

1. Bhandari, G., Subhash, C., Gupta, M., Katiyar, R., Ravi, Y. and Gorain, B. (2018). Factors Stalling Agricultural Growth- Micro-level Evidence from Karsanda Village of Uttar Pradesh. *International Journal of Pure and Applied Biosciences*, 6(6): 72-79.
2. Chand, L., Singh, D.B., Sharma, O.C., Mir, J.J., Kumawat, K.L., Rai, K.M., Rather, S.A., Qureshi, I., Lal, S. and Dev, I. (2018). Lateral bearing trait in Indian walnut (*Juglans regia* L.) germplasm: a potential yield contributing trait in early age of the tree. *International Journal of Bio-resource and Stress Management* 8 (5):605-610.
3. Chaudhary, N., Sindhu, S.S., Kumar, R., Saha, T.N., Raju, D.V.S., Arora, A. and Sharma, R.R. (2018). Effect of growing media composition on growth,

- flowering and bulb production of LA hybrid (Red Alert) and Oriental (Avocado) group of *Lilium* under protected condition. *Indian Journal of Agricultural Sciences* 88 (12): 1843-7.
4. Choudhary, M., Sharma, P.C., Jat, H.S., McDonald, A., Jat, M.L., Choudhary, S., Garg, N. (2018). Soil biological properties and fungal diversity under conservation agriculture in Indo-Gangetic Plains of India. *Journal of Soil Science and Plant Nutrition*, 18(4): 1142-1156.
 5. Khorajiya, M., Shiyani, R.L., Ardesna, N. J., 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.
 6. Lal, S., Singh, D.B., Sharma, O.C., Mir, J.I., Sharma, A., Raja, W.H., Kumawat, K.L. and Rather, S.A. (2018). Impact of climate change on productivity and quality of temperate fruits and its management strategies. *International Journal of Advance Research in Science and Engineering* 7(4): 1833-1844.
 7. Lal, S., Singh, S.K., Singh, A.K. and Singh, N.K. (2019). Assessment of genetic divergence of mango genotypes using multivariate techniques. *Journal of Environmental Biology* 40:17-28
 8. Meena, M.D., Khunt K.A., Meena H.N. and Khorajiya, H.T. (2019). Assessing export competitiveness of Indian groundnut. *Agricultural Economics Research Review* 31 (2): 221-230.
 9. Meena, M.D., Khunt, K.A. and Meena, H.N. (2018). Costs and return in groundnut cultivation: A spatio-temporal analysis in *Indian Journal of Economics and Development*, pp.587-599.
 10. Mir, J.I., Ahmed, N., Singh, D.B., Rashid, M., Singh, S.R., Sharma, O.C., Lal, S. and Sharma, A. (2018). Morphological characterization of walnut genotypes of diverse origin. *Indian Journal of Horticulture* 75(2): 172-176.
 11. Mir, J.I., Nabi, S.U.N., Sharma, O.C., Sharma, A., Lal, S., Singh, D.B., Raja, W.H., Kumawat, K.L., Sheikh, M.A., Shafi, W., Jan, S. and Afzal, A. (2018). Effect of different media supplemented with plant growth regulators for enhancement of corm multiplication in Saffron (*Crocus sativus* L.) under protected conditions. *Bulletin of Environment, Pharmacology and Life Sciences* 7 (9): 36-38.
 12. Raja, W.H., Kumawat, K.L., Sharma, O.C., Sharma, A., Mir, J.I., Nabi, S.U.N., Lal, S. and Iqra Qureshi (2018). Effect of different substrates on growth and quality of Strawberry cv. Chandler in soilless culture. *The Pharma Innovation Journal* 7(12): 449-453.
 13. Ravi, Y., Narayanpur, V.B., Hiremath, J.S., Rathod, V., Ashoka, N. and Shantappa, T. (2018). Yield and economics of ginger cultivation under Soppinabetta ecosystem of Karnataka. *Journal of Pharmacognosy and Phytochemistry*, SP3:479-481.
 14. Ravi, Y., Narayanpur, V.B., Hiremath, J.S., Rathod, V., Erage Gowda, M. and Mahantesh, P.S. (2018). Quality of Ginger (*Zingiber officinale* rosc.) Genotypes grown under Soppinabetta Ecosystem of Karnataka. *Journal of Pharmacognosy and Phytochemistry*, SP3:91-94.
 15. Ravi, Y., Narayanpur, V.B., Jayappa, J., Prashant, A., Santosha, G.R., Mahantesh, P.S., Kotur, N.M. and Avinash, M. (2018). Screening of Ginger Genotypes for Shoot Borer (*Conogethes punctiferalis* Guen.) Resistance under Soppinabetta Ecosystem of Karnataka, India. *International Journal of Current Microbiology & Applied Sciences*, 7(5): 1402-1405.
 16. Sharma, A., Kumar, S., Lal, S., Malik, G., Sharma, O.C., Mir, J.I., Singh, D.B., Raja, W.H. and Arora, S. (2018). Nutrient saving and yield enhancement through fertigation in apple-growing cold humid regions of North-West Himalayas. *Journal of the Indian Society of Soil Science* 66(1):96-102.
 17. Singh, R. and Mishra, A. (2018). Performance of Early Maturing Sugarcane (*Saccharum spp* Hybrid complex) Varieties under Different Row Spacing and Fertilizer Levels in Plant Cane-Ratoon-Wheat System. *International Journal of Current Microbiology and Applied Sciences (IJCMAS)* 7(6): 407-417.
 18. Verma, A.K. and Prasad, K.V. (2019). Organogenesis and anatomical study of gamma rays induced mutant of chrysanthemum (*Chrysanthemum*

- morifolium* Ramat.) from ray florets. *Research Journal of Biotechnology* 14(3):44-53.
19. Verma, A.K. and Singh A. (2018). Harnessing the potential of superabsorbent polymers for alleviating drought and salt stresses in fruit crops: A brief review, *Advances in Agricultural Technology & Plant Sciences* 1(3): 1-10.
 20. Verma, M.K., Dwedi, S.K., Lal, S., Sofi, A.A. and Pandit, B.A. (2018). Cold arid Ladakh. A natural conservatory of folk apricot cultivars for horticultural use. *Indian Journal of Arid Horticulture* 13(1-2): 25-33.
 21. Verma, S.S., Verma, R.P., Verma, S.K., Yadav, A.L. and Verma, A.K. (2018). Responses of ber (*Zizyphus mauritiana* Lamk.) varieties to different level of salinity. *International Journal of Current Microbiology and Applied Sciences*, 7(7): 580-591.
4. Pervez, R., Prasad, D. and Lal, G. (2018). Souvenir and abstracts: 1st International conference on "Climate change and adaptive crops protection for sustainable Agri-horticulture land scape", Published by ICAR-NRCSS, Ajmer and society of plant protection sciences ICAR-NCIPM, New Delhi (India), Pp.1-148.
 5. लाल, जी., सक्सेना, एस.एन., शर्मा, वाई.के., मीना, एस.एस., शिवलाल, मीणा, एम.डी., वर्मा, ए.के. एवं चौधरी, एन. (2019)। बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। तकनीकी पुस्तिका: प्रकाशक— निदेशक भा. कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर, राजस्थान। 1/2019, पेज नं. 1-104.
 6. लाल, जी., जानकीराम, टी., चेरियन, एच., मीणा, एस.एस., शिवलाल, मीणा, एम.डी. एवं चौधरी, एन. (2018)। जलवायु परिवर्तन के परिप्रेक्ष्य में बीजीय मसालों की उन्नत खेती। प्रशिक्षण मैनुअल-1/2018 प्रकाशक— निदेशक भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर, राजस्थान। 1/2018, पेज नं 1-102.
 7. लाल, जी., मीणा, एस.एस., दुबे, पी.एन. एवं मीणा, एम.डी. (2019)। मध्य प्रदेश राज्य में मसालों की प्रोन्नत उत्पादन तकनीकों तथा सस्योत्तर क्रियाएँ। प्रशिक्षण मैनुअल -1/2019 प्रकाशक— निदेशक भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर, राजस्थान पेज नं 1-91

Research Paper Hindi

1. चौधरी, शारदा (2018)। धनिया की फसल के लिए सरल अनुक्रम पुनरावर्ती (माइक्रोसेटेलाइट) चिन्हक: एपियेसि कुल में हि पार प्रजाति प्रवर्धन। भारतीय कृषि अनुसंधान पत्रिका, 33(3): 190-194।
2. सिंह, आर., महेला, आर.एस., ऐश्वथ, ओ.पी., चौधरी, एस. एवं लाल, जी. (2018)। खरपतवार प्रतिस्पर्धा के लिए क्रांतिक अवस्था की पहचान एवं इनका अजवाइन की वृद्धि एवं उपज पर प्रभाव। भारतीय कृषि अनुसंधान पत्रिका, 33(2): 80-87।

Books/ Compendium/ Manuals/ Bulletins

1. Lal, G., Cheriyan, H., Sharma, Y. K., Mishra, B. K., Lal, S. and Chaudhary, N. (2019). *Book of Invited Papers for State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers' Income"*. Published by ICAR-NRCSS, Ajmer (India), 1-155 pp.
2. Lal, G., Meena, M.D. and Verma, A.K. (1/2019). Training Manual on "Present status and future prospects of seed spices research and development in India". Publisher: Director, ICAR-National Research center on Seed Spices, Ajmer-305206 (Rajasthan), India. pp 1-118.
3. Lal, G., Meena, N.K., Meena, R.D. and Choudhary, M.K. (2018). Organic farming of coriander. Published by ICAR-NRCSS, Ajmer (India), Pp., 1-14.

E-books/ News letter/ E-news letter

1. Kant K., Meena, S. R. and Mishra, B.K.(2018) Enhancement of Mass Production of Bio agents activities during 2018 Seed Spices-E-Newsletter - Vol.12(6):2.
2. Kant K. and Meena, S. R. (2018) Crown aphids infestation in Kasuri methi. Seed Spices-E-Newsletter -Vol.13(1):2.
3. Lal G., Aishwath O.P., Mishra B.K., Meena N.K. and Khan M.A. (2018-19) Bi-monthly E-newsletter Vol. 11(1&2) March-April, 2018; Vol. 11(3) May-June, 2018; Vol. 11(4) July-August, 2018; Vol. 11(5) Sept-Oct., 2018; Vol. 11(6) November-December, 2018 and Vol. 12(1) Jan-Feb, 2019. Published by Director, ICAR-NRCSS, Ajmer.

