



वार्षिक प्रतिवेदन
ANNUAL REPORT
2020



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.



ICAR - NRCSS | ANNUAL REPORT 2020



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Correct citation

Annual Report (2020).
ICAR - National Research Centre on Seed Spices
Tabiji, Ajmer - 305206, Rajasthan (INDIA) —p.

Published by

Dr. S.N. Saxena
Director (Acting), ICAR- National Research Centre on Seed Spices,
Ajmer-305206 (Raj.), India.

ISSN : 2456-2467

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Printed at

Job offset Printer's Ajmer

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(ISO 9001 : 2015)

June, 2021



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PREFACE



Agriculture plays a vital role in India's economy. About 54 per cent of the Indian population is engaged in agriculture and allied activities and it contributes about 16 per cent to the country's Gross Domestic Production. Even during the COVID-19 pandemic situation the overall agricultural growth witnessed a positive growth. There was huge domestic as well as abroad demand for spices especially due to medicinal attributes associated with these commodities. Given the importance of seed spices as cash crops ICAR-NRCSS took several steps for its sustainable development during the lock-down period and after that. Steps have been taken to advise the seed spices growers through mass media, press releases and our scientists provided much needed plant protection and cultivation related farm advices via social media, mobile and telephones. The ICAR-NRCSS got notified 04 improved varieties of seed spices and has been identified several elite genotypes through traditional and mutation breeding programme. Concerted research efforts are being taken to improve the resource use efficiency specially drip-irrigation and enhanced nutrient & water efficiency through fertigation, to support organic farming through sustainable management of insect pests and diseases. Special emphasis has been given to minimizing the use of chemical pesticides and fertilizers. For this purpose, the mass multiplication of biocontrol agents, botanical insecticides and biofertilizers were done to provide quality inputs to seed spices growers and other farmers. To spread the improved seed spice varieties & technologies of seed spices cultivation in new areas a dedicated team of scientists is working for transfer of technology under SCSP, TSP and NEH areas through FLDs and scientist-farmer interaction on regular basis. For commercialization of developed technologies 03 MOUs signed with different organizations during this period and several processing industry persons visited the institute for scientific collaboration and interacted with our scientists for possible roll out of post harvest technologies.



There was little or no adverse impact of Covid-19 pandemic on area and production of seed spices, however, due to market demand many farmers could get better prices of cumin, coriander, nigella, fennel and fenugreek in some parts of Gujarat and Rajasthan. As per DASD, Govt. of India 2019-20 estimates, seed spices namely Cumin, Coriander, Fenugreek, Fennel, Ajwain, Dill, Poppy and Celery occupied 17.38 lakh hectare area with a total production of 16.79 lakh tonne in India. During this year the country exported 3.4 lakh tonne seed spices, having a worth of ₹ 4221.39 crore in the international market. Still there is possibility of increasing share of seed spices in export basket of spices and we are continue to put our efforts to achieve this.

I am highly grateful to Dr. T. Mohapatra, Secretary, DARE and DG ICAR, for pertinent guidance and constant encouragement. I express my sincere gratitude to Dr. Anand Kumar Singh, DDG (Horticulture Science) for his persistent support and encouragement in R, E, D activities and progress of the institute. I thank Dr. Vikramditya Pandey, ADG (Hort. Sci.- I) and Dr. B.K. Pandey, ADG (Hort. Sci.- II) for providing all the necessary help from SMD and ICARHQ. I am indebted to the editorial committee for bringing the Annual Report-2020 on time. I thank all the scientists, officers and other staff members of the institute for their significant contribution made in fulfilling the mandate. I hope this issue will surely help the stakeholders on many aspects that is essential for the prosperity of seed spices cultivators and benefit of users. I place before the readers this annual report 2020 for constructive suggestions and information to all stakeholders.

June, 2021

Ajmer

(Shailendra Nath Saxena)



1. Executive Summary

Crop Improvement

- Four new varieties of seed spice crops were developed and notified for release at national and state level. These are Ajmer Ajwain-73 (AA-73), Ajmer Nigella-1 (AN-1), Ajmer Celery-2 (ACel-2) and Ajmer Green Coriander-1 (AGCr-1).
- Ajmer Ajwain-73 takes 165-170 days to maturity and gives average yield 10-11 q/ha. It seed contains 9.15% total oil and 6.38% essential oil. It shows high tolerance to Root rot and *Sclerotium* rot in field condition. Ajmer Nigella-1 takes 145-150 days to maturity and gives average yield 9 q/ha. Ajmer Celery-2 takes 120-125 days to maturity and gives average seed yield 8.74 q/ha. Its seed content essential oil 6.74% which is 17% higher than check variety ACel-1. Ajmer Green Coriander-1 developed for only leaves purpose and also well grown in shade net in summer (off season). It takes 50-60 day for first cutting and gives average yield 74.3 q/ha green leaves in Rabi season.
- Germplasm collection at NRCSS gene bank reached 2331 comprised of nine mandated seed spice crops. A set of germplasm of each crop have been evaluated for breeding specific traits as per descriptors.
- One hundred fenugreek germplasm accessions were evaluated for yield attributing characters along with four checks. Fifteen accessions namely AM-60, AM-119, AM-31, AM-10, AM-51, AM-36, AM-50, AM-155, AM-118, AM-45, AM-12, AM-46, AM-56, AM-62 & AM-95 were found high yielding over the check variety.
- Eleven accessions of Kasuri methi (*Trigonella corniculata* L.) with one check were also evaluated for seed yield which ranged from 192g to 290g/plot.
- Eleven coriander accessions were evaluated along with four checks (ACr-2, ACr-3, Hisar Anand & RCr-728). Highest seed yield (1786.67kg/ha) was recorded in genotype RSM/C18/N as compared to check variety RCr-728 (1312.22 kg/ha).
- Forty three fennel mutant lines were found promising and stable for the selected character such as early flowering (RF/200/30/7), multiple branching from ground level (RF/225/88/1), dwarf (RF/250/73/1), synchronous flowering (RF/225/37/10) and early maturity (RF/200/65/5).
- Fennel genotypes AF-87 (PDI-10.5) and AF-3 (PDI-14.3) were reported lower disease incidence of *Ramularia blight* and recorded as resistant to *Ramularia blight*.
- Two dill genotypes, AD-S-44 (2419 kg/ha) and AD-S-2015-2 (2347 kg/ha) were found higher yielder as compared to check varieties AD-1 (2040 kg/ha) and AD-2 (1685 kg/ha).
- Among 17 genotypes of celery evaluated for seed yield, A-Cel-7 (433 kg/ha) recorded highest seed yield while maximum essential oil (1.8%) was recorded in genotype Karnoli-13 over the check variety A-Cel-2 (388 kg/ha & 1.6%).
- For genetic improvement of cumin for higher yield and wilt resistance, 37 cumin genotypes



with two check varieties were evaluated. Maximum seed yield (631 kg/ha) was recorded in genotype BC-13 followed by (615kg/ha) SPS/29/2 genotype of cumin.

- In ajwain, higher yield (1212.50 kg/ha) has been recorded in AA-3 genotype followed by AA-27 (1162.50 kg/ha) as compared to national check.
- In nigella, higher yield attributes and yield (1305.50 kg/ha) has been recorded in AN-9 genotype followed by (1247.75 kg/ha) AN-10 as compared to national check.
- Six candidate genes in coriander germplasm lines associated with stem gall resistance have been identified and validated and five have been documented at NCBI. Protein structures of the five validated genes have been elucidated and registered to PM& D.
- Biochemical pathways for defence mechanism in fennel for *Ramularia blight* have been identified.

Crop Production

- The microbial inoculation with *Pseudomonas fluorescens* resulted into maximum (5.24 q/ha) yield in cumin and minimum seed yield was recorded with control (3.60 q/ha). In case of fenugreek the highest seed yield (18.77 q/ha) was obtained with microbial inoculation of Rhizobium+ *B. megaterium* while lowest seed yield was obtained with control (15.59 q/ha).
- Under two tier system of production technology in seed spices, coriander in rabi for seed followed by bottle gourd + leafy coriander for vegetable purposes gave maximum FSEY (26797 kg/ha) with maximum gross and net returns (Rs 724806) and 3.40 B:C ratio.
- Under Seed spice based inter cropping with remunerative fruit crops, the highest fruit yield of guava (5540 kg/ha) was recorded in treatment (Guava + Fenugreek) followed by Nigella +

Guava (4893.67 kg/ha) treatment. Highest fruit yield of pomegranate (4,884 kg/ha) was recorded in treatment (Pomegranate + Fenugreek) followed by Nigella+ Pomegranate (4,225 kg/ha) treatment.

- Qualitative assay for potassium solubilization by rhizobacterial isolates was performed under lab conditions, in which maximum K-solubilization index was recorded with DCU-351 (2.9) which was at par with DCU-364 (2.8) and DCU-453 (2.7). The lowest K-solubilization index was observed with DCU-366(1.3).
- Seed yield of ajwain in response to graded levels of N was more with 40 and 60 kg N/ha while rest of treatments were at par with control.
- Response of celery to integrated use of N and FYM produced highest yield of with 10t FYM together with 60 kg N/ha. Nitrogen and phosphorus uptake was enhanced with 10t FYM alone and 30 and 60kg N along with either dose of FYM.
- Across the locations in Ajmer district among 6 cumin varieties, maximum seed yield was recorded from Budhwada (611.0 kg/ha) village followed by Dang (294.5 kg/ha). In summer season maximum yield (368.7 kg/ha) of green coriander was registered under coriander-green, coriander-mung bean cropping system. Maximum seed yield (1165.9 kg/ha) of cluster bean was recorded under fenugreek-cluster bean-cluster bean cropping system.

Crop Protection

- Seed treatment and soil application of *Trichoderma* and *Pseudomonas fluorescens* reduced the root rot incidence (61-67%) in nigella and (43-57%) in ajwain when applied individually and in combinations.
- Applications (3-4 foliar spray) of different recommended fungicides (mancozeb,



difenoconazole and azoxystrobin) scheduling to apply as foliar spray from 45 days after sowing and subsequently at 15 days interval found most effective to combat blight disease of cumin (63-79% reduction as compared to control).

- The minimum mycelium growth (4.10mm) was recorded in the treatment 'Karanj oil 2% + biological agent (B1) 10% followed by (4.60mm) in 'Garlic extract 2% + biological agent (B1) 10%. The maximum mycelium growth (4.60mm) was found in control.
- The maximum per cent reduction in aphid (94.38%) and thrips population (94.88%) was recorded on coriander plants treated with IPM module M5 (imidacloprid 600FS 3ml/kg seed (ST) + ker plant extract 10ml/lit. + *Verticillium lecanii* (1x10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035%). This module M5 was equally effective for aphid and thrips control in cumin crop.
- Treatment with Thiomethoxam-0.025% + Synergist 5% proved most effective in reducing the aphids population in fenugreek, coriander and cumin crops and was superior to the commercial formulation of Thiomethoxam. Among botanical formulations non polar formulation of sesum leaves (*Delbergia sisoo*) and modified neem composition was found more effective than neem oil @2% application in combating the aphids population. Soluble concentrate (SC) formulation of *Verticillium lecanii* proved higher efficacy than normal spore suspension formulation.
- It was critically observed that the cumin blight disease caused by *Alternaria burnsii* was comparatively more in intensity in eastern and central growing regions of Rajasthan than western regions. *Ramularia blight* disease was recorded in low intensity this year (PDI 2). Wilt disease in cumin was seen in range from 1.2 to 8.3 and *Alternaria blight* recorded up to 11.3%.

Downy mildew on fenugreek was seen from 0.8 to 5.2% while powdery mildew in fenugreek recorded from 1.5 to 5.8%. The stem gall and Sclerotium rot on coriander was found in lower intensity (0-2.2%). *Ramularia blight* on fennel was also found in low intensity (0-0.8%).

Basic Science

- Many PGRs treatments were found to enhance cumin seed yield per plant being observed maximum (1.73g) in irradiated carrageenan (IC) 80ppm followed by 1.72g in irradiated sodium alginate (ISA) 120ppm and 1.45g in ISA 20ppm.
- In case of coriander, essential oil yield was increased up to 0.36% as compared to control 0.26% by treatments of IC and ISA 50, 100, 150ppm.

Post harvest management and value addition

- To determine optimum stage of fennel seed for culinary purpose, the maximum score, based on hedonic scale was recorded for overall acceptability (8.27) for seeds harvested at 75 days after anthesis or 182 days after sowing (DAS). In case of fennel seed for chewing purpose, overall acceptability was recorded for the seeds harvested at 35 DAA followed by 40 DAA and 45 DAA.
- Overall acceptability score was recorded highest in the fennel seeds dried by oven drying method (500C) followed by drying in shed with hanging umbels.
- Good amount of phenolic content was recorded in all seed spices being maximum (60 mg GAE/g Seed) in coriander genotype ACr-2 while flavonoid content was more (90 mg QE/g Seed) in fenugreek genotypes AFg-4.

Social sciences

- Cumin export from India registered 19.61 and 26.86 percent compound annual growth in quantity and value, respectively from 2004-05 to



2018-19, its export increased by more than eleven times from 15767 to 180300 tonnes in respective years.

- During 2004-05 to 2018-19, coriander export increased from 33 to 49 thousand tonnes, at compound growth of 3.47 percent per annum. In monetary term its export increased from Rs 82 to 352 Crore at compound growth of 13 per cent per annum. Transition Probability Matrix of coriander pointed out Malaysia as highest loyal market of Indian coriander followed by U.K.
- During the year of 2019-20, a total of 253 frontline demonstrations (FLDs) of different seed spices i.e. coriander, fennel, fenugreek, ajwain, nigella and dill were conducted at farmer's field in different villages of Pratapgarh, Banswara, Dungarpur and Udaipur districts of Rajasthan under TSP project.

Externally funded projects

- Under DUS testing experiment of major seed spices total 35 varieties of coriander, (26 reference and 9 candidate), 22 varieties of fenugreek, 21 varieties of fennel, 9 varieties of cumin were evaluated for developing DUS guidelines.
- Under DUS testing experiment of minor seed spices 9 varieties of ajwain with 15 germplasm lines, 5 varieties of dill with 15 germplasm lines, 5 varieties of nigella with 15 germplasm lines, 4 varieties of celery and 2 varieties of anise were evaluated for developing DUS guidelines.
- Under DASD sponsored Pilot project on pesticide free cumin production through popularization of bio-agents and botanicals for plant health management" FLDs were given to 50 farmers (1.0 ha area each) in Barmer and Nagaur district of Rajasthan. The total revenue of Rs. 931430.0 generated through the sale of different bio agents produced by bio-control lab established under NHM.

- Experiments for nutrient and insect pests/disease management have been conducted for standardization of seed spices based organic farming system under NPOF.

Other activities

- An interface meeting of seed spices stakeholders was organized on foundation day (19 January 2020) of ICAR-NRCSS, Ajmer.
- Non exclusive license for production and multiplication of three seed spice varieties namely ACr-2 (Coriander), AD-2 (Dill) and AFG 5 (Fenugreek) were given to private agencies by signing MoU through ITMU, NRCSS, Ajmer.
- MoU with 3 SAU and one College has been signed for mutual cooperation in the field of Agricultural research and education.
- Thirty eight International/national research publications were made by NRCSS scientists during reporting period.
- National seed spices farmers fair was organized during 15-16 February 2020 in which more than 2500 farmers from Rajasthan, Gujarat, M.P. and U.P. participated.
- ICAR-NRC on Seed Spices, Ajmer observed Vigilance Awareness Week from 27th October, 2020 to 2nd November, 2020 at NRCSS campus. The theme of the Vigilance Awareness Week this year was 'Vigilant India, Prosperous India'.
- Rajbhasha Hindi pakhwada was organized during 14-31 September 2020.
- ICAR-NRC on Seed Spices, Ajmer celebrated the 150th Birth anniversary of Mahatma Gandhi at a grand level using online media which started on 26 September 2020 and a week was celebrated upto 2nd October 2020.
- Constitution day was celebrated as on 26th November to commemorate the adoption of the Constitution of India and to honour and



acknowledge the contribution of the founding fathers of the Constitution.

- ICAR-National Research Centre on Seed Spices observed "Swachhata Pakhwada-2020" programme from 16th December to 31st December 2020. Various swachhata related activities were undertaken during this programme.
- Many events organized under Mera Gaon Mera Gaurav programme for imparting knowledge and skill to farming communities about the latest technological development in seed spices and allied agricultural activities.
- Many Front line demonstrations and field days were organized under Tribal area sub-plan in different districts of Rajasthan. Similarly farmers training programmes were organized under NEH and SCSP programme and inputs distributed to beneficiary farmers and farm women under various on-farm and off-farm training programmes for transfer of improved technologies of seed spices cultivation and post harvest management.
- During 2019-20 TFL seed production of cumin variety GC-4 and fennel variety AF-2, was taken on Farmer's field under Farmer's Participatory Seed Production Programme and total of 299.19 q TFL seed was produced. Besides this, 2832 kg of breeder seed for different varieties of seed spices was produced at ICAR-NRCSS farm.



2. Introduction

The flavour and aroma of Indian spices are spread throughout length and breadth of Globe. Out of 109 spices listed by ISO, 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. 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. 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. Seed spices account for about 51.79 per cent and 19.06 per cent of total area and production of spices in the country. There are about twenty seed spices grown in India, the important among them are coriander, cumin, fennel, fenugreek, ajwain, dill, celery, anise, nigella and caraway. 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. 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. 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. India witnessing a steady increase in total area and production of seed spices during last two decades but realization of potential productivity of major seed spices is still hold major concern. Abiotic stress like frost and infestation of pests, disease leads to major damage to these crops. Late winter, rainfall, etc also adversely affect the quantity and quality of harvested produce. Development of new improved varieties of seed spices, efforts of increasing seed replacement rate, developing crop and variety specific production and protection technologies and efficient use of available natural resources resulted in increase in productivity, however, it still need to reach its full potential. Several issues emerged after making analysis of different constraints affecting production of these crops, which 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.

Seed Spices sector provides 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.

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 ICAR-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 airports are Kishangarh airport (30km) and Jaipur airport 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 (low), P₂O₅ 12 kg/ha (medium), K₂O 85 kg/ha (low), Ca 214.7 kg/ha (high), Mg 258 kg/ha (medium), S 27 kg/ha (medium).

The rainfall in the area is highly erratic and more

than 90% of the rain is received during July to September with several intermittent long dry spells. The monsoon rains generally commence by the end of June but sometimes delayed till the first week of August. The rainfall is confined to the period mostly between July to September, the rainfall averages between 250-500 mm with a maximum of 750 mm in good rainy years and 50-200 mm in scanty rainy years. The temperature ranges from 2-5°C during January and 42-45°C during May. The winter showers are 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%. Annexure-1

2.3 Agro meteorological data for the year 2019-20 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 2019-20 are presented in Annexure 1. The maximum monthly rainfall of 360.0 mm was recorded during August, 2019, whereas it was 160.8 mm during October, 2020. The total rainfall was 760.3 during 2019, whereas it was 485.2 mm during 2020 with 41 rainy days during the year. The rainfall was lower by 9.0 % during 2020 as compared to the mean annual rainfall of 529.0 mm (for the 100 years) in the area. The minimum temperatures drops to 0.5 °C on 10th and 1.0 °C 24th January, 2020 and a frost event was happened which damaged the seed spices and other crops to some extent in the area. Whereas, maximum temperature of 44.0 °C were recorded on 22-27th May during 2020 and remained > 40.0 °C from 9 June, 2020 to 23 June, 2020. The lowest relative humidity was 28.0 per cent on 11-15th April, 2020 while the highest (96%) was recorded on several occasions during the year. The total open



pan evaporation during the year 2019 and 2020 were 3243.8 and 3175.5 mm, which was 8.9 and 8.7 mm/day during 2019 and 2020, respectively. The evaporation remains > 20.0 mm/day during April, 2020. The lowest evaporation of 0.0 mm/day was recorded at many times during October, 2020 whereas the highest evaporation was recorded 27.0 mm/day during 16 June, 2020.

Mandate

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

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

2.7 Financial Outlay (₹ in Lakhs)

HEAD	BUDGET	EXPENDITURE
Minor Works	0.00	0.00
Equipment	20.32	11.50
Information technology	3.44	3.44
Furniture and Fixture	0.24	0.24
Other SCSP capital	2.00	1.36
Salaries	582.10	569.52
Pension	48.82	48.82
Travelling Allowance	2.67	2.67
Research & Operation	145.58	145.58
Administrative Expenses	101.54	101.54
Miscellaneous Expenses	0.21	0.21
TSP	20.00	16.08
NEH	34.84	20.72
SCSP	75.00	50.77
Total	1036.76	972.45

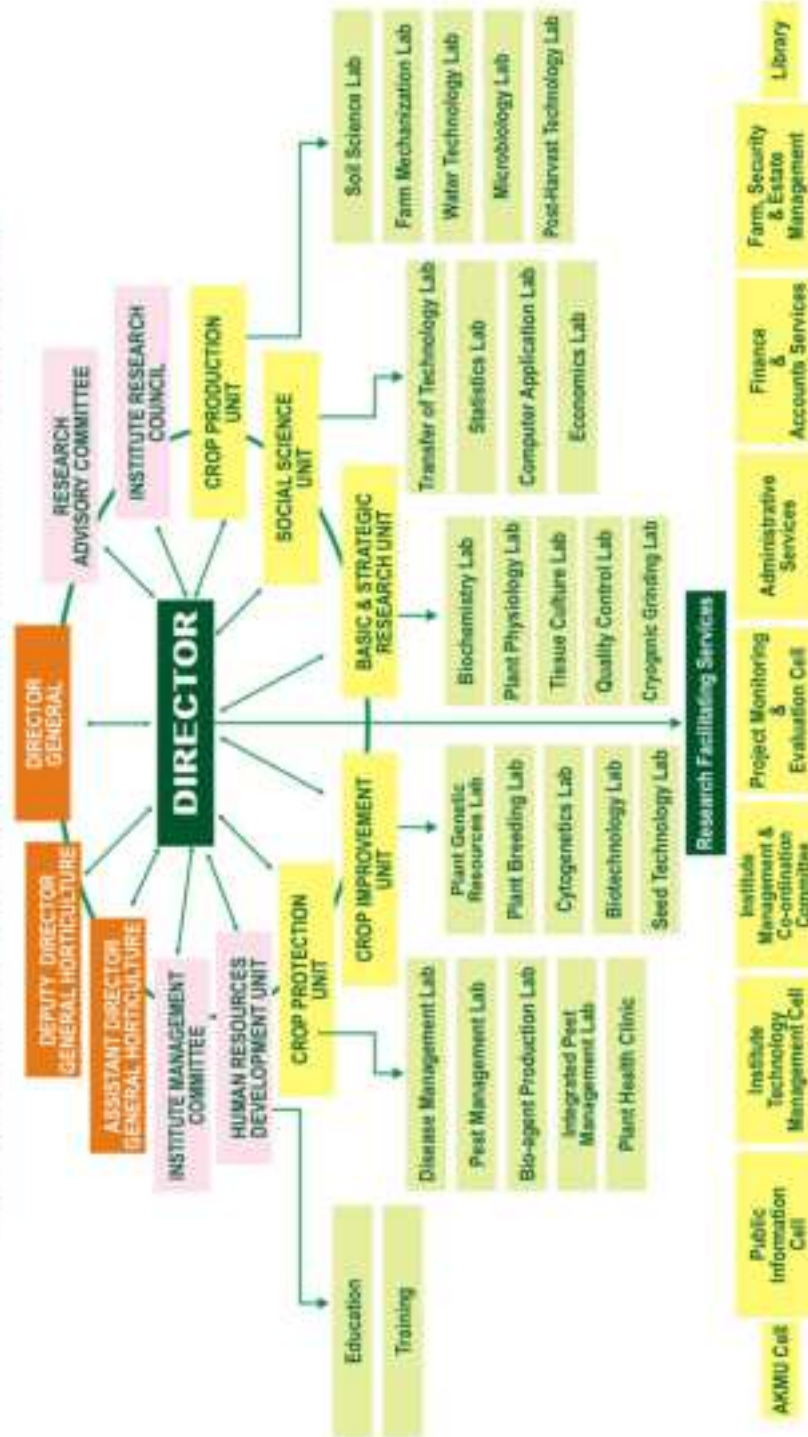


- the seed spices for export, based on environment friendly production of potential technology.
7. Research on seed technology for production of quality seeds of improved varieties.
 8. Study of economics of production and marketing.
 9. Development of pre and post harvest technology for better processing, storage and

2.8 STAFF POSITION on 31-12-2020

S.No.	Class of Posts	Total sanctioned posts	Employees in position
1.	Scientific Posts		
a.	Scientist	16	14
b.	Senior Scientist	04	06
c.	Principal Scientist	2	1
d.	Director/RMP Scientist	1	1
	Total	23	22
2.	Technical Posts		
a.	Category I	1	1
b.	Category II	3	2
c.	Category III	4	2
	Total	8	5
3.	Administrative Posts		
a.	Category "A" posts:-		
	AO	01	0
b.	Category "B" posts:-	06	03
	AF&AO	01	01
	AAO	01	01
	Assistant	04	01
c.	Category "C" posts:-	04	02
	UDC/Steno/LDC		
	Total	11	5
4.	Supporting Skilled Staff	2	2
	Grand Total	42	34

ORGANOGRAM OF NATIONAL RESEARCH CENTRE ON SEED SPICES





3. Research Achievements

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

CI/19.1.1: Management of plant genetic resources of seed spices

(R.S. Meena; S.N. Saxena, S.S. Meena, A.K.Verma and N.K. Meena)

Germplasm Collection

Germplasm collection from various geographical areas of country is a regular activities to enhance the NAGS holdings at NRCSS. In reporting year no new germplasm was added in the collection due to Covid 19 lockdown (table 3.1).

Table 3.1: Total germplasm assemblages at ICAR-NRCSS, Ajmer

Crop	NRCSS Collection			NAGS Holding
	Indigenous	Exotic	Present available	
Cumin	100	7	107	247
Coriander	169	3	176	549
Fenugreek	82	59	135	733
Fennel	118	3	46	297
Ajwain	99	1	91	100
Dill	106	5	108	111
Nigella	21	3	24	24
Celery	36	-	36	36
Anise	18	-	18	18
Caraway	8	2	2	10
Total	790	83	745	2331

Germplasm Evaluation Curators of respective seed spice crop maintained and evaluated the germplasm and recorded observations as per descriptors.

Fenugreek (*Trigonella foenum-graecum*)

One hundred fenugreek germplasm were sown with four checks in Augmented Block Design and evaluated for the yield and its contributed traits. The analysis of variance revealed significant difference among the tested entries for all the traits including seed yield. The seed yield ranged from 30g to 515g. Variability was recorded and presented in table 3.2 and 3.3.

Eliteen accessaries: Fifteen accession of fenugreek (AM-60, AM-119, AM-31, AM-10, AM-51, AM-36, AM-50, AM-155, AM-118, AM-45, AM-12, AM-46, AM-56, AM-62 & AM-95) found high yielding over the check variety.

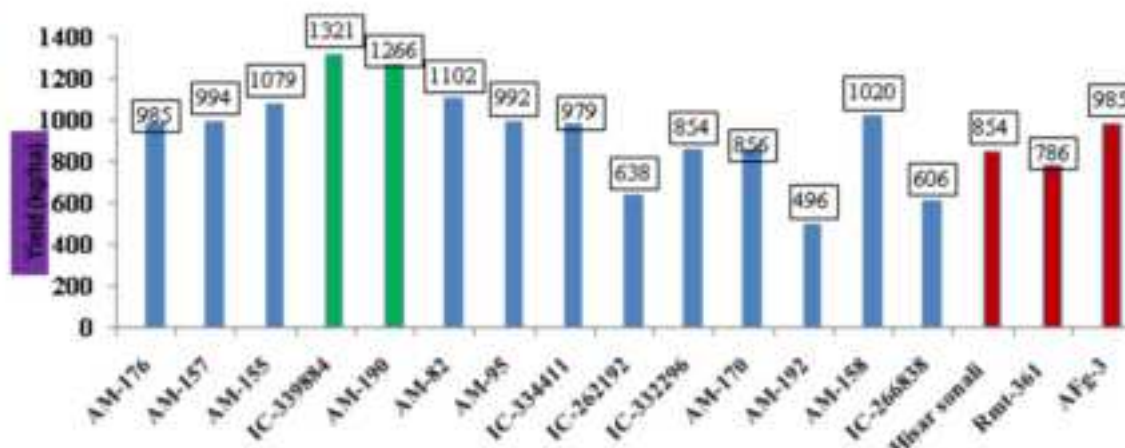
Fenugreek station trial Fourteen genotypes of fenugreek accessions were evaluated along with three checks namely AFG-3, Hisar Sonali & RMT-361 in Randomized Block Design. The analysis of variance revealed significant difference among the tested entries for all the traits including seed yield. The highest seed yield recorded in genotype IC-339884 (1321 kg/ha) over check variety AFG-3 (985 kg/ha) (table 3.4).

Table 3.2: Variability recorded in fenugreek

Character	Mean	Min.	Max.	CV (%)
Plant height	56.95	45	70	10.2
Primary branches	4.20	3	6	7.3
Secondary branches	7.45	5	11	5.6
No. of pods/plant	53.66	19	95	16.8
No. of seeds/pod	16.99	14	22	6.5
Test weight (g)	12.95	11.4	15.5	6.8
Seed yield (g/plot)	193.22	30	515	18.3

**Table 3.3: Evaluation of fenugreek accessions for yield contributes traits**

Character	AFg-3 (Check)	No. of accessions	Promising accessions identified
Plant height (cm)	62	15	AM-35, AM-99, AM-101, AM-117, AM-105, AM-100, AM-108, AM-112, AM-2, AM-11, AM-31, AM-44, AM-61, AM-67, AM-71
Primary branches/plant	5	24	AM-12, AM-45, AM-95, AM-155, AM-9, AM-10, AM-11, AM-14, AM-16, AM-19, AM-27, AM-30, AM-31, AM-34, AM-39, AM-46, AM-50, AM-51, AM-54, AM-56, AM-58, AM-60, AM-62, AM-65
Secondary branches/plant	8	31	AM-95, AM-12, AM-62, AM-129, AM-155, AM-10, AM-14, AM-16, AM-30, AM-39, AM-42, AM-45, AM-46, AM-50, AM-51, AM-55, AM-58, AM-63, AM-67, AM-71, AM-76, AM-100, AM-110, AM-113, AM-115, AM-118, AM-124, AM-136, AM-139, AM-141, AM-144
No. of seeds/pod	17	51	AM-12, AM-45, AM-19, AM-46, AM-10, AM-21, AM-31, AM-54, AM-56, AM-155, AM-16, AM-18, AM-22, AM-32, AM-43
No. of pods/plant	75	22	AM-12, AM-95, AM-45, AM-56, AM-51, AM-155, AM-62, AM-46, AM-36, AM-50, AM-31, AM-60, AM-119, AM-10, AM-51, AM-36, AM-45, AM-12, AM-46, AM-56, AM-62, AM-95
Test weight (g)	14.3	27	AM-10, AM-31, AM-155, AM-12, AM-128, AM-62, AM-119, AM-16, AM-72, AM-95, AM-109, AM-118, AM-138, AM-146, AM-19, AM-29, AM-32, AM-56, AM-60, AM-67
Yield (g)	298	15	AM-60, AM-119, AM-31, AM-10, AM-51, AM-36, AM-50, AM-155, AM-118, AM-45, AM-12, AM-46, AM-56, AM-62, AM-95



CD(0.05)= 185.06 CV(%)= 19.86

Performance of fenugreek genotypes for seed yield (kg/ha) in station trial

Table 3.4: Performance of fenugreek genotypes for ancillary characters in station trial

Genotype	Height (cm)	Primary branches	Secondary branches	Pods /plant	Seed /pod	Test weight (g)	Seed yield (Kg/ha)
AM-176	60.33	4.00	5.67	59.67	17.67	13.17	985
AM-157	63.33	5.67	7.00	56.00	17.67	14.00	994
AM-155	65.33	5.33	8.00	68.00	21.33	16.40	1079
IC-339884	70.00	5.00	7.00	84.00	20.00	15.80	1321
AM-190	71.00	5.33	6.00	80.67	20.67	13.33	1266
AM-82	70.00	5.67	7.00	63.33	17.33	13.20	1102
AM-95	70.67	6.00	8.00	55.00	15.67	12.00	992
IC-334411	55.00	5.00	7.00	75.00	22.00	14.90	979
IC-262192	55.00	6.33	8.00	72.00	18.67	13.50	638
IC-332296	55.00	5.67	8.00	75.00	19.33	12.10	855
AM-170	65.00	5.00	7.00	69.00	16.67	15.10	856
AM-192	50.00	6.33	8.00	56.33	19.33	16.40	496
AM-158	65.00	5.00	7.00	69.67	19.67	13.00	1020
IC-266838	65.00	5.67	6.00	90.33	19.67	9.30	606
Hisar Sonali	69.33	4.90	7.00	68.00	19.77	12.73	855
RMt-361	67.33	5.57	7.70	63.67	19.13	12.91	786
AFg-3	70.67	4.87	7.67	80.33	18.17	15.63	985
Mean	64.68	5.37	7.17	69.76	18.99	13.73	927
CD (0.05)	1.4	1.37	1.31	2.17	3.43	0.75	185.06
CV (%)	1.3	12.34	11.31	1.83	10.76	3.26	19.86

**Table 3.5: Variability recorded in coriander genotypes**

Character	Mean	Min.	Max.	CV (%)
Plant height	93.5	76	124	10.6
Primary branches	4.6	3	7	6.6
Secondary branches	6.3	4	9	8.4
Umbels/ plant	36.2	14	55	30.2
Umbellates / umbel	6	4	7.1	15.4
Seeds /umbellate	5.5	4	8	14.5
Test weight(g)	12.7	10.3	14.5	14.3
Seed yield (g/line)	140.5	40	349.5	45.3

Coriander Fifty four genotypes were sown with four checks in Augmented Block Design tested for yield and its contributed traits. The analysis of variance revealed significant difference among the genotypes for all the traits including seed yield which ranged from 40g to 349.5g (table 3.5 & 3.6).

Ten genotypes of coriander (SDM-19-34, SDM-19-3, SDM-19-19, VDV/GL-114, SDM-19-21, SDM-19-9, SDM-19-45, ACr-160, and ACr-130 & IC-0143700) found high yielding over the check variety.

Table 3.6: Promising genotypes of coriander

Character	ACr-2 (Check)	No. of genotypes	Promising genotypes identified
Plant height (cm)	95	25	SDM-19-35, SDM-19-19, VDV/GL-114, IC-067168, SDM-19-25, SDM-19-45, UD-624, SDM-3-32, IC-143703, SDM-19-48, SDM-19-44, SDM-19-28, EC-0305585, SDM-19-47, SDM-19-24, SDM-19-23, UD-726, SDM-19-50, VDL-GL-29, IC-0143700, UD-752, SDM-19-20, ACR-130, IC-570294, SDM-19-32
No. of pri. branches/plant	6	23	SDM-19-20, SDM-19-3, SDM-19-19, VDV/GL-114, SDM-19-21, SDM-19-9, SDM-19-45, ACr-160, ACr-130, IC-0143700, VDL-GL-29, UD-726, UD-624, SDM-19-23, ACR-19, SDM-19-5, SDM-19-28, IC-0143700, SDM-19-19, SDM-19-21, ACR-153, SDM-19-16, SDM-19-2
No. of secondary branches/plant	7	14	SDM-19-A, SDM-19-5, SDM-19-32, SDM-19-19, IC-067147, SDM-19-22, SDM-19-21, SDM-19-44, SDM-19-1, UD-624, ACR-160, SDM-19-9, VDV/GL-114, ACR-130
No. of umbels /plant	36	23	SDM-19-46, SDM-19-41, SDM-19-21, SDM-19-44, IC-143703, ACR-19, SDM-19-5, SDM-19-32, VDV/GL-114, SDM-19-22, SDM-19-9, SDM-19-34, SDM-19-48, SDM-19-19, SDM-19-28, IC-0143700, SDM-3-32, SDM-19-1, SDM-19-47, UD-624, ACR-160, SDM-19-23, SDM-19-45, ACR-130
No. of umbellates/umbel	6	10	SDM-19-45, SDM-19-19, SDM-19-47, IC-067147, ACR-160, SDM-19-27, SDM-19-49, SDM-19-24, SDM-19-46, SDM-19-15
Test weight (g)	13.7	11	SDM-19-45, SDM-19-22, SDM-19-21, SDM-19-46, SDM-19-41, IC-143703, ACR-19, SDM-19-34, SDM-19-48, SDM-19-28, IC-067168, IC-0143700
Yield (g)	192	10	SDM-19-34, SDM-19-3, SDM-19-19, VDV/GL-114, SDM-19-21, SDM-19-9, SDM-19-45, ACr-160, ACr-130, IC-0143700

Dwarf coriander genotype This genotype was identified during 2017-18. The height of this unique genotype goes to 15-25 cm and having white flower. The seed sown in single plant progeny row and any segregation observed in the population was discarded. Efforts were made to stabilize this character. Now the dwarfism has been stabilized. Experiments on crop geometry and PoPs are being continue to compromise the yield as compared to normal coriander genotype (table 3.7).



