

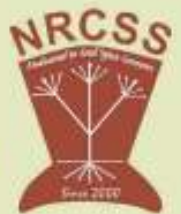
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वार्षिक प्रतिवेदन Annual Report 2015-16



भाकृअनुप - राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र
तबीजी, अजमेर - 305206 (राजस्थान) भारत

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





भा.कृ.अनु.प.-रा.बी.म.अनु. केन्द्र, अजमेर

भा.कृ.अनु.प.-रा.बी.म.अनु. केन्द्र, अजमेर की स्थापना वर्ष 2000 में हुई तथा देश की जनता को आय सुरक्षा प्रदान करने हेतु, बीजीय मसाला अनुसंधान एवं विकास पर कार्यरत है।

आधारभूत एवं नीतिगत कार्यों के अतिरिक्त, रा.बी.म.अनु. केन्द्र बीजीय मसालों पर अनुप्रयोगात्मक अनुसंधान के द्वारा घरेलू खपत तथा निर्यात के सन्दर्भ में उत्पादकता तथा गुणवत्ता में सुधार पर कार्य कर रहा है। संस्थान में रेल तथा रोड़ के द्वारा सुगम्यता से पहुँचा जा सकता है, यह अजमेर रेलवे स्टेशन से 13 किलोमीटर दूर, अजमेर-ब्यावर रोड़ पर स्थित है तथा नजदीकी एयरपोर्ट जयपुर है।

अजमेर, राजस्थान का पाँचवा बड़ा शहर है तथा जयपुर, राज्य की राजधानी से 135 किलोमीटर पश्चिम में तथा दिल्ली से 391 किलोमीटर दूरी पर स्थित है। अजमेर, अरावली पर्वत माला से घिरा हुआ है। यह सूफी सन्त ख्वाजा मोइनुद्दीन चिश्ती की दरगाह का धार्मिक केन्द्र है तथा पुष्कर में भगवान ब्रह्मा का विश्वप्रसिद्ध एकमेव मन्दिर 11 किलोमीटर दूरी पर स्थित है।





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ICAR - National Research Centre
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Front : Field view of seed spices under drip irrigation at NRCSS
Back : Value added products (Fenugreek biscuits, RTS, Cryo grinded powder).
Varieties of seed spices ACr-1 (Coriander), AD-2(Dill); AF-2 (Fennel)

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PREFACE



The year 2014-15 has been immense fruitful to the seed spice growers & processors in terms of increase in area (72, 520 ha; 5.24%) and production (34, 340 tonnes; 2.84%) over the past year. Though the annual rainfall in the region was slightly lower than the past years average, but this did not hamper the production of seed spices. The export indices for seed spices reveal increase (16,175 tonnes); resulting into additional export revenue generation of 15% higher (Rs. 348.17 crores) than previous year to the magnitude of Rs. 2650.49 crores. The institute contributed new high yielding and disease tolerant/resistant varieties for coriander (ACr-1), dill (AD-2) and fennel (AF-2) for the benefit of seed spice growers. The major problem in the coriander growing region (Kota and adjoining area) was stem gall, which was addressed through the popularization of resistant variety ACr-1, which sustained yield levels under adverse climatic conditions of the region. To encounter the blight and wilt issues in cumin, research work is continuing at full pace. The centre is constantly working to improve various aspects of production, protection and post harvest technology. Farmers friendly technologies in terms of, Off – season coriander production under economically viable protected structures, nutrient management through fertigation, drying of Nagauri methi, etc are also being tested and disseminated among the stakeholders. To provide quality seeds to the seed spice producers, participatory seed production by involving more and more farmers has also been taken at large scale by the institute. To make the seed spices economically more profitable, value added products have been prepared and demonstrated at various foras. Patents have also been filed with the agencies and to make the technology popular it has been made available to the entrepreneurs by signing MOU's for better propagation among masses. NRCSS has grown to a lead position now and has made remarkable impact on the improvement of seed spice crops production and productivity. The annual report 2015-16 of ICAR-NRCSS will provide the glimpses of ongoing research & development activities as well as significant achievements made during the year. I am grateful to Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR for the encouragement and guidance. I place on record my sincere gratitude to Dr. N.K. Krishna Kumar, DDG (Hort.



Science) for his support and guidance in the activities and progress of the institute. I thank Dr. T. Janakiram, AdG (Hort. Science-I) for the support and encouragement. I am also thankful to Dr. Balraj Singh, former Director, ICAR-NRC on Seed Spices, for his leadership, hardwork and dedication for all round development of the institute. His efforts has brought new laurels to the centre. I owe great debt to the editorial committee for bringing the Annual Report on time. I thank all the scientists, officers and other staff members of the institute for the significant contribution made in fulfilling the mandate. I hope this issue will surely help the stake holders on many aspects that is essential for seed spice growers and users. I invite suggestions on various aspects for betterment.

Ajmer

25 June, 2016

Gopal Lal

1. EXECUTIVE SUMMARY

1.1 Crop Improvement

1.1.1. New varieties

- Ajmer Fennel -2 (AF-2): high yielding, *Remuleria* blight tolerant and better quality variety has been identified for release at all India level.
- Ajmer Coriander-1 (ACr-1): a high yielding, dual purpose and stem gall resistant variety has been released for Rajasthan state.
- Ajmer Dill-2 (AD-2): a high yielding and short duration variety has been released for Rajasthan state.

1.1.2. Plant genetic resources management

- NRCSS is maintaining a collection of 2094 germplasm lines of ten seed spice crops in the period under report. 685 lines of fenugreek, 206 lines of fennel and 24 lines of nigella were sown in the field for maintenance and evaluation.
- Multilocation evaluation was also carried out for 60 lines of coriander, 50 lines of fennel, 50 lines of fenugreek and 20 lines of cumin.

1.1.3 Breeding programme

- In Station Trial I, one population (UF-206) among the fifteen populations of fennel was found to be elite with maximum yield (33.41 q/ha) along with moderately resistant to *Remularia* blight (PDI-28.0 %).
- In Station Trial II, two populations AF-257 and AF-11 of fennel were found to be superior and high yielding, recorded seed yield 24.4 and 24.3 q/ha respectively.
- A dwarf fennel genotype was maintained through sib-mating. More than 50 crosses using dwarf fennel were made during reporting period.
- Among the tested nine populations of celery, two populations viz. K-25 (8.0 q/ha) and A Cel-9 (7.7 q/ha) were found promising as compared to check (ACel-1, 5.6 q/ha).
- In multilocation trial in collaboration with PAU, Ludhiana two entries, A Cel-5 and A Cel-6 were found best for yield in collaborative trial conducted at both the locations during 2014-15.
- In dill population AD-5-01-24 (2041.7 kg/ha) and AD-5-03-35 (1954.2 kg/ha) gave 14.30 and 9.40 per cent

higher yield, respectively as compared to best check AD-2.

- In station trial of Ajwain, higher yield (1516 kg/ha) was recorded in AA-73 population as compared to national check.
- The most promising anise entry AAni-17-Sel 4 having high yield, matured in 120 days showing a significant advantage of 20 days in maturity under Ajmer conditions.
- Out of 605 lines of cumin three lines SPS-13-69 (3.8 g), SPS-13-13 (3.13 g), and SPS-13-40 (3.05 g) showed highest survival percentage against *Fusarium* wilt and Root rot complex disease.
- On the basis of the performance of two fenugreek purelines viz. B4-22-7-2-1 (AFg-7) and A3-47-1 (AFg-8) have been submitted for coordinated testing.
- Two entries namely SKCV-09-40 and CGP-3-1 of coriander for stem gall resistance has been submitted for coordinated testing renamed as ACr-4 and ACr-5, respectively.

1.1.4 Biotechnology

- Genetic diversity between 137 coriander genotypes using RAPD and ISSR markers was evaluated. RAPD markers amplified with 15 % polymorphism. Similarly, in ISSR 56 % polymorphism was recorded.
- In fennel 17 fennel varieties and 134 accessions were studied which resulted in 73.41% and 86.44% polymorphism with RAPD and ISSR markers, respectively.

1.2 Crop production

1.2.1 Weed management

- On the basis of one season data, the critical stage for weed competition in ajwain and fennel were found to be 67 and 69 days, respectively.
- The response of different herbicides varied in different crops. Best pre emergence herbicide was Oxadiargyl (6% EC) for all the seed spices followed by Pendimethalin in all the crops except fenugreek and anise.

1.2.2 Intercropping

- Fully grown ber orchard +(fenugreek-okra) performed better, resulting into highest coriander equivalent yield (6549 kg/ha) followed by ber + (ajwain - round gourd, tinda) to the tune of 5969 kg/ha.
- Fully grown aonla orchard + (fenugreek-okra) resulted into highest coriander equivalent yield (5365 kg/ha) followed by aonla + (ajwain-round gourd) to the tune of 4953 kg/ha.
- Intercropping of fennel with knolkhol in 1:2 ratio exhibited the highest fennel equivalent yield (4186 kg/ha), net returns (Rs. 160050/ha) and BCR (3.25).
- The highest dill equivalent yield (4843 kg/ha), net returns (Rs. 124879/ha) and BCR (2.80) obtained in intercropping of dill and knolkhol in 1:2 ratio.

1.2.3 Sowing method and fertigation

- The maximum seed yield was recorded in fennel (2608 kg/ha) followed by dill (2312 kg/ha), celery (1247 kg/ha) and lowest in ajwain (901 kg/ha) under drip fertigation.
- The maximum yield of fennel, dill and celery were recorded through transplanting technology and yield of transplanted fennel, dill, celery and ajwain were 2966.7, 2705.7, 1612.8 and 696.0 kg/ha, respectively.
- In fenugreek only irrigation regimes by drip system had shown significant differences in terms of seed yield. Drip irrigation at 60 % PE, 80% PE and 100% PE are found at par in terms of seed yield.

1.2.4 Nutrient management

Response of micro nutrients :

- Fennel crop responded well in terms of growth and yield to soil application of iron (10 kg/ha), manganese seed treatment 500 ppm and zinc foliar application 0.5% over the control.
- Cumin crop response to applied micronutrients was not significant in terms of growth and yield.
- Average uptake of micronutrients by fennel was Fe-1982.6 g/ha, Mn- 1465.7 g/ha, Cu-333.8 g/ha, Zn-443.3 g/ha and B-336.6 g/ha.
- Average uptake of micronutrients by cumin was Fe-439.8 g/ha, Mn-201.8 g/ha, Cu-107.6 g/ha, Zn-22.2 g/ha and B-37.4 g/ha.

1.2.5 Edaphic factors affecting crop growth

- Coriander growth, yield and quality was highest with maximum temperature at early growth stage ~ 28.2°C and middle stage was ~ 22.8 °C.
- Fennel crop withstood higher compaction as compared to coriander and cumin.

1.2.6 Microbial approaches for plant nutrition

- Significant effect on yield attributing traits in fennel plants treated with different Phosphate Solubilising Bacteria (PSB) isolates in comparison to control was observed. The highest seed yield was recorded with PSB-36 (29.6 g/plant) which was at par with PSB-1 (27.4 g/plant) and minimum seed yield was observed under control.
- Seed treatment with Plant Growth Promoting Rhizobacteria (PGPR) resulted into highest seeds per umbellet (8.20) with Azoto-7 which was at par with King's B-15. The maximum yield 13.38 g/plant was found with King's B-15. The minimum was found with Azoto-9 which was at par with control.

1.2.6 Summer/Off season cultivation

- Flower initiation was very late in Ajmer Green (AGCr-1) cultivar of coriander (53.33 DAS) during summer season, which is a most desirable character for leafy type cultivars, however JBT-38/94 flowered in only 35.33 DAS and ACr-1 (check) flowered only in 41.67 DAS.
- In Ajmer Green Coriander best yield (2568.15 kg/ha) was recorded in the crop sown on 16 April, 2015 and lowest 1342.22 kg/ha in crop sown on 7 May 2015.
- In fenugreek maximum plant height (31.77 cm) at harvest was exhibited by AFG-5 which is a late flowering line and bolting was initiated at 36.33 DAS, 50% flowering was recorded at 46.67 DAS as compared to earliest bolting initiation (27.33 DAS) and 50% flowering (33.67 DAS) in AFG-3.

1.2.7 Non edible oil cakes application

- The lowest powdery mildew disease severity was recorded with application of 100% recommended dose of nitrogen (RDN) through castor cake with castor cake ash.

1.2.8 Post harvest management

- RTS made of fennel, coriander and dill can be stored up to two months and squashes up to one year without spoilage. No bacterial and fungal count were recorded in this period and the products were safe for consumption.
- Six patents (provisional) have filed for different value added products namely Methi Biscuits, Methi Tea, Dill based Herbal Chew, Coriander/Fennel/Dill based squash & RTS at Indian Patent Office, Dwarka, New Delhi.

1.3 Crop protection

1.3.1 Survey and surveillance

- The disease severity range varied from field to field. In cumin, blight (0-46%), yellowing (0-25%), wilt (3-12%) & powdery mildew (0-4%) were recorded. Similarly in coriander, stem gall (0-90%), wilt (0-6%), powdery mildew (0-18%), in fenugreek powdery mildew (0-70%), downy mildew (0-40%) and in fennel *Ramularia* blight (0-4%) were prevalent in areas surveyed.
- The causal agent of the cumin yellowing disease was detected to be a member (*Vanilla distortion mosaic virus* (VDMV) of family Potyviridae.

1.3.2 Disease management

- Seed treatment with *Trichoderma*, soil application with castor cake and foliar spray with chlorothalonil followed by two sprays of difenoconazole and azoxystrobin was found most effective for the management of *Alternaria* blight of cumin.
- In coriander highest yield of 2176.2 kg/ha was recorded from the plots caged with *Apis mellifera* colony for bee pollination and which was 140.3% higher than control (without bee pollination caged). In fennel highest yield 2130.65 kg/ha was recorded from the plots caged with *A. mellifera* colony for bee pollination, which was 183.7 higher than control.

1.4 Basic sciences

- Dominant fatty acids in fenugreek seed oil were linolenic and linoleic acid (n-3 and n-6 fatty acid) which comes under Essential Fatty Acids (EFA) as well as PUFA and ranging between 66.86 to 82.17 %.

- In Fenugreek water stress at flowering and post flowering stage increased the oil content from a minimum of 3.29% in AFG-6 to a maximum of 5.31 in AM 327-3.
- Modified methodology for the analysis of pesticide residues in cumin and coriander belonging to organophosphates, fungicides, pyrethroids, neonicotinides, carbamates and herbicides was standardised.

1.5 Social sciences

- Databases were updated with latest production, price, export scenario, mandi information, package and practices as well as other relevant dimensions and information of seed spices. A domain for the NRC on Seed Spices, www.nrcss.res.in was purchased and informations uploaded.

1.6 Externally funded projects

NMPB funded Project

- Ninety one fennel and 145 coriander genotypes have been evaluated for total oil content and its constituents. Three hundred seventy fenugreek germplasm lines have been evaluated for total oil content and fatty acid methyl esters profiling and grouped as per major fatty acids methyl esters (FAME).

DUS Project (PPV&FRA funded):

- Under DUS project varieties of fennel (17) and cumin (9) were sown at two locations NRCSS, Ajmer (Rajasthan) and DMAPR, Anand (Gujarat).

Centrally Sponsored Scheme –MIDH Development programme on Seed Spices

- TFL seed production of cumin variety GC-4, coriander variety ACr-1 and AGCr-1, ajwain variety AA-93, fenugreek variety AFG-3, fennel variety AF-1 and AF-2, nigella variety AN-1 and AN-20 and anise variety AAni-1 have been taken at Farmer's field under Farmer's Participatory Seed Production Programme.
- 198.12 quintals of TFL seed of different seed spices varieties were produced through farmer's participatory seed production programme and 36.63 quintals breeder seeds was produced at NRCSS farm of fenugreek varieties (AFG-1, AFG-2 and AFG-3, AFG-4,) Fennel variety (AF-1), Coriander variety (ACr-1), Dill varieties (AD-1 and AD-2), Ajwain varieties (AA-1 and AA-93) and nigella variety (AN-1 and AN-20).

AMAAS project

- All isolated bacterial colonies/ strains were identified by gram staining, morphological and biochemical characterization. Sixteen unique microbial cultures were identified based on morphological and biochemical characterization and sequencing is in progress.

Consortia platform for High value compounds/ phytochemicals

- Studies on animal activity indicated that galactomannan is acted as anti diabetic and anti lipidemic compound. An edible coating from seed spices extracts for increasing shelf life with health beneficial properties have been developed for fruits and vegetables. Suitability of nigella and fenugreek fixed oil has been tested for edible oil due to presence of high levels of EFA and PUFA.

Outreach programme on management of sucking pests in horticultural crops

- Application of neem cake in soil during seed sowing followed by spray of neem oil 2% showed most effective at both application. Marginal decline of predators coccinellids and aphids parasitoides *Aphidius* sp. population was recorded by both insecticides and botanicals treatments. However number of bee visit on the crop was not affected on the crop by different treatments. Mixing of adjuvant developed on plant of *Sapindus mucorasi* and *Dalbergia sissoo* and APSA 2% proved significant enhanced efficacy in comparison to alone application of insecticide and botanicals.

Consortium research platform on "management of seed borer (*Systole albipennis* Walker) in seed spice crops"

- Soil application of chlothianidin @ 0.5 a.i. Kg/ha during sowing showed maximum protection against borer followed by foliar application of imidacloprid 0.005% and abamectin 1.9EC @ 2ml/lit.

Outreach project on phytophthora, fusarium and ralstonia diseases of horticultural & field crops

- Survey was conducted in Rajasthan (Ajmer, Nagaur, Jodhpur) and Madhya Pradesh (Mandsaur, Ratlam, Ujjain, Neemach) for disease prevalence in seed spices. Total 30 plant samples showing wilt symptoms were collected and processed for isolation of casual organisms.

