

वार्षिक प्रतिवेदन ANNUAL REPORT 2019



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

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





ICAR-NRCSS, Ajmer

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

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

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Front : Ajmer Coriander-2, Ajmer Coriander-3, Ajmer Celery-2, Ajmer Fennel-3 (from bottom to top)

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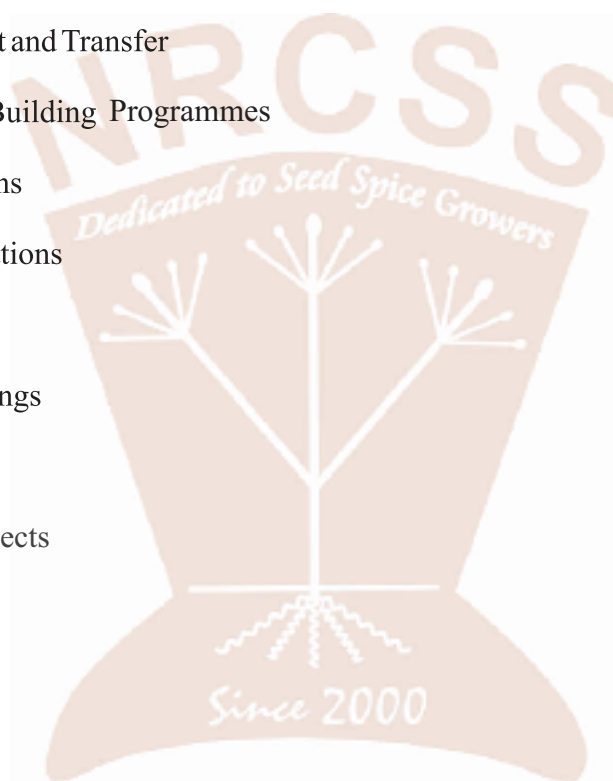
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6 June, 2020

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PREFACE



Indian spices exports have great potential throughout the globe. Indian spice industries have a very broad and historical perspective and have bright prospects for future growth. India is the largest producer and consumer and exporter of spices in the world. Spices exports are an important source of foreign exchange for India economy since colonial era. Today also, spice export plays an important role in agriculture export from India. Therefore stabilization of spice exports is critical for achieving long term growth in Indian spices economy. As per 2018-19 estimates, seed spices occupied an area of 17.47 lakh hectare with a total production of 15.50 lakh tonne in India. During 2018-19, 11,00,250 tons of spices and spice products valued Rs. 19505.81 crore (US\$ 2805.50 Million) have been exported from the Country as against 10,28,060 tons valued Rs. 17980.16 crore (US\$ 2789.35 Million) in 2017-18, registering an increase of 7% in volume and 8% in rupee terms and 6% in dollar terms of value (Spice Board, 2019). To increase exchange earning through spice export there is need for setting up of growth targets and formulating various plans and policies and determination of a unified course of action to achieve these growth targets within a given time frame work. Changing consumption pattern of the people like increasing consumption of ethnic foods due to internationalization, Ready-to-use foods & vegetables e.g. spice pastes, sauces, curries, pizzas, and other convenience food and has created increasing demand for Indian spices globally. However, sanitary and phytosanitary standards of Indian seed spices particularly cumin seed spice has to match with the international standards to meet the importing countries for pesticide residue and other allergens free export of Indian spices. Large scale adoption of Good Agricultural Practices (GAP) by the seed spice growers can be a milestone in the journey of making local seed spices cultivars / products into global brand of seed spice.

The institute has developed new high yield and disease tolerant/ resistant varieties for Coriander (Acr-3) and Fennel (AF-3) for the benefit of farmers. The ICAR-NRCSS, Ajmer is constantly working to develop innovative solutions for problems faced by farming community through concerted efforts by a team of scientists and technical staff. Our focus is conservation of genetic resources and sustainable use of natural resources for optimum production with

higher productivity per unit of resource used. Eco-friendly insect pest and disease management through organic/microbial inputs is another major theme area of our focused research. To enhance the income of farmers by 2022, various technologies/products have been developed through value addition in seed spices. We have got FSSAI license for manufacturing and sale of these value added products at the centre. Many FLDs, field days and farmers training programmes were organized during the reporting period for Transfer of technology (ToT) under TSP, NEH and SCSP programme. The annual report (2019) of ICAR-NRCSS, Ajmer will provide the information of the salient achievements under ongoing research and development activities at the centre along with significant achievements during the year.

I am grateful to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR, Ministry of Agriculture & Farmer Welfare, Govt. of India, New Delhi for the guidance and support to this institute. I place on record my gratitude to Dr. Anand Kumar Singh, Deputy Director General (Horticulture Science), ICAR, New Delhi for his constant encouragement and support in the R&D activities of the institute. I also thank Dr. T. Janakiram, ADG (Horticulture Science-I) for his keen interest and timely guidance. I thank all the scientists, officers and other staff members of the institute for their contribution in achieving our mandated targets in seed spices basic and strategic research activities. I also congratulate the editorial committee members for compiling and editing the information for timely publication the Annual Report- 2019. I am sure that this annual report will help all the stakeholders of seed spices sector on various aspects. I invite the critical suggestions from readers for further positive growth.

Ajmer

6 June, 2020



(Gopal Lal)



भारत
ICAR

1. Executive Summary

Crop Improvement

- Total 86 new germplasm lines were collected in different seed spices and thus total seed spices germplasm assemblage at National Active Germplasm Site, ICAR- NRCSS, Ajmer has reached 2331.
- Two new varieties; Ajmer Coriander-3 (ACr-3) and Ajmer Fennel-3 (AF-3) have been released vide notification in 27th CVRC meeting held on 02.09.2019 at New Delhi.
- Another two varieties Ajmer Ajwain-73 (AA-73), Ajmer Nigella-1 (AN-1) identified in AICRP workshop at T.N.A.U. Coimbatore, (Tamilnadu) and two varieties Ajmer Celery-2 (ACel-2) and Ajmer Green Coriander-1 (AgCr-1) identified in Rajasthan state varietal release committee.
- Two ajwain genotypes AA-3 and AA-51 recorded higher seed yield 1662.00 kg/ha and 1630.67 kg/ha respectively as compared to check varieties (Ajmer Ajwain-1, Ajmer Ajwain-2 and GA-1) during 2018-19.
- Celery genotype, A-Cel-25 was recorded higher seed yield (4.93 q/ha) and karnoli-13 recorded higher essential oil (1.9%) than check variety A-Cel-1 (4.68 q/ha & 1.7%).
- Cumin germplasm lines SPS-14/13 (690.7 kg/ha), SPS-28/1 (670.0 kg/ha) and Barmer Hairy Cumin (667.3 kg/ha) were recorded higher yield as compared to check variety GC-4 (656.4 kg/ha).
- In cumin floral biology study, natural crossing was not recorded between hairy and non-hairy cumin. This may be due to high rate of self pollination and/or cross incompatibility between two lines.
- Fifteen fennel and cumin genotypes/varieties screened against salinity stress under culture dish condition. Irrespective of salinity levels, the fennel genotype AF-302 recorded maximum germination per cent (87%). Whereas the genotype AF-01-521 recorded highest shoot length (5.24 cm) and root length (4.72 cm). Cumin genotype JC-9-89 recorded 68% germination, whereas the genotypes hairy cumin and AKV-103 has recorded maximum shoot

length (3.08 cm) and root length (3.43cm) respectively.

- Fennel genotype AF-01-172-4(PDI-7.3) followed by AF-01-521 (PDI-10.7), AF-256 (PDI-11.2) and AF-302 (PDI-12.3) showed resistance reaction to *Ramularia* blight disease.
- Whole transcriptome sequencing for six coriander samples (seeds and leaf both) were performed and sample wise unigenes were identified based on high mapping and coverage estimated by sample wise read alignments.

Crop production

- Microbial inoculant, *Pseudomonas fluorescens* recorded highest cumin seed yield (5.62 q/ha) as compared to untreated control (2.91 q/ha). Four bacterial isolates of cumin rhizobacteria (previously isolated) were found effective to inhibit the growth of cumin wilt pathogen (*Fusarium oxysporum* f.sp. *cumini*) in dual culture test on Potato Dextrose Agar medium.
- Based on 16S rDNA nucleotide homology and phylogenetic analysis, four previously isolated endorhizobacteria isolates from fenugreek roots were identified as *Bacillus aryabhattai* (Rhizo-Fen-3), *Bacillus megaterium* (Rhizo-Fen-8), *Bacillus haynesii* (Rhizo-Fen-12) and *Pseudomonas chengduensis* (Rhizo-Fen-27).
- Under Intercropping of seed spices with guava, the highest fruit yield of guava was recorded in treatment Guava + Fenugreek (5540 kg/ha) followed by Guava + Nigella (4893.67 kg/ha) treatment. Similarly, the highest fruit yield of pomegranate was recorded in treatment Pomegranate + Fenugreek (4,884 kg/ha) followed by Pomegranate + Nigella (4,225 kg/ha).
- In preliminary study, 23 isolates of native Zn solubilization bacteria/fungi were isolated from 21 soil samples of cumin growing fields. Zn-solubilization index of these isolates ranged from 1.66 to 3.00 ZnSI after 7 days of incubation at 25±2 °C.

- All the growth and yield parameters of celery were enhanced with applied nitrogen, however seed yield and some other parameters were at par with 100 and 80 kg N ha⁻¹. Similarly, growth and yield parameters of celery were enhanced with applied phosphorus, however seed yield and some other parameters were at par with 40 to 60 kg N ha⁻¹.
- Seed germination of ajwain reduced about 55% with RSC up to 6.0 meq l⁻¹ in lab study. Seed and stover yield reduced significantly with increased levels of sodicity and reduction was about 37%.
- There was no direct relation with soil properties studied and cumin performance except where there was a crop or weed residue incorporated in the soil.
- Under the experiment of standardization of organic source of nutrition in nigella, maximum plant height (67.13 cm), no. of capsule per plant (29.20) and harvest index (26.56%) were recorded under the treatment of vermicompost 50% + neem cake 50%. The maximum seed yield of nigella (1032 kg/ha) and test weight (2.7 g) were registered under neem cake 75% + vermicompost 25%.

Crop protection

- In survey and monitoring of major and minor seed spice diseases during 2018-19, wilt disease in cumin was observed in the range of 1.0 to 4.6%; *Alternaria* blight of cumin was recorded up to 20.0%. Downy mildew on fenugreek was recorded from 0.1 to 6.5%; *Alternaria* blight and powdery mildew in fenugreek was observed 0 - 6.5 % and 0 - 4.9%, respectively. The stem gall and *Sclerotium* rot on coriander (0-4.2%) and *Ramularia* blight on fennel (0-0.8%) found in low intensity.
- Ten isolates were collected from foliar canopy, rhizosphere (root zone) from different cumin growing areas were maintained and screened *in vitro* against the cumin blight (*Alternaria burnsii*). One isolate 'B1' was screened and found most effective among all tested isolates and showed minimum mycelium growth (08 mm) with more than 90% growth inhibition.
- Management of nematodes in cumin field experiments showed that application of soil sterlent Metham sodium and Dazomet gave excellent protection up (3% plant mortality) in comparison to 63% in control to the maturity of the crop up to 90 days among nematopathogens, soil application of *Paecilomyces lilacinus* 10⁸ CFU/g + *Trichoderma harzanium* 10⁸ CFU/g + *Pseudomonas fluorescens* 10⁸ CFU/g also gave good control up to 60 days where only 6.0 per cent plant mortality was observed.
- Spray scheduling of recommended fungicides mancozeb, difenoconazole and azoxystrobin (3-4 sprays at 15 days interval) reduced the cumin blight disease (62-64%) under field conditions.
- Spraying with new molecules of fungicides hexaconazole, tebuconazole and trifloxystrobin reduced the powdery mildew (PDI 17.5-20.8) and leaf blight (PDI 13.3-14.7) disease in fenugreek.
- Amongst eight IPM modules, maximum per cent reduction (95.1%) in aphid population and in thrips population (96.37%) was recorded on coriander plants treated with IPM module IPM module M₅ (imidacloprid 600FS 3ml/kg seed (ST) + ker plant extract 10ml/lit. + *Verticillium lecani* (1×10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@0.035%).
- The micro emulsion formulation of deltamethrin was found better than other micro encapsulation in control of aphids in crop of cumin, coriander and fenugreek. Application of botanical formulation, sesum (*D. sissoo*) leaf extract –Non polar and polar at 0.5% concentration showed that non polar formulation yields better result in comparison to polar formulation. Modified neem composition @ 5% tested against aphids gave superior control over neem oil-2%. Similarly *Verticillium lecanii* 1.5% SC was found better than powder formulation.

Basic science

- The trend obtained for coriander yield (q/ha) showed that the treatment consisting application of Thiamethoxam and Difenoconazole (T₃) was found more efficient for coriander yield followed by application of Thiamethoxam and Mancozeb (T₂), Acetamiprid and Mancozeb (T₄), Acetamiprid and Difenoconazole (T₁), Thiamethoxam and Dinocap

(T₅), Acetamiprid and Dinocap (T₆) as compared to untreated control (T₇). Residue levels of these molecules were below detection limit after crop harvest in coriander seed samples.

- The maximum Pre-harvest Interval determined for the three fungicides viz. Copper oxychloride, Hexaconazole and Propiconazole in general lies between 12-27 days after harvest at the single & double dose application rates respectively in fenugreek crop.
- Irradiated sodium alginate and caragennan showed growth promoting effect when applied exogenously as most of the growth parameters of coriander increased under these treatments. Essential oil content was significantly increased with Irradiated sodium alginate and Irradiated caragennan (0.33%) and 0.35% with sodium alginate.

Post harvest management and value addition

- Based on preliminary findings, the fennel seeds should be harvested at 138 days from seed sowing or 35 days after anthesis for chewing propose. Similarly, the fennel seeds should be harvested at 75 days after anthesis for culinary propose.

Social Sciences

- In coriander, price varied from 2202 to 9656 rupees per quintal during study period. Coriander arrival in the surveyed markets varied from 4.6 to 2538 tones in a month. Higher prices were observed in lean season i.e. from April to November whereas lower prices were observed in peak season from December to March month with lowest prices during February and March months when highest arrivals was recorded.
- In cumin, during 2008 to 2019 cumin price varies between 7221 to 19155 rupees per quintal. There was increasing trend in cumin prices from 2008 to 2019 except 2014.

Externally funded projects

- A Network Project on Organic Farming (NPOF) "Standardization of seed spices based organic farming system" sponsored by ICAR-IIFSR,

Modipuram is running at ICAR-NRCSS, Ajmer to develop 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.

- DUS experiment of major seed spices (Coriander, fenugreek, fennel and cumin) was laid out with 35 varieties of coriander, (26 references and 9 Candidate), 22 varieties of fenugreek, 21 varieties of fennel, 9 varieties of cumin were included to develop test guidelines for these crops.
- DUS experiment of minor seed spices included anise, nigella, celery, ajwain and dill varieties genotypes.

Other Activities

Approximately 25000 farmers and other stakeholders visited the ICAR-NRCSS experimental farm, knowledge park and bio-control lab during 2019. 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.

- International yoga day was celebrated at ICAR-NRCSS campus under the guidance of Yoga instructor and demonstrators form Vivekanand Kendra Kanyakumari Branch, Ajmer.
- Vigilance Awareness week was celebrated during 28 October to 2 November 2019 at the centre.
- Rajbhasha Hindi pakhwada was organized during 14-31 September 2019.
- Many visits organized under MeraGaonMera Gaurav programme for imparting knowledge and skill to farming community about the latest technological development in seed spices and allied agricultural activities.
- 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 technologies in new area.

- A series of radio talks on seed spices cultivation practices by different subject specific scientists were recorded at All India Radio Centre (Akashvani),

Jaipur in local hindi language and broadcasted for benefit of farming community.

- During 2018-19 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 226 quintals of TFL seed was produced. Besides this, 7342 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. Total 109 spices are listed by ISO and 63 spices are grown in India. The seed spices are a group, which denotes all those annuals whose dried fruit or seeds are used as spice. There are about twenty seed spices are grown in India, the important among them are coriander, cumin, fennel, fenugreek, ajwain, dill, celery, anise, nigella and caraway. Almost all the seed spices are winter season crops (rabi) need cool weather conditions for better growth and development. Majority of these seed spices are treated as cash crop in arid and semi-arid regions of India particularly Rajasthan, Gujarat and parts of Madhya Pradesh. However frost leads to major damage to these crops. Late winter rainfall also adversely affect the quality and quantity of production by infestation of disease, pests etc. The seed spices are aromatic vegetable products of tropical origin and are commonly used in pulverized state, primarily for seasoning or garnishing the foods and beverages. They are also used in preparation of various value added products viz. spice oils, oleoresins and spice powders. Seed spices possess industrial importance and are used in cosmetic, perfumery and various pharmaceutical preparations medicines. The seed spices constitute an important group of agriculture commodities and play a significant role in our national economy. Since ancient time, India has always been recognized as a land of spices. Seed spices account for about 51.79 per cent and 19.06 per cent of total area and production of spices in the country. Out of the twenty seed spices grown in the country ten are prominent. The crops covered are Coriander, Cumin, Fennel and Fenugreek as major seed spices, while Ajwain, Dill, Celery, Nigella, Caraway and Anise constitute minor group of seed spices. Seed spices are low volume and high value crops, requiring less water and nutrient for their successful cultivation. Seed Spices are annual herbs best suited for diversification of existing cropping system of arid and semi arid region of our country. Rajasthan and Gujarat states are the two largest seed spice growing states, accounting for more than 70 per cent and 80 percent of the total area and production respectively. Seed spices also play important

role in the annual export basket of spices of our country. Production of seed spices has critical constraints which need to be tackle on priority basis. The most important constraint adversely affecting the promotion of these crops to farmers for diversification of the existing cropping system is low productivity. The major factors presently contributing to low productivity are very low seed replacement rate, the lack of authentic seeds of improved varieties, growing of these crops in low/marginal soil fertility and drought prone conditions, attack of major pest and diseases and above all unorganized marketing. Several issues emerge after making analysis of different constraints affecting production of these crops, which is need for systematic and well planned strategic and applied research backed by a vigorous transfer of technology campaign for promotion of the new technologies evolved.

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 by a quantum jump in the production and productivity of seed spices.

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

2.1 History

There has been ever increasing demand of seed spices and importing countries look at India as consistent source. In view of the aforesaid importance of seed spices in the country, the Indian Council of Agricultural Research established the National Research Centre on Seed Spices at Ajmer to initiate research work on seed

spices especially aimed at improving the productivity and quality with reference to export value and domestic demand. The Indian Planning Commission approved establishment of an independent National Research Centre on Seed Spices (NRCSS) during the IX Five-year Plan and came into being on April, 22, 2000. The site selection committee constituted in 1998 by ICAR, recommended establishment of NRCSS at the site offered by the Government of Rajasthan with 50 acres of land.

2.2 Location and Climate

The NRCSS is located in Tabiji farm area on the Ajmer-Beawar road 13 km away from railway station in the city. The Ajmer city is well connected by road and railway line to Ahmadabad and Delhi with distance of 516 km and 388 km, respectively in opposite directions. The nearby airport is Jaipur, situated about 125 km away from Ajmer. The centre lies on 74° 35' 39" E to 74° 36' 01" longitude and 26° 22' 12" to 26° 22' 31" N latitude at an altitude of 460.17 m above mean sea level. The soil of the research farm is sandy loam, poor in fertility and water holding capacity, having pH 8 to 8.3, EC 0.07 to 0.12 and 0.15 to 0.23% organic carbon, available N 178.5 kg/ha (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 2018-19 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 2018-19 are presented in Annexure 1.

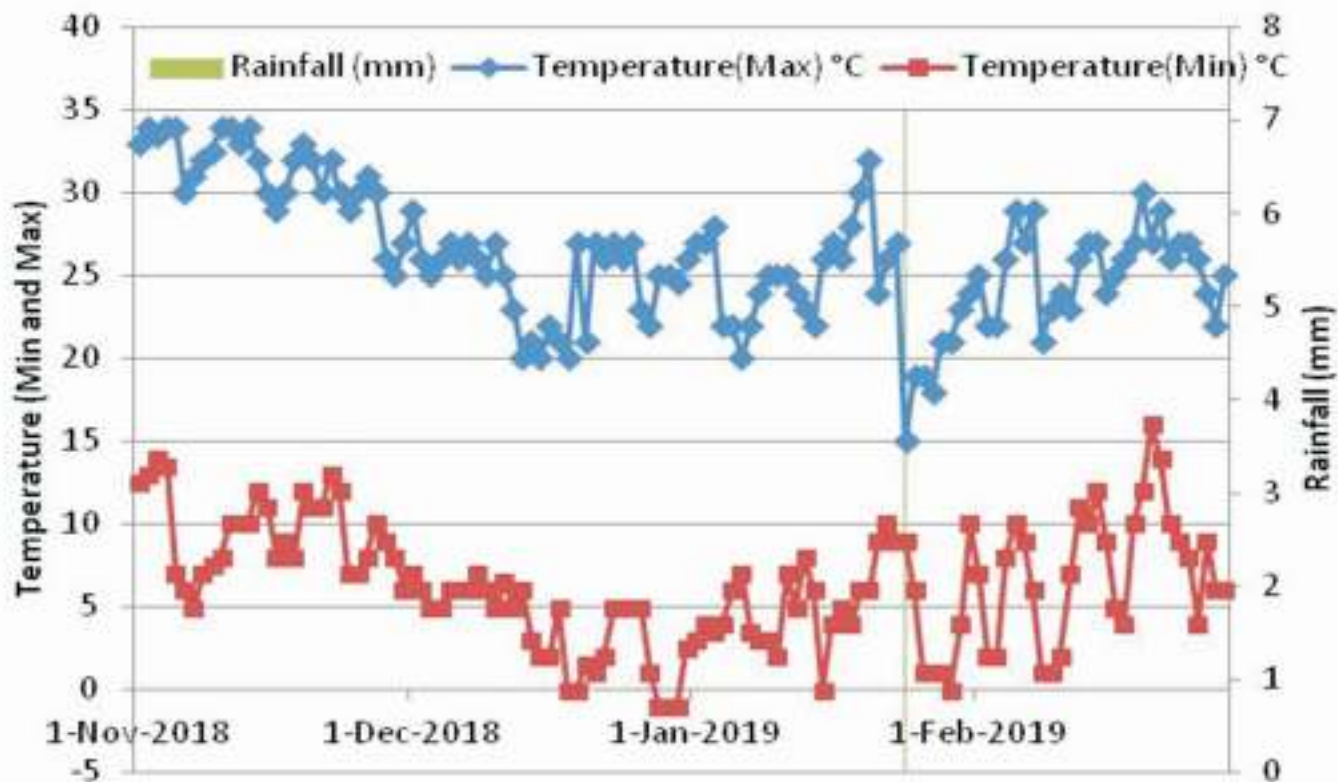
The maximum monthly rainfall of 125.6 mm was recorded during August, 2018, whereas it was 360.0 mm during August, 2019. The total rainfall was 480.3 during 2018, whereas it was 760.3 mm during 2019 with 37 rainy days during the year. The rainfall was higher by 43.7 % during 2019 as compared to the mean annual rainfall of 529.0 mm (for the 100 years) in the area. The minimum temperatures drops to 0 °C on 15th and 29th January, 2019 and a frost event was happened which damaged the seed spices and other crops to some extent in the area. Whereas, maximum temperature of 47.0 °C were recorded on 9th June during 2019 and remained ≥ 45.0 °C from 31 May, 2019 to 10 June, 2019. The lowest relative humidity was 25.3 per cent on 18th March, 2019 while the highest (96%) was recorded on several occasions during the year. The total open pan evaporation during the year 2018 and 2019 were 3153.8 and 3243.8 mm, which was 8.6 and 8.9 mm/day during 2018 and 2019, respectively. The evaporation remains ≥ 19.4 mm/day during April-June, 2019. The lowest evaporation of 0.0 mm/day was recorded at many times during August, 2019 whereas the highest evaporation were recorded 30.0 mm/day during 29-30 April, 2019.

2.4 Mandate

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

2.5 Mandate crops

1. Coriander (*Coriandrum sativum* L.)
2. Cumin (*Cuminum cyminum* L.)
3. Fennel (*Foeniculum vulgare* Mill.)
4. Fenugreek (*Trigonella foenumgraecum*, *Trigonella corniculata* L.)
5. Ajwain (*Trachyspermum ammi* Sprague)
6. Dill (*Anethum graveolens* L., *Anethum sowa* Kurz.)



Daily weather data at Tabiji

The weather parameter during cropping season 2018-19 at Tabiji, Ajmer

- 7. Nigella (*Nigella sativa* L.)
- 8. Aniseed (*Pimpinella anisum* L.)
- 9. Celery (*Apium graveolens* L.)
- 10. Caraway (*Carum carvi* L.)

2.6 Objectives

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

2.7 FINANCIAL OUTLAY (Rs in Lakhs)

HEAD	Govt. Grant (2019-20)	
	Budget	Expenditure
Minor works	20.00	20.00
Equipment	21.96	16.62
Information technology	5.18	5.18
Furniture and fixture	2.85	2.85
Others SCSP capital	15.00	15.00
Salaries	575.00	562.00
Pension	55.00	51.97
Travelling allowance	16.35	16.35
Research & Operation	94.04	94.04
Administrative expenses	82.14	110.66
Miscellaneous expenses	7.48	7.48
TSP	10.00	10.00
NEH	25.00	24.86
SCSP	35.00	34.99
Total	965.00	972.00

2.8 STAFF POSITION on 31-12-2019

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



3. Research Achievements

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

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

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

Germplasm Collection: Total 86 germplasm lines were collected in different seed spices. One germplasm exploration was made in Jammu & Kashmir with the collaboration of NBPGR, New Delhi which consist of coriander (8), fenugreek (3) and fennel (3). One another germplasm exploration was made in Kota and Madhya Pradesh with the collaboration of NBPGR, New Delhi which includes fenugreek (2), coriander (35), fennel (1) and ajwain (14). A part from these explorations, 10 genotypes of kasuri methi collected from Nagaur district of Rajasthan. In another exploration, 7 coriander, 1 cumin, 1 nigella & 1 ajwain lines were collected from the Kota, Rajasthan (Table 3.1). Thus total seed spices germplasm assemblage at National Active Germplasm Site, ICAR-NRCSS, Ajmer has reached 2331.

Table 3.1: Total germplasm assemblages holding 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	2245+86=2331

Germplasm Evaluation: Curators maintained and evaluated germplasm and recorded observations as per descriptors. Crop wise details are given below:

Fenugreek germplasm evaluation:

Two hundred lines of fenugreek sown with five checks evaluated in Augmented Block Design for yield and its contributing traits. The plot size was 3 x 2 meter 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 entries for all the traits including seed yield. The seed yield ranged from 22.6 g to 490.0 g. Variability was recorded (Table 3.2) for as below:

Table 3.2 : Variability recorded in fenugreek germplasm

Character	Mean	Minimum	Maximum	CV (%)
Plant height (cm)	55.98	25.2	80.5	10.2
Primary branch	3.9	2.3	6.1	7.3
Secondary branch	6.2	3.1	9.2	5.6
No. of pods/plant	74.28	20	135	16.8
No. of seed/pod	16	10	19	6.5
Test weight (g)	11.94	1.5	16.8	6.8
Seed yield (g)	270	22.6	490	18.3

Out of 200 genotypes, 14 genotypes were recorded higher yield as compare to check namely, AM-176, AM-190, IC-266838, IC -339884, IC-262192, AM-170, AM-95, AM-155, AM-192, AM-158, IC-334411, IC-332296, AM-82 & AM-157. It will be utilized in future breeding programme for further improvement.

Evaluation of kasuri methi:

Eleven test entries of kasuri methi with one check were evaluated in Augmented Block Design for yield and its contributing traits in a plot size of 3 x 2 meter. The line to line spacing was 30 cm and plant to plant distance was 20 cm which was maintained by thinning. The analysis of variance revealed significant difference among the entries for all the traits including seed yield (Table 3.3). The seed yield ranged from 165 g to 230.6 g. The highest yield recorded in genotype RSM-18-20.

Coriander germplasm evaluation:

Total 120 lines of coriander sown with four checks in Augmented Block Design and tested for yield and its contributing traits in a plot size of 3 x 2 meter. The line to line spacing was 30 cm and plant to plant distance was 10 cm which was maintained by thinning. The analysis of variance revealed significant difference among the entries for all the traits including seed yield (Table 3.4). The seed yield ranged from 20 g to 455 g. Variability recorded as under:

Table.3.3: Performance of kasuri methi genotypes for ancillary characters

Genotype	Plant height (cm)	Primary branches	Secondary branches	Pod/plant	Seed/pod	Test weight (g)	Yield (g)
RSM-18-30	55	6	12	75	17	1.7	210
RSM-18-31	50	7	12	82	17	1.8	195
RSM-18-20	60	8	13	90	20	2.0	230.6
RSM-18-32	52	6	11	84	18	1.6	172
RSM-18-33	62	5	10	74	16	1.8	165
RSM-18-34	54	5	11	68	18	1.6	180
RSM-18-16	55	6	10	72	19	1.8	192
RSM-18-19	56	6	10	65	17	1.7	175
RSM-18-15	58	7	11	67	18	1.8	191
RSM-18-18	55	7	10	75	17	1.7	215
IC-342428	58	8	10	76	18	1.7	200
Pusa kasuri (C)	62	6	10	67	17	1.6	165
Mean	56.61	6.41	10.83	74.58	17.66	1.73	206.7
CD(0.05)	0.8	1.21	1.24	2.23	1.56	0.72	1.52
CV (%)	1.01	1.32	1.51	2.54	1.76	0.86	1.74

Table 3.4 : Variability recorded in coriander germplasm

Character	Mean	Minimum	Maximum	CV (%)
Plant height (cm)	60.2	30	70	8.2
Primary branches	4.5	3	6	5.3
Secondary branches	9	3	11	8.6
Umbel/ plant	40	19	65	30.3
Umbellate / umbel	4.5	2	5	14.2
Seed /umbellate	5	2	7	13.3
Test weight(g)	12.3	7	14.6	13.4
Seed yield (g)	275	20	455	50.2

High yield performance was recorded in the genotypes namely RSM-C18-A30, RSM-C18-A11, RSM-C18-A22, RSM-C18-N, GG-JHALAWAD, RSM-C18-A18, RSM-C18-A15, RSM-C18-A23, RSM-C18-A8.

Fennel germplasm evaluation:

200 fennel lines with four checks sown in Augmented Block Design and evaluated for yield and its contributed traits in a plot size of 3 x 2 meter. The line to line spacing was 60 cm and plant to plant distance was 30 cm which was maintained by thinning. The analysis of variance revealed significant difference among the entries for all the traits including seed yield. The seed yield ranged from 14 g to 597.7 g. Variability recorded as under:

Table 3.5.: Variability recorded in fennel germplasm

Character	Mean	Minimum	Maximum	CV %
Plant height (cm)	158.9	140	189	10.1
Primary branches	8.6	6	11	6.3
Secondary branches	17.5	11	30	8.5
Umbel/plant	46.3	15	67	40.2
Umbellate /umbel	33.2	18	45	17.4
Seed /umbellate	25.32	15	32	16.5
Test weight (g)	6.7	5	8.2	16.3
Seed yield (g)	201	14	597.7	72.3

Ten lines AF-49, AF-48, AF-27, AF-87, AF-98, AF-17, AF-162, AF-94, 598490, AF-45 found elite for seed yield over the check variety.

Varieties Developed:

Two new varieties Ajmer Coriander-3 (ACr-3) and Ajmer Fennel-3 (AF-3) have been released vide notification in 27th CVRC meeting held on 02.09.2019 at New Delhi. Another two varieties Ajmer Ajwain-73 (AA-73), Ajmer Nigella-1 (AN-1) identified in AICRP workshop at T.N.A.U. Coimbatore, (Tamilnadu) and two varieties identified in Rajasthan state varietal released committee (ACel-2) Ajmer Celery-2 and (AgCr-1) Ajmer Green Coriander-1.