Extension bulletins/folders

1. Lal, G. (2018). Value added products developed from seed spices. Published by Director, ICAR-NRC on Seed Spices, Ajmer, India.
2. सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर.डी. एवं मीणा, एम.डी. (2019)। "जीरा उत्पादन की उन्नत तकनीकी" रा. बी.म.अनु.के.-प्रसार पत्रक-1/2019 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
3. सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर.डी. एवं मीणा, एम.डी. (2019)। "धनिया उत्पादन की उन्नत तकनीकी" रा. बी.म.अनु.के.-प्रसार पत्रक-2/2019 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
4. सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर.डी. एवं मीणा, एम.डी. (2019)। "मेथी उत्पादन की उन्नत तकनीकी" रा. बी.म.अनु.के.-प्रसार पत्रक-3/2019 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
5. सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर.डी. एवं मीणा, एम.डी. (2019)। "सौंफ उत्पादन की उन्नत तकनीकी" रा. बी.म.अनु.के.-प्रसार पत्रक-4/2019 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
6. सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर.डी. एवं मीणा, एम.डी. (2019)। "अजवाइन उत्पादन की उन्नत तकनीकी" रा. बी.म.अनु.के.-प्रसार पत्रक-5/2019 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
7. सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर.डी. एवं मीणा, एम.डी. (2019)। "कलौंजी उत्पादन की उन्नत तकनीकी" रा. बी.म.अनु.के.-प्रसार पत्रक-6/2019 प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
2. Aishwath, O.P., Kumar, P., and Jalwania, R. (2019) Production of seed spices with saline/alkali soils and water in arid and semi-arid regions. In: *Horticulture in arid and semi-arid regions* (eds: Jatav et al). Publisher- New India Publishing Agency, New Delhi. (ISBN:978-93-87973-55-8) pp 127-136.
3. Aishwath, O.P., Kumar, P., Balai, R.C. and Jalwania, R. (2019) Spices, medicinal and aromatic plants in degraded arid and semi-arid regions. In: *Horticulture in arid and semi-arid regions* (eds: Jatav et al). Publisher- New India Publishing Agency, New Delhi. (ISBN:978-93-87973-55-8). pp 137-150.
4. Kant, K. and Meena, S.R (2018). Pests of Seed Spices. In: *Pests and Their Management*, Omkar (Ed.) Springer Publisher New York, pp 697-718.
5. Kumawat, K.L., Raja, W.H., Singh, D.B., Sharma, O.C., Lal, S. and Chand, L. 2019. Enhancing featuring in one year old apple nursery tree through plant growth regulators, pp.10. In: *Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture*, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176p.
6. Lal G. and Verma A.K. (2019). "Value Chain in Seed Spices" in technical session VI -B (Production Technology-Conventional Horticulture). In: 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture at IGKV, Raipur, Chattishgarh, 17-21st, January, 2019 organized by Horticulture Society of India, New Delhi.
7. Lal, G. 2018. "Usable technologies of different seed spices" In: Annual Zonal Workshop including 62 KVKs organizes by ATARI, Jodhpur at SKRAU, Bikaner during 10th June, 2018.
8. Lal, G. and Meena, S.S. (2018) Doubling Farmer's Income Through Seed Spices "National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment" 27-29th October, 2018 at ICAR-CIAH, Bikaner. PP 16-21.
9. Lal, G. and Verma, A.K. (2018). Seed species for diversified agriculture to enhance farmer's income. In: *Shod Chintan- Intensification and Diversification in Agriculture for Livelihood and Rural Development* (Editors: H.P. Singh, R.C.

Chapters in books/ manuals/ compendium

1. Aishwath, O.P. (2018) Carbon management in soils of arid and semi-arid regions with special reference to Indian subcontinent. In: *Compendium of Orientation course on 'Agricultural education, research and extension management'*, held on 11th June to 1st July, 2018. Pub. Agricultural university, Jodhpur. pp 60-71.

- Srivastava, Dhiraj Sharma and Babita Singh), Publisher : ASM Foundation, New Delhi, 10: ISBN: 9788193226636, pp 214-219.
10. Lal, G. and Verma, A.K. (2019). Recent advances in research and development of seed spices in India. In: Training Manual on "Present status and future prospects of seed spices research and development in India" (Eds). Published by ICAR-National Research Centre on Seed Spices, Ajmer-305206, Rajasthan. Pp. 19-22.
 11. Lal, G. and Verma, A.K. 2018. "Seed spices for diversified agriculture to enhance farmer's income" technical session III (Innovation in Production system Management for Vegetables, Tubers and Spices). In: National Conference on "Intensification and Diversification in Agriculture for Livelihood and Rural Development" at Samastipur, Bihar, during 28-31 May, 2018.
 12. Lal, G., Chaudhary, N., Lal, S. and Verma, A.K. (2019). Organic seed spices: challenges and opportunities. In: Souvenir State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" 27-28 March, 2019 at ICAR-NRCSS, Ajmer. Pp. 8-17.
 13. Lal, G., Lal, S. and Meena, S.S. (2018) Vertical Farming: Status, Researchable Issues and Way Forward in Seed Spices Edited by T. Jankiram, Nutan Kaushik, Vikramaditya Pandey, Ranvir Singh and Abhishek Sharma Published by ICAR-Krishi Anusandhan Bhawan-II Pusa, New Delhi PP 138-143.
 14. Lal, G., Meena S.S. and Lal, S. (2019). "Seed Spices as Medicine in Wellness Industry" In: National Seminar cum Interactive Workshop on "Noni and Medicinal Plants in Human Wellness during, 23 - 24 March, 2019.
 15. Lal, G., Meena, M.D. and Verma, A.K. (2019). Scenario of seed species cultivation and their economic importance. In: Training Manual on "Present status and future prospects of seed spices research and development in India" (Eds). Published by ICAR-National Research Centre on Seed Spices, Ajmer-305206, Rajasthan. Pp. 1-8.
 16. Lal, G., Meena, R.S. and Lal, S. (2019). "Biodiversity of seed Spices: Status and opportunities under changing climatic scenario". In: Program and Abstracts Satellite Symposia IDDC. Publisher: IDDC and Arid Zone Research Association of India. Pp 45-47.
 17. Lal, G., Meena, S.S, Lal, S. and Verma, A.K. (2019). Post-harvest management and value addition in seed spices. In: Souvenir State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" 27-28 March, 2019 at ICAR-NRCSS, Ajmer. Pp. 125-135.
 18. Lal, G., Verma, A.K. and Choudhary, M.K. (2019), "Climate resilient technologies for seed spices". In: Extended Summery (Plenary, Evening and Lead lecture) IDDC. IDDC and Arid Zone Research Association of India. Pp 157-161.
 19. Lal, G., Verma, A.K., and Maheria, S.P. (2018). Sustainable production of seed spices under the changing climate scenario: Impact and Adaptive strategies In: 1st International conference on "Climate change and adaptive crops protection for sustainable Agri-horticulture land Scape" during 20-22 December, 2018 Pp. 17-18.
 20. Lal, S. and Sharma, N. (2018). Hazelnut (*Corylus avellana* L.), pp 297-340. In book Temperate fruit crops: theory to practical by Gosh, S.N., Kumar, A., Rehman MU and Sharma, R.R. (Eds). New India Publishing Agency, New Delhi-110034
 21. Lal, S., Meena, S.S., Meena, M.D. and Chaudhary, N. (2019). Maturity indices in fennel. In: Souvenir of State Level Seminar on "Clean and Safe Production of seed spices for enhancing farmers, Income" held on 27-28th March, 2019 at ICAR-NRCSS, Ajmer, Rajasthan (India), 136p.
 22. Meena, M.D. Lal, G. Verma, A.K. Scenario of seed species cultivation and their economic importance (2019). In Training Manual on Present status and future prospects of seed spices research and development in India. pp 1-8.
 23. Mir, J.I., Sharma, O.C., Singh, D.B., Sharma, A., Shafi, W., Jan, S., Raja, W.H., Kumawat, K.L., Nabi, U.S., Lal, S. and Kirmani, S. (2019). Plant canopy management influencing fruit quality and productivity- a prerequisite for HDP in apple, pp. 115. In: Souvenir cum lead oral paper abstract

- book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176 p.
24. Raja, W.H., Singh, D.B., Kumawat, K.L., Nabi, U.S., Sharma, O.C., Sharma, A., Mir, J.I. and Lal, S. (2019). Development of greenhouse soilless system for production of strawberry in North Western Himalayan Region, pp.82. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176 p.
 25. Sharma, Y.K. (2019). *Fusarium* wilt of seed spices and their management. In: Wilt Diseases of Crops (Editors: Ashok Bhattacharyya, B.N. Chakraborty, R. N. Pandey, Dinesh Singh and S.C. Dubey). Indian Phytopathological Society, New Delhi: 183-196.
 26. Singh, D.B., Mir, J.I., Sharma, O.C., Lal, S., Sharma, A., Raja W.H., and Kumawat K.L. (2018). Research developments for increasing productivity and quality of apple at ICAR-CITH, Srinagar, pp 133-153. In: Ahmed, N., Wani, S.A. and Wani, W.M. (Eds). Apple: production and value chain analysis edited by pp 470. Daya Publishing House, New Delhi.
 27. Singh, R. (2019). Protected cultivation technologies for seed spices in semi-arid conditions of Rajasthan and Gujarat. In Training Manual on "Present status and future prospects of seed spices research and development in India" held during 27 December, 2018 to 2 January, 2019 at NRCSS, Ajmer pp 44-48.
 28. Singh, R. and Lal, G. (2019). Advances in production technologies of major seed spices. In Training Manual on "Present status and future prospects of seed spices research and development in India" held during 27 December, 2018 to 2 January, 2019 at NRCSS, Ajmer pp 44-48.
 29. Verma, A.K., Choudhary, S., Meena, R.S., Lal, G. and Sharma, M. (2018). Improvement of seed spices. In: *Phytochemistry of Fruits and Vegetables* (Peter, K.V. Editor). Brillion Publishing, New Delhi-110005, India. Pp. 287-314. ISBN: 9789387445000.
 30. Verma, A.K., Singh, A., Meena, R.L. and Singh, B. (2018). Approaches for enhancing salt tolerance in seed spices. In: *Engineering Practices for Management of Soil Salinity: Agricultural, Physiological, and Adaptive Approaches* (Editors: S.K. Gupta, Megh R. Goyal and Anshuman Singh). Apple Academic Press Inc., USA. pp. 367-401. ISBN: 978-1-77188-676-5
 31. Verma, M.K., Dwivedi, S.K., Lal, S., Singh, S.K., Patel, V.B. and Kumar, C. (2018). Temperate Fruits for sustainable livelihood in cold arid regions of India. In: Proceedings of the National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment, held at Central Institute for Arid Horticulture, Bikaner, Rajasthan, India on 27-29 October, 2018. pp 68-73.
 32. शिवलाल एवं लाल, जी. (2019)। बीजीय मसालों में खड़ी खेती का भविष्य एवं उपयोगिता। तकनीकी पुस्तिका: बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। प्रकाशक: निदेशक, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर, प्रशिक्षण मैनुअल, 1/2019, पृ.सं. 89-93।
- Popular article/ technical article**
- Hindi**
1. ऐश्वथ, ओ.पी. (2018)। भौतिक रूप से निम्न कोटि भूमि एवं मृदाओं में सफल बागवानी फसलें। मसाला सुरभि, जनवरी-जुलाई, पेज नं. 15-21।
 2. अंकेगोडा, एस.जे., चौधरी, नरेन्द्र, अक्षिता, एच.जे., दिनेश, आर एवं निर्मल, बाबू के. (2018)। सफलता की कहानी, राजभाषा आलोक, वार्षिकांक: 2017 (अंक 21)।
 3. दुबे, पी.एन., मीणा, आर.डी. एवं वर्मा, ए.के. (2018)। जीरे की सतत खेती के लिये एकीकृत पोषक प्रबंधन, एकीकृत कीट प्रबंधन एवं नविनतम तकनीक। ज्ञानपदपदक खंडनस च्च 21ए
 4. कान्त, कृष्ण एवं सियाराम मीणा (2018)। जीरे की फसल में माहू का समेकित प्रबंधन। मसाला सुरभि (1): 26-28।
 5. कुमार मनीश, राजकुमार, पगोदिया, आर.के., बेनियाल, आर, सिंह, ए., लाल, एस. एवं यादव, आर. (2019)। लवण प्रभावित मृदाओं में जैतून की खेती की संभावनाए। कृषि किरण, वार्षिकांक, पृ.सं. 57-62।
 6. लाल, जी., सक्सेना, एस.एन. एवं मीणा, एस.एस. (2019)। बीजीय मसालों की उपयोगिता एवं औषधिय महत्व (2019)। लाल, जी., सक्सेना, एस.एन., शर्मा, याच.के., मीणा, एस.एस., लाल, एस., मीणा, एम.डी., वर्मा, ए.के. एवं चौधरी।