Network project on organic horticulture "Development of Organic Production Technologies for Seed Spices"

- In cumin highest plant height of 32.33 cm at 75 DAS was obtained with application of 100 % RDN, 2/3 by FYM), 1/3 by non-edible oil cake (NEOC) along with pest and disease management module-1 (comprising of foliar spray of karanj oil + neem oil (1:1 ratio) @ 2% (v/v) + *Verticillium lecanii* (10⁸ spore/g) + foliar spray of Azadirachtin 10000 ppm (3ml/lit seed treatment with *Trichoderma viride* + soil application of neem seed cake/mustard seed cake @ 500 kg/ha +foliar spray of garlic extract.

Micronutrient management in horticultural crops (Seed Spices) for enhancing yield and quality

- Seedling and vigour index was better with all the micronutrient except copper in coriander and fenugreek.

Standardization of production technologies for seed spice under protected conditions

- Insect proof net covered walk in tunnel gave maximum seed yield of 2115.0 and 1525 kg/ha in coriander and dill whereas plastic sheet covered walk in tunnel gave maximum seed yield of 2688.0, 2763.0 and 665.0 kg/ha in fennel, fenugreek and cumin, respectively with low incidence of diseases and pest as compared to open conditions.

CRP on Agro-biodiversity "Regeneration and characterization of ten seed spices germplasm"

- 375 fenugreek, 63 fennel and 30 ajwain germplasm lines received from NBPGR have been tested for germination. Observations on morphological and pathological characters have been recorded and seeds were deposited to NBPGR, New Delhi.

Organic Farming (NPOF) "Standardization of seed spices based organic farming system"

- The performance of 75% organic with 25% inorganic treatment recorded best followed by state recommendation with respect to plant growth and yield of coriander and fennel.

1.7 Other activities

- Rashtriya Kisan Beej Mela avam Krishak Mahatosav-2015 organized on 28-30, September, 2015 which was inaugurated by Prof. Sanwar Lal Jat, Minister of State



for Water Resources, River Development and Ganga Rejuvenation, Govt. of India.

- Twenty eight well scheduled cleanliness programmes contributing 109 hrs during the period July, 2015 to March, 2016 were conducted under National Campaign "Clean India Mission" within & outside the NRCSS campus.
- A 21-days ICAR sponsored Winter School on "Utilization of degraded land and soil through horticultural crops for improving agricultural productivity and environmental quality" was organized at NRC on Seed Spices, Ajmer, during 3-23 December, 2015.
- National Research Centre on Seed Spices, Ajmer in collaboration with Indian Society of Seed Spices (ISSS), Ajmer and DASD, Calicut organized a National Seminar

on "New Dimensional Approaches for Enhancement of Seed Spices Productivity and Profitability under Era of Climate Change" during February, 2-3, 2016.

- On 23rd January, 2016 ICAR-National Research Centre on Seed Spices, Ajmer was awarded with the prestigious Zee Rajasthan News Agriculture Award-2016 in a function organized at SIAM, Durgapura, Jaipur.
- Captive Power Generation - Commissioning of 105 KW Power Grid connected Solar PV Power Plant on rooftops under the Plan Work titled "Captive Power Generation and Sub Station up gradation" was initiated through M/s. Rajasthan Electronics & Instruments Ltd. Jaipur at a cost of Rs. 83,46,450.00.

2. INTRODUCTION

Spices as whole have been an inherent component of human food chain since antiquity. These are having immense inbuilt medicinal qualities, flavoring constituents and minerals. The taste of spices has migrated and reached every part of the globe thus culminating into its presence in almost every home. This fascinating popularity of spices has not only increased the consumer demand but also has created a pressure on the producers to enhance productivity for fulfilling the generated demand at national as well as international level.

India is known for producing most of the spices which include pepper, chilli, cinnamon, cardamom, cumin, coriander, fennel, fenugreek etc. The term seed spices is designated for annual herbaceous spice crops in which seed or fruit is main commercial produce. Ten seed spices have been mandated to NRCSS for basic and strategic research. The Indian agro-climatic regions under the arid and semi arid climates of Rajasthan & Gujarat are well suited for cumin cultivation whereas coriander, fennel, fenugreek, ajwain, nigella, celery, anise and dill being cultivated all over India. The seed spices together hold a stake of 36 percent in area and 17 percent in production out of the total spices cultivation in the country.

The estimated area under seed spices cultivation in India is 14.56 lakh ha with production of 12.43 lakh tones (2013-14). The current statistical scenario reveals that the area under cultivation of major seed spices namely cumin, coriander, fenugreek and fennel is 6.90, 5.16, 0.91 and 0.94 lakh ha and their production is 4.45, 4.96, 1.11 and 1.36 lakh tones, respectively.

Seed spices export scenario of the country is very promising as there is continuous increase in quantity as well export revenue from the preceding years. The crop wise export (in thousand tonnes) for coriander, cumin, fenugreek, fennel and celery during 2014-15 was 46.0, 155.50, 23.10, 11.65 and 5.65, respectively. During 2014-15 the total export of seed spices were 241.9 thousand tonnes generating revenue of Rs. 2650 crores to the country.

The NRC on Seed Spices, Ajmer, Rajasthan caters the needs of the seed spices stake holders on every front, right from production, protection, improvement, quality aspect to socio-economic paraphernalia.

In the last few years the coriander cultivation has suffered in Rajasthan due to the outbreak of stem gall disease whereas cumin cultivation is still facing the wrath of wilt and blight disease. To manage the problem of stem gall in coriander, a variety from the NRCSS namely, ACr-1 was propagated to the farmers due to its ability to resist stem gall. Thus cultivation of this variety has now gained momentum replacing the older susceptible varieties. The disease issues in cumin which is highly sensitive to climatic variation are also being taken care of by popularizing soil solarization, new resistant variety GC-4 and effective insect-pest management judicious use of agro-chemicals having better efficacy and lesser residual effects. The centre has also come out with novel innovations such as nursery raising and transplanting techniques for fennel & celery to reduce the crop period and provide more benefits to the stake holders. To enhance the farmer's income, various intercropping options have also been tested and made available. Many technologies in terms of irrigation, fertigation, walk in tunnels covered with insect proof net, plastic sheet or shed nets during off season, two tier system of raising seed spices with vegetables etc were introduced. Solar tunnel drying of Nagauri (Kasuri) methi under plastic sheet covered high tunnel has also been popularized among the farmers. In its endeavor to promote improved modern crop cultivation practices, the centre conducted *kisan mela*, *beej vitran mela*, *national seminars*, demonstrations and participatory quality seed production. The endeavors by NRCSS have resulted in more confidence in the farmers, processors and users in terms of improved quality & quantity produce which in turn is leading to enhancement in exports. On campus & off campus trainings are regularly conducted for the farmers coming through the different agencies like ATMA & NGO's. The center's activities have flavoured the lesser known flavouring seed spices among the farmers.



On the post harvest technology front, different value added novel products like RTS, biscuits, prass, prag etc. were demonstrated to the stake holders and commercialized. The technology of producing these new value added products of seed spices has been placed for patenting with the government agencies. Adding more feathers to its baskets the NRC on Seed Spices has also released two high yielding & quality varieties namely ACr-1 (coriander) & AD-2 (dill).

2.1 Location and Climate

ICAR-National Research Centre on Seed Spices is located in the vicinity of Tabiji village on the Ajmer-Beawar road, 13 km away from Ajmer railway station. The Centre lies between 74°35' 39" to 74°36' 01" E longitude and 26°22' 12" to 26°22' 31" N latitude at an altitude of 460.17 m above mean sea level. The Ajmer city is well connected by road and railway line to Ahmadabad and Delhi. The nearest airport is Jaipur, situated about 135 km away from Ajmer. The soil of the research farm is sandy loam, poor in fertility and water holding capacity, having pH 8 to 8.3, EC 0.07 to 0.12 and organic carbon 0.15 to 0.23%, available N 178.5 kg ha⁻¹ (low), P₂O₅ 12 kg ha⁻¹ (medium), K₂O 85 kg/ha⁻¹ (low), Ca 214.7 kg ha⁻¹ (high), Mg 258 kg ha⁻¹ (medium), S 27 kg ha⁻¹ (medium).

Under the influence of climate change 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 monthly weather parameters recorded at agro-meteorological observatory, NRCSS, Ajmer for the year 2014 and 2015 are presented in Annexure I and II. A total rainfall of 494.3 mm was recorded at Agro-Met Observatory as compared to the mean annual rainfall of 529.0 mm (for the 100 years). The year 2014 and 2015 was a deficient rainfall year (6.5 and 12.1 % of the mean annual rainfall) at Ajmer. The maximum monthly rainfall of 203.6 mm was recorded in August during 2014, whereas it was maximum 202.0 mm in July during 2015. There were 26 rainy days during 2014 as compared to 28 during the 2015. The minimum and maximum temperatures, 1.0°C and 47.5 °C were recorded on 13th January and 5th May, 2015 respectively. The lowest relative humidity was 10

per cent on 2nd May while the highest (92%) was recorded on several occasions during the year. The total open pan evaporation during the year was 2133.3 mm, which is 4.6 times higher than the annual rainfall. The lowest evaporation of 0.5 mm was recorded during January, whereas the highest of 19.0 mm was on 26th May, 2015. The annual loss through PET is ~1566 mm. The relative humidity in the district is generally higher than 60% during the monsoon season reaching to as high as 75%, but the annual average humidity is less than 50%. The agro meteorological data for the cropping year for which the results are presented in this report and other weather parameters are given in Annexure-I and II.

2.2 Mandate

- To conduct basic, strategic and applied research to enhance production, productivity and quality of seed spices with reference to export and domestic demand.
- To serve as the National repository of information on seed spices and establishing global gene bank for seed spices
- To establish relevant institutional linkages nationally and internationally, offer consultancy and training.
- Providing adequate infrastructure for seed spices research, by establishing modern laboratory for analysis of plant, seed produce with export fitness.
- To monitor the adoption of new and existing technologies to make sure that research is targeted to the needs of farming community.

2.3 Mandate crops

Presently following ten seed spice crops are the mandate crops:

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

2.4 Objectives

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

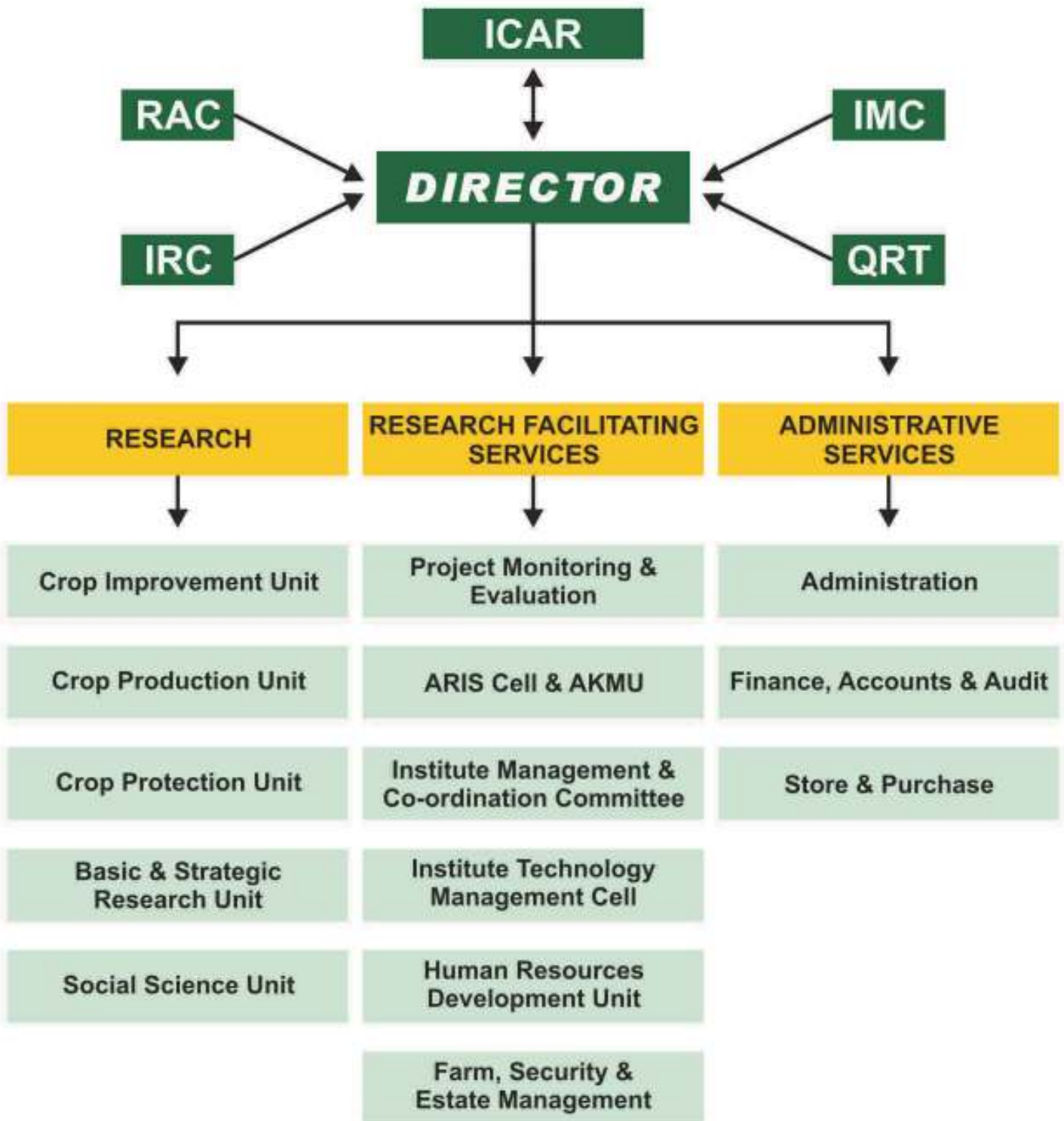
2.5 Staff position as on 31-3-2016

Grade	Sanctioned	In position	Vacant
Scientific	20+1	20	1
Technical	8	7	1
Administration	11	6	5
Supporting	2	2	-
Total	42	35	7

2.6 Budget and financial outlay (2015-16)

NRCSS, AJMER HEAD	PLAN 2015-16 (In Lakhs)		NON-PLAN 2015-16 (In Lakhs)	
	RE	Expenditure	RE	Expenditure
Works	58.42	58.42	0.00	0.00
Equipment	13.68	12.54	4.00	4.00
Library Books & journals	4.32	4.32	0.00	0.00
Furniture & Fixture	13.58	13.58	2.00	1.99
Establishment Expenses	0.00	0.00	430.00	407.80
TA	5.00	4.99	7.00	6.99
Total Research & Operational expenses	60.00	59.99	75.00	75.00
Total Admn. Expenses	35.00	35.00	89.00	89.00
HRD	4.00	4.00	0.00	0.00
Other Miscellaneous Expenses	0.00	0.00	4.61	4.61
NEH	0.00	0.00	0.00	0.00
TSP	6.00	6.00	0.00	0.00
Grand total	200.00	198.84	611.61	589.39

Organogram



3. RESEARCH ACHIEVEMENTS

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

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

(R.K. Kakani, R.S. Meena, R. K. Solanki, S.S. Meena, S. Choudhary, A.K. Verma, Harisha C.B., H. Asangi and Diwakar Y.)

Collection and conservation of germplasm: NRCSS is having a collection of 2094 germplasm lines from ten seed spices crops. Total germplasm assemblage crop wise available at NRCSS is presented in Table 3.1.

Table 3.1 Total germplasm assemblage at NRCSS

Crop	NRCSS collection				NAGS holding
	Indigenous	Exotic	Lost	Present available	
Cumin	100	7	-	107	247
Coriander	169	3	27	145	518
Fenugreek	82	59	6	135	733
Fennel	118	3	75	46	297
Ajwain	99	1	9	91	100
Dill	106	5	3	108	111
Nigella	21	3	-	24	24
Celery	36	-	-	36	36
Anise	18	-	-	18	18
Caraway	8	2	8	2	10
Total	759	83	128	714	2094

Evaluation and maintenance of germplasm: Evaluation and maintenance of seed spices germplasm is carried out by respective crop curators through sib-mating or selfing as per crop-pollination behaviour. The curators are also evaluating germplasm and recording observations as per descriptors. This year germplasm lines were sown in the field for maintenance and evaluation which included 685 lines of fenugreek, 261 lines of fennel and 24 lines of nigella. Multilocation evaluation was also carried out for 60 lines of coriander, 50 lines of fennel, 50 lines of fenugreek and 20 lines of cumin.

Fenugreek germplasm evaluation: In fenugreek, total 685 germplasm lines available were planted in the field in Augmented Block Design with 4 check varieties namely AFg-1, AFg-3, AFg-5 and RMT-361. Out of total sown entries 674 entries germinated and observations were recorded for 26 characters. Total variability recorded for fenugreek is summarized in Table 3.2.

Using these data, core set was developed through making different classes in each character. On the basis of all the 26 characters 602 germplasm were categorized, manually. 53 germplasm lines were selected using Power Core 1.0 for core set of fenugreek which exhibited, slightly lower mean, slightly increased coefficient of variation (%) and Nei's diversity index (Nei.) for each class (allele) for almost all characters.