Salient Features of the Variety Acr-2

The variety Acr-2 was developed through recurrent selection. It is a variety suitable for leaves and seeds production, performs well under irrigation, essential oil content up to 0.50-0.60% and average yield 12-13 q seeds per hectare. The plants are semi erect, seeds are medium in size, seed shape oval and suitable for export purpose. The plants are resistant to stem gall and have tolerance to powdery mildew. This variety is suitable for cultivation for green leaves during off-season also.

ACr-2 variety has been identified for notification on 5th November, 2018 in Krishi Bhawan, New Delhi.



Salient Features of the Variety ACr-3

The variety of coriander i.e. ACr-3 gave 13.09 q/ha average seed yield, variety ACr-3 screened against powdery mildew disease. It is 5-10 days earlier than the tested checks. ACr-3 is superior in quality. Its seed contains 0.55% essential oil which was 22.2 and 7.84 % higher than Hisar Anand and RCr-728 respectively. Its essential oil contains 75.42% linalool.

Ajmer Coriander-3 (ACr-3) has also been identified for notification in 27th CVRC meeting on 02.09.2019 at New Delhi



Salient Features of the Variety AF-3

The fennel variety AF-3 gave 21.43 q/ha average seed yield, which is 12.6% and 9.95% higher as compared to national check RF-205 and RF-101 respectively in 27 trials conducted at different locations across the country. The variety AF-3 gave 20.44 q/ha average seed yield which is 7.35% and 4.83%. AF-3 is moderately resistant to Ramularia blight diseases is superior in quality and its seed contains 1.9% essential oil.

Ajmer Fennel-3 (AF-3) has been identified for notification in 27th CVRC meeting on 02.09.2019 at New Delhi

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

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

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

A station trial on dill was conducted during 2018-19 to find out genotype with higher yield, quality non-seed shattering. The experiments consisted of 13 test entries and two checks varieties (AD-1 & AD-2). The entries AD-S-1-24 recorded maximum (197.6 cm) plant height followed by AD-S-45 (194.2 cm). Maximum (12.4) number of primary branches was recorded in genotype AD-S-44 followed by Genepool (12.2), while the maximum (36.1) secondary branched was recorded on

AD-S-1-28 followed by AD-S-44 (35.9). Maximum number of umbel per plant was recorded on AD-S-28 (61) followed by Genepool (56.6) likewise maximum (39.3) number of seed per umbellate was recorded on AD-S-28 followed by Genepool (38.7). With regards to yield kg/ha, maximum yield (2318.1 kg/ha) was recorded on AD-S-1-28 followed by AD-S-44 (2241.7 kg/ha) and Genepool (2233.8 kg/ha), it was significantly higher when compared to AD-1 (2141.5 kg/ha) & AD-2 (1876.2 kg/ha). Data presented in table 3.6 revealed that the lowest (28.8 kg/ha) seed shattering was recorded on genotype AD-2 and AD-67, which were non significant with other genotypes, similarly, among the test entries maximum oil content (2.41%) was recorded on genotype AD-S-1-28 followed by AD-50 (2.34%).

Table: 3.6: Ancillary characters of dill genotypes

Genotype	Plant height (cm)	Primary branches	Secondary branches	Umbel /plant	Seed/ umbellate	Yield (kg/ha)	Seed shattering (kg/ha)	Essential oil (%)
AD-2	183.1	10.6	33.9	43.0	33.3	1876.2	28.8	1.76
AD-1	181.8	11.1	35.1	45.0	32.7	2141.5	29.5	2.11
Genepool	183.3	12.2	34.7	56.6	38.7	2233.8	31.0	2.33
AD-67	193.6	12.1	29.0	48.3	34.3	1321.6	28.8	2.25
AD-S-1-28	192.7	12.2	36.3	61.0	39.3	2318.1	32.8	2.41
AD-S-3-35	192.6	12.1	28.8	48.0	34.7	1770.2	33.0	1.95
AD-S-44	192.6	12.4	35.9	57.6	38.3	2241.7	33.3	2.23
AD-S-1-24	197.6	11.3	29.8	45.0	35.7	1803.9	30.6	1.90
AD-S-11	188.2	11.4	33.2	43.0	30.0	1340.7	29.4	2.15
AD-S-14	179.9	10.7	27.6	42.9	30.0	1347.6	34.1	1.76
AD-S-50	185.4	11.1	32.3	44.9	28.0	1845.4	30.7	2.34
AD-S-1-3	187.2	11.2	30.1	46.4	29.3	1759.3	28.9	1.14
AD-S-3-8	184.4	11.1	28.0	44.8	30.7	1482.8	30.3	2.33
AD-S-3-2	188.7	11.8	25.8	47.3	28.7	1665.7	29.9	2.16
AD-S-45	194.2	12.1	27.3	45.3	33.3	1797.2	29.8	2.18
CD(5%)	N/A	N/A	4.9	5.2	3.1	152.3	N/A	0.424

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

(PI: S.S. Meena; Co-PI: 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 2018-19. All observations on

growth parameters such as yield and yield attributing traits were recorded. In the experiment maximum seed yield (1662.00 kg/ha) was recorded in AA-3 genotypes followed by AA-51 (1630.67 kg/ha) as compared which was higher than national check. Data on ancillary characters presented in Tables 3.7 given below:

Table 3.7: Ancillary characters of ajwain genotypes

Genotypes	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/plant	Diameter of main umbel (cm)
AA-1	118.00	17.00	193.33	5.23
AA-2	118.33	17.33	247.33	5.50
AA-84	119.00	15.33	189.00	5.53
AA-74	114.00	16.00	215.67	5.13
AA-43	111.00	13.67	252.33	5.47
AA-51	114.00	14.33	223.67	5.07
AA-45	123.00	15.00	221.67	5.30
AA-96	118.33	16.00	244.33	5.30
GA-1	123.00	16.00	227.67	5.00
AA-85	114.00	14.00	206.67	5.20
AA-27	116.67	18.33	245.67	5.40
AA-100	120.00	15.33	210.67	5.40
AA-44	125.33	16.33	214.33	5.50
AA-3	120.00	15.33	217.33	5.67
AA-61	125.00	16.33	208.67	5.20
C.D.	7.43	2.28	20.15	0.32
SE(m) ±	2.55	0.78	6.92	0.11
C.V. %	3.72	8.59	5.42	3.61

Table 3.8: Ancillary characters of ajwain genotypes

Genotypes	No. umbels / plant	No. of umbellates / umbel	No. of seeds / umbellate	Seed yield (kg/ha)	Test weight (g)	Essential oil (%)	Essential oil (kg/ha)
AA-1	504.67	19.30	22.07	1402.17	0.56	6.42	89.97
AA-2	340.33	16.17	24.13	1138.23	0.65	5.99	68.14
AA-84	422.67	17.73	22.10	1225.67	0.83	6.17	75.67
AA-74	351.67	17.67	23.33	1221.07	0.72	6.21	75.83
AA-43	237.67	17.43	21.80	1257.50	0.81	6.55	82.37
AA-51	527.67	19.57	23.43	1630.67	0.79	6.41	104.47
AA-45	363.67	18.00	21.47	1007.53	0.78	7.16	72.14
AA-96	420.33	16.13	21.50	1414.10	0.65	6.45	91.21
GA-1	297.00	16.00	21.63	1091.73	0.76	6.47	70.60
AA-85	415.00	17.60	21.07	1343.17	0.83	4.30	57.71
AA-27	288.00	17.00	22.30	1385.50	0.63	6.63	91.86
AA-100	450.67	17.00	22.60	1055.57	0.69	6.39	67.49
AA-44	415.0	18.37	22.33	1393.33	0.74	6.48	90.24
AA-3	531.00	20.33	23.50	1662.00	0.71	6.70	111.41
AA-61	464.67	19.17	22.00	1258.57	0.63	9.83	123.72
C.D.	55.75	2.24	1.77	172.46	N/A	0.76	11.48
SE(m) ±	19.14	0.77	0.61	59.23	0.06	0.26	3.94
C.V. %	8.25	7.46	4.70	7.90	15.04	6.91	8.05

The second station trial was also conducted for bold seed type ajwain as per the farmers preference and market demand. For this purpose, 14 test entries and one check variety namely Ajmer Ajwain-1 was evaluated during the year 2018-19. Important observations such as growth parameters, yield attributes and yield were recorded. Higher yield attributes and yield (1757.67

kg/ha) has been recorded in AA-95 genotypes followed by AA-99 (1695.33 kg/ha) as compared to national check. Maximum essential oil was recorded in AA-24 genotype (164.97 kg/ha) followed by AA-95 (113.31kg/ha). All ancillary characters were recorded and data presented in Table 3.9 given below.

Table 3.9: Performance of ajwain genotypes in trial for bold seed

Genotypes	Plant height (cm)	No. umbels /plant	No. of umbellates /umbel	Seed yield /plant (gm)	Seed yield (kg/ha)	Test weight (gm)	Essential oil (%)	Essential oil (kg/ha)
AA-16	118.20	455.00	18.00	46.40	1060.17	0.75	5.04	53.40
AA-24	112.33	448.60	19.20	63.43	1658.00	0.72	9.95	164.97
AA-27	116.80	375.40	15.00	61.60	1438.33	0.82	6.08	87.45
AA-31	120.20	338.00	18.90	53.07	1440.00	0.67	5.53	79.63
AA-37	118.70	407.50	18.30	61.87	1576.17	0.60	5.42	85.38
AA-52	110.30	348.20	18.50	51.80	1380.33	0.68	6.30	87.00
AA-56	111.40	419.50	17.30	57.23	1574.33	0.55	5.99	94.36
AA-61	114.60	343.50	18.10	54.17	1616.00	0.66	6.28	101.54
AA-63	120.50	427.60	16.50	54.13	1222.50	0.63	4.93	60.27
AA-67	119.30	414.50	18.80	54.40	1374.67	0.87	5.51	75.70
AA-72	107.00	426.80	17.90	53.93	1381.00	0.75	5.45	75.22
AA-95	118.27	514.10	18.80	72.50	1757.67	0.74	6.45	113.31
AA-98	123.20	346.40	17.90	57.63	1370.83	0.68	6.67	91.39
AA-1©	121.87	364.80	17.70	55.53	1583.40	0.90	5.62	88.93
AA-99	109.90	479.10	18.50	65.37	1695.33	0.82	5.42	91.94
C.D.	8.12	68.97	2.00	10.72	268.08	N/A	0.83	16.69
SE(m) ±	2.79	23.69	0.69	3.68	92.07	0.09	0.28	5.73
C.V.%	4.16	10.07	6.63	11.08	10.81	20.55	8.15	11.03

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

(PI: A.K. Verma; Co-PI: S. Choudhary and R.D. Meena; 2014-19, extended to 2020)

In the year 2018-19, 121 mutant lines of fennel with two checks, RF-125 & AF-1 were sown. Two cumin mutant lines were also evaluated during the present investigation. Data presented in table 3.10 revealed that the highest (44.1%) coefficient of variation (CV) was recorded for plant height which ranges from 65 cm to 205 cm, followed by number of umbel per plant (27.5%), seed yield per plant (25.2%), number of secondary branches (24.6%), number of seeds per umbel (23.8%).

Lowest (5.7%) CV was recorded with the days to maturity although the days to maturity among different mutant lines ranged from 157 days to 210 days. Among the mutant lines, some unique characters were induced and found stable like dwarf stature of the plants, early maturity, synchronous flowering, higher yield etc. Total 121 mutant lines of fennel were grown to evaluate the stability of the selected mutants and characters. Out of which 47 mutant lines were found promising and selected for the further evaluation. Two selected cumin mutant lines (GC/200/25/3 and GC/200/15/5) in M₂ generation of were evaluated in M₃ generation for yield and yield attributing characters.

Table 3.10: Mean, range and coefficient variation of the traits among the selected fennel mutants

Traits	Minimum	Maximum	Average	CV (%)
Plant height (cm)	65	205	135	44.1
Number of primary branch	6	13	9.5	18.7
Number of secondary branch	16	45	30.5	24.6
Number of umbel per plant	23	84	53.5	27.5
Number of umbellate/umbel	15	29	22	13.3
Number of seeds per umbel	272	972	622	23.8
Days to maturity	157	210	183.8	5.7
Seed yield per plant (g)	25	181	103	25.2

Wide variability was recorded among the selected mutant lines & fennel with respect to yield and yield contributing characters. Among the selected mutant line of fennel variability was recorded wide with respect to yield and yield contributing characters (Fig. 1 and Table 3.10). The plant height of mutant lines varies from 65 cm to 205 cm and maximum (44.1%) coefficient of variation was recorded with plant height of the mutants. The targeted trait day to maturity ranges from 157 days to 210 days with minimum (5.7%) coefficients of variation.

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

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

A trial was conducted with 11 test entries and two check varieties (Ajmer *Nigella*-20 and Azad Kalongi) during 2018-19. All observations such as growth parameters, yield attributes and yield were recorded. Higher yield attributes and yield (1368.67 kg/ha) had been recorded in AN- Sel-4-1 genotype as compared to national check. All necessary observations were recorded and data presented in tables 3.11 and 3.12.

Table 3.11: Performance of nigella genotypes

Genotypes	Plant height (cm)	No. of primary branches /plant	No. of secondary branches /plant	Days to 50% flowering
AN-9	65.67	7.93	15.63	101.33
AN-16	64.33	7.20	17.23	101.33
AK	68.00	7.77	21.37	99.33
AN-20	68.67	8.33	21.57	99.67
SEL-10	68.33	9.50	26.73	103.67
SEL-9	65.67	7.40	23.63	105.67
SEL-5	68.33	7.67	25.13	101.67
SEL-4-1	71.33	8.07	20.73	100.67
SEL-4	63.67	7.53	21.80	99.00
AN-24	58.00	6.27	13.40	102.33
AN-19	75.67	8.13	16.63	103.00
AN-10	63.00	6.60	13.63	101.67
AN-4	68.00	7.00	16.53	103.00
C.D.	5.07	1.21	1.47	2.56
SE(m) ±	1.73	0.41	0.50	0.87
C.V.%	4.48	9.36	4.42	1.49



a Early (50 days) flowering mutant, b Dwarf (82 cm) mutant which mature in 161 days, c Mutant line having high no. of seeds per umbel, d Dwarf (67 cm) and early maturing mutant (157 days)

Table 3.12: Performance of nigella genotypes

Genotypes	No. of siliqua / plant	No. of seeds / siliqua	Seed yield / plant (g)	Seed yield (kg/ha)	Test weight (g)	Total Oil (%)
AN-9	65.93	84.07	38.67	775.83	2.40	16.200
AN-16	70.27	90.53	43.00	929.33	2.42	17.750
AK	70.33	93.67	33.00	719.83	2.31	14.795
AN-20	62.57	94.27	26.67	900.67	2.42	13.390
SEL-10	71.53	99.00	51.67	1025.33	2.52	15.355
SEL-9	69.53	87.67	44.00	872.00	2.45	21.155
SEL-5	67.60	81.33	51.00	925.67	2.43	21.550
SEL-4-1	77.03	88.07	66.00	1368.67	2.52	16.785
SEL-4	57.23	79.40	29.67	695.67	2.34	15.530
AN-24	64.87	75.93	39.67	627.67	2.52	20.970
AN-19	63.27	78.27	40.00	953.67	2.42	17.415
AN-10	64.43	75.93	20.67	781.33	2.38	14.735
AN-4	71.13	62.73	33.00	713.67	2.56	17.885
C.D.	3.58	3.27	2.63	45.31	N/A	2.167
SE(m) ±	1.22	1.11	0.89	15.43	0.08	0.738
C.V. %	3.13	2.30	3.89	3.08	5.81	7.435

CI/16.2.2: Breeding for yield and quality in celery

(PI: R.S. Meena; Co-PI: S. Choudhary, N.K. Meena, A.K. Verma, Ravi, Y., RD.Meena; 2016-21)

In the trial, 12 test entries with one check sown in augmented block design for evaluation of yield and its contributed traits. The size of plot was 3 x 2 meter and

seed sown 60 cm row to row and 20 cm plant to plant which was maintained by thinning. The analysis of variance revealed significant difference among the entries for all the traits including seed yield. The seed yield ranged from 1.01 to 4.93 q/ha. Variability recorded as under:

Table 3.13: Performance of celery genotypes

Entries	Plant height (cm)	Pri. bran.	Sec. bran.	Umbel/ plant	Umbellate/ umbel	Seed/ umbellate	Test weight (g)	Yield (q/ha)	Essential oil (%)
A-Cel-8	80.2	6.4	11.3	60.1	10.2	14.3	0.59	3.48	1.5
A-Cel-4	62	7.1	10.2	41.2	11.2	14.3	0.41	3.00	0.8
A-Cel-11	79.3	6.2	11.2	54.6	8.6	12.6	0.48	3.34	1.3
A-Cel-13	82	6.1	10.5	48.2	9.6	13.2	0.46	2.56	1.7
A-Cel-15	67.3	5.1	8.1	34.4	7.2	10.6	0.31	1.01	0.8
A-Cel-25	85	6.4	11.2	70.1	11.5	14.2	0.61	4.93	1.5
Karnoli-3	90.2	7.2	12.3	70.5	10.8	16.3	0.38	2.54	1.5
Karnoli-9	66.2	6.1	11.1	53.2	10	14.3	0.52	2.82	1.4
Karnoli-10	70.8	6.4	10.4	51.9	11.1	14.1	0.42	3.58	0.8
Karnoli-13	78.4	6.7	10.8	68.2	10.4	14.5	0.43	4.0	1.9
A-Cel-2	82	6.3	11.1	72.3	12	15.3	0.53	4.37	1.6
A-Cel-1	92.3	6.8	11.5	67.9	10.6	15.1	0.57	4.68	1.7
Mean	77.9	6.4	10.8	57.7	10.2	14.0	0.48	3.36	1.3
CV (%)	1.24	1.12	2.31	2.14	1.54	2.53	0.97	2.87	0.68

Entry A-Cel-25 (4.93 q/ha) was recorded highest seed yield and karnoli-13 recorded maximum (1.9%) essential oil which was higher than check varieties A-Cel-1 (4.68 q/ha & 1.7%).

Ajmer Celery-2 (A-Cel-2) identified for state release in 33rd meeting of SVRC, on 23.08.2019 at Jaipur.



Photo of plant and seed of Ajmer Celery-2 (A-Cel-2)

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)

Station trial-1 was conducted with 37 elite lines and two checks (GC-4 & RZ-209) to evaluate the available germplasm of cumin for higher yield and quality. Cumin germplasm lines SPS-14/13 (690.7 kg/ha), SPS-28/1 (670.0 kg/ha) and Barmer Hairy Cumin (667.3 kg/ha) were recorded higher yield as compare to check variety GC-4 (656.4 kg/ha). In second experiment, 42 germplasm lines of cumin screened under sick plot against *Fusarium wilt* in cumin. No germplasm lines were recorded resistance against wilt although germplasm lines SPS-14-A-17-18 and SPS-5-A-17-18 were recorded

lowest wilt incidence i.e. 19.2% and 19.3% respectively.

Cumin floral biology: The inflorescence is compound umbel. The corolla is made-up of five petals and flower has five stamens (Fig. 1&2). It has bicarpellary gynoecium (fused ovary, stigma and a style) and have two styles. The ovary is inferior and bilocular. So far no any type of sterility has been reported in cumin. The complete process of flowering for one single umbel takes about 5-7 days. The fruits (schizocarp) can be split into the two mericarps (having a single seed). No natural crossing was recorded between hairy and non hairy cumin may be due to high rate of self pollination and or cross incompatibility between two lines.



Cumin flower development stages (a-f)



Reproductive parts of cumin flower

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

(PI: Ravi Y. (on study leave from August 2019); Co-PIs: S.N. Saxena (PI w.e.f. August 2019) and O.P. Aishwath; 2018-21)

In the experiment, seeds of fifteen fennel and cumin genotypes including popular varieties were screened for salinity stress under culture dish condition. Pre developed saline solutions were prepared and applied to the culture dishes at definite intervals.

Table 3.14: Effect of different levels of salinity on germination, shoot length and root length of fennel genotypes

Salinity Level vs Genotypes	Germination (%)						Shoot length						Root length					
	S1	S2	S3	S4	S5	Mean	S1	S2	S3	S4	S5	Mean	S1	S2	S3	S4	S5	Mean
AF-01	47.50	20.00	22.50	10.00	7.50	21.50	4.84	4.20	1.62	1.49	0.00	2.43	2.59	2.54	3.35	2.27	1.95	2.54
RF-143	57.50	65.00	45.00	55.00	30.00	50.50	4.36	6.76	5.96	3.8	1.14	4.39	2.07	3.35	2.37	2.06	1.07	2.18
Azad Sounf	70.00	65.00	70.00	65.00	45.00	63.00	4.90	4.43	5.30	5.26	4.69	4.97	4.56	4.11	4.10	4.07	4.05	4.17
HisarSwarup	65.00	52.50	40.00	47.50	17.50	44.50	5.39	4.40	3.57	3.52	0.92	3.52	4.00	3.20	3.72	3.53	0.60	3.01
RF-125	72.50	60.00	55.00	40.00	35.00	52.50	3.59	4.98	5.16	3.48	2.44	3.93	2.40	3.97	3.72	2.69	0.78	2.71
RF-101	37.50	40.00	32.50	20.00	17.50	29.50	4.41	5.49	3.05	1.60	0.00	2.91	2.78	5.86	3.30	2.19	2.33	3.29
Guj. Fennel-1	72.50	82.50	70.00	65.00	35.00	65.00	4.70	6.40	4.02	1.92	0.93	3.59	3.79	6.13	4.81	3.20	3.74	4.33
Guj. Fennel-2	32.50	45.00	42.50	37.50	35.00	38.50	5.65	4.95	5.01	3.62	3.12	4.47	4.43	4.20	3.05	2.05	2.25	3.19
Pant Madhurika	22.50	32.50	22.50	17.50	15.00	22.50	3.20	4.25	1.80	2.51	4.13	3.18	1.58	3.46	1.00	1.75	2.07	1.97
Raj. Sourabha	10.00	5.00	7.50	5.00	0.00	5.50	4.65	0.00	0.00	0.00	0.00	0.93	0.62	0.26	0.30	0.34	0.00	0.30
AF-302	100.0	80.00	90.00	92.50	75.00	87.50	4.55	5.30	5.55	3.50	3.47	4.47	3.29	4.95	4.90	4.05	4.00	4.21
AF-01-521	80.00	55.00	75.00	67.50	57.50	67.00	7.31	4.97	5.69	5.26	4.07	5.51	5.62	4.72	5.43	4.93	4.28	4.99
AF-01-172	82.50	82.50	70.00	67.50	42.50	69.00	3.07	5.88	5.60	4.63	3.99	4.63	2.52	4.81	4.85	5.24	3.50	4.18
AF-72	77.50	75.00	65.00	70.00	72.50	72.50	5.89	6.23	5.78	3.98	0.62	4.50	4.50	5.22	4.36	4.52	1.75	4.07
AF-30	90.00	70.00	72.50	72.50	72.50	75.50	4.50	5.57	5.65	4.93	3.66	4.86	3.68	4.80	5.95	4.66	4.47	4.71
Mean	61.17	54.67	51.17	49.00	38.50		4.73	4.92	4.26	3.26	2.24	3.22		4.10	3.68	3.17	2.45	
		-				CD (@0.05)		S.Em±				CD (@0.05)		S.Em±				CD (@0.05)
A (salinity level)		3.06				8.64		0.24				0.70		0.27				0.76
B (genotypes)		1.77				4.99		0.14				0.40		0.15				0.43
AXB		6.86				19.33		0.55				1.56		0.64				1.70

NOTE: S1: EC 0dSm-1 (Control); S2: EC 4dSm-1; S3:EC 8dSm-1; S4:EC 12dSm-1; S5:EC 16dSm-1

With respect to germination percentage of cumin, irrespective of NaCl concentrations the genotype JC-9-89 (68%) recorded significantly maximum germination percentage which is on par with AE-WMT-16-40 (66.80%), whereas the varieties GC-3, RZ-19 and RZ-223; and the genotype AKV-102 failed to germinate under in vitro condition. The genotype Hairy cumin recorded maximum shoot length (3.08 cm) which is on par with

GC-2 (2.90 cm) and the lowest was recorded in AKC-103 of 0.64cm. Significantly maximum root length was observed in AKV- 103 (3.43cm) which is on par with followed by RZ-209 (3.04 cm) and GC-2 (2.89 cm) and least was recorded by AE-WMT-16-40 (1.708 cm). Further the varieties GC-3, RZ-19 and RZ-233 and; the genotype AKV-102 recorded no shoot and root length due to non-germination under in vitro condition (Table 3.15).

Table 3.15: Effect of different levels of salinity on germination, shoot length and root length of cumin genotypes.

Salinity Level vs Genotypes	Germination (%)						Shoot length						Root length					
	S1	S2	S3	S4	S5	Mean	S1	S2	S3	S4	S5	Mean	S1	S2	S3	S4	S5	Mean
GC-2	48.00	44.00	54.00	84.00	76.00	61.20	3.38	4.20	3.47	1.97	1.49	2.90	1.74	5.03	4.68	3.00	0.00	2.89
GC-3	0.00	0.00	0.00	0.00	0.00	00.00	0.00	0.00	000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GC-4	82.00	70.00	50.00	50.00	28.00	56.00	2.81	3.62	2.66	0.41	0.35	1.97	1.64	3.50	3.27	0.49	0.46	1.87
RZ-19	0.00	0.00	0.00	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Cumin	58.00	52.00	70.00	50.00	42.00	52.80	3.53	4.08	3.89	2.94	0.98	3.08	1.99	2.43	3.52	3.38	0.46	2.35
RZ-209	44.00	56.00	50.00	36.00	36.00	44.40	2.81	3.85	3.12	2.78	0.35	2.58	1.74	4.72	3.89	4.49	0.37	3.04
UC-341	44.00	52.00	46.00	42.00	0.00	36.80	2.99	2.55	0.82	1.97	0.00	1.66	2.30	2.23	1.42	3.00	0.00	1.79
AE-WMT-16-40	80.00	70.00	68.00	64.00	52.00	66.80	3.11	3.53	1.97	1.49	0.18	2.05	2.21	2.96	3.00	0.00	0.00	1.70
AKV-102	0.00	0.00	0.00	0.00	0.00	00.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CE-15	38.00	38.00	20.00	0.00	0.00	19.20	1.65	1.66	0.52	0.10	0.00	0.78	4.80	4.35	2.83	0.46	0.00	2.48
AKV-103	76.00	60.00	64.00	50.00	0.00	50.00	3.26	3.91	3.60	2.35	0.00	2.62	3.81	3.05	2.09	0.49	0.00	3.43
AKV-163	76.00	44.00	44.00	36.00	0.00	40.00	1.16	1.04	0.62	0.41	0.00	0.64	3.81	3.05	2.09	0.49	0.00	1.88
RZ-223	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BC Bold	78.00	62.00	54.00	64.00	34.00	58.40	1.31	1.05	1.00	0.00	0.00	0.67	3.70	4.70	3.37	0.00	0.00	2.35
JC-989	78.00	78.00	70.00	62.00	52.00	68.00	1.24	1.51	0.70	0.18	0.00	0.72	4.95	4.64	3.11	0.37	0.00	2.64
Mean	46.80	38.67	38.13	38.67	22.27		1.81	2.06	1.49	0.97	0.22		2.16	2.87	2.43	1.28	0.11	
		S.Em±		CD@0.05			S.Em±		CD (@0.05)		S.Em±		CD (@0.05)		S.Em±		CD (@0.05)	
A (salinity level)		3.33		9.38			0.12		0.35		0.20		0.57		0.16		0.33	
B (genotypes)		1.92		5.41			0.07		0.20		0.16		0.33		0.64		1.28	
AXB		7.40		20.98			0.28		0.79		0.64		1.28					

NOTE: S1: EC 0dSm-1 (Control); S2: EC 4dSm-1; S3:EC 8dSm-1; S4:EC 12dSm-1; S5:EC 16dSm-1

Out fifteen fennel and cumin genotypes/ varieties screened against salinity stress under culture dish condition. Irrespective of salinity levels the Fennel genotype AF-302 recorded maximum germination per cent (87%). Whereas the genotype AF-01-521 recorded highest shoot length (5.24 cm) and root length (4.72 cm) (Table 3.14). Cumin genotype JC-9-89 recorded 68% germination, whereas the genotypes Hairy cumin and AKV-103 has recorded significantly maximum shoot length (3.08 cm) and root length (3.43cm) respectively.

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

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

Breeding for dwarfism:

F₂ seed sown in the field and main umbel of F₂ was selfed

and segregants plants were discarded and individual plant seed was harvested separately. F₃ seed of main umbel will be sown in coming season.



Field view of F₃ dwarf fennel

Table 3.16: Screening of fennel (*Foeniculum vulgare*) varieties against Ramularia blight

S. No.	Treatment name	Replication wise PDI			Disease index (PDI)	Disease reaction	Seed yield q/ha
		R1	R2	R3			
1	AF-1 (Control)	18.2	20.4	19.4	19.3	MR	22.00
2	AF-2	14.6	15.8	14.9	15.1	MR	32.22
3	AF-302	12.1	11.7	13.3	12.3	R	26.67
4	AF-01-172-4	8.	9.2	7.3	8.3	R	30.00
5	AF-01-521	11.7	10.8	9.6	10.7	R	25.56
6	AF-256	10.2	12.1	11.4	11.2	R	27.78

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)

Genotype (AF-01-172-4) was reported lowest disease incidence and so considered initially as resistant against Ramularia blight (PDI-7.3), while another genotypes AF-01-521 (PDI-10.7), AF-256 (PDI-11.2) and AF-302 (PDI-12.3) also showed resistance reaction to the disease.

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

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

Wet lab validation of ten stem gall markers (Microsatellites) and six genes have been completed in ten varieties of coriander (Table 3.17). Whole transcriptome sequencing for six coriander samples (seeds and leaf both) were performed and sample wise unigenes were identified based on high mapping and coverage estimated by sample wise read alignments.

21291, 31121, 27311, 38063, 25505 and 31168 unigenes were obtained in coriander leaf and seed samples. Differential expression analysis was carried out on CDS common between coriander leaf and coriander seed samples. 337 to 529 CDS were significantly up-regulated and 777 to 1081 were down-regulated in coriander seed sample with respect to leaf sample. 15300+ SSRs were identified and validated in different coriander varieties. Main genes involved in Monoterpenoid biosynthesis AG, ATH, ALY, PT, GES, ASOL etc were identified in coriander.

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-PIs: A.K. Verma, P.N. Dubey, M.B.N. Naika; 2018-21)

Eight lines of fennel germplasm and varieties were used in the study (AF-1, AF-05-12-1, AF-F2-53, AF-12-5-32, FNL-75, RF-101, AJ-FN-2, GF-11). Crop was sown in two replications for pure seed and experimental data. Seed harvested at 162-170 days of maturity (green, juicy seed) and 192-198 days of maturity (fully mature) for EO extraction.