- प्रकाशक: भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र, अजमेर।
7. लाल, एस. एवं लाल, जी. (2019)। बीजीय मसाला फसलों में खड़ी खेती का भविष्य एवं तकनीकी पुस्तिका "बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तक उपयोगी तकनीकियाँ। प्रकाशन - निदेशक, भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र-तकनीकी पुस्तिका, पृ.सं. 89-96।
 8. लाल, जी. एवं मीना एम.डी., (1/2019)। भारत में मसाला एवं बीजीय मसाला उत्पादन का परिदृश्य एवं संभावनाएँ। पुस्तक: बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। पृ. सं. 7-15।
 9. लाल, जी. सक्सेना, एस.एन. एवं कांत.के. (2019)। बीजीय मसालों की कटाई एवं उटाई उपरांत प्रबंधन। लाल, जी., सक्सेना, एस.एन., शर्मा, वाय.के., मीणा, एस.एस., लाल, एस., मीणा, एम.डी., वर्मा, ए.के. एवं चौधरी, एन.। प्रकाशक: भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र, अजमेर।
 10. लाल, जी., मीणा, एम.डी., मीणा, एस.एस. एवं मीणा, आर. एस. (2018)। कृषक आय वृद्धि में बीजीय मसालों का योगदान मसाला सुरभि (जनवरी-जून 2018), भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान, पेज न. 3-7।
 11. लाल, जी., शेखावत, नेहा एवं चौधरी, महेन्द्र कुमार (2018)। सीफ के मूल्य संवर्धित उत्पाद तथा उनके विपणन की संभावनाएँ मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर, राजस्थान पेज नं. (1):11-12।
 12. लाल, जी., सक्सेना, एस.एन., शर्मा, वाय.के., मीणा, एस.एस., लाल, एस., मीणा, एम.डी., वर्मा, ए.के. एवं चौधरी (2019)। बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। प्रकाशक: भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र, अजमेर।
 13. मीणा, एस.एस., लाल, जी. एवं अग्रवाल, पी.के. (2018)। सीफ के औषधीय उपयोग मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान पेज नं. 44-45.(1)
 14. मीणा, एस.एस., लाल, जी. अग्रवाल, पी.के. एवं बलई, एस. आर. (2018)। अनार तथा अमरुद के बागों में बीजीय मसाला फसलों की खेती मसाला सुरभि, भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र तबीजी, अजमेर राजस्थान पेज नं. 35-36.(1)
 15. मीणा, एस.आर., कृष्ण कांत एवं मीणा, एन.के. (2018)। मधुमक्खी: एक लाभदायक एवं उपयोगी कीट। मसाला सुरभि 1: पृ.सं. 37-38।
 16. मीणा, एन.के., लाल, जी., मीणा, आर.एस. एवं मीणा, एम.डी. (2018)। प्रमुख भंडारण कीटों से बीजीय मसालों की सुरक्षा। मसाला सुरभि, जनवरी-जून 2018, पेज नं. 31-34।
 17. मीणा, आर.एस., लाल, एस. एवं चौधरी, एन. (2019)। सीफ उत्पादन की उन्नत तकनीकियाँ। तकनीकी पुस्तिका (1/2019)- बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। प्रकाशक: भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र, अजमेर (भारत), पृ.सं. 39-44।
 18. मीना एम.डी., लाल, जी. (2019)। भारत में मसाला एवं बीजीय मसाला उत्पादन का परिदृश्य एवं संभावनाएँ। पुस्तक: बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। पृ.सं. 7-15।
 19. मीना, एम.डी. एवं लाल, जी. (2019)। कृषि आय में बीजीय मसालों का योगदान। पुस्तक: बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। पृ.सं. 79-88।
 20. मीणा, रामदयाल एवं शर्मा, युगल किशोर (2018)। मेथी (ट्राइगोनेला फोईनम: ग्रेकम) के प्रमुख रोग एवं उनका उचित नियंत्रण। मसाला सुरभि, राजभाषा हिन्दी पत्रिका, राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर। पेज.न. 29-30।
 21. मिश्रा, बी.के. एवं मीणा, आर.एस. (2019)। मेथी उत्पादन की उन्नत तकनीकियाँ। तकनीकी पुस्तिका 1/2019- बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। प्रकाशक: भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र, अजमेर (भारत), पृ.सं. 45-48।
 22. मिश्रा, बी.के. एवं लाल, जी. (2018)। परमपरागत कृषि उत्पादन की तकनीक: एक नई पहल, मसाला सुरभि, (जनवरी-जून, 2018), खण्ड-1 प्रकाशक: भा.कृ.अनु.प.-रा.बी.म.अनु.केन्द्र, अजमेर (भारत), पृ.सं. 8-10।
 23. रवि वाई., लाल, जी. एवं मीना, एम.डी. (2018). काली मिर्च के मूल्य संवर्धित उत्पाद, मसाला सुरभि, जनवरी-जून 2018, पेज नं. 41-43।
 24. रवि, वाई., आसंगि, होन्प, वर्मा, ए.के. एवं मीना, एम. डी. (2018)। मेथी-बहुउद्देशीय चिकित्सीय फसल, मसाला सुरभि, जनवरी, जुलाई, पेज नं. 39-40।
 25. शर्मा, युगल किशोर (2019)। बीजीय मसाला फसलों में समेकित रोग प्रबंधन। पश्चिमी राजस्थान में मसाला उत्पादन तकनीक-प्रशिक्षण मैन्युअल, कृषि अनुसंधान केन्द्र, कृषि विश्वविद्यालय, जोधपुर। पृ.सं. 81-84।

26. शर्मा, युगल किशोर (2019)। बीजीय मसालों के प्रमुख रोग एवं नियंत्रण। Compendium of District Level Seminar on Strategies for enhancing productivity of seed spices. MPUAT, Udaipur.
 27. शर्मा, वाई. के. एवं रवि, वाई. 2019। सोवा उत्पादन की उन्नत तकनीकियाँ। बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। भा.कृ.अनु.प.-राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर। पृ.सं. 57-62।
 28. सिंह, आर. मीणा, एस.एस. एवं चौधरी, एस. (2019)। बीजीय मसाला फसलों के प्रमुख खरपतवार एवं उनका प्रबंधन। तकनीकी पुस्तक (1/2019): बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ। पृ. सं. 97-102।
 29. वर्मा, ए.के., मीना, आर.एस., चौधरी, एस. एवं रवि, वाई. (2018)। अधिक उत्पादकता और गुणवत्ता के लिए बीजीय मसाला फसलों में उत्पत्तिवर्तन प्रजनन का योगदान. मसाला सुरभि, जनवरी -जुलाई, पेज नं. 22-25।
- English**
1. Aishwath, O.P. (2018) Spices, medicinal and aromatic plants for sustenance of soil health and water quality in semi-arid regions. In: souvenir of national conference on "Managing Natural Resources for Sustainable Agriculture" held during December 8 - 9, 2018 at Agra, pp 54-62.
 2. Aishwath, O.P. (2018) Spices, medicinal and aromatic plants for sustenance of soil and water quality in NEH region. In Proc.National Conference on 'Sustainable management of soil and water resources for doubling farmers' income' held during 25-27 October 2018 at Assam Agricultural University, Jorhat, Assam. pp 31-50.
 3. Balaji Rajkumar, Ankegowda S. J., Alagupalamuthirsolai M, Faisal M, Akshita, H. J. and Narendra C. (2018). Giant African snail: Enemy for spice growers. Spice India(Kannada) 31(6): 4-8.
 4. Kumawat, K.L., Raja, W.H., Singh, D.B., Sharma, O.C., Lal, S. and Chand, L. (2019). Enhancing featuring in one year old apple nursery tree through plant growth regulators, pp.10. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176p.
 5. Kumawat, K.L., Verma, M.K., Singh, D.K., Sofi, A.A., Ahmed, N., Singh, D.B., Lal, S. and Chand, L. (2018). Exploring promising almond cultivars for health and prosperity. *Indian Horticulture*, 63(6):15-17
 6. Lal, G., Chaudhary, N., Lal, S. and Verma, A.K. (2019). Organic seed spices: challenges and opportunities. In: Souvenir of State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers, Income" held on 27-28th March, 2019 at ICAR-NRCSS, Ajmer, Rajasthan (India), 8p.
 7. Lal, G., Meena, S.S., Lal, S. and Verma, A.K. (2019). Post-harvest management and value addition in seed spices. p 125. In: Souvenir of State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers, Income" held on 27-28th March, 2019 at ICAR-NRCSS, Ajmer, Rajasthan (India), 125p.
 8. Lal, S., Meena, S.S., Meena, M.D. and Chaudhary, N. (2019). Maturity indices in fennel. In: Souvenir of State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers, Income" held on 27-28th March, 2019 at ICAR-NRCSS, Ajmer, Rajasthan (India), 136p.
 9. Mir, J.I., Sharma, O.C., Singh, D.B., Sharma, A., Shafi, W., Jan, S., Raja, W.H., Kumawat, K.L., Nabi, U.S., Lal, S. and Kirmani, S. (2019). Plant canopy management influencing fruit quality and productivity- a prerequisite for HDP in apple, pp.115. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176 p.
 10. Mishra, B.K. (2019). Plant growth promoting rhizobacteria for enhancing seed spices productivity. In: *Training manual on "Present status and future prospects of seed spices research and development in India"* (Eds. Lal G., Meena M.D. and Verma A.K.), Published by ICAR-NRCSS, Ajmer (India), pp54-63.
 11. Raja, W.H., Singh, D.B., Kumawat, K.L., Nabi, U.S., Sharma, O.C., Sharma, A., Mir, J.I. and Lal, S. (2019). Development of greenhouse soilless system for production of strawberry in North Western

- Himalayan Region, pp.82. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176 p.
12. Ravi, Y, and Lal, G. (2018). Nutmeg in numerous forms. *Kerala Karshakan E-journal*. July, 6(1): 22-24.
 13. Ravi, Y, Meena, S.S and Meena, M.D. (2018). Value addition of Turmeric and Ginger. *Kerala Karshakan E-journal*. October, 6(4): 4-7.
 14. Ravi, Y. and Gautam, K. (2019). Geographical indications in Indian Spices. *Kerala Karshakan E-journal*. January, 6(7): 4-9.
 15. Ravi, Y., Asangi, H. and Verma, A.K. (2018) Fenugreek- Multipurpose Potential Therapeutic crop. *Kerala Karshakan E-journal*. June, 5(12): 14-15.
 16. Ravi, Y., Verma, A.K., Anupama, G. and Avinash, M. (2018). Kalonji: A Potential Medicinal Seed Spice. *Kerala Karshakan E-journal*. (April).
 17. 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.
 18. Verma, M.K., Dwivedi, S.K., Lal, S., Singh, S.K., Patel, V.B. and Kumar, C. (2018). Temperate Fruits for sustainable livelihood in cold arid regions of India. In: Proceedings of the National Conference on Arid Horticulture for Enhancing Productivity and Economic Empowerment, held at Central Institute for Arid Horticulture, Bikaner, Rajasthan, India on 27-29 October, 2018. pp 68-73.
- Paper presentation in Conference/ Symposia/ Seminar**
1. Aishwath O.P., Jha, B.K., Dubey, P.N., Yadav, R.K. and Meena, R.L. (2018) Liming influence on dill (*Anethum graveolens*) under acid soils of eastern plateau hill regions of Ranchi. In: Book of Abstracts; 27th National Conference on 'Sustainable management of soil and water resources for doubling farmers' income' held during 25-27 October 2018 at Assam Agricultural University, Jorhat, Assam. pp 118.
 2. Aishwath, O.P. (2019) Seed spices cultivation in problematic soil: Prospects and challenges. In *book of invited papers for state level seminar on "Clean and safe production of seed spices for enhancing farmers' income"* held on 27-28 March, 2019 at ICAR-NRCSS, Ajmer, Rajasthan. pp 65-68.
 3. Aishwath, O.P., Dubey P.N., Yadav, R.K., Meena, R.L., Jha, B.K., and Lal, G. (2019) Performance of nigella (*Nigella sativa*) with sodic irrigation water in TypicHaplustepts. In: Book of Abstracts of 28th National Conference on "Farmers friendly soil and water conservation technologies for mitigating climate change impact" held on January, 31st to February 2nd 2019 at ICAR-IISWC, Regional Centre, Udhagamandalam, Tamil Nadu. pp 145.
 4. Aishwath, O.P., Dubey, P.N. Mehta, R.S., Harisha, C.B. and Lal, G. (2018) Yield, nutrient uptake and growth kinetics of fennel with applied nitrogen in TypicHaplustepts. In: Proc: 83rd Annual Convention of ISSS held on November 27-30, 2018 at Anand Agricultural University, Anand. pp 85.
 5. Aishwath, O.P., Dubey, P.N., Mehta, R.S. and Lal, G. (2018) Assessment of climate change impact on performance of coriander. In Souvenir and Abstracts of 1st International Conference on "Climate change and Adaptive crop protection for Sustainable Agri-horticulture Land Landscape" held on 20-22 December, 2018 at ICAR-NRCSS, Ajmer, Rajasthan. pp 124.
 6. Choudhary, S. (2018) Isolation and characterization of Rhizobium strains from *Trigonella foenumgraceum* (Fenugreek) soils of Rajasthan. In International Seminar on "Climate change and Adaptive Crops Protection for Sustainable Agri-horticulture Land Landscape" from 20 to 22 December 2018. Jointly organized by Indian Society of Seed Spices, Ajmer and Society of Plant Protection Sciences, New Delhi at ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan. Pp-56. (Poster)
 7. Choudhary, Sharda (2018) Isolation and characterization of Rhizobium strains from *Trigonella foenumgraceum* (Fenugreek) soils of