Plate: Field view of fenugreek germplasm evaluation

Table 3.2 Variability recorded in fenugreek

Quantitative Characters	Mean	Minimum	Maximum	CV (%)
Leaf area (cm ²)	3.48	1.26	9.53	21.75
Leaf width (cm)	1.48	0.63	3.64	15.78
Leaf length (cm)	3.47	1.43	6.96	13.69
Petiole length (cm)	1.71	0.86	4.08	15.33
Pod length (cm)	9.70	1.80	15.72	8.65
No. of seeds/pod	16.55	6.00	23.00	13.87
Shelling %	69.37	51.61	90.54	8.26
Test weight (g)	13.36	1.67	26.77	25.36
yield /plant (g)	9.67	0.67	22.22	33.75
Seed yield (g/m ²)	174.06	12	400	33.76
Qualitative Characters	Mean	Minimum	Maximum	Mode
Leaf colour	2.02	1	3	2
Leaf size	4.96	3	7	5
Petiole colour	2.01	1	3	2
Petiole pubescence	1.00	0	1	1
Stem colour	2.52	1	3	3
Stem pubescence	1.00	0	1	1
Stem shape	2.92	1	3	3
Inflorescence colour	2.00	1	3	2
Plant growth habit	2.78	1	3	3
Growth pattern	1.47	1	2	1
Category of plant	2.00	1	2	2
Leaf margin	2.00	2	2	2
Leaf tip shape	2.41	1	4	2
Immature pod colour	1.25	1	2	1
Pod curve	1.89	1	2	2
Pod shape	1.54	1	2	2

Fennel germplasm evaluation: 204 fennel germplasm lines have been evaluated in Augmented Block Design with four checks namely AF-1, RF-101, RF-125 and GF-2 (Table 3.3).

Nigella germplasm evaluation: 24 nigella germplasm lines have been evaluated with three check varieties namely AN-1, Azad Kalonji and Pant Krishna (table 3.4). Seed yield per plant were minimum in AN- 13 whereas, it was maximum in AN-24 (12.83 g/plant). Maximum test weight (3.03 g) and total essential oil (26.99) were recorded in AN -4 and AN -24, respectively (Table 3.4).

Table 3.3 Variability recorded in fennel

Characters	Mean	Minimum	Maximum	CV (%)
Days to germination	10.79	10.0	11.0	3.8
King umbel anthesis	25.66	19.0	31.0	7.3
Days to 50% flowering	114.21	102.0	132.0	8.1
King umbel diameter	16.13	11.0	27.8	12.1
Plant height	179.39	148.0	209.2	5.4
Primary branchess	7.78	5.4	12.6	15.8
Secondary branches	22.14	9.0	38.8	20.3
Umbel per plant	42.86	20.2	71.2	18.7
Umbellate per umbel	30.68	22.4	46.8	13.1
Seed per umbellate	28.23	20.2	37.8	12.2
Test weight	5.87	3.96	9.1	16.2
Seed yield (gm)	205.84	100.5	469.0	38.4

Table 3.4 Variability recorded in nigella

Parameters	Min.	Max.	Mean	SD	CV (%)
Plant height (cm)	29.4	50.60	39.08	4.56	11.67
Length of first internode (cm)	1.12	2.48	1.74	0.34	19.56
No. of primary branches / plant	5.4	7.60	6.26	0.57	9.06
No. of secondary branches/plant	12.2	17.20	14.81	1.41	9.55
Days to 50% flowering	64.0	77.00	68.08	3.08	4.53
Angle of first primary branch (o)	14.8	25.00	18.18	3.13	17.20
No. of effective branches	4.4	20.40	7.48	4.27	57.12
No. of siliqua / plant	25.0	70.00	42.99	9.35	21.74
No. of seeds / siliqua	67.9	93.92	80.73	6.39	7.92
Siliqua size	2.7	3.36	3.08	0.17	5.61
Seed yield / plant (g)	4.1	12.83	8.77	2.03	25.15
Weight of 1000 seeds	1.9	3.03	2.50	0.27	10.75
Total oil (%)	11.2	26.99	20.07	3.83	19.10
Root rot (%)	5.0	49.00	27.21	14.04	51.61



"Ajmer Coriander-1" ACr-1)

A coriander population namely Ajmer Coriander-1 (ACr-1) released by Rajasthan State. This variety is stem gall resistant and it gave an average 11.7 q/ha seed yield.

Germplasm evaluation (Multi location): 50 germplasm lines of fenugreek, 60 of coriander and 50 of fennel were evaluated in ABD. The observations were recorded, summarized and variability presented in Table 3.5, 3.6 & 3.7.

Table 3.5: Variability recorded in fenugreek germplasm

Characters	Mean	Minimum	Maximum	CV(%)
Petiole length (cm)	1.58	1.04	2.12	14.46
Plant height (cm)	52.74	36.80	69.60	16.17
Pri. branches /plant	5.55	1.60	12.20	27.47
Sec. branches/plant	3.91	0.00	19.60	107.13
Pod length (cm)	8.12	6.44	10.24	9.96
No. of pods/plant	34.88	13.8	103.20	45.11
No. of seeds/pod	17.38	13.0	21.00	11.48
Shelling (%)	68.15	48.33	77.59	7.96
Test weight (g)	14.48	8.10	15.60	108.16
Seed yield /plant (g)	4.27	1.75	7.95	27.48

Table 3.6: Variability recorded in coriander germplasm

Characters	Mean	Minimum	Maximum	CV(%)
Plant height up to main umbel (cm)	77.44	42.2	119.8	18.14
Plant height up to top (cm)	86.92	50.6	130.2	16.14
Primary branches / plant	6.93	5.0	10.8	17.46
Secondary branches / plant	17.89	8.4	29.2	27.14
No. of umbel per plant	29.06	12.8	49.4	25.12
No. of umbellate per umbel	5.9	4.2	8.8	14.01
No. of fruits per umbel	34.44	21.0	58.8	22.66
Test weight (g)	11.43	6.8	15.8	20.25
Seed yield/plant (g)	5.41	1.72	9.33	34.1

Table 3.7: Variability recorded in fennel germplasm

Characters	Minimum	Maximum	Mean	CV (%)
Days to germination	10.0	11.0	10.81	3.67
Plant height up to top of plant (cm)	101.0	185.8	149.98	20.98
Number of primary branches per plant	4.4	20.0	6.70	30.46
Number of secondary branches	9.8	39.2	18.68	27.40
Days to 50% flowering	101.0	110	105.38	2.37
Number of umbel per plant	19.0	58.6	35.58	20.75
Number of umbellate per umbel	17.0	73.0	26.21	25.16
Number of seed per umbellate	19.6	31.8	26.29	8.67
Seed yield/line (g)	60.5	486.0	213.86	43.45
Weight of 1000 seeds(g)	3.22	8.8	5.07	20.23
Seed yield per plant (g)	7.6	60.8	26.02	47.08

CI-20: Cytogenetical and biochemical characterization of cumin (2012-16)

(R. K. Solanki and S. S. Rathore)

Mitosis studies showed normal events. The karyotypes of cumin variety GC-4 and RZ-209 were compared. The karyogram was found to be non-symmetric, GC-4 (4 Sm + 3 St) whereas of RZ-209 (5Sm + 2M), the variation shows that cytomorphological variability exists among the varieties.

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

CI-4: Breeding for high yield, quality and resistance to biotic and abiotic stress in fennel (2009-15)

(R.S.Meena, R.K.Kakani, R.S.Mehta, R.D.Meena, Krishna Kant, S.N.Saxena, Sharda Choudhary)

Germplasm Evaluation: Total 204 accessions were evaluated in augmented design, 29 promising accessions were identified on the basis of yield, which ranged from 3.04-10.01 q/ha.

Station Trial I: The analysis of variance revealed significant difference among the genotypes for all the traits including seed yield. The yield ranged from 13.73-33.41 q/ha with check varieties namely AF-1 (30.50 q/ha) and RF-125 (29.71 q/ha). Among the fifteen genotypes one genotypes were found elite and maximum yield was recorded in UF-206 (33.41 q/ha). This genotype (UF-206) was also found moderately resistant (PDI-28.0 %) for *Remularia* blight (Fig 1). Performance of fennel genotypes is given in Table 3.8. The essential oil content in the genotype ranged from 0.30 to 3.17 %. The Fig 2 show that maximum essential oil was observed in genotype AF-F2-53 of 3.17 % and UF-135 (3.0%) which was higher as compared with checks AF-1 (1.67 %) (Table 3.8).

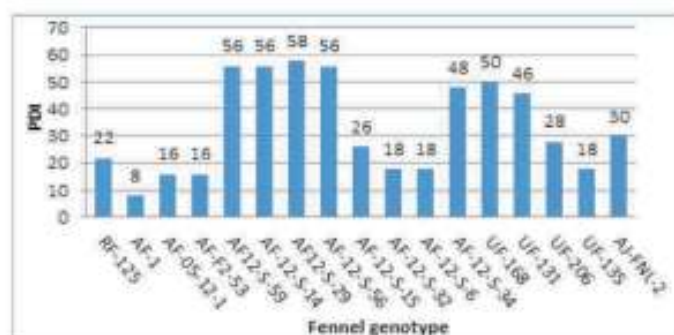


Fig.1: Screening of fennel (*Foeniculum vulgare*) genotypes for *Ramularia* blight disease

Table 3.8 : Performance of fennel genotypes

Genotypes	Plant height (cm)	Primary branches (No.)	Secondary branches (No.)	Umbel/ plant (No.)	Umbellates/ umbel (No.)	Seed/ umbellates (No.)	Test weight (g)	Seed yield q/ha
AF-05-12-1	183.7	9.4	27.9	43.4	38.2	33.7	7.0	24.4
AJ-FNL-2	194.9	10.2	21.3	48.9	29.6	28.6	5.9	17.3
AF-F2-53	194.0	9.4	19.6	45.5	33.0	29.2	5.2	21.4
AF-12-S-59	177.1	9.7	27.6	51.6	30.7	28.2	6.0	23.5
AF-12-S-14	174.5	8.8	30.6	57.0	32.9	31.7	6.3	16.4
AF-12-S-29	182.8	9.7	30.2	66.0	43.9	29.9	5.5	22.9
AF-12-S-56	184.2	8.7	30.0	67.9	38.2	25.9	5.4	13.7
AF-12-S-15	178.2	9.0	35.3	62.7	32.7	28.0	5.0	17.6
AF-12-S-32	194.4	8.3	32.7	54.0	33.3	27.2	5.1	16.0
AF-12-S-6	194.4	8.8	28.7	47.8	30.0	29.2	6.1	23.3
AF-12-S-34	183.1	9.0	28.6	49.8	30.8	29.5	6.4	24.6
UF-168	166.0	10.2	21.2	56.2	30.1	30.1	6.5	17.8
UF-131	174.5	10.3	22.5	48.4	30.7	28.0	5.0	16.1
UF-206	187.0	10.0	21.6	53.1	27.9	29.3	6.0	33.4
UF-135	197.2	9.9	23.3	46.3	29.4	30.5	4.9	27.3
RF-125	162.7	10.2	19.2	55.1	31.8	28.4	5.7	29.7
AF-1	191.0	10.7	22.6	50.3	33.8	32.9	6.4	30.5
CD (P=0.05)	4.2	1.2	2.0	2.9	1.2	2.1	1.3	4.7
CV (%)	0.1	0.4	0.3	0.2	0.1	0.2	0.8	0.7

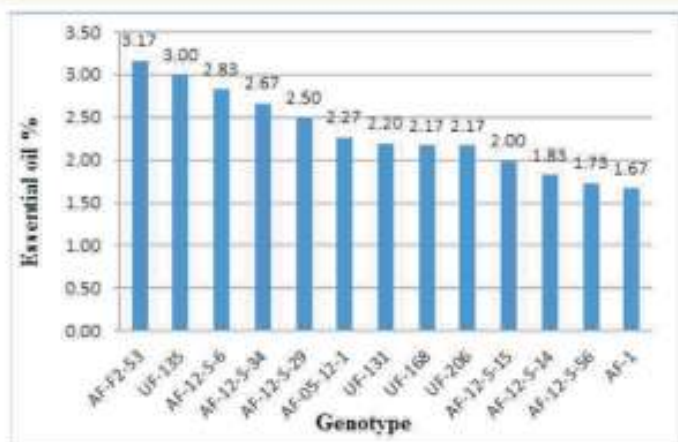


Fig. 2: Essential oil % in fennel genotypes

Station Trial II: Analysis of variance revealed significant difference among the genotypes for all the traits including seed yield. The yield ranged from 9.34-24.44 q/ha compared with check varieties namely AF-1 (13.51 q/ha), GF-1 (22.5 q/ha) and RF-125 (19.87 q/ha). Among the sixteen genotypes, two genotypes were found elite and higher yield was recorded in AF-257 (24.4 q/ha) and AF-11 (24.3 q/ha) compared to check varieties. Performance of fennel genotypes is given in Table 3.8. The essential oil content in the genotype ranged from 0.33 to 2.07 %. Fig. 3 shows that the maximum essential oil was recorded in AF-134 (2.07%) and AF-299 (2.00%) as compared with checks AF-1 (1.07%).

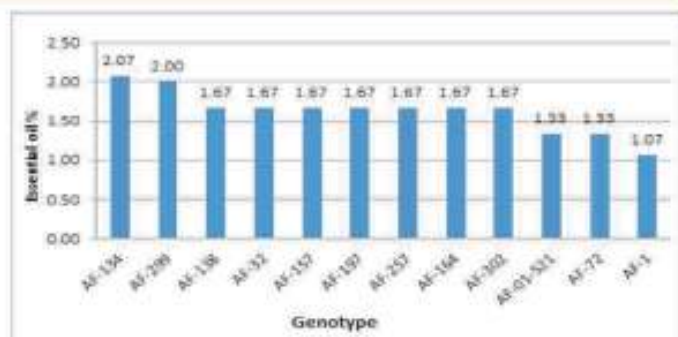


Fig. 3: Essential oil % in fennel genotypes



Ajmer Fennel -2 (AF-2):
A fennel population namely AF-2 has been developed and identified for release AICRPS workshop at IISR Calicut during October 5 to 7, 2015. AF-2 gave 17.9 q/ha seed yield which is moderately resistant to *Ramularia* blight diseases.

Dwarf genotype identified

Dwarf fennel seed were sown during 2014-15 all plant were critically evaluated for yield and yield related



Dwarf plant of fennel

traits. Dwarf fennel plants were maintained by selfing through caging. Also efforts were attempted to make more than 50 crosses in dwarf fennel during 2014-15. However some crosses produced seed and viability of crosses will be tested in next cropping season.

CI-7: Breeding for high yield, quality and resistance to biotic and abiotic stress in celery (2009-15)

(R.S. Meena, R. K. Kakani, R.D. Meena, S. Choudhary and Krishan Kant)

The analysis of variance revealed significant difference among the genotypes for all the traits including seed yield. The yield ranged from 3.8 to 8.0 q/ha with one check varieties A-Cel-1(5.6 q/ha). Among the nine genotypes two were superior, K-25 (8.0 q/ha) and A Cel-9 (7.7 q/ha) as compared to checks (Table 3.9). Performance of celery entries are given in Table 3.10. Screening of celery (*Apium graveolens*) genotypes for *Cercospora* leaf blight is given in Fig 4.

Table 3.9: Performance of celery entries at NRCSS

Genotypes	Primary branches	Secondary branches	Plant height (cm)	Umbellate / umbel	Seed / umbellate	Umbel / plant	Yield (q/ha)
ACel-1	16.6	59.7	110.3	20.6	52.0	447.5	5.6
K-4	17.0	77.3	117.3	21.4	52.7	439.0	5.3
K-5	18.6	68.4	119.2	23.0	71.0	501.2	4.4
A-Cel-9	20.8	71.0	123.1	21.8	53.7	514.3	7.7
K-23	36.3	65.3	82.1	33.7	57.6	453.2	3.8
K-24	17.6	66.7	119.0	22.3	60.1	539.1	4.4
K-25	21.0	68.7	122.8	22.9	57.3	548.2	8.0
A-Cel-8(S)	29.0	64.1	93.2	34.3	47.7	365.9	4.3
A-E-Cel-08	29.3	67.1	112.0	37.0	55.6	573.3	5.0
Mean	22.9	67.6	111.0	26.3	56.4	486.8	5.4
CD (P=0.05)	2.2	7.9	29.6	3.4	10.0	182.4	5.4
CV (%)	5.5	6.8	15.4	7.5	10.3	21.6	2.9

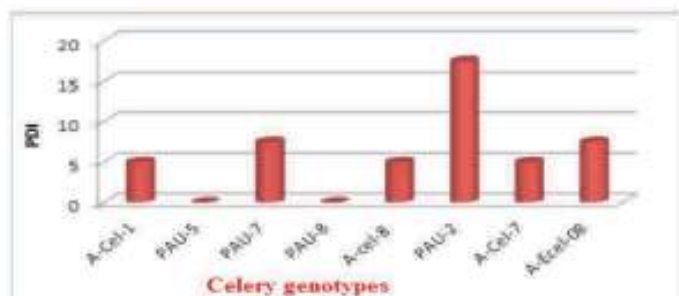


Fig. 4: Screening of celery (*Apium graveolens*) genotypes for *Cercospora* leaf blight

Multilocation trial for Celery in Collaboration with PAU, Ludhiana

Two entries, A Cel-5 and A Cel-6 were found best for yield in collaborative trial conducted at both the locations at NRCSS, Ajmer and PAU, Ludhiana during 2013-2015 (Table 3.10).

Table 3.10 : Yiled (kg/ha) performance of celery entries at Ajmer and PAU during 2013-15

Genotypes	2013-14 PAU	2014-15 PAU	2014-15 AJMER	Mean	Rank
PAU-1	897	907	735	846.3	7
PAU-2	925	996	880	933.6	3
PAU-4	823	745	608	725.3	13
PAU-5	936	982	736	884.6	5
PAU-7	762	661	884	769	11
ACel-4	862	873	870	868.3	6
ACel-5	977	894	946	939	2
ACel-6	1043	944	990	992.3	1
ACel-7	983	787	760	843.3	8
A-E-Cel-8	741	793	740	758	12
ACel-8 (S)	1021	846	531	799.3	9
ACel-11	950	902	920	924	4
ACel-1 (C)	940	855	577	790.6	10

CI-8: Breeding for high yield and quality in dill (*Anethum graveolens* L & *Anethum sowa* Kurz.) (2009-15)

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

One station trial was conducted with 12 test entries and two check varieties namely AD-1 and AD-2. Observation recorded on yield and contributing characters. The population AD-67 matures early as compared to other populations. The entry AD-5-01-24 was the highest

yielder among the test entries with 2125.6 kg/ha seed yield while the best check was AD-1 with 1895.6 kg/ha seed yield.