Table 3.17: Details of genes validated in Coriander varieties for Stem Gall Disease expression

S.No	Gene Name	Primer detail	Genbank Accession No.
1	Leucine Rich Repeat (LRR)	GTCGAATAATTCACCCGAGA ATACGCAGTACAATCCGAAA	MT053859
2	GDSL esterase/lipase (GDSL)	GGTGGTGCATGTAATGAAAA ATGCTGAAGGTTTTTGGACA	MT053860
3	Universal Stress Protein (USP)	GACATCGGCATCTACTGAAG AAAGAGGAGCTTAAAGCCAG	MT053861
4	Ankyrin repeat-containing (ANK)	CACTCTTTGTTTATCGCAGC GATGGGAATAATGGCATCCT	MT053862
5	Probable Disease Resistance (PDR)	GAGGGTTATCTACCAATCC CAGTTTAGCATGGCAGTTAG	MT053863

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

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

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

The cumin seedling germination was highest with T₃ (85 %) and lowest was recorded with control (76.60 %) 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 T₁ *Bacillus subtilis* (10.33) which was at par with T₆ *Bacillus* sp. W1, while minimum was recorded in control (8.0). Similarly, maximum number of secondary branches per plant (28.0) was recorded with T₃ *Pseudomonas fluorescens* and minimum number of secondary branches per plant (20.0) was recorded with control. Highest number of umbels per plant (35.0) was recorded with T₄ *Pseudomonas* sp-1 which was at par with T₃ and T₁. The highest cumin seed yield was obtained with T₃ *Pseudomonas fluorescens* (5.62 q/ha) and lowest was recorded with control (2.91 q/ha) (Table-1). Previously isolated cumin rhizobacteria were screened for antagonism against cumin wilt pathogen (*Fusarium oxysporum* f. sp. *cumini*) through dual culture test on Potato Dextrose agar media and it was observed that only four bacterial isolates could inhibit the growth of pathogen. These cumin rhizobacterial strains were also evaluated for tolerance against Carbendazim 50% WP (Bavistin) at different conc. (0, 0.1, 0.2, 0.4, 0.6 and 1.0 %) and it was observed that majority of selected cumin bacterial isolates can tolerate Carbendazim 50% WP upto 0.4 % conc. in nutrient agar growth medium under laboratory conditions (Table 3.19).

For evaluation 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 and different *Bacillus* strains in various combinations. The highest seedling vigour index (7760) was recorded with T₄ (*Rhizobium*+*B. subtilis* +*B. megaterium*) and lowest seedling vigour index (6430) was recorded with control at 15 days after sowing. The highest seedling dry weight was recorded with T₄ *Rhizobium*+*B. subtilis* +*B. megaterium* (0.120 g) and lowest of the same was recorded with T₇- *Bacillus subtilis* (0.089) at 15 DAS (Table 3.20). 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 nodules per plant (27.0) was recorded with T₄ (*Rhizobium*+*B. subtilis* +*B. megaterium*) which was at par with T₂ whereas the minimum nodules per plant was recorded with control (20.40) at 70 DAS. Similarly, at 105 DAS (pod formation stage), the maximum no. of nodules per plant (38.30) was recorded with T₄ (*Rhizobium*+ *B. subtilis* + *B. megaterium*) which was followed by T₂ (*Rhizobium*+*B. megaterium*) and minimum was recorded with control (31.0). The no. of pods per plant ranged from 25.300 to 40.33 and no. of seeds per pod ranged from 14.66 to 18.40 in the various treatments of fenugreek crop. The highest fenugreek seed yield (15.22 q/ha) was obtained with T₂ (*Rhizobium*+ *B. megaterium*) and lowest was recorded with control (11.44 q/ha) (Table 3.21). Based on 16S rDNA nucleotide homology and phylogenetic analysis, four previously isolated endorhizobacteria isolates from fenugreek roots were identified as *Bacillus aryabhatai* (Rhizo-Fen-3), *Bacillus megaterium* (Rhizo-Fen-8), *Bacillus haynesii* (Rhizo-Fen-12) and *Pseudomonas*

Table 3.18 : Effect of bacterial inoculation on yield and yield attributes of cumin

Treatment	Germination (%) 20 DAS	No. of Primary branches	No. of Secondary branches	No. of umbels per plant	No. of umbelletes per umbel	No. of seed per umbellete	Yield (q/ha)
T ₁ - <i>Bacillus subtilis</i> NRCSS-1	78.33	10.33	25.33	34.00	5.33	6.60	3.93
T ₂ - <i>Bacillus megaterium</i>	81.66	8.33	27.00	32.67	5.00	7.00	3.49
T ₃ - <i>Pseudomonas fluorescens</i>	85.00	8.33	28.00	34.00	5.60	8.30	5.62
T ₄ - <i>Pseudomonas sp.-I</i>	80.00	9.67	24.67	35.00	5.00	7.00	3.40
T ₅ - <i>Bacillus sp.</i>	82.00	9.33	27.33	32.00	5.40	6.60	3.88
T ₆ - <i>Bacillus sp. W1</i>	77.50	10.00	26.33	31.33	5.60	7.40	3.08
T ₇ -Control	76.60	8.00	20.00	29.33	5.20	6.60	2.91
CD@0.05	3.40	1.96	2.10	1.29	NS	NS	1.19

Table 3.19 : Effect of Carbendazim 50% WP (Bavistin) on growth of selected cumin rhizobacteria

S.No.	Bacterial strains	0.4 % Bavistin	S. No.	Bacterial strains	0.4 % Bavistin
1	DCU-22	+	12	DCU-260	+
2	DCU-159	+	13	DCU-261	-
3	DCU-181	-	14	DCU-262	+
4	DCU-184	+	15	DCU-351	-
5	DCU-188	+	16	DCU-453	+
6	DCU-251	+	17	DCU-354	+
7	DCU-252	+	18	DCU-360	-
8	DCU-253	-	19	DCU-364	+
9	DCU-254	+	20	DCU-366	-
10	DCU-258	+	21	DCU-371	+
11	DCU-259	+	22	DCU-651	+

where + = growth, - = no growth
All the selected bacterial isolates were able to grow at 0.2% Carbendazim 50% WP (@2g/kg seed)

Table 3.20 : Effect of microbial inoculation on fenugreek seedling vigour and root nodules

Treatment	Seedling vigour index (20DAS)	Seedling dry weight (g)	No. of nodules/pl. at 35 DAS	No. of nodules/pl. at 70 DAS	No. of nodules/pl. at 105 DAS
T ₁ - <i>Rhizobium</i> + <i>B. subtilis</i>	6950	0.105	14.00	22.30	35.60
T ₂ - <i>Rhizobium</i> + <i>B. megaterium</i>	7340	0.084	11.60	25.00	36.80
T ₃ - <i>Rhizobium</i> + <i>Bacillus sp.</i> + <i>B. subtilis</i>	6857	0.104	12.00	20.30	33.60
T ₄ - <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	7760	0.120	13.30	27.00	38.30
T ₅ - <i>Bacillus sp.</i> + <i>B. megaterium</i>	7520	0.094	16.30	24.60	35.60
T ₆ - <i>Bacillus sp.</i>	6510	0.091	16.00	22.60	33.30
T ₇ - <i>Bacillus subtilis</i>	7120	0.089	12.00	21.00	34.00
T ₈ - <i>Rhizobium</i>	7250	0.107	11.60	23.00	34.00
T ₉ -Control	6430	0.090	11.20	20.40	31.00
CD@0.05	188	0.016	NS	2.68	2.47

Table 3.21 : Effect of microbial inoculation on yield and yield attributes of fenugreek

Treatment	No. of primary Branches/pl.	No. of Pods/pl.	No. Seeds/pod	Yield (q/ha)
T ₁ - <i>Rhizobium</i> + <i>B. subtilis</i>	6.30	28.66	18.00	12.93
T ₂ - <i>Rhizobium</i> + <i>B. megaterium</i>	5.60	40.33	17.40	15.22
T ₃ - <i>Rhizobium</i> + <i>Bacillus sp.</i> + <i>B. subtilis</i>	5.60	33.33	18.20	11.91
T ₄ - <i>Rhizobium</i> + <i>B. subtilis</i> + <i>B. megaterium</i>	6.60	39.33	18.40	12.42
T ₅ - <i>Bacillus sp.</i> + <i>B. megaterium</i>	5.30	26.66	17.60	13.81
T ₆ - <i>Bacillus sp.</i>	5.60	24.66	16.60	12.17
T ₇ - <i>Bacillus subtilis</i>	5.30	30.66	17.00	13.34
T ₈ - <i>Rhizobium</i>	5.00	28.66	15.40	12.72
T ₉ - Control	4.60	25.33	14.66	11.44
CD@0.05	NS	2.65	0.42	2.51

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

(PI: R. Singh; 2016-21, Co-PI: K. Kant, R.D. Meena)

Experiment I: Standardization of crops for bower system during rabi season

Fenugreek and coriander varieties AFg-1 and ACr-1 were raised as sub plot crop during the rabi season in the relay cropping system with vine vegetables. The main plot crops were sown in the standing crop of coriander and fenugreek during January. Vine vegetables namely

bottle gourd (Pusa Naveen), bitter gourd (Pusa Aushadhi) and ridge gourd (Pusa Nutan) were sown as relay crop. The fenugreek and coriander were harvested during March/April. The seed yield of fenugreek were 2389 kg/ha and gave net returns of Rs 31282/ha with B:C ratio of 1.61, Whereas it was 2599 kg/ha in coriander with the net returns Rs 95671/ha along with the B:C ratio of 2.85 (Table 3.22). The effect of vine vegetables on the seed yield, net returns and B:C ratio were non-significant but maximum values were recorded with the bottle gourd.



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

Table 3.22 : Seed yield (kg/ha) and net returns(Rs/ha) of fenugreek and coriander under different vine

Treatment	Seed yield (kg/ha)				Net returns(Rs/ha)			
	Bottle Gourd	Bitter Gourd	Ridge Gourd	Mean A	Bottle Gourd	Bitter Gourd	Ridge Gourd	Mean A
Fenugreek	2,368	2,065	2,733	2,389	31,211	18,641	43,993	31,282
Coriander	2,660	2,723	2,413	2,599	94,638	98,086	94,288	95,671
Mean B	2,514	2,394	2,573		62,924	58,364	69,141	
Factors	C.D.	SE(d)	SE(m)		C.D.	SE(d)	SE(m)	
Factor(A)	N/A	109	77		8,463	4,241	2,999	
Factor(B)	N/A	133	94		N/A	5,195	3,673	
Factor(A X B)	375	188	133		14,658	7,346	5,195	

Experiment II: Standardization of crops for bower system

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 vine vegetables namely bottle gourd taken 25-26 days in germination, ridge guard germinated 28-29 days whereas bitter gourd taken 32-34 days. The average yield of ridge gourd, bottle gourd and bitter gourd were 4424, 12444 and 3549 kg/ha as tier 2 crop. Whereas the yield of leafy vegetables namely fenugreek,

coriander, spinach and amaranths were 1093, 1269, 13139 and 1528 kg/ha which were raised in soil as tier 1 crop below the canopy of tier 2 crop on the bower system. The results in Table 3.24 show that, coriander in rabi for seed followed by bottle gourd + leafy spinach for vegetable during summer (Kharif) gave significantly maximum fenugreek seed equivalent yield (FSEY) to the magnitude of 12842 kg/ha with maximum gross returns (Rs 449465 /ha with net returns of Rs 236365/ha and B:C ratio 2.11. Coriander in rabi for seed followed by ridge gourd + leafy spinach for vegetable during summer (as tier 2 and tier 1 crops in kharif) also gave FSEY of 11674 kg/ha with gross returns Rs 408575/ha, net returns Rs 202025/ha with B:C ratio of 1.98.

Table 3.23 : Fenugreek seed equivalent yield (kg/ha) under different treatments

Rabi crop	Coriander			Fenugreek			
	Summer vegetables	Bottle gourd	Ridge gourd	Bitter gourd	Bottle gourd	Ridge gourd	Bitter gourd
Coriander		8,444	9,997	5,685	7,046	7,012	5,248
Fenugreek		8,977	9,346	7,564	6,418	6,410	4,648
Spinach		12,842	11,674	8,975	9,101	8,780	7,729
Amaranthus		9,805	9,237	6,773	6,935	5,976	4,358
Factors			C.D.	SE(d)	SE(m)		
Factor(A)			370.9	185.9	131.4		
Factor(B)			454.2	227.6	161.0		
Interaction A X B			642.4	321.9	227.6		
Factor(C)			524.5	262.9	185.9		
Interaction A X C			N/A	371.7	262.9		
Interaction B X C			N/A	455.3	321.9		

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

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

Intercropping of seed spices with guava

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

trees in open space. Among the seed spices the fenugreek resulted 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 3.26, 3.27 and 3.28 given below.

Table 3.26 : Effect of guava based intercropping on growth parameters of intercropped

Treatments	Days to Germination	Plant height (cm)	No. of primary branches/plant	No. of secondary branches/plant
Fenugreek+ Guava	4.00	73.60	5.80	8.00
Coriander +Guava	13.33	96.90	12.30	39.70
Nigella +Guava	14.33	66.40	8.50	22.80
Anise + Guava	18.00	67.60	7.60	16.10
Ajwain+Guava	14.00	121.40	17.10	187.10
Sole Fenugreek	3.00	78.40	5.90	8.10
Sole Coriander	13.00	104.10	12.60	44.80
Sole Nigella	14.67	67.30	9.50	24.80
Sole Anise	17.67	73.80	8.43	18.60
Sole Ajwain	13.00	128.10	17.90	228.00
Sole Guava	0.00	0.00	0.00	0.00
C.D.	1.18	7.03	1.18	4.89
SE(m) ±	0.40	2.37	0.40	1.65
C.V. %	6.03	5.14	7.18	5.24

Table 3.27 : 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 (g)
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 3.28 : Effect of seed spices on guava yield

Treatments	Fruit yield (kg/tree)	Fruit yield (kg/ha.)
Fenugreek+Guava	20.00	5540.00
Coriander+Guava	16.23	4496.63
Nigella+Guava	17.67	4893.67
Anise+Guava	16.67	4616.67
Ajwain + Guava	16.97	4699.77
Sole Fenugreek	0.00	0.00
Sole Coriander	0.00	0.00
Sole Nigella	0.00	0.00
Sole Anise	0.00	0.00
Sole Ajwain	0.00	0.00
Sole Guava	19.77	5475.37
C.D.	2.01	556.16
SE(m) ±	0.68	187.21
C.V.%	12.00	12.00



Guava+Seed Spices

Intercropping of Seed Spices with Pomegranate

The highest seed yield of seed spices was obtained in open space followed by with pomegranate association. This might be due to no competition of seed spices with fruit trees in open space. Among the seed spices the fenugreek 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 3.29, 3.30 and 3.31 given below.

Table 3.29 : Effect of Pomegranate based intercropping on growth parameters of intercropped

Treatments	Days to germination	Plant height (cm)	No. of primary branches/ plant	No. of secondary branches/ plant
Fenugreek + Pomegranate	3.67	73.27	5.93	8.00
Coriander + Pomegranate	12.67	96.57	12.20	39.70
Nigella + Pomegranate	13.67	66.97	8.33	24.80
Anise + Pomegranate	17.33	66.47	8.07	16.10
Ajwain + Pomegranate	13.67	121.07	17.00	193.60
Sole Fenugreek	3.00	74.87	6.07	8.30
Sole Coriander	13.00	109.43	13.47	47.00
Sole Nigella	14.67	66.97	8.50	25.10
Sole Anise	17.67	67.27	8.30	16.87
Sole Ajwain	13.00	127.87	17.67	228.00
Sole pomegranate	0.00	0.00	0.00	0.00
C.D.	1.24	7.36	1.69	5.31
SE(m) ±	0.42	2.48	0.57	1.79
C.V.%	6.49	5.42	10.26	5.61

Table 3.30 : 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

Table 3.31 : Effect of seed spices on pomegranate fruit and yield attributes

Treatments	Weight /Fruit (g)	No. of Fruit/ plant	Fruit yield/ plant (kg)	Fruit yield Kg/ha
Fenugreek+Pomegranate	160.000	55.000	8.800	4,884.000
Coriander+Pomegranate	141.100	46.667	6.583	3,654.487
Nigella+Pomegranate	148.300	51.333	7.613	4,225.067
Anise+Pomegranate	143.433	47.667	6.837	3,794.530
Ajwain + Pomegranate	145.300	46.000	6.683	3,709.510
Sole Fenugreek	0.000	0.000	0.000	0.000
Sole Coriander	0.000	0.000	0.000	0.000
Sole Nigella	0.000	0.000	0.000	0.000
Sole Anise	0.000	0.000	0.000	0.000
Sole Ajwain	0.000	0.000	0.000	0.000
Sole pomegranate	152.233	52.000	7.913	4,393.453
C.D.	9.967	2.996	0.447	248.421
SE(m) ±	3.355	1.009	0.150	83.622
C.V. %	7.180	6.434	6.452	6.460



Pomegranate+Seed Spices

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

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

One survey of Barmer, Jalore and Jaiselmer was also undertaken for collection of soil samples from cumin field during March 2019. Field survey was also conducted during summer months (May-June) in Kota, Baran and Bundi area for collection of soil samples from coriander fields, for isolation of bacterial cultures for temperature tolerant strains. In first stage of screening 70 isolates were screened from cumin and coriander field soil and plant samples. Out of 70, 59 were bacteria and 11 were fungus. Out of 59 bacterial isolates, 32 (P solubilizers), 18 (K solubilizers), 23 (Zn solubilizer) were observed. During preliminary study, isolates of native Zn

solubilization bacteria/fungi were isolated from 21 soil samples of cumin growing fields. Based on halo zone formed by an isolates, Zn-solubilization index (ZnSI) was calculated. SI values of these isolates ranged from 1.66 to 3.00 ZnSI after 7 days of incubation at 25±2 C. The highest solubilization index was found 3.7 followed by 3.4, 3.3 and 3.2 associated with isolate CU- 451, CU-453, CU-184 and CU-188, respectively. The lowest SI was 2.2 recorded in isolate CU-169 (Table 3.32).

Ten bacterial isolates were screened for phosphate solubilization ability, those could solubilize tricalcium phosphate, however, the P-solubilizing potential varied amongst these isolates as evidenced by the size of halo zone on Pikovskaya 's agar plates. The maximum phosphate solubilization zone was 19 mm followed by 17 mm recorded in isolate CU-251 and CU-262,

respectively. The least solubilization zone was 11 mm due to isolate CU-551. Phosphate solubilization index ranged 1.6-3.1. Highest SI was 3.1 followed by 2.9, 2.8 and 2.7 associated with isolate CU-251, CU-262, CU-22 and CU-4, respectively. The Lowest value of SI was 1.5 due to isolate CU-551. (Table 3.33)

Table 3.32 : Screening of Zinc solubilizing bacteria

Microbial Isolates	Solubilization zone (mm)	Solubilization Index
CU-169	17	2.2
CU-181	17	3
CU-184	19	3.3
CU-188	20	3.2
CU-451	26	3.7
CU-453	21	3.4
CU-460	12	2.6
SEm	0.98	0.11
CD (@5%)	2.1	0.22

Table 3.33 : Screening of Phosphate solubilizing bacteria

Microbial Isolates	Solubilization zone (mm)	Solubilization Index
CU-4	15	2.7
CU-22	16	2.8
CU-188	16	2.5
CU-251	19	3.1
CU-252	14	2.2
CU-262	17	2.9
CU-264	14	2.3
CU-551	11	1.5
CU-567	12	2.1
CU-570	13	2.5
SEm	0.60	0.17
CD (@5%)	1.40	0.39

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

(PI: OP Aishwath; Co-PI: S.N. Saxena and R. Singh 2017-22)

Response of celery to applied graded levels of N:

All the growth and yield parameters of celery were enhanced with applied nitrogen, however seed yield and some other parameters were at par with 100 and 80

kg N ha⁻¹ (Fig 3.1). Uptake and soil available nutrients were also more with applied N over the control moreover uptake of N and its availability was more with successive higher levels of N.

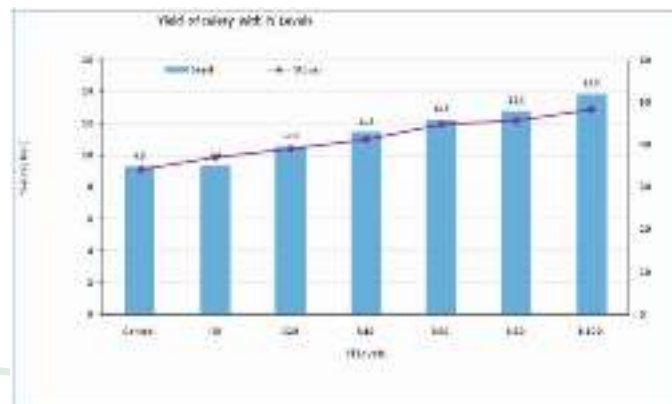


Fig. 3.1 : Effect of N on yield of celery

Response of celery to applied graded levels of P:

Growth and yield parameters of celery were enhanced with applied phosphorus, however seed yield and some other parameters were at par with 40 to 60 kg N ha⁻¹ (Fig 3.2). Uptake of nutrients and soil availability were also more with applied P over the control moreover difference between was meagre.

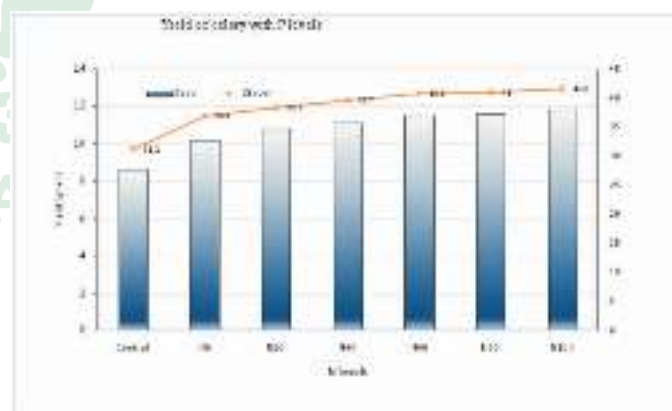


Fig. 3.2 : Effect of P on yield of celery

Response of celery to integrated use of N and FYM:

Growth and yield and their parameters of celery were improved by N and FYM alone and their combine application, however most of the parameters were statistically indifferent with graded levels of higher doses. (Fig 3.3). The similar trend was followed by nutrient uptake and availability in soil.

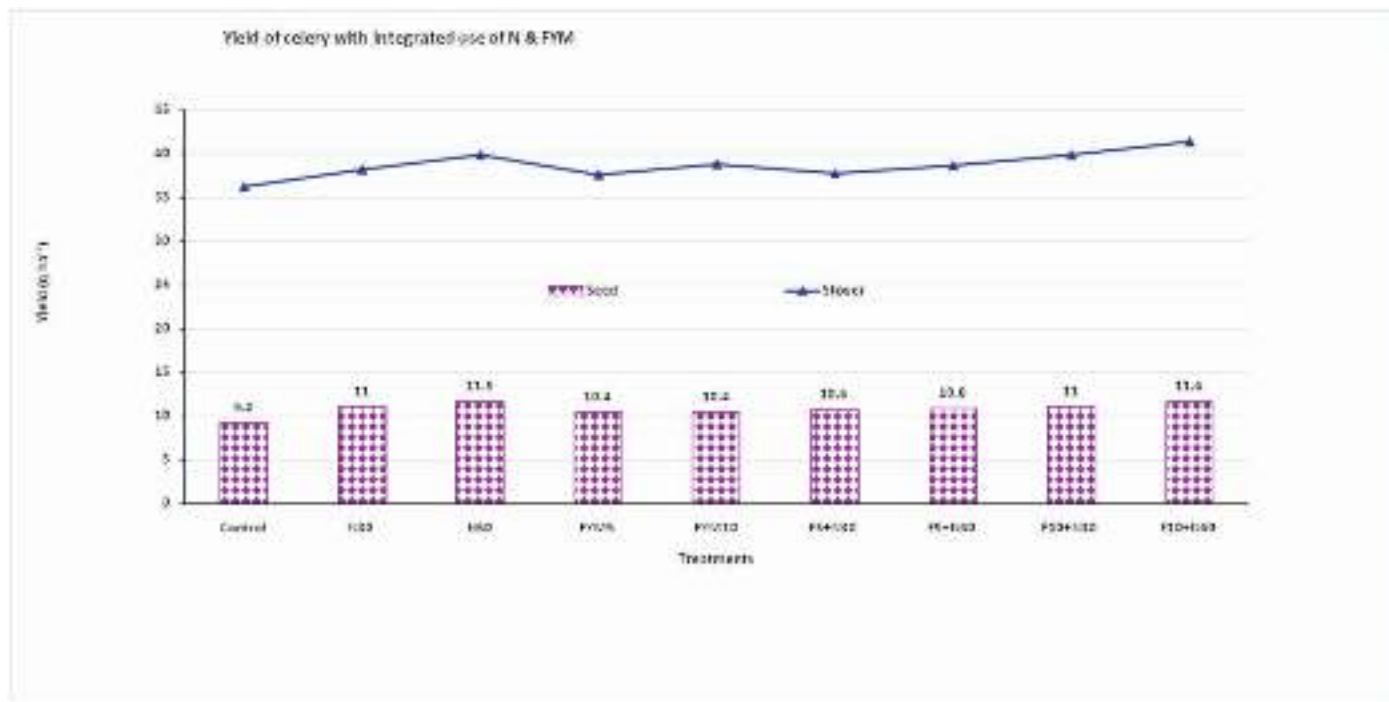


Fig. 3.3 : Effect of N and FYM on yield of celery

Response of celery to various modes of micronutrients application.

Three experiments were carried out in pot culture for three modes of micronutrients application i.e. seed

priming, soil application and foliar spray. Crop responded to all the three types of micronutrients application over the control, however Cu and Mn effect was prime on seed yield (Table 3.34).

Table 3.34 : Effect of micronutrients on celery yield by seed priming, soil and foliar application.

Seed priming	Yield (g pot ⁻¹)		Soil application	Yield (g pot ⁻¹)		Foliar spray	Yield (g pot ⁻¹)	
	Seed	Stover		Seed	Stover		Seed	Stover
Control	20.6	41.7	Control	19.7	41.3	Control	18.4	40.0
Cu-500	24.7	45.1	Cu-5	23.8	44.6	Cu-0.2	23.5	43.7
Fe-500	24.4	44.3	Fe-10	23.5	43.8	Fe-0.5	23.4	42.7
Mn-500	24.7	43.4	Mn-10	23.8	43.4	Mn-0.5	23.8	43.4
Zn-500	23.2	43.6	Zn-5	23.2	43.1	Zn-0.5	23.2	42.1
B-250	21.7	39.1	B-5	20.8	38.6	B-0.2	20.5	36.9
CD at 5%	1.4	5.7	CD at 5%	1.4	5.7	CD at 5%	1.4	5.6

Response of celery to rise in temperature.

Response of celery was assessed at various soil temperatures showed that growth and yield parameters were reduced with rise in temperature (table 3.35). About 60 per cent yield reduced with 13.0 °C beyond the

ambient. Days to maturity were reduced from 198 to 175 days with advancing in temperature which is about 24 hrs advancement with per degree rise in temperature). Nutrient uptake was also reduced with higher temperature.

Table 3.35 : Effect of soil temperature on growth and yield and yield of celery.

Treatment	Plant Height (cm)	Primary branches /plant	Secondary branches /Plant	No of umbel /Plant	No of umbellate /Umbel	No of Seed /umbellate	Seed yield (q/ha)	Stover yield (q/ha)
T ₁ (5 Oct.)	149.8	11.3	26.4	83.4	20.2	27.7	11.3	36.3
T ₂ (15 Oct.)	146.8	10.8	23.8	80.8	19.7	25.7	10.1	34.3
T ₃ (25 Oct.)	136.2	10.3	21.8	77.0	19.2	23.4	8.1	25.9
T ₄ (5 Nov.)	126.8	9.4	20.1	63.1	17.4	22.1	6.5	20.0
T ₅ (15 Nov.)	121.8	8.8	15.8	56.3	15.0	18.7	4.6	12.8
CD at 5 %	1.3	0.4	1.3	1.7	0.6	0.6	1.0	3.5

Effect of sodic water on performance of ajwain

Seed germination of ajwain reduced about 55% with RSC up to 6.0 meq l⁻¹ in lab study. Seed and stover yield reduced significantly with increased higher levels of

sodicity, and reduction was about 37% (Fig. 3.4). Uptake and soil availability of nutrients was also reduced down with rise in sodicity.

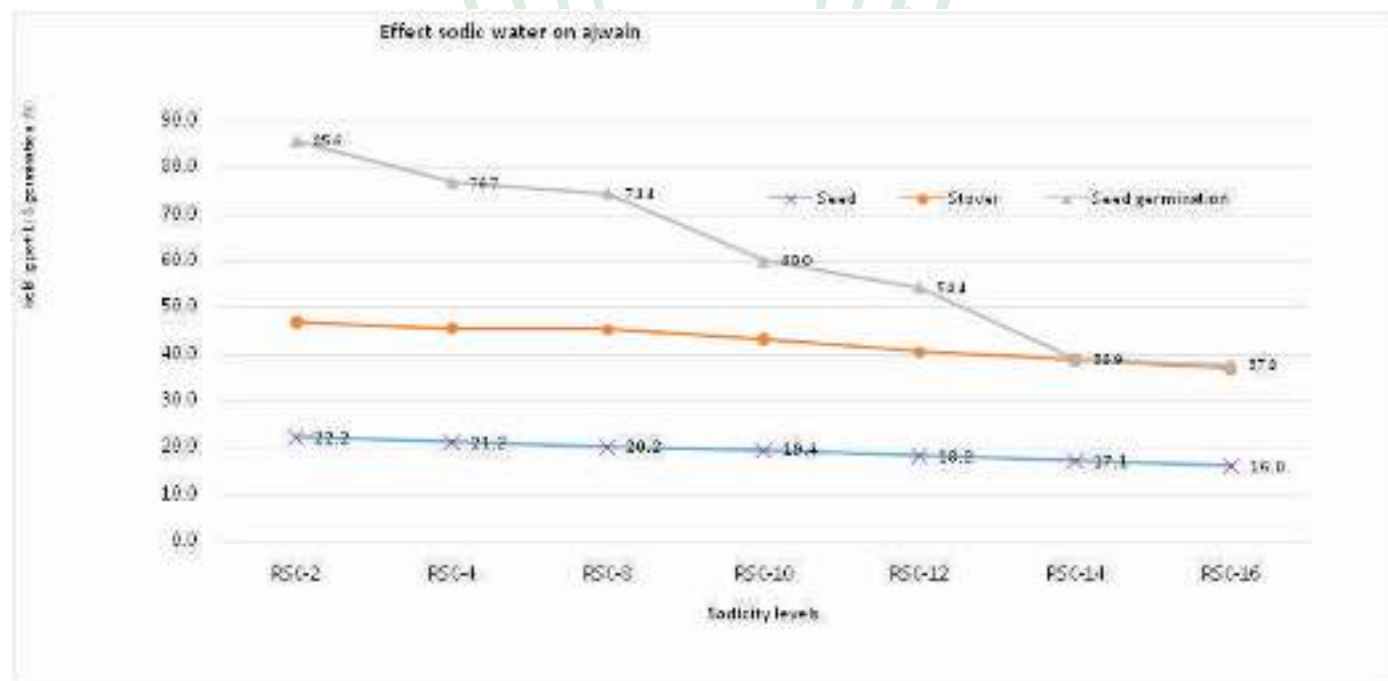


Fig. 3.4 : Effect of sodic water on yield and germination of ajwain

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

(PI: O P Aishwath; Co-PI: M K Vishal (on study leave), M. D. Meena and Ravi Y. 2017-22)

In this area soil, plant and water samples were collected and chemical analysis was done to correlate with crop performance. There was no direct relation with soil properties studied and cumin performance except where there was a crop or weed residues was incorporated in the soil (Table 3.36).



Survey of western part of Rajasthan for cumin growing areas

Table 3.36 : Cumin performance in the surveyed area and other crops in the vicinity.