- Rajasthan. In International Seminar on "Climate change and Adaptive Crops Protection for Sustainable Agri-horticulture Land Scape" from 20 to 22 December 2018. Jointly organized by Indian Society of Seed Spices, Ajmer and Society of Plant Protection Sciences, New Delhi at ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan. Pp-56.
8. Choudhary, Sharda and Meena, R.D. (2018) An advance and effective protocol for high quality RNA isolation from coriander. In International Seminar on "Climate change and Adaptive Crops Protection for Sustainable Agri-horticulture Land Scape" from 20 to 22 December 2018. Jointly organized by Indian Society of Seed Spices, Ajmer and Society of Plant Protection Sciences, New Delhi at ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan. Pp-142-143.
 9. Choudhary, Sharda, Verma, A.K. and Ravi, Y. (2019) Molecular markers for automatizing and enhancing the effectiveness of genotype analysis in coriander. In State level Seminar on "Clean and safe production of Seed Spices for enhancing farmer's income" from 27 to 28 March 2019. Jointly organized by ICAR-NRCSS, Ajmer (Rajasthan) and DASD, Kozhikode (Kerala). Pp-34-38(OP)
 10. Dubey, P.N. Lal, G., and Mishra, B.K. (2018). Pesticide residue issues in some seed spices from arid and semi arid regions of India. In National Extension Education Congress (NEEC) on 'Climate Smart Agricultural Technologies: Innovations and Interventions', CAEPHT, Ranipool, Sikkim (CAU, Imphal) 15-17 November, 2018. Pp147.
 11. Kant, Krishna, Meena, S.R and Meena, N. K (2019). Seed Spice Crops: Reservoir of Predators/ Parasitoides and pollinators. Paper presented in 8th Horticulture Congress held at IGKV, Raipur, January 17-19, 2019.
 12. Kant, Krishna, Mishra, B.K. and Meena, S.R.(2018). Sucking pests management in Major seed spice crops. Oral Paper presented in 1st International conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-Horticulture land Scape at ICAR-NRCSS, Ajmer 20-22 December, 2018. pp 43.
 13. Kant, Krishna, Mishra, B.K., Meena, S.R. and Vishal, M.K.(2018). Impact of Seed Spice oils on management of Cigarette beetle, *Lasioderma serricorne* F. Oral Paper presented in 1st International conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-Horticulture land Scape at ICAR-NRCSS, Ajmer 20-22December,2018,pp 30.
 14. Kumawat, K.L., Raja, W.H., Singh, D.B., Sharma, O.C., Lal, S. and Chand, L. (2019). Enhancing featuring in one year old apple nursery tree through plant growth regulators, pp.10. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, 176 p.
 15. Lal G. and Verma A.K. (2019). "Value Chain in Seed Spices" in technical session VI –B (Production Technology-Conventional Horticulture). In: 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture at IGKV, Raipur, Chattishgarh, 17-21st, January, 2019 organized by Horticulture Society of India, New Delhi Pp.150.
 16. Lal, G. (2018). Preparation and processing of seed spices. International Horticultural Congress-2018 organized by ISHS during 12-18 August, 2018 at Istanbul, Turkey. (OP)
 17. Lal, G., Meena S.S. and Lal, S. (2019). "Seed Spices as Medicine in Wellness Industry" In: National Seminar cum Interactive Workshop on "Noni and Medicinal Plants in Human Wellness during, 23 - 24 March, 2019 Pp. 14.
 18. Lal, G., Meena, N. K., Meena, R. D., Choudhary, M. K. and Neha Shekhawat. (2018). Influences of organic, inorganic and integrated sources of nutrients on growth, yield attributing traits and yield economics of fennel (*Foeniculum vulgare* Mill). In: 1st International conference on "Climate change and adaptive crops protection for sustainable Agri-horticulture land scape" organized by SPPS, ICAR-NCIPM, New Delhi & ISSS during 20-22 December, at ICAR-NRCSS, Ajmer (Rajasthan), Pp. 144. (OP)

19. Lal, S., Kumawat, K.L. Singh, D.B., Sharma, O.C., Mir, J.I., Raina, S.K. and Sharma, A. (2019). *In-vitro* screening of almond (*Prunus dulcis* (mill.) D.A. Webb) genotypes for low temperature sensitivity. In: Book of Abstract (poster papers), 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, p 257.
20. Lal, S., Sharma, O.C., Singh, D.B., Mir, J.I., Sharma, A. and Rather, S.A. (2018). Changing climatic scenario vis-à-vis chilling unit availability and apple productivity in Kashmir valley. In: Souvenir and abstract book of 1st International Conference on Climate change and Adaptive Crops Protection for Sustainable Agri-Horticulture Land Landscape, 20-22nd December, 2018 jointly organized by Indian Society of Seed Spices, Ajmer and Society of Plant Protection Sciences, ICAR-NCIP, LBS Center, Pusa Campus, New Delhi held at ICAR-NRCSS, Ajmer p 72
21. Lal, S., Sharma, O.C., Singh, D.B., Mir, J. I., Sharma, A. (2019). Genetic diversity among peach (*Prunus persica* L.) genotypes for fruit physico-chemical attributes grown under temperate climate. XIV Agricultural Science Congress, 20-23 February, 2019, NASC, Pusa, New Delhi, India, p155.
22. Lal, S., Singh, D.B., Sharma, O.C., Mir, J.I., Raja, W.H. and Sharma, A. (2019). Characterization of strawberry (*Fragaria x ananassa* Duch.) genotypes for flowering, fruiting and fruit physico-chemical attributes under temperate condition. Book of Abstract (poster papers). 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, p 335.
23. Lal, G., Meena, N.K., Meena, R.D., Choudhary, M.K. and Shekhawat, Neha. (2018). Influence of organic and integrated sources of nutrients on growth, yield attributed traits and yield economics of fennel (*Foeniculum vulgare* Mill.) variety AF-1.
24. Meena, M.D. Meena, S.S. Lal, Shiv and Choudhary N. (2019). Seed spices export: challenges and opportunities. In: Souvenir, State Level Seminar on Clean and Safe Production of seed Spices for Enhancing Farmers' Income. pp 148-154.
25. Meena, R.D., Meena, R.S., Sharma, Y.K., Meena, S.S. and Meena, N.L. (2018). Characterization of cumin (*Cuminum cyminum* L.) cultivars against various diseases under natural conditions. 1st International Conference on Climate Change and Adaptive Crops Protection for Sustainable Agri-horticulture Land Landscape held on 20-22 December, 2018 at ICAR-NRCSS, Ajmer (Raj.), India. Pp 57. (Best Poster Presentation).
26. Meena, S.R., Kant, Krishna, and Mishra, B.K. (2018). Management of Seed wasp *Systole albipennis* Walker in fennel crop (*Foeniculum vulgare*). Paper presented in 1st International conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-Horticulture land Landscape at ICAR-NRCSS, Ajmer 20-22 December, 2018, pp 45.
27. Meena, S.S. Lal, Shiv, Meena, M.D. and Choudhary Narendra (2019). Maturity indices in fennel. In: Souvenir, State Level Seminar on Clean and Safe Production of seed Spices for Enhancing Farmers' Income. pp 137-139.
28. Meena, S.S., G. Lal, P.N. Dubey and P.K. Agrawal (2018). Boosting farmers Income through Inter Cropping of Seed Spices with Fruits and Vegetables. 9th National Extension Education Congress on "Climate Smart Agriculture Technologies: Innovations and Interventions" (November 15-17, 2018) being held at CAEPHT, Ranipool, Sikkim (CAU, Imphal). India. Pp 137. (Oral Presentation).
29. Meena, S.S., M.D. Meena, Lal, G. and Lal, S. (2019). Innovative approaches for weed management in seed spices. In: Souvenir, State Level Seminar on Clean and Safe Production of seed Spices for Enhancing Farmers' Income. pp 57-64.
30. Meena, S.S., Ved Kant, N.K. Meena, G. Lala and G. K. Tripathi (2018). Response of Sowing Dates, NPK Levels and Weedicides on the Growth and Yield of Nigella (*Nigella sativa* L.). 10th Swadesh Prem Jagriti Sangosthi - 2018 "National Conference on Intensification and Diversification in Agriculture for Livelihood and Rural Development" 28-31 May, 2018, DRPCAU Pusa (Samastipur) Bihar, India. Pp 92. (Oral Presentation).