Pooled data: The genotype AD-67 is early flowering by 15 days. The population AD-5-01-24 and AD-5-03-35 gave 14.30 and 9.40 per cent higher yield, respectively as compared to best check AD-2 (Table 3.11).

Table 3.11 : Performance of the dill genotypes after pooling

Genotypes	2012-13	2014-15	Average	% Higher than AD-2
AD-5-11	2084.2	1163.3	1623.8	
AD-5-14	1968.1	1463.9	1716.0	
AD-5-44	1645.8	1419.4	1532.6	
AD-5-45	1140.8	1893.3	1517.1	
AD-5-50	1728.9	1371.1	1550.0	
AD-67	1543.9	1755.0	1649.5	
AD-5-01-24	1957.8	2125.6	2041.7	14.30
AD-5-03-02	2096.7	1056.1	1576.4	
AD-5-03-35	2159.4	1748.9	1954.2	9.40
AD-5-01-3	2124.4	1328.3	1726.4	
AD-5-01-28	1919.7	1397.2	1658.5	
AD-5-03-8	1940.6	1443.9	1692.2	
AD-1	1641.1	1895.6	1768.3	-1.00
AD-2	1835.8	1736.7	1786.3	0.00



Ajmer Dill -2 (AD-2) :

A dill population namely AD-2 has been released by Rajasthan State, this variety matures in 135 days with average yield of 14.6 q/ha.

CI-9: Breeding for high yield and improved quality in ajwain for Rabi and Kharif season (2008-15)

(S.S. Meena, R.K. Kakani, R. S. Meena, R. D. Meena, K. Kant and R. S. Mehta)

A station trial was conducted with 12 test entries and three check varieties (Ajmer Ajwain-1, Ajmer Ajwain-2 and GA-1) during the year 2014-15. Observations such as growth parameters, yield attributes and yield were recorded. Higher yield attributes and yield (1516 kg/ha) has been recorded in AA-73 genotype as compared to national check, GA-1 (667 kg/ha) as given in Table 3.12.

Table 3.12: Performance of ajwain genotypes in trial

Genotype	Seed yield per plant (g)	Test weight (g)	Seed yield per plot (g)	Seed yield (kg / ha)
AA-1	40.00	0.86	627.67	1046
AA-51	35.75	0.70	233.13	389
AA-96	31.33	0.33	503.70	839
AA-6	56.50	1.01	288.25	480
AA-21	41.80	1.69	814.34	1357
AA-27	57.67	1.36	887.42	1479
AA-43	49.92	0.72	162.25	270
AA-45	54.93	0.74	210.15	350
AA-2	43.67	1.10	782.05	1303
AA-53	52.83	0.81	237.75	396
AA-71	50.17	0.83	259.50	433
AA-73	70.00	1.28	909.67	1516
AA-74	59.00	2.10	890.00	1483
AA-84	31.42	0.38	689.28	1149
GA-1	28.50	0.40	400.20	667
S.Em±	1.67	0.04	21.50	35.8
CD(P=0.05)	4.77	0.11	61.37	102.3
CV(%)	7.13	7.82	8.17	8.2

Field testing of different Ajwain genotypes

CI-15: Genetic enhancement of anise for yield and yield contributing traits (2011-16)

(R.K. Solanki and O. P. Aishwath)

A trial of 10 genotypes of anise was conducted with the check variety Ajmer Anise -1. Genotypes AAni-17-Sel 2 and AAni-17-Sel 5 showed early flowering (73 days).

Based on yield per plant AAni-17-Sel 4 (19.91 g/plant) was best followed by check variety Ajmer Anise-1 (17.66 gm/plant). Day to maturity varied among the set of genotypes studied and check variety AAni-1 matured in 140 days whereas the most promising entry AAni-17-Sel 4 having high yield matured in 120 days showing a significant advantage of 20 days under the semi arid conditions of Ajmer (Table 3.13).

Table 3.13: Agro-morphological performance of promising anise entries for yield and yield contributing traits

Genotypes	DF	DM	PH	NPB	NSB	NUP	Num/U	SUm	TW	SYP
AAni-17-Sel 1	75	119	68	7	12	29	15	12	3.23	10.24
AAni-17-Sel 2	73	122	65	8	15	34	15	11	3.5	12.09
AAni-17-Sel 3	80	121	64	8	17	32	14	10	3.46	9.33
AAni-17-Sel 4	74	120	60	9	15	36	16	14	3.89	19.91
AAni-17-Sel 5	73	120	64	7	18	34	15	12	3.60	13.69
AAni-18-Sel 1	75	121	70	9	16	29	16	11	4.01	12.64
AAni-18-Sel 2	78	123	72	8	18	26	14	12	3.64	9.60
AAni-18-Sel 3	76	119	68	7	14	32	13	13	3.78	12.63
AAni-18-Sel 8	79	122	71	8	16	37	15	13	3.21	14.44
AAni-18-Sel 10	80	126	65	9	13	29	14	11	3.78	10.25
AAni-1	98	140	73	11	17	31	16	14	4.03	17.66
Mean	78.3	123.0	67.3	8.3	15.6	31.7	14.8	12.1	3.65	12.95
CV	3.5	3.8	8.6	6.7	10.3	12.5	5.4	12.6	4.20	15.60
									CD at 5 %	2.06

DF: Days to 50 % flowering; DM: Days to maturity; PH: Plant height (cm); NPB: Number of primary branches; NUP: Number of umbels per plant; Num/U: Number of umbellets per umbel; SUm: Seeds per umbel; TW: Test weight (g); SYP: Seed yield per plant (g)

CI-18: Genomic study of seed spices (Fennel and Coriander) (2012-15)

(Sharda Choudhary and M.K. Vishal)

The experiments were conducted for molecular characterization of released varieties and accessions of coriander and fennel available at NRCSS through RAPD and ISSR analysis.

Coriander : DNA isolation protocol was standardized for high quality DNA from coriander leaves and seeds which eliminates the use of liquid nitrogen. The protocol is inspired by the CTAB method and Sambrook principles. In the present study, genetic diversity between 137 coriander genotypes using RAPD and ISSR markers was evaluated. Out of 20 RAPD markers 18 were amplified with 15 % polymorphism. Similarly, in ISSR out of 20, only

10 primer gave clear scorable band with 56 % polymorphism. Results showed that these are the markers of choice for studying genetic diversity giving accurate results (Fig. 5 & 6).

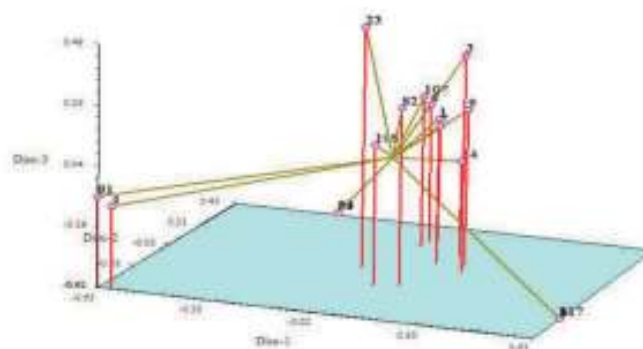


Fig. 5: PCA for representing lines of coriander using RAPD markers

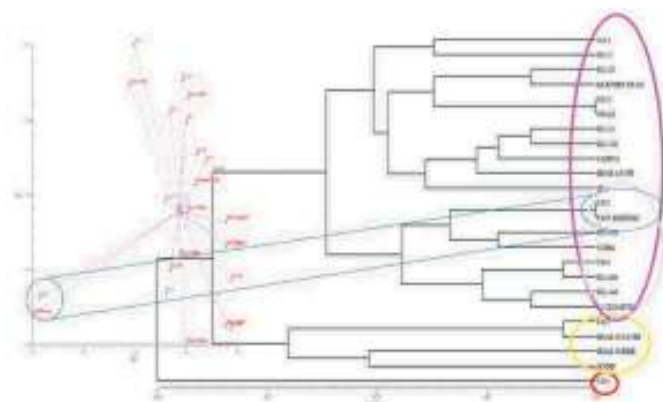
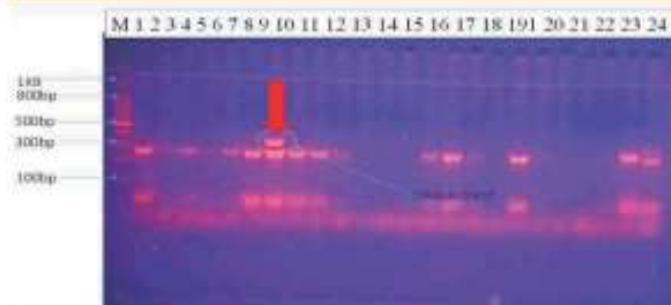


Fig. 6: Dendrogram with ISSR primer in coriander varieties

Unique bands in coriander genotypes: One primer gave unique bands in a specific coriander genotype as shown in (Table 3.14). This primer produced a specific DNA band which distinguished one genotype from the rest. Primer OPB-16 generated a unique allele for RCr-446 (Fig. 7).

Table 3.14: Unique/genotype specific bands as detected by RAPD primer in 24 genotypes of coriander

RAPD Primers	Genotype	No. of Unique band	Size of Band (bp)
OPB-16	RCr-446	1	550
Total		1	



1: Ger-1, 2: Ger-2, 3:Res-11, 4:Res-20, 5:Res-435, 6:Res-436, 7:Res-446, 8:Res-684, 9:Hisar Segundi, 10:Hisar Anand, 11:Hisar Sudhi, 12:Rajendra-Sudhi, 13:Azad Dhanya, 14:CO-1, 15:CO-2, 16:CO-3, 17:CO-4, 18: Pant Harina, 19: JD-1, 20: Ace-1, 21: Soyati, 22: Sadhana, 23: Sindhu, 24: Sudha.

Fig. 7: Specific DNA band which distinguished one genotype of coriander

Fennel : Two DNA based molecular marker techniques viz., Random Amplified Polymorphic DNA (RAPD) and inter-simple sequence repeat (ISSR), were used to study the molecular diversity among 17 fennel varieties and 134 accessions. A total of 26 polymorphic primers (16 random and 10 ISSR) were used. Amplification of genomic DNA of

17 genotypes, using RAPD analysis, yielded 79 fragments, in which 58 (73.41%) were polymorphic. The 10 ISSR primers produced 59 bands across 17 genotypes, of which 51 (86.44%) were polymorphic (Fig. 8 & 9).

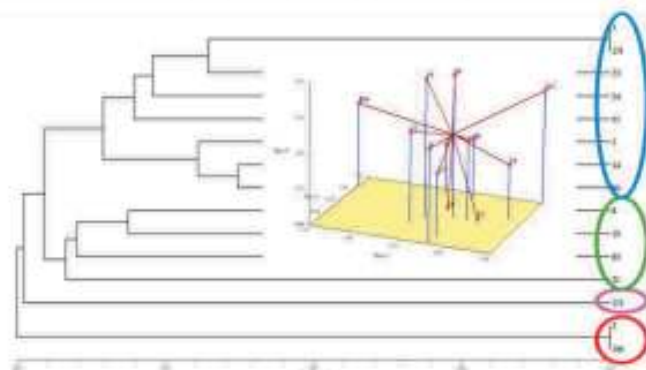


Fig. 8 : Dendrogram from representing (each group) lines of fennel

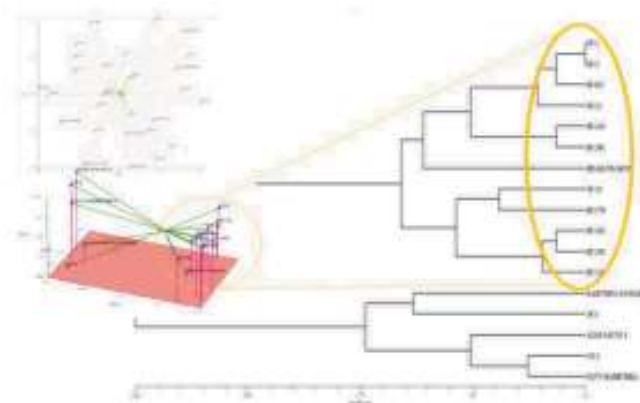


Fig. 9 : Dendrogram with ISSR primer in fennel varieties

Molecular Marker identified for fennel genotypes using RAPD primers :

Two RAPD primers (OPB-07 and OPB-11) generated unique bands in specific fennel genotypes as shown in (Table 3.15). These primers produced specific DNA band which distinguished the genotypes from the rest of the genotype. Primer OPB-07 generated a unique allele for Pant-madurika and Primers OPB-11 generated a unique band for the variety CO-1 (Fig. 10). These primers, OPB-07 and OPB-11 may work as specific molecular markers for the identification of Pant-madurika and CO-1 variety respectively. The identified band from both type of primers may be used to develop the SCAR (Sequence Characterize Amplified Region) markers which are specific and reproducible.

Table 3.15: Unique/genotype specific bands detected by 2 RAPD primers in Fennel

RAPD Primers	Genotype	Geographical Origin	Unique band	Size of Band (bp)	Primer Sequence
OPB-07	Pant-madurika	GBPAUT-Pantnagar, Uttarakhand	one	1850	GGTGACGCAG
OPB-11	CO-1	TAU- Coimbatore, Tamil Nadu	one	210	GTAGACCCGT

Table 3.16: Unique/genotype specific bands detected by ISSR primers in Fennel

ISSR primer	Genotype	Geographical Origin	No. of Unique band	Size of Band (bp)	Primer Sequence
UBC-810	Hisar-swarup	CCHAU Hisar, HR	one	1550	(GA)8T

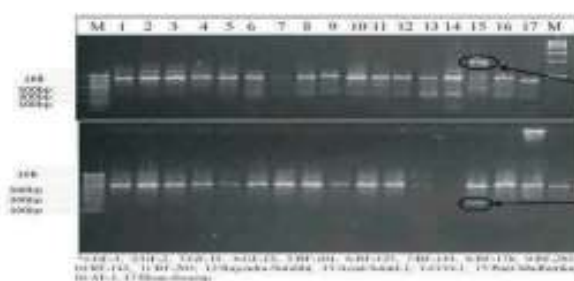


Fig. 10: Specific DNA band which distinguished fennel genotypes

Molecular Marker identified for fennel genotypes using ISSR primers:

ISSR primer (UBC-810) generated a unique bands in specific fennel genotypes (Table 3.16). This primer produced a specific DNA band which distinguished the genotypes from the rest. Primer UBC-810 generated a unique allele for fennel variety Hisar-swarup (Fig. 11). This unique band may be specific for identification of Hisar-swarup genotypes and differentiate from other genotypes. Hence, this marker may be further validated to develop, reproducible SCAR marker.

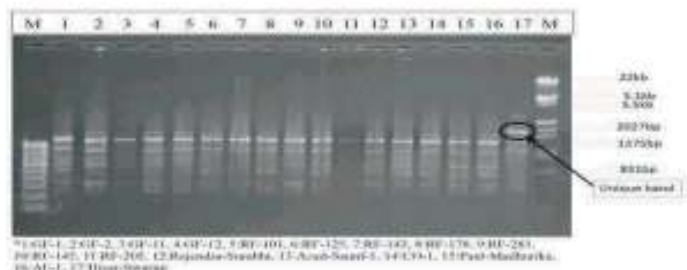


Fig. 11: Specific DNA band which distinguished fennel genotypes

CI-19: Enhancing genetic variability in cumin (2012-18)

(R.K. Solanki, R.S. Meena, A.K. Verma and H.S. Mehla)

Station Trial: 11 test entries were evaluated in the station trial for yield and yield contributing traits along with two checks RZ-209 and GC-4 (Table 3.17).

Table 3.17: Performance of cumin entries (station trial)

Entry	DF	DM	PH	PB	SB	UPP	UmU	SYP (g)	
CE-2	77.4	121.5	37.8	4.4	11.3	22.6	4.2	4.1	
CE-4	76.4	120.5	36.6	4.1	10.5	22.5	4.3	4.0	
CE-5	76.4	117.6	34.5	3.5	9.9	23.8	4.1	4.0	
CE-6	75.5	121.5	34.1	3.6	12.3	24.2	3.8	4.7	
CE-7	74.5	116.6	29.1	3.2	8.0	23.2	4.0	4.6	
CE-8	71.5	114.7	30.5	3.6	9.3	26.4	4.2	4.7	
CE-11	74.5	117.6	33.9	3.4	8.5	17.1	3.6	4.2	
CE-13	78.4	122.5	34.6	4.0	16.5	26.8	4.3	4.6	
CE-14	74.5	119.6	31.4	3.6	9.3	21.9	3.5	4.2	
CE-15	78.4	122.5	38.4	4.0	15.6	24.7	4.4	4.9	
CE-3	78.5	120.6	31.6	4.3	10.9	22.9	4.1	4.0	
GC-4	82.4	126.4	30.2	4.0	13.4	25.7	4.5	4.2	
RZ-209	74.6	115.9	45.6	3.9	9.8	18.7	3.9	4.0	
CV %	2.3	2.5	6.9	8.4	10.2	15.2	2.6	18.6	
								CD (5%)	0.12

DF: Days to 50 % flowering; DM: Days to maturity; PH: Plant height (cm); PB: Primary branches; SB: Secondary branches; UPP: Number of umbels per plant; UmU: Number of umbellets per umbel; SYP: Seed yield per plant (g)

Germplasm Assessment and advancement: Total 605 lines were sown in ABD with two checks (RZ-209 and GC-4), infection of *Fusarium* wilt and Root rot complex was recorded high. Data on only 327 lines were recorded. The lines which showed highest survival % were SPS-13-69 (3.8 g), SPS-13-13 (3.13 g), SPS-13-40 (3.05 g).