S.No	Village	Tahsil	Cumin performance	Other crops in the vicinity
1	Jujanta	Jaitaran	Medium	--
2	Jaitaran	"	Good	Fennel
3	KhariaMithapur	"	VG cumin & poor too	fennel, dill
4	Nokhra	"	Avarage	Fennel, dill, wheat, Spinach
5	Bilada	"	Best	Wheat, Alfalfa, Dill
6	Bhavai	Jodhpur	Good	Taramera, Wheat
7	Setsavaa	Jodhpur	VG-best Orabanki	Mustard, Taramira, wheat, Chrysanthimum
8	Setrau, Gesar	"	Average	Coriander, A Arebica
9	Somesar	"	Good but late	Mustard, Ker, Taramira
10	Lambia	Jaitaran	Good	Fennel, mustard, wheat
11	BhagukaGaon	"	Short stature	Taramera, Dhill-short etc
12	Badoda	Pokharan	Good	Coriander, Dill
13	Punasar	Fategarh	Medium	Isabgol
14	SangarGaon	"	Good	Mustard caster
15	Kotra	"	Good	Caster
16	Ravatsar	"	Good but aphid affected	Isabgol
17	Karim ke par	Gadra Road	Aphid attacked cumin	Isabgol
18	Ankhiyan	Nokhada	Average	Isabgol, wheat
19	Before Nokhda	"	Medium	Caster
20	After Nkharda	Gudamalani	Poor	Caster
21	AdilSindari	"	Poor	--
22	Sada/Sara	"	Medium	--
23	Thomdikithandi	Luni	Good but powdery mildew	Vegetables
24	Bagabans	Sojat, Pali	Good	Fennel, Dill
25	Raipur	Marbar	Very Good	Fennel, mustard, wheat, Veg

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

(PI: Ravindra Singh, Co-PI: R. S. Meena: 2017-20)

Eight varieties of cumin GP-1, GC-3, GC-4, RZ-19, RZ-209, RZ-223, RZ-341, RZ-345 were sown at farmers field across the cumin growing area of Rajasthan i.e. Nagaur (Mundawa), Barmer (Gudhamalani), Ajmer (Tabiji) in RBD plot design with 3 replications keeping the plot size 9.0 m². The weather data during the growing season at different location are given in the fig. 3.5. Out of eight varieties, 2 varieties were not germinated/ survived across the locations. The results in Table 3.37 show that,

among the varieties across the 3 locations, maximum seed yield were recorded in GC-4 (1037.1 kg/ha) followed by GP-1 (913.5 kg/ha) and lowest in RZ-223 (644.9 kg/ha). Whereas, the essentials oil (Table 3.38) were maximum in GC-4 (4.18%) followed by 3.81% in RZ-209. Among the locations across the 6 cumin varieties, maximum seed yield were recorded at Tabiji (834.4 kg/ha) followed by Mundawa (796.5 kg/ha) and Gudhamalani (738.8 kg/ha). Whereas % essential oil in cumin seed were maximum at Mundawa (3.12%), followed by Tabiji (3.10%) and lowest at Gudhamalani (3.09%).

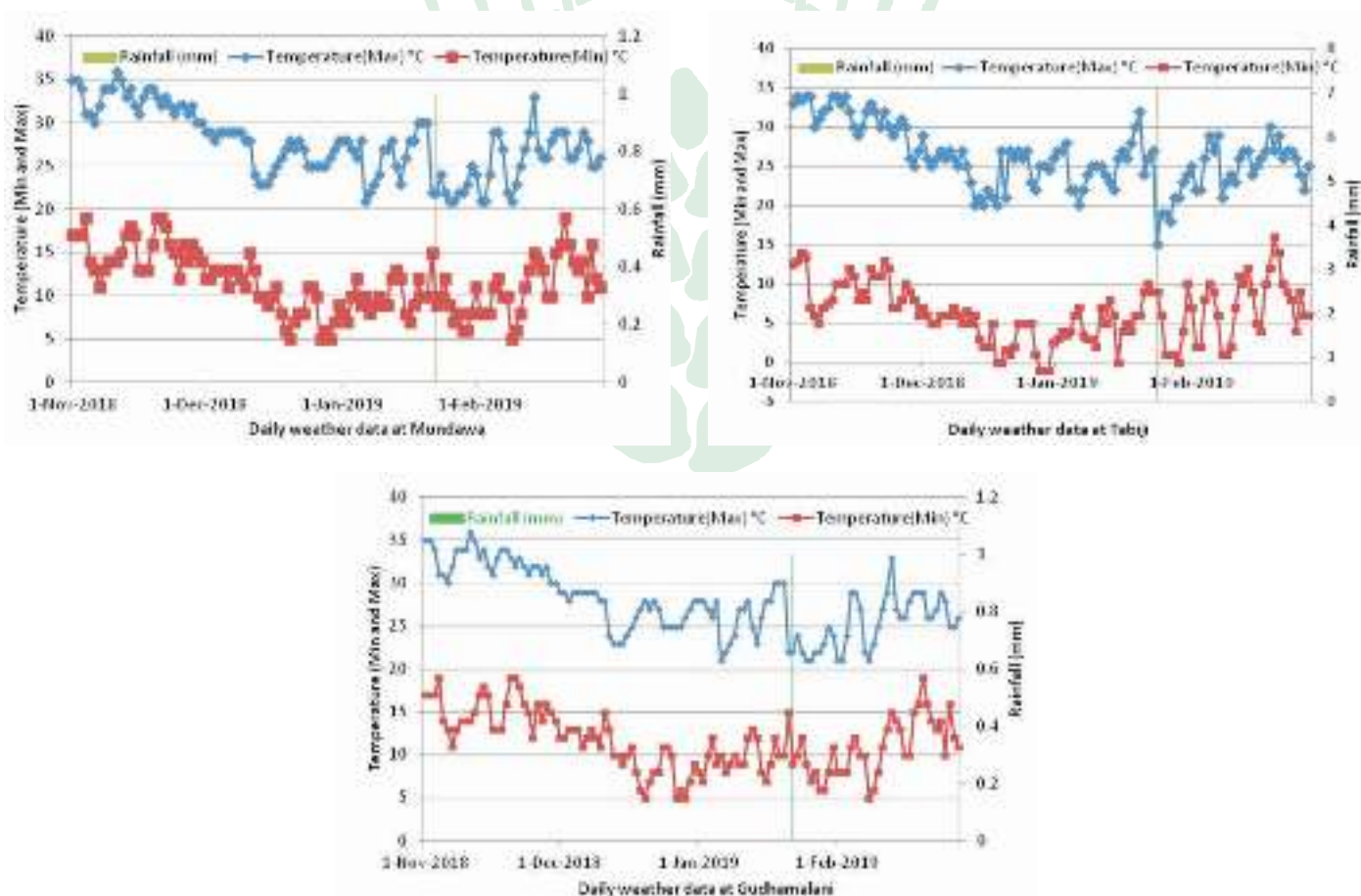


Fig 3.5 : Daily weather data during cumin growing season (2018-19) at Mundawa, Tabiji and Gudhamalani

Table 3.37 : Effect of G*E on cumin seed yield (kg/ha) at Tabiji, Mundawa and Gudhamalani

Treatment	Tabiji	Mundawa	Gudhamalani	Mean B
GP-1	1,055.2	927.1	758.1	913.5
GC-3	762.1	647.2	601.2	670.2
GC-4	1,135.6	966.4	1,009.3	1,037.1
RZ-19	608.9	817.7	802.2	742.9
RZ-209	684.6	771.3	737.4	731.1
RZ-223	760.3	649.5	524.8	644.9
Mean A	834.4	796.5	738.8	
Factors	C.D.	SE(d)	SE(m)	
Factor(A)	57.5	28.5	20.2	
Factor(B)	81.3	40.4	28.5	
Factor(A X B)	140.7	69.9	49.4	

Table 3.38 : Effect of G*E on essential oil in cumin (%) at Tabiji, Mundawa and Gudhamalani

Treatment	Tabiji	Mundawa	Gudhamalani	Mean B
GP-1	2.42	2.46	2.41	2.43
GC-3	3.33	3.46	3.54	3.44
GC-4	4.25	4.20	4.10	4.18
RZ-19	2.13	2.21	2.25	2.20
RZ-209	3.83	3.86	3.74	3.81
RZ-223	2.63	2.51	2.52	2.55
Mean A	3.10	3.12	3.09	
Factors	C.D.	SE(d)	SE(m)	
Factor(A)	N/A	0.05	0.04	
Factor(B)	0.14	0.07	0.05	
Factor(A X B)	N/A	0.12	0.09	



Different varieties of cumin at Tabiji



Different varieties of cumin at Gudhamalani and Mundawa

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

(PI: Narendra Chaudhary; Co-PIs: R. Singh and M.D. Meena and Shiv Lal 2018-23)

Under the experiment of standardization of organic source of nutrition in nigella, maximum plant height (67.13 cm), no. of capsule per plant (29.20) and harvest index (26.56%) were recorded under the treatment of vermicompost 50% + neem cake 50% (Table 3.39). Maximum no. of primary branches (7.33) were registered under vermicompost 75 % + FYM 25%. Maximum no. of

secondary branch (14.27) and straw yield (4396 kg/ha) were recorded under FYM 50 % + neem cake 50%. Maximum no. of seeds per capsule (97.23) were recorded under vermicompost 100%. Maximum seed yield (1032 kg/ha) and test weight (2.7 g) were registered under neem cake 75 % + vermicompost 25%. In soil analysis maximum available N (136.65 kg/ha) and soil organic matter (0.237 %) were recorded under under FYM 50 %+ vermicompost 50%, whereas maximum available P (12.75 kg/ha) and K (226 kg/ha) were found under FYM 75% + vermicompost 25%. However, summer season crop failed.

Table 3.39 : Performance of nigella under organic trial

Treatments	Plant height (cm)	No of Primary branch	No of Sec. Branch	No of capsule per plant	No of seed per capsule	Straw yield kg/ha	Seed yield kg/ha	Harvest Index%	Test weight (g)
Control	67.07	6.87	13.17	26.93	84.47	3523	744	17.97	2.467
FYM 100%	64.20	6.80	13.67	21.33	79.80	3576	846	19.89	2.420
Vermicompost 100%	66.80	6.47	13.73	24.47	97.27	3225	967	23.56	2.557
Neem cake 100%	65.20	6.80	13.07	20.47	83.07	3738	943	20.80	2.670
FYM 50% + VC 50%	65.93	6.60	13.93	23.00	76.33	3985	852	18.09	2.607
FYM 50% + NC 50%	66.67	6.40	14.27	23.40	77.40	4396	937	17.56	2.690
VC 50% + NC 50%	67.13	6.73	12.27	29.20	80.00	2781	941	26.56	2.543
FYM 75% + VC 25%	65.87	6.73	12.93	21.47	94.07	3806	783	17.39	2.527
FYM 75% + NC 25%	65.53	6.67	13.87	21.27	89.07	3149	744	19.11	2.500
VC 75% + NC 25%	66.33	6.47	14.00	17.33	92.13	3650	824	18.58	2.480
VC 75% + FYM 25%	65.07	7.33	12.47	18.07	77.53	3378	959	23.96	2.610
NC 75%+ FYM 25%	61.47	7.07	13.13	16.80	71.13	3459	1004	24.22	2.627
NC 75% + VC 25%	63.27	6.53	13.27	16.93	96.73	3153	1032	25.54	2.713
FYM 33.3%+ VC 33.3%+ NC 33.3%	64.93	6.60	12.93	19.00	77.60	3718	915	19.72	2.670

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

CPt-1: Survey and surveillance of existing and emerging diseases of seed spices

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

Major and minor seed spice diseases were monitored and surveyed. Wilt disease in cumin was seen in range from 1.0 to 4.6 and *Alternaria* blight recorded up 0 to 20.0%. Downy mildew on fenugreek was seen form (0.1 to 6.5%); *Alternaria* blight and powdery mildew in

fenugreek seen 0 - 6.5 % and 0 – 4.9% respectively. The stem gall and *Sclerotium rot* on coriander was found in lower intensity (0-4.2%). *Ramularia* blight on fennel was also found in low intensity (0-0.8%). The powdery mildew symptoms appeared first on fenugreek in fifth standard week (February 28-03, 2019); and downy mildew in 3rd standard week (January 14-20, 2019) and blight in fourth standard week (January 21-27, 2019); cumin blight was initiated in second standard week (January 21-27, 2019) while wilt appeared since germination of seeds. On cumin *Alternaria* blight first appeared (64 DAS). Relative humidity during January-

February month were observed as a key factor especially in initiation and development of downy mildew and *Alternaria* blight disease in cumin among other climatic factors. 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 well towards these environmental factors) and disease initiation was positively affected by these factors alone or cumulatively in manner.

CPT/17.4.3 : Biological management of *Alternaria* blight in cumin

(Pl. R. D. Meena, Co-Pl. B. K. Mishra, 2017-2020)

Ten isolates were collected naturally from foliar canopy, rhizosphere (root zone) from different cumin growing areas were maintained and screened in vitro against the cumin blight (*Alternaria burnsii*). One isolate 'B1' was screened and found most effective among all tested isolates and showed minimum mycelium growth (08 mm) with more than 90% growth inhibition. The isolate was further tested antagonistic effect with *Alternaria burnsii* in Potato Dextrose Agar (PDA) medium containing different adjuvant to observe their effect on it. It was found that the biologically potential isolate was performing well almost in all the medium applied against the cumin blight causing fungus (*Alternaria burnsii*) (Table 3.40).



Survey of seed spices growing areas for diseases



Compatibility of different adjuvant on the biologically potential isolate

Table 3.40 : Performance of the biologically potential isolate against *Alternaria burnsii* with different adjuvant

S.No.	Treatment	Mycelium growth	Mycelium growth inhibition (%)
1.	Water + BA 5%	4.98	97.50
2.	Onion ext 2%+ BA 5%	5.08	97.45
3.	Allovira ext 2%+ BA 5%	5.10	97.43
4.	Tumba ext 2%+ BA 5%	5.08	97.45
5.	Garlic ext 2%+ BA 5%	5.08	97.45
6.	Karanj oil 2%+ BA 5%	5.18	97.40
7.	Perlite 95%+ BA 5%	20.40	89.73
8.	Chalk powder 95%+ BA 5%	30.40	84.70
9.	Cow urine 10%+ BA 5%	5.18	97.40
10.	Buttermilk 10%+ BA 5%	5.80	97.08
11.	Propiconazole 0.1% + BA 5%	5.18	97.40
12.	Propiconazole 0.1	5.15	97.41
13.	Control	50.33	0.00
	CD at 5%	0.183	0.36
	Sem+	0.064	0.1

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

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

The cumin crop was sown at three different date of sowing i.e, at 15th October, 30th October and 15th November to find out impact on nematode population development in relation to different dates of sowing. The populations of nematodes were observed at number of nematodes /5 root samples. Incidence of nematodes (*Protylechus thorni*) on cumin recorded in the cumin field from time of sowing to maturity of the crop. Initially nematodes population isolated in field soil prior to germination (from 10 g soil sample in vicinity of seed sown) and after germination nematodes population isolated from the population associated with the root of the crops. The data from 17-18 and 18-19 (Table 3.41) showed that nematodes population infested cumin root at all three stages of sowing with maximum population noticed at the sowing of crop at 15th November. The maximum numbers of population of nematodes were recorded during 50th and 51st standard week in all three stages of crop sowing. The nematodes population

recorded at increasing trend up to 52nd standard week, there after growth of the population declined and last noticed at 9th standard week.

Management of nematodes in field experiments showed that application of soil sterilent Metham sodium and Dazomet gave excellent protection up to the maturity of the crop up to 90 days. (Fig. 3.7) Application of granular systemic insecticides/nematicides did not yield good control of nematodes population on cumin crop. Among nematopathogens soil application of *Paecilomyces lilacinus* 10⁸ CFU/g + *Trichoderma harzanium* 10⁸ CFU/g + *Pseudomonas fluorescens* 10⁸ CFU/g also gave good control up to 60 days where only 6.0 per cent plant mortality was observed. However, at 90 days plant mortality of 28.5 percent was observed with nematode population of 20 nematodes/5 plant roots. Soil application of *Paecilomyces lilacinus* 10⁸ CFU/g + *Trichoderma harzanium* 10⁸ CFU/g as and *Paecilomyces lilacinus* 10⁸ CFU/g + *Pseudomonas fluorescens* 10⁸ CFU/g also resulted less than 10 per cent plant mortality up to 60 days of sowing. Other treatments were given moderate control of nematodes population as well as plant mortality.

Table 3.41: Impact of different treatments on Plant Mortality and nematode Population

Treatments	Plant Mortality(%)			Population/5 plant root		
	30 days	60 days	90 days	30 days	60 days	90 days
Carbofuran	18	30.5	56.5	13	18	37.5
Chlothianidin	37	53	61.5	22.5	33.5	49.5
Dazomet	0	0	4	0	0.5	2
Metham Sodium	0	0	4	0	1.5	2.5
PL-ST	6	17.5	42	5.5	9.5	22.5
PL-ST+SA	3.5	10.5	33	6	11	25
PL+TH-SA	3.5	9.5	26	5	9.5	16.5
PL+PF-SA	1.5	8.5	38.5	3	6.5	21.5
Allyl Iso thio cynate	20.5	45.5	57	13.5	32.5	37.5
Custard leaf extract	14	22	35	10.5	15.5	23.5
NSKE	16	25	37.5	13	26.5	27
Siver H2O2	10.5	26.5	53	16	34.5	43
PL+TH+PF-SA	1.5	6	28.5	4	7	20
Control	42	55	76	40	53.5	76
S.Em±	0.72	1.07	1.61	0.61	0.92	1.34
CD(0.05)	2.10	3.10	4.68	1.77	2.67	3.91

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)

Field experiments were conducted for bioefficacy of bioagents for the management of root rot diseases of ajwain and nigella. One year data revealed that seed treatment and soil application of *Trichoderma aspesillum* and *Pseudomonas fluorescen* reduced the root rot incidence (38-46%) of nigella when applied as individually and in combinations.

Treatment details:

- 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

(PI: Y.K. Sharma; Co-PI: P.N. Dubey, 2017-20)

Field experiments were conducted to evaluate the effective spray scheduling of recommended fungicides against Alternaria blight of cumin and to evaluate the effect of different fungicides on diseases of fenugreek. Two years data revealed that all schedules reduced the cumin blight PDI as compared to control. Comparatively foliar application of Mancozeb/zineb (0.2%) followed by azoxystrobin(0.1%) and difenoconazole(0.05%) starting from 45 days after sowing at 15 days interval was found most effective to manage the disease (72%) Table 3.42.

Foliar application of different fungicides reduced the disease PDI of downy mildew and leaf blight of fenugreek as compared to untreated control. Foliar application of Chlorothalonil (0.2%), Difenaconzole (0.05%) and Tebuconazole + Trifloxystrobin (0.05%) found effective against leaf blight of fenugreek. Metalaxyl + Mancozeb (0.1%) and Hexaconazole (0.05%) were found effective against downy mildew and powdery mildew diseases respectively.

Table 3.42 : Spray scheduling of fungicides for the management of cumin blight (2017-18 & 18-19)

Treatments	Blight PDI	% Disease control	Seed yield (Kg/ha)
Mancozeb -Zineb -Azoxystrobin -Difenoconazole	10.0 (18.4)	70.8	375
Zineb-Mancozeb -Azoxystrobin-Difenoconazole	9.2(17.7)	72.1	433
Zineb-Azoxystrobin-Mancozeb-Difenoconazole	13.0(21.1)	60.3	381
Zineb-Azoxystrobin-Difenoconazole-Mancozeb	12.4(20.6)	59.8	407
Difenoconazole-Azoxystrobin-Mancozeb	14.9(22.7)	57.7	326
Azoxystrobin-Mancozeb-Difenoconazole	14.5(22.4)	59.5	300
Control	32.5(34.8)	0.0	224
CD (0.05)	5.32(3.75)	-	197.8

Table 3.43 : Effect of fungicide spray application on diseases of fenugreek (2017-18 & 18-19)

Treatments	Leaf blight PDI	Downy mildew PDI	Powdery mildew PDI	Seed yield (Kg/ha)
Copper oxychloride	12.7(20.9)	15.4(23.1)	20.8 (27.1)	1685
Chlorothalonil	12.3(20.5)	15.4(23.1)	18.3 (25.3)	1812
Metalaxyl+Mancozeb	16.0(23.6)	14.7(22.5)	19.2 (25.9)	1908
Hexaconazole	14.0(22.0)	14.7(22.7)	17.5 (24.7)	1963
Tebuconazole	15.7(23.3)	15.4(23.1)	20.8 (27.1)	1753
Tebuconazole + Trifloxystrobin	14.0(22.0)	15.7(23.3)	19.2 (25.9)	1890
Difenaconazole	12.7(20.9)	16.0(23.6)	17.5 (24.7)	1987
control	22.7(28.5)	22.7(28.5)	29.2 (32.7)	1487
CD (0.05)	3.48 (2.83)	3.0(2.42)	4.72 (2.97)	286.8

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

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

Efficacy evaluation of different IPM modules against aphids and thrips on coriander

A field experiment was conducted to evaluate the relative efficacy of eight different IPM modules. Amongst eight IPM modules, maximum per cent reduction (95.1%) in aphid population was recorded with IPM module M₅ followed by IPM module M₇ which reduced 93.76 percent aphid population. The IPM module M₂ was found least effective against aphid reduced 73.18% population.

All the IPM modules were found significantly superior over untreated control in reduction of thrips population. The highest per cent reduction in thrips population (96.37%) was recorded on coriander plants treated with

IPM module M₅ (imidacloprid 600FS 3ml/kg seed (ST) + ker plant extract 10ml/lit. + *Verticillium lecani* (1x10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035%) followed by IPM module M₇ (thiomethoxam 5g/kg seed (seed treatment) + Azadirachtin 0.03EC @ 5ml/lit. + *Metarrhizium anisopliae* @ 6g/lit. + acetamiprid 0.025%), which reduced 93.65 per cent thrips population.

Efficacy evaluation of different IPM modules against aphids and thrips on cumin

A field trial was conducted to evaluate eight different IPM modules. Observations on aphid population were recorded from five randomly selected and tagged plants per plot. The Maximum per cent reduction in aphid population (92.33%) was recorded on plants treated with IPM module 5 followed by IPM module M₇ (90.87%), M₃ (86.05%) and M₆ (85.30%). The treatment of IPM module M₁ was found least effective against pest reduced 77.36 percent aphid population.

All IPM modules were found significantly superior over untreated control in reduction of thrips population. The highest per cent reduction (93.6%) in thrips population was recorded on cumin plants treated with IPM module M₅ (imidacloprid 600FS 3ml/kg seed (ST) + ker plant extract 10ml/lit. + *Verticillium lecani* (1x10⁸cfu/g) @ 6g/lit. + fipronil 5%SC@ 0.035%) followed by IPM modules M₇ and M₃ reduced 91.22 and 87.45 per cent thrips population, respectively whereas, IPM module M₁ was found least effective against thrips, reduced 70.34 per cent population.

Influence of IPM modules on the population of natural enemies and pollinators

The observations on the activities of different natural enemies were also recorded to find the effect of different IPM modules natural enemies and insect pollinators. The natural enemies i.e. coccinellid predators (*Coccinella septempunctata*, *Menochilus sexmaculata* Feb., *Scymnus* sp., *Brumoides saturalis*, *Hippodamia variegata* Goeze), aphid parasitoids, *Aphidius* sp., and syrphid flies (*Episyrphus balteatus* DeGee, *Ischiodons cutellaris* (Fab.) and *Eristalis* sp., were recorded on coriander and cumin crops at different crop growth stages.

Table 3.44 : Efficacy evaluation of IPM modules against aphid and thrips on coriander during 2018-19

Treatment	Per cent reduction in aphid population			Average Reduction (%)	Per cent reduction in thrips population			Average Reduction (%)
	R1	R2	R3		R1	R2	R3	
M ₁	74.20	76.00	74.80	75.00	75.40	77.20	76.57	76.39
M ₂	71.20	76.40	71.94	73.18	80.24	75.00	78.28	77.84
M ₃	83.70	86.00	86.41	85.37	87.60	91.20	88.20	89.00
M ₄	84.20	86.60	89.00	86.60	86.80	89.40	86.45	87.55
M ₅	96.00	94.00	95.30	95.10	96.00	98.60	94.51	96.37
M ₆	75.20	73.24	75.54	74.66	84.20	87.60	86.56	86.12
M ₇	91.64	96.72	92.92	93.76	94.60	92.20	94.15	93.65
M ₈ (Control)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEm				0.99				1.01
CD (p=0.05)				3.00				3.06

Table 3.45 : Efficacy evaluation of IPM modules against aphid and thrips on cumin during 2018-19

Treatment	Per cent reduction in aphid population			Average Reduction (%)	Per cent reduction in thrips population			Average Reduction (%)
	R1	R2	R3		R1	R2	R3	
M ₁	78.00	76.42	77.66	77.36	68.26	72.40	70.36	70.34
M ₂	74.60	79.24	78.36	77.40	74.60	70.20	74.74	73.18
M ₃	85.40	89.00	83.75	86.05	86.82	89.20	86.33	87.45
M ₄	77.40	77.20	79.40	78.00	84.00	89.40	84.99	86.13
M ₅	89.60	94.00	93.39	92.33	91.80	94.00	95.00	93.60
M ₆	84.20	86.45	85.25	85.30	73.00	75.40	73.81	74.07
M ₇	89.64	92.00	90.97	90.87	89.60	93.66	90.40	91.22
M ₈ (Control)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEm				0.88				1.03
CD (p=0.05)				2.66				3.12

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)

Field application of different formulations of insecticides, synergist, botanicals and entomopathogen tested in the field against aphids in the crops of fenugreek, coriander and cumin during 2018-19. Among two formulations of Deltamethrin i.e. micro encapsulation and microemulsion and Thiomethoxam with synergist tested along with commercial formulation available in the market. The microemulsion formulation of deltamethrin was found better than other micro encapsulation. Thiomethoxam applied with

synergist and thiomethoxam alone gave similar performance for aphids control. However, all the treatments were significantly superior over the control treatment for aphids control in all three crops i.e. fenugreek, coriander and cumin. Commercial formulation of deltamethrin and Thiomethoxam alone gave least impact on aphids control in cumin crop. Application of botanical formulation, shesum (*Dalbergia sissoo*) leaf extract –Non polar and shesum (*Dalbergia sissoo*) leaf extract –polar at 0.5% concentration showed that non polar formulation yields better result in comparison to polar formulation. Modified neem composition @ 5% tested against aphids gave superior control over neem oil-2%. Similarly, *Verticillium lecanii* @ 1.5% SC was found better than powder formulation.

Table 3.46 : Effect of different formulation on aphids population in fenugreek

S.No.	Treatments	1 st Spray			
		Population Before Spray	Population 3 day	Population 6 day	Population 9 day
T ₋₁	Deltamethrin -0.003% Micro encapsulation	42	7	3	0
T ₋₂	Deltamethrin -0.003% Micro emulsion	45	3	0	0
T ₋₃	Thiomethoxam-0.025% + Synergist 5%	37.3	3	0	0
T ₋₄	Neem oil -2% + Synergist 5%	39	8	3.3	0
T ₋₅	Shesum leaf extract- Polar- 0.5%	33	8	3	2
T ₋₆	Shesum leaf extract- Non Polar- 0.5%	55	18	5	3
T ₋₇	<i>Verticillium lecanii</i> 1.5% SC	35	20	9	3.3
T ₋₈	Modified Neem Composition -5%	43.3	15	7	3
T ₋₉	Deltamethrin -0.003%	51	0.3	0.3	0
T ₋₁₀	Thiomethoxam -0.025%	33	1	0.3	0
T ₋₁₁	Neem oil-2%	37	18	7	3
T ₋₁₂	<i>Verticillium lecanii</i>	41	31	12	4
T ₋₁₃	Control	45	55	68	60
	CD @5%	4.10	1.88	1.54	1.29

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

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

(PI: P.N. Dubey; Co-PI: S.N. Saxena, K. Kant; 2014-19)

Experiment: Efficacy of pesticides and estimation of pesticide residues of some selected insecticides and fungicides in cumin seeds at harvest.

The insecticides and fungicides evaluated in this experiment comprised of Dimethoate + Mancozeb (T₁), Metham sodium (soil sterilizer), Dimethoate + Difenconazole (T₂), Dimethoate + Difenconazole (T₃), Thiamethoxam + Mancozeb (T₄), Thiamethoxam + Difenconazole (T₅), Acetamiprid + Mancozeb (T₆) and

Control (T₇). Three sprays of recommended doses @ 60, 90 and 105 DAS was carried out. The trend obtained for cumin yield (q/ha) in the pooled data for 2017-2019 (Table 3.48) showed that the treatment consisting of Metham sodium (soil sterilizer), Dimethoate & Difenonazole (T₁) was found to be much efficient followed by the treatments comprising of Acetamiprid &

Mancozeb (T₆), Thiamethoxam & Difenonazole (T₅), Dimethoate & Mancozeb (T₂), Dimethoate & Difenonazole (T₃), Thiamethoxam & Mancozeb (T₄) as compared to T₇ and control (T₈). The residue data reveals that the treatments at 105 DAS had higher values of residues well above the MRL values (Table 3.47).

Table 3.47 : Cumin seed yield at harvest & residue status (2018-19)

S.No.	Treatment	Seed yield (q/ha.)	Residue (ppm) @ 90 & 105 DAS	Residue (ppm) @ 90 & 105 DAS
1	Metham sodium, Dimethoate & Difenonazole (T ₁)	7.3	DM: 0.12, 3.90 (MRL: 2.0)	Difenonazole (MRL: 1.0) 1.04, 1.84
2	Dimethoate & Mancozeb (T ₂)	6.1	DM: 0.83, 4.73	Mancozeb-traces
3	Dimethoate & Difenonazole (T ₃)	4.1	DM: 0.18, 4.51	Difenonazole 1.06, 2.04
4	Thiamethoxam & Mancozeb (T ₄)	3.9	Thiamethoxam (MRL: 1.0) 0.30, 2.06	Mancozeb-traces
5	Thiamethoxam & Difenonazole (T ₅)	6.8	Thiamethoxam BLQ, 0.10	Difenonazole 0.31, 0.21
6	Acetamiprid & Mancozeb (T ₆)	6.6	Acetamiprid (MRL: 1.5) 0.08, 0.02	Mancozeb-traces
7	Acetamiprid & Propiconazole (T ₇)	5.9	Acetamiprid 1.19, 2.19	Propiconazole (MRL: 0.5); 0.41, 0.21
8	Control	3.8	Traces	Traces
9	CD (0.05)	2.03		
	S.Em±	0.33		

Table 3.48 : Cumin seed yield at harvest (Pooled Data 2017-2019)

S.No.	Treatment	Seed yield (2017-18) (q/ha.)	Seed yield (2018-19) (q/ha.)	Seed yield (Average) (q/ha.)
1	Metham sodium (soil sterilizer), Dimethoate & Difenonazole (T ₁)	9.6	7.3	8.45
2	Dimethoate & Mancozeb (T ₂)	6.9	6.1	6.5
3	Dimethoate & Difenonazole (T ₃)	4.9	4.1	4.5
4	Thiamethoxam & Mancozeb (T ₄)	4.1	3.9	3.95
5	Thiamethoxam & Difenonazole (T ₅)	7.9	6.8	7.35
6	Acetamiprid & Mancozeb (T ₆)	8.3	6.6	7.45

Experiment: Efficacy of pesticides and estimation of pesticide residues of some selected insecticides and fungicides in coriander seeds at harvest.

The insecticides and fungicides evaluated in this experiment comprised of Thiamethoxam + Karathane (T₁), Thiamethoxam + Mancozeb (T₂), Thiamethoxam + Difenconazole (T₃), Acetamiprid + Mancozeb (T₄), Acetamiprid + Difenconazole (T₅), Acetamiprid + Karathane (Dinocap) (T₆) and Control (T₇). Three sprays of recommended dose @ 60, 90 and 105 days after sowing (DAS). The trend obtained (Table 3.50) for

coriander yield (q/ha) shows that the treatment consisting of Thiamethoxam & Difenconazole (T₃) was found to be much efficient followed by the treatments comprising of Thiamethoxam & Mancozeb (T₂), Acetamiprid & Mancozeb (T₄), Acetamiprid & Difenconazole (T₁), Thiamethoxam + Karathane (Dinocap) (T₅), Acetamiprid & Karathane (Dinocap) (T₆) as compared to control (T₇).

Residue levels of these molecules were below detection limit after crop harvest in coriander seed samples at with spray at different DAS (Table 3.49).