31. Mir, J.I., Sharma, O.C., Singh, D.B., Sharma, A., Shafi, W., Jan, S., Raja, W.H., Kumawat, K.L., Nabi, U.S., Lal, S. and Kirmani, S. (2019). Plant canopy management influencing fruit quality and productivity- a prerequisite for HDP in apple. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, p.115
32. Mishra, B. K. (2019). Biological nitrogen fixation for sustainable agriculture. Invited key note lecture presentation in national conference on "sustainable agriculture and recent trends in science & technology" held during 22-23 Feb, 2019 at Bhagwant University, Ajmer (Raj.).
33. Mishra, B.K, Sharma, Y.K., Lal, G. and Dubey, P.N. (2018) Evaluation of Microbial Consortium for Growth and Yield of Fenugreek. In: National conference on "strategies & challenges in doubling farmers' income through horticultural technologies in subtropics" during 21-22 June, 2018 at ICAR-CISH, Rehmankhera, Lucknow (U.P.), pp121.
34. Mishra, B.K. (2019). Microbial inoculants for plant growth and yield enhancement in seed spices. In: *Book of Invited papers for state level seminar on "clean and safe production of seed spices for enhancing farmers' income"*. Published by ICAR-NRCSS, Ajmer (India), pp69-75.
35. Mishra, B.K., Sharma, Y.K., Kant, K. and Dubey, P. N. (2018). Co-inoculation effect of *Bacillus* sp. on cumin growth and yield". Oral presentation in International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture landscape" held during 20-22 December, 2018 at ICAR-NRC Seed Spices, Ajmer, Rajasthan, pp. 55
36. P. N. Dubey, G. Lal and B. K. Mishra. (2018). Dynamics of enzymatic activities in cumin field soil under the influence of propiconazole. In National Conference on "Strategy & challenges in Doubling farmers' Income Through Horticultural Technologies in Subtropics", 21-22 June, 2018, Organised by ICAR-Central Institute for Subtropical Horticulture, Lucknow and Society for Development of Subtropical Horticulture, Lucknow. pp-122.
37. Raja, W.H., Singh, D.B., Kumawat, K.L., Nabi, U.S., Sharma, O.C., Sharma, A., Mir, J.I. and Lal, S. (2019). Development of greenhouse soilless system for production of strawberry in North Western Himalayan Region,. In: Souvenir cum lead oral paper abstract book, 8th Indian Horticulture Congress-Shaping Future of Indian Horticulture, IGKV, Raipur, Chattishgarh, 17-21, January, 2019, p.82
38. Ravi, Y., Narayanpur, V.B., Hiremath, J.S, Gangadharappa, P.M. (2018). Performance of Humnabad local under Soppina Betta ecosystem of hill zone of Karnataka" authored by In: 1st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture land scape" held at ICAR-NRCSS, Ajmer during 20-22 Dec. 2018. pp.78. Oral:
39. Ravi, Y., Narayanpur, V.B., Hiremath, J.S., Rathod, V. Erage Gowda, M. and Mahantesh, P.S Quality of Ginger (*Zingiber officinale* Rosc.) Genotypes grown under Soppinabetta Ecosystem of Karnataka. (2018). In: "National Conference on Conservation, Cultivation and Utilization of Medicinal and Aromatic Crops" at COH, Mudigere, (Kar.) during 25-26 April, 2018. pp.10-11. Oral:
40. Ravi, Y., Saxena, S.N., Aishwath, O.P. and Lal, G. (2018). Possibilities for development of salinity tolerant genotypes in cumin. State seminar on "Clean and safe production of seed spices for enhancing farmer income" held at ICAR-NRCSS, Ajmer, Rajasthan, during 27-28 March 2019. Oral:
41. Ravi, Y., Verma, A.K., Chaudhary, N. and Lal, G. (2018). Suitable medicinal plants for arid and semi-arid regions under changing climate scenario. In: 1st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture landscape" held at ICAR-NRCSS, Ajmer during 20-22 Dec. 2018. pp.133. Poster:
42. Saxena, S.N. (2018). Cryogenic grinding technology: An effective approach for production of superior quality ground powder of spices and herbs during state level training programme at SIAM, Durgapura, Jaipur on 4th October 2018

43. Saxena, S.N. (2018). Depolymerized plant growth regulators for stress tolerance in cumin (*Cuminum cyminum* L.) In: 1st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape during 20-22 December 2018 at ICAR-National Research Centre on Seed Spices, Tabiji – 305 206, Ajmer (Rajasthan). Pp:84.
44. Saxena, S.N. (2018). Physiological approaches for enhancing stress tolerance and obtaining pathogen free planting material of spices, medicinal and aromatic plants * during 1st International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Land Landscape during 20-22 December 2018 at ICAR-National Research Centre on Seed Spices, Tabiji – 305 206, Ajmer (Rajasthan).
45. Saxena, S.N. (2018). Quality aspects for promotion of seed spice export during state level training programme at SIAM, Durgapura, Jaipur on 4th October 2018
46. Saxena, S.N. (2019). Significance of quality aspects of seed spices for enhancing farmers income. In: book of invited papers for state level seminar on clean and safe production of seed spices for enhancing farmers income published by Director, ICAR-NRCSS, Ajmer.
47. Saxena, S.N. (2019). Significance of quality aspects of seed spices for enhancing farmers income. during state level seminar on clean and safe production of seed spices for enhancing farmers income held on 20-22 December 2018 at ICAR-National Research Centre on Seed Spices, Tabiji –305 206, Ajmer (Rajasthan).
48. Sharma, M., Choudhary, S., Meena, R.D., Lal, G. and Verma, A.K. (2018). Characterization of gamma rays induced fennel mutants using morphological and molecular markers. In: 1st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture land scape" at ICAR-NRC Seed Spices, Ajmer, Rajasthan during 20-22 December, 2018. Pp. 137-138.
49. Sharma, N. and Aishwath, O.P. (2018) Growth kinetics of fennel with nitrogen application in TypicHaplustepts. In: *Proc./Book of Abstracts of National Conference on "Managing Natural Resources for Sustainable Agriculture"* held on December 8-9, 2018 at Raja Balwant Singh College, Agra (U.P.)pp35.
50. Sharma, Y.K., Mishra, B.K. and Meena, R.D. (2018). Evaluation of consortium of *Trichoderma* isolates for the management of *Fusarium* wilt of cumin (*Cuminumcyminum*). 1st International Conference on Climate Change and Adaptive Crops Protection for Sustainable Agri-horticulture Land Landscape held on 20-22 December, 2018 at ICAR-NRCSS, Ajmer (Raj.), India.
51. Sharma, Y.K., Mishra, B.K. and Meena, R.D. (2019). Diseases in seed spices: current scenario and emerging issues. In: Book of Invited Papers for State Level Seminar on Clean and Safe Production of Seed Spices for Enhancing Farmers' Income (Editors: G Lal, H. Cherian, Y.K. Sharma, B.K. Mishra, S. Lal and N. Choudhary). ICAR-National Research Centre on Seed Spices, Ajmer (Raj.) 305206, India: 76-80.
52. Singh R. (2018) (Oral presentation) of compiled results of "Crop Management fennel" trails at XXIX AICRP on Spices, Annual Workshop held at Dr Y S Parmar University of Horticultural and Forestry, Nauni, Solan, Himachal Pradesh from 4-6 October, 2018. (OP)
53. Singh, R., Lal, G. and Maheria, S.P. (2018). Off season production of leafy coriander under shade net covered walk in tunnels for doubling farmers income" in Extended summaries of XXI Biennial National Symposium of Indian Society of Agronomy on "Doubling Farmers' Income Through Agronomic Interventions Under Changing Scenario" held at RCA, MPUAT, Udaipur from 23-26 October, 2018 pp 593-594
54. Singh, R., Lal, G., Verma, A.K. and Choudhary, S. (2019). Hi-tech intervention for water and nutrients management in horticultural crops and seed spices. In Souvenir of State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" at ICAR-NRCSS, Ajmer from 27-28 March, 2019 pp 41-56.

55. Singh, R., Lal, G., Hannapa, A., Kant, K., Meena, R.D. and Maheria, S.P. (2018). Biotic and abiotic stress management in seed spices through hi tech interventions. Paper presented in 1st International conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-Horticulture land Scape at ICAR-NRCSS, Ajmer 20-22 December, 2018. pp 118.
56. Verma, A.K. (2019). Mutation breeding approaches in fennel. In: State Level Seminar on "Clean and Safe Production of Seed Spices for Enhancing Farmers Income" 27-28 March, 2019 at ICAR-NRCSS, Ajmer. Pp. 27-33. (OP)
57. Verma, A.K., Choudhary, S., Dhanasekar, P., Meena, R.S., Meena R.D. and Lal, G. (2018). Exploring genetic diversity in seed spices through induced mutagenesis. In: International Conference on "Rural Livelihood Improvement by Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Enterprises (RLSIAAe)" during 30th October to 01st November, 2018 at Birla Institute of Technology, Patna. Pp. 91. (OP)
58. Verma, A.K., Choudhary, S., Meena, R.D. and Lal, G. (2018). Gamma rays lethal dose (LD) fixation and estimation of induced variability in fennel (*Foeniculum vulgare* Mill.). In: National Conference on "Intensification and Diversification in Agriculture for Livelihood and Rural Development" at DRPCA, Pusa (Samastipur), Bihar from 28th to 31st May, 2018. pp. 66. (OP)
59. Verma, A.K., Choudhary, S., Meena, R.D., Lal, G. and Aggrawal, P.K. (2018). Induced mutagenesis in fennel (*Foeniculum vulgare* Mill.) for sustainable production under the era of climate change. In: 1st International conference on "Climate change and adaptive crop protection for sustainable agri-horticulture land scape" at ICAR-NRC Seed Spices, Ajmer, Rajasthan during 20-22 December, 2018. Pp. 82-83. (OP)
60. Vishal, M.K., Lal, G., Kant, K., Choudhary, S., Verma, A.K., Khan, M.A. and Meena, M.D. (2018). Assessing approachability and uses of ICT and other effective medium information dissemination of seed spices growers- Cumin and Coriander of western India : A case Study. Paper presented in 1st International conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-Horticulture land Scape at ICAR-NRCSS, Ajmer 20-22 December, 2018. pp 86.

9. RAC/IRC/IMC Meetings

RAC Meeting

1st meeting of VI-Research Advisory Committee (RAC) meeting held under chairmanship of Dr. B.S. Chundawat, Ex. Vice-Chancellor, SDAU Sardar Krishinagar, Dantiwada, Gujarat during 31 August to 1 September, 2018. The following members were present in the meeting: Dr. S. Amarender Reddy, Ex. Director (Extension), Dr. YSR Horti. University (AP), Dr. K.V. Ramana, Former ADG (Hort.), ICAR, New Delhi, Dr. I.S. Singh, Ex. Professor, PHT, NDUAT, Faizabad, Dr. T. Janakiram, ADG (HS-1), ICAR, New Delhi, Dr. V. Srinivasan, Principal Scientist, ICAR-IISR, Calicut, Dr. Ramavtar Sharma, Principal Scientist, ICAR-CAZRI, Jodhpur, Dr. G. Lal, Director, ICAR-NRCSS, Ajmer and Dr. Krishna Kant, Principal Scientist, Entomology, ICAR-NRCSS, Ajmer (Member Secretary). All the scientists of ICAR-NRCSS, Ajmer, participated in the meeting.

The meeting started with the welcome address by Dr. G. Lal, Director, ICAR-NRCSS, Ajmer. He welcomes the chairman and distinguished members of RAC committee and presented the highlight of the various activities of the Institute under different discipline. Hon'ble Chairman Dr. B.S. Chundawat in his inaugural remark showed his satisfaction and suggested that Institute should properly address the mandate and objectives in proper manner to solve the problem of farming community. Dr. Krishna Kant, Member secretary, presented the action taken report of the 3rd meeting of V RAC followed principal investigators of the research project presented salient findings of their respective projects. Finally the committee made the recommendations for future action and better output of the project.

XVIII Institute Research Council Meeting

The XVIII Institute Research Council (IRC) meeting of ICAR-NRCSS was held under the chairmanship of Dr. Gopal Lal, Director, ICAR-NRCSS during 11-12 Sept., 2018 to review the progress of ongoing Institutional research projects at ICAR-NRCSS, Ajmer. In the meeting, new project proposals were also discussed thoroughly and were formally approved by the house. At the outset, I/c PME Cell Dr. Y.K. Sharma, welcomed the Chairman and

other members of IRC. He indicated the number of ongoing research projects to be discussed in IRC. The Chairman, Dr. Gopal Lal also formally welcomed all the members of the IRC and briefed about the ongoing research and development activities at ICAR-NRC on Seed Spices, Ajmer. The action taken report of XVII IRC meeting was presented by I/c PME Cell. The same was discussed in the house. During the meeting, 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 the vote of thanks proposed by I/c PME Cell to the chair and all members.



ICAR-NRCSS 3rd QRT (1 June, 2011 to 31 May, 2016)

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, 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. The final 3rd QRT report was submitted to SMD for consideration in the GB, ICAR during 2018-19.