Plot view of dwarf coriander genotype (2019-20)

Table 3.7: Performance of coriander genotypes for seed yield and it's contributing traits

Genotype	Plant height (cm)	Primary branches	Secondary branches	Umbels/ plant	Umbellates/ umbel	Seeds/ umbellate	Test weight (g)	Essential oil (%)	Seed yield (kg/ha)
RSM/C18/AB	52.00	3.67	6.33	36.67	5.33	5.33	12.43	0.19	1274.44
RSM/C18/N	54.67	4.33	9.00	57.67	6.33	6.00	11.50	0.20	1786.67
SSM/GL/M35	54.00	4.67	8.33	53.33	6.67	4.33	10.13	0.17	1688.89
RSM/C18/A12	58.00	4.67	6.33	59.33	5.67	6.00	12.13	0.35	730.83
RSM/C18/A22	73.33	5.33	7.33	66.67	5.67	6.33	14.43	0.11	167.22
RSM/C18/A11	63.33	4.67	7.67	53.67	5.67	5.00	10.63	0.12	1126.67
GG-Jhalawad	73.00	4.00	9.67	54.33	5.00	5.00	10.43	0.14	1403.33
SSM/GC-34	61.67	4.67	9.33	62.00	5.33	5.67	12.40	0.12	1050.00
GL/18/4	68.33	4.33	10.67	42.67	5.67	6.33	11.67	0.31	1236.67
SSN/GC-37	60.67	5.33	9.67	59.00	6.33	5.33	12.60	0.15	316.67
RSM/C18/A14	57.00	6.67	7.00	54.67	5.33	6.00	13.00	0.09	721.67
Hisar anand	59.67	5.67	9.00	41.00	6.33	5.33	12.73	0.23	886.67
ACr-3	54.67	5.33	7.33	41.33	7.00	5.33	11.60	0.26	1200.00
ACr-2	55.33	5.00	8.67	53	6.67	5.67	11.57	0.25	1031.11
RCr-728	60.00	5.67	8.33	50.00	5.67	6.67	11.73	0.16	1312.22
Mean	60.38	5.12	9.44	52.36	5.91	5.62	11.93	0.19	1062.20
CD (0.05)	6.34	0.97	1.33	4.6	0.97	1.2	0.39	0.16	298.7
CV (%)	6.24	11.47	8.78	5.2	11.0	11.8	1.97	5.18	27.8

Evaluation of coriander genotypes (Station trial)

Eleven coriander accessions were evaluated along with four checks (ACr-2, ACr-3, Hisar Anand & RCr-728) in Randomized Block Design. The size of plot was 3m x 2m and each treatment replicated thrice. The analysis of variance revealed significant difference among the genotypes for all the traits including seed yield. The highest seed yield recorded in genotype RSM/C18/N (1786.67 kg/ha) over check variety RCr-728 (1312.22 kg/ha).

Ajmer Green Coriander-1(AGCr-1): This variety was developed through recurrent selection method at ICAR-NRCSS, Ajmer Rajasthan which was released at state level and gazette notified during 2021. It was developed for only leaves purpose and also well



grown in shade net in summer (off season). The plants are tall erect, seeds are medium in size, oval in shape and suitable for export purpose. Its green leaf contains 0.05% and its seed contains 0.36% essential oil. AGCr-1 Beta hydroxyl tibolone (BHT) found (26.93 mg/lit). It takes 50-60 day to for first cutting and gives average yield 74.3 q/ha green leaves in Rabi season. The plants are resistant to stem gall and have tolerance to powdery mildew.

Kasuri methi (*Trigonella corniculata* L.)

This experiment was started during 2018-19. The kasuri methi genotypes collected from Nagaur district of Rajasthan. Eleven entries of kasuri methi with one check were sown in Augmented Block Design to evaluate the yield and its contributed traits. The size of plot was 3m x 2m having 30 cm line to line and 10 cm plant to plant spacing maintained by thinning. The analysis of variance revealed significant difference among the tested accession for all the traits including seed yield. In table 3.8, the seed yield ranged from 192g to 290g/plot. The highest yield recorded in genotype RSM-18-20 (290g/plot).

Table 3.8: Performance of kasuri methi genotypes for ancillary characters

Genotype	Plant height (cm)	Primary branches	Secondary branches	Pods /plant	Seeds /pod	Test weight (g)	Leaf yield (kg/plot)	Yield (g/plot)
RSM-18-30	60	5	11	68	18	1.7	1.85	285
RSM-18-31	62	6	12	80	18	1.8	1.72	260
RSM-18-20	63	8	13	88	20	2.0	1.95	290
RSM-18-32	54	7	12	83	17	1.6	1.61	258
RSM-18-33	64	6	11	71	18	1.8	1.43	178
RSM-18-34	55	5	10	69	17	1.6	1.62	192
RSM-18-16	52	7	11	71	19	1.8	1.71	252
RSM-18-19	56	6	10	68	18	1.7	1.54	240
RSM-18-15	58	6	12	67	17	1.8	1.63	260
RSM-18-18	59	7	11	77	16	1.7	1.88	285
IC-34242B	60	7	10	71	18	1.7	1.65	265
Pusa kasuri (Check)	64	6	11	68	17	1.6	1.55	240
Mean	56.61	6.41	10.83	74.58	17.66	1.73	1.68	250.41
CD(0.05)	0.8	1.21	1.24	2.23	1.56	0.72	1.52	3.54
CV(%)	1.01	1.32	1.51	2.54	1.76	0.86	2.34	10.52

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

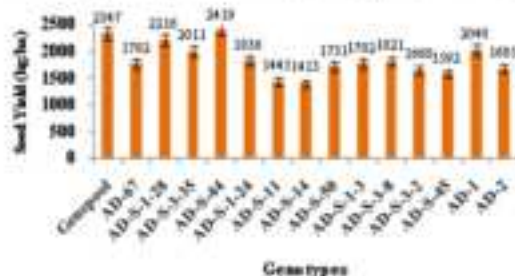
CI-8: Breeding for high yield and quality in dill

(A.K. Verma; Y.K. Sharma and N.K. Meena)

A series of station trial was conducted on dill from 2015-2020 to identified high yield and essential oil content and non-shattering type genotypes. The perusal of data presented in Table 3.9 showed that two dill genotypes, AD-S-44 (2419 kg/ha) and AD-S-2015-2 (2347 kg/ha) were giving the higher yield as compared to check varieties AD-1 (2040 kg/ha) and AD-2 (1685 kg/ha). Genotypes AD-A-1-28 (2.21%) followed by AD-S-2015-2 (2.03%) recorded highest essential oil content as compared to other genotypes and checks varieties. No significant difference was recorded with respect to seed shattering among the tested genotypes (table 3.9).



Elite genotypes of dill developed for high yield and essential oil content; a) AD-S-44, b) AD-S-2015-2



Average yield of different genotype of dill



EO content in different genotype of dill

Table 3.9: Pooled data of ancillary characters of dill genotypes

Genotype	PH	PB	SB	UPP	UPU	No. of seeds/umbellate	Test weight (g)
AD-S-2015-2	162.3	8.8	25.4	80.5	31.6	33.1	4.15
AD-67	168.3	8.2	21.7	68.5	27.2	30.1	3.89
AD-S-1-28	175.5	9.0	26.2	82.9	33.3	31.7	3.83
AD-S-3-35	170.3	8.6	21.9	69.0	29.0	31.4	3.74
AD-S-44	170.3	8.7	23.9	73.0	33.0	32.7	3.74
AD-S-1-24	170.1	8.4	22.3	67.5	28.5	30.8	3.92
AD-S-11	170.3	8.3	23.5	77.8	28.4	28.4	3.26
AD-S-14	158.6	8.4	22.0	68.9	27.3	28.4	4.13
AD-S-50	167.0	8.5	24.1	69.6	30.7	27.3	3.49
AD-S-1-3	166.5	8.2	21.6	64.9	27.2	27.1	3.77
AD-S-3-8	164.2	8.0	20.1	62.7	27.7	28.8	3.33
AD-S-3-2	170.0	8.3	20.7	66.6	30.0	27.9	3.69
AD-S-45	170.8	8.5	21.0	61.1	30.9	29.5	3.15
AD-1	163.2	8.3	24.5	78.3	33.0	30.0	3.92
AD-2	160.1	8.0	22.3	73.5	30.0	29.5	3.31

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

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

During the 2014-15 induced mutagenesis work was started in cumin and fennel with aim to create genetic variability for different essential traits indicated that high dose of gamma radiation reduced germination percentage, seedling survival, shoot length, root length, number of leaves and fresh weight of plant drastically. Gamma rays dose of 200Gy was found LD₅₀ for fennel and cumin.

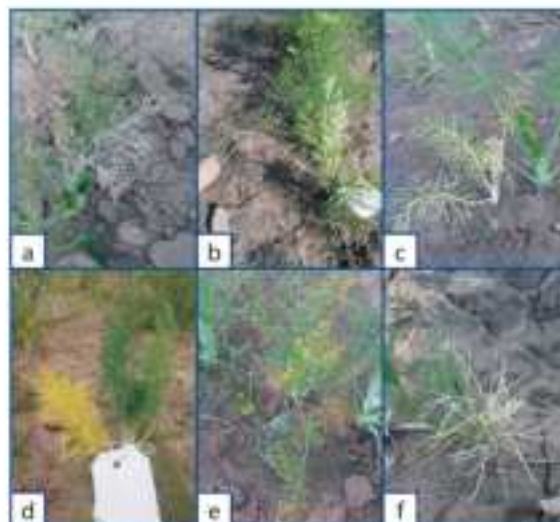
Segregating population (M₁) was raised during 2015-16 for the selection of mutants. A large spectrum of chlorophyll mutants were observed at seedling emergence. In the further growth stage yellow leaves and irregular leaves mutants become normal while mutant devoid of chlorophyll were died. In cumin albino type of mutant also observed.

Identification and selection of mutants under field conditions

The whole surviving M₁ segregating population was evaluated for phenotypic variability. Some new phenotypes appeared in M₁ population. The main

List of developed stable mutants of fennel

AF/175/3/4	RF/200/30/1	RF/225/27/2
RF/200/30/7	RF/200/118/2(1)	RF/225/73/13
RF/200/46/2(2)	RF/200/41/15	RF/200/7/16
RF/200/52/15(1)	RF/225/45/6	RF/200/65/5
RF/200/65/5	RF/200/109/2	RF/200/63/1
RF/200/78/1	RF/225/25/4	RF/200/86/1
RF/200/46/2(1)	RF/250/7/4	RF/225/93/6
RF/200/118/2(2)	RF/225/49/1	RF/150/63/1
RF/225/37/10	RF/250/30/10	RF/175/10/18
RF/225/45/6	RF/175/3/1	RF/175/9/3
RF/225/88/1	RF/200/1/6	RF/200/117/7
RF/250/16/4	RF/200/37/9	RF/200/52/15-1
RF/250/73/1	RF/175/5/1	RF/200/56/1
RF/200/18/14	RF/200/119/2	RF/225/162/1
RF/200/216/1		



Appearance of different types of chlorophyll mutants during the seedling stage in segregating population (a-f)



Expression of different types of mutants in segregating population (a-j)

characteristics of these identified mutants were early flowering, multiples branching at ground level, dwarf, synchronization in flowering etc. Total 190 mutant lines (excluding chlorophyll type mutants) were selected. Cumin crop totally damaged due to disease and seeds could not be harvested.

Selected fennel mutants were evaluated for different traits for stability of characters during 2016-17 to 2019-20 upto M₁ generation. Total 190 fennel lines were evaluated to know the variability and stability of the characters in M₁ generation. Both, morphological and molecular characterization showed that variability was present in induced mutants for different essential traits (M₁). During the 2017-18, the selected mutant lines were grown and evaluated for the stability of the selected characters. The segregating mutant lines were discarded and mutant lines showing stable characters were advances and total 121 (including 4 selection among the segregating mutants) mutant lines were selected for further evaluation. In the year 2018-19, 121 mutant lines of fennel with two checks, RF-125 & AF-1 were grown. Out of which, 47 mutant lines were found promising and selected for the further

evaluation in 2019-20. Total 43 mutant lines were found promising and stable for the selected character(s).

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

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

Twelve genotypes were evaluated along with three checks namely AF-1, AF-3 & RF-101 in Randomized Block Design. The plot size was 3m x 2m and each treatment replicated thrice. The analysis of variance revealed significant differences among the genotypes for all traits including seed yield. Genotype AF-87 recorded for highest seed yield (4278 kg/ha) and AF-27 recorded for maximum essential oil (1.40%) content over the check variety AF-2 (2963 kg/ha & 1.3%). None of the fennel genotype was recorded as immune. Fennel genotypes namely AF-87 (PDI-10.5) and AF-3 (PDI-14.3) were reported lower disease incidence, thus considered initially as resistant against *Ramularia blight*, whereas others showed the moderately resistance reaction to the disease (table 3.10 & 3.11).



Stable fennel mutant lines; a) early flowering (RF/200/30/7), b) multiple branching from ground level (RF/225/88/1), c) dwarf (RF/250/73/1), d) synchronous flowering (RF/225/37/10), e) early maturity (RF/200/65/)

Table 3.10: Performance of fennel genotypes for ancillary characters in station trial

Genotype	Plant height (cm)	Primary branches	Secondary branches	Umbels /plant	Umbellates /umbel	Seeds/ umbellate	Test weight (g)	Essential oil (%)	Seed yield (Kg/ha)
AF-27	161.00	8.00	18.33	34.67	39.33	22.67	5.47	1.40	1561
AF-85	159.67	7.00	15.67	36.33	40.67	36.33	5.83	0.97	3125
AF-45	145.00	6.33	18.33	38.33	36.00	31.33	6.13	1.40	2712
AF-162	151.67	8.33	18.00	32.33	36.33	32.33	6.20	1.28	2544
AF-17	145.00	8.00	24.67	36.33	37.00	37.33	5.93	1.15	3516
AF-98	152.33	8.67	17.33	36.00	40.00	26.00	5.77	1.24	1962
IC-598490	146.00	8.00	17.00	31.00	37.67	23.33	5.73	1.12	1729
AF-20	155.00	8.33	18.33	32.67	38.33	24.67	5.77	1.13	1976
AF-48	164.33	7.33	18.00	41.33	38.33	35.33	5.73	1.41	3054
AF-94	154.67	8.33	17.33	37.67	37.67	27.33	6.03	1.20	1857
AF-49	164.33	7.67	16.33	42.00	37.67	31.67	5.70	1.20	2777
AF-87	152.33	8.33	25.00	46.33	35.67	42.33	5.73	1.26	4278
AF-2	158.67	8.67	18.33	45.67	37.67	38.33	6.13	1.30	2963
AF-3	138.33	8.00	17.67	48.00	41.00	37.33	5.87	1.35	2937
RF-101	145.67	8.00	19.33	50.33	46.33	34.67	5.70	1.32	2796
Mean	152.93	7.93	18.64	39.27	38.64	32.07	5.85	1.27	2652
CD (0.05)	7.00	1.01	1.7	3.0	1.8	1.12	0.11	0.7	286.11
CV (%)	2.72	7.5	5.6	4.5	2.9	2.08	1.11	3.2	10.70

Table 3.11: Screening of fennel genotypes against Ramularia blight

S. No.	Treatment Name	Replication wise PDI			Disease index (PDI)	Disease Reaction
		R1	R2	R3		
1	AF-1 (Control)	22.5	20.5	18.5	20.50	MR
2	AF-2	20	24	22	22.0	MR
3	AF-3	13.6	16	13.3	14.30	R
4	AF-48	16	14	16.2	15.40	MR
5	AF-17	18	17	14.9	16.63	MR
6	AF-27	17	13.9	18	16.30	MR
7	RF-101	25	20.4	26	23.80	MR
8	AF-87	7.3	11.2	13	10.50	R
9	AF-85	17	15.6	19	17.20	MR
10	AF-20	12.9	17.8	15	15.23	MR
11	AF-77	18	14.8	22	18.27	MR
12	IC-598490	17.5	15.4	16.5	16.47	MR
13	AF-45	13.3	16	17.8	15.70	MR
14	AF-49	14.6	15.8	16	15.47	MR
15	AF-98	14.3	18.1	16.9	16.43	MR
16	AF-162	16	18	14	16.00	MR
17	AF-94	16.1	20	14	16.70	MR
18	RF-205	22	24	18	21.33	MR
CD 0.5%					3.78	
SEm±					1.31	

PDI response: I-Immune = PDI (0), R-Resistance = PDI (1-15), MR-Moderate resistance = PDI (16-30), S-Susceptible = PDI (31-50), SH-High susceptible = PDI (<51)

CI/16.2.2: Breeding for yield and quality in celery

(R. S. Meena; S. Choudhary, N. K. Meena, A.K. Verma, Ravi, Y., R. D. Meena)

Seventeen genotypes of celery along with two checks were evaluated in Augmented Block Design. The analysis of variance revealed significant difference among the genotypes for all the traits including seed yield. Genotype A-Cel-7 was recorded highest seed yield (433 kg/ha) and maximum essential oil (1.8%) was recorded in Karnoli-13 over the check varieties A-Cel-2 (388 kg/ha & 1.6%). Ancillary and yield date have been shown in table 3.12.



Ajmer Celery-2(ACel-2): This variety was developed through selection method at ICAR-NRCSS, Ajmer Rajasthan which was released at state level and gazette notified during 2021. The plants are erect type, thus having resistance to lodging caused due to dew. It takes 120-125 days to maturity and gives average seed yield 874.3 kg/ha. Its seed content essential oil 6.74% which is 17% higher than check variety ACel-1. It less infestation to aphid. Seedlings were transplanted at 40-45 days after sowing in nursery.

Table 3.12: Performance of celery genotypes

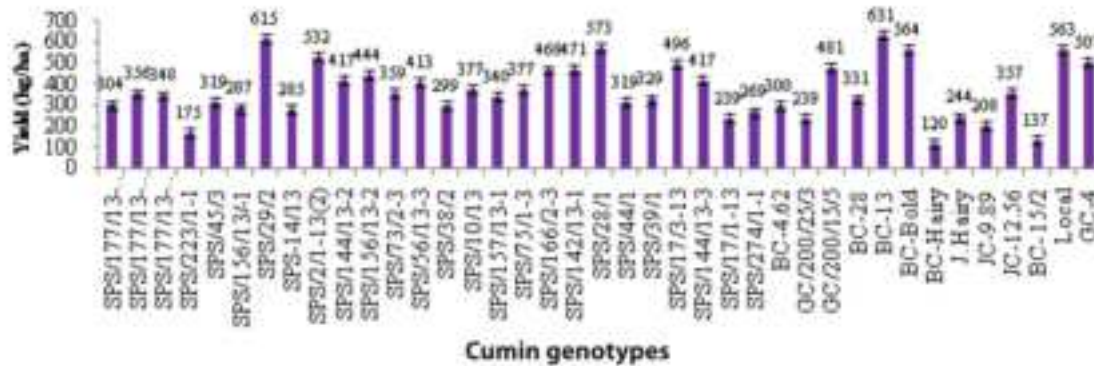
Entry	Plant height (cm)	Primary branches	Secondary branches	Umbels /plant	Umbellates /umbel	Seeds/ umbellate	Test weight (g)	Yield (g/plot)	Essential oil (%)
A-Cel-12	71.67	6	10	46	10	18	1.2	170	0.80
A-Cel-14	70.67	7	11	53	11	20	1.3	117	1.23
A-Cel-3	68.67	5	9	49	12	22	0.8	150	1.00
A-Cel-8	64.67	6	10	50	10	18	1.1	143	1.50
A-Cel-11	71.67	6	12	53	14	22	1.7	242	1.73
K-4	69.33	5	10	95	15	19	1.3	227	1.13
K-5	69.67	5	11	49	10	21	1.2	75	1.00
K-6	69.00	4	8	47	12	17	1.1	83	1.17
A-Cel-7	73.00	9	17	135	16	24	2.1	433	0.83
A-Cel-13	75.33	5	10	44	10	21	1.2	158	1.87
K-9	67.00	5	9	49	12	19	0.9	85	1.13
K-17	73.33	6	10	51	11	20	1.1	75	1.00
K-20	67.33	8	15	116	16	24	1.8	378	1.20
K-23	70.00	5	8	45	11	12	1.3	60	1.10
K-25	70.67	8	11	43	11	18	1.3	183	1.10
K-26	66.33	5	8	45	11	18	1.3	78	1.10
A-Cel-6	69.67	9	15	109	15	24	1.9	350	1.57
A-Cel-2	70.33	9	14	106	16	21	1.6	388	1.57
A-Cel-1	71.67	8	16	117	15	22	1.8	333	1.73
Mean	70.00	6.37	11.26	68.53	12.53	20.00	1.37	117.78	1.25
CD(0.05)	5.17	1.20	2.20	6.06	1.07	1.78	0.15	16.02	0.6
CV%	4.45	4.96	6.18	3.15	5.58	5.22	6.90	8.12	3.32

CI/18.2.1: Genetic improvement of cumin for higher yield and wilt resistance

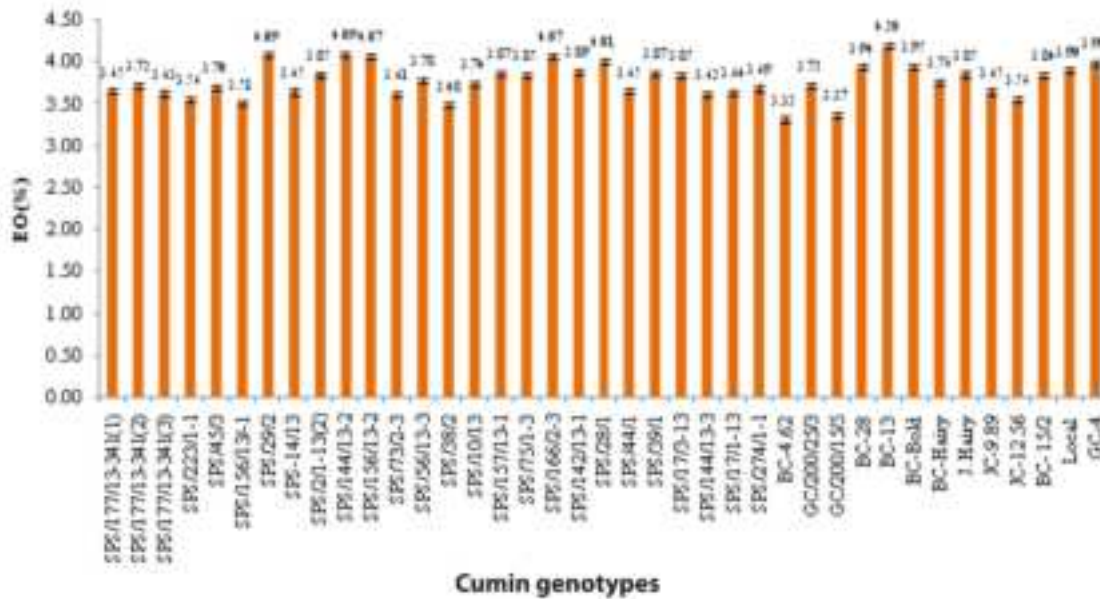
(A.K.Verma; Y.K. Sharma)

A station trial was laid out with 37 cumin genotypes and two checks varieties. Perusal of data presented in Table 3.13 revealed significant variation for the plant height number of umbels per plant (UPP),

number of umbellates per plant, number of seeds per umbel and test weight. The maximum(631 kg/h) yield was recorded on genotype BC-13 followed by SPS/29-2 (615 kg/h) Likewise, essential oil content in different cumin genotypes varies from 2.32 to 4.2% and maximum EO content was recorded on BC-13 which was higher than the check varieties.



Average yield of different genotype of cumin



EO content in different genotypes of cumin



Table 3.13: Mean performance of cumin genotypes

Genotype	Plant height (cm)	Primary branches	Secondary branches	Umbles /Plant	Umbellates /plant	No. seeds /umbel	Seeds/ umbellate	Days to maturity	Test weight (g)
SPS/177/13-341(1)	19.8	6.8	12.3	23.8	119.5	28.5	5.8	122.5	3.83
SPS/177/13-341(2)	18.8	6.8	12.7	20.5	120.2	29.8	5.2	124.5	3.62
SPS/177/13-341(3)	18.6	6.8	11.5	23.2	127.8	30.2	5.3	125.0	3.94
SPS/223/1-1	21.3	6.5	11.5	20.3	106.5	29.5	5.3	131.0	3.76
SPS/45/3	18.4	7.0	10.5	20.5	117.2	29.7	5.8	124.0	3.83
SPS/156/13/-1	21.1	6.8	13.2	21.5	123.0	29.7	5.2	122.5	3.58
SPS/29/2	20.9	8.4	16.5	33.5	140.5	34.7	6.0	122.0	4.33
SPS-14/13	24.9	7.7	12.5	28.3	134.7	27.7	5.3	127.0	3.62
SPS/2/1-13(2)	21.4	7.5	13.0	33.0	133.3	31.2	5.5	121.5	4.32
SPS/144/13-2	20.0	6.5	12.7	24.3	128.0	28.0	5.0	122.5	4.20
SPS/156/13-2	24.1	7.7	12.7	28.5	131.3	31.8	5.7	122.0	4.20
SPS/73/2-3	22.8	7.0	14.5	26.7	131.3	27.3	5.0	129.0	3.83
SPS/56/13-3	17.4	6.8	14.0	27.0	131.8	23.5	5.0	126.0	4.19
SPS/38/2	20.4	7.0	13.5	29.7	131.8	23.3	4.8	125.5	3.68
SPS/10/13	19.2	7.2	12.8	29.0	128.0	24.0	5.0	125.0	3.71
SPS/157/13-1	17.2	6.8	12.3	22.0	118.5	21.8	4.5	122.5	3.93
SPS/75/1-3	20.7	7.5	12.5	27.2	132.2	26.7	5.2	122.0	3.78
SPS/166/2-3	21.6	7.7	13.8	30.3	134.8	22.5	4.7	121.0	4.34
SPS/142/13-1	18.6	6.5	12.0	21.5	127.7	24.0	5.0	125.5	4.20
SPS/28/1	19.6	8.4	15.8	33.1	136.0	33.7	5.8	122.0	4.20
SPS/44/1	18.1	7.0	13.3	23.8	118.5	26.3	5.3	124.5	4.25
SPS/39/1	19.8	6.5	14.3	23.5	126.0	23.0	4.7	125.0	3.62
SPS/17/3-13	18.1	6.5	13.0	19.8	122.3	27.2	5.0	129.0	4.15
SPS/144/13-3	20.3	7.2	14.8	23.8	128.0	30.2	5.5	126.5	3.94
SPS/17/1-13	18.8	6.5	13.2	20.5	116.7	27.3	5.3	122.0	3.69
SPS/274/1-1	17.3	6.3	13.8	18.8	109.3	27.5	5.3	129.0	3.80
BC-4.62	24.4	8.4	12.5	24.2	123.0	18.0	5.0	126.0	3.83
GC/200/25/3	21.8	7.5	15.5	25.7	118.0	29.0	5.3	125.5	3.29
GC/200/15/5	19.2	6.5	13.2	20.3	113.8	32.0	5.7	121.5	3.86
BC-28	19.6	6.8	15.2	26.0	129.8	26.0	5.2	125.0	3.79
BC-13	19.4	7.7	15.8	32.8	138.7	31.3	6.0	125.5	4.35
BC-Bold	20.8	7.7	14.3	31.0	134.0	23.3	4.7	123.5	4.21
BC-Hairy	19.0	7.2	16.3	30.5	134.0	30.8	5.5	124.0	3.68
J. Hairy	17.7	7.2	15.7	25.7	131.0	25.5	5.0	125.0	3.94
JC-9.89	21.7	7.7	14.8	30.7	132.3	29.3	5.3	122.0	3.28
JC-12-56	25.7	7.9	14.5	36.5	135.0	28.3	5.3	123.5	3.93
BC-15/2	23.1	7.7	15.0	30.3	133.3	29.7	5.0	125.5	4.15
Local check	21.1	7.2	17.2	27.7	131.5	28.7	5.3	126.0	4.03
GC-4	18.7	7.0	16.2	30.0	132.7	27.3	5.3	126.0	3.94
SE(m)	0.9	0.45	1.3	2.1	5.67	3.67	0.35	8.7	0.013
CD (5%)	2.6	NS	NS	5.8	16.3	NS	NS	NS	0.037

Pollination behaviour of cumin

In a study two contrasting characters i.e. hairy type cumin and non-hairy type cumin genotypes were taken for random crossing. The seeds harvested separately from the both types of genotypes. In next generation (2019-20) plant to row progeny were raised from separately harvested seeds of individual plant. At the time of flowering in the both hairy and non-hairy plants evaluated for any type of segregation (hairy and non-hairy). No segregation was recorded in both types of cumin genotypes. The seed harvested from hairy cumin produced hairy type plant only and non-hairy produced only non-

hairy type plants. It is concluded that no natural crossing was occurred among the hairy and non hairy types cumin.

In an another study two cumin genotypes with contrasting characters of flower colour were selected. These characters include pink flower cumin and white flower cumin and based on the inheritance of flower colour pollination behaviour was decided. During the current year (2019-20) random crossing between white flower and pink flower were made and seeds from the individual plants harvested separately which will be grown in next year.



Hairy cumin



Non hairy cumin



Pink flower



white flower

**CI/18.2.2: Screening of fennel and cumin genotypes for salinity stress**

(S.N. Saxena and O.P. Aishwath; 2018-21)

During the reporting period, seeds of fifteen fennel and cumin genotypes were screened for salinity level under laboratory condition. Cumin genotypes JC-9-89, AE-WMT-16-40, BC Hairy, AKV-103, RZ- 19 were selected on the basis of good germination under saline conditions. Essential oil content was maximum (4.61%) in genotype AKV-103 followed (4.50%) by AE-WMT-16-40. Total oil content was also more (8.40%) in AKV-103 followed (7.87%) by genotype JC-9-89. Analysis of fatty acids methyl esters of cumin genotypes revealed good amount of Petroselinic acid and linoleic acid in salinity tolerant genotype JC- 989, Pentadecanoic acid and less Benzaldehyde. Cuminaldehyde and cymene content comparatively more in genotype JC-9-89. Fennel genotype AF-302 showed good amount of

germination (87.5%) under saline conditions followed (75%) and AF-72 (72%) as compared to R. Saurabh which showed only 5% germination. There is no much variation in essential oil content of fennel genotypes ranged from a minimum of 0.77% to 1.33%. However, genotype R. Saurabh showed 9.62% total oil and less tolerance to salinity. Af-302 showed less (4.74%) total oil but more tolerance to salinity. Anethole content in essential oil of fennel genotype AF-302 is exceptionally low (30.97%), however, other tolerant genotype AF-30 showed good amount (74.82%) of anethole content. Salinity susceptible genotype R. Saurabh contains 43.69% anethole. 9-Octadecenoic acid was prominent (22.41%) in genotype AE-302 as compared to other genotypes while Benzene, 1-methoxy-4- (1-propenyl)-content was less (17.57%) which is 60.10% in salinity susceptible genotype R. Saurabh (table 3.14 & 3.15).

Table 3.14: Essential oil constituents of cumin genotypes

Constituents	JC-9-89	AE-WMT-16-40	BC HAIRY	AKV-103	RZ-19
Alpha thujene	0.127	0.242	0.166	0.283	0.29
Alpha pinene	0.261	0.581	0.377	0.647	0.31
Beta terpinene	0.535	0.944	0.679	0.975	0.86
Beta pinene	7.548	11.658	9.771	12.914	6.28
Beta myrcene	0.665	0.94	0.748	1.037	0.33
Cymine	18.294	10.071	13.087	12.851	12.4
2 thujene	0.342	0.525	0.362	0.503	0.42
Gama terpinene	25.694	23.156	27.067	32.36	23.07
Cuminaldehyde	24.672	18.972	27.91	15.136	17.97
Anethole+estyragol	3.183	4.842	4.053	3.287	6.59
3-carene-10-ol	17.117	26.206	13.763	18.503	28.27
Total	98.438	98.137	97.983	98.496	97.69

Table 3.15: Essential oil constituents of fennel genotypes

Constituents	AF-01	AF-30	AF-302	AF-72	AF-01-172	RAJ SAURABH
Alpha pinene	0.246	0.525	0.372	0.472	0.532	0.504
Camphene	0.181	0.226	0.199	0.246	0.182	0.236
Myrcene	0.176	0.406	0.247	0.22	0.133	0.195
Cymene	0.225	0.141	0.134	0.181	0.172	0.166
Gama terpinene	5.782	7.756	7.712	8.339	5.91	6.26
(e)-2- butenoic acid	3.111	5.455	4.809	3.966	2.58	4.81
4-allyl anisole	47.497	9.278	54.909	40.58	19.905	42.951
P-anisaldehyde	0.114	0.848	0.26	0.378	1.118	0.748
Anethole+estragol	41.98	74.824	30.978	45.219	69.106	43.691
Total	99.312	99.459	99.62	99.601	99.638	99.561

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

(S.S. Meena; M.D. Meena)

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 2019-20. Observations on growth parameters such as yield and yield attributing traits were recorded (table 3.16

& 3.17). Higher yield attributes and yield (1212.50 kg/ha) has been recorded in AA-3 genotypes followed by AA-27 (1162.50 kg/ha) as compared to national check. Maximum essential oil was obtained in AA-45 genotype (6.01%).

The second station trial was conducted for bold seed type ajwain as per the farmers preference and market demand, with 14 test entries and one check

Table 3.16: Performance of ajwain genotypes in trial

Genotypes	Days to germination	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Days to 50% flowering
GA-1⊙	10.00	123.50	11.60	34.80	74.00
AA-27	12.00	124.30	11.70	36.10	76.50
AA-43	11.00	124.90	11.80	37.90	75.50
AA-74	12.50	126.60	11.90	38.60	76.50
AA-1⊙	11.00	114.50	11.90	34.90	76.50
AA-96	9.50	117.30	11.70	36.00	74.00
AA-45	9.50	117.50	12.30	38.80	75.00
AA-51	11.00	117.80	12.20	36.60	75.00
AA-84	10.00	118.00	12.50	37.80	75.50
AA-2⊙	10.00	117.90	13.80	41.20	77.00
AA-61	9.50	121.10	12.20	35.40	74.00
AA-3	10.00	121.50	13.00	40.60	75.00
AA-44	12.00	121.10	12.30	36.50	75.00
AA-100	12.00	116.60	12.40	37.90	76.50
AA-85	10.50	115.90	11.60	34.70	74.00
CV (%)	7.15	2.09	2.97	4.47	1.54
SEm ±	0.765	2.503	0.362	1.663	1.161
C.D. at 5%	1.6414	5.3675	0.7764	3.5665	NS



Table 3.17: Performance of ajwain genotypes in trial

Genotypes	Umbels/ plant	Umbellates / umbel	Seeds/ umbellate	Seed yield (kg/ha)	Test weight (g)	Essential Oil (%)
GA-10	285.60	16	20.30	707.25	0.83	5.70
AA-27	306.20	17	21.25	1162.50	0.67	4.45
AA-43	307.90	17.43	20.80	783.00	0.78	5.02
AA-74	317.70	17.67	21.35	968.00	0.79	4.86
AA-10	295.70	19.3	21.20	880.00	0.79	5.52
AA-96	300.60	16.13	21.30	758.25	0.73	5.34
AA-45	320.10	18	21.10	734.00	0.79	6.01
AA-51	340.30	19.57	20.60	939.75	0.70	5.69
AA-84	321.50	17.73	20.95	830.25	0.79	5.68
AA-20	332.60	16.17	20.85	1092.00	0.81	4.92
AA-61	320.40	19.17	20.70	353.75	0.76	3.89
AA-3	324.20	20.33	21.53	1212.50	0.72	4.60
AA-44	321.40	18.37	21.20	642.25	0.81	4.23
AA-100	332.20	17	21.00	846.50	0.77	4.52
AA-85	343.50	17.6	20.90	717.25	0.81	5.85
CV (%)	3.77	7.46	1.215	11.57	8.92	
SEm ±	12.003	0.77	0.147	56.27	0.069	
C.D. at 5%	25.744	2.24	0.429	163.85	NS	

Table 3.18: Performance of ajwain genotypes in trial (Bold Seed)

Genotypes	Days to germination	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Days to 50% flowering
AA - 16	11.50	114.80	12.20	38.90	74.00
AA - 24	10.00	112.20	11.40	36.50	73.00
AA - 27	10.50	115.80	11.40	37.90	73.50
AA - 31	13.00	119.70	11.80	38.40	73.00
AA - 37	14.50	116.70	12.20	38.70	72.50
AA - 52	13.50	121.60	12.40	41.90	73.00
AA - 56	14.50	153.70	14.20	44.30	72.50
AA - 61	11.00	128.40	11.90	43.30	72.50
AA - 63	12.50	121.50	12.30	49.20	72.00
AA - 67	10.50	128.30	12.90	42.50	73.50
AA - 72	10.50	128.70	12.70	44.40	71.50
AA - 95	10.00	127.90	13.00	44.40	72.00
AA - 98	13.00	127.00	11.80	43.60	73.00
AA - 10	10.00	120.50	11.40	39.20	72.50
AA - 99	9.50	122.60	11.50	39.70	72.50
Mean	11.63	123.96	12.21	41.53	72.73
CV (%)	12.03	1.35	2.51	2.83	0.76
SEm ±	1.143	1.369	0.250	0.960	0.454
CD at 5%	2.3412	2.8048	0.5123	1.9666	0.9305

variety namely Ajmer Ajwain-1. Observations such as growth parameters, yield attributes and yield were recorded. Higher yield attributes and yield (1381.75 kg/ha) has been recorded in AA-99 genotypes followed by AA-16 (1364.75 kg/ha) as compared to national check. Maximum essential oil (6.48%) was recorded in AA-95 genotype. All necessary observations were recorded and data presented in table 3.18 & 3.19.

Ajmer Ajwain-73 (AA-73)

This variety was developed through mass selection method at ICAR-NRCSS, Ajmer Rajasthan which was released at national level and gazette notified during 2021. The plants are medium tall with good branching, more number of umbel per plants and

No. of seed per umbellate. It takes 165-170 days to maturity and gives average yield 10-11 q/ha. It seed contains 9.15% total oil and 6.38% essential oil. It shows high tolerance to Root rot (PDI=2.2) and Scleritium rot (PDI=1.6) in field condition.



Table 3.19: Performance of ajwain genotypes in trial

Genotypes	Umbels/plant	Umbellates /umbel	Seeds/ umbellate	Seed yield (kg/ha)	Test weight (g)	Essential Oil (%)
AA - 16	335.20	19.70	19.60	1364.75	0.77	5.18
AA - 24	296.80	18.60	19.80	898.75	0.80	4.71
AA - 27	323.00	19.10	19.40	685.00	0.81	5.07
AA - 31	349.00	18.80	19.30	921.50	0.71	5.27
AA - 37	346.30	17.70	19.60	642.50	0.68	4.93
AA - 52	411.00	19.10	20.30	639.50	0.69	5.40
AA - 56	405.50	19.30	19.60	569.50	0.55	5.82
AA - 61	372.60	19.10	20.60	716.25	0.68	4.59
AA - 63	423.50	19.50	19.60	994.75	0.72	5.70
AA - 67	345.70	18.90	20.00	736.75	0.80	4.70
AA - 72	406.40	19.00	19.80	951.00	0.85	5.52
AA - 95	373.30	19.20	19.40	967.25	0.82	6.48
AA - 98	368.10	20.00	20.20	704.75	0.77	4.96
AA - 100	309.60	19.60	19.80	1264.00	0.85	6.37
AA - 99	325.00	20.00	20.40	1381.75	0.90	4.70
Mean	359.40	19.17	19.83	895.87	0.76	
CV (%)	6.70	2.81	2.24	25.97	8.41	
SEm ±	19.655	0.441	0.362	189.991	0.052	
C.D. at 5%	40.262	0.9026	0.7417	389.18	0.1069	

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

(S.S. Meena, S.N. Saxena and M.D. Meena)

A trial was conducted with 13 test entries and two check varieties namely, Ajmer Nigella-20 and Azad

Kalongi during the year 2019-20. Observations on growth parameters, yield attributes and yield were recorded. Higher yield attributes and yield (1305.50 kg/ha) has been recorded in AN-9 genotypes followed by AN-10 (1247.75 kg/ha) as compared to national check. Recorded data presented in tables 3.20 & 3.21.