Table 3.49 : Coriander seed yield at harvest & residue status (2018-19)

S. No.	Treatment	Seed yield (q/ha)	Residue (ppm) @ 90 & 105 DAS	Residue (ppm) @ 90 & 105 DAS
1	Thiamethoxam + Karathane (T ₁)	15.4	Thiamethoxam (MRL: 1.0) 0.05, 0.51	Karathane-traces
2	Thiamethoxam + Mancozeb (T ₂)	16.6	Thiamethoxam (MRL: 1.0) 0.005, 0.05	Mancozeb-traces
3	Thiamethoxam + Difenconazole (T ₃)	17.3	Thiamethoxam (MRL: 1.0) 0.05, 0.05	Difenconazole (MRL: 1.0) 0.04, 0.16
4	Acetamiprid + Mancozeb (T ₄)	16.4	Acetamiprid (MRL: 1.5) 0.12, 0.24	Mancozeb-traces
5	Acetamiprid + Difenconazole (T ₅)	13.9	Acetamiprid (MRL: 1.5) 0.10, 0.23	Difenconazole (MRL: 1.0) 0.04, 0.19
6	Acetamiprid + Karathane (T ₆)	13.4	Acetamiprid (MRL: 1.5) 0.12, 0.17	Karathane

Table 3.50 : Coriander seed yield at harvest (Pooled Data 2017-2019)

S. No.	Treatment	Seed yield (2017-18) (q/ha)	Seed yield (2018-19) (q/ha)	Seed yield (Average) (q/ha)
1	Metham sodium (soil sterilizer), Dimethoate & Difenconazole (T ₁)	9.6	7.3	8.45
2	Dimethoate & Mancozeb (T ₂)	6.9	6.1	6.5
3	Dimethoate & Difenconazole (T ₃)	4.9	4.1	4.5
4	Thiamethoxam & Mancozeb (T ₄)	4.1	3.9	3.95
5	Thiamethoxam & Difenconazole (T ₅)	7.9	6.8	7.35
6	Acetamiprid & Mancozeb (T ₆)	8.3	6.6	7.45

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

(PI: S.N. Saxena; Co-PI: Y.K. Sharma and P.N. Dubey; 2017-19)

Experiments were carried out with immediate objective of addressing key problem of disease management and abiotic stresses by utilizing Irradiated caragennan and plant growth regulators viz., triacontanol (TRIA), Brassinosteroids and some known antioxidants alone and in combinations through their effect on growth and development in cumin cultivation. Irradiated caragennan and sodium alginate positively affect plant growth and yield but at par effect were also noticed with non irradiated chemicals. Total chlorophyll content was increases from 1.85 mg/g Fwt to 3.9 and 3.12 mg/g Fwt with caragennan and sodium alginate respectively after first spray at 45 DAS. However, after second spray not much variation was observed in chlorophyll content but leaf area was more (4.29, 6.22, 5.22 Cm^2 in caragennan proline and disprin treatment as compared to 3.23 in control). Irradiated caragennan and sodium alginate showed antioxidant content up to 79.35 ppm as compared to 68.1 ppm in control. ASA and Proline were also effective in modulation of physiological activities. Maximum essential oil content (7.0%) was recorded in

treatment of methyl jasmonate mixture followed by methyl dihydro jasmonate (6.9, 6.4, 6.2%). However total oil content was less as compared to previous year observed maximum (4.22%) in treatment of prolin 2.0mm as compared to 1.92% under control.

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

(PI: S.N. Saxena; Co-PI: P.N. Dubey; 2017-19)

India is the largest producer and consumer of coriander seeds, there is immense potential of enhancing export by producing coriander seeds with more essential oil content. In this project some PGRs have been tried to increasing growth, yield and oil content in coriander genotypes. Irradiated sodium alginate and caragennan showed growth promoting effect when applied exogenously as most of the growth parameters increased under these treatments. Similarly, other PGRs viz. GA3, 2-ip and Thio Urea were also effective. Leaf area increased with ISA (17.67 Cm^2) and IC (18.98 Cm^2) as compared to control (14.15 Cm^2). Phenolics (5.22ppm) and flavonoid (71.53ppm) was recorded with IC and SA as compared to 2.97 and 44.11ppm under control. Essential oil content was significantly increased with ISA and IC (0.33%) and 0.35% with SA. However, total oil content was less as compared to previous year recorded maximum 3.11% with Sodium Alginate 100ppm (Table 3.51).



Table 3.51 : Effect of PGRs on seed essential and total oil content (%)

T	PGR	Conc.	EO (%)	Total oil (%)
T ₁	6-YY Dimethylallyl AP	0.5mM	0.30	1.89
T ₂	6-YY Dimethylallyl AP	1.0mM	0.27	1.37
T ₃	6-YY Dimethylallyl AP	1.5mM	0.31	0.88
T ₄	6-BAP	0.1mM	0.28	1.34
T ₅	6-BAP	0.2 mM	0.33	0.98
T ₆	6-BAP	0.3 mM	0.25	0.65
T ₇	NAA	0.1mM	0.27	0.90
T ₈	NAA	0.2 mM	0.30	1.30
T ₉	NAA	0.3 mM	0.23	1.31
T ₁₀	GA-3	0.1mM	0.33	2.55
T ₁₁	GA-3	0.2 mM	0.30	0.88
T ₁₂	GA-3	0.3 mM	0.35	1.82
T ₁₃	Thio Urea	0.5mM	0.27	1.31
T ₁₄	Thio Urea	1.0mM	0.28	1.29
T ₁₅	Thio Urea	1.5mM	0.30	0.99
T ₁₆	Irredeated SA	50 ppm	0.31	2.21
T ₁₇	Irredeated SA	100 ppm	0.25	1.24
T ₁₈	Irredeated SA	150 ppm	0.33	1.14
T ₁₉	Irradiated Carragennan	50 ppm	0.30	2.55
T ₂₀	Irradiated Carragennan	100 ppm	0.33	2.53
T ₂₁	Irradiated Carragennan	150 ppm	0.30	1.80
T ₂₂	Sodium Alginate	50 ppm	0.28	0.62
T ₂₃	Sodium Alginate	100 ppm	0.35	3.11
T ₂₄	Sodium Alginate	150 ppm	0.28	0.65
T ₂₅	Carragennan	50 ppm	0.28	0.80
T ₂₆	Carragennan	100 ppm	0.33	0.44
T ₂₇	Carragennan	150 ppm	0.27	2.62
T ₂₈	Distilled water		0.27	1.34
T ₂₉	Absolute control		0.25	1.37
		SD	0.03	0.70

BS/17.5.3: Studies on dissipation kinetics and pre harvest interval of triazoles in fenugreek

(PI: P. N. Dubey; Co-PI: S. N. Saxena, Y. K. Sharma and K. Kant:2017-19)

Experiment: Studies on dissipation kinetics and Pre Harvest Interval for propiconazole, hexaconazole and copper oxychloride for fenugreek.

An experiment was designed with 3 fungicides (propiconazole, hexaconazole and copper oxychloride)

and their two doses viz. single dose and double dose with 3 replications & 3 controls totalling to 21 treatments in RBD for fenugreek, to study the dissipation rates and residual content of these molecules in fenugreek seed samples. Four sprays of Propiconazole, Hexaconazole and Copper oxychloride @ single and double recommended doses at 60, 75, 90 and 105 days after sowing (DAS) was applied to the crop under study. Fenugreek variety Afg-3 was sown during rabi season

2017-18. The treatments included Copper oxychloride (SD) (T₁), Copper oxychloride (DD) (T₂), Hexaconazole (SD) (T₃), Hexaconazole (DD) (T₄), Propiconazole (SD) (T₅) Propiconazole (DD) (T₆) and Control (T₇). The experiment was conducted in the year 2017-18 and 2018-19 continuously (Table 3.52).

Residue status and dissipation rate : The kinetic studies based on regression equation, dissipation rate

constant (K), correlation coefficient (R²) and half-life values of different pesticides in cumin, coriander and fenugreek plant, soil and seed samples at harvest with respect to the Pre harvest intervals at recommended single (SD) & double doses (DD) were: Copper Oxychloride : 14-17 days (SD) & 15-19 days (DD), Hexaconazole: 17-19 days (SD) & 20-23 days (DD) & Propiconazole: 18-21 days (SD) & 24-28 days (DD).

Table 3.52 : Fenugreek seed yield at harvest (Pooled Data 2017-2019).

S.No.	Treatment	Seed yield (2017-18) (q/ha.)	Seed yield (2018-19) (q/ha.)	Seed yield (Average) (q/ha.)
1	Copper Oxychloride (SD) (T ₁)	14.45	18.3	16.37
2	Copper Oxychloride (DD) (T ₂)	14.0	13.7	13.85
3	Hexaconazole (SD) (T ₃)	20.33	16.81	18.57
4	Hexaconazole (DD) (T ₄)	19.53	11.33	15.43
5	Propiconazole (SD) (T ₅)	18.07	14.39	16.23
6	Propiconazole (DD) (T ₆)	19.4	18.73	19.06
7	Control (T ₇)	13.23	12.8	13.02
	CD (0.05)	2.97		
	S.Em±	0.85		

Table 3.53 : Residue status in fenugreek seeds at harvest (2018-19).

S.No.	Treatment	Residue (ppm) @ 90 DAS	Residue (ppm) @ 105 DAS
1	Copper Oxychloride (SD) (T ₁)	Copper Oxychloride NA	Copper Oxychloride NA
2	Copper Oxychloride (DD) (T ₂)	Copper Oxychloride NA	Copper Oxychloride NA
3	Hexaconazole (SD) (T ₃)	Hexaconazole (MRL: 1.0) 0.02	Hexaconazole (MRL: 1.0) 0.04
4	Hexaconazole (DD) (T ₄)	Hexaconazole 0.04	Hexaconazole 0.19
5	Propiconazole (SD) (T ₅)	Propiconazole (MRL: 0.5) BLQ	Propiconazole 0.03
6	Propiconazole (DD) (T ₆)	Propiconazole BLQ	Propiconazole 0.03
7	Control (T ₇)	BLQ	BLQ

Note:- NA: not analysed; BLQ: Below quantification level

Pre harvest Interval (PHI): The maximum PHI determined for the three fungicides viz. Copper oxychloride, Hexaconazole and Propiconazole in general lies between 12-27 days after harvest at the single & double dose application rates respectively. The yields obtained under various treatments are also optimum thus showing the relevancy of the treatments against commonly occurring powdery mildew and downy mildew disease of fenugreek and better quality produce. The PHI were: Copper Oxychloride-13-16 days (SD) & 16-19 days (DD), Hexaconazole-15-19 days (SD) & 20-24 days (DD) & Propiconazole-17-20 days (SD) & 22-27 days (DD). The analytical data for dissipation rates, residue status in the produce and Pre harvest intervals suggest that the residues of the tested pesticides (Propiconazole, Hexaconazole and Copper oxy chloride @ recommended doses) evaluated at harvest in the seeds samples were below the detection level hence safe to be used against various insect-pest and diseases for the crops under study with strict adherence to the recommended doses. The normal application schedule @ 45, 60 & 90 DAS as well as @ 60, 75, 90 & 105 DAS did not show the presence of pesticide residues, thereby the quality of the harvested produce was found to be safe for domestic use as well as for export (Table 3.53).

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)

Determining maturity indices for fennel seeds for different utility

For chewing purpose: To standardize optimum harvesting stage of fennel seed for chewing purpose, a field experiment was carried out at ICAR-NRCSS experimental farm. For the experiment Ajmer Fennel-1 variety was grown using standard cultivation package of practices and umbels was picked up after anthesis (103 days from seed sowing) at six stages in 5 days interval i.e. 25 days after anthesis, 30 days after anthesis, 35 days after anthesis (DAA), 40 days after anthesis, 45 days after anthesis and 50 days after anthesis. Each harvested stage fennel seed sample was dried under shed and was tested for different seed physical, bio-chemical and yield attributes (Table 3.54-3.55). The highest score based on hedonic scale for important sensory attributes such as

seed color (8.6), flavour, (8.6), aroma (8.5), texture (8.5), taste of seed (8.7), fiberness (8.5) and overall acceptability (8.55) was observed for seed harvested at 138 days from seed sowing or 35 days after anthesis. However, highest value for yield attributing traits like seed length (6.33 mm), seed width (1.88 mm), seed thickness (1.24 mm), no. of umbel/plant (39.78), yield (kg/ha) 1446.67 was recorded in seed harvested at 50 days after anthesis. Maximum test weight (4.09), minimum moisture content (33.25%) on fresh weight basis, maximum seed germination (40%) and vigour index (180) was recorded in seed samples harvested at 50 DAA whereas; highest TSS (27.48°B) was recorded at 40 DAA. Total oil content (4.70 %) and essential oil content (2.61%) was estimated highest in seed samples harvested at 25 DAA. Based on preliminary findings the fennel seeds should be harvested at 138 days from seed sowing or 35 days after anthesis for chewing proposes.



Different types of umbels harvested at 138 days after sowing



King umbel seed sample at 138 DAA



Primary umbel seed sample at 138 DAA



Mixed seed sample at 138 DAA

Table 3.54 : Sensory attributes of fennel seeds harvested at six different stages for chewing purpose

Treatments	Seed color	Flavour	Aroma	Texture	Taste of seed	Fibreness	Overall acceptability
Stage 1 (25 days after anthesis)	7.8	7.7	7.9	7.2	8.1	8.7	7.90
Stage 2 (30 days after anthesis)	7.9	7.9	8.1	7.7	8.2	8.6	8.07
Stage 3 (35 days after anthesis)	8.6	8.6	8.5	8.5	8.7	8.5	8.55
Stage 4 (40 days after anthesis)	8.5	8.4	8.4	8.3	8.5	8.4	8.43
Stage 5 (45 days after anthesis)	8.3	8.2	8.2	8.3	8.4	7.6	8.17
Stage 6 (50 days after anthesis)	7.6	7.8	7.8	8.0	8.2	7.1	7.75
CD at 5% 0.13	0.17	0.19	0.16	0.24	0.14	0.16	

*Days taken for anthesis (103)

Table 3.55 : Test weight, quality attributes and seed germination associated traits of fennel seeds harvested at six different stages for chewing purpose

Treatments	Test weight (Seed index)	Moisture Content (%)	Total soluble solids (oB)	Total oil content (%)	Essential oil (%)	Seed germination (%)	Seedling length (mm)	Vigour index
Stage 1 (25 days after anthesis)	2.40	75.45	25.34	4.70	2.61	0.00	0.00	0.00
Stage 2 (30 days after anthesis)	2.46	74.56	26.37	4.63	2.53	0.00	0.00	0.00
Stage 3 (35 days after anthesis)	2.71	64.68	26.96	4.57	2.45	0.00	0.00	0.00
Stage 4 (40 days after anthesis)	2.81	58.46	27.48	3.99	2.38	0.00	0.00	0.00
Stage 5 (45 days after anthesis)	3.15	46.23	14.92	3.19	2.29	24.00	4.15	99.60
Stage 6 (50 days after anthesis)	4.09	33.25	12.63	2.47	2.14	40.00	4.50	180.00
CD at 5%	0.09	3.13	0.59	0.12	0.13	--	-	-

*Days taken for anthesis (103)

For culinary purpose: Similarly to determine optimum harvesting stage of fennel seed for culinary purpose, a field experiment was carried out at ICAR-NRCSS experimental farm. Under the study Ajmer Fennel-1 variety was grown using standard cultivation package of practices and harvesting of umbels (after anthesis) was carried out at eight stages in 10 days interval i.e. at 25 days after anthesis, 35 days after anthesis, 45 days after anthesis, 55 days after anthesis, 65 days, 75 days after anthesis, 85 days after anthesis and 95 days after anthesis. The crop has taken 103 days from sowing for anthesis. The data of each stage harvested samples were recorded for various attributes like sensory (seed color, flavour, aroma, texture, taste of seed, fiberness), seed physico-chemical, yield and germination attributes (Table 3.54, 3.55 and 3.56). Among sensory attributes, maximum score based on hedonic scale was recorded for overall acceptability (8.22) for seeds harvested at 180 days from date of sowing or 75 days after anthesis (DAA).

Maximum no. of umbel/plant (64) was recorded at 65 DAA, higher No. of umbellate/umbel (38.33) was at 25 DAA, higher No. of seeds/umbellate (34.03) at 85 DAA, No. of seeds /umbel (944.67) at 35 DAA and total seeds/plant (37160.3) was recorded at 45 DAA. Highest seed width (1.93 mm), seed thickness (1.29 mm), seed index (8.74) and yield (234 g/m² and 2340 kg/ha) was recorded at 75 DAA. Among physico-chemical attributes of seeds, lowest moisture content (9.78%) on fresh weight basis was recorded at 95 DAA however, highest TSS (27.33°B) at 25 DAA. The maximum total oil content (4.59%) and essential oil content (2.62%) was estimated at 25 DAA. In germination related attributes, maximum seed germination (81.33%) and seedling vigour (561.17) was recorded for seed samples harvested at 75 DAA. Based on preliminary findings the fennel seeds should be harvested at 75 days after anthesis for chewing proposes for culinary proposes as compared to other harvesting stages.



Plants and Umbel harvested at sixth stage (180 days after sowing)



Seed samples harvested at different time interval

Table 3.56 : Sensory attributes of fennel seeds harvested at different stages of seed development for chewing purpose

Treatments	Seed color	Flavour	Aroma	Texture	Taste of seed	Fibreness	Overall acceptability
Stage 1 (25 days after anthesis)	7.78	7.95	7.82	7.21	7.83	8.70	7.88
Stage 2 (35 days after anthesis)	8.43	8.20	8.03	8.12	8.14	8.30	8.20
Stage 3 (45 days after anthesis)	8.22	8.24	8.14	8.23	8.25	7.60	8.11
Stage 4 (55 days after anthesis)	8.10	8.29	8.24	8.24	8.35	7.20	8.07
Stage 5 (65 days after anthesis)	7.92	8.40	8.44	8.55	8.45	6.90	8.11
Stage 6 (75 days after anthesis)	7.76	8.50	8.83	8.86	8.66	6.70	8.22
Stage 7 (85 days after anthesis)	7.11	8.10	7.22	7.17	7.91	6.10	7.27
Stage 8 (95 days after anthesis)	6.41	7.40	6.91	6.57	7.27	5.80	6.73
CD at 5%	0.34	0.36	0.31	0.35	0.44	0.45	0.18

*Days taken for anthesis: (103)

Table 3.57 : Physical attributes of seeds harvested at different stages and yield characteristics for chewing purpose

Treatments	No. of umbel /plant	No. of umbellat /umbel	No. of seeds /umbellat	No. of seeds /umbel	Seed index	Yield (g/m ²)	Yield (kg/ha)
Stage 1 (25 days after anthesis)	23.33	38.33	27.03	523.33	2.46	82.33	805.00
Stage 2 (35 days after anthesis)	33.00	33.33	27.63	944.67	5.71	105.00	1,050.00
Stage 3 (45 days after anthesis)	45.67	30.67	32.77	813.67	7.60	133.00	1,340.00
Stage 4 (55 days after anthesis)	37.00	32.00	21.80	412.00	8.13	173.00	1,736.67
Stage 5 (65 days after anthesis)	46.00	30.67	26.30	527.67	8.47	203.00	2,021.00
Stage 6 (75 days after anthesis)	39.00	30.33	32.70	660.67	8.74	234.00	2,340.00
Stage 7 (85 days after anthesis)	37.33	27.33	34.03	643.00	8.58	182.33	1,823.33
Stage 8 (95 days after anthesis)	35.00	31.33	23.37	391.00	6.46	162.33	1,623.33
CD at 5%	3.53	3.72	5.39	137.75	0.24	5.39	47.997

*Days taken for anthesis: (103)

Table 3.58 : Seed quality attributes of fennel seeds harvested at different stages

Treatments	Moisture content (%)	Total soluble solids (oB)	Total oil (%)	Essential oil (%)	Seed germination (%)	Seedling length (cm)	Vigour index
Stage 1 (25 days after anthesis)	75.31	27.33	4.59	2.62	0.00	0.00	0.00
Stage 2 (35 days after anthesis)	61.93	18.00	4.35	2.51	0.00	0.00	0.00
Stage 3 (45 days after anthesis)	51.58	11.00	4.48	2.44	29.00	4.10	118.90
Stage 4 (55 days after anthesis)	39.56	10.33	2.80	2.30	61.00	4.80	292.80
Stage 5 (65 days after anthesis)	29.14	6.17	1.73	2.17	64.00	5.60	358.40
Stage 6 (75 days after anthesis)	17.16	5.00	1.51	2.10	81.33	6.90	561.17
Stage 7 (85 days after anthesis)	12.03	3.00	1.30	1.98	78.00	7.10	553.00
Stage 8 (95 days after anthesis)	9.78	2.00	1.26	1.76	69.00	7.05	486.45
CD at 5%	2.50	1.95	0.21	0.21	1.79	0.34	25.36

*Days taken for anthesis: (103)

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

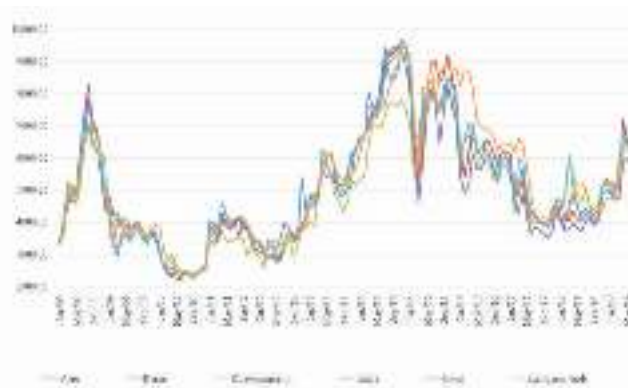
SS/17.6.1 : Economic analysis of production and export performance of coriander and cumin in India

(PI: M.D. Meena; Co-PI: M.K. Vishal (on study leave) and M.A. Khan, 2017-20)

Price of an agricultural commodities play an important role in farm economy of India. They affect production decisions by the farmers and their incomes. Better harvest prices encourage the farmers to make more investment and to increase production and vice versa. Fluctuating prices of agricultural commodities is very prevalent and a big problem in Indian agriculture. Agricultural prices exhibit spatial and temporal price fluctuations. Temporal price variations include seasonal, annual and long-term fluctuations. Therefore present study was undertaken to study seasonality and price variations in cumin and coriander in the country. The major markets for these crops were identified on the basis of maximum arrivals. In coriander Kota, Baran,

Ramganjmandi, Atru, Itawa and Bhawanimandi markets were chosen wherein cumin Jodhpur, Kekri, Merta City, Gondal, and Rajkot were selected for the study (Table 3.53). The information on daily price and arrivals was recorded from January 2008 to June 2019 (138 months). To measure seasonality in price and arrivals moving average method and to study trend linear regression method was used.

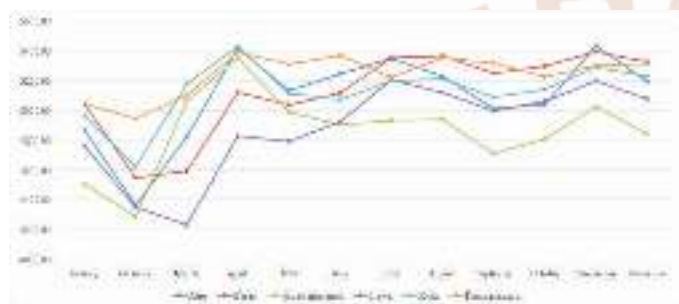
Coriander prices and arrivals analysis



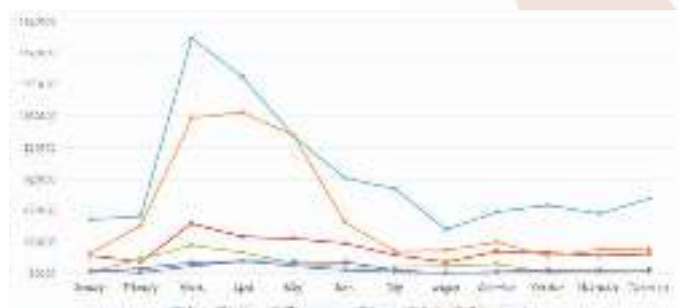
Monthly prices of coriander in major markets (Rs per quintal)

Table 3.59 : Average monthly prices (Rs per quintal) and arrivals (tonnes) of coriander in major markets from Jan. 2008 to June 2019

Name of market	Price (Rs/Q)	Arrivals (tonnes)
Atru	5089.82	488.68
Baran	5113.21	1778.46
Bawanimandi	4866.10	816.56
Itawa	4871.57	555.91
Kota	5128.10	6484.31
Ramganjmandi	5242.19	4103.67



Monthly prices for coriander in major markets (Rs/Quintal)



Monthly average arrivals for coriander in major markets (tonnes)

In coriander, price varied from 2202 to 9656 rupees per quintal during study period. Coriander arrival in the surveyed markets varied from 4.6 to 2538 tones in a month. Higher prices were observed in lean season i.e. from April to November whereas lower prices were observed in peak season from December to March month with lowest prices during February and March months when highest arrivals was recorded. There was positive trend in prices and negative trend in coriander arrivals in the studied markets. There was high degree of correlation in the prices and low correlation in the

arrivals in the major markets. Prices and arrivals was found negatively correlated in most of the markets.

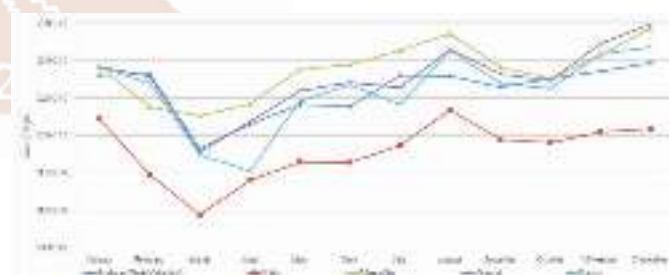
Cumin prices and arrivals analysis



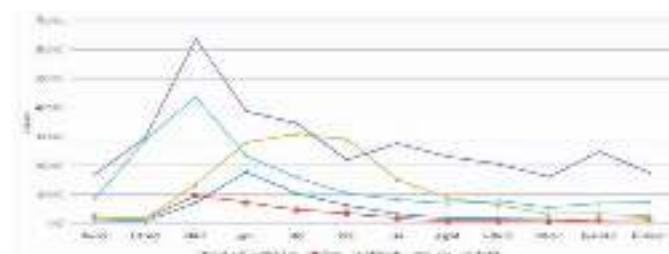
Monthly prices of cumin in major markets (Rs/Quintal)

Table 3.60 : Average monthly prices (Rs per quintal) and arrivals (tonnes) of cumin in major markets from Jan. 2008 to June 2019

Name of market	Price (Rs/Q)	Arrivals (tonnes)
Jodhpur	12535.41	517.67
Kekri	11774.81	303.35
Merta City	12862.55	1329.32
Gondal	12787.58	1790.93
Rajkot	12687.82	1501.17



Average monthly prices (Rs/Quintal) of cumin in major markets



Monthly average arrivals (tones) for cumin in major markets

In cumin, during 2008 to 2019 cumin price varies between 7221 to 19155 rupees per quintal. There was increasing trend in cumin prices from 2008 to 2019 except 2014. Lowest price was found in month of March when highest arrival was there in these markets (Table 3.54). Whereas highest price was observed in January when lower arrival was seen. Study found inverse relationship between market arrivals and prices. Based on the finding of the study it can be concluded that seasonality in coriander and cumin is one of the major cause of variation in the prices in both the crops. Hence government should introduce market stabilization policies to reduce season price fluctuation by insuring ceiling and floor prices in the seed spice crops.

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, 2019-24)

Under TSP area of Rajasthan, 04 districts (Banswara, Pratapghar, Dunderpur and Udaipur) were covered during reporting period. Four Farmers' Capacity Building Programs conducted in respective districts with the help of KVKs and Department of Agriculture GOR. The programs were conducted in Banswara on 21.08.2018, in Pratapghar on 22.08.2018, in Dunderpur 11.09.2018 and Udaipur district on 12.09.2018. The trainings were given on GAP of seed spices to produce quality spices. Seed of improved varieties and required quantity of fertilizers were also given to TSP beneficiaries. Total beneficiaries benefited in these programs were 231. Besides this,

231 frontline demonstrations (FLDs) of different seed spices were also conducted in TSP area of Rajasthan in collaboration with KVK, Pratapgarh, KVK, Banswara, KVK, Dunderpur, and State Department of Agriculture, Jhadol, Udaipur during 2018-19. The yield appreciation of demonstrated varieties and technologies recorded from 21% to 41% higher over local cultivars and practices.

Under NEH program, 02 capacity building programs organized first on "Organic production technologies of seed spices for NEH region" at KVK (ICAR Research Complex for NEH), Namsai, Longding (Arunachal

Pradesh) on 22nd September, 2018. In this training programme 08 lectures were delivered on different aspects of seed spices production. There were 115 participants including scientists, Govt. officials, farmers and entrepreneurs from Arunachal Pradesh participated and benefited. Improved variety seed of different seed spices also given to the participants to grow in their area. Second capacity building program conducted on "Advanced Production and Protection Technologies of Seed Spice for NEH Region" with the of collaboration ATARI, Zone VI, Guwahati, Assam & KVK, Morigaon at Krishi Vigyan Kendra, Morigaon during 29-30 January, 2019. In all 74 beneficiaries from different districts of Assam State participated. All participants NEH programs were also benefited with the supply of seeds of improved varieties of seed spices to demonstrate in small plots of 25M² area.

External Funded Projects

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

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

A Network Project on Organic Farming (NPOF) "Standardization of seed spices based organic farming system" sponsored by ICAR-IIFSR, Modipuram is running at ICAR-NRCSS, Ajmer to develop 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 following results were obtained:

1. The experiments on INM for the development of sustainable seed spices based cropping system in *kharif* (moong bean and cluster bean) and *Rabi* (coriander and fennel) were conducted at organic block of research farm, NRCSS, Ajmer. The results stated that, the performance of 75% organic with 25% inorganic treatment is recorded highest value of all parameters followed by state recommendation both in *Kharif* and *Rabi* season
2. Similarly, the eight varieties of both coriander and

fennel in *Rabi* and eight varieties of moong bean and cluster bean in *Kharif* were tested under organic production system. It was found that the performance of GF-12 was recorded highest value (3235.00 kg/ha yield) followed by AF-1 (3203.33 kg/ha yield) in fennel. In coriander, variety Azad Dania-1 was found best in yield (1671.33 kg/ha yield) and growth parameters followed by ACr-1 (1663.33 kg/ha yield) in *Rabi* and in *Kharif* season, cluster bean variety RGC-1038 (1515.00 kg/ha yield) performed best followed by RGC-1055 (1433.33 kg/ha yield) and in moong bean superior performance was given by cultivar MUM-2 (798.33 kg/ha yield) followed by RMG-975 (791.67 kg/ha yield) with respect to growth and yield aspects.

3. 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 (75.30% & 76.42% reduction) 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.
4. Relative efficacy of six organic based IPM modules (including control) was evaluated against thrips on coriander and fennel under field conditions. It was found that the, IPM module M-3 (garlic extract 10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit + tumba fruit

extract 10ml/lit.) was also found most effective (65.00% & 70.61% reduction) against thrips on both the crops followed by M-2 (field sanitation + NSKE 5ml/lit + Ker extract 10 ml/li.). The remaining treatments IPM modules were found moderately effective against pest on both the crops.

5. In coriander, five different organic treatments were evaluated including soil solarization (21 days), *Trichoderma* (8g kg⁻¹ seed as seed treatment + 2.5 kg ha⁻¹ as soil application), neem cake (0.5t/ha), caster cake (0.5t/ha) and control. Among the treatments, soil solarization was found most effective (PDI 2.98) followed by neem cake (PDI 5.72) while the disease (*Sclerotium* rot of coriander) was recorded maximum under control plots.