10. Distinguished Visitors

S.No.	Name	Designation	Date of visit	Event
1.	Dr. Manjit Singh	Ex Director, ICAR-DMR, Solan	06.04.2018	Assessment Committee meeting
2.	Prof. Arvind Kumar	Vice- Chancellor, Rani Lakshmi Bai Central Agricultural University, Jhansi	19.04.2018	For Visit at ICAR-NRCSS, Ajmer
3.	Sh. R.K. Singh	Professor, Agricultural Economics, BHU, Varanasi	05.06.2018	Assessment Committee meeting
4.	Dr. Khem Chand	Pri. Scientist. (Ag. Economics), Head Division of Social Science, IGFRI	05.06.2018	Assessment Committee meeting
5.	Dr. Rajesh Sharma	Prof & Head, Agriculture College (SKRAU), Bikaner	05.06.2018	Assessment Committee meeting
6.	Dr. Naveen Prakash Singh	Principal Scientist, NIAEPR, New Delhi	05.06.2018	Assessment Committee meeting
7.	Dr. B. S. Chundawat	Ex- VC, SDAU, GUJRAT AND CHAIRMAN, RAC VI OF NRCSS	1-9-2018	RAC VI - 1 st MEETING
8.	Dr. S.A. Reddy	Ex Director Ext. Dr YSRHU, AP	1-9-2018	RAC VI - 1 st MEETING
9.	Dr. I. S. Singh	Ex Prof. & head horticulture and food technology	1-9-2018	RAC VI - 1 st MEETING
10.	Dr. K.V. Ramana	Ex ADG (Hort.), ICAR	1-9-2018	RAC VI - 1 st MEETING
11.	Dr. V. Srinivasan	Principal Scientist, IISR, Kozhikode	1-9-2018	RAC VI - 1 st MEETING
12.	Dr. Ranavtar Sharma	Principal Scientist, CAZRI, Jodhpur	1-9-2018	RAC VI - 1 st MEETING
13.	Dr. P.N. Kalla	Directorate of Extension SKRAU, Bikaner	5-12-18	Soil day celebration
14.	Dr. G. R. Choudahary	Professor	5-12-18	Soil day celebration
15.	Sh. Laxmi Kant Sharma	Principal, DAV Collage, Ajmer	5-12-18	Soil day celebration
16.	Dr. A.K. Purohit	Professor	5-12-18	Soil day celebration
17.	Dr. B. R. Chhipa	Vice-Chancellor, SKRAU, Bikaner	6-12-2018	Visit of ICAR-NRCSS, Ajmer
18.	Dr. N.S. Rathore	Former Director, State Seed Corporation, Govt. of Rajasthan, Jaipur	17-12-2018	Visit of ICAR-NRCSS, Ajmer
19.	Dr. R.S. Paroda	Chairman, TAAS and Former Secretary, DARE & DG-ICAR, New Delhi	20-12-2018	International Conference
20.	Dr. P.L. Saroj	Director, CIAH, Bikaner	21-12-2018	International Conference
21.	Dr. Uma Rao	Head, Division of Nematology IARI, New Delhi	21-12-201	International Conference
22.	Dr. S.K. Singh	Director, ATARI Jodhpur	21-12-2018	International Conference

23.	Sh. Gajendra Singh Shekhawat	MOS Agriculture, Ministry of Agriculture and Farmers' welfare, GOI	24-12-2019	Visit of ICAR-NRCSS, Ajmer
24.	Sh. Vashudev Davnani	MLA, Ajmer- North	24-2-2019	PM-Kisan yojana
25.	Smt. Anita Bhadel	MLA, Ajmer -South	24-2-2019	PM-Kisan yojana
26.	Sh. Suresh Rawat	MLA, Pusker	24-2-2019	PM-Kisan yojana
27.	Sh. Vishav Mohan Sharma	District Collector, Ajmer	24-2-2019	PM-Kisan yojana
28.	Dr. Direndra Singh	AICRP on Spice S.K.N. Collage of Agriculture, Jobner	02-1-2019	Visit of ICAR-NRCSS, Ajmer
29.	Dr. Ravi Prakash	Registrar P.P.V & FRA, New Delhi	02-1-2019	Visit of ICAR-NRCSS, Ajmer
30.	Dr. R.G. Upadhyay	Joint Director Extension UUHF, Tehri Garhwal, Uttarakhand	24-1-2019	Visit of ICAR-NRCSS, Ajmer
31.	Dr. B.S. Tomer	Director, CSWRI, Avikanagar	8-2-2019	Kisan mela
32.	Dr. P.L. Saroj	Director CIAH Bikaner	8-2-2019	Kisan mela
33.	Prof. C.B. Gena	Ex VC, MGS University, Bikaner	8-2-2019	Kisan mela
34.	Sh. Ajai Ranawat	Former Defence Secretary, Govt.of India	8-2-2019	Kisan mela
35.	Sh. Suresh Singh Rawat	MLA, Pushkar	8-2-2019	Kisan mela
36.	Dr. S.K. Singh	Director ATARI Jodhpur	27-02-2019	Assessment Committee meeting
37.	Dr. R L Shyampura	Ex. Head, NBSSLUP Regional Station Udaipur	27-02-2019	Assessment Committee meeting
38.	Dr. P.N. Kalla	Professor, SKRAU, Bikaner	27-02-2019	Assessment Committee meeting
39.	G. R. Choudhary	Professor, SKRAU, Bikaner	27-02-2019	Assessment Committee meeting
40.	B. L. Jat,	Professor, SKN College of Agriculture, Jobner	27-02-2019	Assessment Committee meeting
41.	Prof. Arvind Kumar	Vice- Chancellor Rani Lakshmi Bai Central Agricultural University, Jhansi	16-3-2019	Assessment committee meeting
42.	J .Rema	Principal Scientist, ICAR-IISR, Calicut	16-3-2019	Assessment committee meeting
43.	Dr. Dhurander Singh,	Principal Scientist, ICAR-CIAH, Bikaner	16-3-2019	Assessment committee meeting
44.	Dr. Ravinder Paliwal	Professor, SKNRAU, Jobner	16-3-2019	Assessment committee meeting
45.	Dr. H.P. Singh.	Former DDG (Hort) ICAR, New Delhi	27-3-2019	State level seminar under MIDH
46.	Dr. G.B. Raturi ,	Former Director CIAH, Bikaner and NRCSS, Ajmer	27-3-2019	State level seminar under MIDH

11. Women Empowerment

Celebration of International Women's Day at NRC on Seed Spices, Ajmer

ICAR-NRC on Seed Spices, Ajmer celebrated International Women Days on 8th March 2019 with full enthusiasm, to recognize and appreciate the contributions and achievements of the women in various fields. Director, Dr. Gopal Lal chaired the function and emphasized that today's woman are independent and self-reliant in every respect and is capable of achieving many works not possible earlier. Let's recognise the importance of their existence and motivate them for the future achievements in various fields including agriculture etc. Indian agriculture cannot survive without their active participation in all streams of farming activities. Indian women also provide enormous contribution in animal husbandry, post

harvest management and marketing of farm produces. NRCSS gives due respect to the women employee at office and farm to encourage them for better performance and achievement in their respective fields.

About 125 participants participated in this important programme. All the staffs including Scientists, Technicals, Administrative & Supporting staffs, RA/SRF's and field workers were present during the function. Live telecast of Prime Minister on National Women Livelihood Conference in Varanasi on the occasion of International Women Conference on March, 08, 2019 was broadcast for all participants. Prime minister commitments to make women an equal and integral part of development journey of India and various scheme launched for upliftment of women conveyed among all participants.



Training programme exclusively for SC women

Training programme was exclusively organized for SC women's on "Off-season cultivation of seed spices for higher income" on 15th March, 2019 at ICAR-NRCSS, Ajmer. In this training programme a total of 61 women's were participated from nearby villages such as Tabiji, Saradana, Daurai, Budhwara and Doomara. During the training a total of six lectures were delivered by scientist

of ICAR-NRCSS, Ajmer on different aspects of off season seed spices production. To cultivate off-season coriander for leaf purpose seeds of coriander variety ACr-1 and green shed net were distributed, in addition milk cans for carrying the milk and other liquid items were also distributed to the beneficiaries. The programme was organized by Dr. Gopal Lal, Director, Dr. R.S Meena, Senior Scientist and Shiv Lal, Scientist.



12. Ongoing Research Projects

S.no.	Sub-Project
Project 1: Conservation characterization and utilization of genetic resources in seed spices	
1	CI-1: Management of plant genetic resources of seed spices: (PI: R.S. Meena; Co-PI: S.S. Meena, S.Choudhary, A.K. Verma and Ravi, Y.; 2014-19)
Project 2: Genetic improvement of seed spices for improving productivity, quality and tolerance to biotic and abiotic stresses.	
2	CI-8: Breeding for high yield and quality in dill: (PI: A.K. Verma; Co-PI: Y.K. Sharma and N.K. Meena; 2015-20)
3	CI-9: Breeding for high yield and improved quality in ajwain: (PI: S.S. Meena; Co-PI: M.K. Vishal (on study leave); 2015-20)
4	CI-19: Enhancing genetic variability in cumin: (PI: A.K. Verma; Co-PI: R.S. Meena; 2012-18)
5	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)
6	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)
7	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)
8	CI/15.2.1: Breeding in <i>Nigella sativa</i> L. for higher yield and Improved quality: (PI: S.S. Meena; Co-PI: S.N. Saxena and M.K. Vishal (on study leave); 2015-20)
9	CI/15.2.2: Development of microsatellites (SSRs) markers for Coriander: (PI: S. Choudhary; Co-PI: M.K. Vishal (on study leave); 2015-18)
10	CI/15.2.3: Identification of molecular marker associated with stem gall in coriander: (PI: S. Choudhary; Co-PI: R.D. Meena; 2015-20)
11	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, S.N. Saxena; 2016-21)
12	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, Ravi, Y., R. D. Meena; 2016-21)
Project 3: Development and refinement of efficient crop production technologies of seed spices.	
13	CPd/15.3.1: Isolation and characterization of endophytic micro-organisms from cumin and fenugreek (PI: B.K. Mishra; Co-PI: Y.K. Sharma; 2015-20)
14	CPd/16.3.2: Standardization of two tier system of production technology in seed spices with vine vegetables using bower: (PI: R. Singh; Co-PI: S. S. Meena, S. Choudhary, S. P. Maheria; 2016-19)
15	CPd/16.3.3: Seed spice based inter cropping with remunerative fruit crops: (PI: S.S. Meena; Co-PI: O.P. Aishwath, N.K. Meena, R.D. Meena; 2016-19)
16	CPd/17.3.1: Bioprospecting multitrait bacteria with abiotic stress tolerance from cumin and coriander soil. (PI: B.K. Mishra; 2017-20)
17	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 R. Singh 2017-22)

- 18 CPd/17.3.3: Surveying major growing area of cumin and coriander for soil parameters.
(PI: O.P. Aishwath; Co-PI: M.K. Vishal (on study leave), M. D. Meena and Ravi Y. 2017-22)
- 19 CPd/17.3.4: Studies on G x E interaction in cumin through on farm trial (OFT)
(PI: Ravindra Singh, Co-PI: R. S. Meena: 2017-19)

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

- 20 CPt-1: Survey and surveillance of existing and emerging diseases of seed spices:
(PI: R.D. Meena; Co-PI: Y.K. Sharma, M.K. Vishal (on study leave); 2012-18)
- 21 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)(Extended for one year)
- 22 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, S.R. Meena; 2016-19)
- 23 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)
- 24 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)
- 25 CPt/17.4.3: Biological management of *Alternaria* blight in cumin (*Cuminum cyminum*)
(PI: R.D. Meena; Co-PI: B.K. Mishra, 2017-20)
- 26 CPt/17.4.4: Development of IPM modules to combat aphids and thrips in coriander and cumin (PI: N. K. Meena; Co-PI: Ravindra Singh, M.D. Meena : 2017-21)
- 27 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)