Evaluation in *Fusarium* wilt sick plot: 40 test entries were evaluated in *Fusarium* wilt sick conditions, out of which 19 entries were found to be promising and yield and other related observation were recorded for these entries (Table 3.18).

Table 3.18: Performance of the cumin test entries under *Fusarium* wilt sick plot

Entry	PH	NU	Num	PB	SB	SU	Sum	SYP	PDI
SPS 223	26.0	32.7	4.2	4.3	21.3	20.0	4.5	2.8	20
SPS 214	22.4	16.0	4.8	3.6	11.0	17.8	4.4	1.8	22
SPS 249	26.0	26.2	4.5	5.6	12.6	18.2	4.0	2.0	23
SPS 216	28.8	18.4	4.6	4.6	13.2	21.0	4.8	2.2	25
SPS 266	23.8	9.0	4.5	4.0	8.4	18.0	4.5	1.6	34
SPS 219	29.0	24.7	4.5	4.0	14.0	17.8	4.5	2.1	37
SPS 250	25.2	20.0	4.5	5.6	12.8	15.8	3.5	1.9	38
SPS 95	13.4	9.6	4.1	4.0	9.0	15.0	4.5	1.6	38
SPS 247	25.6	25.2	4.6	5.8	13.8	15.6	4.0	1.9	46
SPS 252	23.8	22.2	4.3	5.8	13.2	15.8	3.7	1.9	47
SPS 246	22.0	22.8	4.3	5.6	14.6	19.6	4.5	2.2	48
SPS 248	29.8	46.3	4.0	5.5	16.5	16.3	4.1	2.1	50
SPS 254	31.0	19.5	4.5	4.5	13.0	15.5	5.0	1.9	50
SPS 270	22.5	10.0	4.5	3.8	10.0	12.3	4.9	1.5	52
SPS 51	21.0	15.5	4.5	6.5	12.5	14.5	4.5	1.77	52
SPS 251	21.2	25.6	4.5	5.0	19.2	13.6	4.5	1.42	52
SPS 288	25.8	9.8	4.3	4.0	9.2	13.6	4.5	1.53	54
SPS 274	28.2	23.2	4.5	6.2	17	15.4	4.5	2.11	55
SPS 288	18.4	18.3	4.5	4.0	10	14.3	4.0	1.87	62

PH: Plant height (cm); NU: Number of umbels; Num: Number of umblets per umbel; PB: Primary branches; SB: Secondary branches; SU: Seeds per umbel; Sum: Seeds per umblet; SYP: Seed yield per plant (g); PDI: % Disease Index

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

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

Evaluation of fenugreek purelines for higher yielding ability:

Two entries namely AFG-5 and AFG-6 have been submitted for coordinated testing to AICRP on Spices. These entries are selected on the basis of yield in station trial conducted at NRCSS, Ajmer. Both the entries has completed three year of testing. AFG-5 ranked at second place in coordinated testing after pooling all the data over the locations and years. Overall performances of the entreis are presented in Table 3.19.

Evaluation of fenugreek pure lines

Eleven advanced lines developed through mutation breeding have been evaluated in randomized block design with three check varieties namely AFG-1, AFG-3 and Hisar Sonali using three replications. This evaluation was repeated for second year to confirm the superiority of

Table 3.19: Performance of different entries after pooling of 31 trial data tested by different Coordinated Centres during 2012-13 to 2014-15

Genotype	Code	Yield (kg/ha)	Rank	% higher Hisar Sonali	% higher RMT-361
JFg 245	FGK-39	1442.1	14	-6.74	-6.17
JFg 266	FGK-40	1421.3	15	-8.08	-7.52
AFg 5	FGK-41	1658.8	2	7.27	7.94
AFg 6	FGK-42	1448.0	13	-6.35	-5.78
LFC 98	FGK-43	1575.0	5	1.85	2.48
LFC 93	FGK-44	1537.3	7	-0.58	0.03
HM 259	FGK-45	1531.2	9	-0.98	-0.37
HM 280-1	FGK-46	1491.1	11	-3.57	-2.97
UM 202	FGK-47	1594.7	4	3.13	3.76
UM 354	FGK-48	1754.3	1	13.45	14.15
NDM 69	FGK-49	1622.1	3	4.9	5.55
NDM 72	FGK-50	1509.7	10	-2.37	-1.76
RM 188	FGK-51	1254.7	16	-18.86	-18.36
RM 194	FGK-52	1450.2	12	-6.22	-5.64
Hisar Sonali (NC)		1546.3		0	0.62
RMt 361 (NC)		1536.8		-0.61	0

entries. Performance of these lines after pooling for seed yield is presented in Table 3.20. On the basis of the performance of these lines B4-22-7-2-1 (AFg-7) and A3-47-1 (AFg-8) have been submitted for coordinated testing.

Table 3.20 : Performance (seed yield) of fenugreek genotypes after pooling (kg/ha)

Genotypes	2014-15	2013-14	Average	% high than AFG-3
A3-31-1-17	1955.6	419.4	1187.5	-27.6
A4-31-2-1-3	1783.3	334.4	1058.9	-35.44
B4-22-1	2255.6	556.7	1406.1	-14.28
B5-33-10-3	2886.1	554.2	1720.1	4.87
B2-19	2533.3	424.4	1478.9	-9.84
B2-31-8-16-2	2381.7	496.9	1439.3	-12.25
A3-76-9-2	2561.1	638.6	1599.9	-2.46
B5-48-2-6-1	2285.6	290.8	1288.2	-21.46
B4-22-7-2-1	2971.7	663.1	1817.4	10.8
A3-43-3	2800.0	699.7	1749.9	6.68
A3-47-1	2883.3	708.9	1796.1	9.5
AFg-3	2688.9	591.7	1640.3	0
AFg-1	2380.6	563.9	1472.2	-10.25
Hisar Sonali	2622.2	563.3	1592.8	-2.9

Evaluation of fenugreek genotypes for powdery mildew, downy mildew and blight infection: 685 germplasm lines of fenugreek have been evaluated in augmented block design. Observations on disease spread in different germplasm lines were recorded. The percent disease index(PDI) for all the three diseases is presented in Table 3.21.

Table 3.21 : Spread of disease in terms of PDI in fenugreek germplasm

Disease	Mean	Minimum	Maximum
Downey mildew	8.8	0.0	25.0
Powdery mildew	21.9	0.0	37.5
Alternaria blight	17.6	0.0	25.0

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

(R.K. Kakani and Y.K. Sharma)

Evaluation of coriander populations: Nine advance coriander populations have been evaluated in randomized block design with 1 check variety namely Hisar Sugandh.

The population SKCV-09-40 gave the highest yield followed by VDV/GL-2 and CGP-3-1 with seed yield 1993.06, 1854.17 and 1816.67 kg/ha, respectively (Fig. 12). On the basis of performance in the trial, two entries namely SKCV-09-40 and CGP-3-1 has been submitted for coordinated testing renamed as ACr-4 and ACr-5, respectively.

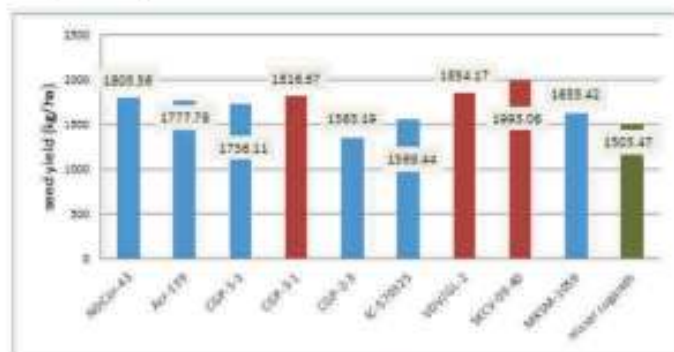


Fig. 12: Performance of coriander population in trial for seed yield (kg/ha)

Another station trial of coriander has been conducted with eight test entries and two check varieties namely Hisar Sugandh and ACr-1. ACr-1 was the highest yielder check with 1802.1 kg/ha seed yield. Among the test entries UD-375-1 was the highest yielder with 2795.1 kg/ha seed yield followed by VDV/GL-20-1 with 2445.8 kg/ha seed yield.

Gene pool (composite) maintenance: Three gene pools viz. early maturing, high yielding and small size seeded pool. A pool with 4 basal leaf, medium height, higher no. of seed per umbel and higher yield, created through sib-mating of selected population is being maintained and selections were carried out within the pools. A survey was also conducted in the stem gall affected area i.e. Kota and Baran districts of Rajasthan and observed that most of the area was seriously affected by the disease but ACr-1 was found free from stem gall infection at many locations.

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

(A.K. Verma, R.K. Kakani, R.K. Solanki and R.D. Meena)

Among five doses of gamma rays irradiation, the maximum seed germination was observed at 150Gy, followed by 175Gy, 200Gy, 225Gy and 250Gy in both crops

(cumin and fennel) and varieties (GC-4 and RZ-209; AF-1 and RF-125). At 200Gy, the germination was 70% in fennel variety AF-1 but the seedling survival decreased from 100% (in control) to 50.67%. Gamma rays dose of 200Gy showed optimum (50%) survival of seedlings in both crops and varieties (Fig. 13). The maximum growth recorded on lower doses of gamma rays in both crops and varieties. Likewise in fennel (RF-125), maximum number of leaves (20.8), number of roots per plant (17.2), root length (16.94 cm), shoots length (12.86 cm) and fresh weight per plant (0.090 g) recorded at lowest dose of gamma rays (150Gy) followed by 175Gy, 200Gy, 225Gy and 250Gy at 30 DAS. After 40 days of sowing, the growth parameters of plants were affected by gamma rays dose in field conditions. The growth of plants significantly reduced in gamma rays irradiated plants as compared to control. The root length, shoot length, fresh and dry weight per plant were reduced by increased dose of gamma rays.

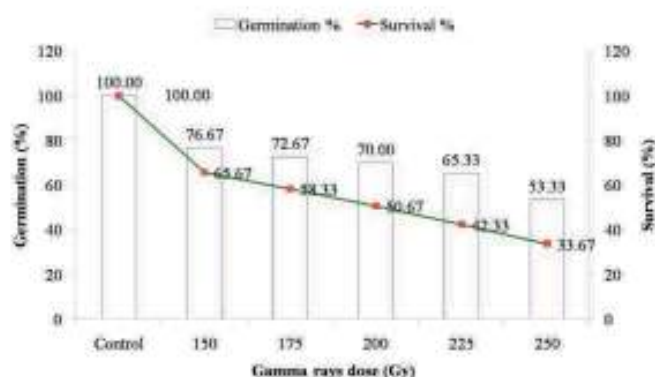


Fig. 13: Effect of different doses of gamma irradiation on seed germination and seedling survival in fennel cv AF-1

The number of umbels per plant and seeds per umbellate significantly varied from one dose to another doses in both crops and varieties. The number of umbellate per umbel significantly decreased in all doses of gamma rays as compared to control in RF-125, while in AF-1 it was increased at gamma ray dose of 200 Gy (37.4) as compared to control. The maximum test weight was observed in control (6.33 g) followed by 200Gy (6.24 g), 250Gy (5.32 g), 150Gy (4.97 g), 175Gy (4.76 g), 225Gy (4.67 g) in RF-125. The seed yield per plant was increased

in the dose of 200GY (42.4 g), followed by 250Gy (41.6 g), 225Gy (39.6 g) and decreased in 175 (31.0 g) and 200Gy (32.4 g) as compared to control (36.7g) in RF-125 variety of fennel.

Project: CI/15.2.1- Breeding in *Nigella sativa* L. for higher yield and improved quality (2015-2020)

(Diwakar Y., R. K. Kakani, R.K. Solanki and S. N. Saxena)

Nine superior genotypes of nigella (AN-4, AN-9, AN-16, AN-3, AN-21, AN-10, AN-5, AN-19 and AN-24) and one prevailing variety (AN-1) for identified traits were selected as parents for gene pool study. In gene pool study, pollens from more than thousand plants within the selected ten parents were manually collected, pooled and randomly pollinated on the emasculated flowers of more than three hundred plants grown under cover. As a result, one thousand seven hundred and seventy two seeds have been obtained for further population improvement and advancement. Similarly, field and laboratory experiments were conducted to determine the floral biology and reproductive phenology of *Nigella sativa* L. by taking AN-1 as a reference plant. Here through repeated sampling and observations, results on days for anthesis, days for initiation of male phase/anther dehiscence, phenotypic indices of male phase, duration of male phase, pollen viability, days for initiation of female phase/stigma receptivity, phenotypic indices of female phase, length of flowering period and pollination and fertilization have been obtained along with respective temperature and relative humidity during the flowering period. Through *in-vitro* pollen germination study using 45 % sucrose in combination with 0.04 % boric acid media, it is found that > 70 per cent of the pollens are viable (Fig. 14). Similarly, by hydrogen peroxide method it is revealed that stigma receptivity occurs on 5th day of flower opening. The laboratory results thus obtained were strongly supported by the results of field emasculation and pollination experiments that were conducted to determine the days to stigma receptivity.

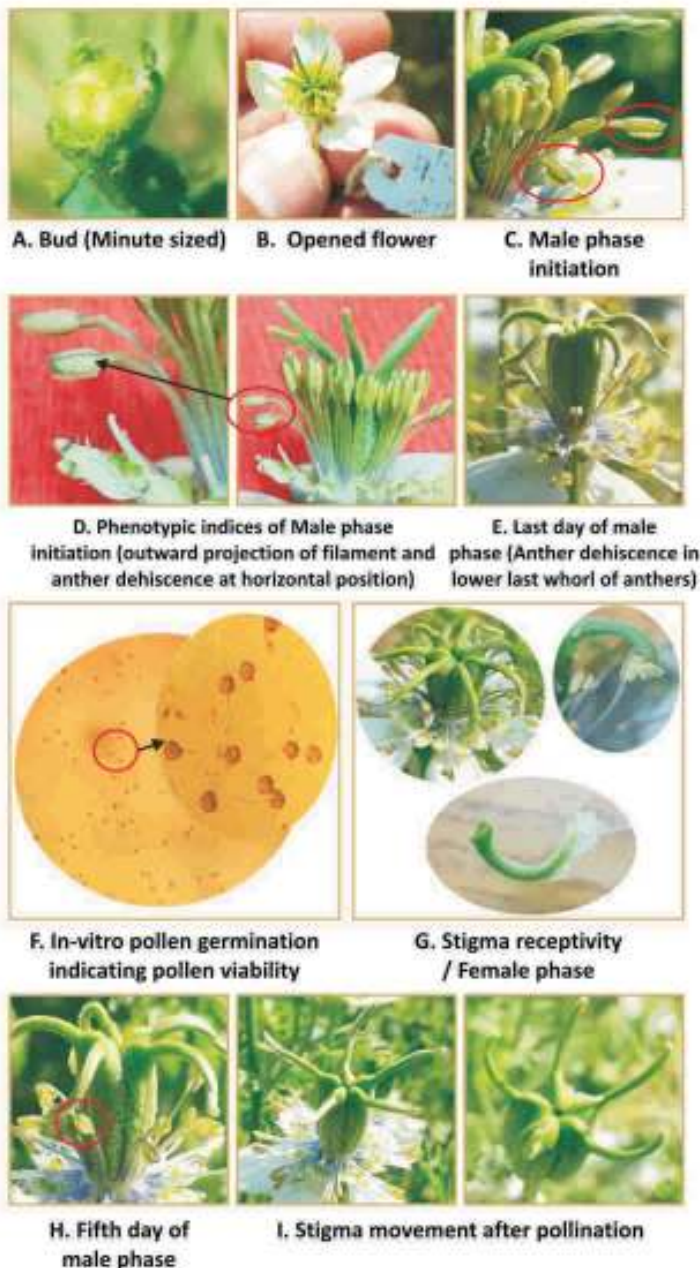


Fig. 14: Various stages (A to I) of Floral Development in nigella

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

CPd-17: Identification of critical stage for weed management in seed spices (coriander, ajwain and fennel) (2010-15)

(Ravindra Singh, Gopal Lal, R. S. Mehta, O. P. Aishwath and Sharda Choudhary)

Two field experiments involving fennel and ajwain were conducted at Research Farm, NRC on Seed Spices, Tabiji, Ajmer, Rajasthan. There were 22 treatments comprising of initial weed free periods of 15, 30, 45, 60, 75, 90, 105,

120, 135, 150 days after sowing (DAS) and weedy upto 15, 30, 45, 60, 75, 90, 105, 120, 135, 150 DAS along with weed free till harvest (weed free check) and weedy till harvest (un-weeded check) in ajwain and fennel. The weed dry weight increases with the increasing weedy period from 15 DAS to harvest stage and it was decreased with increase in weed free period from 15 DAS to harvest stage. The uptake of nitrogen were 1.45 kg/ha at 15 DAS which increased to the tune of 25.8, 52.9 and 157.3 kg/ha at 30, 45 and 60 DAS by *Chenopodium* Spp alone. The losses of nitrogen due to weeds were increased to 207.6 kg/ha, if they were not managed upto harvest stage in fennel and ajwain (Table 3.23).

The maximum seed yield of ajwain and fennel (686.0 and 3113.1 kg/ha) was recorded with the weed free throughout growth period treatment, whereas lowest yield recorded (15.3 and 555.6 kg/ha) in weedy check plots, respectively. On the basis of one season data, the critical stages for weed competition in ajwain and fennel were 67 and 69 DAS, respectively (Fig. 15 and 16). The loss in yield due to weeds (weedy throughout growth) in ajwain and fennel were 670.7, and 2555.5 kg/ha as compared with weed free plots. The net returns and B:C ratio were maximum at weed free throughout growth period which were decreased with increasing weedy period and leads to net loss rather than gain in both the crops. The growth and yield attributes as influenced by different weed and weedy free period in ajwain and fennel were also recorded which were maximum under weed free environment throughout growth period.