In the same project, the work on spice premixes was initiated based on organoleptic evaluation. The eight spice premixes using Garam masala, Rajma masala, Chana masala, Tea masala, Raita masala, Jal Jeera, Sabji masala, Jeeroli, cumin aonla squesh and cumin squesh were prepared are to be standardized. Among them, i.e. Garam masala, Rajma masala, Chana masala, Tea masala, Raita masala, Jal Jeera and Sabji were evaluated organoleptically and scored from 7.06 to 7.91 out of nine (9-Hedonic ranking test scale). The value added products were also carried out their shelf life storage studies under laboratory. The organic spices (fennel, coriander and fenugreek) were procured from ICAR-NRCSS, Tabiji, Ajmer (Rajasthan) for preparation above spice premixes. Standardized products also obtain FSSAI licence number 12219009000491 on dated 15 October, 2019.





DUS testing guideline in major seed spices crops.

Dr. R.S. Meena (PI)

DUS experiment of major seed spices (Coriander, fenugreek, fennel and cumin) was laid out at NRCSS, Ajmer (Rajasthan) during 2018-19. In this experiment 35 varieties of Coriander, (26 references and 9 Candidate), 22 varieties of fenugreek, 21 varieties of fennel, 9 varieties of cumin were included to develop test guidelines for these crops. The meeting of Task Force Validation of DUS test guidelines in fennel and cumin was held under the Chairmanship of Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer, on 02 January, 2019 to examine the draft DUS Test Guidelines developed by ICAR-NRCSS Ajmer to finalize the same in the light of the PPV&FR Act, 2001.

DUS test guidelines in minor seed spice crops.

Dr. R.S. Meena (PI)

DUS experiment of minor seed spices (ajwain, dill, nigella, celery and anise) were laid out at ICAR-NRCSS, Ajmer (Rajasthan) during 2018-2019. In this experiment 8 varieties of ajwain, 5 varieties of dill, 5 varieties of nigella, 3 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. The meeting of Task Force Validation of DUS test guidelines in ajwain, dill and anise was held under the Chairmanship of Dr. Dharendra Singh, Prof. & Head S.K.N.A.U. Jobner on 03 January, 2019 to examine the draft DUS Test Guidelines developed by ICAR-NRCSS Ajmer to finalize the same in the light of the PPV & FR Act, 2001.



Dr. Ravi Prakash, Registrar, PPV&FRA, Dr. Dharendra Singh, Prof. & Head S.K.N.A.U & Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer during DUS field visit at ICAR-NRCSS Ajmer.

Centrally Sponsored Scheme –MIDH Development programme on Seed Spices.

Dr. Y.K. Sharma (PI)

Production of quality planting materials of seed spices (2018-19)

During 2018-19 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. The programme was taken at various farmers field located in Ajmer, Nagaur, and Jaisalmer districts of Rajasthan. The production details are as under:

Crop	Variety	Production (Quintals)
Cumin	GC-4	221.00
Fennel	Ajmer Fennel -2	5.00
Total		226

Besides this breeder seed production of fenugreek varieties AFg-1, AFg-2, AFg-3, AFg-4 and AFg-5, Fennel variety AF-1 and AF-2, Coriander variety ACr-1 and ACr-2,

Dill variety AD-1, AD-2, Ajwain varieties AA-1, AA-2 and AA-93, nigella variety AN-1 and AN-20 and Kasuri-methi were also taken at ICAR-NRCSS farm. The production details of breeder seed produced at NRCSS fields are as under:

Crop	Variety	Production (kg)
Coriander	Ajmer Coriander-1	130
Coriander	Ajmer Coriander-2	250
Fennel	Ajmer Fennel-1	950
Fennel	Ajmer Fennel-2	600
Fenugreek	Ajmer Fenugreek-1	150
Fenugreek	Ajmer Fenugreek-2	100
Fenugreek	Ajmer Fenugreek-3	2076
Fenugreek	Ajmer Fenugreek-4	112
Fenugreek	Ajmer Fenugreek-5	1750
Ajwain	Ajmer Ajwain-1	60
Ajwain	Ajmer Ajwain-2	100
Ajwain	Ajmer Ajwain-93	200
Dill	Ajmer Dill-1	80
Dill	Ajmer Dill-2	150
Nigella	Ajmer Nigella-1	20
Nigella	Ajmer Nigella-20	100
Kasuri Methi	Pusa Kasuri	514
Total		7342

44 Front line Demonstrators (FLDS) of seed spices conducted at the famous field in different districts of Rajasthan.

Under TOT programme, three farmers trainings, one district level seminar and one state level seminar organised.

4. Technology Assessment and Transfer

4.1. Technology Dissemination through Frontline Demonstrations on Seed Spices (2019)

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

Under Centrally Sponsored Scheme- MIDH Development programmes on seed spices, 21 Front Line Demonstrations (FLDs) of seed spices were conducted at the farmers fields of different districts of Rajasthan. In the demonstration plots, the total FLDs of fenugreek (10), fennel (03), and Coriander (08) with improved varieties of fenugreek, fennel and coriander and recommended package of practices (POP) including seed treatments, line sowing, were demonstrated on the farmers' fields. Fenugreek and coriander FLDs were managed organically.

District wise distribution of front line demonstrations on different seed spices

Name of district	Crop	No. of FLDs
Sikar	Fenugreek	10
Sikar	Fennel	01
Baran	Coriander	08
Ajmer	Fennel	02
	Total	21



Coriander seed distribution at Anta, Baran District of Rajasthan

Dr. N. K. Meena and Dr. Narendra Chaudhary distributed seeds of coriander (ACr-1) and trichoderma for conduction of frontline demonstrations (FLDs) at farmers field in Baran District. The Scientists interacted with the farmers about package of practices of coriander and provided pamphlets of the coriander for better adoption of technology developed by ICAR-NRCSS.



Fenugreek seed distribution at Sikar District of Rajasthan

4.2. Capacity Building Programme under TSP & NEH region during-2019

(G. Lal, N. K. Meena, R.S. Meena, M.D. Meena and Shiv Lal)
230 frontline demonstrations (FLDs) of seed spices i.e. coriander variety ACr-1 (62) and AGCr-1 (4), fenugreek-AFg-3 (69), fennel-AF-1 (25), ajwain-AA-1 (45), dill-AD-1 (05) and nigell-AN-1 (20) were conducted at tribal farmers field at Pratapgarh, Banswara, Dungarpur and Udaipur districts of Rajasthan under Tribal Sub-plan project of ICAR-NRCSS, Ajmer. These FLDs were organized in collaboration with Krishi Vigyan Kendra, Pratapgarh, KVK, Banswara, KVK, Dungarpur, and State Department of Agriculture, Phalasia, Udaipur during Rabi 2018-19. In the FLDs, improved varieties and recommended package of practices (POP) including seed treatments, line sowing, weed management, nutrient management and plant protection measures were demonstrated on the farmers' fields. In plant protection measures, foliar treatment of imidacloprid 17.8 SL @ 0.003% and botanicals (Ker plant extract 10ml/lit., and azadirachtin 0.03EC 5ml/lit.) were used. The performance of crops under all the frontline demonstrations (FLDs) was observed better in respect to

Table 4.2 Average performance of FLDs of different seed spices at tribal districts of Rajasthan in 2019.

Sl. No.	Crop	Technology Demonstrated	Variety	No. of FLDs	Area (ha.)	Demo. Yield q/ha			Yield of local Check (q/ha)	Increase in yield (%)
						H	L	A		
1.	Coriander	Crop Production and protection technologies for seed spices	ACr-1	62	15.5	7	5.55	6.18	4.51	37.15
			AGCr-1	04	0.40	32.00	26.00	29.00	24.25	19.58
2.	Fenugreek		AFg-3	69	17.25	18.45	13.62	15.75	11.68	35.20
3.	Ajwain		AA-1	45	11.25	10.05	7.68	9.03	6.24	42.76
4.	Nigella		AN-1	20	5.00	6.70	4.70	5.56	4.39	32.16
5.	Dill		AD-1	05	1.25	12.8	10.9	11.98	9.54	25.57
6.	Fennel		AF-1	25	6.25	14.67	11.93	13.14	10.48	24.56
Total				230	57.75					

overall growth parameters, yield and yield attributes. Results of the FLDs at different farmers fields (Table 1) revealed that yield of seed spices under demonstration plots was higher in comparison to local checks/practices which were ranged from 19 to 37 percent. It was found 37.15 % higher in coriander, 35.20% in fenugreek, and 24.56% in fennel, 42.76 % in ajwain, 32.16% in nigella, and 25.57% in dill.



FLDs input distribution at Phalasia (Udaipur)



FLDs input distribution at KVK, Banswara



FLDs input distribution at KVK, Pratapgarh

Farmers Trainings organized under TSP during 2019:

During the period reported upon, 06 farmers' trainings and capacity building programmes were conducted. Details are giving below.

One day farmer's training on Good agricultural practices for seed spices cultivation was organized at KVK (MPUA&T), Badal Mahal, Dungarpur on 13th June, 2019. In this training, a total of 5 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Dungarpur on various aspects of Good agricultural practices for seed spices cultivation and other related field. A total of 60 farmers from different villages participated in the training programme organized by NRCSS under TSP project.

One day farmer's training on Sustainable agricultural production technology for seed spices was organized at KVK (MPUA&T), Banswara on 27th June, 2019. In this training, a total of 5 lectures were delivered by the

scientists, ICAR-NRCSS, Ajmer and KVK, Banswara on various aspects of Sustainable agricultural production technology for seed spices. A total of 55 farmers from different villages participated in the training programme organized by NRCSS under TSP project.

One day farmer's training on Organic cultivation of seed spices was organized at KVK (MPUA&T), Pratapgarh on 8th July, 2019. In this training, a total of 7 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Pratapgarh on various aspects of Organic cultivation of seed spices. A total of 63 farmers from different villages participated in the training programme organized by NRCSS under TSP project.

One day farmer's training on Improved production technologies for seed spices cultivation at Agriculture Department, Govt. of Rajasthan, Panarwa, Phalasia (Udaipur) on 12th October, 2019. In this training, a total of 6 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and Agriculture Department, Panarwa (Phalasia) Udaipur, on different aspects of production and protection technologies in seed spices and other related field. A total of 53 farmers from different villages

participated in the training programme organized by NRCSS under TSP project.

One day capacity building programme on Plant protection in organic cultivation of seed spices was organized at KVK (MPUA&T), Banswara on 26th December, 2019. In this training, a total of 6 lectures were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Banswara on various aspects of Plant protection in organic cultivation of seed spices and other related field. A total of 54 farmers from different villages participated in the training programme organized by NRCSS under TSP project.

One day capacity building programme on Plant protection in organic cultivation of seed spices was organized at KVK (MPUA & T), Pratapgarh on 27th December, 2019. In this programme, 6 lectures on various aspects of Plant protection in organic cultivation of seed spices and other related field were delivered by the scientists, ICAR-NRCSS, Ajmer and KVK, Pratapgarh. A total of 55 farmers from different villages participated in the training programme organized by NRCSS under TSP project.





Farmers training at KVK, Vallabnagar (Udaipur)

A Farmers Capacity Building Programme on “Production Technology on Seed Spices for NEH Region” at CAU, Imphal

Two days Capacity Building Programme on “Production Technology on Seed Spices for NEH Region” was organized by ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer (Rajasthan) in collaboration with KVK, Imphal East Andro for the farmers of Manipur State at College of Agriculture, CAU, Imphal during 2-3 August, 2019 under NEH component of the institute. In inaugural function, Dr. R.K. Saha, Director, Extension Education, CAU Imphal was Chief Guest, Dr. K. Mamocha Singh, Registrar, CAU, Imphal and Dr. A.N. Ganeshamurthy, Dean College of Agriculture, Imphal were Guests of Honour and Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer Presiding over the function. In the inaugural function, Dr. N.K. Meena, Coordinator of the programme formally welcomed the dignitaries, faculty scientists and farmers. Dr. Saha addressed the gathering interacted with trainee farmers and shared his ideas about how seed spices become more useful for famers in the State. He said about tremendous possibilities of seed spices particularly coriander and fenugreek for leaf as well as seed purpose in Manipur. He emphasized the role of spices to make cuisines more testy and attractive, hence farmers should adopt seed spices cultivation for fulfil the daily need of every house hold. Dr. G. Lal, while presiding over the inaugural session addressed the participants and presented the overall picture of seed spices production trend, their importance for medicinal and nutritional point of view, consequently seed spice's area and productivity enhancement in the country as well as

farmers benefit due to low volume and high value crops. He also emphasized that the farmers can earn more income by growing ACr-1 and AGCr-1 varieties of coriander and AFg-3 and AFg-5 varieties of fenugreek in their farms and/or farming system. Farmers should come forward for graded packaging and value addition to maintain the quality and shelf life of these commodities consequently they may fetch more price in off season. Guest of Honour Dr. K. Mamocha Singh also interacted with the farmers and encourages them to come forward for the cultivation of seed spices in Manipur State. He also spoke on pest problems coming in present cropping pattern in Manipur and possible control measures. Dr. Ganeshamurthy also discussed with farmers and shared his ideas about importance of spices particularly coriander and fenugreek.

In two days deliberation, Scientists from ICAR-National Research Centre on Seed Spices, Ajmer, Dr. N.K. Meena, Sr. Scientist (Entomology), Dr. Shiv Lal, Scientist (Horticulture) and Dr. A.K. Verma, Scientist (Horticulture) delivered lectures on various aspects of production, package of practices, improved varieties of seed spices specially fenugreek and coriander suitable for NEH region, insect-pests, diseases and weed management, organic farming and post-harvest & value addition. Scientists from College of Agriculture, Imphal and ICAR Research Complex for NEH Region Manipur Centre also interacted with farmers given their presentation on various aspects in respect to seed spices cultivation in the state. Mrs (Dr.) Molibana Devi, Sr. Scientist & Head, Krishi Vigyan Kendra, Imphal East, Andro while interacting with farmers told about benefit of farmers through seed

spices. In this programme 50 farmers from different districts of Manipur State were actively participated and benefited with new valuable crops. In this programme, quality seed of fenugreek (AFg-3) and coriander (ACr-1) was given to each farmer as FLD for 100 sq meter area and also distributed plastic crates to the farmers which will be useful in carrying vegetables and other produces. At the end of the programme, Dr. N.K. Meena, Co-PI of the project proposed vote of thanks to all participants.



Lightening of lamp by dignitaries during the State level awareness programme



New initiatives for popularization of seed spices in non-traditional areas

To popularize seed spice cultivation in non-traditional (Telangana State), a new initiative has been taken up in collaboration with TSHDCL, Hyderabad. Under this initiative a State level awareness programme on “Prospects and potential for cultivation of seed spices in Telangana State” was organized on 15.10.2019 at Thti, Red Hills, Hyderabad by TSHDCL, Hyderabad. Sri S. Niranjan Reddy Garu, Hon'ble Minister for Agriculture and Allied Sectors, Govt. of Telangana was the Chief Guest of the function and Sri C. Partha Sarathi, IAS, APC & Prl. Secy. to Govt., A&C Dept. Govt. of Telangana was Guest of Honor. The Chief Guest has emphasised on importance and potential of seed spices in income enhancement of farmers. In this programme Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer (special guest) delivered talk on “An overview on Seed Spices in India” as invited

speaker and interacted with farmers/officials of Telangana State. Dr. Lal stressed upon prospect of seed spices especially coriander and Ajwain in the state. He further suggested that ICAR-NRCSS, Ajmer has been developed scalable technologies which will be very profitable for new seed spice growers in the state. The Telangana is non traditional areas for seed spices and its potential must be explored with the existing promising technologies. In addition to that Dr. N.K. Meena, Sr. Scientist and Dr. Shiv Lal, Sr. Scientist also delivered their lectures on specific topics and interacted with gathering. This programme was attended by 250 farmers. An exhibition of different seed spices was also displayed during the programme and the Chief Guest impressed by different promising varieties developed by ICAR-NRCSS, Ajmer. In this awareness programme officials from SKLTSHU, Telangana, KVK, Department of Horticulture and TSHDCL, Hyderabad participated. This programme was coordinated by Director of Horticulture & Sericulture, Deputy Director Horticulture, Govt. of Telangana.



Dr. Gopal Lal briefing about ICAR-NRCSS, Ajmer promising seed spices varieties to Sri S.Niranjan Reddy Garu, Hon'ble Minister for Agriculture and Allied Sectors, Govt. of Telangana and Sri C. Partha Sarathi, IAS, APC & Prl. Secy. to Govt., A&C Dept. Govt. of Telangana

Farmers' trainings under TSP during 2019

Sl. No.	Coordinator	Title of training	Duration	Place	No. of beneficiaries
1.	Dr. N. K. Meena, Dr. N Choudhary and Mr. Ravi Y.	Good agricultural practices for seed spices cultivation	13 June, 2019	KVK, Dungarpur	60 farmers
2.	Dr. R. S. Meena, Dr N K Meena & Dr. M D Meena	Sustainable agricultural production technology for seed spices	27 June, 2019	KVK, Banswara	55 farmers
3.	Dr. M D Meena, Dr. N. K. Meena, Dr. Shiv Lal & Narendra Chaudhary	Organic cultivation of seed spices	8 July 2019	KVK, Pratapgarh	63 farmers
4.	Dr. G. Lal, Dr. N. K. Meena, Dr. Shiv Lal & Dr. M. D. Meena	Improved production technologies for seed spices	12 Oct., 2019	Ag. Department, Govt. of Raj. Phalasic, Udaipur	53 farmers
5.	Dr. G. Lal, Dr. N. K. Meena & Dr. R. S. Meena	Plant protection in organic cultivation of seed spices	26 Dec., 2020	KVK, Dungarpur	54 farmers
6.	Dr. R. S. Meena & Dr. N. K. Meena	Plant protection in organic cultivation of seed spices	27 Dec., 2020	NOFRI, Sikkim	55 farmers
Total (07 Farmers training/capacity building programme)					447 farmers

Training programme organized under Scheduled Caste Sub Plan (SCSP)-2019

Title of training	Duration	Coordinators	Sponsoring agency	Farmers benefitted
Seed spices cultivation for higher profitability and prosperity" on at ICAR-NRCSS, Ajmer	6 July, 2019 (One day)	Gopal Lal, Director (Training Director), Dr. Shiv Lal, Sr. Scientist (training coordinator) and Dr. Murlidhar Meena, Scientist (training coordinator).	SCSP	100
Input distribution for FLDs of seed spices under SCSP" at ICAR-NRCSS, Ajmer	4 Oct., 2019 (One day)	Gopal Lal, Director (Training Director), Dr. Shiv Lal, Sr. Scientist (training coordinator)	SCSP	38
Input distribution of for seed spices frontline	11 Oct., 2019 (One day)	Dr. Gopal Lal, Director (Training Director), Dr. Dr. S.S Meena, Pr. Scientist	SCSP	51

demonstration and sustainable production technologies " was organized in collaboration with Krishi Vigyan Kendra, Rajasamand at KVK, Rajasamand		(training coordinator), Dr. Shiv Lal, Scientist (training coordinator), Dr. R.D. Meena, Scientist (training coordinator) and Mr. P.K. Agarwal, TA (Traning Co-coordinator) Dr. P.C. Regar, Scientist, Animal Sciences and Dr. R.S Patodiya, Ex. Senior Scientist & Head (local training coordinator) KVK, Rajasamand (local training coordinator).		
"Advanced production technologies for seed spices and input distribution for frontline demonstration" in collaboration with Krishi Vigyan Kendra, Bhilwara.	6 Nov., 2019 (One day)	Dr. Gopal Lal, Director (Training Director), Shiv Lal, Sr. Scientist (training coordinator), Dr. R.D. Meena, Scientist (training coordinator), Dr. M.D. Meena, Scientist (training coordinator) and Mr. Sreeram Balai, TA from ICAR-NRCSS and Dr. C. M Yadav, Head and Sr. Scientist, KVK, Rajasamand (local training coordinator).	SCSP	42
Advanced production technologies for seed spices and input distribution for frontline demonstration" on in collaboration with Krishi Vigyan Kendra, Jhunjhunu.	7 Nov., 2019 (One day)	Dr. Shiv Lal, Sr. Scientist (training coordinator), Dr. R.D. Meena, Scientist (training coordinator), Dr. M.D. Meena, Scientist (training coordinator) and Mr. Sreeram Balai, TA from ICAR-NRCSS and Dr. Dayananad, Head and Sr. Scientist, KVK, Abusar, Jhunjhunu (local training coordinator).	SCSP	30
Good agricultural practices for quality seed spice production" at ICAR-NRCSS, Ajmer.	17 Dec., 2019 (One day)	Dr. Gopal Lal, Director (Training Director), Dr. Shiv Lal, Sr. Scientist (training coordinator), Dr. A.K. Verma, Scientist (training coordinator) and Dr. R.D. Meena, (training co-coordinator)	SCSP	23
Advanced seed spices production technologies for higher profitability	14-18 Oct., 2019 (5 days)	Dr. Gopal Lal, Director (Training Director), Dr. Shiv Lal, Sr. Scientist (training coordinator), G.K. Tripathy , STA, (training coordinator)	ATMA, Rajasamand	33

Transfer of technologies through capacity building and FLDs under SCSP

For capacity building and dissemination of ICAR-NRCSS Ajmer promising technologies among the famers belongs to SC community, a total of 6 trainings and 156 frontline demonstrations were organized at various locations of the state of Rajasthan under SCSC during the period. The details of training and FLDs are as mentioned below:

The first one day farmers training programme was

conducted on the topic "seed spices cultivation for higher profitability and prosperity" on 6th July, 2019 at ICAR-NRCSS, Ajmer. In this training a total of 100 farmers of Tabiji, Masinia, Saradhna, Doomara, Nandala, Nayagaon, Daulatpura, Hatundi, Rajgarh, Daurai, Bhudol, ramganj and Budhwara villages were participated. During the training programme a total of seven lectures were delivered by scientist of ICAR-NRCSS, Ajmer on different aspects of seed spices production, protection and postharvest management.



To protect their crops and application of bio-pesticides, a hand operated spray machines were distributed in addition to training kit to all the beneficiaries. The programme was organized by Dr. Gopal Lal, Director (Training Director), Dr. Shiv Lal, Sr. Scientist (training coordinator) and Dr. Murlidhar Meena, Scientist (training coordinator).

The second one day's programme was conducted on the topic "Input distribution for FLDs of seed spices under SCSP" on 4th October, 2019 at ICAR-NRCSS, Ajmer. In this programme a total of 34 farmers belong to Bunravata (Naguar), Datra, Nayagaon, Budhwara, Hatundi, Tabiji, Bandanwara and Masinia villages were participated. During the programme lectures were delivered by scientist of ICAR-NRCSS, Ajmer on different aspects of



seed spices. In this programme a total of 38 FLDs (Cumin-13, Fennel-6 and Fenugreek-15) along with *Tirchoderma viride* (100 g) were also distributed in addition to training kit to all the beneficiaries. The programme was organized by Dr. Gopal Lal, Director (Training Director) and Dr. Shiv Lal, Sr. Scientist (training coordinator).

The third one day farmers training on "Input distribution of for seed spices frontline demonstration and sustainable production technologies" was organized on 11th October, 2019 in collaboration with Krishi Vigyan Kendra, Rajasamand at KVK, Rajasamand. In this training programme a total of 51 farmers (majority female) of SC community from different villages (Uthnaul, Railmangra, Machind, Gudla, Malida, Rajnagar, Bara



Bhanuja, Nichli Odan, Jhalo ki Madar, Bagol, Kucholi, Mohi, Dhyla, Sema, Chapar) of Rajasamand were participated. In this training programme a training kit and hand sprayer and 5kg seeds of improved fenugreek variety (AFg5/AFg-3) along with *Tirchoderma viride* (100 g) for front line demonstration was distributed to each participant. During training programme Director ICAR-NRCSS, Ajmer delivered lecture on technologies for organic seed spices production besides five lectures on various aspects of sustainable seed spice production technologies were delivered by officials of ICAR-NRCSS and KVK, Rajasamand. Scientist and farmers also interacted on issues related to front line demonstration of fenugreek and standard PoP. The programme was organized by Dr. Gopal Lal, Director (Training Director), Dr. Dr. S.S Meena, Pr. Scientist (training coordinator), Shiv Lal, Scientist (training coordinator) and Dr. R.D. Meena, Scientist (training coordinator) and Mr. P.K. Agarwal, TA from ICAR-NRCSS and Dr. P.C. Regar, Scientist, Animal Sciences and Dr. R.S Patodiya, Ex. Senior Scientist & Head (local training coordinator) KVK, Rajasamand (local training coordinator).

The forth one day farmers training cum FLDs programme was organized on "Advanced production technologies for seed spices and input distribution for frontline demonstration" on 6th November, 2019 in collaboration with Krishi Vigyan Kendra, Bhilwara. A total of 42 farmers belongs to SC community from different villages (Sangramgarh, Antani, Magora, Ragunathgarh, Prabhugarh, Arwad, Hurda, Puravato ka Akola, Kaliyas, Jethgarh, Pondras, Varondani) of Bhilwara were participated in the programme. A training kit and 5kg seeds of improved fenugreek (AFg-3) and 3 kg cumin (GC-4,) variety along with *Tirchoderma viride* (100 g) was distributed to each participant for FLDs.



During training programme Director ICAR-NRCSS, Ajmer delivered lecture on technologies for advanced production technologies of seed spices besides six lectures on various aspects of advanced seed spice production technologies were delivered by officials of ICAR-NRCSS, KVK, Rajasamand and College of Agriculture, Bhilwara. A field visit of KVK, Bhilwara was also carried and scientist and farmers were also interacted on issues related to front line demonstration of fenugreek, cumin and their standard package of practices (PoP). The programme was organized by Dr. Gopal Lal, Director (Training Director), Shiv Lal, Sr. Scientist (training coordinator), Dr. R.D. Meena, Scientist (training coordinator), Dr. M.D. Meena, Scientist (training coordinator) and Mr. Sreeram Balai, TA from ICAR-NRCSS and Dr. C. M Yadav, Head and Sr. Scientist, KVK, Rajasamand (Local training coordinator). On the occasion Dean Collage of Agriculture Dr. K.L. Jinger and Dr. R.K. Sharma, Associate professor College of agriculture, Bhilwara was also delivered their talk.

The fifth one day farmers training cum FLDs programme was organized on topic "Advanced production technologies for seed spices and input distribution for frontline demonstration" on 7th November, 2019 in collaboration with Krishi Vigyan Kendra, Jhunjhunu. A





total of 30 farmers belongs to SC community from different villages (Degal, Ghodiwala, Mobbatsari, Jantwali, Sangasi, Abusar) of Jhunjhunu were participated in the programme. During the training programme lectures on various aspects were delivered by Scientists/officials of ICAR-NRCSS, Ajmer and KVK, Jhunjhunu. A training kit and 5kg seeds of Fenugreek variety AFG-3 and spray machine, training kit along with *Tirchoderma viride* (100 g) were distributed to all the participants for FLD's. The farmers were also briefed about package of practices of fenugreek cultivation. The programme was organized by Shiv Lal, Sr. Scientist (training coordinator), Dr. R.D. Meena, Scientist (training coordinator), Dr. M.D. Meena, Scientist (training coordinator) and Mr. Sreeram Balai, TA from ICAR-NRCSS and Dr. Dayananad, Head and Sr. Scientist, KVK, Abusar, Jhunjhunu (local training coordinator).

practices, insect-pest management and post harvest technology were delivered by Scientists/officials of ICAR-NRCSS, Ajmer. A training kit and spray machine were distributed to all the participants. The programme was organized by Dr. Gopal Lal, Director (Training Director), Dr. Shiv Lal, Sr. Scientist (training coordinator), Dr. A.K. Verma, Scientist (training coordinator) and Dr. R.D. Meena, (training co-coordinator)

Field demonstration of 50-75% shading intensity green shade net covered walk in tunnels for Off season leafy coriander production at Tabiji and Dang

Two crops (50-55 days duration) were undertaken by the farmer during off-season. Average green leafy biomass

The sixth one day farmers training programme was organized on topic "Good agricultural practices for quality seed spice production" on 17 December, 2019 at ICAR-NRCSS, Ajmer. A total of 23 farmers belongs to SC community from different villages (Dantra, Masinia, Badanwara, Budhwara and Hatundi) of Ajmer were participated in the programme. During the training programme lectures on good agricultural package of



production of 1st crop was 80 kg from 100 m² and sold in the market @ Rs 105.0/kg amounting the total revenue of Rs 8400, whereas the second crop was produced 80.0 kg and sold in the market @ Rs 40.0/kg amounting the total revenue of Rs 3200. The cost of cultivation including the working cost of the tunnel were Rs 6750, hence net profit the farmer got Rs4850.0 from 100 m² area, within 100 to 105 days during the off season when the prices of leafy coriander is very high.

Off Season Coriander production under shade net covered walk in tunnel: technology demonstration at NRCSS

On farm field demonstrations were conducted at NRCSS for showing the off- season production technology of green leafy coriander under shadenet covered walk in tunnels at ICAR-NRCSS, Ajmer. Coriander variety AgCr-1 were sown under shade net covered walk in tunnel during June- September, in an area of 100.0 meter square (25.0x4.0 m²) size tunnels. Six walk in tunnels having white, black and red coloured shadenet of 50 % shading intensity along with three tunnels of green colour shade net of 50, 75 and 90 shading intensity were demonstrated and compared. Among the different color tested green and black shad net were more effective for off season leafy coriander production than white and red shadenets during June and September. 75-90%

shading intensity of green shadenet or 50% black shade net covered walk in tunnels were equally effective for higher leafy biomass production during off season for both coriander. Two crops of coriander were taken from 1 June to 30 September with crop duration of 50-55 days which gave cumulative yield of 1875, 1638, 1348 kg/ha biomass of green leafy coriander under 90% Green, 50% Black and 75% Green shad net during off season.

4.3 Farmers visit to the Centre

Farmers and other stakeholders visited the ICAR-NRCSS experimental farm, knowledge park and bio control lab during April, 2019 to December, 2019. 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 25,000 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.



4.4 Sponsored Farmers training programmes organized at ICAR-NRCSS, Ajmer

Sr. No.	Title of training	Duration	Coordinators	Sponsoring agency	Farmers benefited
1	Beejeey Masalo ki Utapadan Vidhiya	17 to 21 Sep., 2019	Dr. Y.K. Sharma Dr. A.K. Verma Mr. M.A. Khan	PD, ATMA, Bhilwara (Raj.)	30
2	Beejeeye masalo ki unnat kheti	24 to 28 Sep., 2019	Dr. S.N. Saxena Dr. M.D. Meena Mr. S.R. Meena	PD, ATMA, Jaipur (Raj.)	30
3	Adhika aaye hetu beejeey masala fasal utpadan ki aadunik Vidhiya	14 to 18 Oct., 2019	Dr. K.K. Kant Dr. Shiv Lal Mr. G.K. Tripathi	PD, ATMA, Rajsamand (Raj.)	29
4	Beejeey Masala Fasalo me utapadn ki unat taknikiya	4 to 8 Nov., 2019	Dr. Ravindra Singh Dr. Narendra Chaudary Mr. P.K. Agrawal	PD, ATMA, Bikaner (Raj.)	20
5	Beejeey masala fasal utpadan ki unnat kheti	19 to 23 Nov., 2019	Dr. O.P. Aishwath Dr. Sharda Choudhary Mr. M.A. Khan	PD, ATMA, Pali (Raj.)	27
6	Aadunik takniyose beejeeye masalo ki kheti	25 to 29 Nov., 2019	Dr. S.S. Meena Dr. R.D. Meena Mr. S.R. Balai	PD, ATMA, Pali (Raj.)	31
7	Beejeey masala fasal utpadan	16 to 20 Dec., 2019	Dr. B.K. Mishra Dr. M.D. Meena Dr. A.K. Verma	State Agri. Management Institute Rahman kheda, Lucknow (U.P.)	26

One day training programme on "Farmers capacity building program on good agricultural practices (GAP) of cumin" under MIDH on 03.11.2019 held at KVK, Gudamalani, Barmer.