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

- 28 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, K. Kant; 2014-19)
- 29 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)
- 30 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)
- 31 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)

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

- 32 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, S.P. Maheria, M.D. Meena; 2014-18)
- 33 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 (on study leave); Co PI: K. Kant, S. Choudhary, A. K. Verma, R. D. Meena, M.D. Meena, M. A. Khan, S. R. Meena; 2016-18)
- 34 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 (on study leave) and M.A. Khan, 2017-20)

New Sub-Project Proposals

S.No.	Sub-Project
1.	Transcriptome-based discovery of genes and pathways related to disease (Ramularia blight) and quality in fennel. (PI: Sharda Choudhary, Co-PIs: A.K. Verma, P.N. Dubey, M.B.N. Naika, 2018-21)
2.	Genetic improvement of cumin for higher yield and quality (PI: A.K. Verma; Co-PI: Y.K. Sharma, 2018-22)
3.	Screening of coriander and cumin genotypes for salinity stress (PI: Ravi Y.; Co-PIs: S.N. Saxena and O.P. Aishwath, 2018-21)
4.	Development of value chain for fennel (PI: Shiv Lal, Co-PIs: G. Lal, S.N. Saxena and B.K. Mishra, 2018-23)
5.	Seed Spices based integrated cropping system module for sustainable livelihood security (PI: Narendra Chaudhary, Co-PIs: R. Singh and M.D. Meena)

ICAR-Network/Platform Research Projects

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

External Funded Projects

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

13. Other Informations

Vigilance Awareness Week - 2018

ICAR-NRC on Seed Spices, Ajmer observed Vigilance Awareness Week from 29th October, 2018 to 3rd November, 2018 at NRCSS campus. The theme of the Vigilance Awareness Week this year was '**Eradicate Corruption – Build a New India**'.

The programme for Commencement of Vigilance Awareness Week with administering of Pledge began at ICAR-NRCSS, Ajmer on 29.10.2018 at 11:00 hrs by taking integrity pledge by all officials and staffs of ICAR-NRC on Seed Spices, Ajmer followed by speech by the Director, ICAR-NRCSS and general discussion by the staff on Vigilance and observance of Vigilance awareness week.



Activities organized during Vigilance Awareness Week – 2018:

Debate Competition: Debate competition on क्या भ्रष्टाचार कमी ना खत्म होने वाला रोग है ? was organized on 1st November, 2018 that received good participation from the employees of ICAR-NRCSS. Two participants each from in favour and in opposition were awarded.

Essay Writing and Paragraph Writing Competition: Employees from ICAR-NRCSS participated in Essay writing on भ्रष्टाचार उन्मूलन में सूचना के अधिकार (आरटीआई) अधिनियम का योगदान and Paragraph writing on कार्यस्थल में भ्रष्टाचार उन्मूलन हेतु कोई एक प्रभावी उपाय organized on 2.11.2018.

On 3.11.2018, organized Valedictory function cum Workshop of Vigilance Awareness Week. Dr. A. S. Panwar, Director, ICAR-IIFSR, Modipuram Meerut was the Chief

Guest of the function. Vigilance Officer Dr. Y. K. Sharma briefed about the different activities conducted during the Vigilance Awareness Week by the committee (Dr. S.N. Saxena and Shri Sumit Singh). The Chief Guest Dr. A. S. Panwar addressed in the Workshop about Vigilance awareness and research opportunities in Western Rajasthan to all staff members of ICAR-NRCSS, Ajmer. Dr. G. Lal, Director given award to the award winning participants in different competitions viz. Debate completion, Essay Writing and Paragraph writing completion. He also addressed the gathering and expressed his views about Vigilance Awareness Week and on the theme '**Eradicate Corruption – Build a New India**'. In the end, Dr. Y. K. Sharma, Vigilance Officer proposed vote of thanks to the Chief Guest, Director and participants.



Celebration of National Productivity Week (12-18 February 2019)

National productivity week was organized at ICAR-NRCSS, Ajmer during 12-18 February 2019. The theme of year 2019 was circular economy for productivity and sustainability. The week was inaugurated on 12th February by Dr. Gopal Lal, Director, NRCSS. Dr. S. N. Saxena PS, NRCSS highlighted the significance of productivity week celebration in reference to the theme of year 2019. The current model of production and management of resources, goods and services that seeks to promote short-term consumption is leading the planet to an unsustainable situation. The now a days economic system is the opposite of the life cycle of nature and collides with sustainable development. In agricultural

perspective the theme is very well imply in reference to organic agriculture. Director NRCSS, Dr. Gopal Lal in his speech emphasized to propogate the potential of organic agriculture for sustainable production and better waste management with efficient recycling of resorces. On this occasion Director, NRCSS also constitute Productivity Improvement Committee of NRCSS comprised of Dr. S. N. Saxena (Chairman), Dr. Y. K. Sharma, Dr. O. P. Aishwath, Dr. Ravindra Singh and Dr. Krishna Kant as members. During the productivity week members of MGMG team visited adopted villages under MGMG programme.

Four team of scientist visited different villages and had meeting with progressive farmers and convice them to adopt organic agriculture and recycling the available resouces.

A team visited the villages Makreda and Dumada and also interacted to the Tabiji farmers for the production of organic seed spices on 15.02.2019. We have also hold the meeting cum training for organic cultivation and processing of their produces. Traing was also imparted on how to increase productivity by using existing resources, cleaning for weed free farm. How to use farm waste recycling throgh various composting methods for bring the sustainability.



Imparting training to the farmers



Animals and compost pits at farmers field for farm waste utilization



Scientist visiting organic seed spices and vegetables.



Azola production as an component of organic milk production

Another team comprised Dr. S.N. Saxena, Dr. S.S. Meena, Dr. N.K. Meena and Mr. Ravi, Y. visited the Dang Village of Saradhana Panchayat on dated 13.02.2019. On this visit team interacted with farmers Sh. Harkaran Paroda, Sh. Ram Sodan, Sh. Jayram and their family members and discussed the various agricultural activities going on in Rabi season crop including plant protection measures.

Interaction was also made with farmers along with their family on integrated farming system. All farmers having good land with minimum irrigation water facilities and having 4-6 buffalow, 1-2 cows and 3-4 goats, hence it was suggested to create compost pit as well as vermicompost pit at their farm yard or nearby by farm yard. They were also suggested to install orchard of ber and aonla for better integration of resources.



One more team made a visit on 16th February, 2019 at Atal Sewa Kendra, of village Kalesara, Ajmer and discussed with them how the agricultural productivity can be enhanced through new and advanced technologies and recycling of nutrients. The team also visited the agriculture farm of a progressive farmer Mr Brijesh Soni and discussed with him to rectify the lacuna in technologies adopted by him or to install the effective advanced technologies available for high productivity. The people of village were encouraged to use bio-pesticides. Farmers were suggested to use need based pesticides application at correct time with optimum dose. They were advised to recycle water and nutrients by using water saving irrigation systems.

A team of scientists visited Mangaliwas village and interacted with Mr. Sukhpal, innovative farmer, regarding cropping system and other farm related activities taken up by him from last 3 years. Mr. Sukhpal at present grows cumin (GC-4), medicago, wheat, barley in addition to cotton and vegetables. He used to burn straw after harvesting. Scientists advised him not to burn straw as it can be used to prepare compost with farm yard manure, so that nutrient cycling can be maintained at farm. Composting procedure can be fastening with the addition of urea. In addition to that scientist explained him that how to increase productivity of crops by judicious application of fertilizers, drip irrigation, adoption of high yielding varieties.



On concluding day of productivity week the institute organized one day training programme on Organic production technology of seed spices for a group of 50

farmers. Dr. Gopal Lal, Director NRCSS delivered one hr talk to farmers about organic production technology of seed spices.



Dr. S.N.Saxena, Chairman, Productivity improvement committee of NRCSS conveyed thanks to all scientists and staff of NRCSS and farmers for their active participation and showing their willingness to follow circular economy rather than linear economy.

Celebration of 150th Birth anniversary of Mahatma Gandhi

On 2nd October, 2018 ICAR - NRCSS, celebrated 150th birth anniversary of Mahatma Gandhi at ICAR-NRC on Seed Spices, Tabiji, Ajmer, Rajasthan. As Babu's dream clean India (Swachh Bharat), first one hour cleanliness drive was carried out at the farm field and in the polyhouse. Then the celebration was done at Dr. R.S. Paroda auditorium, four scientists from the Institute delivered speech on childhood, education, profession and freedom fight movements of Mahatma Gandhi. Quiz competition was also conducted for the farm labour and farmers who are all participated in the programme and 1st, 2nd, 3rd and consolation prizes were distributed to the winners. A mini gallery/ museum was inaugurated by the director, in this gallery ten different quotes of Mahatma Gandhi were displayed to spare his message to all the participants. Further, Dr. Gopal Lal, Director, NRCSS delivered speech on Mahatma Gandhi, he addressed the Babu's life history, his concern about cleanliness and major freedom fight drives.



Rashtriya Ekta Diwas (National Unity Day)

The Birth Anniversary of Sardar Vallabhbhai Patel was celebrated as Rashtriya Ekta Diwas (National Unity Day) on 31 October 2018 at ICAR-NRCSS, Ajmer. The programme on Rashtriya Ekta Diwas (National Unity day) was began with the formal welcome of the all the participants and brief introduction about the importance of observance of birth anniversary of Sardar

Vallabhbhai Patel as Rashtriya Ekta Diwas (National unity day) by Dr. Shiv Lal, (Nodal officer). During the occasion Mr. Sumit Singh, Administrative officer, ICAR- NRCSS- Ajmer has spoken in brief about the major contribution of Sardar Vallabhbhai Patel in India's freedom struggle. After that Dr. S.N. Saxena, Pr. Scientist (Plant Physiology) briefed about the early life of Sardar Vallabhbhai Patel and significant contribution in nation building. On the occasion Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer delivered a short speech about significant contribution of Sardar Vallabhbhai Patel in integrating the nation after independence. He urged all the staff to follow the path of Sardar Vallabhbhai Patel and contribute with full dedication in nation building. To mark the occasion, all the staff of ICAR-NRCSS, Ajmer participated in Rashtriya Ekta Diwas pledge ceremony and Run for Unity and then programme was concluded with vote of thanks.