Identification of critical stages for weed competition in ajwain and fennel

Effect of pre-emergence and early post emergence herbicides on weeds in seed spices

An experiment was conducted using 9 herbicides i.e. Pendimethalin, Oxadiargyl (6% EC), Isoproturon,



Effect of different herbicides on weeds in crops (fennel, coriander and fenugreek)

Table 3.22: N content (%) and uptake by weeds (kg/ha)

Crop growth stage	Average N content (%) (<i>Chenopodium</i>)	Average weed dry biomass (kg/ha)	N Uptake kg/ha
15 DAS	2.3	63	1.46
30 DAS	2.9	891	25.83
45 DAS	3.3	1605	52.95
60 DAS	5.8	2714	157.39
75 DAS	4.1	4272	175.15
90 DAS	3.6	5437	195.72
105 DAS	2.5	7680	192.00
120 DAS	2.4	8543	205.04
135 DAS	2.3	8559	196.85
150 DAS	2.2	9267	203.87
Harvest	2.1	9887	207.63

Oxadiargyl (80%WP), Imazethapyr, Butachlor, Metribuzin, Oxyflourfen and Glyphosate as pre emergence or early post emergence herbicides to evaluate their impact on weed control and crop growth of major and minor seed spices. The response of different herbicides was varying in different crops. Best herbicides were Oxadiargyl (6% EC) for all the seed spices followed by Pendimethalin in all the crops except fenugreek and anise as pre emergence application.

CPd-18: Standardization of sustainable and profitable cropping system with fruit crops (2011-15)

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

A study was conducted to find profitable cropping system, using six seed spice crops in association with fruit trees and in open space. The highest seed, stover and biological yield of seed spices was obtained in sole crop followed by aonla association. This might be due to no competition of seed spices with fruit trees in sole crop. Fully grown ber orchard + (fenugreek-okra) performed better resulting highest coriander equivalent yield (6549 kg/ha) followed by ber + (ajwain-round gourd) with 5969 kg/ha. Simultaneously fully grown aonla orchard + (fenugreek-okra) performed better resulting highest coriander equivalent yield (5365 kg/ha) followed by aonla + (ajwain - round gourd) with (4953 kg/ha). Fruit yield of ber and aonla was recorded higher with fenugreek. Highest net returns were recorded with ber +(fenugreek- okra)as presented in Table 3.23.

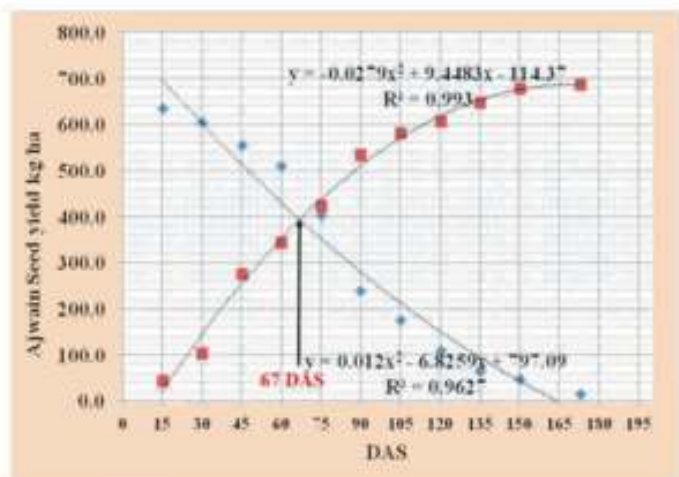


Fig 15. Critical stage (days after sowing) for weed competition in ajwain

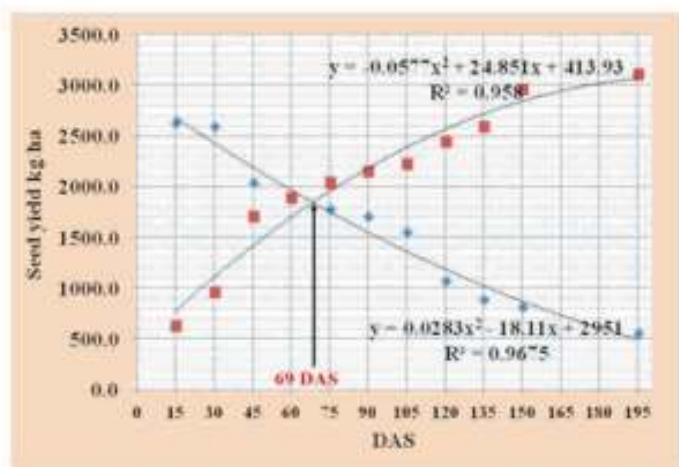


Fig 16. Critical stage (days after sowing) for weed competition in fennel



Ber and Aonla orchard with vegetables in kharif season



Ber and Aonla + Fenugreek based intercropping in rabi season

Table 3.23: Effect of seed spice based inter cropping with fruit trees on yield and cost of cultivation (Rs/ha)

Treatments	Yield of kharif crops (kg/ha)	Yield of Rabi crops (kg/ha)	Fruit yield (kg/ha)	Coriander equivalent yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B : C ratio
Ber + (Nigella - Cowpea)	8400	499	25236	5825	168300	873750	705450	4.19
Ber + (Anise - Cluster bean)	5220	523	25227	5319	159432	797835	638403	4.00
Ber + (Rai - Black gram)	525	966	25372	4831	151800	724600	572800	3.77
Ber (Ajwain - Tinda)	9500	559	24861	5969	173300	895375	722075	4.17
Ber (Fenugreek - Okra)	12600	1225	26271	6549	173060	982275	809215	4.68
Ber + (Coriander - Green gram)	620	528	25256	5027	156060	754000	597940	3.83
Aonla + (Nigella - Cowpea)	8200	484	48473	4809	173000	721330	548330	3.17
Aonla +(Anise - Cluster bean)	5180	514	47246	4252	164132	637740	473608	2.89
Aonla + (Rai - Black gram)	520	967	46900	3726	156500	558950	402450	2.57
Aonla + (Ajwain - Tinda)	9180	564	47478	4953	178000	742980	564980	3.17
Aonla + (Fenugreek - Okra)	12400	1220	48358	5365	177760	804780	627020	3.53
Aonla + (Coriander - Green gram)	610	512	47410	3957	160760	593600	432840	2.69
Sole Ber	-	-	24580	4097	110300	614500	504200	4.57
Sole Anola	-	-	48425	3228	115000	484250	369250	3.21
Sole (Nigella - Cowpea)	8950	600	-	1793	58000	269000	211000	3.64
Sole (Anise - Cluster bean)	5460	831	-	1393	49132	208920	159788	3.25
Sole (Rai - Black gram)	630	1980	-	996	41500	149400	107900	2.60
Sole (Ajwain -Tinda)	9700	800	-	2093	63000	314000	251000	3.98
Sole (Fenugreek - Okra)	11800	1250	-	2073	62760	311000	248240	3.96
Sole (Coriander - Green gram)	760	832	-	1187	45760	178000	132240	2.89
Semt	307.0	34.3	1313.7	157.8	-	23669	18729	0.13
CD at 5%	882.4	98.7	3818.9	451.6	-	67762	53620	0.37
CV (%)	8.7	7.2	6.2	7.1	-	7.06	7.15	6.24

CPd-19: Screening of plant growth promoting rhizobacteria for coriander (*Coriandrum sativum* L.) (2011-15)

(B.K. Mishra, Y.K. Sharma, K. Kant, O.P. Aishwath and M.K. Vishal)

A field experiment was conducted for evaluation of selected strain (s) of rhizobacterial inoculants on growth and yield of coriander. For this, a randomized block design experiment was laid out with 11 treatments and 3 replications on a plot size 4x3 m². All the rhizobacterial isolates had positive effect on seedling vigour index when compared to control (Fig. 17). Highest seedling vigour index was recorded for T₈ followed by T₃ and minimum in control.



Fig. 17: Effect of PGPR treatments on coriander seedling vigour index

Effect of PGPR isolates on coriander plant biometrical data was recorded at 30, 60 and 90 DAS. At 30 DAS, observations revealed that treatment T₁₀ has the highest shoot length which was at par with T₃, T₅ and T₇. Shoot

length at 30 DAS ranged from 10.70-14.20 cm. The highest root length was observed with T₅ which was at par with T₂ at 30 DAS and root length varied from 11.91-13.43 cm (Table 3.24).

All the PGPR treatments exhibited early flowering than control. The observations recorded for effect of PGPR on coriander plant biometrical data at 60 and 90 DAS revealed that the shoot length, shoot fresh weight as well as shoot dry weight was maximum with T₈ and the same were recorded minimum under control. However, significant difference was recorded for fresh shoot weight and dry shoot weight at 90 DAS of coriander plants treated with PGPR isolates.

At harvest stage maximum plant height was recorded with T₁ (83.16 cm) which was at par with T₉ (82.96 cm) however highest fresh plant weight of coriander plants was observed with T₉ and lowest fresh weight was recorded with T₁. Number of primary branches /plant (8.33) was highest with T₉ and same were at par with T₂ while number of secondary branches /plant (16.53) were highest with T₂ and same were at par with T₉. The umbels per plant ranged from 21.47-28.8 but there was non-significant difference w.r.t. number of umbellets per umbel among the PGPR treatments and control. There was significant difference in total number of seeds per umbellet and highest seeds per umbellet (8.20) were found with T₂ which was at par with T₉. Coriander seed yield ranged

Table 3.24: Effect of PGPR on coriander plant biometrical data at 30 DAS

Treatments	Shoot length (cm)	Root length (cm)	Fresh shoot weight (g)	Fresh root weight (g)	Dry shoot weight (g)	Dry root weight (g)
Azoto-4 (T ₁)	13.80	12.53	2.46	0.66	0.51	0.05
Azoto-5 (T ₂)	13.57	13.30	2.11	0.62	0.43	0.04
Azoto-7 (T ₃)	14.03	12.36	2.88	0.73	0.45	0.06
Azoto-8 (T ₄)	12.80	12.33	2.58	0.47	0.32	0.04
Azoto-9 (T ₅)	14.13	13.43	3.25	0.54	0.37	0.04
Azoto-10 (T ₆)	13.57	12.50	2.86	0.86	0.44	0.06
King's B-2 (T ₇)	14.20	12.40	3.22	0.79	0.48	0.06
King's B-9 (T ₈)	13.77	12.87	3.04	0.65	0.63	0.03
King's B-15 (T ₉)	13.47	12.73	4.07	0.89	0.96	0.06
PSB-15 (T ₁₀)	14.13	12.57	3.22	0.69	0.45	0.06
Control	10.70	11.91	2.49	0.47	0.11	0.05
SEm	0.28	0.34	0.33	0.14	0.10	0.01
CD (P = 0.05)	0.81	1.00	0.97	0.31	0.28	0.02

Table 3.25 : Effect of PGPR on coriander yield attributing traits and seed yield

Treatments	Primary branches	Secondary branches	Umbels / plant	Umbellets / umbel	Seeds/ umbellet	Seed yield / plant (g)
Azoto-4 (T ₁)	7.73	15.40	25.60	5.80	6.40	10.83
Azoto-5 (T ₂)	8.13	16.53	28.80	5.53	7.13	9.58
Azoto-7 (T ₃)	7.33	14.13	24.27	5.73	8.20	11.55
Azoto-8 (T ₄)	7.73	16.07	27.20	5.47	7.00	11.85
Azoto-9 (T ₅)	7.33	13.67	22.93	5.67	7.93	7.71
Azoto-10 (T ₆)	7.40	14.47	23.47	5.80	7.53	10.98
King's B-2 (T ₇)	7.60	15.80	27.33	5.40	7.40	9.00
King's B-9 (T ₈)	7.47	15.40	24.93	5.67	7.53	12.38
King's B-15 (T ₉)	8.33	16.00	28.13	5.53	8.07	13.38
PSB-15 (T ₁₀)	7.80	15.53	26.13	5.80	7.73	12.21
Control	7.33	12.47	21.47	5.67	6.00	8.25
CD (P=0.05)	0.95	1.24	2.79	N.S.	1.25	4.3

from 8.25-13.38 g/plant and the maximum yield 13.38 g/plant was found with T₉ and the minimum was found with T₅, which was at par with control (Table 3.25).

CPd-20: Isolation and evaluation of phosphate solubilising microorganisms for fennel (*Foeniculum vulgare* L.) (2011-15)

(B. K. Mishra, O. P. Aishwath and S. S. Rathore)

Ten selected PSB isolates were used for seed bacterization using Talc based formulation prepared at microbiology laboratory of NRCSS, Ajmer. These selected PSB isolates were also tested for various biochemical parameters like utilization of different sources of carbon and nitrogen (Table 3.26) along with their potential to grow at different pH, temperature and salinity condition. These experiments were performed by using standard microbiological protocols.

A field experiment was also conducted for screening of these PSB isolates for their effect on growth and yield of fennel plants. Different plant growth parameters were recorded at 30 days intervals since sowing of the treated fennel crop. Standard package of practices like fertilizers, irrigation and pesticides /fungicides were applied in the field as and when required. At 30 DAS, there were no difference w.r.t. shoot length, root length and fresh shoot weight of various PSB treatments in fennel plants except control. However at 60 DAS there were significant difference in growth parameters of PSB treated fennel plants. The maximum shoot length was recorded with T₆ (62.8 cm) which was at par with T₁ and T₃. Maximum root length was recorded with control (21.4 cm) which was at par with T₁ at 60 DAS. Fennel plants fresh shoot weight ranged from 39.5 to 51.1 g/plant and dry shoot weight ranged from 3.5 to 4.9 g/plant. At harvest highest shoot

Table 3.26 : Biochemical screening for carbon source and nitrogenous compounds utilization by PSB isolates

Culture	Glucose	Adonitol	Lactose	Arabinose	Sorbitol	Lysine	Ornithine	Urease	Phenylalanine deamination	Nitrate reduction
PSB-1	+	-	-	+	-	+	+	-	-	+
PSB-3	+	-	-	+	-	-	-	-	-	-
PSB-20	+	-	-	+	+	+	+	+	-	+
PSB-8	+	-	-	+	+	+	+	-	-	-
PSB-10	+	-	-	+	+	+	+	-	-	+
PSB-6	+	-	-	+	+	+	+	-	-	-
PSB-26	+	-	-	+	-	+	+	-	-	+
PSB-36	+	+	+	+	+	+	+	-	-	+
PSB-40	+	-	-	+	-	+	+	-	-	+
PSB-43	+	-	+	+	+	+	+	-	-	-

Where : + = Positive test, - = Negative test

length (205.0 cm) was recorded with T₁ whereas the lowest shoot length was recorded with control (189.9 cm). There was significant difference in number of primary branches, umbels per plant, umbellets per umbel and seeds per umbellet in the fennel plants treated with different PSB isolates in comparison to control. The highest seed yield was recorded with T₈ (29.6 g/plant) which was at par with T₁ (27.4 g/plant) and minimum seed yield was observed with T₂ (20.8 g/plant) followed by control (Table 3.27).

Table 3.27 : Effect of PSB on fennel plant biometrical characters

Treatments	Plant height (cm)	Fresh plant weight (g)	Maturity (DAS)	Seed yield /plant (g)
PSB-1 (T ₁)	205.0	268.4	211.7	27.4
PSB-3 (T ₂)	201.2	219.5	211.7	20.8
PSB-20 (T ₃)	198.4	238.2	211.0	25.0
PSB-8 (T ₄)	200.1	246.8	212.0	26.8
PSB-10 (T ₅)	201.0	278.0	213.7	23.7
PSB-6 (T ₆)	202.3	238.0	211.7	28.1
PSB-26 (T ₇)	199.3	255.8	211.7	27.5
PSB-36 (T ₈)	199.2	289.9	213.3	29.6
PSB-40 (T ₉)	200.3	224.3	213.0	25.4
PSB-43 (T ₁₀)	200.3	264.5	213.7	25.1
Control	189.9	224.9	215.0	22.5
Sem±	6.8	49.8	1.9	0.7
CD (P=0.05)	2.3	16.9	0.6	2.2

CPd-21 Design and Development of Database for Seed Spices

(M. K. Vishal, Gopal Lal, R. K. Kakani, S. N. Saxena, Y. K. Sharma, K. Kant and M. A. Khan)

Databases were updated with latest production, price, export scenario, mandi information, package and practices as well as other relevant dimensions and information of seed spices. In the online database section, the work on development, updating and modification (editing and deleting) module of the seed spices information were done. A domain for the NRCSS, Ajmer being research institute, www.nrcss.res.in was also purchased and information hosted on this domain.



CPd-24: Fertigation scheduling for efficient nutrient and water management in major and minor seed spices (2012-16)

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

Effect of nursery raising methods on seed spices: An experiment comprising of two factors i.e. 4 seed spice crop (fennel, dill, ajwain and celery) in main plot and 4 planting methods in sub plot were conducted under drip fertigation. The results show that, maximum seed yield 2608 kg /ha was recorded in fennel followed by dill (2312 kg/ha) and celery (1247 kg/ha) as compared to lowest in ajwain (901 kg/ha) under drip fertigation (Table 3.28). Among the planting techniques, transplanted crops in all the four spices performed better than the seed sown crop. Among the nursery raising techniques, nursery raised in pro tray followed by transplanting gave maximum seed yield in all the four crops (1966 kg/ha) followed by soil less media (1890 kg/ha), nursery raised in soil (1712 kg/ha) and lowest in direct seed sown crop (1502 kg/ha).