4.5 Radio/Television talks

Name of Scientists	Topic/Title of the talk	Date	Venue
वैज्ञानिक का नाम	वार्ता का विषय	प्रसारण दिनांक	
डॉ गोपाल लाल	उत्कृष्ट कृषि विधियाँ: एक परिचय	02-10-2019	AIR, Jaipur
डॉ आर एस मीणा	बीजीय मसाला फसलों की उन्नत किस्मों द्वारा उपज वृद्धि	16-10-2019	AIR, Jaipur
डॉ एस एस मीणा	मुख्य बीजीय मसाला फसलों की उन्नत खेती	06-11-2019	AIR, Jaipur
डॉ ओ पी ऐश्वथ	सिमटते भूमि संसाधन का बीजीय मसाला, द्वारा असीमित उपयोग अथवा बीजीय मसाले समस्याग्रस्त भूमि एवं जल के लिए एक उपहार	20-11-2019	AIR, Jaipur
डॉ रविन्द्र सिंह	बीजीय मसाला फसलों में बूंद-बूंद सिंचाई प्रणाली, इसकी देखरेख एवं सीमित जल संसाधनों का उपयोग	04-12-2019	AIR, Jaipur

डॉ वाई के शर्मा	बीजीय मसाला फसलों के प्रमुख रोग एवं नियंत्रण करने का एक उत्तम विकल्प।	18-12-2019	AIR, Jaipur
Dr. R. Singh	<i>Beejiye Masalon Ki Kheti</i>	23-10-2019	DD, Kisan
	बातचीत: बीजीय मसाला फसलों में बूंद-बूंद सिचाई किसानों के लिए वरदान	20-11-2019	AIR, Jaipur
	बीजीय मसाला फसलों में विशेषकर सौंफ व धनियां में उन्नत कृषि क्रियाएँ और बुवाई से जुड़ी महत्वपूर्ण कृषि सलाह	22-11-2019	DD, Rajasthan
Dr. A.K. Verma	<i>Phoolon ki kheti</i>	20-5-2019	DD, Jaipur



Participation of ICAR-NRCSS in different Exhibition, Kisan mela and Conferences during 2019

Sr. No.	Name of Event	Date	Organised by	Name of Exhibitors
1	Kisan Mela and Foundation day	16, Sept., 2019	ICAR-CAZRI Jodhpur	Dr. M.D Meena Mr. P.K. Agrawal
2	Seed World-2019 Bengaluru	18-21, Sept. 2019	Indian Council of Food and Agriculture, New Delhi	Dr. R.S. Meena Dr. M.D. Meena
3	Farmers fair	30, Sept., 2019	ICAR-CSWRI, Bikaner	Dr. G. Lal Dr. B.K Mishra Dr. M.D. Meena
4	Farmer Seminar	17, Sept., 2019	IFFCO Regional Office Jaipur	Dr. M.D. Meena Mr. M.A. Khan
5	3 rd Global Meet GMST-2019	01-02, Dec., 2019	Hi-Tech Horticulture Society Meerut (U.P)	Dr. M.D. Meena
6	Organic Festival-2019 Shilpgram, Udaipur	29-30, Nov., 2019	Organic Farming Association of India	Dr. R.D. Meena Dr. N. Chaudhary
7.	Kissan samelan 2019 Jaipur	17, Dec., 2019	Government of Rajasthan	Dr. M.D. Meena Mr. S.R. Meena
8.	World soil day	05, Dec., 2019	NRCSS, Ajmer, KVK, Ajmer & Agriculture Department	Dr. O.P. Aishwath



5. Training and Capacity Building Programmes

Training and Capacity Building of ICAR Employees

5.1 Training and Capacity Building of NRCSS Employees

Y.K. Sharma	Management Development Programme on Priority setting, Monitoring and Evaluation of Agricultural Research Projects NAARM, Hyderabad.	18-23, July, 2019
S. Choudhary	"CRISPR/Cas mediated genome editing: Applications, tools, and experimental design" sponsored by DBT & IUSSTF under Indo-US Genome engineering /editing technology initiative (GET in) program Department of Genetics, University of Delhi South campus, New Delhi.	27-31 May, 2019
A.K. Verma	Attended a training programme on "Hospitality Management" at ICAR-NAARM, Hyderabad.	26, June, - 02, July, 2019
N.Choudhary	Attended training programme on "Analysis of Experimental Data" held at NAARM, Hyderabad.	22-27, Aug, 2019

5.2 Seminar/Symposia/Conference/Workshop/Meeting etc. attended by employees

G. Lal	Attended Annual Zonal Workshop of KVKs of Rajasthan, Haryana & Delhi at MPUA&T, Udaipur at MPUA&T, Udaipur.	22-24, June, 2019
	Attended Review Meeting of the schemes on Spices & Aromatic Plants under MIDH conduct by DASD. University of Agriculture and Technology, Bhubaneswar, Orissa.	11-12, June, 2019
	Brainstorming Session on Technological Innovations and Strategies for Farmers Prosperity in Rajasthan at NASC Complex, Pusa, New Delhi on Foundation day function and SMD Meeting at ICAR, NASC complex, Pusa, New Delhi.	16-17, July, 2019
	Meeting with NED Spice Processing India, Koovappadam, Cochin, India was organized for commercialization of Cumin cultivation Technologies and training their staff.	31, Aug, 2019
	QRT review of AICRP on Spices Centres, at Jaipur, period 01.04.2013 to 31.03.2018 ICAR Indian Institute of Spices Research (ICAR IISR) and All India Coordinated Research project on Spices (AICRPS).)	27, Aug, 2019
	Spices Board Kochi First Meeting to discuss key issue of spices sector	4, Sept, 2019
	Foundation day of ICAR-CIHS, Bikaner.	28, Sept, 2019
	Attended Award function at National Conference of Agri exports meet at New Delhi (world Agri tech Congress 2019) World Agri tech Congress 2019, at New Delhi.	8, Nov, 2019

	Attended "NPOF Workshop" at CIARI Port Blair.	11-13, Nov, 2019
	Guest of honour at Western Sport meet at Awika Nagar Tonk, Rajasthan Avikanagar, Tonk, Rajasthan.	18, Nov, 2019
	Meeting for finalization of the implementation of AICRP Review Committee recommendations for their inclusion in the new EFC for the period 2020-25 Horticulture SMD at New Delhi.	30, Oct, 2019
	Farmers and Stakeholders Workshop, organised by Telengana State Department of Horticulture at Hyderabad during.	14-15, Oct, 2019
G.Lal	AICRPS (All India Co-ordinated Research Project on Spices) Workshop at T.N.A.U., Coimbatore, Tamilnadu.	14-16, Nov, 2019
R. Singh		
K. Kant		
S.S. Meena		
R.S. Meena		
S.N. Saxena	Attended meeting for implementation of Agriculture Export Policy announced by Gol in Rajasthan along with Rajasthan State Agriculture Marketing Board, Jaipur (Raj.)	25, June, 2019
O.P. Aishwath	International Conference on Soil and Water resource management for Climate Smart Agriculture, Global Food and Livelihood Security" held at NASC Complex, New Delhi.	5-9, Nov, 2019
	Role of micronutrients on morpho-physiological and nutritional parameters including diseases suppression of fenugreek. In: Proc: 84 th Annual Convention of ISSS held at Banaras Hindu University, Varanasi, UP.	5-18, Nov, 2019
B.K. Mishra	37 th Academic Council Meeting of Bhagwant University at Bhagwant University, Ajmer (Raj.).	16, Feb, 2019
	39 th Academic Council Meeting of Bhagwant University at Bhagwant University, Ajmer (Raj.).	23, Aug, 2019
	Two days Hindi Karyashala " <i>Bh. Kri. Anu. P. mein Rajbhasha Hindi Ke badalte aayam</i> " at ICAR-CIAH, Bikaner (Raj.).	30-31, Aug, 2019
B.K. Mishra	<i>Nagar Rajbhasha Karyanvayan simiti ki 77 vi baithak</i> , at sabha kaksh,	19, Dec, 2019
G. Lal	Mandal Rail Prabandhak Karyalya , Ajmer (Raj.).	
B.K. Mishra	<i>Nagar Rajbhasha Karyanvayan simiti ki 76 vi baithak</i> , at sabha kaksh,	06, June, 2019
S.N. Saxena	Mandal Rail Prabandhak Karyalya , Ajmer (Raj.).	
R.S. Meena	Indian Council of Food & Agriculture, New Delhi Seed World 2019,	
M.D. Meena	Bengaluru.	18-21, Sept, 2019
O.P. Aishwath	International conference on "Innovative Horticulture and Value Chain Management" organized by ASM Foundation, New Delhi,	28-31, May, 2019
S.S. Meena		
N.K. Meena	GBPUA&T, Pantnagar, CHAI & TAAS, New Delhi held at Pantnagar (UK).	
Shiv Lal		
N. Chaudhary		

S. Choudhary	International Conference on Recent Advances in Agricultural, Environmental & Applied Sciences for Global Development (RAAEASGD-2019) held at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P., India.	27-29, Sept, 2019
Shiv Lal	One day brainstorming on Horti-Millets (Researchable issues and way foreword) at ICAR-IIMR, Rajendra nagar, Hyderabad	13, Sept, 2019
	One day meeting on Implementation of Agriculture Export Policy - Cluster level committee's formulation for Rajasthan state. Rajasthan Agriculture Marketing Board, Jaipur.	25, June 2019
	State level awareness programme on "Prospect and potential for cultivation of seed spices in Telangana state at Hyderabad.	15, Oct, 2019
N. Chaudhary	Participated in Review Meeting of the schemes on Spices & Aromatic Plants under MIDH implemented through DASD, Calicut held at OUAT, Bhubaneswar.	11-12, June, 2019.
	Participated in 14 th Annual Group Meeting of AI-NPOF held at Port Blair	12-14, Nov, 2019
All NRCSS Staff	International Conference: 3 rd Global Meet on Science and Technology for ensuring quality Food and Nutritional Security (GMST 2019) at National Research Centre on Seed Spices, Ajmer (Rajasthan). Jointly organized by Hi Tech Horticultural Society, Meerut and Prerna Foundation Meerut (UP). IFFCO, Kisan Mela held at NRCSS, Ajmer.	01-03, Dec, 2019
	International Conference on Materials for Environment, Sustainable Society and Global Empowerment (MESSAGE-2019) jointly organised by Department of Nanotechnology, Visvesvaraya Technological University and NESI at Chikkaballapura, Karnataka, India.	17, Sept, 2019 19-20, Dec, 2019

5.3 Education (students guided)

Name of the student	Degree	Title of thesis	Name of university	Guide
Ms. Dhanni Devi	Ph. D.	Isolation, characterization and evaluation of plant growth promoting rhizobacteria and their influence on growth performance of cumin.	College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur	Dr. B.K. Mishra, Principal Scientist (Co-Major Advisor),

6. Awards and Recognitions

6.1 Awards

Dr. Gopal Lal

- i. NESAFellowship-2019- conferred by National Environment Science Academy, New Delhi.
- ii. India Agribusiness Award-2019 - conferred by Indian Chamber of Food and Agriculture, New Delhi.
- iii. Life Time Achievement Award of HTHS-2019. Conferred by Hi Tech Horticultural Society, Meerut (UP), India.
- iv. ICAR-National Research Centre on Seed Spices, Ajmer (Rajasthan) is recognized as Best Centre of All India Network Programme on Organic Farming (AI-NPOF) for the year 2018-19. The award presented in 13th Annual Group Meeting held at ICAR-CIARI, Port Blair (A&N) during 11-14th November, 2019.

Dr. Narendra Choudhary: Conferred CHAI-Fellow-2019 in International Conference on "Innovative Horticulture and Value Chain Management – Shaping Future Horticultural held at GBPUA & T, Pantnagar from 28th to 31st May, 2019

- 3rd Global Meet on Science and Technology for Ensuring Food and Nutritional Security (GMSC 2019) 01-03, December, 2019 held at ICAR-National Research Centre on Seed Spices
- ii. Conferred Fellow of Confederation of Horticulture Associations of India (CHAI), New Delhi-2019 during International Conference on Innovative Horticulture and Value Chain Management - Shaping Future Horticulture organized during 28-31, May 2019 at GBPUA&T, Pantnagar, Uttarakhand, India.



- iii. First prize in debate competition organized during Vigilance Awareness Week-2019 at ICAR-NRCSS, Ajmer.

Dr. Sharda Choudhary : Awarded with "Young Woman Scientist Award" in the International Conference on Recent Advances in Agricultural, Environmental & Applied Sciences for Global Development (RAAEASGD-2019) held during 27-29, September 2019 at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P., India.

Dr. O.P. Aishwath : (i) Fellowship of Confederation of Horticulture Association of INDIA (CHAI), for the dedicated effort and contribution in the field of soil requirement for horticultural crops during "International conference on Innovative Horticulture and Value Chain Management' held during 28-31, May 2019, GBPUA & T, Pantnagar, UK.

- ii. Best Oral Presentation Award for the paper entitled 'Nutritional and Biochemical Basis of Reddening, Wilt and Blight in Cumin' presented in Technical session-10: Workshop on Innovation in Management of Insect, Pest and Diseases and Safe



Dr. Shiv Lal (i) Young Scientist Associates Award-2019 conferred by Hi-Tech Horticulture Society, Meerut and Prerna Foundation Meerut during the



Use of Agrochemical for Effective Value Chain. In: International Conference on Innovative Horticulture and Value Chain Management' held during 28-31, May 2019, GBPUA&T, Pantnagar, UK.



6.2 Recognitions

G. Lal

- President, Indian Society of Seed Spices, Ajmer (From 26 March, 2016 to till date).
- Editor, Journal Plant Development Sciences (An International Monthly Referred Research Journal), Published from Meerut (UP), India.
- Member of Coordination Committee for doubling of Farmers Income- 2017-2019 (under the Chairmanship of Hon'ble VC, MPUAT, Udaipur).
- Member Forum of Agricultural Institutions in Rajasthan (FAIR)-2020-21, constituted by Chief Sectary Govt. of Rajasthan. Govt. of Rajasthan, Jaipur.
- Member & Special Invitee, Central Variety Release Committee-2019 (CVRC-2019), New Delhi.
- Chairman, Technical Session-II. International Conference: 3rd Global Meet on Science and technology for ensuring food and nutritional security (GMST 2019) during 01-03 December, 2019 at ICAR-NRCSS, Ajmer. Jointly organized by Hi Tech Horticultural Society, Meerut and Prerna Foundation Meerut (UP).
- Guest of Honour, Foundation Day cum Scientist-Farmer Interaction at CSWRI, Regional Research Station, Bikaner on April 04, 2019
- Guest of Honour, ICAR Western Zone Sport Meet at CSWRI, Avikanagar Tonk, Rajasthan on 18 November, 2019.
- Guest of Honour, Annual Review Meeting of MIDH programme organised by DASD Calicut at OUAT, Bhubaneswar during 11-12 June, 2019.
- Invited as Special Invitee to deliver a lecture on "Entrepreneurship in Seed Spices" to the students of College of Agribusiness Management (SKRAU), Bikaner on April 04, 2019
- Guest of Honour, Farmers and Stakeholders Workshop, organised by Telengana State Department of Horticulture at Hyderabad during 14-15 October, 2019.

	<ul style="list-style-type: none">• Guest of Honour, Review Meeting of the MIDH schemes on Spices & Aromatic Plants conducted by DASD at University of Agriculture and Technology, Bhubaneswar, Orissa during 11-12 June, 2019.
S.N. Saxena	<ul style="list-style-type: none">• Editor, International Journal of Seed Spices.
Y.K. Sharma	<ul style="list-style-type: none">• Editor, Annual Report, NRCSS 2018-19, published by ICAR-NRCSS, Ajmer
K. Kant	<ul style="list-style-type: none">• Editor, Annual Report, NRCSS 2018-19, published by ICAR-NRCSS, Ajmer
O.P. Aishwath	<ul style="list-style-type: none">• Councillor: Nominated as a Council member of 'In Society of Soil Survey and Land use Planning, Nagpur' during June, 2019.• Editor-in-Chief: Global Journal of Biology Agriculture & Health Sciences: Re-appointed by Global Institute for Research and Education during 2019.• 'Convener' for the Technical Session VI: Socio Economic Issues in Resources Management for livelihood security of International Conference on Soil and Water resource management for Climate Smart Agriculture, Global Food and Livelihood Security" held during 5-9 Nov., 2019 at NASC Complex, New Delhi. pp 149.
R. Singh	<ul style="list-style-type: none">• Secretary, Indian Society of Seed Spices, Tabiji, Ajmer, Rajasthan
S.S. Meena	<ul style="list-style-type: none">• Vice President, Indian Society of Seed Spices, Ajmer.• Local organizing secretary in inaugural session of in 3rd Global Meet on Science and Technology for ensuring quality Food and Nutritional Security (GMST 2019) from 01-03 December, 2019 at National Research Center on Seed Spices, Ajmer (Rajasthan) organized by Hi-Tech Horticulture Society, Meerut and Prerna Foundation Meerut.
B.K. Mishra	<ul style="list-style-type: none">• Editor, Annual Report NRCSS-2018-19 Published by ICAR- NRCSS, Ajmer, 106 p.• Editor, Masala Surabhi Rabhasha Hindi Patrika Jan-June, 2019 Published by ICAR- NRCSS, Ajmer, p.• Local organizing secretary in inaugural session of in 3rd Global Meet on Science and Technology for ensuring quality Food and Nutritional Security (GMST 2019) from 01-03 December, 2019 at National Research Center on Seed Spices, Ajmer (Rajasthan) organized by Hi-Tech Horticulture Society, Meerut and Prerna Foundation Meerut.
S. Choudhary	<ul style="list-style-type: none">• Editor, Masala Surabhi Rabhasha Hindi Patrika Jan-June, 2019 Published by ICAR- NRCSS, Ajmer.
M.D. Meena	<ul style="list-style-type: none">• Local organizing secretary in inaugural session of in 3rd Global Meet on Science and Technology for ensuring quality Food and Nutritional Security (GMST 2019) from 01-03 December, 2019 at National Research Center on Seed Spices, Ajmer (Rajasthan) organized by Hi-Tech Horticulture Society, Meerut and Prerna Foundation Meerut.
A.K. Verma	<ul style="list-style-type: none">• Second in Debate completion in Vigilance Awareness Week -2019• Electoral officer for ISSS Election-2019

Shiv Lal

- Acted as Convener in technical session IV during 3rd Global Meet on Science and Technology for ensuring quality Food and Nutritional Security (GMST 2019) from 01-03 December, 2019 at National Research Center on Seed Spices, Ajmer (Rajasthan) organized by Hi-Tech Horticulture Society, Meerut and Perna Foundation Meerut.

N. Choudhary

- Editor, NRCSS Annual Report 2018-19 published by ICAR-NRCSS, Ajmer.



7. Linkages and Collaborations

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

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

Central Agricultural University, Campus, Pasighat, Arunachal Pradesh.

Collage of Horticulture and Forestry, Jhalawar, Rajasthan.

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

Farmers, NGOs and Traders.

ICAR-ATARI, Barapani, Meghalaya.

ICAR-ATARI, Jodhpur, Rajasthan.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ICAR-NRC for Orchids, Pakyong, Sikkim.

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

ICAR-Spices Board, Cochin, Kerala.

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

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

State Agriculture Department of Rajasthan and Gujarat.

8. Publications

International Journals

1. Lal, G., Lal, S., Choudhary, M.K. and Chaudhary, N. 2019. Organic Coriander Production: A Review. *Current Investigation Agri. Current Res.* 8(1): 1046-1049.

National Journals

1. Agarwal, D., Saxena, S.N., Dubey, P.N., Mishra, B.K., Kant, K. and Lal, G. (2019). Genotypic variation in pharmacological potential of seed extracts of cumin (*Cuminum cyminum* L.) genotypes. *Indian J. Pharm. Sci.*, 81(5):946-954.
2. Aishwath, O.P., Mehta, R.S. and Lal, G. (2019). Effects of on-farm composted seed spices residues on coriander, nutritional parameters and seasonal carbon offset by the crop and soil. *International J. Seed Spices*, 9(1):91-99.
3. Choudhary, S., Naika, M.B.N., Sharma, R., Meena, R.D., Singh, R., and Lal, G. (2019). Transcriptome profiling of coriander: a dual purpose crop unravels stem gall resistance genes. *Journal of Genetics*, 98(1):19
4. Devi, D., Gupta, S.B. and Mishra, B.K. (2019). Isolation and characterization of potential Zn Solubilizing Rhizobacteria from cumin (*Cuminum cyminum*). *Int. J. Curr. Microbiol. App. Sci.*, 8 (07): 1865 - 1880. doi: <https://doi.org/10.20546/ijcmas.2019.807.222>.
5. Harisha, C.B., Singh, R. and Asangi, H. (2019). Growth, seed yield, water and nutrient use efficiency of coriander (*Coriandrum sativum* Benth.) as affected by varied irrigation levels and fertigation practices. *Indian J. Agril. Sci.*, 89(7): 107-112.
6. Kant, K., Meena, S.R., Sharma, Y.K., Meena, N.K., Vishal, M.K. Saxena, S.N. and Mishra, B.K. (2019). Development of aphids *Hyadaphis coriandri* (Das), its natural enemies and pollinators on coriander (*Coriandrum sativum* L.). *Int. J. Seed Spices*, 9(1):79-84.
7. Lal, G., Chaudhary, N., Lal, S. and Choudhary, M.

- (2019). Production of seed spices organically: A review. *Annals of Horticulture*. 12(1): 11-19
8. 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, *Int. J. Seed Spices*, 9(2):1-5.
9. Lal, G., Meena, N.K., Chaudhary, N. and Choudhary, M.K. (2019). Performance of fennel varieties under organic production system. *Int. J. Seed Spices*, 9(1):21-26.
10. Lal, G., Singh, R., Metha, R.S., Meena, N.K., Maheriya., S.P. and M.K. Choudhary (2019). Study on irrigation levels based on IW/CPE ratio and irrigation methods on growth and yield of fenugreek (*Trigonella foenium-graecum* L.): *Legume Research*, doi: 10.18805/LR-4050
11. Meena R.D., Sharma, Y.K., Meena N.L., Mishra, B.K., Meena S.S. and Meena, N.K. (2019). Economic feasibility of neem cake, Trichoderma and soil solarization on weed management in cumin (*Cuminum cyminum* L.). *Int. J. Seed Spices*, 9(2):76-79.
12. Meena, S.S., Lal, G., Dubey, P.N., Agrawal, P.K. and Sharma, D.K. (2019). Economic appreciation in *Nigella sativa* L. via effective weed management strategies. *Int. J. Seed Spices*, 9(2):85-89.
13. Meena, M.D., Lal, G., Meena, S.S., Lal, S. and Chaudhary, N. (2019). Seed spices export from India: Prospects and constraints. *Int. J. Seed Spices*, 9(2):12-20.
14. Meena, N.K., Lal, G., Meena, R.D. and Choudhary, M.K. (2019). Field evaluation of IPM modules for thrips management in fennel under integrated organic farming system. *Int. J. Seed Spices*, 9(1): 85-90.
15. Meena, N.K., Lal, G., Meena, S.S., Kant, K. and Meena, R.D. (2019). Screening of coriander varieties/entries for their relative susceptibility against aphids under field conditions. *J. Hortl. Sci.*, 14(2):39-42.

16. Meena, R.S., Lal, G., Meena, N.K. and Mali, S.C. (2019). Variability and character association in fennel (*Foeniculum vulgare* Mill.) germplasm. *Int. J. Seed Spices*, 9(2):29-36.
17. Meena, R.S., Verma, A.K., Meena, N.K., Ahari, Anita., Balai, S.R. and Mali, S.C. (2019). Variability and correlation studies for yield and yield contributing traits in fennel (*Foeniculum vulgare* Mill.) germplasm. *Int. J. Seed Spices*, 9(2):67-72.
18. Mishra, B.K., Lal, G., Sharma, Y.K., Kant, K., Saxena, S.N. and Dubey, P.N. (2019). Effect of microbial inoculants on cumin (*Cuminum cyminum* Linn.) growth and yield. *Int. J. Seed Spices*, 9(1): 53-56.
25. Verma, A.K., Sindhu, S.S., Singh, A., Kumar, A., Singh, A. and Chauhan, V.B.S. (2019). Conditioning effects of biodegradable superabsorbent polymer and vermi-products on media properties and growth of gerbera. *Ecological Engineering*, 132: 23–30. Doi:10.1016/j.ecoleng.2019.03.012
26. Verma, M.K., Lal, S., Sharma, V.K., Chaudhary, H. and Ahmed, N. (2019). PCA and genetic divergence analysis in pomegranate (*Punica granatum* L.) cultivars. *Int. J. Innovative Hort.*, 8(1):45-50.

Other Research Publications

19. Chauhan, V.B.S., Kumar, R., Behera, T.K., Yadav, R.K. and Verma, A.K. (2019). Inheritance of fruit weight and mode of gene action for yield contributing traits in tomato. *Res. J. Biotechnol.*, 14(4):73-78.
20. Chauhan, V.B.S., Kumar, R., Behera, T.K., Yadav, R.K., Kaur, C., Choudhury, H. and Verma, A.K. (2019). Inheritance of ascorbic acid and nature of gene action for nutritional traits in tomato. *Res. J. Biotechnol.*, 14 (12): 1-7.
21. Lal, S., Singh, A.K., Singh, S.K., Srivastav, M. and Singh, N.K. (2019). Genetic diversity in mango cultivars revealed by SSR markers. *Indian J. Hort.* 76(3):382-394.
22. Lal, S., Singh, D.B., Sharma, O.C., Mir, J.I., Kumawat, K.L., Raja, W.H. and Sharma, A. (2019). Association and multivariate analysis of chromatic and antioxidant attributes in cape gooseberry (*Physalis peruviana* L.) grown under temperate climate. *Int. J. Chemical Studies*, 7(3): 3969-3976.
23. Meena, M.D., Khunt, K.A., Meena, H.N. and Khorajiya, H.T. (2019). Export competitiveness of groundnut: A State wise-Analysis. *J. Oil seed Res.*, 35(3):210-218.
24. Meena, M.D., Khunt, K.A., Meena, H.N. and Khorajiya, H.T. (2019). Assessing export competitiveness of Indian groundnut. *Agril. Economics Res. Rev.*, 31 (2), 221-230.
1. Lal, G., Panwar, A.S., Ravisankar, N., Meena, N.K., Chaudhary, N., Shekhawat, N. and Choudhary, M.K. (2019). Value added products of organic seed spices, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
2. Lal, G., Panwar, A.S., Meena, N.K., Ravisankar, N., Choudhary, M.K. and Shekhawat, N. (2019). Organic farming of fennel, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
3. Verma, A.K., Meena, M.D., Mishra, B.K., Lal, G. (2019). *Beejeey Masaala Phasalotpaadan*, Farmers Training Manual, Published by ICAR-National Research Centre on Seed Spices. P. 1-103.
4. Lal, G. Meena, M.D. and Verma, A.K. (2019). Training Manual on Present status and future prospects of seed spices research and development in India. Publisher: Director, ICAR-National Research Center on Seed Spices, Ajmer-305206 (Rajasthan), India. P.1-118.
5. Prasad, D., Lal, G. and Ahmad, I. (2019) Adaptive Crop Protection Management Strategies (Edited) Published by Write & Print Publications, New Delhi-110052 (ISBN:978-93-88317-08-5). pp.1-425.
6. लाल, जी. ए मीणा. एस.एस.ए दुबे, पी.एन. और मीणा, एम. डी. (1/2019)। मध्य प्रदेश राज्य में मसालों की प्रोन्नत उत्पादन तकनीकी तथा सस्योत्तर क्रियाएँ। प्रकाशक: निदेशक, भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर, राजस्थान। पृ.सं. 1-91.

7. लाल, जी., सक्सेना एस.एन., शर्मा, वाई.के., मीना, एस. एस., लाल, शिव., मीना, एम.डी., वर्मा, ऐ.के., चौधरी एन., (2019)। बीजीय मसालों की जैविक एवं आधुनिक उत्पादन तकनीकियाँ (1/2019)। प्रकाशक: निदेशक, भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर, राजस्थान। पृ.सं. 1-104.
 8. गोपाल लाल, आर.एस. मीणा एवं एन.के. मीणा (2019) बीजीय मसाला फसलों की टिकाऊ खेती। भा.कृ.अनु.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर (ISBN:978-93-84189-77-8). पेज नं. 1.152.
 9. Lal, G. and Lal, S. (2019). Innovations in production and value chain management in seed spices, pp 270-277. In: Shodh Chintan on innovative horticulture and value chain management – Shaping future horticulture, ASM Foundation, New Delhi, 11:428.
- Extension bulletins/ folders**
1. Lal, G., Meena, N.K., Meena, R.D., Chaudhary, N., Choudhary, M.K. and Shekhawat, N. (2019). Performance of coriander varieties under organic production system, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
 2. Lal, G., Meena, N.K., Meena, R.D., Chaudhary, N., Choudhary M.K. and Shekhawat, N. (2019). Best Performing varieties of fennel under organic production system, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
 3. Lal, G., Meena, N.K., Meena, R.D., Chaudhary, N., Choudhary, M.K. and Shekhawat, N. (2019). Best Performing varieties of green gram under organic production system, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
 4. Lal, G., Meena, N.K., Meena, R.D., Chaudhary, N., Choudhary, M.K. and Shekhawat, N. (2019). Best Performing varieties of cluster bean under organic production system, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
 5. Lal, G., Panwar, A.S., Ravisankar, N., Chaudhary, N., Shekhawat, N. and Choudhary, M.K. (2019). Different products of organically produced cumin, published by Director & PI, AI-NPOF, ICAR-NRCSS, Ajmer.
 6. लाल, जी., सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर. डी. एवं मीणा एम.डी. (2019)। जीरा उत्पादन की उन्नत तकनीकी, रा.बी.म.अनु.के.—प्रसार पत्रक 1 भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 7. लाल, जी., सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर. डी. एवं मीणा एम.डी. (2019)। धनिया उत्पादन की उन्नत तकनीकी, रा.बी.म.अनु.के.—प्रसार पत्रक 2 भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 8. लाल, जी., सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर. डी. एवं मीणा एम.डी. (2019)। मेथी उत्पादन की उन्नत तकनीकी, रा.बी.म.अनु.के.—प्रसार पत्रक 3 भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 9. लाल, जी., सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर. डी. एवं मीणा एम.डी. (2019)। सौंफ उत्पादन की उन्नत तकनीकी, रा.बी.म.अनु.के.—प्रसार पत्रक 4 भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 10. लाल, जी., सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर. डी. एवं मीणा एम.डी. (2019)। अजवायन उत्पादन की उन्नत तकनीकी, रा.बी.म.अनु.के.—प्रसार पत्रक 5 भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
 11. लाल, जी., सक्सेना, एस.एन., मीणा, एस.एस., मीणा, आर. डी. एवं मीणा एम.डी. (2019)। कलौंजी उत्पादन की उन्नत तकनीकी, रा.बी.म.अनु.के.—प्रसार पत्रक 6 भा.कृ.अनु.प.—राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, तबीजी, अजमेर।
- Chapters in books/manuals/compendium**
1. Lal, G. and Lal, S. (2019). Technological interventions in seed spices production for enhancing productivity sustainability. In: Souvenir of 3rd Global meet on science and technology for ensuring food and nutritional security (GMST-2019), organised by during 01-03, December, 2019 at ICAR-NRCSS, Ajmer. Hi Tech Horticultural Society, Meerut, India. pp.07-16.
 2. Lal, G., Verma, A.K., Choudhary, M.K. and Kumar, N. (2019). Sustainable production of seed spices under the changing climate scenario: Impact and adaptive strategies. In: Adaptive Crop Protection Management Strategies (Eds. Prasad, D., Lal, G. and Ahmad, I.). Write & Print Publications, New Delhi-110052 (ISBN: 9789388317085) pp.214-230.