Table 3.20: Performance of nigella genotypes in trial

Genotypes	Days to germination	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Days to 50% flowering
AN-9	10.00	68.40	8.00	22.70	67.50
AN-16	10.00	73.00	7.50	25.20	66.00
AK	9.00	64.10	6.90	25.40	67.50
AN-20(c)	10.00	62.70	8.40	21.50	67.50
SEL-10	10.00	70.50	8.00	21.00	69.00
SEL-9	10.50	61.70	7.90	19.00	66.00
SEL-5	9.50	72.00	7.70	20.10	66.00
SEL-4-1	11.00	74.30	7.90	22.00	66.00
SEL-4	9.00	64.50	9.00	22.50	67.50
AN-24	10.00	67.70	9.20	23.30	67.50
AN-19	10.50	62.80	8.70	20.30	67.50
AN-10	9.00	62.00	8.00	20.40	67.50
AN-4	9.00	72.70	8.20	21.90	66.00
AN-1	9.50	62.20	8.40	18.90	67.50
AN-6	9.00	63.00	8.40	23.50	67.50
CV (%)	5.40	6.81	3.19	5.00	2.29
SEm ±	0.526	4.547	0.260	1.091	1.535
C.D. at 5%	1.1272	NS	0.5577	2.3407	NS

Table 3.21: Performance of nigella genotypes in trial

Genotypes	Siliqua/ plant	Seed/ Siliqua	Test weight (g)	Seed yield (kg/ha)	Total Oil (%)
AN-9	76.00	88.20	2.30	1305.50	16.200
AN-16	72.60	80.50	2.40	638.25	17.750
AK	72.60	84.00	2.30	541.75	14.795
AN-20 (c)	62.60	85.00	2.20	1050.75	13.390
SEL-10	80.00	89.80	2.41	1091.50	15.355
SEL-9	67.20	77.20	2.37	1250.50	21.155
SEL-5	93.30	86.80	2.42	880.00	21.550
SEL-4-1	83.40	88.50	2.54	1195.25	16.785
SEL-4	85.30	82.80	2.59	1080.50	15.530
AN-24	61.50	80.80	2.39	880.75	20.970
AN-19	65.00	84.70	2.41	1022.25	17.415
AN-10	83.80	82.90	2.39	1247.75	14.735
AN-4	83.50	79.70	2.52	988.50	17.885
AN-1	84.50	83.50	2.39	765.25	19.685
AN-6	53.70	84.60	2.38	888.75	18.960
CV (%)	7.50	3.51	3.45	7.07	7.435
SEm ±	5.626	2.943	0.083	40.42	0.738
C.D. at 5%	12.066	6.3123	0.1779	117.70	2.167

Ajmer Nigella-1 (AN-1): This variety was developed through mass selection method at ICAR-NRCSS, Ajmer Rajasthan which was released at national level and gazette notified during 2021. The plants are medium tall with good branching, more number of umbel per plant and No. of seed per umbellate. It takes 145-150 days to maturity and gives average yield 9 q/ha. Its seed contains total oil contains 21.14 per cent 9-Octadecenoic Acid (Oleic Acid) ., 3.32 per cent Octadecenoic Acid (Oleic Acid), Cis-11, 3.14 per cent 14- Eicosadienoic Acid. It is tolerant to root rot with (PDI 4.4) in field condition



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

(S. Choudhary; R.D. Meena)

During the reporting year, validated six candidate genes in coriander varieties/cultivars/germplasm lines and five have been documented at NCBI. Protein structures of five validated genes have been developed and the NCBI-CDD predicted conserved domains, result presented with NCBI-CDD Accession

number in the parenthesis. LRR gene contain Serine/threonine kinases (STKc)-interleukin-1 receptor-associated kinase-1 (IRAK-1) (CD14066), GDSL gene contain SGNH Hydrolase (cd01053), USP contain USP like (cd00293), ANK contain ANK2 (cd31515) and PDR contain NB_ARC (cd33662). Designed and wet lab validation of ten FDM-SSR primer-pairs (Microsatellites) completed in varieties of coriander and registered at NCBI. Secondary metabolite synthesis pathway has been identified and five markers validated in coriander varieties for quality.

CI/18.2.3: Transcriptome-based mining of genes and pathways related to disease (*Ramularia* blight) and quality (secondary metabolites) in fennel

(S. Choudhary; A.K. Verma, P.N. Dubey, M.B.N. Naika)

Seeds collected from ICAR- NRCSS germplasm store and sown in the field (NRCSS, Ajmer) with taking care for purity for all varieties (AF-1, AF-05-12-1, AF-F2-53, AF-12-5-32, FNL-75, RF-101, AJ-FN-2, GF-11 and AF-2). Total DNA and RNA isolated from the leaf and seed. Samples were prepared for RNA seq. Pathways for defence mechanism in fennel for *Ramularia* blight has been identified.

NCBI submissions for registrations are as: SRA: SUB7781277, BIOSAMPLES: SAMN15548380, SAMN15548317, SAMN15548310, SAMN15548309, SAMN15548219, SAMN15548217 and SAMN15548195 under BIOPROJECT: PRJNA646631 entitled Transcriptome data analysis and gene mining in fennel.

Table 3.22: Details of the designed FDM-SSR primer-pairs

Primer Name	Gene name	NCBI ids
ACorSGD-1	Peptidyl-prolyl cis-trans isomerase CYP19-4	MT759811
ACorSGD-2	E3 ubiquitin-protein ligase UPL3	MT759812
ACorSGD-3	UTP-glucose-1-phosphate uridylyltransferase	MT759813
ACorSGD-4	Polycis-polyprenyl diphosphate synthase	MT759814
ACorSGD-5	bZIP transcription factor 53	MT759815
ACorSGD-6	Auxin response factor 6-like	MT759816
ACorSGD-7	phosphoinositide phosphatase SAC2-like	MT759817
ACorSGD-8	Lysine-specific demethylase JMJ25-like	MT759818
ACorSGD-9	Peroxidase 19	MT759819



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

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

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. The results presented in table 3.23 to 3.27. The cumin seedling germination was highest (82.60 %) with T3 and lowest (76.90 %) was recorded with control at 20 days after sowing (DAS). At maturity stage, significant difference was recorded for cumin yield attributing traits. Maximum number of primary branches per plant was recorded with T4- *Pseudomonas sp.-1* (8.79), while minimum was recorded in control (7.41). Similarly, maximum number of secondary branches per plant (37.37) was recorded with T1- *Bacillus subtilis* and minimum number of secondary branches per plant (30.04) was recorded with T6. The highest per plant yield (3.22g) was recorded with T2 which was at par with T3 (3.14g) and lowest (2.44g) was recorded in control. The maximum cumin seed yield (5.24 q/ha) was obtained with T3- *Pseudomonas fluorescens* which was at par with T2 (5.11 q/ha) and minimum seed yield (3.60 q/ha) was recorded with control. The essential oil content in cumin seed samples of different rhizobacterial treatments ranged from 2.28-3.64 per cent.

For evaluation of plant growth promotion potential of microbial consortia on 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* sp. and different *Bacillus* strains in various combinations. The highest seedling vigour index (9091) was recorded with T1 (*Rhizobium+B. subtilis*) which was at par with T2 (8370) and lowest seedling vigour index (6430) was recorded with T5 (6067) and control (6282) at 15 days after sowing. The highest seedling dry weight (0.110 g) was recorded with T2- *Rhizobium+B. megaterium* and lowest (0.084) of the same was recorded with T4- *Bacillus subtilis* at 15 DAS. There was non-significant difference in number of root nodules per plant at 35 DAS but at 70 and 105 DAS there were significant difference among treatment for root nodulation in fenugreek plants. The maximum nodule per plant (21.77) was recorded with T3 (*Rhizobium+ Bacillus sp. + B. subtilis*) which was at par with T4, T6 and T7 where as the minimum nodules per plant was recorded with T9-control (18.78) at 70 DAS. Similarly, at 105 DAS (pod formation stage), the maximum number of nodules per plant (25.66) was recorded with T3 (*Rhizobium+ Bacillus sp. + B. subtilis*) and minimum was recorded with control (20.11). Number of pods per plant was recorded maximum with T3 (61.55) followed by T7 (59.88) and lowest was recorded with T1 (51.77) which was at par with control (54.22). Highest test weight of fenugreek seeds was recorded with T2 (16.30 g) which was at par with T3 (15.92 g) and lowest was recorded with T1 (14.60g) which was at par with T9-control (14.92). In case of fenugreek the highest seed yield was obtained with T2-*Rhizobium +B. megaterium* (18.77 q/ha) and lowest seed yield was obtained with control -T9 (15.59 q/ha).

Table 3.23: Effect of microbial inoculation on yield attributes of cumin

Treatment	Primary branches	Secondary branches	No. of umbels/plant	No. of umbellets/umbel	No. of seed per umbellet
T1- <i>Bacillus subtilis</i> NRCSS-1	8.00	37.37	35	5.22	6.22
T2- <i>Bacillus megaterium</i>	7.83	36.87	33.55	5.11	7.003
T3- <i>Pseudomonas fluorescens</i>	8.16	33.08	35.66	5	5.667
T4- <i>Pseudomonas</i> sp.-I	8.79	36.91	30.88	5.33	6.113
T5- <i>Bacillus</i> sp.	8.21	35.12	28.89	5	5.887
T6- <i>Bacillus</i> sp. W1	7.79	30.04	32.11	5.11	5.777
T7-Control	7.417	36.75	31.33	5.22	5.89
CD@0.05	0.189	0.624	N/A	N/A	N/A
SEm	0.061	0.2	2.181	0.085	0.381

Table 3.24 : Effect of microbial inoculation on cumin yield

Treatment	per plant Seed yield (g/plant)	Seed yield(q/ha)	Essential oil content (%)
T1- <i>Bacillus subtilis</i> NRCSS-1	3.13	4.58	2.32
T2- <i>Bacillus megaterium</i>	3.22	5.11	2.28
T3- <i>Pseudomonas fluorescens</i>	3.14	5.24	2.98
T4- <i>Pseudomonas</i> sp.-I	3.13	3.62	3.64
T5- <i>Bacillus</i> sp.	2.92	5.06	3.26
T6- <i>Bacillus</i> sp. W1	3.20	3.63	2.64
T7-Control	2.44	3.60	2.70
CD@0.05	0.33	0.292	NS
SEm	0.10	0.094	0.68

Table 3.25: Effect of microbial inoculation on fenugreek Seedling vigour index

Treatment	germination 15 days (%)	Seedling vigour index	Seedling dry weight (g)
T1- <i>Rhizobium</i> + <i>B. subtilis</i>	93.33	9091	0.105
T2- <i>Rhizobium</i> + <i>B. megaterium</i>	90.00	8370	0.110
T3- <i>Rhizobium</i> + <i>Bacillus</i> sp. + <i>B. subtilis</i>	91.66	5958	0.102
T4- <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	93.33	6720	0.084
T5- <i>Bacillus</i> sp. + <i>B. megaterium</i>	93.33	6067	0.097
T6- <i>Bacillus</i> sp.	93.33	7560	0.098
T7- <i>Bacillus subtilis</i>	93.33	7523	0.099
T8- <i>Rhizobium</i>	91.66	7388	0.095
T9-Control	90.00	6282	0.096
CD @0.05	N/A	248	0.014
SEm	7.32	80.29	0.009

Table 3.26: Effect of microbial inoculation on fenugreek root nodules

Treatment	No. of nodules /pl. at 35 DAS	No. of nodules /pl. at 70 DAS	No. of nodules /pl. at 105 DAS
T1- <i>Rhizobium</i> + <i>B. subtilis</i>	9.33	18.89	20.55
T2- <i>Rhizobium</i> + <i>B. megaterium</i>	11.11	19.55	21.11
T3- <i>Rhizobium</i> + <i>Bacillus</i> sp. + <i>B. subtilis</i>	9.89	21.77	25.66
T4- <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	10.11	21.44	21.33
T5- <i>Bacillus</i> . sp. + <i>B. megaterium</i>	11.78	18.77	21.44
T6- <i>Bacillus</i> sp.	8.66	21.00	23.33
T7- <i>Bacillus subtilis</i>	8.55	21.44	20.22
T8- <i>Rhizobium</i>	11.33	19.44	21.99
T9-Control	9.66	18.78	20.11
CD @0.05	N/A	2.039	3.302

Table 3.27: Effect of microbial inoculation on yield and yield attributes of fenugreek

Treatment	No. of primary Branches / pl.	No. of Pods / pl.	No. Seeds/ pod	test weight	Yield (q/ha)
T1- <i>Rhizobium</i> + <i>B. subtilis</i>	5.66	51.77	15.33	14.60	17.83
T2- <i>Rhizobium</i> + <i>B. megaterium</i>	5.44	56.55	16.11	16.30	18.77
T3- <i>Rhizobium</i> + <i>Bacillus</i> sp. + <i>B. subtilis</i>	5.22	61.55	15.11	15.92	17.38
T4- <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	5.55	55.66	16.88	15.51	17.58
T5- <i>Bacillus</i> . sp. + <i>B. megaterium</i>	5.22	52.77	14.33	15.45	16.18
T6- <i>Bacillus</i> sp.	5.44	55.78	14.11	14.82	15.63
T7- <i>Bacillus subtilis</i>	5.55	59.88	16.66	14.62	15.85
T8- <i>Rhizobium</i>	5.22	58.00	14.66	14.80	16.02
T9-Control	4.78	54.22	15.22	14.92	15.59
CD @0.05	N/A	4.466	N/A	0.67	0.579

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

(R. Singh; K. Kant and R.D. Meena)

Three levels of fertilizer (NPK) i.e. 40, 60 and 80 % of recommended dose of fertilizers (N, P, K) in main plot along with three varieties fenugreek (AFg-2, AFg-3 and AFg-5) and coriander (ACr-1, ACr-2 and AGCr-1) were raised as sub plot crop during the rabi season in the relay cropping system with vine vegetables. The vine vegetables were sown in the standing crop

of coriander and fenugreek during February. Among the fenugreek and coriander varieties, maximum seed yield was 2443 and 1760 kg/ha with AFg-5 and ACr-1, whereas 80% of recommended fertilizers gave significantly superior yield under both the crops (table 3.28). After fully canopy coverage by the vine vegetables, leafy vegetables namely fenugreek, coriander, spinach and amaranths were sown in field below the canopy of the vine vegetables in two tier system.

Table 3.28: Effect varieties and fertilizers dose on seed yield (kg/ha) of fenugreek and coriander

Treatment	Fertilizer dose			Mean
	Fenugreek			
Fertilizer dose/variety	40%	60%	80%	
AFg-2	2,003	2,278	2,744	2,341
AFg-3	2,199	2,491	2,556	2,415
AFg-5	2,278	2,503	2,548	2,443
Mean	2,160	2,424	2,616	
	Coriander			
ACr-1	1,584	1,786	1,911	1,760
ACr-2	1,487	1,705	1,744	1,645
AgCr-1	1,397	1,532	1,561	1,497
Mean	1,489	1,674	1,739	
Factors	C.D.	SE(d)	SE(m)	
Factor(A)	195.1	61.7	43.6	
Factor(B)	98.6	45.2	32.0	
Interaction A X B	139.4	64.0	45.2	
Factor(C)	N/A	48.1	34.0	
Interaction A X C	138.0	68.0	48.1	
Interaction B X C	169.0	83.3	58.9	
Interaction A X B X C	N/A	117.8	83.3	



Performance coriander varieties in bower and vine vegetables as relay crop sown in February



Performance of fenugreek varieties in bower and vine vegetables as relay crop



The tier 2 crop i.e bottle gourd, bitter gourd and ridge gourd were trailed with support of net on the bower. After fully canopy coverage (81-106 days after sowing) by the vine vegetables, Tier 1 leafy vegetables namely fenugreek, coriander, spinach and amaranths were sown as sub plot crops in field below the canopy of the vine vegetables (natural shading of crop foliage of tier 2 crop). The average yield of bottle gourd, ridge gourd, and bitter gourd were 65061, 5653 and 8063 kg/ha as tier 2 crop (table 3.29). Whereas the yield of leafy vegetables namely fenugreek, coriander, spinach and amaranths were 1019 kg, 3366 kg, 694 kg and 852 kg/ha which were raised in

soil as tier 1 crop below the canopy of tier 2 crop on the bower system. Fenugreek and coriander were raised during the rabi season in the cropping system gave 2389 and 2599 kg/ha seed yield. The yield of bottle gourd, ridge gourd and bitter gourd were 65061, 5653 and 8063 kg/ha as tier 2 crop. Whereas the yield of leafy vegetables namely fenugreek, coriander, spinach and amaranths were 1019, 3366, 695 and 852 kg/ha which were raised in soil as tier 1 crop in the bower system. Coriander in rabi for seed followed by bottle gourd + leafy coriander for vegetable gave maximum FSEY (26797 kg/ha) with maximum gross and net returns (Rs 724806) with 3.40 B:C ratio (table 3.30 & 3.31).

Table 3.29: Fenugreek seed equivalent yield (kg/ha) of two tier cropping system (rabi spice crop-vine vegetables - summer leafy vegetable) under different treatments

Summer vegetables	Rabi crop			Fenugreek		
	Bottle gourd	Coriander Ridge gourd	Bitter gourd	Bottle gourd	Ridge gourd	Bitter gourd
Coriander	26,797	12,527	8,992	25,391	9,438	8,558
Fenugreek	26,231	10,680	9,641	23,043	8,033	6,729
Spinach	26,069	9,875	8,007	22,241	7,289	6,767
Amaranthus	24,434	10,370	8,653	22,568	6,724	6,244
Factors		C.D.	SE(d)	SE(m)		
Factor(A)		372.6	117.9	83.3		
Factor(B)		694.1	318.6	225.3		
Interaction A X B		N/A	450.6	318.6		
Factor(C)		797.0	397.5	281.0		
Interaction A X C		N/A	562.1	397.5		
Interaction B X C		N/A	688.4	486.8		
Interaction A X B X C		N/A	973.6	688.4		

Table 3.30: Net returns (Rs/ha) of two tier cropping system (rabi spice crop-vine vegetables - summer leafy vegetable) under different treatments

Summer vegetables	Rabi crop			Fenugreek		
	Bottle gourd	Coriander Ridge gourd	Bitter gourd	Bottle gourd	Ridge gourd	Bitter gourd
Coriander	724,806	233,336	101,179	675,573	125,231	85,984
Fenugreek	711,976	158,693	123,883	600,409	66,044	21,946
Spinach	699,319	139,067	73,705	565,335	48,566	30,304
Amaranthus	647,074	159,400	99,286	581,771	31,765	14,971
Factors		C.D.	SE(d)	SE(m)		
Factor(A)		13,007	4,125	2,909		
Factor(B)		23,385	10,151	7,602		
Interaction A X B		N/A	14,731	10,151		
Factor(C)		27,897	12,987	9,735		
Interaction A X C		N/A	18,535	12,001		
Interaction B X C		N/A	25,138	18,478		
Interaction A X B X C		N/A	34,076	24,095		



Bottle gourd and ridge gourd on beds (tier 2 crop) trailed on bower and leafy vegetable in flat beds

Table 3.31: B:C ratio under of two tier cropping system (rabi spice crop-vine vegetables - summer leafy vegetable) under different treatments

Rabi crop	Coriander			Fenugreek			
	Summer vegetables	Bottle gourd	Ridge gourd	Bitter gourd	Bottle gourd	Ridge gourd	Bitter gourd
Coriander		3.40	1.14	0.47	3.17	0.61	0.40
Fenugreek		3.46	0.74	0.58	2.92	0.31	0.10
Spinach		3.28	0.67	0.36	2.65	0.24	0.15
Amaranthus		3.11	0.79	0.49	2.80	0.16	0.07
Factors			C.D.	SE(d)	SE(m)		
Factor(A)			0.062	0.02	0.014		
Factor(B)			0.118	0.054	0.038		
Interaction A X B			N/A	0.077	0.054		
Factor(C)			0.134	0.067	0.047		
Interaction A X C			N/A	0.094	0.067		
Interaction B X C			N/A	0.116	0.082		
Interaction A X B X C			N/A	0.164	0.116		

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

(S.S. Meena, O.P. Aishwath, N.K. Meena, R.D. Meena, Shivalal)

The highest seed yield of seed spices was obtained in open space followed by with guava association. This might be happened due to no competition of seed spices with fruit trees in open space. Among the seed spices the fenugreek resulted significantly highest seed (1625kg/ha.) over other seed spices followed by Ajwain. Highest fruit yield of guava (5540 kg/ha) was recorded in treatment (Guava + Fenugreek) followed by Nigella+Guava (4893.67 kg/ha) treatment. All necessary observations were recorded and data presented in table 3.32.

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 happened due to no competition of seed spices with fruit trees in open space. Among the seed spices the fenugreek resulted significantly highest seed (1656.25kg/ha.) over other seed spices followed by Ajwain. Highest fruit yield of pomegranate (4,884 kg/ha) was recorded in treatment (Pomegranate + Fenugreek) followed by Nigella+ Pomegranate (4,225 kg/ha) treatment. All necessary observations were recorded and data presented in table 3.33.

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

Treatments	No. pods/umbels/ siliqua/plant	No. of umbellates/umbel	No. of seeds/ pod/umbellate	Seed yield (kg/ha.)	Test weight (gm)
Fenugreek + Guava	25.20	0.00	17.70	1484.72	21.80
Coriander + Guava	50.10	40.13	50.00	613.75	7.45
Nigella + Guava	35.60	0.00	81.90	222.99	2.19
Anise + Guava	31.40	14.60	18.10	651.39	3.20
Ajwain + Guava	237.40	16.23	22.97	652.08	1.09
Sole Fenugreek	31.30	0.00	18.00	1625.00	22.19
Sole Coriander	52.30	44.20	50.40	675.83	7.58
Sole Nigella	39.30	0.00	94.20	339.38	2.23
Sole Anise	31.40	16.97	19.10	706.25	3.90
Sole Ajwain	270.20	18.40	23.20	979.58	1.11
Sole Guava	0.00	0.00	0.00	0.00	0.00
C.D.	8.44	2.65	3.56	163.65	0.70
SE(m) ±	2.84	0.89	1.20	55.09	0.24
C.V. %	6.73	11.29	5.78	13.20	6.17

Table 3.33: Effect of pomegranate based intercropping on yield attributes of intercropped

Treatments	No. pods/ umbels/ siliqua/plant	No. of umbellates/ umbel	No. of seeds/ pod/ umbellate	Seed yield (kg/ ha.)	Test weight (gm)
Fenugreek+Pomegranate	25.20	0.00	17.40	1512.50	21.75
Coriander+Pomegranate	50.10	37.47	49.30	553.13	7.50
Nigella+Pomegranate	35.60	0.00	94.27	233.54	2.43
Anise+Pomegranate	31.40	17.23	18.23	706.25	3.33
Ajwain+Pomegranate	237.40	16.03	22.07	652.08	1.03
Sole Fenugreek	26.50	0.00	18.40	1656.25	22.53
Sole Coriander	51.80	44.20	50.53	613.75	7.77
Sole Nigella	61.00	0.00	95.10	327.29	2.63
Sole Anise	31.50	17.27	19.00	791.88	4.10
Sole Ajwain	260.20	16.87	23.53	990.21	1.27
Sole Pomegranate	0.00	0.00	0.00	0.00	0.00
C.D.	10.83	1.61	3.26	206.71	1.43
SE(m) ±	3.65	0.54	1.10	69.58	0.48
C.V. %	8.57	6.93	5.12	16.50	12.31

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

(P.I. B.K. Mishra: 2017-20)

Qualitative assay for potassium solubilization by rhizobacterial isolates was performed under lab conditions, in which maximum K-solubilization index was recorded with DCU-351 (2.9) which was at par with DCU-364 (2.8) and DCU-453 (2.7). The lowest K-solubilization index was observed with DCU-366(1.3).

Eleven selected rhizobacterial cultures along with PSB cultures were field tested for their effect on coriander growth and yield. Various growth and yield attributing characters were recorded and analyzed. In case of coriander crop field experiment, the seed yield ranged from 13.44 to 10.18 q/ha. The maximum seed yield was recorded with T1 followed by T2 and minimum seed yield was recorded in control which was at par with T6 & T10. The essential oil content in coriander seeds ranged from 0.20 to 0.29 per cent (table 3.35).

For field evaluation of effect of selected microbial cultures on cumin crop, seeds treated with 15 rhizobacterial isolates along with PSB culture and one control were sown in RBD with 3 replication. There were significant effects of various microbial treatments on growth parameters of cumin plant. Number of primary branches per plant ranged from 8.11 to 10.00 and likewise number of secondary branches per plant varied from 24.56 to 34.67. Although, there was significant effect of microbial treatment on number of umbels per plant which varied from 2.11 to 33.56, non-significant effect was observed in case of umbellates per umbel and seeds per umbellate (table 3.36). The highest cumin seed yield was obtained with T9 (6.757q/ha) which was at par with T2 and lowest was recorded with T12 (4.337 q/ha).

CPd/17.3.2: Nutrient requirement of minor seed spices (Celery and Ajwain) and their management.

(O.P. Aishwath; S.N. Saxena and R. Singh)

Plant height of ajwain was higher only at 60 kg N ha⁻¹

Table 3.34 : Qualitative assay for K solubilization by rhizobacterial isolates

Sr.No.	Culture	Zone of clearance	KS Index
1.	DCU-22	12	2.4
2.	DCU-251	13	2.1
3.	DCU-121	10	2.2
4.	DCU-352	12	2.0
5.	DCU-355	13	2.3
6.	DCU-362	10	2
7.	DCU-367	13	2.2
8.	DCU-351	16	2.9
9.	DCU-353	13	2.1
10.	DCU-354	11	2
11.	DCU-360	10	2.3
12.	DCU-364	15	2.8
13.	DCU-366	9	1.3
14.	DCU-371	11	1.7
15.	DCU-372	13	2.1
16.	DCU-451	12	2.5
17.	DCU-453	14	2.7
18.	DCU-651	13	2.5
	SEm	0.857	0.252
	CD (5%)	1.773	0.471
	CV	5.281	6.523

and beyond level, whereas primary and secondary branches were only higher at 40 kg N ha⁻¹ and higher level (Table 3.37). Unlikely to the above umbel per plant were more at all level of applied N. However, Umbellate per umbel, seeds per umbel and test were at par to control. The seed yield was only more with 40 and 60 kg N ha⁻¹ and the rest of treatments were at par with control. Likewise uptake of N and P was also more with 40 and 60 kg N. However, K and micronutrient uptake was higher with all level of N. Oil content enhanced by graded levels of N.

Ajwain plants were taller with 40kg P ha⁻¹ of applied and it's beyond levels (Table 3.38). However, primary branches were higher beyond the 20 kg P ha⁻¹ and umbellate per umbel at all the levels of P. Rest of the growth and yield parameters were indifferent to absolute control. Seed yield was marginally higher with applied P. N, P, K and Cu uptake was more

**Table 3.35: Effect of treatment microbial inoculants on Coriander crop growth and yield**

Treatment	Umbels / plant	Umbellets /umbel	Seeds per umbellet	Seed yield (Q/ha)
T1- DCU-22 + PSB	30.13	5.66	10.89	13.44
T2- DCU-181 + PSB	29.66	5.44	8.77	12.90
T3- DCU-184 + PSB	30.23	5.33	7.66	12.01
T4- DCU-188 + PSB	27.56	5.44	11.00	10.82
T5- DCU-251 + PSB	32.10	5.66	9.66	10.56
T6- DCU-262 + PSB	30.23	5.44	8.11	10.44
T7- DCU-351 + PSB	28.66	5.55	7.67	12.47
T8- DCU-364 + PSB	30.20	5.66	9.55	11.98
T9- DCU-451 + PSB	27.10	5.55	9.55	10.41
T10- DCU-453 + PSB	28.23	5.55	9.44	10.26
T11- DCU-651 + PSB	28.00	5.44	7.33	11.90
T12- control	27.60	5.33	8.00	10.18
CD	2.17	N/A	1.61	0.52
SEm	0.83	0.203	0.54	0.17

Table 3.36. Effect of microbial treatment on cumin crop growth and yield

Treatment	Umbels / plant	Umbellets /umbel	Seeds / umbellet	Seed yield (Q/ha)
T1- DCU-22 + PSB	26.78	5.66	6.00	4.827
T2- DCU-181 + PSB	28.22	5.00	6.77	6.350
T3- DCU-184 + PSB	24.45	5.00	6.00	5.737
T4- DCU-188 + PSB	26.67	5.33	6.23	5.113
T5- DCU-251 + PSB	23.11	5.66	6.67	5.237
T6- DCU-262 + PSB	33.56	5.00	6.23	4.96
T7- DCU-351 + PSB	32.44	5.33	6.90	4.767
T8- DCU-364 + PSB	31.44	5.00	6.87	4.703
T9- DCU-451 + PSB	30.89	5.00	7.23	6.757
T10- DCU-453 + PSB	29.45	5.33	6.77	5.143
T11- DCU-651 + PSB	30.33	5.33	6.87	6.317
T12- <i>Bacillus cepacia</i> + PSB	29.89	5.00	6.97	4.337
T13- <i>Pseudomonas alcalifaciens</i> + PSB	32.00	5.33	7.00	6.207
T14- <i>Pseudomonas fluorescens</i> + PSB	26.00	5.66	6.87	4.717
T15- <i>Bacillus polymyxa</i> + PSB	31.00	5.00	7.23	4.583
T16- control	29.34	5.66	6.80	5.733
CD	5.39	N/A	N/A	0.425
SEm	1.86	0.30	0.41	0.147

Table 3.37. Effect of N levels on growth yield and their parameters of ajwain

Treatment	Plant Height (cm)	Prim. Branches/plant	Second. Branches/plant	Umbel/plant	Umbellate / Umbel	Seeds/ Umbellate	Test Wt (gm)	Seed Yield (q/ha)
Control	99.6	18.3	48.0	251.0	17.0	28.0	1.29	16.2
N0	101.7	18.6	48.0	255.9	17.2	28.2	1.29	16.8
N20	102.0	19.6	50.7	261.3	17.2	28.4	1.27	17.6
N40	100.0	20.6	51.2	261.9	17.2	28.5	1.27	18.7
N60	105.0	20.4	51.7	260.4	17.3	28.8	1.27	18.8
N80	104.8	20.6	51.9	259.3	16.9	27.8	1.25	16.7
N100	106.4	21.8	52.2	257.6	16.8	27.9	1.25	16.2
CD at 5%	3.9	1.5	2.9	7.5	NS	NS	NS	1.7

Table 3.38. Effect of P levels on performance of celery

Treatment	Pl. Height	Prim. Branch./plant	Secon. Branch./plant	Umble/pl	Umbellate /Umbel	Seeds/ Umbellate	Test Wt.	Seed Yield (q/ha)
Control	98.2	18.2	49.0	250.9	16.1	27.4	1.30	16.4
P0	100.0	18.4	49.8	255.0	16.2	27.5	1.30	16.9
P20	100.3	18.5	49.8	255.7	16.3	27.6	1.29	17.4
P30	100.4	20.4	50.3	256.7	16.9	27.6	1.28	18.1
P40	103.3	20.8	50.5	256.9	16.9	28.1	1.28	18.2
P50	103.4	20.9	50.9	259.1	16.9	28.2	1.27	18.4
P60	105.1	21.2	51.0	259.5	17.2	28.4	1.26	18.4
CD at 5%	4.0	2.1	NS	NS	0.9	NS	NS	NS

beyond the 30kg applied P and Na beyond 50 kg P. Moreover, uptake of iron, zinc and manganese were only higher at 50 and 60 kg applied P in ajwain. Oil content increased with increased levels of applied P.

Response of celery to integrated use of N and FYM

Plants were taller with all the level of N and FYM alone and their combinations (Table 3.38 to 3.41). Likewise other parameters per plants, umbellate per umbel, seeds per umbellate and seed yield was also more with all the levels of N and FYM by single or combine application. Whereas, secondary branches were only higher at 10t FYM along with 60 kg N, while primary branches are higher with all individual and combine application of N and FYM except 30kg ha⁻¹. Similarly, test weight was higher only at 10t FYM along with 30 and 60 kg N ha⁻¹. Highest yield of celery was obtained with 10t FYM together with 60 kg N ha⁻¹. Nitrogen and phosphorus uptake was

enhanced with 10t FYM alone and 30 and 60kg N along with either dose of FYM. Whereas K and Cu uptake was higher with 60 kg N +5t FYM and their higher levels including 60 kg of N ha⁻¹ alone. The uptake of Mn was more only at 10t FYM along with either dose of N. Iron and Zn Uptake was higher with all levels N and FYM alone or together with, except single application of both 30 kg N and 5t FYM.

Response of celery to various modes of micronutrients application.

Plant height of celery increased with combine application mode of micronutrients (Fe, Zn, Mn, Ca, & B) i.e seed priming and foliar application together (Table 3.40). However, Plant height was the highest by Zn 200ppm and foliar application by 0.5%. Primary branches were more in number with Zn (500ppm) and least with boron. Secondary and number of umbel were more with Fe and Zn. Umbel per plant was higher in numbers with all micronutrients and



results were superior with Fe among the rest. Seed test weight and seeds per umbellats were highest with Fe application by both the modes together. Seed yield was only higher Fe and Zn application by seed priming and foliar application.

Soil application of micronutrients improved the plant

height with either of their levels, however response of celery with lower level of Cu and Mn as well as either dose of Fe was at par with control and rest of the micronutrients effect was significant (Table 3.41). Most of the growth, yield and yield parameters were higher with 10 kg applied Cu in Soil.

Table 3.39. Effect of N and FYM on growth and yield of celery

Treatment	Plant Ht (cm)	Prim. Branch./plant	Second. Branch./plant	Umbel /plant	umbellate/ Umbel	Seed/ umbellate	Test wt (gm)	Yield (q/ha)
Control	108.0	6.8	17.6	71.1	15.8	22.6	0.39	7.6
N30	126.0	7.2	18.6	82.0	16.6	25.2	0.39	8.7
N60	135.1	7.5	20.9	83.3	18.0	25.9	0.41	9.2
FYM ₅	132.0	7.5	20.7	80.0	18.1	25.8	0.39	8.9
FYM ₁₀	135.1	8.2	20.9	82.7	18.4	25.9	0.40	9.5
FYM ₅ +N ₃₀	145.8	9.6	23.2	93.9	18.9	27.3	0.40	9.9
FYM ₅ +N ₆₀	146.5	10.4	25.2	100.9	19.0	29.2	0.40	10.3
FYM ₁₀ +N ₃₀	145.4	10.3	25.2	101.2	19.8	29.6	0.42	10.5
FYM ₁₀ +N ₆₀	148.1	11.7	25.9	109.9	20.6	30.2	0.42	11.5
CD at 5 %	4.2	0.4	7.7	2.8	0.4	1.8	0.03	1.0

Table 3.40. Effect of seed priming and foliar application with micronutrients on growth and yield of celery.

Treatment	Plant ht (cm)	Primary branc./plant	Second. branc./plant	umbel/ Pl.	umbellate/ Umbel	Seed/ umbellate	Test wt(g)	Yield (q/ha)
Control	128.4	8.9	21.7	95.1	18.6	24.9	0.39	8.7
Cu ₁₀₀ + 5K	143.6	10.7	24.5	110.6	19.9	28.5	0.43	9.8
Fe ₃₀₀ + 5K	146.6	11.8	26.3	115.7	21.4	30.9	0.44	11.7
Mn ₃₀₀ + 5K	144.0	10.6	24.1	104.7	19.8	26.5	0.42	9.5
Zn ₃₀₀ + 5K	145.9	11.4	25.3	107.6	21.5	28.7	0.43	10.1
B ₂₀₀ +2K	143.7	10.3	24.1	105.2	19.3	26.3	0.40	9.7
CD at 5 %	9.4	1.5	2.8	4.3	2.6	1.4	0.04	1.2

Table 3.41. Effect of soil application of micronutrients on growth and yield of celery.

Treatment	Pl. ht (cm)	Prim. Branc./plant	Second. Branc./plant	Umbel /Pl.	Umbellate/ Umbel	Seed/ umbellate	Test wt (g)	Yield (q/ha)
Control	111.1	8.1	21.8	85.2	18.3	24.8	0.39	8.5
Cu ₅	142.1	10.4	24.8	108.9	20.0	28.9	0.43	11.2
Cu ₁₀	144.9	12.1	27.4	113.6	21.8	30.9	0.44	12.0
Fe ₁₀	142.4	10.4	23.8	98.6	19.6	27.2	0.42	9.5
Fe ₂₀	132.4	10.8	24.8	101.6	19.2	27.6	0.42	9.9
Mn ₁₀	143.1	10.1	24.5	103.6	20.2	27.9	0.39	9.9
Mn ₂₀	143.8	11.1	25.4	105.6	20.0	28.2	0.40	10.1
Zn ₅	147.4	11.1	25.8	106.2	20.2	28.6	0.43	10.9
Zn ₁₀	147.7	11.8	26.4	110.2	21.8	29.4	0.43	11.3
B ₅	144.4	11.4	24.7	105.9	20.1	28.4	0.42	9.8
CD at 5 %	10.2	2.9	2.9	7.2	1.8	3.7	0.03	1.31

Response of celery to rise in temperature

Growth and yield parameters of celery were reduced with rise in temperature. About 44.3 per cent yield reduced with 6.0 to 8.0 °C beyond the optimum. Days to maturity reduced from 207 to 167 days with advancing in temperature which is about 24 hrs

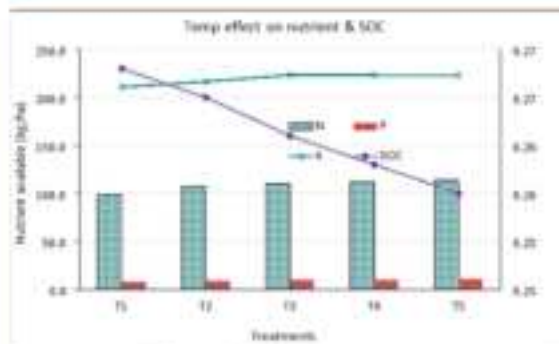
advancement with per degree rise in temperature. Macro and micro-nutrient uptake was also reduced with higher temperature. Soil available nutrients increased and SOC decreased might be due to mineralization of SOC with frequent irrigation by rise in temperature during maturity (Table 3.42 & 3.43).