Table 3.28 : Seed yield (kg/ha) of fennel, dill, ajwain and celery as influenced by nursery raising technique with drip fertigation

Treatment Crop	Nursery raising/ sowing method				Mean A
	Pro-tray	Media	In Soil	DSS	
Fennel	2,845	2,678	2,539	2,369	2,608
Dill	2,595	2,546	2,334	1,774	2,312
Celery	1,339	1,286	1,215	1,149	1,247
Ajwain	1,084	1,049	761	712	901
Mean B	1,966	1,890	1,712	1,502	
Factors	CD	SE(d)	Sem±		
Factor(A)	178.6	77.8	55.0		
Factor(B)	163.9	80.5	56.9		
Factor(B)at same level of A	N/A	161.0	110.1		
Factor(A)at same level of B	N/A	159.7	112.9		

Where : DSS(Direct seed sown)



Planting methods in fennel and dill by direct seed sown (DS), transplanted by raising nursery in soil, soil less media (SLM) and pro trays (PT)

Effect of different bed size and planting methods : An experiment comprising of combinations of two bed sizes (75 and 150 cm) and four seed spices (fennel, dill celery and ajwain) in main plot and four sowing/planting methods in sub plot were conducted in split plot design. The maximum yield of fennel, dill, celery and ajwain were recorded at transplanting where by the nursery raised in portrays followed by soil less media and lowest with seed sown crop except in ajwain. The average yield of transplanted fennel, dill, celery and ajwain were 2966.7, 2705.7, 1612.8 and 696.0 kg/ha, respectively (Table 3.29). In Fennel, dill and celery crops, the lowest yield was recorded with the seed sown crop whereas in ajwain it was lowest under transplanted crop where nursery was raised in soil.

Effect of Irrigation methods on seed spices:

An experiment having two irrigation methods (surface and drip irrigation) in main plots and nine seed spice crops (fenugreek, nigella, anise, coriander, ajwain, celery, dill, fennel and cumin) in sub plots was conducted. Maximum seed yield of different crops was recorded under drip fertigation and lowest with surface irrigation (Table 3.30). Among the crops maximum yield was recorded in fennel (2449.5 kg/ha) followed by fenugreek (2316.8 kg/ha), dill (1908.7 kg/ha), coriander (1558.4 kg/ha) and celery (718.7 kg/ha).



Table 3.29 : Effect of bed size, nursery raising technique on yield of seed spices (fennel, dill, ajwain and celery) transplanted under drip fertigation

Sowing method	75 cm bed				150 cm bed			
	Fennel	Dill	Celery	Ajwain	Fennel	Dill	Celery	Ajwain
Nursery raised in pro-tray	3,183.3	3,516.8	1,635.3	643.3	3,033.3	2,645.3	1,850.0	933.3
Nursery raised in soil less media	3,016.8	3,150.0	1,633.3	636.5	2,933.5	2,216.8	1,683.3	690.0
Nursery raised in soil	2,950.0	3,066.8	1,516.8	590.0	2,866.8	2,206.8	1,583.5	663.5
Direct seed sown (DSS)	2,900.0	2,700.0	1,416.8	605.0	2,850.0	2,133.3	1,493.3	806.8
Factors				Sem±	C D			
Factor(A)				27.1	79.8			
Factor(B)				38.4	112.9			
Interaction A x B				54.3	159.7			
Factor(C)				33.1	93.3			
Interaction A x C				46.8	N/A			
Interaction B x C				66.2	186.6			
Interaction AxBxC				93.6	N/A			

Table 3.30 : Seed yield of major and minor seed spices as influenced by irrigation methods

Treatment (Crop)	Drip fertigation	Surface irrigation (Flat bed)	Mean
Fennel	2,893.3	1,805.6	2,349.5
Dill	2,309.2	1,508.3	1,908.7
Coriander	1,786.3	1,330.6	1,558.4
Fenugreek	2,972.5	1,661.1	2,316.8
Celery	933.3	502.8	718.1
Ajwain	720.4	238.9	479.7
Nigella	890.6	419.5	655.0
Anise	595.7	216.7	406.2
Cumin	284.4	183.3	233.9
Factors	CD	Sem±	
Factor (A)	56.9	12.2	
Factor (B)	127.4	44.6	
Factor(B) at same level of A	184.7	36.6	
Factor(A) at same level of B	177.8	60.7	

Sub Project CPd 15.3.2 : Effect of drip irrigation regimes and fertigation levels on growth, yield and quality of coriander (*Coriandrum sativum* L.) and fenugreek (*Trigonella foenum-graecum* L.)

(Honnappa Asangi, Ravindra Singh and Harisha, C. B.)

An experiment comprising of four drip irrigation levels (40, 60, 80 and 100% PE) and three fertigation levels (50, 75 and 100% RDF of NPK) on growth and yield of coriander and fenugreek was laid out in split plot design. The results presented in Table 3.31 revealed that drip irrigation @ 100% PE and 80% PE are at par each other with respect to seed yield (18.5 and 18.0 q/ha respectively). Whereas, fertigation @ 100% RDF recorded highest seed yield

(18.11 q/ha) in coriander. In case interaction effect of irrigation and fertigation, no significant differences were observed even then drip irrigation @ 100% PE combined with fertigation @ 100% RDF recorded highest seed yield(19.4 q/ha) followed by 80% PE combined with fertigation @ 100% RDF with recorded seed yield of 19.03 q/ha.



Effect of different levels of fertigation on fenugreek and coriander under drip irrigation

In fenugreek crop only drip irrigation levels influenced the seed yield significantly but no fertigation effect were recorded. Among the drip irrigation levels highest average seed yield (28.01 q/ha) was recorded from drip irrigation at 100% PE followed by 80% PE (27.14 q/ha). In case of fertigation 100% RDF recorded highest seed yield (26.48 q/ha) but found non significant. Interaction effect was not found significant but highest yield (28.57 q/ha) was obtained from drip irrigation @ 100% PE combined with fertigation @ 100% RDF which was at par with the seed yield (28.33 q/ha) of 100% PE combined with fertigation @ 75% RDF.

Table 3.31 Effect of drip irrigation and fertigation levels on seed yield(q/ha) of coriander and fenugreek

Treatments	Coriander				Fenugreek			
	F1-50%	F2-75%	F3-100%	Mean	F1-50%	F2-75%	F3-100%	Mean
I ₁ -40% PE	13.83	15.07	16.8	15.2	21.66	22.38	22.14	22.06
I ₂ -60% PE	15.26	16.02	17.27	16.2	22.62	26.9	27.61	25.71
I ₃ -80% PE	17.23	17.65	19.03	18.0	26.66	27.14	27.62	27.14
I ₄ -100% PE	18.03	18.21	19.40	18.5	27.14	28.33	28.57	28.01
Mean F	16.08	16.74	18.11		24.52	26.19	26.48	
Factors	CD	SE(d)	SE(m)		CD	SE(d)	SE(m)	
Factor A (Irrigation)	1.91	0.76	0.54		4.02	1.61	1.14	
Factor B (Fertigation)	1.36	0.63	0.45		-	1.15	0.81	
Factor B at same levels of A	-	1.27	0.93		-	2.30	1.97	
Factor A at same levels of B	-	1.29	0.91		-	2.47	1.75	

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

(O. P. Aishwath, R. Singh, B. K. Mishra, R. S. Mehta, P. N. Dubey and Harisha C. B.)

N requirement of coriander on soil test basis: Plant height of coriander increased with each successive levels of N up to 40 kg ha⁻¹ and thereafter each alternative levels of N up to 100 kg ha⁻¹. Primary and secondary branches were more with each alternate higher level of N however, primary branches were also more with control (N₀) as compare to absolute control. Number of umbels per plant increased with each successive levels of N up to 60 kg N ha⁻¹ and thereafter these were more with alternate higher level of N. Moreover, number of umbellate per umbel were more with each successive levels of applied N. Number of seeds per umbellate were recorded more with each treatments as compared to control. Seed and straw yield improved by the application of N with its each alternate successive levels of N. Almost similar trend was followed in the oil yield (kg ha⁻¹) with the application of N levels. However, harvest index was only higher with lower level of N but least with 100 kg N ha⁻¹, which indicates that higher application of N encourages more of foliage than the economic yield. Oil yield and oil content was also improved with applied N and remained at par with 80 and

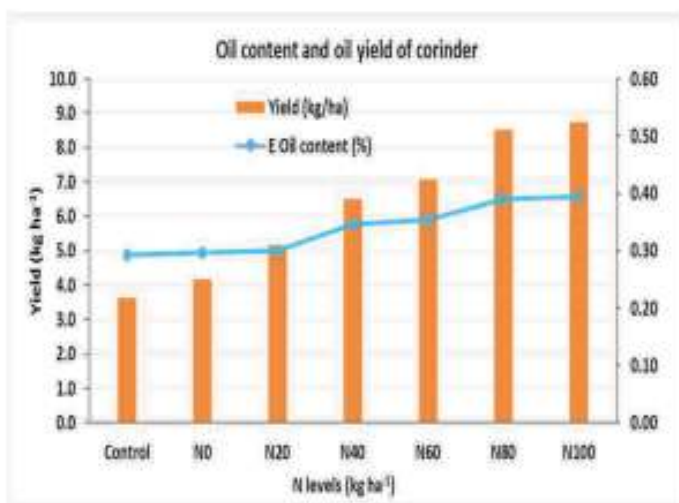


Fig.18 : Oil content and oil yield of coriander with N levels

100 kg N ha⁻¹ (Fig. 18). N and P uptake enhanced with each alternate levels of N up to 100 kg N ha⁻¹ (Table 3.32). Potassium uptake was more with higher levels of N as compared to control and absolute control. Iron, zinc and manganese uptake increased with almost each successive levels of N (up to 80 kg N ha⁻¹). Among the micronutrients, Fe uptake accounted more than any others. Agronomic N use efficiency decreased with increase in N application. Similarly N apparent recovery efficiency also went down from 62% to 38% with higher doses of N application.

Nutrient re-translocation rate was also studied within the plants which indicates that 65-70% N, P and K translocated from lower parts of plants to growing parts at the age of 115 days. Irrespective of treatments, re-translocated part of N accounted 68.1% of its total uptake at 115 days which contributes about 50% uptake at this stage. Re-translocation of P was about 65% which contributes 34% of uptake at 115 days. However, K re-translocation was 66%, which contributes about 65% at 115 days reflecting that uptake of K is maximum at early growth stage of coriander and maybe applied accordingly for higher use efficiency. Average re-translocation rate of K was highest followed by N and P (Fig. 19). Re-translocation rate of K and N was highest in stem 12.2 ng s⁻¹ plant⁻¹ and 7.1 ng s⁻¹ plant⁻¹, respectively.

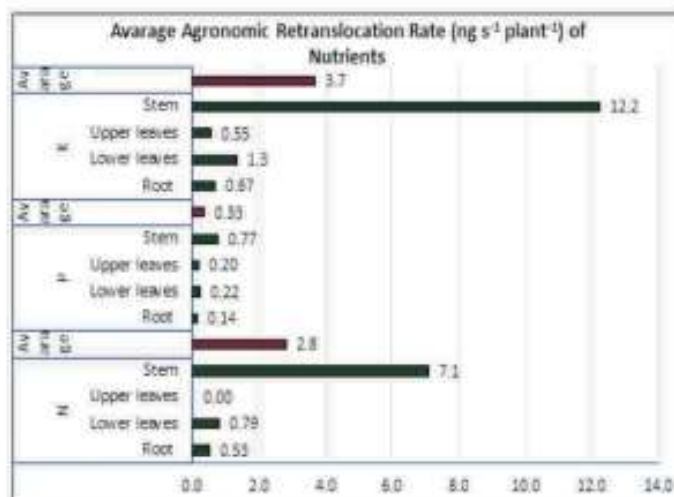


Fig. 19 : Re-translocation rate of nutrients in various plant parts.

Table 3.32 : Macronutrient (kg/ha) and micronutrient uptake (g/ha)

Treatment	N	P	K	Cu	Fe	Mn	Zn
Control	40.7	7.4	41.7	67.5	1165.7	115.0	134.6
N ₃₀	46.1	8.9	51.7	77.8	1237.8	131.3	149.2
N ₆₀	58.6	11.2	66.9	98.7	1631.4	166.9	195.1
N ₉₀	67.3	12.9	79.0	118.4	1957.3	192.9	227.6
N ₁₂₀	73.2	14.0	87.0	150.7	2156.2	207.4	250.0
N ₁₅₀	80.4	15.4	99.2	163.8	2330.6	227.5	270.8
N ₂₀₀	84.5	16.0	103.2	169.9	2373.4	231.1	281.4

P requirement of coriander (ACr-1) on soil test basis:

Application of graded levels of P influenced the plant height (Table 3.33). Primary and secondary branches were also more with applied P. Contrary to N application, stem girth of coriander significantly improved with higher level of P application. Yield parameters like umbel per plant, umbellate per umbel and seeds per umbellate were only higher at higher level of applied P. Seed and stover yield of coriander was also higher at higher level of P. Application of P also improved the oil content. Similar trend was followed by the oil yield with graded levels of applied P. Uptake of N, P and K was not improved with successive levels of P however, these were higher with higher levels of P. Uptake of micronutrients also enhanced with higher doses of P as compare to control whereas, agronomic use efficiency reduced with higher levels of P. The agronomic use efficiency of P was 2-3% of its applied amount. Moreover, physiological use efficiency also decreased and was ranged from 55-60 kg kg⁻¹ of seed. Apparent P

Table 3.33 : Response of coriander to P levels

Treatment	Plant height	No. of primary branch	No. of secondary branch	No. of umbel/plant	No. of umbellate/umbel	No. of seed/umbellate	Seed yield (qha ⁻¹)	Straw yield (qha ⁻¹)
Control	97.0	8.4	18.1	19.7	6.2	10.1	13.8	35.3
P ₀	106.1	9.8	18.6	18.9	6.7	11.2	14.5	53.6
P ₂₀	125.8	10.0	18.9	20.0	5.8	10.3	15.1	53.9
P ₃₀	128.1	10.3	20.1	22.6	5.4	9.7	15.3	54.6
P ₄₀	138.4	10.7	21.8	28.0	5.2	9.4	15.4	55.3
P ₅₀	147.6	11.2	21.7	27.4	6.0	11.8	15.6	56.0
P ₆₀	149.3	11.7	23.2	29.8	6.7	12.9	16.7	57.9
CD at 5%	4.0	0.6	1.6	1.4	0.9	2.2	1.4	4.6

recovery per cent in coriander was lower with higher level of P which ranged from 5-6% with graded levels of P.

Response of coriander with integrated use of manures and fertilizers: Growth and yield of coriander was improved by application of N together with FYM (Table 3.34). However, yield was significantly more only with higher dose of N or in combination of N and FYM. The coriander variety 'ACr-1' was developed with good soil fertility and sufficient supply of fertilizers resultant organic response is poor. Uptake of macro and micronutrients was also more with N and FYM input, however response was only positive with higher doses. Concurrently, essential oil content and yield was also more with higher doses of N and FYM and their combinations.

Table 3.34 : Growth and yield performance of coriander with combined use of N and FYM.

Treatment	Plant height (cm)	No. of secondary branches	No. of umbel/plant	Yield (q/ha)	seed	straw
Control	97.09	13.44	21.44	15.8	44.1	
N30	99.83	15.33	23.33	17.0	46.0	
N60	107.78	15.67	23.67	17.3	46.0	
FYM5	112.87	18.00	26.00	16.1	45.1	
FYM10	117.50	18.78	26.78	16.6	45.6	
FYM5+N30	120.50	18.56	28.56	17.5	47.5	
FYM5+N60	126.87	19.00	29.00	17.8	48.7	
FYM10+N30	138.98	22.11	32.11	18.3	48.9	
FYM10+N60	142.54	22.44	32.44	18.9	50.0	
CD at 5%	3.92	1.72	1.72	1.6	3.1	

CPd-26: Evaluation of seed spices for edaphic stress (2012-17)

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

Influence of sodic water on coriander and fennel: Application of sodic water marginally improved the growth and yield of fennel (Table 3.35). However, significant reduction took place only after RSC-12. Though the primary branches and seed per umbellate were more at RSC-12 and 14, respectively, which were at par with other levels of RSC. Contrary to this, pH and EC of soil was enhanced by application of graded levels of sodic water (Fig. 20). Above the RSC-4 EC of soil did not enhance significantly at higher levels except RSC-16.

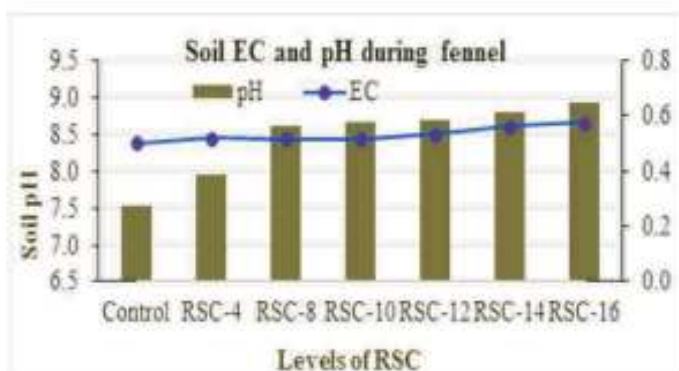


Fig. 20 : Effect of sodic water on soil EC & pH

Table 3.35 : Growth and yield of fennel with sodic water

Treatments	Plant height (cm)	Primary branches / plant	Secondary branches / plant	Umbels / plant	Umbellate / umbel	Seed/ umbellate	Yield/pot (g)	
							Seed	Straw
Control	92.1	5.2	5.3	12.4	12.0	14.3	12.7	45.7
RSC-4	92.1	5.2	5.6	12.5	12.3	14.3	13.0	46.3
RSC-8	92.6	5.2	5.9	12.6	15.8	15.0	14.8	51.8
RSC-10	93.7	5.3	6.1	12.8	16.3	14.9	15.5	55.3
RSC-12	104.4	5.4	6.7	13.2	14.1	15.2	14.3	51.9
RSC-14	82.2	5.1	4.4	10.6	15.2	15.3	11.6	41.0
RSC-16	77.4	4.8	4.3	10.3	16.4	15.1	11.5	40.8
CD at 5%	8.2	NS	1.2	2.9	4.0	NS	1.4	2.9

Effect of soil compaction on performance of fennel: In experiment carried out with various levels of soil compaction to assess the performance of fennel. Adverse effect of compaction on growth and yield of fennel was observed (Table 3.36). However, negative drastic change recorded beyond the p_c 1.75 cm^{-3} . This crop can withstand higher compaction as compared to coriander and cumin. The ability to come up well with higher compaction is a positive signal to cope up against chemical compaction induced by sodicity.