3. Aishwath, O.P. (2019). Horticultural crops for degraded land. In: Handbook of Horticulture (Eds. Verma et al. and Tech. Coordinator Dr. K.L. Chadha), Pub. ICAR-DKMA, New Delhi, 1: 205-215.
4. Meena, M.D., Lal, G. and Verma, A.K. (2019). Scenario of seed species cultivation and their economic importance. In: Training Manual on present status and future prospects of seed spices research and development in India. pp. 1-8.
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9. RAC/IRC/IMC Meetings

RAC Meeting

The 2nd meeting of VI Research Advisory Committee of ICAR- National Research Centre on Seed Spices (NRCSS) Tabiji, Ajmer was held at the centre during 14-15 May, 2019 under the chairmanship of Dr. B.S. Chundawat, Ex. Vice- Chancellor, SDAU Sardar Krishinagar, Dantiwada, Gujarat. The following members were present in the meeting: Dr. S. Amarender Reddy, Ex. Director (Extension), Dr. YSR Horti. University (AP), Dr. K.V. Ramana, Former ADG (Hort.), ICAR, New Delhi, Dr. I.S. Singh, Ex. Professor, PHT, NDUAT, Faizabad, Dr. T. Janakiram, ADG (HS-1), ICAR, New Delhi, Dr. V. Srinivasan, Principal Scientist, ICAR-IISR, Calicut, Dr. Ramavtar Sharma, Principal Scientist, ICAR-CAZRI, Jodhpur, Dr. G. Lal, Director, ICAR-NRCSS, Ajmer and Dr. Krishna Kant, Principal Scientist, Entomology, ICAR-NRCSS, Ajmer (Member Secretary). All the scientists of ICAR-NRCSS, Ajmer, participated in the meeting.

The meeting started with the welcome address by Dr. G. Lal, Director, ICAR-NRCSS, Ajmer. He welcomed the Chairman and distinguished members of the RAC 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 07 varieties has been notified and 02 varieties identified in the AICRP on spices workshop 2018 held at Solan, H.P.) 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 1st meeting of VI- RAC which was held during 31st August 2018 to 1st September, 2018 under the Chairmanship of Dr. B S Chundawat. It was suggested to modify the ATR incorporating the projects formulated as per suggestion of last meeting. The RAC members interacted with scientists regarding the projects / research experiments started in light of RAC recommendations. Subsequently the Chairman RAC invited the scientists to present their research findings of the reporting period 2017-18. The principal investigators of the research project presented salient findings of their respective projects.

Institute Research Council (IRC) Meeting

The XIX Institute Research Council (IRC) meeting of ICAR-NRCSS was held under the chairmanship of Dr. Gopal Lal, Director, ICAR-NRCSS during 06-07 Sept., 2019 to review the progress of ongoing institutional research projects at ICAR-NRCSS, Ajmer. In the meeting, new project proposals were also discussed thoroughly and were formally approved by the house. At the outset, I/c PME Cell Dr. Y.K. Sharma, welcomed the Chairman and other members of IRC. He indicated the number of ongoing research projects to be discussed in IRC. The Chairman, Dr. Gopal Lal also formally welcomed all the members of the IRC and briefed about the ongoing research and development activities at ICAR-NRC on Seed Spices, Ajmer. The action taken report of XVIII 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 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	Event
1.	Dr B I Fateh	R University Ahmedabad	09/04/2019	Campus Visit
2.	Sh Pawan	IAS Add Chief Secretary Agr. Hort.	16/04/2019	Visited Campus
	Dr Kumar Goyal	Animal Husabandory		
3.	Prof K R Mourya	Former VC R A Univ. Pusa Bihar and M J R P Univ. Jaipur	19/07/2019	Campus Visit
4.	Mr Narayanan G	Scientist ICAR -DGR, Junagarh Guj	09/05/2019	Visit of Museum
5.	Dr Devendra kumar	ICAR CSWRI, Avikanagar	26/07/2019	Campus Visit
6.	Dr Dilip Kumar Verma	ICAR -IARIRS, Indore	27/07/2019	Institute Inspection
7.	Sh Laxmi Narayan Meena	Divisional commissioner, Ajmer	09/08/2019	Campus Visit
8.	Dr Madhuri Joshi	Director at SKNAU, Jobner	21/08/19	Campus Visit
9.	Dr Vishal Patidar	PD ATMA, Burhanpur, M.P	28/09/2019	Campus Visit
10.	Dr N J Jadon	Prof of Dept of Soil Science AAU, Anand, Gujarat	11/10/2019	Campus Visit
11.	RTS batch	RTS batch 29 RRT, Ajmer	07/11/2019	Campus visit
12.	Dr A D Jhony	Spices Board, Regional Office Jodhpur	13/11/2019	Campus visit with 25 farmers from Pali
13.	Dr J S Sandhu	Vice Chancellor SKNAU, Jobner	25/11/2019	Campus Visit
14.	Dr R S paroda	former DG, ICAR	25/11/2019	Campus visit
15.	B R Choudhary	Vice Chancellor, Jodhpur Agr Univ	01 to 03/12/2019	3 rd Global Meet 2019
16.	Dr P Chandrashekhar	DG, NIAM, Jaipur	01 to 03/12/2019	3 rd Global Meet 2019
17.	Dr J S Sandhu	VC, Jobner, SKNAU, Jobner	01 to 03/12/2019	3 rd Global Meet 2019
18.	Dr Rajkumar	VC, Medical University, Itawa	01 to 03/12/2019	3 rd Global Meet 2019
19.	Dr S N Puri	Former VC, CAU, Imphal, Manipur	01 to 03/12/2019	C.A.S Meeting 2019
20.	T Jankiram	ADG, New Delhi	03/12/2019	3 rd Global Meet 2019
21.	Dr P L Saroj	CIAH, Bikaner	01 to 03/12/2019	3 rd Global Meet 2019
22.	Dr Ramesh Mittal	Director, NIAM, Jaipur	01 to 03/12/2019	3 rd Global Meet 2019
23.	Dr A S Panwar	Director, IIFSR, Meerut	01 to 03/12/2019	3 rd Global Meet 2019
24.	Dr Vijendra Singh	Dean, College of Horticulture	01 to 03/12/2019	3 rd Global Meet 2019
25.	Dr M Srinivasan Rao	Principal Scientist, CRIDA	10/12/2019	To Attend C.A.S Meeting
26.	Dr P M Kanwat	Prof and Ex Head SKNCOA, Jobner	10/12/2019	To Attend C.A.S Meeting
27.	B.K. Pandey	PS, SMO (H.S.) ICAR, New Delhi		
28.	Dr A K Soni	Prof. and Head Horticulture, SKNAU, JOBNER	21/12/2019	To Attend C.A.S Meeting
29.	Dr P R Meghwal	P.S. CAZRI, Jodhpur	21/12/2019	To Attend C.A.S Meeting

30.	Dr Brahma singh	Chairman, Prof BSHF	21/12/2019	To Attend C.A.S Meeting
31.	Dr R M Sharma	Division of FHI,IAR, NEW DELHI	21/12/2019	To Attend C.A.S Meeting



11. Ongoing Research Projects

S.no. Sub-Project

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

- 1 CI-1: Management of plant genetic resources of seed spices:
(PI: R.S. Meena; Co-PI: S.S. Meena, S. Choudhary, A.K. Verma and Ravi, Y.; 2014-19)

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

- 2 CI-8: Breeding for high yield and quality in dill:
(PI: A.K. Verma; Co-PI: Y.K. Sharma and N.K. Meena; 2015-20)
- 3 CI-9: Breeding for high yield and improved quality in ajwain:
(PI: S.S. Meena; Co-PI: M.K. Vishal (on study leave); 2015-20)
- 4 CI/14.2.1: Induction of genetic variability in cumin and fennel through gamma radiation: (PI: A.K. Verma; Co-PI: S. Choudhary and R.D. Meena; 2014-19)
- 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.K. Vishal (on study leave): 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, 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, Ravi, Y., R. D. Meena; 2016-21)
- 9 CI/18.2.1: Genetic improvement of cumin for higher yield and wilt resistance:
(PI: A.K. Verma; Co-PIs: Y.K. Sharma: 2018-22)
- 10 CI/18.2.2: Screening of fennel and cumin genotypes for salinity stress :
(PI: Ravi Y. (on study leave from August 2019); Co-PIs: S.N. Saxena (PI w.e.f. August 2019) and O.P. Aishwath, 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-PIs: 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: krishan Kant, R.D. Meena; 2016-19)
- 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; 2016-19)
- 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. 2017-22)

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

(PI: Ravindra Singh, Co-PI: R. S. Meena: 2017-19)

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

(PI: Narendra Choudhary; Co-PIs: R. Singh and M.D. Meena, 2018-23)

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

20 CPt-1: Survey and surveillance of existing and emerging diseases of seed spices:

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

21 CPt/16.4.1: Studies on population diversity and management of nematodes in cumin (*Cuminum cyminum* L.): (PI: K. Kant; Co-PI: Y.K. Sharma, S.R. Meena; 2016-19)

22 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)

23 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)

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

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

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

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

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

(PI: Krishna Kant; Co-PI: B. K. Mishra and P.N. Dubey: 2017-20)

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

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

(PI: P.N. Dubey; Co-PI: S.N. Saxena, K. Kant; 2014-19)

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

(PI: S.N. Saxena; Co-PI: Y.K. Sharma and P.N. Dubey; 2017-19)

29 BS/17.5.2: Exogenous application of PGRs for improving essential oil content in coriander (*Coriandrum sativum* L.) (PI: S.N. Saxena; Co-PI: P.N. Dubey; 2017-19)

30 BS/17.5.3: Studies on dissipation kinetics and pre harvest interval of triazoles in fenugreek

(PI: P. N. Dubey; Co-PI: S. N. Saxena, Y. K. Sharma and K. Kant: 2017-19)

31 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)

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

32 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)

33 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, 2019-24)

New Sub-Project Proposals

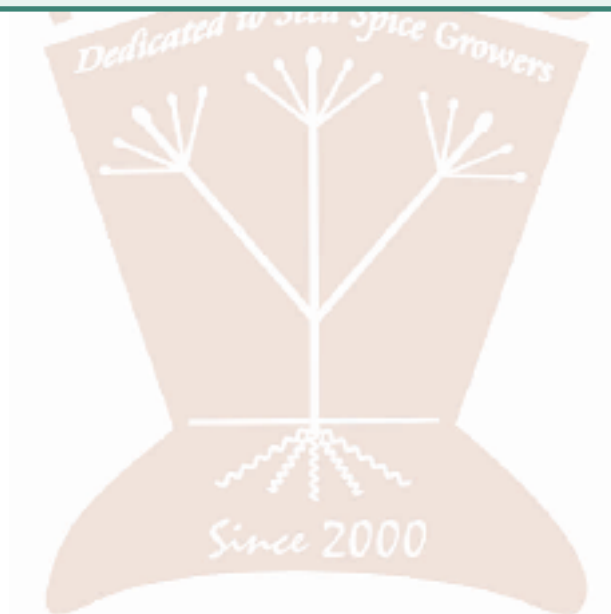
S.No.	Sub-Project
1.	Plant extracts analysis of seed spices for bioactive phytochemicals and its utilization in developing health promoting nutraceutical products. (PI: S.N. Saxena, Co-PIs: B. K. Mishra and Shiv Lal, 2019-22)

ICAR-Network/Platform Research Projects

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

External Funded Projects

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



12. Other Informations

Celebration of Rashtriya Ekta Diwas on 31st October, 2019

During Vigilance Awareness Week, National Unity Day (Rashtriya Ekta Diwas) was celebrated on 31.10.2019 at the center (vide ICAR endorsement No. F. No. GAC-2 1 - 5512019-CDN dated 23.10.2019) to commemorates 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, 2019 at 11.00 A.M. Dr Y.K. Sharma, Vigilance

Officer briefed about the celebration of Rashtriya Ekta Diwas and the activities to be organized on the occasion. Dr G. Lal, Director, ICAR-NRCSS administered the Rashtriya Ekta Diwas Pledge to all officials and staff members. He also addressed the gathering and expressed his views about Rashtriya Ekta Diwas, its importance and words about the Iron Man Sardar Vallabhbhai Patel. Further, to permeate message of national unity a human chain and a run for unity was organized in the campus.



Constitution day celebration on 26, November, 2019 at ICAR-National Research Centre on Seed Spices, Ajmer

Constitution day was celebrated as on 26, 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, Ajmer, 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 presented floral welcome to the dignitaries and 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 emphasized that one must equally abide with fundamental duties as like fundamental rights.

Dr. D.S. Bhati, Head, KVK, Ajmer and Dr. Dinesh Arora, In-charge, ARSS, Ajmer also delivered their remarks on the importance of constitution and celebration of constitution day. Report card of various Govt. of India flagship programme implemented at ICAR-NRCSS,

Ajmer were presented by nodal officers of respective schemes. Dr. Ravindra Singh, Principal Scientist briefed about the Mera Gaon Mera Gaurav programme activities and Dr. Shiv Lal, Sr. Scientist spoke about the various activities and programmes executed in SCSP (Scheduled caste sub plan), TSP (tribal sub plan), Swacch Bhart Mission, Jal Shakti Abiyan, Plastic free India etc.

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 Padhao 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 individual and was concluded by casting vote of thanks by Dr. Shiv Lal, Sr. Scientist and Co-ordinator of the function.



Glimpses of constitution day celebrated on 26th November, 2019 at ICAR-National Research Centre on Seed Spices, Ajmer



संस्थान में राजभाषा हिन्दी पखवाड़ा (14– 30 सितम्बर, 2019) मनाया गया

भा. कृ. अनु. प. – राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर (राजस्थान), पर राजभाषा हिन्दी पखवाड़ा 14–30 सितम्बर, 2019 के मध्य मनाया गया। पखवाड़ा का शुभारम्भ 16 सितम्बर, 2019 को राजभाषा क्रियान्वयन समिति की बैठक के साथ हुई जिसमें डा. एस. एन. सक्सेना, प्रधान वैज्ञानिक (पादप कार्यिकी विज्ञान), ने अध्यक्षता की। इस राजभाषा हिन्दी पखवाड़ा में कार्यालय में हिन्दी के और अधिक प्रयोग पर सभी लोगो को ज्यादा ध्यान देने की आवश्यकता पर जोर दिया गया। राजभाषा हिन्दी-पखवाड़ा 2019 के उद्घाटन कार्यक्रम में राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र पर राजभाषा हिन्दी के प्रगामी प्रयोग हेतु अनेक सुझावों पर चर्चा की गयी। 19 सितम्बर, 2019 को संस्थान में कार्यरत वैज्ञानिकों, अधिकारियों तथा कर्मचारियों के मध्य राजभाषा हिन्दी के प्रचार-प्रसार हेतु तत्काल-आशु भाषण एवं टिप्पणी-लेखन का आयोजन किया गया। दिनांक 26 सितम्बर 2019 को वाद-विवाद प्रतियोगिता "किसानों की आय दुगुनी करने में बाजार की नीतियां एक बाधा हैं" – विषय पर आयोजन हुआ। इसके उपरांत निबंध लेखन "२९वीं सदी में महात्मा गांधी के विचारों का महत्त्व" शीर्षक पर किया गया। इन प्रतियोगिताओं में संस्थान में कार्यरत वैज्ञानिक, अधिकारी, कर्मचारी, एवं अनुसंधान अध्येता

वर्ग के लोगों ने अधिक संख्या में हिस्सा लिया। इस अवसर पर डा. गोपाल लाल, निदेशक, रा.बी.म.अनु.केंद्र ने संस्थान के सभी लोगों को हिन्दी में कार्य करने के लिए विशेष तौर पर प्रेरित किया तथा मानक वर्तनी के प्रयोग को वैज्ञानिक लेखों में बढ़ावा देने पर बल दिया।

डा. गोपाल लाल, निदेशक के मार्गदर्शन में डा. बृजेश कुमार मिश्र, प्रधान वैज्ञानिक एवं प्रभारी राजभाषा अधिकारी ने विभिन्न कार्यक्रमों का सफल आयोजन करते हुए निर्णायक मण्डल के सदस्यों डॉ. एस.एन. सक्सेना, डॉ. युगल किशोर शर्मा तथा डॉ. कृष्ण कान्त का विशेष आभार व्यक्त किया। दिनांक 2 अक्टूबर 2019 को, महात्मा गाँधी के 150वें जन्म दिवस समारोह के मध्य हिन्दी पखवाड़ा कार्यक्रम के विभिन्न विजेता प्रतिभागियों को नकद पुरस्कार का वितरण डा. गोपाल लाल, निदेशक भा.कृ.अनु.प.–राष्ट्रीय बीजीय मसाला अनुसंधान केंद्र, अजमेर द्वारा किया गया। डा. बृजेश कुमार मिश्र, प्रधान वैज्ञानिक एवं प्रभारी राजभाषा अधिकारी ने विजेता प्रतिभागियों और समस्त वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को इस हिन्दी पखवाड़ा कार्यक्रम-2019 को सफल बनाने के लिए धन्यवाद ज्ञापन किया। राजभाषा हिन्दी पखवाड़ा (14– 30 सितम्बर, 2019) के विभिन्न प्रतियोगिताओं में सफल प्रतिभागियों की सूची निम्नवत हैं:-

क्र. स.	प्रतियोगिता कार्यक्रम	विजेता प्रतिभागी का नाम
1	वाद-विवाद प्रतियोगिता पक्ष एवं विपक्ष (सभी वर्गों के लिए)	प्रथम: श्री भीम सिंह द्वितीय: श्री सुनील कुमार अग्रवाल तृतीय: डा. आर. डी. मीना
2	तत्काल- आशु भाषण प्रतियोगिता (सभी वर्गों के लिए)	प्रथम: डॉ. पी. एन. दूबे द्वितीय: श्री भीम सिंह तृतीय: श्री जी. के. त्रिपाठी
3	टिपण्णी लेखन प्रतियोगिता (सभी वर्गों के लिए)	प्रथम: श्री संजीव शर्मा द्वितीय: श्री प्रमोद कुमार अग्रवाल तृतीय: श्री राज कुमार कांवरिया
4	निबंध लेखन प्रतियोगिता	प्रथम: श्री महेंद्र कुमार चौधरी द्वितीय: श्री अमित कुमार गुप्ता तृतीय: श्रीमती सरला देवी



Observance of Vigilance Awareness Week – 2019

ICAR-NRC on Seed Spices, Ajmer observed Vigilance Awareness Week from 28th October, 2019 to 2nd November, 2019 at NRCSS campus. The theme of the Vigilance Awareness Week this year was 'Integrity- A way of life'. The observance of Vigilance Awareness Week was commenced with integrity pledge on 28.10.2019 at 11:00 hrs by the officials and staffs of ICAR-NRC on Seed Spices, Ajmer followed by general discussion by the staff on Vigilance and observance of Vigilance Awareness Week.

Activities organized during the week

Debate Competition: Debate competition on “क्या नैतिकता के द्वारा ही भ्रष्टाचार का उन्मूलन संभव है?” was organized on 30th October, 2019 that received participation from the employees of ICAR-NRCSS. Three participants from in favour and in opposition were awarded. Participants were also given participation certificate those participated in debate and other completions.

Essay Writing and Paragraph Writing Competition:

Employees from ICAR-NRCSS participated in Essay writing on “भ्रष्टाचार उन्मूलन में समाज की भूमिका” and

Paragraph writing on “सतर्कता का विभागीय कार्यकलापों में महत्व” organized on 31.10.2019.

Panel discussion: All staff members of ICAR-NRCSS participated in panel discussion on 'कार्य के प्रति निष्ठा ही वास्तविक देश भक्ति है' conducted on 31.10.2019. The staff members shared their views on the topic.

Workshop and Valedictory of Vigilance Awareness Week:

On 2.11.2019, NRCSS organized a Workshop on Theme: 'Integrity- A way of life' and valedictory function of the week. Dr. G. Lal, Director, ICAR-NRCSS & Chief Guest on the occasion addressed the gathering and expressed his views about Vigilance Awareness Week and on the theme 'Integrity- A way of life'. While summarizing the week, Dr. Y. K. Sharma, Vigilance Officer briefed about the different activities conducted during the Vigilance Awareness Week. Director, Dr. G. Lal awarded certificates to the award winning participants in different competitions viz. Debate completion, Essay Writing and Paragraph writing competition and also to the participants for their active participation in different events. Shri Sunil K. Agarwal, AFAO & Member Vigilance Awareness Week Committee proposed vote of thanks.





Swachhata Hi Sewa

ICAR-National Research Centre on Seed Spices observed "Swachhata Hi Sewa" programme from 11th September to 2nd October 2019. Various swachhata related activities were undertaken during this programme. NRCSS officials were engaged themselves in different cleanliness activity of farm, guest house, residential area, office building. In order to give wide publicity of this

mission, the NRCSS officials visited MGMG village and interacted with students and farmers. To create awareness among the farmers about the importance of swachhata, many farmers and visitors were explained during this programme. Many farmers, visitors and other delegates along with NRCSS officials took swachhata pledge administered by the Director, NRCSS, Ajmer. All the officials of NRCSS were actively participated in "Swachhata Hi Sewa" programme.





Parthenium Awareness Week, celebrated during 16-22, August, 2019

Parthenium Awareness Week was observed during 16-22, August 2019 at ICAR-National Research Centre on Seed Spices, Ajmer. During the week period various activities were carried out to make all the staff farm workers and nearby offices aware about the menace of Parthenium. On dated 16/08/2019 firstly extension/display materials related to Parthenium was displayed at various locations (farm section, processing section, inside institute building, institute main gate) of ICAR-NRCSS, Ajmer. To create awareness among other nearby sister organization such as at KVK, Ajmer, Agricultural Research Sub-Station Tabiji, Ajmer, ATC, Ajmer, Rajasthan state seeds corporation limited, Ajmer the extension/display materials was also distributed to display in their office premises. On 19/08/2019 ICAR-NRCSS, Ajmer was carried out extensive drive for uprooting Parthenium in nearby areas. On the day Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer briefed to the entire staff (scientists, farm technical and contractual workers) about the menace of Parthenium which is responsible for causing health problem in human being and animals, besides deteriorating environment loss of productivity and biodiversity. In this drive all the staffs were uprooted the Parthenium along the roadside and in front of ICAR-NRCSS, Ajmer premises and all the uprooted Parthenium was collected and deposited in

compost pit. To create awareness among the farm labour and contractual staff, Dr. Gopal Lal, Director, ICAR-NRCSS, Ajmer delivered a brief lecture on 'Harmful effect of Parthenium on crop, animal and human' on 20/08/2019 at farm of ICAR-NRCSS, Ajmer. Dr. Lal emphasised to get rid of completely from Parthenium and keep each and every place Parthenium free. He also stressed upon uprooting of Parthenium from their respective crop field and nearby residential areas. In this activity a total of 40 farm workers participated. On dated 22/08/2019 the Parthenium Awareness Week, 16-22 August, 2019 was concluded with the spirit to keep Parthenium free crop field, institute premises and nearby areas throughout the year. All the activities during 14th Parthenium Awareness Week, 16-22 August, 2019 were coordinated by Dr. Shiv Lal, Sr. Scientist (SS)-Horticulture and Dr. N. Chaudhary, Scientist-Horticulture.



Staff of ICAR-NRCSS, Ajmer during uprooting Parthenium in nearby areas



Farm workers and contractual staff of ICAR-NRCSS, Ajmer during awareness talk on 'Harmful effect of Parthenium on crop, animal and human' at farm of ICAR-NRCSS, Ajmer



Staff of ICAR-NRCSS, Ajmer during uprooting Parthenium along roadside areas

Events performed on the Celebration of 150th Birth Anniversary of Mahatma Gandhi (Shri Mohan Das Karam Chand Gandhi) at ICAR-NRC on Seed Spices, Tabiji, Ajmer

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 which was started a year back, the whole year was devoted to the holy saint, our beloved Father of the nation "BAPU".

115th 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. As per instruction from head quarter celebrations started on 25 September 2019 and a week was celebrated upto 2nd October 2019.

Details of events and celebrations are as:

Event organized on 25 September 2019

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.

Event organized on 26 September 2019

Cut outs of Gandhiji, Gandhi Chashma, Gandhiji ke teen Bandar and Charkha were prepared and placed at Gandhi gallery of NRC on Seed Spices. A Hindi essay writing competition was organized under Hindi Pakhwada karyakarm and the topic was "21वीं सदी में महात्मा गाँधी के विचारों का महत्व". Three winners were awarded with prize.

Event organized on 27 September 2019

The gallery was inaugurated with ribbon cutting by Director, NRCSS, and witness by the whole staff of the NRCSS, Ajmer. After inauguration of the gallery the programme continued at Dr. R.S. Paroda auditorium at NRCSS, Ajmer at 11:15 AM.

Event organized on 28 September 2019

A competition for poster making, essay and debate was organized by ICAR-NRCSS at Government Senior Secondary School, Saradhana, Ajmer for the students of the school and three best competitors were selected for certificate based on their performance. Ten Winners were awarded with certificate on Gandhi Jayanti.

Event organized on 01 October 2019

A documentary film on Mahatma Gandhi was displayed

at 4:40 PM at Dr. R. S. Paroda Auditorium, NRCSS, Ajmer. The movie was watched by all the staff members of NRCSS including Scientific, technical, Administrative and contractual staff.

Event organized on 02 October 2019

Main programme was celebrated on 2nd October 2019 at Dr. R.S. Paroda auditorium, NRCSS, Ajmer.

Programme was started at 11:00 AM with registration of the participants; total 138 members were present in the celebration. Chief Guest of the celebration was Dr. L.K. Sharma, Principal, DAV College, Ajmer. Special Guests of the programme were Dr. D.S. Bhati, Head, KVK, Ajmer, Dr. Dinesh Arora, Incharge, ARSS, Ajmer and Dr. O.P.Sharma, Joint Director, ATC, Ajmer.

The distinguished guests and Director of the institute had visited the Gandhi Gallery of the institute, which was very much praised by all. After a small tea break with sakoras (single use plastic free campus) celebrations started at auditorium. 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. Along with 150th Anniversary of Mahatma Gandhi we have also celebrated 115th birth anniversary of our former Prime Minister Shri Lal Bahadur Shastriji. One fortnight 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. On this event our biologically senior most officer Dr. P.N. Dubey delivered a lecture on life of Mahatma Gandhi. He told about childhood, education, profession and freedom fight movements of Mahatma Gandhi. All the special guests of the day also delivered their view on struggles and life of Gandhiji and Shri Lal Bahadur Shahstriji.

A prize distribution programme was organized to facilitate the winners of competitions organized at Saradhana School and essay writing on Gandhiji at NRCSS.

After award ceremony the Chief Guest of the day Dr. L.K. Sharma addressed the gathering and highlighted the main events of life of Mahatma Gandhiji. He also appreciated the activities conducted by ICAR-NRC on Seed Spices, Ajmer and the weeklong celebrations.

Programme was concluded with vote of thanks and Rashtriya Gaan at auditorium.

After the programme at auditorium whole staff of NRCSS and invited guests of the day gathered at lawn of NRCSS and made a "CHAL MANAV SHRANKHLA" with slogan Jai Jawan Jai Kisan. High tea was served to all the participants taking care of plastic, all the snacks were served in paper plates and drinking water in earthen matka (pot) and served using lotas. Not a single piece of plastic was used in programme.



News paper coverage

Mera Gaon Mera Gaurav Progress report 2019-20 (1 April, 2019 to 31 December 2019) (Nodal Officer: Ravindra Singh)

Activities undertaken

- Promoted farmers for organic farming
- They were promoted for growing cumin for better income
- People were urged to incorporation of bio-pesticides such as Trichoderma, Paecilomyces, Neem product and PSB for organic farming.
- Farmers were suggested to use as per need based application pesticides at correct time, optimum dose
- Farmers were advised recycle water to stop depletion in ground
- Farmers were motivated for water saving irrigation systems like drip fertigation in seed spices, vegetables and flower
- Interaction with farmers for nursery raising of cauliflower in summers/flower cultivation in the MGMG villages using shad nets
- Application of solar pumps for irrigation using drip fertigation
- They were guided to raise nursery and use of certified seed
- They were directed for off season production of coriander for high profit
- Organized a formal meeting with a group of farmers including farm women of the village and interacted with them on preamble of the constitution as well as fundamental rights and duties as enshrined in the Indian Constitution for every citizen of India under Constitution Awareness Abhiyan which is going to

be observed from 26th November, 2019 to 26th November, 2020.

- Gosthis were organized at Budhwada, Makreda and Dumda for the rabi season crops. Using Chaupal system of the villages, about 10-15 farmers clusters and other farm workers made aware about the crop planning and water and nutrient saving by drip irrigation and fertigation. Information also shared on insect pest and disease management, composting organic farming and importance of vegetation and animals for nutrient management. We also meet government officials and innovative farmers for the implementation of schemes for farmers.
- Awareness for the common problems such as (root rot in cauliflower, *Alternaria* blight, black aphid in seed spices), animal immunization, enormous use of synthetic pesticides, children health, village sanitation, lack of awareness, grasshopper (fadka) in rainy season, white ants/ termites, wild cow (neelgai), fodder scarcity, pasu aahar, village sanitation, creating employment, drinking water, Irrigation, hard water, lack of awareness among villagers for better life and labour availability.
- Farmers were advised to use 'seed spices app' for the problems and FAQ on the crops
- Awareness brought among the farmers for fundamental duties and rights for conservation of natural resources, respect of flag, cherish the noble idea, inspire freedom struggle, uphold the unity and integrity, defend the country, render national services when called upon, brotherhood for religion, linguistic etc, value and preserve of national heritage & public properties, develop scientific temper respect individual and provide equal opportunities to all etc.

Activities organised by ICAR -NRCSS, Ajmer under MGMG

S. No.	Name of activity	No. of activities conducted	No. of farmers participated & benefitted
1.	Visit to village by teams	7	242
2.	Interface meeting/ Goshthies	6	27
3.	Training organized	0	0
4.	Demonstrations conducted	0	0
5.	Mobile based advisories (No of message)	23	27
6.	Literature support provided (No)	7	18
7.	Awareness created (No)	6	58
8.	Input supplied or Other, if any	0	0
	Total	49	372



Glimpses of Constitution Awareness Abhiyan organized at Dang Village on 10 December, 2019



Constitution Awareness Abhiyan and activity for transplanting onion seedlings organized at Kaleshra Village, 27 December, 2019



Gosthis were organized at Budhwada, Makreda and Dumda for the rabi season crops Using Chaupal system



Organic vegetables production and interaction with farmers

13. Personnel

13.1 Scientific Staff

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

13.2 Technical Staff

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

13.3 Administrative Staff

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

13.4 Skilled Supporting Staff

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

13.5 Study Leave

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

13.6 Transfer & posting

1. Sh. Sumit Singh, AO (w.e.f. 07-09-2019) transferred to ICAR - IARI, New Delhi

13.7 Promotions during 2019

1. Dr. Shiv Lal w.e.f. 26-02-2018 (in Research Level 12) (Letter received on 17-09-2019)
2. Dr. A.K. Verma w.e.f. 01-01-2018 (in Research Level 11) (Letter received on 08-08-2019)
3. Smt. Sarla Devi (MACP) w.e.f. 02-11-2016
4. Pukhraj Paroda (MACP) w.e.f. 06-11-2016
5. Sh. Siya Ram Meena w.e.f. 28-03-2017 (STA to ACTO) vide office order 27-07-2019



Annexure - I

Table 1 : Monthly mean temperature, relative humidity, evaporation and rainfall during 2018

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

Table 2: Monthly mean temperature, relative humidity, evaporation and rainfall during 2019

Year 2019	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

Certificate of Registration

Awarded to

ICAR - NATIONAL RESEARCH CENTRE ON SEED SPICES

TABIJI, AJMER – 305206, RAJASTHAN, INDIA.

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

ISO 9001:2015

For the Scope of activities described below

"QUALITY RESEARCH AND DEVELOPMENT OF SEED SPICES"

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



Director



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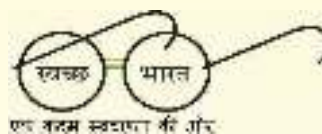
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