Table 3.42. Effect of soil temperature on growth and yield and yield of celery

Treatment	Pl. ht. (cm)	Primary branch./plant	Secondary branch./plant	Umbel/Plant	Umbellate/ Umbel	Seeds/ umbellate	Seed yield (q/ha)
T ₁ (25 Sept)	151.1	11.3	27.4	87.4	21.2	28.7	12.1
T ₂ (5 Oct)	148.4	11.8	27.5	87.8	21.3	27.3	12.7
T ₃ (15 Oct)	148.2	11.3	27.8	82.0	20.6	25.1	12.3
T ₄ (25 Oct)	128.8	10.4	21.8	68.1	19.1	23.8	11.2
T ₅ (5 Nov)	123.8	9.8	17.5	61.3	16.7	20.3	8.8
CD at 5%	4.0	0.4	1.3	1.7	0.6	0.6	1.5

Table 3.43. Effect of soil temperature on nutrient uptake by celery

Treatment	N (kg/ha)	P (kg/ha)	K (kg/ha)	Na (kg/ha)	Fe (g/ha)	Zn (g/ha)	Mn (g/ha)	Cu (g/ha)
T1	58.1	15.4	76.8	105.0	2223.0	106.2	407.8	227.7
T2	63.9	17.2	83.1	115.5	2522.5	117.6	456.4	258.5
T3	65.1	17.6	84.8	115.3	2580.3	115.7	455.9	255.7
T4	54.7	14.9	68.9	96.3	2117.9	94.9	384.0	212.8
T5	42.8	11.6	52.4	71.1	1631.9	73.7	286.2	165.9
CD at 5%	4.0	1.0	5.6	12.7	148.3	8.7	33.2	18.4



Effect of soil temperature on soil parameters of celery

CPd/17.3.4: Studies on G × E interaction in cumin through on farm trial (OFT)

(Ravindra Singh, R. S. Meena)

Eight varieties of cumin GP-1, GC-3, GC-4, RZ-19, RZ-209, RZ-223, RZ-341, RZ-345 were sown at three locations i.e. Nagaur (Mundawa), Barmer (Dhorimana), Ajmer (Tabiji) at farmers field. Out of eight varieties, one variety was not germinated/ survived across the locations. Across the 3 locations, maximum seed yield was recorded in GC-4 (716.6 kg/ha) followed by GP-1 (478.0 kg/ha) and lowest in RZ-19 (331.8 kg/ha).

Whereas, the essential oils were maximum in GC-4 (4.17%) followed by 3.81% in RZ-209. Among the locations across the 6 cumin varieties, maximum seed yield was recorded at Budhwada (611.0 kg/ha) followed by Dang (294.5 kg/ha). Essential oil in cumin seed was maximum at Dang (3.01%), followed by Budhwada (2.98%). Local weather parameters in the cumin growing area influence the seed yield and quality of the cumin as reflected by the data in interaction tables on yield (table 3.44) and essential oil content (table 3.45) in seed.

Table 3.44: Effect of G*E interaction on seed yield (kg/ha) at two locations

Treatment	Dang	Budhwada	Mean B
Gp-1	362.9	593.1	478.0
GC-4	662.6	770.5	716.6
RZ-19	173.3	490.3	331.8
RZ-209	161.1	680.1	420.6
RZ-223	287.8	553.5	420.6
RZ-341	248.1	582.0	415.1
RZ-345	165.9	607.3	386.6
Mean A	294.5	611.0	
Factors	C.D.	SE(d)	SE(m)
Factor(A)	57.5	70.3	34.0
Factor(B)	81.3	131.5	63.6
Factor(A X B)	140.7	N/A	90.0

Table 3.45: Effect of G*E interaction on essential oil content (%) in seed at two locations

Treatment	Dang	Budhwada	Mean B
Gp-1	2.43	2.47	2.45
GC-4	4.30	4.03	4.17
RZ-19	2.20	2.23	2.22
RZ-209	3.90	3.73	3.82
RZ-223	2.63	2.47	2.55
RZ-341	2.30	2.40	2.35
RZ-345	3.30	3.50	3.40
Mean A	3.01	2.98	
Factors	C.D.	SE(d)	SE(m)
Factor(A)	N/A	0.06	0.05
Factor(B)	0.24	0.12	0.08
Factor(A X B)	N/A	0.17	0.12



Cumin varieties at experimental site at Dang/Tabiji during 2019-20



Cumin varieties at experimental site visit at Budhwada during 2019-20

CPD/18.3.1: Seed spices based cropping system for sustainable livelihood security

(Narendra Choudhary; R. Singh and M.D. Meena)

In rabi season maximum seed yield (929.93 kg/ha) of coriander was registered under coriander-green coriander-mung bean cropping system. Maximum seed yield (1411.72 kg/ha) of fenugreek was recorded under fenugreek-green coriander-cluster bean cropping system. Maximum seed yield (832.85 kg/ha) of nigella was recorded under nigella-green coriander-mung bean cropping system. In summer season maximum yield (368.7 kg/ha) of green

coriander registered under coriander-green coriander-mung bean cropping system. Maximum seed yield (1165.9 kg/ha) of cluster bean recorded under fenugreek-cluster bean-cluster bean cropping system. In kharif season maximum seed yield (286.30 kg/ha) of mung bean recorded in coriander-cluster bean-mung bean cropping system. Maximum seed yield (1094.44 kg/ha) of cluster bean recorded in fenugreek-cluster bean-cluster bean cropping system (table 3.46).

Under the experiment of standardization of organic source of nutrition in nigella, maximum plant height (64.80 cm), no. of secondary branch and no. of capsule per plant were recorded under FYM 100%. Maximum seed yield (1215.55 kg/ha) was recorded under neem cake 100% followed by (1183.70 kg/ha) neem cake 75% + vermicompost 25%. Maximum no. of primary branch (6.80) and biological yield (6521.32 kg/ha) were recorded under neem cake 100%. Maximum total oil (13.15%) recorded under FYM 33.3% + vermicompost 33.3% + neem cake 33.3% (table 3.47, 3.48 & 3.49).

Table 3.46 Evaluation of seed spices based cropping system

Sl. No.	Cropping system (Rabi-Summer-Kharif)	Rabi (2019-20) Yield (Kg/ha)	Summer (2020) Yield (Kg/ha)	Kharif (2020) Yield (Kg/ha)
T ₁	Coriander-Cluster bean-Mung bean	422.22	1131.9	286.30
T ₂	Coriander-Cluster bean-Cluster bean	430.79	1025.9	1019.26
T ₃	Coriander-Green Coriander-Cluster bean	928.48	292.3	885.93
T ₄	Coriander- Green Coriander-Mung bean	929.93	368.7	228.52
T ₅	Fenugreek-Cluster bean-Mung bean	950.71	1040.0	234.07
T ₆	Fenugreek-Cluster bean-Cluster bean	966.29	1165.9	1094.44
T ₇	Fenugreek-Green Coriander-Cluster bean	1411.72	362.6	947.41
T ₈	Fenugreek- Green Coriander-Mung bean	1409.20	298.5	247.04
T ₉	Nigella-Cluster bean-Mung bean	640.81	1051.1	180.37
T ₁₀	Nigella -Cluster bean-Cluster bean	651.63	1105.2	1011.85
T ₁₁	Nigella -Green Coriander-Cluster bean	807.68	361.4	980.00
T ₁₂	Nigella - Green Coriander-Mung bean	832.85	366.6	238.89



Crop field view of summer season (2020)



Crop field view of kharif season (2020)



Crop field view of rabi season (2019-20)



Field view of organic trial of nigella

Table 3.47: Standardization of organic source of nutrition in nigella

Treatments	Plant height (cm)	No of Primary branch/plant	No of Sec. Branch/plant	No of capsule per plant
Control	62.80	6.13	11.93	19.27
FYM 100%	64.80	6.40	13.20	26.07
Vermicompost 100%	59.53	6.60	11.60	24.00
Neem cake 100%	61.47	6.80	12.73	24.33
FYM 50% + VC 50%	62.47	6.73	11.93	24.00
FYM 50% + NC 50%	61.80	6.60	13.13	25.73
VC 50% + NC 50%	58.13	6.73	12.53	20.93
FYM 75% + VC 25%	61.00	6.33	12.60	24.73
FYM 75% + NC 25%	60.00	5.80	12.40	22.80
VC 75% + NC 25%	59.60	6.07	12.67	24.00
VC 75% + FYM 25%	61.20	6.60	12.67	24.67
NC 75%+ FYM 25%	62.00	6.53	12.67	24.60
NC 75% + VC 25%	61.13	6.07	11.80	22.20
FYM 33.3% + VC 33.3% + NC 33.3%	62.67	6.40	11.73	23.33

**Table 3.48: Standardization of organic source of nutrition in nigella**

Treatment	No of seed per capsule	Seed yield (Kg/ha)	Biological yield (Kg/ha)
Control	87.20	924.07	3801.87
FYM 100%	89.93	914.44	5284.45
Vermicompost 100%	94.00	1028.14	5089.27
Neem cake 100%	87.73	1215.55	6521.32
FYM 50% + VC 50%	93.47	1092.59	6274.78
FYM 50% + NC 50%	95.20	950.37	5394.26
VC 50% + NC 50%	82.80	1022.96	5370.83
FYM 75% + VC 25%	93.40	947.03	5513.79
FYM 75% + NC 25%	87.07	1040.00	5425.93
VC 75% + NC 25%	94.60	1015.18	5545.36
VC 75% + FYM 25%	97.53	1085.18	5201.07
NC 75%+ FYM 25%	86.47	894.074	4107.62
NC 75% + VC 25%	91.33	1183.70	5298.45
FYM 33.3% + VC 33.3% + NC 33.3%	82.47	930.370	4877.57

Table 3.49: Standardization of organic source of nutrition in nigella

Treatment	Harvest Index %	Test weight (g)	Total oil %
Control	26.56	2.80	10.01
FYM 100%	17.97	2.56	10.95
Vermicompost 100%	23.56	2.69	9.76
Neem cake 100%	20.80	2.67	12.82
FYM 50% + VC 50%	18.09	2.72	10.60
FYM 50% + NC 50%	17.56	2.59	6.29
VC 50% + NC 50%	19.89	2.68	9.89
FYM 75% + VC 25%	17.39	2.62	9.62
FYM 75% + NC 25%	19.11	2.49	12.37
VC 75% + NC 25%	18.58	2.56	10.31
VC 75% + FYM 25%	23.96	2.72	10.77
NC 75%+ FYM 25%	24.22	2.62	11.25
NC 75% + VC 25%	25.54	2.70	13.10
FYM 33.3% + VC 33.3% + NC 33.3%	19.72	2.66	13.15

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

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

(Y.K. Sharma; K. Kant)

Bioefficacy of different bioagents and their

combinations were evaluated against root rot of ajwain and nigella crops under field experiments. Seed treatment and soil application of *Trichoderma* and *Pseudomonas fluorescense* reduced the root rot incidence (61-67%) in nigella and (43-57%) in ajwain when applied individually and in combinations. Combinations (mixture) of bioagents were more effective than applied individually (table 3.50 & 3.51).

Table 3.50. Effect of bioagents (seed and soil application) on root rot of nigella

Treatments	Root rot incidence (%)		Disease control (%)	Seed yield (Kg/ha)
T1	7.0	(15.3)	62.0	907
T2	6.4	(14.7)	65.3	947
T3	6.6	(14.8)	64.2	1029
T4	7.1	(15.5)	61.2	928
T5	6.4	(14.7)	65.0	1040
T6	6.1	(14.2)	67.0	1099
T7	6.8	(15.1)	63.2	1029
T8	18.4	(25.3)	-	852
CD (0.05)	1.66	(1.82)	-	195.0

T1: ST & SA *Trichoderma viride*, T2: ST & SA *Trichoderma harzianum*, T3: ST & SA *Pseudomonas fluorescense*, T4: ST & SA *Paecilomyces lilacinus*, T5: ST & SA *T. viride* + *P. fluorescense*, T6: ST & SA *T. harzianum* + *P. fluorescense*, T7: ST & SA *P. fluorescense* + *P. lilacinus*, T8: control

Table 3.51. Effect of bioagents (seed and soil application) on root rot of ajwain

Treatments	Root rot incidence (%)		Disease control (%)	Seed yield (Kg/ha)
T1	14.1	(22.0)	43.1	1313
T2	13.9	(21.9)	44.1	1308
T3	13.7	(21.7)	44.6	1487
T4	13.9	(21.9)	43.9	1282
T5	10.6	(19.0)	57.1	1619
T6	11.3	(19.6)	54.5	1706
T7	11.7	(20.0)	52.7	1392
T8	24.8	(29.9)	-	1251
CD (0.05)	2.68	(2.18)	-	478.4

T1: ST & SA *Trichoderma viride*, T2: ST & SA *Trichoderma harzianum*, T3: ST & SA *Pseudomonas fluorescense*, T4: ST & SA *Paecilomyces lilacinus*, T5: ST & SA *T. viride* + *P. fluorescense*, T6: ST & SA *T. harzianum* + *P. fluorescense*, T7: ST & SA *P. fluorescense* + *P. lilacinus*, T8: control

CPt/17.4.2: Bioefficacy of new molecules of fungicides for the management of *Alternaria* blight disease of cumin and fenugreek

(Y.K. Sharma; P.N. Dubey)

Field experiments were conducted to evaluate spraying schedule of fungicides and evaluation of new molecules of fungicides against *Alternaria* blight of cumin and fenugreek. Three to four foliar spray of different recommended fungicides (mancozeb, difenoconazole and azoxystrobin) were

scheduled to apply as foliar spray from 45 days after sowing and subsequently at 15 days interval found most effective to combat blight disease of cumin (63-79% reduction as compared to control) (table 3.52 & 3.54).

Spray application of fungicides difenoconazole, tebuconazole and trifloxystrobin reduced the leaf blight (PDI 16.7- 18.0) disease and Copper oxychloride (0.2%), Chlorothalonil (0.2%) and Metalaxyl+Mancozeb (0.1%) reduced downy mildew (PDI 23.3-25.8) in fenugreek (table 3.53 & 3.55).

Table 3.52. Spray scheduling of fungicides for the management of cumin blight

Treatments	Blight PDI	Disease control (%)	Seed yield (Kg/ha)
T1	6.0 (14.1)	79.5	235
T2	6.7 (14.8)	77.1	241
T3	8.7 (17.0)	70.5	230
T4	9.3 (17.8)	68.1	238
T5	10.0 (18.4)	65.9	224
T6	10.7 (19.0)	63.5	209
T7	29.3 (32.8)	-	136
CD (0.05)	2.81 (2.80)	-	46.87

T1: Mancozeb (0.2%)-Zineb (0.2%)-Azoxystrobin (0.1%)-Difenoconazole (0.05%); T2: Zineb (0.2%)-Mancozeb (0.2%)-Azoxystrobin (0.1%)-Difenoconazole (0.05%); T3: Zineb (0.2%)-Azoxystrobin (0.1%)-Mancozeb (0.2%)-Difenoconazole (0.05%); T4: Zineb (0.2%)-Azoxystrobin (0.1%) -Difenoconazole (0.05%) -Mancozeb (0.2%); T5: Difenoconazole (0.05%)-Azoxystrobin (0.1%)-Mancozeb (0.2%); T6: Azoxystrobin (0.1%)-Mancozeb (0.2%)-Difenoconazole (0.05%); T7: Control

Table 3.53. Effect of fungicide spray application on diseases of fenugreek

Treatments	Leaf blight PDI	Downy mildew PDI	Seed yield (Kg/ha)
T1	22.0 (27.9)	24.2 (29.4)	2083
T2	23.3 (28.9)	25.8 (30.5)	2211
T3	25.3 (30.2)	23.3 (28.9)	2333
T4	26.0 (30.6)	30.8 (33.7)	2013
T5	22.0 (27.9)	28.3 (32.1)	1874
T6	18.0 (25.1)	26.7 (31.1)	1939
T7	16.7 (24.1)	31.7 (34.2)	2463
T8	36.0 (36.9)	46.7 (43.1)	1787
CD (0.05)	4.22 (2.91)	5.26 (3.52)	330.07

T1 Copper oxychloride (0.2%); T2 Chlorothalonil (0.2%); T3 Metalaxyl+Mancozeb (0.1%); T4 Hexaconazole (0.05%); T5 Tebuconazole (0.05%); T6 Tebuconazole + Trifloxystrobin (0.05%); T7 Difenoconazole (0.05%); T8 Control

Table 3.54. Evaluation of new molecules of fungicides for the management of cumin blight

Treatments	Blight PDI	% Disease control	Seed yield (Kg/ha)
T1 Cabrio top (metiram 55%+ Pyraclostrobin 5%)	20.7 (27.0)	63.2	366
T2 Avtar (Zineb 68% +Hexaconazole4%)	15.3 (23.0)	72.8	473
T3 Curzate (Cymoxanil 8%+ Mancozeb 64%)	22.0 (27.9)	61.2	401
T4 Amistar top (Azoxystobin82% + Difenconazole)	12.7 (20.7)	76.8	471
T5 Nativo (Tebuconazole50%+Trifloxystobin)	29.3 (32.8)	47.3	359
T6 Cocide (Copper hydroxide)	34.7 (36.1)	37.8	283
T7 Control Total (Hexaconazole)	30.7 (33.6)	45.2	303
T8. Control	56.7 (48.9)	-	179
CD (0.05)	7.41 (4.97)		82.29

Table 3.55. Effect of new molecules of fungicide spray application on diseases of fenugreek

Treatments	Leaf blight PDI	Downy mildew PDI	Seed yield (Kg/ha)
T1 Cabrio top (metiram 55%+ Pyraclostrobin5%)	22.0 (28.0)	32.5 (34.7)	2074
T2 Avtar (Zineb 68% +Hexaconazole4%)	19.3 (26.0)	30.0 (33.2)	2154
T3 Curzate (Cymoxanil 8%+ Mancozeb 64%)	22.0 (28.0)	25.0 (29.9)	2117
T4 Amistar top (Azoxystobin82% +Difenoconazole)	18.7 (25.6)	28.3 (32.1)	2330
T5 Nativo (Tebuconazole50%+Trifloxystobin)	31.3 (34.0)	31.7 (34.2)	2148
T6 Cocide (Copper hydroxide)	20.7 (27.0)	33.3 (35.2)	2015
T7 Control Total (Hexaconazole)	20.7 (27.0)	45.8 (42.6)	1996
T8. Control	33.3 (35.3)	50.0 (45.0)	1948
CD (0.05)	3.53 (2.46)	7.91 (4.99)	360.9

New molecules of fungicides containing mixture of two different fungicides Amistar top 0.5ml/lit (Azoxystobin82% + Difenconazole) and Avtar 2g/liter (Zineb 68% + Hexaconazole 4%) found most effective for the management of blight in cumin and fenugreek.

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

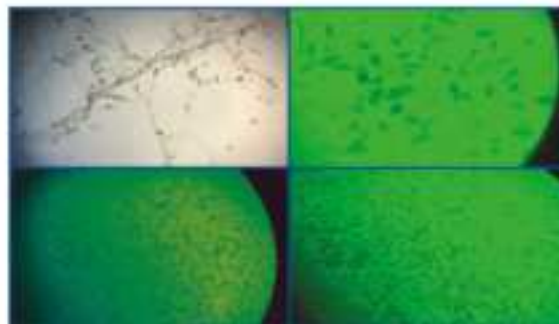
(R.D. Meena and B.K. Mishra)

All biologically potential isolates were maintained *in vitro* and screened *in vivo* against *Alternaria burnsii*.

The disease index was calculated for all different applied formulations separately. The minimum mycelium growth (4.10mm) was recorded in the treatment 'Karanj oil 2% + biological agent (B1) 10%' followed by (4.60mm) in 'Garlic extract 2% + biological agent (B1) 10%'. The maximum mycelium growth (4.60mm) was found in control. The minimum disease intensity (PDI 10.8) was recorded in Karanj oil 2% + B1 (10%) followed by (PDI 14.17) in Garlic extract with biocontrol (10%) of volume basis. The maximum disease intensity (PDI 29.1) was recorded in control (table 3.56 & 3.57).



Field view of experiment area


Table 3.56: Efficiency of various formulations used against *Alternaria burnsii* in vitro

Treatment	Mycellium growth (mm)	Mycellium growth inhibition %
1 Water + B1 (10%)	5.03	95.57
2 Onion ext 2% + B1 (10%)	5.28	95.34
3 Allovira ext 2% + B1 (10%)	5.50	95.15
4 Tumba ext 2% + B1 (10%)	5.78	94.90
5 Garlic ext 2% + B1 (10%)	4.60	95.94
6 Karanj oil 2% + B1 (10%)	4.10	96.38
7 Chalk powder spray + B1 (10%)	9.78	91.38
8 Chalk powder dusting + B1 (10%)	10.13	91.05
9 Cow urine 10% + B1 (10%)	5.63	95.04
10 Buttermilk 10% + B1 (10%)	5.03	95.57
11 Propiconazole 0.1% + B1 (10%)	4.53	96.01
12 Propiconazole 0.1% (No B1)	5.50	95.14
13 Control	88.25	0.00
CD at 0.05%	1.12	0.82
SEM±	0.39	0.29
CV	6.42	0.65

Table 3.57: Effect of different formulations on cumin blight

Treatment	BLIGHT DI <i>In Vivo</i>	BLIGHT DI <i>In Vitro</i>	Yield (Q/ha)
1 Water + B1 (10%)	16.67	50.5	7.81
2 Onion ext 2% + B1 (10%)	20.83	46.8	7.96
3 Aloe-vera ext 2% + B1 (10%)	18.33	65.0	5.01
4 Tumba ext 2% + B1 (10%)	20.00	62.3	5.87
5 Garlic ext 2% + B1 (10%)	14.17	27.0	8.53
6 Karanj oil 2% + B1 (10%)	10.83	25.0	9.11
7 Chalk powder spray + B1(10%)	18.33	29.8	8.50
8 Chalk powder dusting +B1(10%)	21.67	55.0	5.69
9 Cow urine 10% + B1 (10%)	18.33	53.3	5.41
10 Buttermilk 10% + B1 (10%)	20.83	50.0	7.78
11 Propiconazole 0.1% + B1 (10%)	15.83	35.7	8.50
12 Propiconazole 0.1% (No B1)	16.67	51.5	7.13
13 Control	29.17	85.0	5.36
CD at 0.05%	2.9	8.3	0.827
SEM±	1.01	2.82	0.28
CV	9.4	9.9	6.8



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

(N. K. Meena; Ravindra Singh and M.D. Meena)

Evaluation of different IPM modules for the management of aphids and thrips in coriander

A field trial was conducted to evaluate the effectiveness of eight different IPM modules (including control) viz., 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 + *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 control against aphid on coriander.

Amongst eight IPM modules, maximum per cent reduction (94.38%) in aphid population was recorded on coriander plants treated with IPM module M₁ followed by IPM module M₆, reduced 92.62 per cent aphid population. Similar module were found effective against thrips reduced 94.88% by M-5 and 92.21% by M-7 module.

The maximum seed yield (2861 kg/ha), test weight (11.20g) and essential oil (0.42%) of coriander variety ACr-2 was also recorded in the plots treated with IPM module M₁.

Evaluation of different IPM modules for the management of aphids and thrips on cumin

A field experiment was conducted to evaluate eight similar IPM modules (including control) against aphid and thrips on cumin under field conditions. Results found that all IPM modules were found significantly superior in reduction of aphid and thrips population over untreated control. The Maximum per cent reduction in aphid (93.31%) and thrips (91.78%) was recorded on cumin plants treated with IPM module M₁ followed by IPM module M₆ (91.71% aphid and 90.22% thrips).

The effect of different IPM modules on yield of cumin variety GC-4 was recorded and found the highest seed yield (976 kg/ha) with test weight 5.16g and essential oil 5.96% in the plots treated with IPM module M₁ followed by IPM module M₆.

Validation of deliverable efficient IPM module at farmers' field on cumin and coriander

Field trials were conducted on farmers' field at two locations i.e. Mangliyawas and Dang villages of Ajmer district for validation of most effective IPM module [M₁-Imidacloprid 600FS 3ml/kg seed (ST) + ker plant extract 10ml/lit. + *Verticillium lecani* (1x108cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035%] for the management of aphid and thrips and their impact on yield of cumin variety GC-4. At Mangliyawas location, the cumin seed yield 1170 kg/ha was recorded in the IPM module treated field, where as cumin yield 990 kg/ha was recorded in farmer practices followed, hence, the treatment of IPM module M₁ enhanced the cumin seed yield 180 kg/ha (18.18% yield appreciation). At Dang location, the cumin seed yield 975 kg/ha was recorded in the IPM module treated field and 780 kg/ha was recorded under farmer practices. Hence IPM module M₁ enhanced the yield of cumin by 195



kg/ha (25% yield appreciation) over farmer practices at farmers field.

A field trial was conducted on farmers field at Khedli Toran (Kota) for validation of most effective IPM module [M₁- Imidacloprid 600FS 3ml/kg seed (ST) + Ker plant extract 10ml/lit. + *Verticillium lecani* (1x10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035%] for the management of aphid and thrips and their impact on yield of coriander ACr-2. Data showed that coriander seed yield 2400 kg/ha was recorded in the IPM module treated field, whereas, coriander yield 1920 kg/ha was recorded under local practices, hence tested IPM module M₁ enhanced the yield of coriander by 480 kg/ha at farmers field over farmers local practices for pest management.

Effect of different IPM modules on other minor pest of coriander and cumin

The observations on impact of various tested IPM modules on other minor pests were also recorded simultaneously in both the crops (coriander and cumin) and found that the population of jassids and white fly was under check in all IPM modules. It was also recorded that no infestation of jassids and whitefly was reported in the plots treated with IPM modules M₁ up to 30 days after germination. Similarly, the highest per cent reduction (89.44 and 82.56%) in jassids population was recorded in coriander and cumin, respectively under IPM module M₁ over untreated control.

Cpt/17.4.5 : Evaluation of novel pesticide formulations for better efficacy and lower residues in major seed spices

(Krishna Kant; B. K. Mishra and P.N. Dubey)

Evaluation of novel pesticide formulations for better efficacy and lower residues in major seed spices

were carried out for the three year period from 2017-18 to 2019-20. Twelve different products were evaluated with one control treatment against the aphids of seed spice crops viz., cumin, coriander and fenugreek developed in collaboration with Institute of Pesticide Formulation Technology, Gurugram (Govt. of India). Among the treatment there were two formulations of Deltamethrin i.e. Micro encapsulation and Micro emulsion. Botanical synergist used with Thiomethoxam and neem oil. Modified Neem composition, Sesum (*Delbergia sisoo*) leaves of polar and non polar formulation, entomopathogen *Verticillium lecani* soluble concentrate formulation. The new products/ formulation was tested along with commercially available Deltamethrin, Thiomethoxam and spore suspension of *V.lecani*.

The different treatment effect combine with all the year and crops (table-3.58) showed that treatment Thiomethoxam-0.025% + Synergist 5% proved most effective in reducing the aphids population in all the three crops and was superior to the commercial formulation of Thiomethoxam. Application of Deltamethrin - 0.003% micro encapsulation, Deltamethrin - 0.003% micro emulsion were found statistically at par with commercial formulation but total number of aphids reduction on the crop was more in micro encapsulation and micro emulsion formulation of Deltamethrin. Among botanical formulations non polar formulation of sesum leaves (*Delbergia sisoo*) and Modified neem composition was found more effective than neem oil -2 % application in combating the aphids population. Soluble concentrate (SC) formulation of *Verticillium lecanii* proved higher efficacy than normal spore suspension formulation.

**Table 3.58. Effect of different noval pesticide formulation on aphids population on fenugreek, coriander and cumin crop.**

S.No.	Treatments (Cumulative of all crop of three years)	Population/5 cm. twig, before spray	Population after spray		
			3 day	6 day	9 day
T-1	Deltamethrin - 0.003% Micro encapsulation	105.06 ^f	11.88 ^h	5.4 ^h	3.38 ^{af}
T-2	Deltamethrin - 0.003% Micro emulsion	106.85 ^f	5.45 ^{hg}	4.15 ^h	0.85 ^{af}
T-3	Thiomethoxam-0.025% + Synergist 5%	129.25 ^{de}	3.68 ^g	0.8 ^g	0.27 ^f
T-4	Neem oil -2% +Synergist 5%	135.15 ^{abcd}	14.54 ^f	9.11 ^h	7.84 ^{de}
T-5	Sesum leaf extract- Polar- 0.5%	136.24 ^{abcd}	31.08 ^e	11.16 ^f	3.44 ^{af}
T-6	Sesum leaf extract- Non Polar- 0.5%	85.62 ^g	6.55 ^{fg}	2.62 ^h	1.58 ^{af}
T-7	<i>Verticillium lecanii</i> 1.5%SC	121.91 ^e	88.53 ^d	58.7 ^d	18.07 ^c
T-8	Modified Neem Composition -5%	130.63 ^{abc}	50.29 ^e	22.21 ^e	13.07 ^{af}
T-9	Deltamethrin -0.003%	104.91 ^f	5.7 ^g	2.4 ^h	2.15 ^{af}
T-10	Thiomethoxam -0.025%	140.89 ^b	9.21 ^{hg}	4.61 ^h	2.8 ^{af}
T-11	Neem oil-2%	164.93 ^a	63.79 ^c	31.69 ^d	17.19 ^c
T-12	<i>Verticillium lecani</i>	101.23 ^f	65.11 ^c	45.74 ^d	36.21 ^b
T-13	Control	138.79 ^{bc}	160.43 ^a	157.06 ^a	143.44 ^a

CPT/19.4.1: Survey and surveillance of seed spices diseases

(R.D. Meena; Y.K. Sharma, M.D. Meena and N. Chaudhary)

Various seed spices growing areas including Ajmer, Jhalawad, Nagaur, Kota, Baran, Sawai Madhopur, Tonk and adjacent areas were surveyed. During the survey various seed spice diseases were observed, data were taken and disease intensity was calculated separately for all the diseases crop wise. It was critically observed that the cumin blight disease caused by *Alternaria burnsii* was comparatively more in intensity in eastern and central growing regions of Rajasthan than western regions. *Ramularia* blight disease was recorded in low intensity this year (PDI 2). Wilt disease in cumin was seen in range from 1.2

to 8.3 and *Alternaria* blight recorded from 0 to 11.3%. Downy mildew on fenugreek was seen from 0.8 to 5.2%; powdery mildew in fenugreek seen 1.5 – 5.8%. The stem gall and *Sclerotium rot* on coriander was found in lower intensity (0-2.2%). *Ramularia* blight on fennel was also found in low intensity (0-0.8%).

Major seed spices diseases were linked with the environmental conditions (factors of disease development) prevailed during the disease development occurred were included temperature (°C) relative humidity (RH %) and rainfall (mm). Certain diseases were responded fine towards these environmental factors) and disease commencement was positively affected by these factors alone or cumulatively in manner (table 3.59 & 3.60).

Table 3.59: Inter-relationship between environmental conditions and disease initiation

Calendar time 2019-20	Std. Week No	Environmental factors			Disease severity %							
		Temp. (°C)	RH (%)	Rain (mm)	Cumin Wilt	Cumin Blight	Cor. PM	Cor. SG	Ramul. Blight	Fenugreek PM	Fenugreek DM	
28 Oct -3 Nov.	44	24.2	74.7	0	0	0	0	0	0	0	0	0
4-10 Nov.	45	23.5	78.4	0	0	0	0	0	0	0	0	0
11-17 Nov.	46	21.9	80.6	0	0	0	0	0	0	0	0	0
18-24 Nov.	47	21.1	84.6	0	0	0	0	0	0	0	0	0
25-1 Dec.	48	18.9	83.2	0	0.1	0	0	0	0	0	0	0
2-8 Dec.	49	15.3	87.3	0	1.2	0	0	0	0	0	0	0
9-15 Dec.	50	14.2	83.1	10	1.8	0	0	0	0	0	0	0
16-23 Dec.	51	13.5	79.1	0	2.1	0	0	0	0	0	0	0
23-29 Dec.	52	11.05	81.4	0	2.6	0	0	0	0	0	0	0
30Dec-5 Jan.	1	14.2	79.2	0	2.9	0	0	0	0	0	0	0
6-12 Jan.	2	12.6	80.4	0	3.2	0	0	0	0	0	0.3	0.2
13-19 Jan.	3	13.4	79.7	0	4.3	0	1	0	0	0	1.2	6.7
20-26 Jan.	4	15.1	75	7.1	7.6	0	3	0	0	0	3.5	7.9
27 Jan -2 Feb.	5	13.5	73.1	0	10.9	0	8	0	0	0	6.2	10.4
3-9Feb.	6	14.7	71.4	0	12.7	0.2	13.5	0	0	0	9	13.6
10-16 Feb.	7	18.3	64.6	0	13.5	6.2	18.6	0	0	0	11	14.5
17-23 Feb.	8	18.8	74.1	0	15.2	10.5	22	1.0	0.8	0.8	12.5	17.5

Table 3.60: Maximum intensity of seed spices diseases / disorders reported during survey

S.No.	Disease	Disease Range
1	Cumin wilt	0.1-15.2
2	Cumin blight	0-10.5
3	Coriander PM	0-22
4	Coriander stem gall	0-9.17
5	<i>Ramularia</i> blight	0-0.8
6	Fenugreek PM	0.3-12.5
7	Fenugreek DM	0.2-17.5

During survey from different seed spices growing areas two seed spice disease samples were collected, pathogen isolated and maintained pure culture for further study. During the reporting year the stem gall disease of coriander and *Ramularia* blight disease of fennel were found in very less form comparatively previous years.

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

BS/17.5.1: Modulation of morpho-physiological activities and stress tolerance in cumin by concomitant application of depolymerised plant growth regulators:

(S.N. Saxena; Y.K. Sharma and P.N. Dubey)

Among various tested PGRs and other chemicals many chemicals were found to modulate the physiological parameters. Observations were recorded on 10th day after spray treatments. Maximum FW (4.28g) increase was observed in TRIA (1ppm) as compared to control (0.78g) followed by proline (3.26g), IC (2.56g) and 6BAP (2.07g). Maximum SL (22.87cm) was observed in ASA (2.0mM) followed (22.57cm) by Proline (1.0mM) and TRIA (0.5-1.0ppm), Most of the treatments increase



RL as compared to control. Triacontanol, methyl jasmonate, proline, 6 BAP, ISA and IC produces significant increase in leaf area and chlorophyll content.

After 2nd spray, most of the treatments showed increased leaf area as compared to control and DW treatments (1.93 and 2.84). Total chlorophyll content was however, less affected by PGR treatments. IC+TRIA combination recorded more than control chlorophyll content (2.84mg/g Fwt). Many PGRs treatments were found to enhance seed yield per plant being observed maximum (1.73g) in IC 80ppm followed by 1.72g in ISA 120ppm and 1.45g in ISA 20ppm. Other concentrations of IC, MJ mix and ASA were also produced significantly more seed yield than control.

Essential oil content was significantly more in all treatments of MJ isomer and MJ mixture being observed maximum (5.97%) in MJ isomer 0.5mM

followed by 5.91% in MJ isomer 1.0mM, 5.85 and 5.83% in 1.5 and 2.0mM concentration. IC in combination with TRIA @40ppm resulted in significant increase in total oil content being observed 13.57% as compared to control (6.22%). IC alone 120ppm was also effective with 8.75% total oil content while TRIA alone 0.01mM resulted in 8.56% total oil content. Another PGR MJ isomer @0.5mM increased the oil yield up to 10.34%. 6-BAP and Proline treatments were also found effective.

The disease index ranged from 17.5 to 80 percent under open and natural conditions while under in vitro conditions with artificially applied selection pressure of alterneria spores treatment of SA alone showed minimum disease incidence (PDI 17.5) while maximum PDI (80) was noticed in the treatment of MDHJ. Several other treatments were also found effective such as T2, T7, T8 and T12, where the disease was observed less than 40 percent (table 3.61).