Mera Gaon Mera Gaurav - Activities undertaken by ICAR-NRCSS, Ajmer

- Field demonstration of Off season leafy coriander production
- Organized Field day, Ajmer and interaction with farmers participated from the MGMG selected villages
- Drip fertigation in seed spices, vegetables and flower

- Organic farming of field crops and vegetables and Vermi-compost production
- Field demonstrations for application of bio fertilizers and bio-pesticides for pest/ disease management in vegetables
- Interaction with farmers for nursery raising of cauliflower in summers/flower cultivation in the MGMG villages using shad nets
- Application of solar pumps for irrigation using drip fertigation
- Organic farming
- People were urged to use bio-pesticides such as *Trichoderma*, *Paecilomyces*, Neem product and PSB for organic farming.
- Farmers were suggested to use as per need based application pesticides at correct time, optimum dose and in perfect format for effective pest management and better produce.
- Farmers were advised to construct farm ponds for water harvesting and recharging ground water
- Farmers were motivated for adopting drip and sprinkler irrigation systems to save water
- They were counseled to raise nursery and use of certified seed for planting and growing certain crops.
- Vegetables (cauliflower & cabbage), off season production of coriander

Activities organised by ICAR -NRCSS, Ajmer under MGMG Programme

S. No.	Name of activity	No. of activities conducted	No. of farmers participated & benefited
1.	Visit to village by teams	31	278
2.	Interface meeting/ Goshthies	22	201
3.	Training organized	4	20
4.	Demonstrations conducted	20	50
5.	Mobile based advisories (No of message)	55	103
6.	Literature support provided (No)	18	153
7.	Awareness created (No)	17	122
8.	Other, if any	1	0
	Total	168	927

Glimpses of MGGM activities



Summer cauliflower and azzola production in summer under MGGM



Farmers interaction, hybrid Bt cotton and agro forestry demonstration conducted at village Kalesara, Makreda and Bhudhwada, Ajmer under MGGM

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पत्रिका सिटीजन

केंद्रीय कृषि राज्यमंत्री प्रो.सखाराम करेने उद्घाटन

बीजीय मसाला किसान मेला व संगोष्ठी कल से

बीबीएन न्यूज नेटवर्क
www.bbnnews.com

अजमेर, राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर में केंद्र के अध्यक्ष बीजीय मसाला किसान मेला व संगोष्ठी का उद्घाटन 2 व 3 दिसंबर को किया गया। केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने उद्घाटन के दौरान किसानों को संबोधित करते हुए कहा कि इस कार्यक्रम का उद्देश्य किसानों को बीजीय मसाला की खेती के लिए आवश्यक ज्ञान प्रदान करना है।

उद्घाटन के दौरान केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने कहा कि बीजीय मसाला की खेती में किसानों को उचित ज्ञान और तकनीक की आवश्यकता है। उन्होंने कहा कि केंद्र के माध्यम से किसानों को उचित ज्ञान प्रदान किया जा रहा है।

इस अवसर पर केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने कहा कि बीजीय मसाला की खेती में किसानों को उचित ज्ञान और तकनीक की आवश्यकता है। उन्होंने कहा कि केंद्र के माध्यम से किसानों को उचित ज्ञान प्रदान किया जा रहा है।

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पत्रिका सिटीजन

अनुसंधान सलाहकार समिति की दूसरी वार्षिक बैठक

बीजीय मसालों का निर्यात पांच गुना बढ़ा

बीबीएन न्यूज नेटवर्क

अजमेर में बीजीय मसाला अनुसंधान केंद्र में बीजीय मसाला निर्यात में पांच गुना बढ़ाई गई है। केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने कहा कि इस बढ़ाई का कारण है कि किसानों को उचित ज्ञान प्रदान किया जा रहा है।

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राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र तबीजी

बायो पेस्टिसाइड से तैयार होंगी अब मसाला फसलें

अजमेर के वैज्ञानिकों ने खोज विकल्प, धनिया की रोग रीज किंगम की विकसित, जीवा, चीक एंव मैथी की फसलों पर सफल प्रयोग



कृषि विभाग के अजमेर के क्षेत्र के किसानों को बायो पेस्टिसाइड से तैयार होंगी अब मसाला फसलें

कृषि विभाग के अजमेर के क्षेत्र के किसानों को बायो पेस्टिसाइड से तैयार होंगी अब मसाला फसलें

अजमेर के वैज्ञानिकों ने खोज विकल्प, धनिया की रोग रीज किंगम की विकसित, जीवा, चीक एंव मैथी की फसलों पर सफल प्रयोग

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प्रधानमंत्री किसान सम्मान निधि योजना का उद्घाटन

‘अन्नदाता समृद्ध तो देश होगा समृद्ध

जिला स्तर पर 11 पात्र किसानों का सम्मान

बीबीएन न्यूज नेटवर्क

अजमेर, प्रधानमंत्री किसान सम्मान निधि योजना का उद्घाटन कार्यक्रम को शुभारंभ करने के लिए जिला स्तर पर 11 पात्र किसानों का सम्मान किया गया।



प्रधानमंत्री किसान सम्मान निधि योजना का उद्घाटन कार्यक्रम को शुभारंभ करने के लिए जिला स्तर पर 11 पात्र किसानों का सम्मान किया गया।

4 माह में तीन किसानों में मिलने 6 हजार रुपए

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कृषि वैज्ञानिकों ने की अनुसंधान परियोजनाओं पर चर्चा

राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र पर अनुसंधान सलाहकार समिति की दो दिवसीय बैठक का अखंड सत्र

बीबीएन न्यूज नेटवर्क

अजमेर में राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र पर अनुसंधान सलाहकार समिति की दो दिवसीय बैठक का अखंड सत्र चल रहा है।



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किसान मेले का शुभारंभ, किसानों को उच्च गुणवत्ता के कृषि उत्पादन की दी जानकारी

श्रुति रिपोर्टर | अजमेर

तबीजी, स्थित राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र में शुक्रवार को दो दिवसीय किसान मेले का शुभारंभ हुआ। पुष्कर विधायक सुरेश रावत ने बतौर मुख्य अतिथि मेले का शुभारंभ कर किसानों को संबोधित किया। मेले में केंद्र सरकार के कृषि एवं किसान कल्याण राज्यमंत्री गजेंद्र सिंह शेखावत को बतौर मुख्य अतिथि आमंत्रित किया गया था, लेकिन किसी कारणों से वे नहीं आ सके। मेले के दौरान किसानों को उच्च गुणवत्ता के कृषि उत्पादन की जानकारी देकर कृषि विशेषज्ञों द्वारा किसानों को कृषि संबंधी



शुक्रवार को दो दिवसीय किसान मेले में कृषि उत्पादन की जानकारी लेते लोग।

के निदेशक डॉ. एस्के सिंह, पूर्व दो। मेले के शुभारंभ के बाद रक्षा सचिव अजय विक्रम सिंह, इफको द्वारा प्रगतिशील किसानों को परस्कार किया गया। इस



एशिया की एक प्रमुख अजमेर में किसानों को उच्च गुणवत्ता के कृषि उत्पादन की जानकारी देकर कृषि विशेषज्ञों द्वारा किसानों को कृषि संबंधी

जीरा की प्रतिरोधक किस्म तैयार करने में जुटे कृषि वैज्ञानिक

राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र में कृषि वैज्ञानिकों की टीम ने जीरा की प्रतिरोधक किस्म तैयार करने में जुटे हैं।



कृषि वैज्ञानिकों की टीम ने जीरा की प्रतिरोधक किस्म तैयार करने में जुटे हैं।

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कृषि वैज्ञानिकों की टीम ने जीरा की प्रतिरोधक किस्म तैयार करने में जुटे हैं।

बीजीय मसालों में 2.5 गुणा वृद्धि



राष्ट्रीय बीजीय मसाला केंद्र के उद्घाटन कार्यक्रम में विद्युत नारा प्रगतिशील किसानों को सम्मानित।

दो दिवसीय बीजीय मसाला किसान मेला एवं संगोष्ठी का उद्घाटन

डॉ. एस्के सिंह, पूर्व रक्षा सचिव अजय विक्रम सिंह, इफको द्वारा प्रगतिशील किसानों को परस्कार किया गया। इस

पांच गुना बढ़ा बीजीय मसालों का निर्यात



बीजीय मसालों का निर्यात पांच गुना बढ़ा है।

बीजीय मसालों का निर्यात पांच गुना बढ़ा है।

अन्नदाता समृद्ध होगा, तो देश समृद्ध होगा



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आधुनिक खेती करने की महत्ता पर डाला प्रकाश



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किसान आत्मनिर्भर होगा तभी देश में विकास संभव



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किसान आत्मनिर्भर होगा तभी देश में विकास संभव।

14. Personnel

14.1 Scientific Staff

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 (Horticulture)
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. Ravi Y., Scientist (Spices, Plantation, Medicinal & Aromatic Plants)
18. Dr. Shiv Lal, Scientist (Horticulture)
19. Dr. Narendra Chaudhary (Spices, Plantation, Medicinal & Aromatic Plants)

14.2 Technical Staff

1. Sh. M.A. Khan, CTO
2. Sh. S.R. Meena, STO
3. Sh. G.K. Tripathi, Technical Officer
4. Sh. P.K. Agarwal, Technical Assistant
5. Sh. S.R. Balai, Technical Assistant

14.3 Administrative Staff

1. Sh. Sumit Singh, AO
2. Sh. Bhim Singh, AAO
3. Sh. Sunil Kumar Agrawal, AF&AO
4. Sh. Sanjeev Sharma, Assistant
5. Sh. Pradeep Kulhari, Assistant
6. Sh. R.K. Kanwaria, UDC
7. Sh. Amit Kumar Gupta, LDC
8. Sh. Mukesh Kandari, LDC

14.4 Skilled Supporting Staff

1. Smt. Sarla Devi, SSS
2. Sh. Pukhraj Paroda, SSS

14.5 Study Leave

1. Sh. Mukesh Kumar Vishal, Scientist (Agriculture Statistics)

14.6 New Joining

1. Dr. Shiv Lal, joined as scientist on 04.07.2018 at ICAR-NRCSS, Ajmer
2. Dr. Narendra Chaudhary, joined as scientist on 02.07.2018 at ICAR-NRCSS, Ajmer

14.7 Transfer & posting:

1. Sh. Honnappa Asangi Scientist, transferred to ICAR - IISR, Calicut (Kerala) & relieved on 23.06.2018
2. Sh. Suresh Kumar, Assistant, transferred to ICAR, HQ, New Delhi on 08.03.2019

14.8 Promotions

1. Sr. G.K. Tripathi, promoted as Technical Officer, w.e.f. 12.12.2017
2. Sr. P.K. Agrawal, promoted as Technical Assistant, w.e.f. 04.11.2016
3. Sr. S.R. Balai, promoted as Technical Assistant, w.e.f. 22.02.2018

14.9 Retirement

1. Sh. S.P. Maheria, CTO retired on 31.01.2019



Annexure - I

Table 1: Monthly weather data during 2017 at ICAR-NRCSS, Ajmer (Raj.)

Year 2017	Mean Temperature ($^{\circ}$ C)		Relative humidity (%)		Evaporation mm/day Minimum	Total rainfall (mm) Maximum
	Minimum	Maximum	7.40 am	2.40 pm		
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

Table 2: Monthly weather data during 2018 at ICAR-NRCSS, Ajmer (Raj.)

Year 2018	Mean Temperature ($^{\circ}$ C)		Relative humidity (%)		Evaporation mm/day	Total rainfall (mm)
	Minimum	Maximum	7.40 am	2.40 pm		
January	4.2	25.4	86.6	57.2	3.7	
February	8.9	28.2	83.1	46.8	4.9	
March	14.0	33.7	79.0	45.4	8.3	
April	22.7	39.2	73.3	32.2	12.9	
May	26.2	42.4	72.7	42.9	20.1	10.3
June	27.8	39.3	42.8	40.2	18.6	50.2
July	25.5	33.7	80.2	64.8	7.3	179
August	24.6	32.3	60.5	62.9	5.2	125.6
September	22.2	31.3	74.7	56.5	5.2	115.2
October	15.9	35.0	74.6	29.4	7.1	
November	9.5	31.2	66.8	28.4	6.1	
December	3.7	24.6	78.1	51.9	4.2	
Average	17.1	33.0	72.7	46.5	8.6	480.3

Certificate of Registration

Awarded to

ICAR - NATIONAL RESEARCH CENTRE ON SEED SPICES

TABLI, AJMER – 305206, RAJASTHAN, INDIA.

It is Certified that Quality Management System of
Organization has been audited and found to be in accordance
with the requirements of

ISO 9001:2015

For the Scope of activities described below

“QUALITY RESEARCH AND DEVELOPMENT OF SEED SPICES”.

Certificate No :	17DQAL54	
Initial Registration Date :	19-04-2017	Issuance Date : 19-04-2017
Date of Expiry* :	18-04-2020	
1st Surve. Due	19-03-2018	Ind Surve. Due 19-03-2019



Director



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