Table 3.61 . Quality parameters recorded at harvest and Blight PDI at maturity stage of cumin var. GC-4

Treatment	PGR	Con ⁿ	EO(%)	Total oil (%)	Blight PDI
T1	ASA	0.5mM	4.70	5.84	22.0
T2	ASA	1.0mM	4.34	6.83	13.3
T3	ASA	1.5mM	4.88	7.44	17.3
T4	ASA	2.0mM	4.93	8.71	24.0
T5	MJ(isomer)	0.5mM	5.97	10.34	27.3
T6	MJ(isomer)	1.0mM	5.91	6.44	22.0
T7	MJ(isomer)	1.5mM	5.85	7.92	16.0
T8	MJ(isomer)	2.0mM	5.83	8.43	24.0
T9	MDHJ	0.5mM	4.89	6.26	22.7
T10	MDHJ	1.0mM	4.95	7.49	30.0
T11	MDHJ	1.5mM	5.15	6.32	14.7
T12	MDHJ	2.0mM	5.26	7.08	18.7
T13	MJ (mixture)	0.5mM	4.39	7.58	22.0
T14	MJ (mixture)	1.0mM	4.93	7.31	18.7
T15	MJ (mixture)	1.5mM	5.48	6.75	20.7
T16	MJ (mixture)	2.0mM	5.06	6.67	17.3
T17	Triacantenol	0.01PPM	5.15	8.56	20.7
T18	Triacantenol	0.1ppm	4.72	6.50	20.7
T19	Triacantenol	0.5ppm	5.05	5.68	25.3



T20	Triacntenol	1.0ppm	4.69	6.22	15.3
T21	ISA	20ppm	4.25	6.59	20.0
T22	ISA	40ppm	4.89	5.34	19.3
T23	ISA	80ppm	4.56	6.88	19.3
T24	ISA	120ppm	5.42	6.60	18.7
T25	IC	20ppm	4.74	6.75	20.7
T26	IC	40ppm	4.52	7.31	19.3
T27	IC	80ppm	4.31	4.31	14.0
T28	IC	120ppm	4.83	8.75	15.3
T29	IC+tria 0.5ppm	20ppm	4.93	6.63	14.0
T30	IC+tria 0.5ppm	40ppm	4.56	13.57	14.0
T31	IC+tria 0.5ppm	80ppm	4.74	7.27	16.0
T32	IC+tria 0.5ppm	120ppm	4.92	5.81	11.3
T33	6-BAP	0.5mm	4.56	6.33	18.0
T34	6-BAP	1.0mm	4.68	6.31	14.0
T35	6-BAP	1.5mm	4.90	8.23	13.3
T36	6-BAP	2.0mm	4.75	5.90	14.7
T37	Proline	0.5mm	4.71	5.71	10.7
T38	Proline	1.0mm	4.74	7.82	19.3
T39	Proline	1.5mm	4.74	6.41	26.0
T40	Proline	2.0mm	4.52	6.74	21.3
T41	Disprine/asprine	0.5mm	4.30	7.51	16.7
T42	Disprine/asprine	1.0mm	4.76	6.96	12.7
T43	Disprine/asprine	1.5mm	4.50	6.38	16.0
T44	Disprine/asprine	2.0mm	4.81	7.49	14.7
T45	Carragennan	80ppm	4.71	4.94	16.7
T46	Sodium alginate	80ppm	4.19	7.14	12.7
T47	Distilled water		4.22	6.79	23.3
T48	Absolute control		4.10	6.22	14.7

ASA - Acetyl Salicylic Acid, MSHJ - Methyl Dihydro Jasmonate, MJ - Methyl Jasmonate
ISA - Irradiated Sodium Alginate, IC - Irradiate Carrageenan

BS/17.5.2: Exogenous application of PGRs for improving essential oil content in coriander (*Coriandrum sativum* L.)

(S.N. Saxena and P.N. Dubey)

Exogenous application of some depolymerized chemicals and other established PGRs showed enhanced effect of morpho-physiological parameters in coriander crop. FW of plants was increased from 106.70g in control to 125.03g in treatment of irradiated sodium alginate (ISA)

100ppm followed (123.7) by irradiated carrageenan (IC) 150ppm, Carrageenan 100ppm alone also improved FW up to 116.37. Similar chemicals and concentration also increased shoot length from 60.57cm in control to 72.50cm in IC 150ppm and 70.83cm in ISA 50ppm. ISA 50ppm significantly increased root length up to 25.73cm as compared to 12.67cm in control. Irradiated and non irradiated carageennan also showed marked increase in root length. 6 BAP and Thio-urea was also found effective.



Leaf area significantly increased in treatments of 6 BAP, 6-yy-Dimethyleaalyaminopurin, NAA and GA3 maximum (25.35² cm) being observed in 6BAP 0.2mM followed (23.32) by 0.3mM 6 BAP and 21.27 in treatment of 2-ip 0.5mM. GA3 0.3 and 0.2 mM also

produced significantly more leaf area 22.55 and 22.06 respectively. However, total chlorophyll content was not influenced by treatment instead many treatments showed less chlorophyll content than control (3.67mg/g FW).

Table 3.62. Quality parameters recorded at harvest

T	PGR	Con ^a	Seed wt/plant	EO (%)	Total oil (%)
T1	6- YY Dimethylallyl AP	0.5mM	7.33	0.33	4.49
T2	6- YY Dimethylallyl AP	1.0mM	8.68	0.33	4.15
T3	6- YY Dimethylallyl AP	1.5mM	8.21	0.36	2.90
T4	6-BAP	0.1mM	7.08	0.33	3.52
T5	6-BAP	0.2 mM	9.47	0.32	2.40
T6	6-BAP	0.3 mM	6.91	0.35	5.28
T7	NAA	0.1mM	4.27	0.30	4.14
T8	NAA	0.2 mM	6.03	0.26	2.87
T9	NAA	0.3 mM	6.69	0.26	1.73
T10	GA-3	0.1mM	4.97	0.30	4.05
T11	GA-3	0.2 mM	2.41	0.34	2.28
T12	GA-3	0.3 mM	4.14	0.34	2.62
T13	Thio Urea	0.5mM	5.39	0.30	2.06
T14	Thio Urea	1.0mM	10.46	0.32	2.08
T15	Thio Urea	1.5mM	3.74	0.35	1.66
T16	Irradiated SA	50 ppm	5.93	0.37	4.52
T17	Irradiated SA	100 ppm	7.44	0.31	2.08
T18	Irradiated SA	150 ppm	5.07	0.33	3.19
T19	Irradiated Carrageenan	50 ppm	5.95	0.29	3.40
T20	Irradiated Carrageenan	100 ppm	5.61	0.36	2.91
T21	Irradiated Carrageenan	150 ppm	9.31	0.36	2.48
T22	Sodium Alginate	50 ppm	7.10	0.27	4.09
T23	Sodium Alginate	100 ppm	6.52	0.31	2.90
T24	Sodium Alginate	150 ppm	9.16	0.26	4.38
T25	Carrageenan	50 ppm	9.67	0.33	4.21
T26	Carrageenan	100 ppm	10.60	0.36	4.14
T27	Carrageenan	150 ppm	8.02	0.33	3.72
T28	Distilled water		6.01	0.31	2.88
T29	Absolute control		6.60	0.26	3.41
	SEM/SD		0.96	0.3	0.96
	CD 0.05		2.69	-	-
	CV %		31.15	-	-



Among secondary metabolites TPC was not very much affected by PGRs treatment but significant increase was noticed in TFC with the treatments of carrageenan plain and depolymerized. Antioxidant content was also increased with similar treatments of IC and Carrageenan and 6 BAP.

After 2nd spray FW was found to increase significantly in treatments of 6 BAP, 6-yy-Dimethyleaaly laminopurin, IC and Sodium alginate treatments maximum (477.80g) being recorded in 6 BAP0.3mM and 399.33 in 0.2mM as compared to 288.97 in DW treatment and 155.87 in absolute control. Other concentrations of SA and Carrageenan were also effective in increasing root length.

After 2nd spray LA was found to increase significantly in treatments of Irradiated and non irradiated Carrageenan and SA being recorded maximum 28.45² cm in carrageenan 150ppm followed (24.51) by IC 150ppm and 22.10 by IC 100ppm.

Seed yield per plant was recorded at harvest of crops showed significant increase in seed yield in many treatments. As compared to control (6.60g) Carrageenan 100ppm produced 10.60g/plant seeds

followed (9.67g) by carrageenan 50ppm IC and SA 150ppm also produced 9.31 and 9.16g seed yield respectively. Essential oil yield was increased up to 0.36% as compared to control 0.26% by treatments of IC and ISA 50, 100, 150ppm. Similarly total oil content was also recorded more than control (3.41%) in treatments of 6-BAP 0.3mM (5.28%), 6-yy-Dimethyleaalyaminopurin 0.5mM (4.49%), ISA 50ppm (4.52%) and SA 150ppm (4.38%) (table 3.62).

BS/18.5.1: Development of value chain for fennel:

(Shiv Lal; G. Lal, S.N. Saxena and B.K. Mishra)

Determination of maturity indices for fennel seeds for spice (culinary) purposes

To determine optimum stage of fennel seed for culinary purpose, observations on various attributes like sensory (seed color, flavour, aroma, texture, taste of seed, fiberness), seed physico-chemical, yield and germination were recorded at different stages of seed maturity. Among sensory attributes, maximum score, based on hedonic scale was recorded for overall acceptability (8.27) for seeds harvested at 75 days after anthesis or 182 days after seed sowing

Table 3.63: Variation in N%, P%, K% and crude protein% in fennel seeds harvested at different maturity

Treatments	Crude protein %	N%	P%	K%
25 DAA	21.44	3.43	0.378	1.19
35 DAA	20.75	3.32	0.391	1.32
45 DAA	20.63	3.30	0.493	1.40
55 DAA	20.38	3.26	0.585	1.49
65 DAA	19.88	3.18	0.573	1.46
75 DAA	19.38	3.10	0.570	1.44
85 DAA	16.25	2.60	0.410	1.35
95 DAA	13.13	2.10	0.380	1.29
CD at 5%	1.20	0.12	0.015	0.06

Days taken for anthesis: (107), *DAA: Days after anthesis

(DAA). Maximum no. of umbel/plant (46) was recorded at 95 DAA, higher no. of umbellate/umbel (36.33) was at 75 DAA, maximum seed index (8.84) was at 75 DAA, maximum TSS (21.10 °B) at 25 DAA and yield 2490 kg/ha at 75 DAA. Variation in total oil and essential oil contents was affected by different harvesting stages and as the stages of harvesting advances the seed moisture content showed



Fennel seeds samples harvested at 75 days after anthesis



Fennel seeds samples harvested at 85 days after anthesis

reducing trend. Similarly total oil and essential oil content was also showed decreasing trend as harvesting advances. Seed germination attributes of fennel seeds harvested at different stages were recorded and highest germination percentage (92.13), seedling length (7.10 cm) and vigour index (654.12) was observed in seed samples harvested at 75 DAA. Nutritional contents N%, P%, K% and crude protein% of fennel seeds harvested at different maturity was also estimated and highest % crude protein content (21.44) was estimated in seed harvested at 25 DAA and lowest (13.13) in seed harvested at 95 DAA. Similar trend was also observed in case of N% whereas highest % P and highest % K contents was recorded in the seed sample harvested at 55 DAA (table 3.36). Highest seed length and seed thickness was recorded in seed samples harvested at 75 DAA.

Determination of maturity indices for fennel seeds for chewing purposes

To determine maturity indices for chewing purposes in fennel, seeds of fennel var. AF-1 was harvested at six stages in 5 days interval i.e. at 25 days, 30 days, 35 days, 40 days, 45 days and 50 days after anthesis. The important sensory attributes (seed color, seed flavour, aroma, texture, taste, fiberness and overall acceptability) were recorded. Overall acceptability was recorded for the seeds harvested at 35 DAA followed by 40 DAA and 45 DAA. Highest TSS was recorded at 142 days after sowing or 35 days after anthesis (DAA) followed by 147 days from seed sowing or 40 DAA. In total oil and essential oil content, decreasing trend was observed as stages advances. N% and crude protein % content showed decreasing trend as harvesting stages advances however, P% and K% contents showed increasing trend as harvesting stages advances (table 3.64 & 3.65).

Table 3.64: Sensory attributes of fennel seeds harvested at different stages

Stage of Harvesting	Seed color	Flavour	Aroma	Texture	Taste of seed	Fibreness	Overall acceptability
25 DAA*	7.9	7.8	7.8	7.3	8.1	8.9	7.97
30 DAA	8.1	8.1	8.0	7.8	8.2	8.7	8.15
35 DAA	8.7	8.5	8.2	8.6	8.6	8.6	8.53
40 DAA	8.5	8.3	8.4	8.4	8.4	8.4	8.40
45 DAA	8.1	8.2	8.5	8.3	8.0	7.9	8.22
50 DAA	7.7	7.9	8.6	8.1	7.9	7.5	7.95
CD at 5%	0.20	0.16	0.10	0.14	0.24	0.12	0.15

Days taken for anthesis: (107), *DAA: Days after anthesis

Table 3.65: Variation in N, P, K and crude protein (in per cent) in fennel seeds harvested at different maturity

Treatments	Crude protein	N	P	K
25 DAA*	21.44	3.43	0.378	1.19
30 DAA	21.40	3.40	0.385	1.28
35 DAA	21.35	3.37	0.404	1.35
40 DAA	21.31	3.34	0.455	1.38
45 DAA	21.05	3.30	0.489	1.40
50 DAA	20.56	3.24	0.580	1.43
CD at 5%	0.95	0.18	0.014	0.05

Days taken for anthesis: (107), *DAA: Days after anthesis



Fennel seeds (umbel wise) harvested at 35 days after anthesis



Fennel seeds (umbel wise) harvested at 40 days after anthesis

Standardization of drying techniques for fennel seeds harvested at different maturity stages

Sensory attributes of fennel seed dried by different drying methods were analyzed and overall acceptability score was recorded highest in the seeds dried by oven drying method (50°C) followed by drying in shed with hanging umbels. Effect of drying on TSS and oil content was also estimated

and highest total oil content was recorded in seeds dried by oven drying method (50°C) followed by oven drying method (40°C) and drying in shed with hanging umbels. Highest seed test weight and TSS content was recorded in seeds dried by oven drying method (50°C) followed by drying in shed with hanging umbels (table 3.66).



Sun drying



Shed drying



Shed net drying



Oven drying



Low cost poly solar drying



hanging umbels in shed net

View of different drying methods

Table 3.66: Sensory attributes of fennel seeds dried by different drying methods

Method of drying	Seed color	Aroma	Seed appearance	Overall acceptability
Sun drying	7.65	7.20	6.20	7.02
Shed drying	7.78	7.89	7.50	7.72
Oven drying (40°C)	8.20	8.42	8.35	8.32
Oven drying (50°C)	8.50	8.76	8.69	8.67
Shed net drying	8.00	8.32	8.23	8.18
Low cost poly solar dryer	7.90	8.13	8.11	8.05
Drying in shed net with hanging umbels	8.35	8.45	8.36	8.46
CD at 5%	0.25	0.24	0.23	0.24

Effect of different drying methods on seed quality and other attributes (Seed harvested at 75 DAA)

Sensory attributes of fennel seed dried by different drying methods were recorded and overall acceptability score was recorded highest in the seeds dried by oven drying method (50°C) followed by drying in shed with hanging umbels. Effect of drying on TSS and oil content was also recorded and highest total oil content was recorded seeds dried by oven drying method (50°C) followed by oven drying method (40°C) and drying in shed with hanging umbels. Highest seed test weight and TSS content was estimated highest in seeds dried by oven drying method (50°C) followed by drying in shed with hanging umbels. Effect of drying method on fennel seed germination attributes was also observed and highest seed germination was recorded in seeds dried in shed with hanging umbels followed by oven drying method (40°C) and shed drying. Seed physical attributes also influenced by different drying methods. Maximum seed length was recorded seeds dried under oven drying method (50°C) followed by drying in shed with hanging umbels and oven drying method (40°C). Seed vigour index and seedling length was measured highest in drying in shed with hanging umbels followed by shed net drying.

Development of process technology for preparation of fennel based novel value added products

To standardized process technology for fennel based RTS different blending combinations of fennel, mango and alovera juice/extract were tried and physico-chemical and microbial attributes were recorded during storage period. Total soluble solid, TSS/Acid and pH content showed increasing trend as storage period advances however, titratable acidity (TA) decreases as storage period advances up to 60 days. Microbial load (fungal and bacterial

count) up to 60 days was also estimated and no significant microbial contamination was observed up to 60 days of storage.



Fennel based ready to serve drink

BS/19.5.1: Plant extracts analysis of seed spices for bioactive phytochemicals and its utilization in developing health promoting nutraceutical products:

(S.N. Saxena; B.K. Mishra and Shiv Lal)

Ground seed powder (1 gm) of selected genotypes of cumin, coriander, fennel and fenugreek were extracted with 5 ml of different solvent (methanol, DW). Extractive value of Distilled Water was more as compared to methanol irrespective of crop and genotypes being observed maximum (25%) in fenugreek genotype AFg-3 while lowest (6.20%) extractive value was observed in methanol extract of genotype AFg-4 (table 3.67). Table 2 showed the occurrence of phenolic and flavonoid compounds in seed spice crops (table 3.68). Good amount of phenolic content was recorded in all seed spices being maximum (60 mg GAE/g Seed) in coriander genotype ACr-2 while flavonoid content was more (90 mg QE/g Seed) in fenugreek genotypes AFg-4. Gallic acid was more in DW extract of coriander genotype ACr-2 while cumin genotype GC-4 showed more gallic acid in methanol extract. DW extract of Fennel genotype AF-1 showed maximum quercetin phenolic followed by DW extract of coriander ACr-2. Eugenol content was significantly more (224.4 mg/100g) in DW extract of fennel genotype AF-1 and AF-2 (177.88). Daidzein content was found only DW extract of fennel genotypes and

methanol extract of cumin GC-4 (26.99) and coriander genotype ACr-1. Psoralen content was significantly more in DW extract of coriander genotype ACr-2 and methanol extract (88.8) of ACr-1. There is genotypic variation in essential and total oil content in seed spices. Coriander genotype ACr-2 showed 0.26% essential oil while total oil content (9.32) was more in ACr-1 (table 3.69). In both the genotype of fennel anethol was the major compound followed by 4-allyl anisole and gamma terpinene. 9-Octadecenoic acid was most abundant in fatty oil of both the fennel genotypes followed by

Estragole and Benzene, 1-methoxy-4- (1-propenyl) and 9,12- Octadecadienoic acid. Linalool was major constituent in coriander essential oil of both the genotypes followed by anethole, gamma terpinene and 4-allyl anisole. 6-octadecenoic fatty acid was found abundant in both the coriander genotypes followed by 9,12- octadecadienoic acid and Hexadecanoic acid. 9,12- Octadecadienoic acid and 9,12,15- Octadecatrienoic acid followed by Hexadecanoic acid were most abundant fatty acids in fenugreek seed oil of all the genotypes.

Table3.67: Extractive index of methanol/DW

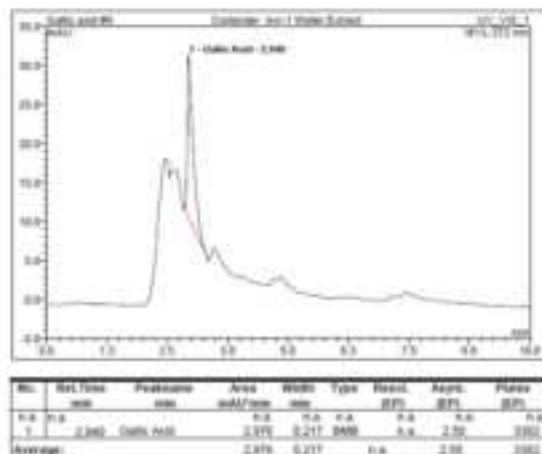
S.No.	Sample Name	Extractive Value (%)	
		D Water Extract	Methanol Extract
1	Coriander ACr-1	15.32	6.49
2	Coriander ACr-2	16	6.98
3	Cumin GC-4	23.75	13.57
4	Fennel AF-1	22.95	8.26
5	Fennel AF-2	20.29	7.9
6	Fenugreek AFG-3	25.3	6.33
7	Fenugreek AFG-4	24.0	6.20

Table3.68: Occurrence of major phenolic and flavonoid compounds in seed spices

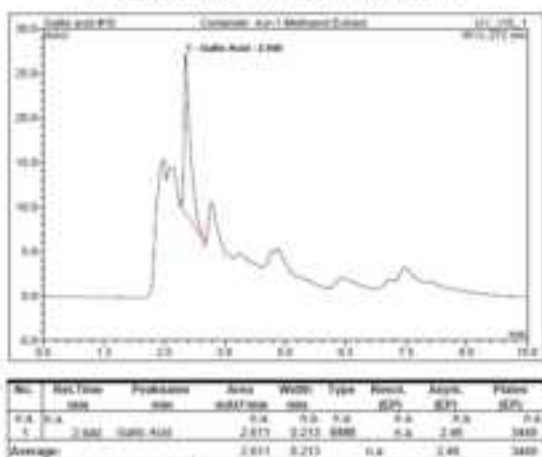
Seed spices genotypes	Gallic acid (mg/100g)		Quercetin (mg/100g)		Eugenol (mg/100g)		Daidzein (mg/100g)		Psoralen (mg/100g)	
	DW	ME	DW	ME	DW	ME	DW	ME	DW	ME
	Coriander ACr-1	322.2	205.2	167.0	139.3	1.63	1.37	0.0	12.5	9.56
Coriander ACr-2	701.0	470.3	270.7	0.0	1.28	0.89	0.0	0.00	130.7	6.64
Cumin GC-4	470.8	648.9	112.4	218.6	0.95	1.27	0.0	26.9	0.00	0.00
Fennel AF-1	198.5	193.1	309.4	136.9	224.4	132.7	101.9	17.3	43.7	18.9
Fennel AF-2	307.3	244.2	116.5	0.0	177.8	1.4	16.2	0.0	16.8	14.2

Table 3.69: Oil content in seed spice genotypes

S.No.	Sample Name	Essential oil (%)	Total oil (%)
1	Coriander ACr-1	0.19	9.32
2	Coriander ACr-2	0.26	7.55
3	Cumin GC-4	1.60	7.61
4	Fennel AF-1	1.22	7.33
5	Fennel AF-2	0.78	5.58
6	Fenugreek AFG-3	-	3.68
7	Fenugreek AFG-4	-	3.30



Chromatogram of Coriander Acr-1 Water Extract



Chromatogram of Coriander Acr-1 Methanol Extract

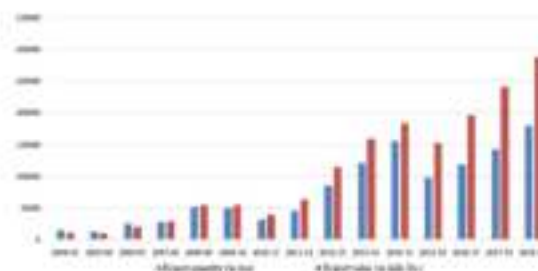
Project 6: Improving knowledge and skill of stakeholders for improving productivity of seed spices.

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)

Agricultural export plays an important role in Indian economy. Cumin and coriander export is important

source of foreign exchange for the country. Database was developed for country wise export in quantity and value for both the crops during 2004-05 to 2018-19. It is seen that direction of their export has change over time, was analysed through Markov Chain analysis. Export supply function for both the crops was estimated during 1980-81 to 2018-19 to highlight the factors influences the export of these seed spices from the country during above period. The required information was collected from Spice Board India, Ministry of Statistics and Programme Implementation, Gol and Reserve Bank of India.

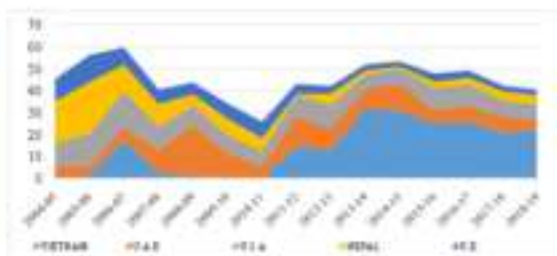


Cumin export from India in quantity and value from 2004-05 to 2018-19

Cumin export from India registered 19.61 and 26.86 percent compound annual growth in quantity and value, respectively from 2004-05 to 2018-19. Its export increased by more than eleven times from 15767 to 180300 tonnes in respective years. In value term it increased by more than 25 times, from 115 to 2884 crore rupees. As result of increased export of cumin its export share to total spice export from the country increased from four percent in 2004-05 to 17.75 percent in 2018-19 in volume.

Shift in direction of cumin export

During 2004-05 to 2018-19, Vietnam, U.A.E., U.S.A., Nepal and U.K. were major importer of Indian cumin. Nepal was the largest importer in 2004-05 and 2005-06 followed by USA. After 2010-11, Vietnam emerged as largest importing market of Indian cumin and share of Nepal goes on decreasing.



Top five destinations for cumin export (in quantity) from India

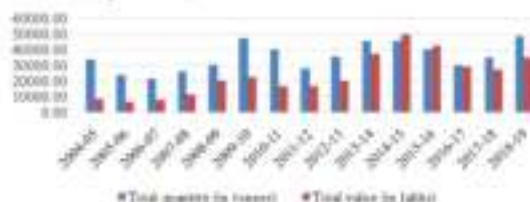
The results of Markov Chain i.e. diagonal of transition probability matrix shows that during period I (2004-05 to 09-10), Pakistan and U.K. were highest loyal markets for Indian cumin followed by U.A.E. During period II (2010-11 to 18-19) Vietnam has emerged as highest loyal market for Indian cumin followed by U.S.A. Nepal and Pakistan were good destinations during period I, lost their shares to other importing countries in second period. Nepal lost its share to U.S.A. and U.K. whereas Pakistan lost its share to Spain.

To identify the price and non-price factors influences export of cumin from India during 1980-81 to 2018-19, multiple linear regression was employed. Quantity of cumin export (in tonnes) was regressed against Production (MT), Area (Ha), Export unit price (Rs/ton), Exchange rate (Rs/\$), GDP at factor cost (in crore Rs; at constant prices 2004-05), National population (in million), Per capita income (Rs) and Total national export (in Cr Rs). Export price, exchange rate and population of the country were found to influence cumin export from India significantly. Cumin export increased with depreciating rupee and total export from country whereas it decreased with increase in population of the country.

Coriander export from India

During 2004-05 to 2018-19, coriander export increased from 33 to 49 thousand tonnes, at compound growth of 3.47 percent per annum. In monetary term its export increased from 82 to 352

crore rupees at compound growth of 13 per cent per annum (Figure 14).



Coriander export from India in quantity and value term from 2004 to 2019

Shift in Direction of coriander export

Malaysia, U.A.E., U.K., South Africa and U.S.A. were most preferred destinations for Indian coriander during 2004-05 to 2018-19. Malaysia is the largest importer for Indian coriander with 26 percent share in total during period I, further increased to 30 percent shares in total during period II, whereas share of UAE decreased. During this period Oman, U S A and Qatar have come up as emerging destinations for Indian coriander whereas; Singapore and UAE have registered negative growth.



Top five destinations (in quantity) for Indian coriander

Transition Probability Matrix of coriander pointed out Malaysia as highest loyal market of Indian coriander followed by U.K. during period I. Retention over previous year has improved for Malaysia during period II. Saudi Arabia has also become regular importer in later period.

Export supply function of coriander during 1980-81 to 2018-19 pointed out Exchange rate (Rs/\$), Population of India (in million) and Total export from the country (in Cr Rs) playing significant role in influencing coriander export from the country. Coriander export increases with decreasing value of rupee and total export from the country. Due to increase in population or domestic consumption its export found to decrease.

SS/18.6.1: Dissemination of seed spices production, protection and post-harvest under TSP and NEH region

(G. Lal; N.K. Meena, R.S. Meena, Shiv Lal and M.D. Meena)

During the year of 2019-20, a total of 253 frontline demonstrations (FLDs) of different seed spices i.e. coriander, fennel, fenugreek, ajwain, nigella and dill were conducted at farmer's field in different villages

of Pratapgarh, Banswara, Dungarpur and Udaipur districts of Rajasthan under TSP project. Among five locations, 65 FLDs [coriander var. ACr-1 (20), fenugreek var. AFg-3 (20), ajwain var. AA-1 (10), fennel var. AF-1 (05), nigella var. AN-20 (05) and dill var. AD-1 (05)] were conducted at Pratapgarh district, wherein the yield of seed spices under demonstration plots was recorded higher in the range between 17.60 to 45.70 per cent as comparison to local checks and practices. 53 frontline demonstrations (FLDs) of different seed spices (coriander ACr-1, fenugreek AFg-5, nigella AN-1 and ajwain AA-93) were conducted at Banswara in which yield appreciation was recorded in the range of 31.08 to 36.42 percent. 55 FLDs of seed spices [Coriander ACr-1 (15), fenugreek AFg-3 (10), fennel AF-1 (15), ajwain (10) and nigella (05)] were conducted at Dungarpur district in which yield of different seed spices enhanced between 20.09 to 46.15 percent. 50 FLDs of different seed spices i.e.



FLDs input distribution in TSP area

coriander (ACr-1), fenugreek (variety AFg-3), fennel (AF-1), ajwain (AA-93) and nigella (AN-20) were conducted at Phalasia area of Udaipur district, where yield appreciation was recorded from 20.44 % in fennel to highest 60.26 % in fenugreek over local check with farmer's practices. 30 FLDs of three seed spices, coriander (ACr-1), ajwain (AA-93) and nigella (AN-20) were conducted at Salumber (Udaipur) wherein, yield appreciated 43.71% in ajwain, 32.81% in nigella and 23.90% in coriander over local checks and farmer practices.

External Funded Projects

DUS testing guideline in major seed spices (Fennel, fenugreek, coriander and cumin) crops.

(R.S. Meena, Sharda Choudhary)

DUS experiment of major seed spices (coriander, fenugreek, fennel and cumin) was laid out at NRCSS, Ajmer (Rajasthan) during 2019-20. In this experiment 35 varieties of Coriander, (26 reference and 9 Candidate), 22 varieties of fenugreek, 21 varieties of fennel, 9 varieties of cumin were included to develop test guidelines for these crops.



Field view of coriander DUS testing



Field view of fenugreek DUS testing

DUS test guidelines in minor seed spice (ajwain, dill, nigella, celery and anise) crops.

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

DUS experiment of minor seed spices (ajwain, dill, nigella, celery and anise) were laid out at ICAR-NRCSS, Ajmer (Rajasthan) during 2019-2020. In this experiment 9 varieties of ajwain with 15 germplasm lines, 5 varieties of dill with 15 germplasm lines, 5 varieties of nigella with 15 germplasm lines, 4 varieties of celery and 2 varieties of anise were included to develop test guidelines for these crops. Observations were recorded on various growth stages of concern crop plants. These characteristics are used to make groups of varieties.



Celery DUS testing field view

AICRP on Spices (Crop management)

(Ravindra Singh)

Standardization of drip fertigation in cumin

Pooled data of 3 years show that drip fertigation significantly increased the yield as well as water productivity. The drip irrigation at 0.8 IW/CPE ratio with 80 and 100% RDF through fertigation gave significantly higher seed yield of 755.7 and 830.8 kg/ha; gross returns (Rs 128468 and 141229); net returns (Rs 77023 and 89559) with the B:C ratio (1.50 and 1.73) and water productivity of 2.47 and 2.29 kg/ha-mm water. Maximum water use efficiency (2.65 kg/ha-mm) with the seed yield of 402.3 kg/ha were recorded at the treatment of drip fertigation at 0.4 IW/CPE ratio with 100 % RDF, whereas the

minimum seed yield (298.6 kg/ha) were obtained at drip irrigation at 0.4 IW/CPE ratio with 60 % RDF with the water use efficiency of 2.08 (kg/ha-mm). The seed yield of cumin was 440.7 kg/ha with surface irrigation 0.8 IW/CPE along with 100% RDF which gave lowest water use efficiency of 0.98 kg seed /ha-mm of water. Hence drip irrigation in cumin at 0.8 IW/CPE ratio with 80 or 100% RDF through fertigation recommended for higher yield, gross returns, net returns with high B:C ratio and water productivity.

Standardization of drip fertigation in fennel

The experiment was conducted during rabi 2019-20. The results showed that drip irrigation as well as drip fertigation significantly increased the plant height, number of primary and secondary branches, umbels/ plant, umbellate/umbel, seeds per umbel, test weight, seed yield and water use efficiency of fennel as compared to surface irrigation with conventional fertilization. The drip fertigation at 0.8 IW/CPE ratio with 80 % RDF recorded significantly higher plant height (184.5 cm), number of primary branches (20.0), number of secondary branches (49.3), umbels/plant (35.8), umbellets/umbel (29.3), seeds/umbellate (30.0), test weight (6.11 g), seed yield (2321 kg/ha) and water use efficiency (2.21 kg/ha-mm). However it remained at par to drip fertigation with 60% RDF at 0.8 IW/CPE ratio. Maximum water use efficiency 3.07 kg/ha-mm were recorded with drip fertigation at 0.4 IW/CPE ratio with 100% RDF. Whereas, it was lowest (1.27 kg/ha-mm) at surface irrigation at 0.8 IW/CPE ratio with 100% RDF



Fennel under drip irrigation

Micronutrient management in Cumin

The results showed that application of micronutrients significantly increased the plant height, branches/ plant, umbels/ plant, umbellets /umbel, seeds per umbel, test weight, seed yield, net returns, B:C ratio and incidence of blight and powdery mildew in cumin as compared to control. The application of all micronutrients viz., zinc, iron, manganese and boron recorded significantly higher plant height (31.43 cm), primary branches/ plant (9.72), secondary branches/ plant (17.09), umbels/plant (40.0), umbellets/umbel (5.96), seeds/umbel (33.06), test weight (4.69 g), seed yield (1248.2 kg/ha), net returns (Rs 155385/ha), B:C ratio (3.74) and minimum incidence of blight (9.43%) and powdery mildew (2.84%) on cumin.

The application of 50% micronutrient in soil application along with foliar spray significantly increased the plant height (29.42 cm), umbellets/umbel (5.47), seeds/umbellet (8.83), seeds/umbel (30.95), test weight (4.57 g), seed yield (924.1 kg/ha), net returns (Rs 102715/ha), B:C ratio (2.86) and slightly higher incidence of blight (21.48%) and powdery mildew (9.89%) on cumin.

DASD sponsored Project on "Pilot project on pesticide free cumin production through popularization of bio-agents and botanicals for plant health management"

(Krishna Kant, B K Mishra, Y K Sharma and Narendra Chaudhary)

The project was launched during financial year

2019-20 with financial support from DASD, Calicut for the large scale demonstration of botanicals and biocontrol agents for eco-friendly management of pests and diseases of high value seed spice crop namely cumin. The aim of the programme is to implement the Good Agricultural Practices (GAP) for clean and safe production of cumin at farmer's level. Since Cumin is an important commodity among export spices from India, pesticide residue is one of the important non tariff barriers for cumin in international market. The project was launched at two locations at farmer's fields at Gudamalani in Barmer and Mundwa in Nagaur districts. Each location 25 fields of 1.0 ha. was selected for the study. All inputs including seed, recommended doses of fertilizers and plant protection agents (bioagents/ botanicals/ bio fertilizers) were supplied

by the ICAR-NRC Seed Spices, Ajmer. An awareness programme of cumin farmers was organised at ICAR-National Research Centre on Seed Spices (NRCSS) on 4th of October, 2019. The crop at farmer's field was monitored by the project team since crop sowing to harvesting. Training programme was conducted at both the location for proper management of crop for pests and diseases management through non chemical methods and scientific method of crop harvest and packaging for better quality produce. The cumin crop was successfully raised and harvest without using any chemical pesticides for pests and diseases management. The average yield obtained was at par with the conventional methods of farmers using chemical for plant protection. The yield obtained was as under

S.No.	Crop	Location	Average Yield (q/ha)	
			Without chemical protection	With chemical control
1	Cumin	Gudamalani, Barmer, Rajasthan	5.86	6.10
2	Cumin	Mundwa, Nagaur, Rajasthan	9.0	9.7



Project Activities at Farmers Fields

Mass Production of bio agents /botanicals at Biocontrol Laboratory

The laboratory engaged in mass multiplication and distribution of various bio agents/botanicals/ bio fertilizers for quality production of seed spices and other horticultural crops. The salient achievement of biocontrol laboratory during 2020 for production and supply of different bio agents are as under. Maintained and mass produced nine types of microbial biocontrol agents and botanical biopesticide. Among microbial bioagents three strains of entomopathogens, *Verticillium lecanii*, *Beauveria bassiana* and *Metarhizium anisopliae* three soil antagonist, *Trichoderma viride*, *T. Harzianum*, *Pseudomonas fluorescens* *Bacillus subtilis* two

nematophagen *Paecilomyces lilacinus*, *Pachonia chlaydosporium* one for mite control *Hirsutella thompsoni* maintained and produced for insect and diseases management, *Botanical Insecticide Soap* for control of sucking and lepidopterous pests also produced. Mass multiplication activity Bio fertilizers production including *Phosphorus Solubilising Bacteria (PSB)*, *Azotobactor* and *Zinc Solubilising Bacteria* was done. These microbial inoculants were supplied to farmers for control of pests and diseases of seed spice crops, protected cultivation, vegetables and fruit crops. Total revenue of Rs. 931430.0 (Nine Lakh, Thirty One Thousand, Four Hundred thirty) generated through this sale of different bio agents from 1st January 2020 to 31st December, 2020.



ICAR-Network/Platform Research Projects

Network Project on Organic Farming (NPOF) in collaboration with IIFSR, Modipuram "Standardization of seed spices based organic farming system" Duration

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

To standardized seed spices based cropping system under INM approach, screening of seed spices cultivars under organic management, evaluation of IPM Modules against aphid and thrips infesting coriander and fennel and management of Sclerotium rot of coriander and Ramularia blight of fennel. During the period reported upon, the salient research outcomes were given as below:

1. The eight varieties of both coriander and fennel in Rabi and eight varieties of moong bean and cluster bean in Kharif were tested under organic production system. It was found that in fennel varieties highest yield (28.00 q/ha) was recorded in GF-12 followed by AF-1 (27.50 q/ha). In coriander, variety Azad Dania-1 was found best in yield (17.06 q/ha yield) and growth parameters followed by ACr-1 (16.93 q/ha) in Rabi and in Kharif season, cluster bean variety RGC-1038 (15.95 q/ha) was performed best followed by RGC-1055 (15.16 q/ha) and in moong bean superior performance was given by cultivar MUM-2 (796.67 q/ha) followed by BMG-975 (7.88 q/ha yield) with respect to growth and yield aspects.
2. Six organic based IPM modules (including control) were tested against aphid on coriander and fennel under field conditions. The results showed that, the all IPM modules were found significantly superior over untreated one. However, IPM module M-3 (garlic extract 10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit + tumba fruit extract 10ml/lit.) was found most effective (77.00% & 79.50%) against aphid on both the crops followed by M-2 (field sanitation + NSKE

5ml/lit + Ker extract 10 ml/lit.). Remaining treatments, IPM modules were found moderately effective against pest on both the crops.

3. Under evaluation of natural farming practices in seed spices based cropping system the results revealed that in the terms of equivalent yield T6 (Beejamrit + Ghanjeevamrit @250kg/ha+ Jeevamrit @500 lit/ha/irrigation twice in a month + Fennel straw as mulch@5t/ha) recorded highest seed yield followed by T4 (Beejamrit+ Ghanjeevamrit @250kg/ha + Jeevamrit @500 lit/ha/irrigation twice in a month + Whapasa (irrigation in alternate furrows at noon) cow pea crop in kharif season.
4. To evaluate organic, inorganic and integrated production system involving seed spices. The experiments on INM for the development of sustainable seed spices based production/cropping system in kharif (cow pea sole and cow pea + maize inter cropping) and Rabi (coriander, fennel and cabbage intercrops with both crops) were conducted at organic block of research farm, NRCSS, Ajmer. The results stated that, the performance of PS4 (25% nutrients through organic +25% nutrients through inorganic source of nutrients + Seed/Seedling treatment with Beejamrit + application of Ghanjeevamrit @ 250 kg/ha, Jeevamrit @ 500 litres /ha /time twice a month with irrigation water) treatment is recorded highest value of all parameters followed by state recommendation in Kharif season.



Natural farming practices in seed spices based cropping system at ICAR-NRCSS, Ajmer

4. Technology Assessment and Transfer

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

For transfer scientific package of practices of latest crop varieties in seed spices, front line demonstrations (FLDs) organized at various locations of Rajasthan. During the report period 10 FLDs of fennel in Karauli and Bharatpur, 09 FLDs of fenugreek at Sikar, 15 FLDs of coriander at Baran and Kota, 05 FLDs of cumin at Ajmer and Nagaur districts of Rajasthan were organized under MIDH project of Directorate of Arecanut and Spice Development, Calicut, Kerala.



Fenugreek (AFg-3) seed distribution at Sikar under MIDH FLDs



Fennel (AF-1 & AF-2) seed distribution at Hindaun (karauli) under MIDH FLDs



Coriander (ACr-1) seed distribution at Sangod, Kota under MIDH FLDs

4.2 Transfer of Technology Activities in NEH region

Farmers training program at Agaratala (Tripura)

ICAR-NRC on Seed Spices, Ajmer (Raj.) along with staff of College of Agriculture Tripura, Agartala organized the farmers training programme on "Advances in Production Technologies and Crop Improvement of Seed Spices at College of Agriculture, Tripura, Agartala on 25th February, 2020. In this training program 157 farmers from four different districts of Tripura participated to learn about the seed spices cultivation techniques. Dr. S. N. Saxena in his inaugural address informed the farmers and farm women about the role of different seed spices and their economic and medicinal importance. He urged the participants for diversification of agriculture through high value low volume seed spice crops. Two technical sessions and one farmers –scientist interaction session were organized for popularization of seed spices varieties and technologies in Tripura state of NEH region. Several farmers expressed their keen interest in off –season leafy coriander and fenugreek cultivation technology developed by ICAR-NRCSS, Ajmer.

Dr. B. K. Mishra and Dr. A. K. Verma also delivered lecture in the technical sessions on various issue of seed spice production in agro-climatic conditions of Tripura state. Dr. Debashish Sen, Principal, College of Agriculture Tripura, interacted in native language (Bengali) with the farmers of four different districts that were participating in the interaction workshop on seed spices production. After completion of technical session's farm input (neem seed cake and spray pumps) were distributed to all the participants for safe and clean agriculture production particularly off-season coriander and fenugreek. This training programmed was organized under NEH fund of ICAR- NRC on Seed Spices, Ajmer.



Farmers training on Production Technologies and Crop improvement in Seed Spices

Farmers training on Organic Production & Protection Technologies of Seed Spices for Sikkim State

One day farmer training programme on "Organic Production & Protection Technologies of Seed Spices for Sikkim State" was organized by ICAR-National Research Centre on Seed Spices, Ajmer in collaboration with Krishi Vigyan Kendra, South Sikkim at Namthang, Sikkim on dated 05th March, 2020. In this training Dr. N.K. Meena, Dr. R. D. Meena, Sh. M.A. Khan and Sh. Sunil Kumar Agrawal, from ICAR-NRCSS, Sh. I. P. Shivakoty, Sr. Scientist & Head, KVK, Namthang, South Sikkim and Miss Meena Pradhan, SMS (Extension Education), KVK, Namthang, South Sikkim were actively involved. In technical session of this training, seven lectures delivered by the Scientists of NRCSS, KVK & Agriculture Department, Namthang, Sikkim and Head, IARI, Regional Station, Kalimpong. The topics covered various aspects of seed spices like seed spices production an over view, possibilities of its cultivation in Sikkim, important varieties of seed spices particularly coriander, fenugreek and fennel, organic component for nutrients and insect-pests and diseases management, weed management, processing and value addition. A total of 80 farmers from South Sikkim participated and benefited. Through this farmers training at Namthang, Sikkim, ICAR-NRCSS popularized seed spices production technologies of ICAR-NRCSS in Sikkim, which multiply the acreage of seed spices in the country. In this training, a total of 80 knapsack spray machines were given to 80 farmer participants (01 machine to each farmer) from South Sikkim district of Sikkim which will be useful for spraying of various plant health management substances on crops.

Another, One day farmer training on "Organic Production & Protection Technologies of Seed Spices for Sikkim State" was organized at Krishi Vigyan Kendra, Namthang, South Sikkim collaboratively by ICAR-NRCSS, Tabiji, Ajmer and



KVK, Namthang on 06th March, 2020. This program was organized by Dr. N.K. Meena, Sh. M.A. Khan, Dr. R. D. Meena, and Sh. Sunil Kumar Agrawal, from NRCSS and Sh. I. P. Shivakoty, and Miss Meena Pradhan, from KVK, Namthang, South Sikkim. In this training, seven lectures on different aspects of seed spices like seed spices production an over view, possibilities of its cultivation in Sikkim, important varieties of seed spices particularly coriander, fenugreek and fennel, organic component for nutrients and insect-pests and diseases management, weed management and value addition were delivered by the Scientists of NRCSS, KVK and Department of Agriculture, Namthang, Sikkim. In the training, farmers had shown interest for cultivation of coriander and fenugreek at Sikkim as its use as spices, medicinal and direct use as leafy vegetable. Farmer demanded for availability of quality seed at Sikkim for cultivation. Through this training, seed spices production technologies were described among a group of farming community at Sikkim for its wide spread and population in new area. A total of 81 farmers (another group of farmers) from South Sikkim were participated and benefited. In this training, a total of 160 numbers of plastic crates were given to 80 farmer participants (02 crates to each farmer) from South Sikkim district of Sikkim which will be useful for carrying various agriculture products like seed packets, vegetables and other value added products.

One day Farmers training at Krishi Vigyan Kendra, Anjaw, ICAR-RC for NEH Region, Arunachal Pradesh (A.P.)

ICAR-NRCSS, Ajmer organized one day farmers' training programme on "Seed Spices Production and Value Addition" in Arunachal Pradesh on 12 March, 2020 at Krishi Vigyan Kendra, Anjaw, ICAR-RC for NEH Region, Arunachal Pradesh (A.P.). The training programme was inaugurated by MLA Dasanglu Pul, the Chief Guest spoke on the performance and steps being taken up by ICAR-KVK, Anjaw for welfare of the farming community of the district towards qualitative development of agriculture. She also urged the farmers to join hands with the KVK officials to help them in adopting the scientific knowledge in farming, which she said would pave way to bring the district forward. Dr Manish Kanwat, Sr Scientist and head, KVK Anjaw highlighted the importance and awareness regarding the present status and prospects of seed spices in the district as well as in the state. Dr S S Meena, Principal Scientist, ICAR-NRCSS, Ajmer, Rajasthan gave a brief presentation on the importance of seed spices, its uses production & value addition. Farm implements were distributed to 110 farmers, women SHGs and rural youths from various villages of Anjaw district. The programme was concluded by open discussion with farmers to resolve their day to day farming problems related to seed spices and other horticultural crops.



Farmers training at NOFRI, Sikkim

TOT activities under NEH region during 2020

Sl. No.	Title of training	Date	Place	No. of beneficiaries	Coordinators
1.	Organic Production Technology on Seed Spices for NEH Region	30-31 Jan, 2020	ICAR-NOFFRI, at Tadong, East Sikkim, Sikkim	57 farmers	Dr. N. K. Meena, Dr. R.S. Meena & Dr. Shiv Lal
2.	Advances in Production Technologies and Crop Improvement of Seed Spices	25 Feb, 2020	College of Agriculture, Tripura, Agartala	157 farmers	Dr. S.N. Saxena, Dr. B.K. Mishra, & Dr. A.K. Verma
3.	Advances in Seed Spice Production Technology in NEH region	27 Feb, 2020	Mizoram University, Aizawl (Mizoram)	170 farmers	Dr. Shiv Lal & Dr. N. Choudhary
4.	Prospects of seed spices production and value addition in Mizoram	29 Feb, 2020	Mizoram University, Aizawl (Mizoram)	120 farmers	Dr. Shiv Lal & Dr. N. Choudhary
5.	Organic Production & Protection Technologies of Seed Spices for Sikkim State	05 March, 2020	KVK, Namthang, South Sikkim	80 farmers	Dr. N. K. Meena, Dr. R. D. Meena, Sh. M.A. Khan & Sh. S.K. Agrawal
6.	Organic Production & Protection Technologies of Seed Spices for Sikkim State	06 March, 2020	KVK, Namthang, South Sikkim	81 farmers	Dr. N. K. Meena, Dr. R. D. Meena, Sh. M.A. Khan & Sh. S.K. Agrawal
7.	Seed Spices Production and Value Addition in Arunachal Pradesh	12 March, 2020	KVK, Anjaw, Arunachal Pradesh	110 farmers	Dr. S.S. Meena, Sh. G.K. Tripathi & Sh. P.K. Agrawal



Farmers training at Aizawl, Mizoram



Farmers training at Anjaw, Arunachal Pradesh



Farmers training at College of Agriculture,
Agartala, Tripura



Farmer trainings at Namthang,
South Sikkim, Sikkim

4.3 Transfer of Technology Activities Under Tribal Area Sub Plan

During the year of 2019-20, a total of 253 frontline demonstrations (FLDs) of different seed spices i.e. coriander, fennel, fenugreek, ajwain, nigella and dill were conducted at farmer's field in different villages of Pratapgarh, Banswara, Dungarpur and Udaipur districts of Rajasthan under TSP project. Among five locations, 65 FLDs [coriander var. ACr-1 (20), fenugreek var. AFg-3 (20), ajwain var. AA-1 (10), fennel var. AF-1 (05), nigella var. AN-20 (05) and dill var. AD-1 (05)] were conducted at Pratapgarh district, wherein the yield of seed spices under demonstration plots was recorded higher in the range between 17.60 to 45.70 per cent as comparison to local checks and practices. 53 frontline demonstrations (FLDs) of different seed spices (coriander ACr-1, fenugreek AFg-5, nigella AN-1 and ajwain AA-93) were conducted at Banswara in which yield appreciation was recorded in the range of 31.08 to 36.42 percent. 55 FLDs of seed spices [Coriander ACr-1 (15), fenugreek AFg-3 (10), fennel AF-1 (15), ajwain (10) and nigella (05)] were conducted at Dungarpur district in which yield of different seed spices enhanced between 20.09 to 46.15 percent. 50 FLDs of different seed spices i.e. coriander (ACr-1), fenugreek (variety AFg-3), fennel (AF-1), ajwain (AA-93) and nigella (AN-20) were conducted at Phalasia area of Udaipur district, where yield appreciation was recorded from 20.44% in fennel to highest 60.26% in fenugreek over local check with farmers practices. 30 FLDs of three seed spices, coriander (ACr-1), ajwain (AA-93) and nigella (AN-20) were conducted at Salumber (Udaipur) wherein, yield appreciated 43.71% in ajwain, 32.81% in nigella and 23.90% in coriander over local checks and farmer practices.



FLDs input distribution for FLDs in TSP scheme

4.4 Transfer of Technology Activities under Scheduled Caste Sub Plan (SCSP)

Input distribution programmes under SCSP

Five one day programme was conducted on "Distribution of agri-inputs and items related to crop production/post harvest management" on 25, 26, 27, 29 and 30 June 2020 at ICAR-NRCSS, Ajmer. In these programmes a total of 100 scheduled caste farmers of Tabiji, Doomara, Saradana, Budhwara, Datra, Masinia, Kesarpura, Makreda, hatundi villages of Ajmer district were participated. During the programme farmers were made aware about the safety measures to be undertaken in prevailing COVID-19 situation. They were advised to grow off season leafy coriander and fenugreek under green shed net and for that green shed net of size 75

square meter were distributed to all the participants in addition to that one plastic crate for handling the leafy vegetable or farm produce and 1 kg fenugreek AFG-5 fenugreek seed were also distributed to all the beneficiaries. The programme was coordinated by Dr. Shiv Lal, Dr. R.D. Meena, Dr. A.K. Verma and Dr. M.D. Meena.

At Sangramgarh, on the occasion of field day different inputs like botanical insecticide soap of ICAR-NRCSS, Ajmer and Kisan torch were distributed among 30 SC beneficiaries. The method of application and preparation of botanical insecticide soap was also briefed among the farmers. The programme was coordinated by Dr. Shiv Lal, Sr. Scientist (Horticulture), Dr. R.D. Meena, Scientist (Plant pathology) and Sh. S.R. Balai, TA.



Input distribution to SCSP beneficiaries of Ajmer district at ICAR-NRCSS



Input distribution to SCSP beneficiaries at Sangramgarh, Bhilwara



Transfer of technologies through capacity building and frontline demonstrations (FLDs) under SCSP

For capacity building and dissemination of ICAR-NRCSS Ajmer promising technologies among the farmers belongs to SC community, a total of 02 trainings and 155 frontline demonstrations were organized at various locations of the state of Rajasthan under SCSP during the period.

Post-harvest management and value addition in seed spices

Organized one day training on "Post-harvest management and value addition in seed spices under SCSP" was organized at KVK, Hindon city, Karauli. The Scientists of ICAR-NRCSS, Ajmer and Scientists/officials of KVK, Hindon city delivered their lectures and made interaction with farmers. A total of 100 farmers belong to SC community were participated in this training programme besides staff of KVK. In this training programme the seeds of fenugreek variety AFG-3 (500 g), plastic crates, kisan torch and training kits were distributed among all the trainee participants.



Training programme organized at KVK, Hindon city, Karauli

Training programme organized under SCSP scheme :

Title of training	Date	Place	No. of beneficiaries	Coordinators
Post-harvest management and value addition in seed spices	7/3/2020	KVK, Hindon city	100	Dr Gopal Lal, Dr. S.S. Meena, Dr. Shiv Lal, P.K. Agarwal
Field day	30/12/2020	Sangramgarh	35	Dr. Shiv Lal, Dr. R.D. Meena and S.R. Balai



Front line demonstrations of cumin variety (GC-4) at Budhwara village of Ajmer district of Rajasthan





Front line demonstrations of fennel varieties (AF-1 and AF-2) at Dantra village of Ajmer district of Rajasthan



Interaction with farmers for harvesting fennel at early stage for chewing purposes



Front line demonstrations of Fenugreek variety (Afg-3) at Sangramgarh village of Bhilwara district of Rajasthan

During 2020-2021, a total of 155 Front Line Demonstrations (FLDs) of seed spices were conducted at the farmer's fields in different villages of Ajmer and Bhilwara district under the ICAR-NRCSS SCSP programme.

Monitoring of FLDs

Monitoring of FLDs (8 fenugreek, AFg-4; 2 fennel, AF-2; Coriander, ACr-2) performance at farmer's field at different location of Sangramgarh village of Bhilwara district were carried out on 30/12/2020. In one of the fenugreek FLD incidence of downy mildew was observed while at another location weed infestation was higher. The necessary measures for weed management, irrigation and plant protection etc. were suggested to FLDs beneficiaries. It was also suggested to use minimum chemical pesticides and maximum use of organic plant protection measures. Monitoring was carried out by Dr. Shiv Lal, Sr. Scientist (Horticulture), Dr. R.D. Meena, Scientist (Plant pathology) and and Sh. S.R. Balai, TA.

District wise distribution of front line demonstrations on different seed spices during 2020-21 under SCSP

Name of district	Crop	No. of FLDs
Ajmer	Cumin	87
	Coriander	1
	Fenugreek	50
Bhilwara	Fennel	4
	Coriander	5
	Ajwain	5
	Nigella	3
Total	155	

Field day

A field day was organized at Sangramgarh on 30/12/2020, at the field of one of the SCSP FLD beneficiary. In this field day a total of 35 SC community farmers were participated and got benefitted. During the field day programme various crop management issue like management of aphids,

downy mildew and irrigation were discussed with farmers and possible management were suggested. In this programme inputs like botanical insecticide soap of ICAR-NRCSS, Ajmer and Kisan torch were distributed among the beneficiaries. The method of application and preparation of botanical insecticide soap was also briefed among the farmers. The programme was coordinated by Dr. Shiv Lal, Sr. Scientist (Horticulture), Dr. R.D. Meena, Scientist (Plant pathology) and Sh. S.R. Balai, technical assistant.



Front line demonstrations of fenugreek and Coriander varieties at Sangramgarh village of Bhilwara district of Rajasthan



Demonstration of Fenugreek FLDs to SCSP beneficiaries during Field day

4.5. Technology transfer and awareness programmes on "Good Agriculture Practice (GAP) of selected seed spices in Western Dryland Region under Biotech Kisan Programme"

During October, 2020 ICAR-NRCSS distributed thirty field level demonstration for cumin, fenugreek and Nagouri Pan Methi (Ten each crop) in Ajmer, Nagour and Jhunjhunu districts of Rajasthan. Six cumin demonstrations were given in village Katyasani (Nagour), one in each village namely Saradhana, Makreda, Bhudwada and Dabla in Ajmer districts.

Seven fenugreek demonstrations were given in Bhatiwada village of Jhunjhunu district and three demonstrations were given in Saradhana (1) and Dabla (2) villages of Ajmer district. Ten demonstrations of Nagouri Pan Methi were distributed in Marwad Mundwa village of Nagour district. Inputs like High yielding varieties (Cumin GC-4; Fenugreek AFG-3; Nagouri Pan Methi-Pusa Kasoori), fertilizers (Urea, DAP, MoP), Herbicide and bio control agents were supplied to the farmers.



Fenugreek input distribution at KVK Jhunjhunu



Cumin input distribution at Katyasani



Nagouri Pan Methi input distribution at Marwad Mundwa



Fenugreek and cumin input distribution at NRCSS Ajmer

Workshop on "Promoting GAP & IPM based Cumin Production System"

ICAR-National Research Centre on Seed spices in collaboration with Spice Board India, South Asia Biotechnology Centre and State Agriculture Department, Govt. of Rajasthan organised Cumin Workshop on "Promoting GAP & IPM based Cumin Production System" on 04th November, 2020. The workshop was attended by more than 35 cumin farmers from Ajmer and Nagour districts. Participants were imparted with knowledge on Good Cumin Production System, Integrated pest and disease management, market opportunities, and Bio-Package of Practices in cumin.



Brainstorming session on "Nagouri Pann Methi: Origin, Domestication, Crop Improvement and Production system"

On 3rd December, 2020 ICAR-National Research Centre on Seed spices in collaboration with South Asia Biotechnology Centre and State Agriculture Department, Govt. of Rajasthan organised

Brainstorming session on "Nagouri Pann Methi: Origin, Domestication, Crop improvement and Production system" at Department of Agriculture, Nagoure (Rajasthan). The session was attended by 50 Nagouri Pann Methi farmers from Nagoure district and scientists of above departments. Sh. Harjiram ji and Sh. Sharkar Ram Siyak from state department provided details regarding this crop in the district. The facts were noted for filling Geographical Indicator of Nagouri Pann Methi so that farmers can get premium price for their produce.



Monitoring of demonstration fields

Scientist of ICAR-NRCSS visited the demonstration plots to examine the performance of the technologies at the farmer's field. The beneficiaries were recommended about application of appropriate pesticides as per need apart from advice of inter-culture operations, thinning of plants and irrigation etc.



Monitoring of cumin fields at Katyasini (Nagour)



Monitoring of Nagouri Pan Methi field at Marwad Mundwa

4.6. National farmers fair

Two days Seed Spices Kisan Mela was conducted at ICAR-NRCSS Ajmer on 15-16th February 2020. The fair was inaugurated by Sh. Bhagirath Choudhary, MP, Ajmer and graced by Sh. Vasudev Devnani, Smt. Anita Bhadel, MLAs from Ajmer district. Apart from them Director, ICAR-CSWRI, Avikanagar, ICAR-NRCC, Bikaner, Dr. Laxmikant Sharma, Principal DAV college Ajmer, Dr. V. K. Sharma, Deputy Director (Agriculture), Dr. D. S. Bhati, Incharge KVK, Ajmer were also present as guest of honour. Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer welcomed all the dignitaries on the dais, scientists, officials from various line departments and more than 2500 farmers that gathered for the events from the various parts of the state of Rajasthan, Gujarat and MP and UP. At Mela ground 50 stalls were exhibiting their products, technologies with live samples including CAZRI, Jodhpur, CIAH Bikaner, CSWRI, Avikanagar, NRCC, Bikaner and SAUs, MPUAT, SKNUA, NGOs and private vendors from Rajasthan. There were two hrs farmer-scientist interactions in which farmers were encouraged to ask their agricultural problems to experts. Director, NRCSS in his speech appraised the august gathering about the various activities of the centre

involving development & release of varieties, technologies, post harvest management of seed spices and other related activities. He also mentioned that Rajasthan and Gujarat are together producing 80% of seed spices of the country (18.5 lakh tons) with the cropping area of about 18 lakh hectares and also that the increase in production has gone up by 2.5 times within the last two years. He also mentioned about the climatic vagaries and ways to mitigate them. The various technologies developed w.r.t. INM, IPM were also mentioned by him. The seed spices processing, use of nano technology, patents and commercialization activities were also presented before the audience. As a mile stone achievements the spread of seed spices to the farthest north-eastern area were also mentioned here.

Chief guest Sh. Bhagirath Choudhary expressed happiness for presence of large number of farmers in the fair. He urged farmers to utilize the latest technologies developed by the host institute. He was of the opinion to enhance agriculture education in Ajmer district. Sh. Vasudev Devnani praised the research work done at host institute for benefit of seed spices farmers. He stressed upon raising farmers income by adopting new innovation in seed spice cultivation technology. Smt. Anita Bhadel in her speech advocated organic farming and increasing resource use efficiency particularly in water deficit areas. Dr. Bhati briefed about various achievements of the KVK, Ajmer w.r.t. animal husbandry, vermi-composting, mushroom and azola production as well as poultry etc. Progressive farmers from different areas were given certificate of appreciation. The programme was coordinated by Dr. S.N. Saxena, Principal Scientist and his team which ended with vote of thanks to all.



4.7 Seed Spices Stakeholders Interface

The Seed Spices Stakeholders Interface was held on January 19, 2020 at Dr. R.S. Paroda Auditorium of ICAR- National Research Centre on Seed Spices, Tabiji, Ajmer (Raj.). The programme was chaired by Dr. Anand Kumar Singh, Deputy Director General (Horticultural Science), ICAR, New Delhi. Sh. R. K. Menan, Chairman, World Spice Organization, Ernakulam (Kerala) and Dr. Homey Cheriyan, Director, DASD, Calicut (Kerala) were co-chairmen. The Seed Spices Stakeholders Interface was held under MIDH project sponsored by Directorate of Arecanut and Spices Development, Calicut (Kerala). Dr. A.K. Singh, told that we have to do collaborative work for on-farm monitoring of pesticide application based on real time monitoring of insect pests and disease causing pathogens through the use of Internet of Things (IOT) and giving forecast advice to seed spice growers. He also advocated for awareness program among farmers for judicious use of pesticides. Dr. Singh also told that there is a need

for collaborative role of private firms/ NGOs and exporter of seed spices in achieving the produce clean and safe as well as fixing the realistic MRLs in the produce. The target of doubling Agri-export by 2025 can be achieved by giving emphasis on high value cash crops like seed spices. For this a Global trade map of major seed spices has to be prepared with economics of crop, potential buyers, suppliers and competitors. He advised that outdated pesticides must be removed from package of practices of different crops and crop residues should be used for further value addition. He told that elaborate research work should be conducted on use of seed spices crop residues for enhancing animal health and milk quality.

Sh. R. K. Menan, co-chairman of the interface, apprised the participants about the emerging issue of allergens in seed spices such as peanut allergens and new MRLs for pyridine alkaloids in exported spices. Dr. Homey Cheriyan, Director, DASD, Calicut, highlighted the importance of large scale



demonstrations of GAPs in seed spice crops for clean and safe production, suitable for domestic as well as export quality parameters.

Dr. Krishna Kant, Principal Scientist (entomology), ICAR-NRCSS, Ajmer, made a presentation on "status of pesticide residue in seed spices". He informed to the participants that commonly used pesticides in seed spice crops do not have label claim. Seed spices harbor large number of insect pests during crop growth as well as after harvest. Dr. S.N. Saxena, Principal Scientist (Plant Physiology), ICAR- NRCSS, Ajmer presented the Cryogenic grinding technology for spices in which liquid nitrogen is used to cool down the spice temperature during the grinding process. It helps in retention of volatile components and preserves the natural aroma/ fragrance besides higher medical potential of cryogenic ground spices. A live demonstration of cryogenic grinding of spices was organized for all stakeholders during this event.

4.8 Farmers visit to the Centre

Farmers and other stakeholders visited the ICAR-NRCSS experimental farm, knowledge park and bio control lab during January, 2020 to December, 2020. Various farmers' group from Rajasthan and adjoining states viz., Gujarat, M.P., U.P., Punjab, Haryana and Maharashtra visited the centre during cropping season as well as off season of seed spices. Groups were explained about the ongoing research activities and various seed spice production technology developed by the centre. Approximately 5551 farmers, students and extension workers benefitted from the on-site demo of advanced and innovative seed spices production technologies such as fertigation, off season production, high yielding varieties, value added products and post harvest management technologies of the centre. During Kisan Mela and different sponsored farmers training programmes, knowledge and skill up gradation of the farmers was the prime aim of the ICAR-NRCSS, Ajmer.

4.9 Sponsored Farmers Training programme organized at ICAR-NRCSS

Sr. No.	Title of training	Duration	Sponsoring agency	Farmers benefited	Coordinators
1	Beejeey masala utpadan ki unnat praudyogikiyan	25 to 29 Jan., 2020	ATMA, Chandrapur Maharashtra	31	Dr. P.N. Dubey Dr. N.K. Meena Mr. G.K. Tripathi
2	Beejeey masala utpadan or ki unnat takneekiya	3 to 7 Feb., 2020	PD, ATMA, Nagour (Raj.)	34	Dr. K. Kant Dr. R.D. Meena Mr. S.R. Meena
3	Beejeeye masalo ka utpadan or mulysvardhan	11 to 15 Feb., 2020	PD, ATMA, Chittorgarh (Raj.)	30	Dr. R.S. Meena Dr. M.D. Meena Dr. N. Choudary
4	Adhik aamdani hetu beejeeye masala fasalotpadan	14-15 Feb., 2020	Narishakti FPO, Alwar (Raj.)	40	Dr. M.D. Meena
5	Beejeeye masala fasalotpadan ki unnat takanikiya	14-15 Feb., 2020	Dhori FPO, Vadgam (Guj.)	20	Dr. R.S. Meena
6	Beejeey masala fasaloutpadan ki unnat krishan kiriyae (Women farmers)	24 to 28 Feb., 2020	PD, ATMA, Nagour (Raj.)	27	Dr. S.N. Saxena Dr. R.D. Meena Sh. S.R. Balai

**4.10 Radio/Television talks**

Name of Scientists	Topic/Title of the talk	Date and venue
Dr. G. Lal	"To Advisory to the horticulture farmers to mitigate the challenges arises due to COVID-19", राजस्थान में बीजीय मसालों की खेती की संभावनाएं और राष्ट्रीय बीजीय मसाला अनुसंधान संस्थान के बढ़ते कदम	Radio Talk in Phone in Air- 'Hum Honge Kamyab' program of AIR, Jaipur on 16 May, 2020 TV Talk on 03 November, 2020 DD Jaipur.
Dr. S.N. Saxena	"Use of PGRs in Agriculture"	12 March, 2020, AIR, Jaipur
Dr. Y.K. Sharma	Management of cumin disease	AIR, Jaipur on 04 January, 2020
Dr. Krishan Kant	IPM on Seed Spices	8 December, 2020 DD-Rajasthan, Jaipur
Dr. B.K. Mishra	"बीजीय मसालों में सूक्ष्मजीवी का उपयोग"	18 December, 2020 DD-Rajasthan, Jaipur
Dr. A.K. Verma	Seasonal Agriculture Operations in Coriander and Cumin	13 March, 2020, DD Kisan, Jaipur

4.11 Exhibitions conducted/participated

Sr. No.	Name of exhibition/fair	Duration	Organised by	Name of exhibitors
1	Global Potato Conclave 2020, Gandhinagar, Gujarat	28-31 Jan. 2020	Indian Potato Association and ICAR-CPRI	Dr. M.D. Meena Dr. S.S. Meena Dr. Y.K. Sharma Mr. P.K. Agrawal
2	Kisan Mela, 2020, Ajmer	15-16 Feb. 2020	ICAR-NRCSS Ajmer	Dr. M.D. Meena Mr. M.A. Khan
3	Kisan Mela, 2020, Barmer	24 Feb. 2020	KVK Gudamalani	Dr. K. Kant, Mr. S.R. Meena

4.12 Technology Commercialization by I.T.M. Unit

Under the leadership of Director, ICAR-NRCSS, Ajmer Dr. B.K. Mishra, nodal officer and In-charge ITMU successfully executed the task of technology commercialization and prepared the monthly and annual report of NAIF funded IP & TM project of ICAR. A non-exclusive MoU was executed for

commercialization of seed spices variety Ajmer Dill-2 (AD-2) between ICAR-NRCSS, Ajmer and R. K. Seeds Company, Shivaji Nagar CID CO. Aurangabad (Maharashtra) 431003, India on 10th February, 2020 in which a license fee of Rs. 30,000/- was charged for three years along with applicable royalty charge.

A non-exclusive MoU was executed for commercialization of seed spices variety Ajmer Fenugreek-5 (AFg-5) between ICAR-NRCSS, Ajmer and Chavan Seeds Company, Near Savana Phata, Buldhana, (MH) on 20th Nov, 2020 in which a license fee of Rs. 30,000/- was charged for three years along with applicable royalty charge.

A non-exclusive MoU was executed for commercialization of seed spices varieties Ajmer Coriander-2 (ACr-2) and Ajmer Dill-2 (AD-2) between ICAR-NRCSS, Ajmer and GPS Hybrid Seeds Pvt. Ltd. Krushi Audyogik, Sahakari Sangh, Ganeshpeth Nagar, Nagpur (MH) on 1st Dec, 2020 in which a license fee of Rs. 60,000/- was charged for three years along with applicable royalty charge.

Newly renovated ITMU Museum was inaugurated on 19th Jan, 2020 by Dr. Anand Kumar Singh, Deputy Director General (Horticultural Science), ICAR, New Delhi in the presence Sh. R. K. Menan, chairman, World Spice Organization, Ernakulam (Kerala) and

Dr. Homey Cheriyan, Director, DASD, Calicut (Kerala) and Dr. Gopal Lal, Director, NRCSS. On this occasion scientists, progressive farmers and seed spice processors at were also present at ICAR- NRCSS, Ajmer.

Intellectual Property and Technology Management Unit (IP/TM), ICAR- NRCSS, contacted with many seed marketing and food items producing firms for commercialization of the institute technology to end user. NRCSS, Ajmer got success in commercialization of Eight seed spices varieties through Memorandums of Understanding/Agreements with Seed Companies/ FPO./ NGO, in recent years, namely **Ajaymeru Kisan Samruddhi Producer Co. Ltd.** (A FPO under SFAC, MoA &FW, Govt. of India) Kekri, Ajmer, **Narishakti Agriculture Producer Company Ltd.** C/O Ibtada, Near Itarana Circle, Rajgarh Road, 200 Feet Bye Pass Road, Alwar Rajasthan, India and **R.K. Seeds company**, Shivaji Nagar, CIDCO, Aurangabad-431003, (Maharashtra), India.



Release of NRCSS technology Calender on the occasion of Foundation day on 19 Jan, 2020



Visit of ITMU knoweldge park during Interface meeting of stakeholders on 19 Jan, 2020



MOU for licensing Dill seed variety of ICAR- NRCSS, Ajmer



5. Training and Capacity Building Programmes

5.1 Training and Capacity Building of NRCSS employees

Dr. B.K. Mishra attended RTI-PIO-25 training during 27-28 Feb, 2020 at Institute of Secretariat Training & Management, old JNU campus, Ber Sarai, New Delhi.

Dr. B.K. Mishra attended fourteen days virtual workshop-cum-training on "Intellectual Property Rights in Agricultural Research & Education in India", jointly organized by ICAR- IP & TM Unit, New Delhi & National Agricultural Higher Education Project, ICAR, New Delhi during 12-28 September, 2020

Dr. Narendra Choudhary attended 21 days Winter School on "Good agricultural practices and value chain management in high value low volume horticultural crops" from 1 to 21 February, 2020 at ICAR-NRCSS, Ajmer.

5.2 Training and Capacity Building Programmes Organised by NRCSS

ICAR sponsored Winter school

A Winter School on "Good Agricultural Practices and Value Chain Management in High Value Low Volume Horticultural Crops" from 1-21 February 2020 was organized at ICAR- NRCSS, Ajmer, Rajasthan. The training programme was inaugurated by Dr. N.S. Rathore, Vice-Chancellor, MPUAT, Udaipur. In the inauguration function Dr. Rathore emphasizes on significance of GAPs and postharvest management in agriculture particularly in horticultural crops. Director ICAR-NRCSS and Course Director, Winter School highlights importance of Good Agricultural Practices and Post Harvest Management in Horticultural Crops particularly seed spices to double the farmers income and to produce the clean and safe produce for the domestic as well as international market. This training programme was

sponsored by Agricultural Education Division, Indian Council of Agricultural Research, New Delhi. Scientists and Assistant Professors and above from ICAR institutes and State Agriculture Universities were participated in the training programme. Total 20 trainees from 7 states attended the training programme. This programme has been planned with broad objectives of imparting advance technologies to the ICAR scientists and teachers/researchers of National Agriculture Research System to improve their skills with latest knowledge and techniques. The course contents were designed to develop better understanding and high level of competency in trainees towards good agriculture practices and postharvest management of horticulture crops. The lectures and practicals were delivered by the experts from ICAR- NRCSS and from others institutes. In the exposure visit of trainees, they were visited Spice Park Jodhpur, CAZRI, Jodhpur and a local Fruit and flower processing Unit, Ajmer.



**5.2.2 Conference/Seminar/Symposia/Workshop/Meetings etc. attended**

G. Lal	• Video Conference of all Directors of ICAR Institutes	10 April, 2020
	• Webinar on "Science, society and exponential change: Reimagining the future" conducted by DDG (Ag. Edu.), ICAR, New Delhi	16 May, 2020
	• Meeting on Review the achievements of ICAR-IIFSR including AICRP-IFS and AI-NPOF schemes for the period of 2017-20 and discuss Future research programmes and activities during 2020-2025	26 May, 2020
	• Webinar on "Spices in the post COVID scenario" organized by ICAR-IISR, Kozhikode at ICAR-IISR, Kozhikode.	27 May, 2020
	• Webinar on "Post Pandemic (COVID-19) Challenges and Options in Agriculture including Horticulture" organized by CHAI in conjunction with Lt Amit Singh Memorial Foundation and PJTSAU, Hyderabad	28 May, 2020
	• Webinar on "Indian Seed Spices: Quality, Challenges & Opportunities" organized by All India Spices Exporters Forum .	29 May, 2020
	• Webinar on "Ecology is the Stable Economy" Organized by IARI, New Delhi on the occasions of world environment day.	05 June, 2020
	• National webinar on Avenues in Horticulture in post COVID scenario, and deliver a lead lecture on Seed Spices - An Option for entrepreneurship, organizing by Collage of horticulture and forestry Jhalarapatan city, Jhalawar Rajasthan .	08 June, 2020
	• Meeting of the State Food Security Mission Executive Committee (SFSMEC) held under the Chairmanship of Principal Secretary, Agriculture and Horticulture at CR-2 Secretariat Jaipur.	15 June, 2020
	• 14 th Annual Review Meeting of MIDH programmes organised by DASD, Calicut	28-29 July, 2020
	• State Level Inter Departmental Work Group meeting under ATMA project at Agriculture Commissionerate, Jaipur, Rajasthan.	16 September, 2020
	• 78 th Hindi meeting Nagar Rajbhasa Karyanvayan Samiti, Ajmer.	23 September, 2020
	• Review meeting of Horticulture division Chaired by MOS Sh. Kalash Chodhary.	22-23 Sept, 2020
	• Plant Germplasm Registration Committee Meeting organizing by AICRP unit IISR Calicut	29-30 Sept, 2020



	<ul style="list-style-type: none"> • Webinar on "Establishing an Integrated Value Chain for Export of Seed Spices from Jodhpur - An Interface with Key Stakeholders". 	27 October, 2020
	<ul style="list-style-type: none"> • 28th meeting of Central Sub-Committee on Crop Standards, Notification and Release of varieties for Horticultural Crops. 	28 October, 2020
	<ul style="list-style-type: none"> • Meeting of Parliamentary committee on Official Languages at Vigyan Bhawan, New Delhi. 	31 October, 2020
	<ul style="list-style-type: none"> • Meeting of PPVFRA TASK FORCE on Fennel and Cumin on finding DUS guidelines. 	20 November, 2020
S.N. Saxena	<ul style="list-style-type: none"> • Meeting chaired by District Collector, Ajmer at Collectorate, Ajmer for discussing requirement of additional land for ICAR-NRCSS Ajmer in connection with pending issues of ICAR-NRCSS, Ajmer with state government. 	7th January 2020
	<ul style="list-style-type: none"> • Webinar on "Spices in the post-COVID scenario" organized by IISR Calicut through online system 	27th May, 2020
	<ul style="list-style-type: none"> • ICAR Regional Committee Meeting II (Afternoon Session) held on through Zoom meeting. 	8 October, 2020
Y.K. Sharma	<ul style="list-style-type: none"> • Global Potato conclave 2020 at Mahatma Mandir, Gandhinagar, Gujarat 	28-31 January 2020
	<ul style="list-style-type: none"> • Zoom meeting NABL Accreditation of ICAR Laboratories 	22 July, 2020
	<ul style="list-style-type: none"> • 14th Annual Review Meeting of MIDH programmes organised by DASD, Calicut . 	28-29 July, 2020
	<ul style="list-style-type: none"> • XXXI Workshop of AICRP on Spices at ICAR-IISR, Calicut through Virtual platform. 	29-30 Sept 2020
	<ul style="list-style-type: none"> • ICAR Regional Committee Meeting II (Afternoon Session) held on through Zoom meeting . 	8 October, 2020
	<ul style="list-style-type: none"> • National Webinar on Integrated Disease Management in Horticultural Crops organized by College of Horticulture, SDAU, Jagudan. 	22 October 2020
	<ul style="list-style-type: none"> • One District One Product Meeting at District Collectorate, Ajmer. 	24 November, 2020
Krishna Kant	<ul style="list-style-type: none"> • Webinar on Spices in the post- COVID scenario through online system at IISR, Calicut. 	27 May, 2020
O.P. Aishwath	<ul style="list-style-type: none"> • 'National Seminar on Landslide Mitigation and Slope Management' held at ICAR-IISWC, Regional Centre, Udhagamandalam, Tamil Nadu. 	28-29 February 2020



	<ul style="list-style-type: none"> • Webinar on Soil-Centric Green Revolution: A Paradigm Shift organized, by the Punjab Agricultural University (PAU), Ludhiana. 	19 August, 2020
	<ul style="list-style-type: none"> • International web conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2020) 	28-31 Dec, 2020
	<ul style="list-style-type: none"> • 29th National Web- Conference on Sustainable Soil and Water Management for Bio-diversity Conservation, Food Security and Climate Resilience during December 29 & 30, 2020 	29-30 Dec, 2020
S.S. Meena	<ul style="list-style-type: none"> • "Two Days District Level Farmers Seminar on" Krishko ki Aamdani Badane ke Privesh me Bijiye Masalon Ki Unnat Kheti" at KVK (CAZRI), Bhuj (Gujarat). 	29 Feb to 01 March, 2020
B.K. Mishra	<ul style="list-style-type: none"> • National webinar on boosting immunity through horticulture organized by SHRD, Ghaziabad (U.P.). • VAIBHAV SUMMIT - Agro-Economy & Food Security on session Theme - "Microbial Resources for Sustainable Agriculture" organized by ICAR- IARI, New Delhi. 	1-9 September, 2020 October, 2020
	<ul style="list-style-type: none"> • Meeting of Parliamentary committee on Official Languages at Vigyan Bhawan, New Delhi. 	31 October 2020
	<ul style="list-style-type: none"> • "Online National workshop on Intellectual Property Management in Agriculture" organized by ICAR-Indian Institute of Agricultural Biotechnology, Ranchi, Jharkhand. 	28 November, 2020
R.S. Meena	<ul style="list-style-type: none"> • National Webinar on "Entrepreneurship Opportunities in Agriculture for Migrant Workers in Covid-19", at KVK Anta, Baran Rajasthan. 	19th-20 June, 2020
	<ul style="list-style-type: none"> • Webinar on Improved Production Technologies in Black Pepper". 	27 August 2020
	<ul style="list-style-type: none"> • International Webinar on "DUS testing data management/Automation/Image Analysis". 	Oct 7, 2020
	<ul style="list-style-type: none"> • Webinar on Contemplative Perspectives on Seed: Conservation, Quality Assurance and Supply Systems. 	Sep 10, 2020
S. Choudhary	<ul style="list-style-type: none"> • Webinar on Spices in post - COVID scenario organized by IISR, Calicut. 	27 May, 2020
	<ul style="list-style-type: none"> • Webinar on "World Environment Day-2020" organized by NAHEP (ICAR) - CAAST, IARI, New Delhi. 	5 June, 2020
	<ul style="list-style-type: none"> • Webinar on "Agriculture: the back-bone of Indian Economy" organized by Pacific Academy of Higher Education and Research University, Udaipur, Rajasthan. 	2 July, 2020



	<ul style="list-style-type: none"> • National Conference on Agricultural Resource Management for Atmanirbhar Bharat"-2020 organized from 17th to 19th July, 2020 at College of Agriculture, Iroisemba, Manipur, India. 17-19 July, 2020 • International E-Conference on 'Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity' organised by the Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru during 24-27th November, 2020. 24-27 Nov, 2020.
M.D. Meena	<ul style="list-style-type: none"> • National Seminar on Spices: Emerging trends in production, processing and marketing at ICAR-CCARI, Old Goa. 21-22 January, 2020 • "Global Potato Conclave 2020" at Gandhinagar, Gujarat 28-31 January, 2020 • International Web-Conference on New Trend in Agriculture, Environmental and Biological Sciences for Inclusive Development 21-22 June, 2020 • National Webinar on "Recent Advances in Seed Spices Production" SK Dantiwara Agricultural University, Gujarat 4 August, 2020 • 28th Annual Conference of Agricultural Economics Research Association 16-18 Dec, 2020
A.K. Verma	<ul style="list-style-type: none"> • National Webinar on Awareness and Use of CeRA Resources through J-Gate Discovery Platform organized by Nehru Library, CCS Haryana Agricultural University, Hisar in Collaboration with Consortium for eResources in Agriculture (CeRA) DKMA-ICAR, New Delhi. 25 June 2020 • National Conference on Agriculture Resource Management for Atmanirbhar Bharat, organized by Central Agricultural University (CAU), Imphal, Manipir. 17-19 July 2020 • Video Lecture on National Accreditation Board for Testing and Calibration Laboratories (NABL) Accreditation of ICAR Laboratories organized by IP&TM Unit, ICAR Hqrs., New Delhi. 22 July 2020 • International E-Conference on "Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity" organized by the Department of Biotechnology and Crop Improvement, COH, UHS, Bengaluru 24-27 Nov, 2020
Shiv Lal	<ul style="list-style-type: none"> • Webinar organized by CHAI, New Delhi and Lt Amit Singh Memorial Foundation 21 May, 2020. • Webinar on spices in the post-COVID scenario" in conjunction with the Annual General Body meeting of the Indian Society for Spices 27 May 2020



	<ul style="list-style-type: none"> World environment day webinar 2020 organized by Centre for Environment Science and Climate Resilient Agriculture (CESCRA), Nuclear Research Laboratory Building, ICAR-Indian Agricultural Research Institute; New Delhi-110012 	5 June 2020
	<ul style="list-style-type: none"> International Web-Conference on "New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development (NTAEBSD-2020)" 	21-22 June, 2020
	<ul style="list-style-type: none"> Webinar on Agriculture Extension Priorities during COVID times organized RCRC, Buddha foundation and ICAR. 	3 July, 2020
	<ul style="list-style-type: none"> 92nd Foundation Day and Award Ceremony of the Indian Council of Agricultural Research 	16 July, 2020
	<ul style="list-style-type: none"> Video Lecture on NABL Accreditation of ICAR Laboratories organized by ICAR 	22 July, 2020
	<ul style="list-style-type: none"> National Webinar on "Recent advances in Seed Spices Production", organized by Sardarkrushinagar Dantiwada Agricultural University. 	4 August 2020
N. Choudhary	<ul style="list-style-type: none"> Webinar cum Panel discussion on Spices on Post Covid Scenario 	27 May, 2020
	<ul style="list-style-type: none"> Webinar on Post Pandemic (COVID-19) Challenges and Options in Agriculture including Horticulture, organised by ASM Foundation, New Delhi. 	28 May, 2020
	<ul style="list-style-type: none"> International Web-Conference on New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development held on 21-22 June, 2020 by online mode, organised by Agro Environmental Developmental Society, India. 	21-22 June, 2020
	<ul style="list-style-type: none"> Swachhata Workshop 	21 December, 2020

5.3 Education (students guided)

Name of the student	Degree/course	Title of project work	Name of university	Guide
Mr. Vinod Patel , Block Technology Manager, ATMA Project, Ahmadabad (Gujarat)	Certified Farm Advisor on Seed Spices (Cumin)	Management of Insect Pest (Aphid) and Disease (Blight) in Cumin	National Institute of Agricultural Extension Management (MANAGE), Hyderabad, Telangana	Dr. Krishna Kant, Principal Scientist and Mentor Scientist



6. Awards and Recognitions

6.1 Awards

Dr. S. N. Saxena, Principal Scientist (Plant Physiology) was admitted as fellow of Indian Society for Spices, Calicut, Kerala for outstanding research in seed spices

Dr. O.P. Aishwath, Principal Scientist (Soil Science) was awarded fellowship of Society for Scientific Development in Agriculture (SSDAT), for the dedicated effort and contribution in the field of soil science during "Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2020)" during 28-30 December, 2020.

Dr. B.K. Mishra, Principal Scientist (Micro Biology) was awarded fellow of Society for Horticultural Research and Development (SHRD), SD-70, Shastri Nagar, Ghaziabad-201002 (U.P.)

Dr. Sharda Choudhary, Senior Scientist (Bio Technology) was awarded fellow of Society for

Horticultural Research and Development (SHRD) for significant contribution in Horticulture Research and Development.

Dr. Shiv Lal, Senior Scientist (Horticulture) was awarded by Young Horticulturist Award-2020 conferred by Agro Environmental Development Society (AEDS) on the occasion of International Web-Conference on "New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development (NTAEBSID-2020)" held on 21-22 June, 2020 by online mode.

Dr. M.D. Meena, Scientist (Ag. Economics) was awarded by Young Scientist Award for contribution in field of Agricultural Economics by Agro Environmental Development Society (AEDS), Rampur, Uttar Pradesh during Web-Conference on New Trend in Agriculture, Environmental and Biological Sciences for Inclusive Development during 21-22 June, 2020.

6.2 Recognitions

- | | |
|-----------------|---|
| Dr. S.N. Saxena | <ul style="list-style-type: none">• Elected Vice President of Indian Society of Seed Spices, Ajmer• Acted as reviewer of journals (Journal of Food Processing and Preservation, Journal of essential oil Research, Journal of Essential Oil Bearing Plants, Legume Research and other journals)• Coordinator for Seed Spices Stakeholders Interface on Good Agricultural Practices (GAPs) for domestic and export promotion of clean and safe seed spices on 19 January, 2020 at ICAR-NRC on Seed Spices, Tabiji, Ajmer (Ra.)• Coordinator for Seed Spices Kisan Mela during at ICAR-NRCSS Ajmer of 15-16th February 2020. |
| Dr. Y.K. Sharma | <ul style="list-style-type: none">• Member of Monitoring Team of AICRP on Spices to monitor the AICRPS experiments on different centres. |



- Chair the session on Crop Protection on 30 September 2020 in XXXI Workshop of AICRP on Spices
 - Editor, Annual Report of ICAR-NRC on Seed Spices, Ajmer
 - Evaluated M.Sc. (Ag.) Plant Pathology Thesis of SK RAU, Bikaner.
 - Invited as Resource Person and delivered lecture on 'IDM in export oriented seed spices crops for higher quality' in Winter school on Good Agricultural Practices and Value Chain management in high value low volume horticultural crops from 1-21 February 2020 at ICAR- NRCSS, Ajmer.
- Dr. O.P. Aishwath
- Elected as a vice president of 'Soil conservation Society of India' for the year January 1, 2020 to December 2023.
 - Nominated and appointed as Councilor by the Indian society of soil survey and land use planning for the year 1999-2020 & 2020-2021.
 - Lead speaker in national conference: Invited as a lead speaker on "Landslide mitigation and sustainable slope management through bio-engineering of horticultural crops for three dimensional benefits" in 'National Seminar on Landslide Mitigation and Slope Management' held during 28th to 29th February 2020 at ICAR-IISWC, Regional Centre, Udhamandalam, Tamil Nadu.
 - Observer: for JET Exam conducted by AU Kota to observe smoothly conduction of exam at St. Joseph Sr Secondary School, Ajmer on 29.09.2020.
 - Chairman of the session: Soil contamination, Remediation and Management. During 29th National Web- Conference on Sustainable Soil and Water Management for Biodiversity Conservation, Food Security and Climate Resilience during December 29 & 30, 2020.
- Dr. Krishna Kant
- Elected as Secretary, Indian Society of Seed Spices, Ajmer
 - Appointed as Mentor Scientist for Certified Farm Advisor on Seed Spices by MANAGE, Hyderabad.
 - Editor, Annual Report of ICAR-NRC on Seed Spices, Ajmer
- Dr. S. S. Meena
- Course Coordinator for organizing 21 days Organized Twenty One days Winter School on "Good Agricultural Practices and Value Chain Management in High Value Low Volume Horticultural Crops" during 1-21 February, 2020 at ICAR-NRCSS, Ajmer (Raj.) Sponsored by Agricultural Education Division, ICAR, New Delhi.
- Dr. B.K. Mishra
- Member Academic Council of Bhagwant University, Ajmer and participated in three virtual academic council meetings held during 2020.
 - Editor, International Journal of Seed Spices, published by Indian Society of Seed Spices (ISSS), ICAR-NRC on Seed Spices, Ajmer-305206 (Raj.)
 - Fellow of Society for Horticultural Research and Development (SHRD), SD-70, Shastri Nagar, Ghaziabad-201002 (U.P.)



- Chief Editor, Annual Report of ICAR-NRC on Seed Spices, Ajmer
 - Course Co-coordinator for organizing 21 days ICAR- Winter school on Good Agricultural Practices and Value Chain Management in High Value Low Volume Horticultural Crops during 1 to 21 Feb, 2020 at ICAR-NRCSS, Tabiji, Ajmer.
 - Co-coordinator for Seed Spices Stakeholders Interface on Good Agricultural Practices (GAPs) for domestic and export promotion of clean and safe seed spices on 19 January, 2020 at ICAR-NRC on Seed Spices, Tabiji, Ajmer (Raj.)
- Dr. R.S. Meena
- Programme coordinators for capacity building program on organic production technology of seed spices for NEH region at ICAR-NOFRI on 30-31 January 2020
- Dr. S. Choudhary
- Excellence Award as reviewer of Indian Journal of Agricultural Research, ARCC journals.
- Dr. Shiv Lal
- Editor, Masala Surabhi Magazine (Hindi)
- Dr. M.D. Meena
- Editor, International J. Seed Spices
- Dr. A.K. Verma
- Best Oral Presentation Award for presenting a research paper on "Enhancement of genetic resources for higher yield and quality in seed spices through induced mutagenesis" In: National Conference on Agriculture Resource Management for Atmanirbhar Bharat, organized by Central Agricultural University (CAU), Imphal, Manipur during 17-19 July 2020.
 - Editor, Masala Surabhi Magazine (Hindi)
 - Editor, International Journal of Seed Spices
 - Course Coordinator for organizing 21 days Organized Twenty One days Winter School on "Good Agricultural Practices and Value Chain Management in High Value Low Volume Horticultural Crops" during 1-21 February, 2020 at ICAR-NRCSS, Ajmer (Raj.) Sponsored by Agricultural Education Division, ICAR, New Delhi.
- Dr. N. Choudhary
- Co-convener of seed spice farmers fair and Sangoshthi-2019 organised on 15-16, Feb. 2020 at ICAR-NRCSS, Ajmer.
 - Editor, Annual Report of ICAR-NRC on Seed Spices, Ajmer



7. Linkages and Collaborations

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

MOU Signed with SAUs / Institutes

- Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan and ICAR-NRCSS, Ajmer for mutual cooperation in agricultural research, education and extension in area of seed spices on 27 July 2020 at Udaipur.
- Sri Karan Narendra Agriculture University, Jobner, Rajasthan and ICAR-NRCSS, Ajmer for mutual cooperation in agricultural research, education and extension in area of seed spices on 25 August 2020 at Jobner, Jaipur.
- Dayanand Collage, Ajmer, Rajasthan and ICAR-NRCSS, Ajmer for mutual cooperation in agricultural research, education and extension in area of seed spices.
- Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu and ICAR-NRCSS, Ajmer for mutual cooperation in agricultural research & education in area of seed spices).
- All India Coordinated Research Project on Spices (AICRP), Calicut, Kerala.
- Central Agricultural University, Campus, Pasighat, Arunachal Pradesh.
- Collage of Horticulture and Forestry, Jhalawar, Rajasthan.
- Directorate of Arecanut and Spices Development (DASD), Calicut, Kerala.
- Farmers, NGOs and Traders.
- ICAR-ATARI, Barapani, Meghalaya. ICAR-ATARI, Jodhpur, Rajasthan.
- ICAR-Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan.
- ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana.
- ICAR-Central Institute of Sub-Tropical Institute (CISH), Lucknow, Uttar Pradesh.
- ICAR-Central Institutes of Arid Horticulture (CIAH), Bikaner, Rajasthan.
- ICAR-Central Plantation Crop Research Institute, Regional Station, Kahikuchi, Guwahati, Assam.
- ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh.
- ICAR-Central Sheep and Wool Research Institute, Avikanagar, Tonk, Rajasthan.
- ICAR-Central Soil Salinity Research Institute (CSSRI), Karnal, Haryana.
- ICAR-CPRI, Regional Station, Upper Shillong,



- Meghalaya. ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat.
- ICAR-Indian Agricultural Research Institute, Pusa, New Delhi and its regional centres.
 - ICAR-Indian Institute of Farming Systems Research, Modipuram, Uttar Pradesh.
 - ICAR-Indian Institute of Horticultural research (IIHR), Bengaluru.
 - ICAR-Indian Institute of Spices Research (IISR), Calicut, Kerala.
 - ICAR-National Bureau of Agriculturally Important Micro-organism, Mau, Uttar Pradesh.
 - ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi.
 - ICAR-National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur, Maharashtra.
 - ICAR-National Research Centre on Grapes, Pune, Maharashtra.
 - ICAR-NRC for Orchids, Pakyong, Sikkim.
 - ICAR-Protection of Plant Varieties and Farmers Right Authority (PPVFRA), Govt. of India, New Delhi.
 - ICAR-Spices Board, Cochin, Kerala.
 - KVKs: Ajmer, Anta, Banswara, Barmer, Bundi, Chomu, Dungarpur, Gudamalani, Jalore, Jhunjhunu, Jhalawar, Kota, Nagaur, Pokhran, Pali & Pratapgarh.
 - SAU's: i.e. SKRAU, Bikaner; MPUA&T, Udaipur; SKN Agriculture University, Jobner; Kota Agricultural University, Kota; Jodhpur Agricultural University, Jodhpur; SDAU, Dantiwara; CCSHAU, Hisar; PAU, Ludhiana, SKUAT, Sri Nagar; APHU, Hyderabad; UAS, Dharwar and NDUAT, Faizabad.
 - State Agriculture Department of Rajasthan and Gujarat.



8. Publications

International Journals

1. Asangi, H., Saxena, S.N., Kattimani, K.N., Kulkarni, M.S., Kotikal, Y.K., Mastiholi, A.B., Jameel Jhalegar, M.D. and Siddappa, R. (2020). Genetic variation in essential oil constituents of ajwain (*Trachyspermum ammi* L. Sprague) varieties at varying nitrogen levels under semiarid tropics of northern Karnataka, India. *Journal of Essential Oil Bearing Plants*, 23:6, 1324-1333.
2. Choudhary, S., Mahantesha, Naika, B.N. and Meena R.D. (2020). Identification and expression analysis of candidate genes associated with stem gall disease in Coriander (*Coriandrum sativum* L.) Cultivars. *Molecular Biology Reports* <https://doi.org/10.1007/s11033-020-05630-0>.
3. Mishra, B.K., Saxena, S.N., Kant, K. (2020). Abiotic stress tolerance in horticultural crops by phytobeneficial microbial inoculants: a review. *MOJ Food Process Technology*. 8(4):126-130. DOI: 10.15406/mojfpt.2020.08.00252.
4. Barolia, S.K., Mishra, B.K., Tripathi, G.K., Hindala, M.R. and Sewda, M. (2020). Patent application procedure and preparation for filing in India. *International J. of Creative Research Thoughts*, 8(10): 2098-2108.
5. Choudhary, S., Barolia, S.K., Sharma, R., Krishnan, R.S.R., Hindala, M.R. and Sewda, M. (2020). Gene silencing in horticultural transgenic plants: mechanism, technologies and application in horticultural crops. *Int. J. Curr. Microbiol. App. Sci.*, 9(11):1040-1052.
6. Dubey, P.N., Lal, G., Meena, S.S., Saxena, S.N., Sharma, Y.K. and Kant, K. (2020). Performance and residue status of some selected pesticides in cumin cultivation. *International J. Seed Spices*, 10(1):16-19.
7. Kant, K., Sharma, Y.K., Meena, S.S., Mishra, B.K., Saxena, Lal, G. and Meena, S.R. (2020). Technology dissemination and adoption for pest and diseases management in cumin at farmers field through non chemical methods. *International J. Seed Spices*, 10(2):31-34.

National Journals

1. Aishwath, O.P. and Lal, R. (2020). Soil compaction and wetness effects on efflux of greenhouse gases. *Journal of Soil Water Conservation*, 19(3): 244-253. DOI: 10.5958/2455-7145.2020.00033.86.
2. Aishwath, O.P., Mehta, R.S. and Lal, G. (2020). Effects of in-situ composted seed spices residues on growth, yield, nutritional parameters and seasonal carbon offset by anise crop. *International J. Seed Spices*, 10(1):39-46.
3. Balasubramanian, S., Kumar, R., Roselin, P., Saxena, S.N. and Singh K.K. (2020). Determination of thermal properties of ambient and cryoground black pepper. *International J. Seed Spices*, 10(1):76-83.
4. Kant, K., Sharma, Y.K., Mishra, B.K., Saxena, S.N., Meena, N.K. and Meena, S.R. (2020). Farmers level adoption of eco-friendly plant protection techniques for Seed Spice crop. *Ann. Pl. Protec. Sci.*, 28(3):216-219.
5. Lal, G., Choudhary, N., Lal, S., Saxena, S.N., Shekhawat, N. and Choudhary, M.K. (2020). Effect of different drying methods on essential



- oil contents and composition of Lemongrass (*Cymbopogon citratus*). *International J. of Seed Spices*, 10(2): 25-30.
10. Lal, G., Choudhary, M.K., Lal, Shiv, Meena, R.S. and Shekhawat, Neha. (2020). Growth, yield and essential oil of coriander (*Coriandrum sativum* L.) variety ACr-2 as influenced by various nutrient levels and crop geometry. *International Journal of Chemical Studies* 8(4): 2749-2752.
 11. Lal, G., Meena, N.K., Meena, R.S. and Bhati, B.S. (2020). Impact of technological interventions on performance of coriander through FLDs in TSP area of Banswara. *International J. Seed Spices*, 10(1): 20-26.
 12. Lal, G., Meena, N.K., Meena, R.S. and Kannoja, Y. (2019). Impact of technological interventions of seed spices through FLDs in TSP area of Pratapgarh-A success story *International J. Seed Spices*, 9(2): 1-5.
 13. Lal, G., Meena, S.S. and Lal, S. (2020). Nigella (*Nigella sativa* L.), a novel herb can cure many diseases: A review. *International J. Seed Spices*, 10(1): 1-10.
 14. Maloo, S.R., Sharma, R.S., Jain, D., Choudhary, S. and Soan, H. (2020). Assessment of genetic diversity in fenugreek (*Trigonella foenum-graecum*) genotypes using morphological and molecular markers. *Indian Journal of Agricultural Sciences*, 90(1): 25-30.
 15. Meena, B.S., Indoria, D., Meena, R.D. and Meena, S.S. (2020). Inter-relation between spices and chronic diseases: A Review. *International J. Seed Spices*, 10(1): 65-72.
 16. Meena, M.D., Lal, G. and Meena, S.S. (2020). Market arrivals and price behaviour of coriander seeds in Rajasthan, India. *International J. Seed Spices* 10(1): 27-38.
 17. Meena, M.D., Lal, G., Khan, M.A., Meena, R.S., Meena, R.D., Meena, S.S. and Mishra, B.K. (2020). Cumin and coriander cultivation: An economic analysis. *International J. Seed Spices*, 10(2): 74-79.
 18. Meena, R.D., Lal, G., Meena, S.S., Meena, N.K., Chaudhary, N. and Meena, N.L. (2020). Soil borne diseases and their organic management in cumin: A review. *International J. of Seed Spices*, 10(2): 65-73.
 19. Meena, R.D., Meena, R.S., Sharma, Y.K., Meena, S.S. and Meena, N.L. (2020). Response of fenugreek varieties against *Rhizoctonia solani*, causing root rot *International J. Seed Spices* 10(1): 73-75.
 20. Meena, R.S., Lal, G., Meena, N.K. and Mali, S.C. (2019). Variability and character association in fennel (*Foeniculum vulgare* Mill.) germplasm. *International J. Seed Spices*, 9(2): 29-36.
 21. Meena, R.S., Verma, A.K., Meena, N.K., Ahari, A., Balai, S.R. and Mali, S.C. (2019). Variability and correlation studies for yield and yield contributing traits in fennel (*Foeniculum vulgare* Mill.) germplasm. *International J. Seed Spices*, 9(2): 67-72.
 22. Meena, S.S., Lal, G., Sharma, Y.K., Meena, M.D. and Lal, S. (2020). Effect of spacing and fertilizer levels on growth, yield and yield attributes of different ajwain (*Trachyspermum ammi* L.) genotypes. *International J. Seed Spices*, 10(1): 47-51.
 23. Meena, S.S., Lal, G., Sharma, Y.K., Lal, S., Meena, R.D. and Meena, M.D. (2020). Genetic divergence and character association analysis based on growth, yield and yield contributing traits in ajwain. *International J. Seed Spices* 10(2): 46-50.
 24. Mishra, B.K. and Barolia, S.K. (2020). Quality assessment of microbial inoculants as biofertilizer. *International Journal of Current Microbiology and Applied Science*, 9(10): 3715-3729. doi: <https://doi.org/10.20546/ijcmas.2020.910.428>.
 25. Mishra, B.K., Sharma, Y.K., Kant, K., Saxena, S.N. and Lal, G. (2020). Studies on molecular



identification of endorhizobacteria isolated from Fenugreek (*Trigonella foenum-graecum* L.). *Annals of Plant Protection Science*, 28(2): 138-141. doi: 10.5958/0974-0163.2020.00037.3.

26. Mishra, B.K., Sharma, Y.K., Kant, K., Saxena, S.N. and Lal, G. (2020). Abiotic stress tolerance of native *Rhizobium meliloti* strain and its effect on fenugreek (*Trigonella foenum-graecum* L.) growth under saline condition. *International J. Seed Spices*, 10(1):89-92.
27. Saxena, S.N., Vyas, D. and Kakani, R.K. (2020). Evaluation of fenugreek (*Trigonella foenum-graecum* L.) genotypes under limited moisture stress conditions. *International J. Seed Spices*, 10(1):56-64.
28. Sharma, A., Chaudhary, N., Sharma, R. and Anjanawe, S. (2020). Multi storied cropping system in horticulture - An approach for more crop per unit area of land. *Journal of Pharmacognosy and Phytochemistry SP* (6): 25-28.
29. Sharma, M., Choudhary, S., Gupta, S.K., Meena, R.S., Meena, R.D., Lal, G., Jatwa, R., Chauhan, V.B.S. and Verma, A.K. (2020). Estimation of morphological and molecular variability in induced mutant fennel lines. *Journal of Agri. Search* 7(1):1-7. Doi:10.21921/jas.v7i01.17625.
30. Singh, R. and Choudhary, S. (2020). Off-season leafy coriander production technology under shade net covered tunnels. *Indian Farming* 70(05):28-31.
31. Verma, A.K., Reddy, K.S., Dharsekar, P., Solanki, R.K., Chauhan, V.B.S. and Singh B. (2020). Determination of gamma rays radiation dose and their effect on fennel (*Foeniculum vulgare* Mill.) seed germination and seedling growth. *Research Journal of Biotechnology*, 15 (8): 99-105.

Other Research Publications

1. Mir, J.J., Jan, A., Rashid, M., Singh, D.B., Raja, W.H.,

Sharma, O.C., Sharma, A., Lal, S., Kumawat, K.L., Nabi, S.U. and Lal, C. 2020. Genetic diversity in various morphological and quality traits in apple. *Indian Journal of Horticulture*, 77(22): 227-236.

2. Chaudhary, N., Sindhu, S.S., Kumar, Ramesh, Saha, T.N., Raju, D.V.S., Arora, Ajay, Sharma, R.R. and Sharma, Asheesh (2020). Evaluation of LA hybrids and oriental lilies under protected and open conditions. *Journal of Pharmacognosy and Phytochemistry SP* (6): 156-160.
3. Paroda, R.S. and Lal, G. (2020). Motivating and attracting youth in agriculture for sustainability: An overview. *International J. of Seed Spices*, 10(2): 01-11.
4. Verma, M.K., Sharma, V.K., Lal, S., Mir, J.J., Sofi, A.A., Singh, D.B., Pandit, A.H., Mir, M.A., Mir, A. and Bhat, H.A. 2020. Quality profiling of Indian walnut (*Juglans regia*) from Kashmir valley. *Indian Journal of Agricultural Sciences* 90(3):573-576

Books/Compendium/Manuals/Bulletins

1. Lal, G., Meena, S.S., Dubey, P.N., Lal, S. and Meena, M.D. (2020). Seed Spices. Published by Daya Publishing House (ASTRAL), New Delhi (India) ISBN 978-93-89605-85-3(HB): pp1-188.
2. Lal, G., Meena, S.S., Mishra, B.K., Meena, M.D. and Verma, A.K. (2020). Winter School on Good Agricultural Practices and Value Chain Management in High Value Low Volume Horticultural Crops (1-21 Feb., 2020). Published by Director, ICAR-NRCSS, Ajmer. pp 1-270.
3. Lal, G., Saxena, S.N., Kant, K., Mishra, B.K., Dubey, P.N. and Verma, A.K. (2020). Facets of Good Agricultural Practices for domestic and export promotion of clean and safe seed spices. Published by Director, ICAR-NRC on Seed Spices, Ajmer (India). ISBN:978-81-89435-58-5. pp1-116.



4. Meena, S.S., Lal, G. and Lal, S. (2020). A Medicinal and Therapeutic Property of Seed Spices. Published by Director, NRCSS, Ajmer, pp-1-44
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Popular article/technical article

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17. Saxena, S.N. (2020). Delivered lecture on "Cryogenic grinding of spices for preserving flavour and medicinal properties" during Seed spices stakeholders meeting held on 19th January 2020 at ICAR-NRCSS, Ajmer.
18. Saxena, S.N. (2020). Delivered lecture on Advances in Production Technologies and Crop Improvement of Seed Spices at College of Agriculture, Tripura, Agartala during farmers training on 25th February, 2020.
19. Verma, A.K., Dhanasekar, P. and Lal, G. (2020). Enhancement of genetic resources for higher yield and quality in seed spices through induced mutagenesis. In: National Conference on Agriculture Resource Management for Atmanirbhar Bharat, organized by Central Agricultural University (CAU), Imphal, Manipur during 17-19 July 2020.

9. RAC/IRC/IMC Meetings

RAC Meeting

Research Advisory Committee of ICAR- National Research Centre on Seed Spices (NRCSS) Tabiji, Ajmer was held during 19th of the September, 2020. This was the 3rd and final meeting of VI RAC was held under chairmanship of Dr. B.S. Chundawat, Ex. Vice-Chancellor, SDAU Sardar Krishinagar, Dantiwada, Gujarat. The following members were present in the meeting: Dr. S. Amarendra Reddy, Ex. Director (Extension) (online), Dr. YSR Hortl. University (AP), Dr. K.V. Ramana (online), Former ADG (Hort.), ICAR, New Delhi, Dr. I.S. Singh (online), Ex. Professor, PHT, NDUAT, Faizabad, Dr. Vikramaditya Panday (online), ADG (HS-1), ICAR, New Delhi, Dr. V. Srinivasan (online), Principal Scientist, ICAR-IISR, Calicut, Dr. Ram Avtar 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). Looking to the situation of Covid-19 and travel restriction five members of RAC committee attended the meeting through online, while Chairman, RAC and four member including member secretary, physically attended the meeting on given date.

The meeting started with the welcome address by Dr. G. Lal, Director, ICAR-NRCSS, Ajmer. He welcomed the Chairman, RAC and all distinguished members and presented the highlights of the various research activities under crop improvement, crop production, crop protection, basic sciences, value addition, TSP and NEH projects and extension activities through social sciences. He also briefed the esteemed committee about the research achievements in crop improvement of seed spices

(under which 03 varieties has been notified and 02 varieties identified in the AICRP on spices workshop 2019 held at TNAU, Coimbatore.) Transfer of the technology, post harvest activities and strategies to overcome the future challenges for seed spices.

Hon'ble Chairman Dr. B.S. Chundawat in his opening remarks asked the scientists to do research on the basis of field level surveys/ feedback of farmers and problems faced by the growing community. He expressed his satisfaction on new research initiatives on the basis of previous



recommendations of RAC. He also suggested that the institute should properly address the mandate and objectives in appropriate manner to solve the problems of farming community. He also emphasized on the need of quality production and value addition in seed spices. Dr. Krishna Kant, Member Secretary, presented the action taken report of the 2nd meeting of VI- RAC which was held during 14-15 May, 2019 under the Chairmanship of Dr. B.S. Chundawat. The suggestion was approved by the council and implemented the various recommendations in different research programme of the institute.



Presentation during RAC of ICAR-NRCSS, Ajmer

Recommendation of the RAC

1. Minimum standards of varietal release should be fixed with respect to crop duration, quality parameters, disease/insect pest resistance traits and yield.
2. Survey may be conducted extensively to understand the limitations faced by farmers for cultivation of seed spices and research programme may be formulated especially targeting these constraints in order to boost the production. It should be a continuous process.
3. Seed spice specific nutrient mixtures, late germination issue and pollination management should be tackled in farmers prospective and recommendation should be according to soil analysis report/soil health card.
4. Initiate development of screening techniques for diseases in important seed spice crops (cumin, coriander, fennel and fenugreek).
5. The possibilities to extend the cultivation of these crops in non conventional areas like NEH and Leh- Laddakh region with Inter Institutional collaborations may be explored.

Institute Research Council (IRC) Meeting

The XX Institute Research Council (IRC) meeting of ICAR- NRCSS, Ajmer was held under the chairmanship of Dr. Gopal Lal, Director during 25-26

Sept., 2020 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. In the wake of COVID-19, XX Institute Research Council (IRC) meeting of NRCSS, Ajmer was conducted by online mode. Technical sessions were conducted section wise. Scientists of respective section were present physically during presentation of their session and other scientists and technical officers joined the meeting by online mode. 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 XIX 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 was presented by individual scientist working in different sections i.e., Crop Improvement and Basic Sciences, Crop Production, Crop Protection and Social Sciences. The progress of each projects were reviewed and thoroughly discussed in the house. The meeting ended with the formal vote of thanks proposed by I/c PME Cell to the chair and all members.





10. Distinguished Visitors

Sr. No.	Name	Designation	Date of visit
1	Dr. A.K. Singh	DDG (Horticulture Science), ICAR, New Delhi	19.01.2020
2	Dr. Homey Cheriyan	Director, DASD, Calicut Kerala	19.01.2020
3	Sh. R.K. Menon	President, World Spices Organization, Ernakulum, Kerala	19.01.2020
4	Dr. P.K. Rai	Director, ICAR- DRMR, Bharatpur	19.01.2020
5	Dr. Raghavendra Singh	Director, ICAR- CSWRI, Avikanagar, Tonk	19.01.2020 & 15.02.2020
6	Dr. R.K. Sawal	Director, ICAR- NRCC, Bikaner	19.01.2020 & 15.02.2020
7	Sh. Bhagirath Choudhary	Member of Parliament, Ajmer	15.02.2020
8	Sh. Vasudev Devnani	MLA, Ajmer	15.02.2020
9	Smt. Anita Bhadel	MLA, Ajmer	15.02.2020
10	Dr. L.N. Harsh	Former VC, Agriculture University, Jodhpur	04.09.2020
11	Shri Parshottam Rupala	Union Minister of State for Panchayati Raj, Agriculture and Farmers Welfare	02.06.2020 & 03.07.2020
12	Dr. R.S. Paroda	Former DG ICAR and Secretary DARE, GOI and Chairman, TAAS, New Delhi.	24.07.2021



11. Ongoing Research Projects

S.no. Sub-Projects

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

- 1 CI/19.1.1: Management of plant genetic resources of seed spices
(PI: R.S. Meena; Co-PI: S.N. Saxena, S.S. Meena, A.K. Verma and N.K. Meena; 2019-24)

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.D. Meena; 2015-20)
- 4 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; 2014-20)
- 5 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)
- 6 CI/15.2.3: Identification of molecular marker associated with stem gall in coriander
(PI: S. Choudhary; Co-PI: R.D. Meena; 2015-20)
- 7 CI/16.2.1: Breeding for dwarfism and *Ramularia* blight resistance /tolerance in fennel
(PI: R.S. Meena; Co-PI: R.D. Meena, S. Choudhary, N. K. Meena and S.N. Saxena; 2016-21)
- 8 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 and Ravi Y. (on study leave); 2016-21)
- 9 CI/18.2.1: Genetic improvement of cumin for higher yield and wilt resistance
(PI: A.K. Verma; Co-PI: Y.K. Sharma; 2018-22)
- 10 CI/18.2.2: Screening of fennel and cumin genotypes for salinity stress
(PI: S.N. Saxena; Co-PI: Ravi Y. (on study leave), O.P. Aishwath and R.S. Meena; 2018-21)
- 11 CI/18.2.3: Transcriptome-based mining of genes and pathways related to disease (*Ramularia* blight) and quality (secondary metabolites) in fennel
(PI: S. Choudhary; Co-PI: A.K. Verma, P.N. Dubey, M.B.N. Naika; 2018-21)

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

- 12 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)
- 13 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 and S. Choudhary; 2016-21)
- 14 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 and Shiv Lal; 2016-21)
- 15 CPd/17.3.1: Bioprospecting multitrait bacteria with abiotic stress tolerance from cumin and coriander soil
(PI: B.K. Mishra; 2017-20)
- 16 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)
- 17 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. (on study leave); 2017-22)
- 18 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; 2017-20)
- 19 CPD/18.3.1: Seed spices based cropping system for sustainable livelihood security
(PI: Narendra Choudhary; Co-PI: R. Singh, M.D. Meena and Shiv Lal; 2018-23)

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

- 20 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)
- 21 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)
- 22 CPt/17.4.3: Biological management of Alternaria blight in cumin (*Cuminum cyminum*)
(PI: R.D. Meena; Co-PI: B.K. Mishra; 2017-20)
- 23 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 and M.D. Meena; 2017-21)
- 24 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)



- 25 Cpt/19.4.1: Survey and surveillance of seed spices diseases
(PI: R.D. Meena; Co-PI: Y.K. Sharma and M.D. Meena; 2019-24)

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

- 26 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; 2017-20)
- 27 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; 2017-20)
- 28 BS/18.5.1: Development of value chain for fennel
(PI: Shiv Lal; Co-PIs: G. Lal, S.N. Saxena and B.K. Mishra; 2018-23)
- 29 BS/19.5.1: Plant extracts analysis of seed spices for bioactive phytochemicals and its utilization in developing health promoting Nutraceutical products
(PI: S.N. Saxena; Co-PI: B.K. Mishra and Shiv Lal; 2019-22)

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

- 30 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)
- 31 SS/18.6.1: Dissemination of seed spices production, protection and post-harvest under TSP and NEH region
(PI: G. Lal; Co-PI: N.K. Meena, R.S. Meena, Shiv Lal and M.D. Meena; 2019-2024)

New Sub-Project Proposals

S. No. Sub-Project

1. Breeding for high yield and quality in ajwain (*Trachyspermum ammi* L.) and nigella (*Nigella sativa* L.)
(PI: S.S. Meena; Co-PIs: Y.K. Sharma, M.D. Meena, N. Chaudhary and N.K. Meena; 2020-25)
2. Biopriming in seed spices (coriander, cumin, fennel and ajwain) for enhanced seedling growth and yield
(PI: B.K. Mishra; Co-PIs: S.N. Saxena, Y.K. Sharma and Krishan Kant; 2020-23)
3. Resiliency assessment of minor seed spices (ajwain, nigella and celery) to edapho-climatic stresses for sustained production
(PI: O.P. Aishwath; Co-PI: Shiv Lal, Vasundhara Sharma and Chetan Kumar Jangid; 2020-25)



4. Studied of new botanical formulations on insect-pest management in seed spices
(PI: Krishan Kant; Co-PI: B.K. Mishra and S.R. Meena; 2020-23)
5. Development of IPM strategies to combat pests complex of fenugreek
(PI: N.K. Meena; Co-PIs: Krishan Kant, Shiv Lal and S.R. Meena; 2020-24)
6. Development of process technologies for seed spice waste based fortified products for product diversification
(PI: Shiv Lal; Co-PI: S.N. Saxena, O.P. Aishwath and B.K. Mishra; 2020-25)
7. Marketing and value chain analysis of major seed spices
(PI: M.D. Meena; Co-PI: B.K. Mishra, Krishna Kant and S.S. Meena; 2020-2023)

ICAR-Network/Platform Research Projects

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

External Funded Projects

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

12. Other Informations

राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, तबीजी, अजमेर ने 20वें स्थापना दिवस पर हितधारक इंटरफेस बैठक का आयोजन किया।

राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, तबीजी, अजमेर द्वारा 19 जनवरी, 2020 को 20वां स्थापना दिवस मनाया गया। इस अवसर पर भारतीय कृषि अनुसंधान परिषद् के उप महानिदेशक (बागवानी) डॉ. ए.के. सिंह मुख्य अतिथि के रूप में सम्मिलित हुए तथा श्री आर.के. मेनन, अध्यक्ष, डब्ल्यूएसओ, डॉ. होमी चेरियन, निदेशक, डीएसडी, डॉ. राघवेंद्र, निदेशक, भंड एवं ऊन अनुसंधान संस्थान, अहिलानगर, डॉ. आर.के. सावल, निदेशक, ऊट अनुसंधान केंद्र, बीकानेर, डॉ. पी.के. राय, निदेशक, सरसों अनुसंधान निदेशालय, भरतपुर विशिष्ट अतिथि थे। समारोह में संस्थान के वैज्ञानिक एवं अन्य कर्मचारियों के अलावा कृषि विज्ञान केंद्र के परियोजना समन्वयक डॉ. डी.एस. मटी, कंवीकं, अंता, डॉ. डी.के. सिंह, प्रभारी, कंवीकं, अंता, कंवीकं, बाइमेर के वैज्ञानिक, प्रगतिशील किसान, बीजीय मसाला से जुड़े व्यापारी, हितधारक उपस्थित रहे। इसके अलावा आई.टी.सी., नेड स्प्राइसेस इत्यादि के प्रतिनिधि समारोह में सम्मिलित हुए। पधारें हुए मुख्य अतिथि एवं विशिष्ट अतिथि ने केंद्र के अनुसंधान प्रक्षेत्र का भ्रमण

किया तथा संस्थान के वैज्ञानिकों से विचार विमर्श करते हुए केंद्र द्वारा किये जा रहे अनुसंधान कार्य के बारे में जानकारी ली तथा अब तक हुई प्रगति पर प्रशंसा की तथा भविष्य में किए जाने योग्य अनुसंधान कार्यों की परिचर्चा भी की। मुख्य अतिथि डॉ. ए.के. सिंह ने केंद्र में स्थित आईटीएमयू इकाई के संग्रहालय, प्रदर्शनी स्टालों का उद्घाटन किया।

संस्थान के निदेशक डॉ. जी. लाल ने सभी अतिथियों का स्वागत किया तथा केंद्र द्वारा अर्जित विभिन्न उपलब्धियों का विवरण सभी अतिथियों के सम्मुख रखा। उन्होंने अपने स्वागत भाषण में मुख्य अतिथि एवं विशिष्ट अतिथियों का सक्षिप्त जीवन परिचय भी सभी के सम्मुख प्रस्तुत किया। सभी विशिष्ट अतिथियों ने 20वें स्थापना दिवस के अवसर पर राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र के सभी कर्मचारियों को बधाई देते हुए अपनी शुभकामनाएं व्यक्त की। मुख्य अतिथि डॉ. ए.के. सिंह ने 20वें स्थापना दिवस उद्बोधन में बताया कि हमें अपने भूतकाल के कार्यों का लेखा-जोखा कर आत्म चिंतन एवं वैज्ञानिक मंथन के माध्यम से भविष्य के लिए नई रूप तैयार करना है। उन्होंने कहा कि 21वीं सदी में वैज्ञानिक प्रगति की दर सर्वाधिक है और जिसे फलस्वरूप हमें नई उभरती चुनौतियों का सामना करने की शक्ति नवीन दृष्टिकोण से





अनुसंधान करने पर ही मिलेगी। भविष्य में किसानों को उत्कृष्ट कृषि क्रियाओं को वृहद पैमाने पर अपनाना पड़ेगा, क्योंकि जलवायु परिवर्तन एवं बढ़ती हुई शहर जनसंख्या को खाद्य सुरक्षा सुनिश्चित करने के लिए हमें "न्यूनतम आगमों से अधिकतम उत्पाद" के अन्तर्गत कृषि उत्पादन कार्य करना होगा। किसानों को आर्थिक सुरक्षा में केवल बीजीय मसाला उत्पादन ही नहीं अपितु उनकी गुणवत्ता के साथ-साथ प्रसंस्करण को भी सम्मिलित किया गया है। इसके साथ-साथ विश्व बाजार में प्रतिस्पर्धा हेतु हमें सतत तैयारी करनी पड़ेगी। इसी कार्यक्रम के अंतर्गत संस्थान के विभिन्न वैज्ञानिक प्रकाशनों का विमोचन किया गया। संस्थान के वैज्ञानिकों एवं कर्मचारियों डॉ. एस.एस. मीणा, डॉ. एन.के. मीणा, डॉ. अरविन्द वर्मा, श्री जी.के. त्रिपाठी, श्री प्रदीप कुल्लारी एवं श्रीराम बलाई को प्रोत्साहन हेतु प्रशस्ति-पत्र एवं प्रक्षेत्र कार्मिकों को नकद पुरस्कार मुख्य अतिथि द्वारा प्रदान किया गया। आज भारत में बागवानी फसलों का कुल उत्पादन अन्न उत्पादन से ज्यादा हो रहा है जिसमें हमारे कृषि वैज्ञानिकों एवं देश के नीति निर्माताओं का विशेष योगदान रहा है एवं इसके फलस्वरूप हमने खाद्य सुरक्षा के दिशा में जैव तकनीकी, जलवायु परिवर्तन, स्मार्ट पोशक एवं जलप्रबंधन के साथ-साथ फसल की विभिन्न अवस्थाओं को ध्यान में रखते हुए उन्नत शस्य क्रियाएं अपनायी होगी।

इस अवसर पर बीजीय मसालों हितधारकों की इन्टरफेस परिधर्षा हुई, जिसमें डॉ. गोपाल लाल, निदेशक, डॉ. कृष्ण कांत एवं डॉ. एस.एन. सक्सेना द्वारा प्रस्तुतिकरण किया गया तथा हितधारकों के आंकाओं का समाधान भी किया गया।



इस इन्टरफेस सत्र के अध्यक्ष डॉ. ए.के. सिंह, उप-महानिदेशक, भा.कृ.अनु.प., नई दिल्ली द्वारा अनेक महत्वपूर्ण सुझाव हितधारकों एवं संस्थान के वैज्ञानिकों को दिया गया जिसमें अन्तर्राष्ट्रीय/राष्ट्रीय स्तर के शोधपत्रों/लेखों के प्रकाशन द्वारा बौद्धिक सम्पदा अधिकार संरक्षण पर विशेष बल दिया। डिजिटल मास मीडिया के माध्यम से किसानों तक संस्थान की उपलब्धियों को पहुँचाने की महत्ता बतायी। इस इन्टरफेस बैठक का प्रायोजन एम.आई. डी.एच. परियोजना के अंतर्गत, सुपारी एवं मसाला विकास निदेशालय, कालीकट एवं राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर द्वारा संयुक्त रूप में किया गया। कार्यक्रम के अंत में धन्यवाद ज्ञापन डॉ.एस.एन. सक्सेना द्वारा किया गया।

Celebration of Birth anniversary of Dr. Bhimrao Ramji Ambedkar on 14th April 2020

Looking to the countrywide lockdown due to Covid-19 pandemic, it was suggested to observe and read the preamble of constitution of India and constitution duties along with family members in their respective homes while maintaining social distance and other prescribed protocols during the process. Dr. Gopal Lal, Director, NRCSS, Dr. S. N. Saxena, Principal Scientist, NRCSS, Dr. Shiv Lal, Sr. Scientist and other NRCSS staff read out preamble of Indian constitution and fundamental duties in front of their family members and circulated the message through social media platform.

Dr. Gopal Lal, Director, NRCSS, Dr. S.N. Saxena, Principal Scientist, NRCSS, Dr. Shiv Lal, Nodal officer, SCSP reading preamble of Indian constitution and fundamental duties in front of their family members



15th Parthenium Awareness Week

ICAR-National Research Centre on Seed Spices, Ajmer observed 15th Parthenium Awareness Week from 16th to 22nd August, 2020. During this week staff members of NRCSS involved themselves in Parthenium eradication activities viz. uprooting of Parthenium and spraying of herbicides. Awareness campaigns were also organized during this week. Director, NRCSS, Dr. Gopal Lal inaugurated the Parthenium Awareness Week. He spoke about various harmful effect of Parthenium and insisted upon the staff to make their surroundings and NRCSS farm free of Parthenium which is main goal of observing this week every year. Further, he added that being agriculturist this is our moral duty to make our stakeholders aware about the detrimental effect of this noxious weed.

The NRCSS campus is free of 3P (plastic, paper and Parthenium) even then staff members moved to non approachable areas of campus in search of Parthenium and uprooted the same. 15th Parthenium Awareness Week programme was coordinated by Dr. Narendra Chaudhary and Dr. Shiv Lal.



**हिन्दी पखवाड़ा**

विगत वर्षों की भांति इस वर्ष भी हिन्दी पखवाड़ा दिनांक 14-30 सितम्बर, 2020 के दौरान आयोजित किया गया। इस

दौरान आयोजित होने वाले विभिन्न कार्यक्रमों की रूपरेखा निम्नलिखित है:-

क्र.स.	कार्यक्रम	दिनांक
1.	हिन्दी पखवाड़ा उद्घाटन एवं हिंदी दिवस कार्यक्रम पर संचो	14-09-2020
2.	ऑनलाइन कार्यशाला : कृषि विज्ञान में राजभाषा हिंदी की आवश्यकता एवं योगदान- मुख्यवक्ता : डा. बी. एस. चुण्डावत, अध्यक्ष- वैज्ञानिक सलाहकार समिति - रा. बी. म. अनु. केंद्र, अजमेर कार्यक्रम अध्यक्ष: डा. गोपाल लाल, निदेशक, रा. बी. म. अनु. केंद्र, अजमेर	14-09-2020 19-09-2020 19-09-2020
3.	राजभाषा हिन्दी पखवाड़ा-2020 समापन समारोह	30-09-2020

उक्त पखवाड़ा कार्यक्रम में संस्थान में आप सभी लोगों ने कोविड-19 महामारी के रोकथाम हेतु आवश्यक निर्देशों का पालन करते हुए केवल आनलाइन कार्यशाला में भाग लिया। कोरोना महामारी के बढ़ते प्रकोप के कारण इस बार हिन्दी पखवाड़ा कार्यक्रम के दौरान विभिन्न प्रतियोगिताओं का आयोजन नहीं किया जा सका अर्थात् सभी कर्मचारियों एवं अधिकारियों द्वारा हिन्दी में कार्य को प्रोत्साहित किया गया।

संसदीय राजभाषा समिति की दूसरी उपसमिति द्वारा दिनांक 31 अक्टूबर 2020 को विज्ञान भवन, नई दिल्ली में भा. कृ. अनु. प. - राष्ट्रीय बीजोद्यम मसाला अनुसंधान केंद्र, अजमेर के राजभाषा हिंदी संबंधित कार्यों का निरीक्षण किया गया जिसमें संस्थान के निदेशक डा. गोपाल लाल एवं प्रभारी राजभाषा अधिकारी डा. बृजेश कुमार मिश्र ने इस केंद्र द्वारा किये जा रहे राजभाषा क्रियान्वयन संबंधित प्रस्तुतिकरण किया।

राजभाषा क्रियान्वयन समिति की बैठक:

राष्ट्रीय बीजोद्यम मसाला अनुसंधान केंद्र, अजमेर में राजभाषा समिति की तिमाही समीक्षा हेतु बैठकों का आयोजन 21 फरवरी 2020, 11 जून 2020, 14 सितम्बर 2020 तथा 21 नवम्बर 2020, को डॉ. गोपाल लाल, निदेशक की अध्यक्षता में डा. बृजेश कुमार मिश्र द्वारा आयोजित किया गया। इन बैठकों में हिन्दी के प्रगामी प्रयोग एवं प्रकाशन पर विशेष बल दिया गया। इस अवधि में राजभाषा क्रियान्वयन को कारगर ढंग से लागू करने के लिए दो बार राजभाषा हिंदी कार्यशाला का आयोजन किया गया जिसमें दिनांक 19-09-2020 को

ऑनलाइन कार्यक्रम में डा. बी.एस. चुण्डावत, अध्यक्ष, अनुसंधान सलाहकार समिति, एवं डा. विक्रमादित्य पाण्डेय, सहायक महानिदेशक (बागवानी विज्ञान) द्वारा कृषि विज्ञान में राजभाषा हिंदी की आवश्यकता एवं योगदान पर विचार प्रस्तुत किये। 21-11-2020 को राजभाषा हिंदी कार्यशाला का आयोजन किया गया जिसमें मुख्य वक्ता डा. गोपाल लाल, निदेशक, रा. बी. म. अनु. केंद्र, अजमेर द्वारा संघ का राजकीय कार्य हिंदी में करने के लिए वार्षिक कार्यक्रम-2020-21 के अनुसार कार्यालय कार्यों का निष्पादन विषय पर इस केंद्र के समस्त कार्यालय कर्मचारियों को आवश्यक जानकारी दी गई। इस एक दिवसीय कार्यशाला का समन्वयन डा. बृजेश कुमार मिश्र, प्रधान वैज्ञानिक एवं प्रभारी वृ. राजभाषा अधिकारी, रा. बी. म. अनु. केंद्र, अजमेर ने किया।

राष्ट्रीय बीजोद्यम मसाला अनुसंधान केंद्र के हिन्दी प्रकाशन

1. भा. कृ. अनु. प. - राष्ट्रीय बीजोद्यम मसाला अनुसंधान केंद्र, तबीजी, अजमेर (राजस्थान) द्वारा अर्ध-वार्षिक राजभाषा पत्रिका-"मसाला सुरभि" का प्रकाशन प्रारम्भ किया गया है। इस पत्रिका के जुलाई 2020 अंक का इस अवधि में प्रकाशन किया गया।
2. वार्षिक प्रतिवेदन-2019- राष्ट्रीय बीजोद्यम मसाला अनुसंधान केंद्र, अजमेर।
3. गोपाल लाल, टी. जानकीरम, होमी घेरियन, सुमेर सिंह मीना, शिवलाल, मुरलीधर मीना एवं नरेन्द्र चौधरी (2020) प्रशिक्षण मैन्युअल कृषकों की आमदनी बढ़ाने के परिवेश



में बीजीय मसालों की उन्नत खेती। प्रकाशक निदेशक भाकृअनुप-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, 1/2020, प्र. सं. 104.

अन्य लेख

1. वृजेश कुमार मिश्र, शिव लाल, नरेन्द्र चौधरी एवं श्री राम बलाई (2020)। सौंफ उत्पाद की उन्नत तकनीकी, प्रसार पत्रक, प्रकाशक निदेशक भाकृअनुप-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, 1/2020।
2. शिवलाल, गोपाल लाल, सुमेर सिंह मीणा, मुरलीधर मीना, एवं जी आर चौधरी (2020)। बीजीय मसाले हैं गुणों की खान जो करते रोगों का निदान। मसाला सुरभि, प्रकाशक-निदेशक, भाकृअनुप-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, 1/2020, पृ.सं. 77-85।
3. शिवलाल, गोपाल लाल, मुरलीधर मीना, जी आर चौधरी, श्री राम बलाई एवं प्रमोद कुमार अग्रवाल (2020)। बीजीय मसालों में पैकजिंग एवं ब्रांडिंग का महत्व। मसाला सुरभि, प्रकाशक-निदेशक, भाकृअनुप-राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, 1/2020, पृ.सं. 55-59।
4. शिवलाल एवं गोपाल लाल (2020)। बीजीय मसाला फसलों में उत्तम कृषण क्रियाओं के उद्देश्य, लाभ एवं चुनौतियाँ। मसाला सुरभि, जुलाई-दिसम्बर, 2019, पृ.सं. 4-8।

Celebration of 150th Birth anniversary of Mahatma Gandhi

Every year on 2 October, the birth anniversary of Mohandas Karamchand Gandhi or Mahatma Gandhi is observed with prayer services and tributes across the nation. This year, India celebrated the 150th birth anniversary of Gandhi. Born on 2 October, 1869, Gandhi incorporated a non-violent resistance, taking the forefront of India's freedom struggle movement against the colonial British rule. Raised in a Hindu family in coastal Gujarat's Porbandar, Gandhi's (popularly known as Bapu) relentless work to ensure India's Independence from British colonialism fueled the UN General Assembly's decision on 15 June, 2007, to adopt a resolution to celebrate 2 October as the International Day of Non-Violence.

This year ICAR-NRC on Seed Spices, Ajmer celebrated the event at a grand level using online media to follow the COVID-19 rules. The programme which was started two years back, these two years was devoted to the holy saint, our beloved Father of the nation "BAPU", Birth anniversary of our former Prime Minister Shri Lal Bahadur Shastriji was also celebrated at the institute and Director and other guests had delivered speech and highlighted the main events of Shri Lal Bahadur Shastriji.

Celebrations started on 26 September 2020 and a week was celebrated upto 2nd October 2020.

Event organized on 26 September 2020

ICAR-NRC on Seed Spices, Ajmer was decorated on the theme of Gandhiji, Banners were placed inside and outside the institute. Different pictures of Gandhiji and slogans/ morals/quotes of Gandhiji were framed and placed in a corner at reception and the corner was named as Gandhi gallery. The gallery was inaugurated with ribbon cutting by Director, NRCSS, and witness by the whole staff of the NRCSS, Ajmer.

Event organized on 27-28 September 2020

Cut outs of Gandhiji, Gandhi Chashma, Gandhiji ke teen Bandar and Charkha were prepared and placed at Gandhi gallery of NRC on Seed Spices.

Event organized on 29 September 2020

Painting Competition was organized for the family members of NRCSS staff. In this competition Siddhi Chouhan, Avani Meena and Sakshi Tripathi were the winners. Winners were awarded with certificate.

Event organized on 30 September 2020

Slogan and photography Competition was organized for the NRCSS staff. In this competition Smt. Sarla Devi was the winner. Winners were awarded with certificate.

Event organized on 01 October 2020

Open gallery visit was organized for the staff members following the COVID-19 guidelines.

Vichar Prastuti Competition was organized for the



NRCSS staff. In this competition Smt. Sarla Devi was the winner. Winners were awarded with certificate.

Event organized on 02 October 2020

The birth anniversary was celebrated following the COVID-19 guidelines and Welcome address and highlights of Gandhiji's life were narrated by Dr. Gopal Lal, Director, NRCSS. He shared his views about Gandhiji and told that we all should follow the Gandhiji's morals for truth, honesty and hard work in our life. One programme on Swachhta Hi Sewa Hai was also performed during this programme and extra care was taken to eradicate the plastic, specially the single use plastic from the institute. Oath taking ceremony celebrated and pictures were share by the staff members through whatsapp. The programme was lead by Dr. Sharda Choudhary and Dr. A.K. Verma.



Observance of Rashtriya Ekta Diwas or National Unity Day

During Vigilance Awareness Week, National Unity Day (Rashtriya Ekta Diwas) was observed on 31.10.2020 at the center to commemorate the birth anniversary of Sardar Vallabhbhai Patel, the architect of national integration of independent India. For celebrating the National Unity Day, a Pledge taking ceremony was organized to mark the occasion on 31 October, 2020 at 3.00 P.M. Dr Y.K. Sharma, Vigilance Officer briefed about the celebration of Rashtriya Ekta Diwas and administered the Rashtriya Ekta Diwas Pledge to all officials and staff members of ICAR-NRCSS through video conferencing. He also expressed his views about Rashtriya Ekta Diwas, its importance and words about the Iron Man Sardar Vallabhbhai Patel.



Observance of Vigilance Awareness Week

ICAR-NRC on Seed Spices, Ajmer observed Vigilance Awareness Week from 27th October, 2020 to 2nd November, 2020 at NRCSS campus. The theme of the Vigilance Awareness Week this year was '**Vigilant India, Prosperous India**'.

Activities organized during Vigilance Awareness Week

Commencement of Vigilance Awareness Week with administering of Pledge

The observance of Vigilance Awareness Week at ICAR-NRCSS, Ajmer was commenced with integrity pledge on 27.10.2020 at 11:00 A.M. administered by Dr G. Lal, Director, ICAR-NRCSS to the officials and staffs of ICAR-NRC on Seed Spices, Ajmer followed by speech by the Director and general discussion on Vigilance and observance of Vigilance awareness week. Looking to the covid-19 effect, the staff members were joined for integrity pledge through video conferencing. Few members including Director, Vigilance Officer and committee members were present in the auditorium with all precautions and guide lines issued (maintaining social distancing, wearing of mask, etc.).



Display of slogans for vigilance awareness at different places

The slogans and pamphlets for the awareness of vigilance were displayed at different places in the campus and outside the campus to sensitize the persons for vigilance awareness.

Interaction with contractual manpower of the Centre for awareness about vigilance and Covid-19

To aware the contractual farm workers an interaction was organized following all guidelines of Covid-19 in the campus in which, Director, NRCSS Dr. G. Lal, Vigilance Officer Dr. Y.K. Sharma, Farm Incharge Dr. Shiv Lal and Farm Manger were participated and interacted. In his speech Director, ICAR-NRCSS conveyed the message of Vigilance awareness, sanitation and Covid-19. They were also asked for timely payment of their wages, deduction PF, insurance etc. Apart from Vigilance they were also aware for the precautions of Covid-19. Vigilance Officer and I/c Farm also interacted for the awareness.

Workshop and Valedictory of Vigilance Awareness Week

On 2.11.2020, ICAR-NRCSS organized a Workshop on Theme: 'Vigilant India, Prosperous India' and valedictory function of the week through Video Conferencing in which officials and staff of ICAR-NRCSS, participated. While summarizing the week, Dr. Y. K. Sharma, Vigilance Officer briefed about the different activities conducted during the Vigilance Awareness Week. Dr. G. Lal, Director, ICAR-NRCSS & Chief Guest on the occasion delivered the speech and expressed his views about Vigilance Awareness Week and on the theme '**Vigilant India, Prosperous India**'. He also conveyed a message of Hon'ble Agriculture Minister on the occasion and appealed to work hard for the development of the organization and ultimately for the development of the country. At last Dr. Y K Sharma proposed vote of thanks to the Director and all the staff members.

Celebration of Constitution Day

Constitution day was celebrated as on 26th November to commemorate the adoption of the Constitution of India and to honour and acknowledge the contribution of the founding fathers of the Constitution at ICAR-National Research Centre on Seed Spices, Ajmer. Smt. Anita Bhadel, Honorable member of legislative assembly, Ajmer South, was chief guest of the function. Dr. D.S. Bhati, Head, KVK, Ajmer and Dr. Dinesh Arora, In-charge, ARSS, Ajme, Dr. O. P. Sharma, Deputy Director, ATC were among the special guests. Staff of respective department, farmers and students was the audience. In beginning, Dr. S.N. Saxena, coordinator of the function described the significance of this celebration. Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer addressed the gathering about constitutional fundamental right and duties. He stressed upon fundamental duties and their relevance in individual life and nation building. Dr. Lal emphasised that one must equally abide with fundamental duties as like fundamental rights.

In her presidential address Smt. Anita Badel highlighted the efforts taken place in compilation and writing the Constitution. She informed gathering that roots of harmony and unity in diversity lies in planning of Indian Constitution by quoting the facts about various symbols like Mahabharat, Ramayana, Bhagirath & River Ganga, Mahatma Gandhi, Nalanda Vishwavidhyalaya carved on first page of original Indian constitution. She also advocated the role of fundamental duties and national flagship programme such as Swacch Bharat Mission, Beti Pathao Beti Bachao, Clean India Green India, Plastic free India etc. As the main event of the function chief guest Smt. Bhadel clearly and loudly read out the Preamble of Indian constitution during the programme and suggested every individual to follow the Indian constitution for nation building.



The celebration was witnessed by more than 130 individuals and was concluded by casting a vote of thanks by Dr. Shiv Lal, Sr. Scientist and Co-ordinator of the function.

Awareness program on Indian Constitution

In the series of events conducted from November 2020 to April 2020 a team of NRCSS scientists visited the Dang Village of Saradhana Panchayat on dated 10.12.2019 under the leadership of Dr. S.N. Saxena, Pr. Scientist (Plant Physiology). On this visit a formal meeting with a group of farmers including farm women of the village was organized and interaction was held on the preamble of the constitution as well as fundamental rights and duties as enshrined in the Indian Constitution for every citizen of India. Villagers were made aware of their fundamental duties and urged the farmers to communicate these things among other farmers also. Farmers were advised to visit the institution and take the benefits



of technologies developed by the Institute. In this programme, 20 farmers, youth and farm women were participated and benefited.

The constitution awareness programme was also organized in village Kalesara of Ajmer district on 27/12/2019. A total of 20 women farmers were participated in this awareness programme.



Similar awareness programme was also conducted in village Budhwada, Dumada and Makreda for fundamental duties and rights for conservation of natural resources, respect of flag, cherish the noble idea, get inspiration from freedom struggle, uphold the unity and integrity, defend the country, render national services when called upon.



Under SCSP programme of ICAR-NRCSS, Ajmer, one day farmers training programme was organized on 17/12/2019 to brief about ICAR-NRCSS, Ajmer technologies and creating awareness about constitution of India and fundamental duties. A total of 23 farmers of different villages such as Budhwara, Dantra, mashinia, Bandanwara of Ajmer district were participated.



Swachhata Pakhwada

ICAR-National Research Centre on Seed Spices observed "Swachhata Pakhwada-2020" programme from 16th December to 31st December 2020. Various swachhata related activities were undertaken during this programme. NRCSS officials were engaged themselves in different cleanliness activities of farm, guest house, residential area, office building. To create awareness among the farm workers about the importance of swachhata, many farm workers were explained during this programme. KISAN DIWAS celebration was also conducted during this programme. NRCSS officials were taken swachhata pledge administered by the Director, NRCSS, Ajmer. All the officials of NRCSS were actively participated in "Swachhata Pakhwada-2020" programme. "Swachhata Pakhwada-2020" programme was coordinated by Dr. Narendra Chaudhary, Nodal Officer, Swachh Bharat Mission.



PRESS MEDIA GALLERY

उन्नतशील प्रौद्योगिकी के उपयोग से सुधरेगी किसानों की स्थिति

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र में दो दिवसीय विज्ञान मेला शुरू



राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र में दो दिवसीय विज्ञान मेला शुरू

बिड़रवाड़ा, राजस्थान

सुधरेगी किसानों की स्थिति से उन्नतशील प्रौद्योगिकी के उपयोग से सुधरेगी किसानों की स्थिति, राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र में दो दिवसीय विज्ञान मेला शुरू हुआ।

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र में दो दिवसीय विज्ञान मेला शुरू हुआ। इस दौरान केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने कहा कि उन्नतशील प्रौद्योगिकी के उपयोग से किसानों की स्थिति सुधरेगी।

मेले में डॉ. राजेश कुमार शर्मा ने कहा कि उन्नतशील प्रौद्योगिकी के उपयोग से किसानों की स्थिति सुधरेगी।

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र का स्थापना दिवस मनाया

नवीन दृष्टिकोण से अनुसंधान पर मिलेगी नई चुनौतियों का सामना करने की शक्ति



राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र का स्थापना दिवस मनाया

बिड़रवाड़ा, राजस्थान

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र का स्थापना दिवस मनाया गया। इस दौरान केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने कहा कि नवीन दृष्टिकोण से अनुसंधान पर मिलेगी नई चुनौतियों का सामना करने की शक्ति।

मेले में डॉ. राजेश कुमार शर्मा ने कहा कि नवीन दृष्टिकोण से अनुसंधान पर मिलेगी नई चुनौतियों का सामना करने की शक्ति।

एक दिन - अनुसंधान केंद्र पर 71 दिवसीय रोजगारमूलक प्रशिक्षण कार्यक्रम में दो आवस्यकों पर विशेषज्ञ करेंगे प्रतिभागियों को प्रशिक्षित



एक दिन - अनुसंधान केंद्र पर 71 दिवसीय रोजगारमूलक प्रशिक्षण कार्यक्रम में दो आवस्यकों पर विशेषज्ञ करेंगे प्रतिभागियों को प्रशिक्षित

किसानों को जैविक खेती के लिए प्रेरित

दो दिवसीय विज्ञान मेले का समापन



किसानों को जैविक खेती के लिए प्रेरित

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र लखौजी में विज्ञान मेला

उन्नतशील कृषि प्रौद्योगिकी अपनाएं काश्तकार



राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र लखौजी में विज्ञान मेला

लखौजी, राजस्थान

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र लखौजी में दो दिवसीय विज्ञान मेला शुरू हुआ। इस दौरान केंद्र के अध्यक्ष डॉ. राजेश कुमार शर्मा ने कहा कि उन्नतशील कृषि प्रौद्योगिकी अपनाएं काश्तकार।

मेले में डॉ. राजेश कुमार शर्मा ने कहा कि उन्नतशील कृषि प्रौद्योगिकी अपनाएं काश्तकार।

खाद्य सुरक्षा के लिए अधिकतम कृषि उत्पादन जरूरी : डॉ. सिंह

राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र, लखौजी में मसाला 2020 सम्मेलन विस्तार, संवर्धन तथा प्रदर्शन पर उपलब्धता



खाद्य सुरक्षा के लिए अधिकतम कृषि उत्पादन जरूरी : डॉ. सिंह

लखौजी, राजस्थान

खाद्य सुरक्षा के लिए अधिकतम कृषि उत्पादन जरूरी, राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र लखौजी में मसाला 2020 सम्मेलन विस्तार, संवर्धन तथा प्रदर्शन पर उपलब्धता।

मेले में डॉ. राजेश कुमार शर्मा ने कहा कि खाद्य सुरक्षा के लिए अधिकतम कृषि उत्पादन जरूरी।

कृषि वैज्ञानिकों को प्रौद्योगिकीय प्रशिक्षण

लखौजी, राजस्थान

कृषि वैज्ञानिकों को प्रौद्योगिकीय प्रशिक्षण, राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र लखौजी में मसाला 2020 सम्मेलन विस्तार, संवर्धन तथा प्रदर्शन पर उपलब्धता।

मेले में डॉ. राजेश कुमार शर्मा ने कहा कि कृषि वैज्ञानिकों को प्रौद्योगिकीय प्रशिक्षण।

पंजीकरण कर मंडी पहुंचाएं उत्पाद

लखौजी, राजस्थान

पंजीकरण कर मंडी पहुंचाएं उत्पाद, राष्ट्रीय बीजतीय मसाला अनुसंधान केंद्र लखौजी में मसाला 2020 सम्मेलन विस्तार, संवर्धन तथा प्रदर्शन पर उपलब्धता।

मेले में डॉ. राजेश कुमार शर्मा ने कहा कि पंजीकरण कर मंडी पहुंचाएं उत्पाद।



13. Personnel (31.12.2020)

14.1 Scientific Staff

S.No.	Name and Designation
1.	Dr.Gopal Lal, Director
2.	Dr.S.N.Saxena, Principal Scientist
3.	Dr. Shyam Sunder Meena, Principal Scientist
4.	Dr. Y.K. Sharma, Principal Scientist
5.	Dr. O.P. Aishwath, Principal Scientist
6.	Dr. Ravindra Singh, Principal Scientist
7.	Dr. Krishna Kant, Principal Scientist
8.	Dr. S.S. Meena, Principal Scientist
9.	Dr. B.K. Mishra, Principal Scientist
10.	Dr. R.S. Meena, Senior Scientist
11.	Dr. N.K. Meena, Senior Scientist
12.	Dr. Sharda Choudhary, Senior Scientist
13.	Dr. Shiv Lal, Senior Scientist
14.	Dr. R.D. Meena, Scientist
15.	Sh. Mukesh Kumar Vishal, Scientist
16.	Dr. Murli Dhar Meena, Scientist
17.	Dr. A.K. Verma, Scientist
18.	Dr. Narendra Choudhary, Scientist
19.	Dr. Sanjay Kumar, Scientist
20.	Sh. Ravi Y, Scientist
21.	Dr. Chetan Kumar Jangir, Scientist
22.	Dr. Vasundhara Sharma, Scientist

14.2 Technical Staff

S.No.	Name and Designation
1.	Sh. M.A. Khan, CTO
2.	Sh. S.R. Meena, ACTO
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**

S.No.	Name and Designation
1.	Sh. Bhim Singh, AAO
2.	Sh. Sunil Kumar Agrawal, AF & AO
3.	Sh. Sanjeev Sharma
4.	Sh. Pradeep Kulhari, Assistant
5.	Sh. R.K. Kanwaria, UDC
6.	Sh. Amit Kumar Gupta, LDC

14.4 Skilled Supporting Staff

S.No.	Name and Designation
1.	Smt. Sarla Devi, SSS
2.	Sh. Pukhraj Paroda, SSS

14.5 Study Leave

1.	Sh. Mukesh Kumar Vishal, Scientist (Agriculture Statistics)
2.	Sh. Ravi Y., Scientist (Spices, Plantation, Medicinal and Aromatic Plant)

14.6 New Posting

1.	Dr. Chetan Kumar Jangir, Scientist (Joined on 04.04.2020)
2.	Dr. Vasundhara Sharma, Scientist (Joined on 04.04.2020)

14.7 Transfer & Joining

1.	Sh. Mukesh Kandari, LDC (Transferred on 27.06.2020)
2.	Sh. Sanjeev Sharma, Assistant (Transferred on 30.09.2020 with lean to join as AO in NID Kurukshetra, Haryana)
3.	Dr. Sanjay Kumar, Scientist (Joined ICAR-NRCSS on 09.11.2020)
4.	Dr. Shyam Sunder Meena, Principal Scientist (Joined on 08.12.2020)

14.8 Promotions

1.	Dr. Narottam Kumar Meena, Senior Scientist (w.e.f. 08.01.2019)
2.	Dr. Narendra Chaudhary, Scientist (w.e.f. 01.07.2018)

14.9 Retirement

1.	Dr. Pradyumn Narayan Dubey, Pr. Scientist (w.e.f. 29.02.2020)
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Annexure - I

Table 1: Monthly mean temperature, relative humidity, evaporation and rainfall during 2019

Year 2019 Month	Mean Temperature (°C)		Relative humidity (%)		Evaporation mm/day	Total rainfall (mm)
	Minimum	Maximum	7.40 am	2.40 pm		
January	4.8	23.9	83.4	67.2	4.8	7.1
February	7.5	25.6	80.3	64.6	5.3	
March	12.5	31.6	69.6	47.8	7.5	
April	21.5	39.8	80.4	59.2	19.9	17.4
May	25.6	40.8	79.7	54.6	19.4	17.4
June	29.5	41.2	69.7	55.7	19.5	9.3
July	26.1	34.5	89.0	79.0	9.7	297.0
August	24.9	31.4	92.2	86.6	3.0	360.0
September	24.7	33.6	83.2	74.9	5.4	34.1
October	17.2	33.5	84.6	63.0	6.3	8.0
November	15.2	29.2	88.6	73.7	4.4	
December	5.8	22.0	85.8	79.0	2.4	10.0
Average	17.9	32.3	82.2	67.1	8.9	760.3

Table 2 : Monthly mean temperature, relative humidity, evaporation and rainfall during 2020

Year 2020 Month	Mean Temperature (°C)		Relative humidity (%)		Evaporation mm/day	Total rainfall (mm)
	Minimum	Maximum	7.40 am	2.40 pm		
January	6.0	21.6	84.8	71.4	2.2	7.1
February	6.8	27.2	82.9	58.7	4.6	
March	6.0	21.6	84.8	71.4	2.2	7.1
April	6.8	27.2	82.9	58.7	4.6	
May	16.8	29.5	85.4	46.0	5.2	
June	20.1	37.9	81.1	35.5	11.1	25
July	25.2	41.9	87.6	66.0	20.0	17.4
August	26.6	39.2	89.6	69.3	16.2	56.5
September	27.1	36.7	90.7	74.7	12.0	131
October	25.8	32.5	94.5	86.0	11.7	160.8
November	25.0	34.9	90.0	71.5	6.4	80.3
December	18.3	35.0	86.3	57.0	6.4	
Average	18.0	32.7	88.1	63.6	8.7	485.2

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ISSN 2456-2467



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