Effect of soil temperature on performance of coriander: Soil temperature play a significant role for the growth and yield of coriander and T_3 seems most optimum for seed and stover yields. Oil content was also more with this treatment, concomitantly oil yield was also more. Higher and lower temperature also had adverse effect on root-shoot parameters. Adverse effect of higher temperature was more pronounced than the lower temperature. Growth, yield and quality was the highest, when average maximum temperature at early growth stage $> 28.2^\circ C$ and middle stage was $> 22.8^\circ C$. Following nutrients will be the limiting factor for coriander with rise in temperature in order of macronutrients $N>P>K$ and micronutrients $Fe>Zn>Mn>Cu$. Rise in temperature of $1^\circ C$ is more devastating than lowering down of temperature of $7-8^\circ C$ from its optimum level. Rise in temperature of about $1.0^\circ C$ at the $26^\circ 30'$ latitude, the reduction in seed yield was $> 40.0\%$ and was oil yield $> 50\%$.

Table 3.36 : Performance of fennel with soil compaction

Soil compaction BD (\pm 0.01)	Plant height (cm)	Primary branches/plant	Umbels/plant	Umbellates/umbel	Seeds/umbellate	Seed yield (g/pot)	Straw yield (g/pot)
1.25	86.2	5.2	14.5	13.8	15.6	12.7	47.4
1.35	87.3	5.2	14.6	13.9	15.8	12.4	45.5
1.45	77.8	5.1	14.4	13.3	15.4	12.2	44.8
1.55	73.0	5.1	14.8	14.1	16.1	12.1	44.5
1.65	70.4	5.1	15.8	15.1	14.5	11.6	42.5
1.75	58.0	4.4	15.2	12.7	14.0	7.9	29.0
1.79	50.3	4.4	13.1	13.4	14.0	7.7	28.4
CD at 5%	4.0	NS	0.8	2.5	1.4	1.0	3.8

Influence of soil porosity and irrigation methods on yield of cumin: A field experiment carried out to improve the soil porosity in interaction with methods of irrigation and its impact on cumin was observed. Methods of irrigation and soil porosity significantly influenced the yield of cumin. Cumin plant growth was fettle and yield was more with more porosity along with optimum water supply by any means (drip, sprinkler or surface irrigation).

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

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

Five coriander cultivars (JSS-R-50, JBT-38/94, Ajmer Green, IC-771744 and ACr-1) were sown under green shade net (50%) considering Acr-1 as check in RBD and screened for green leaf production during off season.

Performance of coriander lines: Ajmer Green Coriander-1 (AGCr-1) took minimum time for germination initiation (7.33 days), germination completion (10.67 days) with maximum plant height (25.29 cm) at harvest. Flower initiation was very late (53.33 DAS) in (AGCr-1) in the summer season, which is a most desirable character for leafy type cultivars, however JBT-38/94 flowered in only 35.33 DAS and ACR-1 (check) flowered only in 41.67 DAS. Similarly, 50% flowering was also recorded after 64.00 DAS in AGCr-1 as compared to JBT-38/94 (45.33 DAS) and ACR-1 (50.00 DAS). With respect to leafy characters it is inferred that AGCr-1 exhibited longest first leaf (19.57 cm), second leaf (18.22 cm) with maximum number of basal leaves per plant (12.93), longest basal leaf (21.01 cm) and number of leaf lets per plant (7.87). The crop was harvested at 47 DAS (JBT-38/94) and at 51

DAS (Check, ACr-1), however AGCr-1 was harvested after 66 DAS due to delayed 50% flowering. It is further stated that AGCr-1 exhibited maximum yield (2834.81 kg/ha) of green leaves as compared to check (ACr-1, 2246.67 kg/ha). Minimum PDI (5.87%) with respect to powdery mildew was also recorded in AGCr-1 as compared to maximum PDI (47.96%) in ACr-1 (check).



Off season production of different coriander varieties under shade net covered walk in tunnels

Standardization of POP for AGCr-1 cultivar : Cultivar AGCr-1 was sown at five different dates (09, 16, 23, 30 April and 07 May, 2015) to study the influence of dates of sowing on the performance of the herbage production of the cultivar. Best yield (2568.15 kg/ha) was recorded in the crop sown on 16 April, 2015 as compared to lowest 1342.22 kg/ha green leaf in the crop sown on 7 May 2015. Under crop geometry and fertilizer experiments the cultivar AGCr-1 was sown at three planting geometry (25 x 10 cm, 25 x 7.5 cm and 25 x 5.0 cm) with three fertilizer doses (40:25:20, 50:35:25 and 60:45:30 kg NPK/ha). The performance of crop with respect to almost all the characters was recorded best in G₁F₁ (25 x 5.0 cm spacing and 60:45:30 kg NPK/ha) treatment combination with maximum yield (3505.93 kg/ha) of green leaf.

Performance of fenugreek lines: An experiment on the evaluation of fenugreek varieties for green leaf production under off (summer) season was carried out including 05 varieties in RBD considering Hisar Sonali as check. In AFG-5, the seed germination was initiated after 2.33 DAS and completed after 3.33 DAS as compared to 2.33 and 4.67, respectively in Hisar Sonali (Check). Maximum plant height (31.77 cm) at harvest was exhibited by AFG-5 as compared to minimum (23.77 cm) in AFG-4. AFG-5 is a late flowering line and bolting was initiated at 36.33 DAS and 50% flowering was recorded at 46.67 DAS as compared to earliest bolting initiation (27.33 DAS) and 50% flowering (33.67 DAS) in AFG-3. Check (Hisar Sonali) exhibited bolting initiation at 33.00 DAS and 50% flowering at 40.33 DAS. The crop harvesting was started for green leaf yield from 35 DAS, however AFG-5 was harvested after 49 DAS due late in 50% flowering. Highest green leaf yield (2337.04 kg/ha) with maximum number of branches (5.95/plant) and minimum number of flowers (4.10/plant) were recorded in AFG-5 cultivar. Results further revealed that minimum PDI for powdery mildew (9.3%) was recorded in AFG-5 cultivar as compared to maximum (14.70%) in AFG-6 and 14.30% in Hisar Sonali (check).

Standardization of POP for AFG-5 fenugreek for green leaf production : Under date of sowing experiment for AFG-5, results revealed that the performance of this cultivar was good if sown up to third week of April. The crop geometry and fertilizer application experiment revealed that the performance of crop was best if sown at 25 x 5.0 cm crop geometry with 30:20:20 kg/ha NPK application.

Temperature and relative humidity: Weekly mean minimum temperature range was recorded from 14.0 °C to 27.0 °C and mean maximum from 25.0 °C to 40.0 °C under green shade. Similarly weekly mean morning humidity under green shade nets ranged from 66.0% to 89.0% and evening RH from 42.0% to 78.0%.

CPd/13.7.1: Standardization of economical intercropping system of seed spices with vegetables (2013-15)

(R.S. Mehta, S.S. Meena, R. Singh, Harisha C.B., S.P. Maheria)

Two field experiments on intercropping of fennel and dill with five vegetables (Cabbage, knolkhol, lettuce, french-



bean and fenugreek with fennel and cabbage, knolkhol, beetroot, french-bean, and fenugreek with dill) in three intercropping ratio of 1:1, 1:2 and 2:2 were conducted with three replications in randomized block design with low pressure drip irrigation system. Two crops of knolkhol were taken within 80 days after sowing of base crop but only one crop of other vegetables were taken. Intercropping of fennel with knolkhol in all the three ratio resulted at par fennel equivalent yield, however, intercropping of fennel with knolkhol in 1:2 ratio exhibited the highest fennel equivalent yield (4186 kg/ha), net return (Rs.160050/ ha) and BCR (3.25) followed by 1:1 intercropping ratio but higher land equivalent ratio was obtained with intercropping of fennel or dill with leguminous vegetables like french-bean and fenugreek in all the intercropping ratio (Table 3.37). Intercropping of fennel with knolkhol in 1:2 and 2:2 ratio produced 70 and 56 percent higher fennel equivalent yield, respectively over sole fennel. Similarly, the highest dill equivalent yield (4843 kg /ha), net return (Rs.124879/ha) and BCR (2.80) was obtained in intercropping of dill and knolkhol in 1:2 ratio which was at par with 1:1 inter-cropping ratio of dill + cabbage (Table 3.38). Dill + knolkhol in 1:2 ratio and dill + knolkhol in 1:1 ratio produced 136 and 121 percent higher dill equivalent yield, respectively over sole dill crop (Table 3.38).



Table 3.37 : Effect of fennel based intercropping systems on yield of fennel, vegetables, returns and B : C ratio

Treatment	Fennel yield (kg/ha)	Vegetable yield (kg/ha)	Fennel equivalent yield (kg/ha)	Land equivalent ratio	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Sole fennel	2450	0.0	2450	1.0	36480	122500	86020	2.36
Sole cabbage	0	14750	2950	1.0	43250	147500	104250	2.41
Sole knolkhol	0	15250	3050	1.0	47240	152500	105260	2.23
Sole lettuce	0	2588	1294	1.0	41240	64688	23448	0.57
Sole french-bean	0	954	1145	1.0	33230	57240	24010	0.72
Sole fenugreek	0	6863	1373	1.0	28250	68625	40375	1.43
Fennel+ Cabbage (1:1)	1955	9313	3817	1.43	46750	190859	144109	3.08
Fennel+ Cabbage (2:2)	2083	8245	3732	1.41	46750	186604	139854	2.99
Fennel+ Cabbage (1:2)	1627	10037	3634	1.34	46750	181720	134970	2.89
Fennel+ Knolkhol(1:1)	2050	9513	3953	1.46	49250	197625	148375	3.01
Fennel+ Knolkhol (2:2)	2116	8575	3831	1.43	49250	191570	142320	2.88
Fennel+ Knolkhol(1:2)	2011	10875	4186	1.53	49250	209300	160050	3.25
Fennel+ Lettuce (1:1)	1961	1288	2605	1.30	43350	130273	86923	2.01
Fennel+ Lettuce(2:2)	1983	1152	2559	1.25	43350	127967	84617	1.95
Fennel+ Lettuce (1:2)	1845	1325	2508	1.27	43350	125378	82028	1.89
fennel+ French-bean(1:1)	2115	750	3015	1.65	42350	150750	108400	2.56
Fennel+ French-bean(2:2)	2175	675	2985	1.60	42350	149250	106900	2.52
Fennel+ French-bean(1:2)	1872	844	2885	1.65	42350	144232	101882	2.41
Fennel+ Fenugreek (1:1)	2055	5260	3107	1.61	41240	155350	114110	2.77
Fennel+ Fenugreek (2:2)	2120	4890	3098	1.58	41240	154918	113678	2.76
Fennel+ Fenugreek (1:2)	1811	5725	2956	1.57	41240	147797	106557	2.58
SEm±	78	291	128	0.06	-	6402	4614	0.04
CD(P=0.05)	227	834	365	0.16	-	18299	13188	0.11

Table 3.38 : Effect of dill based intercropping systems on yield of dill, vegetables, dill equivalent yield, returns and B : C ratio

Treatment	Dill yield (kg/ha)	Vegetable yield (kg/ha)	Dill equivalent yield (kg/ha)	Land equivalent ratio	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Sole dill	2045	0	2045	1.00	33450.0	71575	38125	1.14
Sole cabbage	0	13500	3857	1.00	43275.0	134995	91720	2.12
Sole Knolkhol	0	14450	4129	1.00	46240.0	144500	98260	2.13
Sole Beetroot	0	7565	3242	1.00	37460.0	113475	76015	2.03
Sole French-bean	0	883	1514	1.00	33230.0	53000	19770	0.59
Sole fenugreek	0	6525	1864	1.00	33240.0	65250	32010	0.96
Dill +Cabbage(1:1)	1672	9245	4314	1.50	43240.0	150977	107737	2.49
Dill +Cabbage(2:2)	1762	8420	4168	1.49	43240.0	145869	102629	2.37
Dill +Cabbage(1:2)	1575	9425	4268	1.47	43240.0	149375	106135	2.45
Dill +Knolkhol(1:1)	1725	9825	4532	1.52	44630.0	158625	113995	2.55
Dill +Knolkhol(2:2)	1880	8624	4344	1.52	44630.0	152040	107410	2.41
Dill +Knolkhol(1:2)	1750	10825	4843	1.61	44630.0	169509	124879	2.80
Dill + Beetroot (1:1)	1775	4325	3629	1.44	39570.0	127000	87430	2.21
Dill +Beetroot(2:2)	1810	4025	3535	1.42	39570.0	123725	84155	2.13
Dill+Beetroot(1:2)	1680	4745	3714	1.45	39570.0	129975	90405	2.28
Dill +French-bean(1:1)	1825	650	2939	1.63	38540.0	102875	64335	1.67
Dill +French-bean(2:2)	1891	600	2919	1.60	38540.0	102172	63632	1.65
Dill +French-bean(1:2)	1785	728	3033	1.70	38540.0	106155	67615	1.75
Dill+Fenugreek(1:1)	1835	5060	3281	1.67	37540.0	114825	77285	2.06
Dill+Fenugreek(2:2)	1940	4553	3241	1.65	37540.0	113430	75890	2.02
Dill+fenugreek(1:2)	1710	5462	3271	1.67	37540.0	114470	76930	2.05
SEm±	70	288	151	0.06	-	5299	3629	0.09
CD(P=0.05)	203	826	433	0.17	-	15147	10373	0.25

CPd/13.10.1: Effect of non-edible oil cakes on coriander and cumin growth and yield (2013-15)

(R.S. Mehta, G.Lal, R. Singh, O. P. Aishwath, B.K. Mishra, S. S. Meena, S. S. Rathore, R. D. Meena and H. Asangi)

Field experiments on effect of non-edible cake on yield, quality and disease incidence in cumin and coriander comprising of twelve treatments (100 % RDN through castor cake, 100% RDN through neem cake, 100% RDN through Jatropha cake, 100% RDN through castor cake+ castor cake ash, 100% RDN through neem cake + Castor cake ash, 100% RDN through Jatropha cake+ castor cake ash, 75% RDN through castor cake + Bio-fertilizers, 75% RDN through Neem cake + bio-fertilizers, 75% RDN through Jatropha cake + bio fertilizer, RDF, control (absolute control) were conducted with three replications in randomized block design. Application of 100 % RDN by castor cake with castor cake ash exhibited better growth parameters viz. plant height and number of leaves per plant at 45 and 75 DAS in cumin which are comparable to RDF (Table 3.39). *Alternaria blight* diseases severity measured in terms of PDI was recorded lowest (52.50) with application of 100 % RDN through castor cake.

Table 3.39 : Effect of non-edible oil cakes on yield attributes and yields of coriander

Treatments	No. of umbels /plant	No. of umbellates /umbel	No. of seeds/ umbellate	Test weight (g)	Seed yield (kg/ha)	Disease severity (PDI)%
100 % RDN by CC	41.47	5.73	11.60	8.87	1341	20.0
100% RDN by NC	40.67	4.93	11.33	8.44	1148	17.0
100% RDN by JC	40.53	5.33	11.80	8.47	1170	29.0
100% RDN by CC+ CCA	42.33	5.82	12.80	8.52	1451	11.0
100% RDN by NC+CCA	40.07	4.80	11.20	8.67	1204	31.0
100% RDN by JC+CCA	41.93	5.47	12.07	8.22	1215	11.0
75% RDN by CC + BF	41.60	4.87	12.27	8.81	1341	18.0
75% RDN by NC + BF	40.87	4.25	10.87	8.99	1052	24.0
75% RDN by JC+ BF	41.00	5.07	11.53	8.85	1154	21.0
Control	39.60	4.17	10.67	8.84	1093	38.0
Absolute control	34.47	4.25	8.27	8.22	915	32.1
RDF	40.20	4.93	11.87	8.71	1333	18.2
SEM±	1.44	0.18	0.41	0.31	44	0.91
CD (P= 0.05)	4.24	0.53	1.20	NS	128	1.98

In coriander application of 100% RDN through castor cake with castor cake ash and RDF resulted significantly higher growth parameters viz. plant height and number of leaves /plant at 45, 75 DAS and yield attributes. The lowest powdery mildew disease severity was recorded with application of 100% RDN through castor cake with castor cake ash.

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

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

The experiment was conducted to study the effect of micronutrients (iron, manganese, zinc, copper and boron) on growth and yield of fennel and cumin. The results revealed significant differences in growth, yield and yield attributing characters of fennel (Fig. 21). The highest plant height in fennel (10.5cm) at 45 DAS in seed priming was recorded with manganese 500 ppm. At 90 DAS, foliar application of FeSO₄ @ 0.5% recorded the maximum plant height (86.2 cm) and soil application of iron @ 10 kg per hectare recorded highest plant height (227.7 cm) at harvest. The total dry matter accumulation in fennel (13.39 t/ha) and seed yield (23.8 q ha⁻¹) was recorded with soil application of iron @ 10 kg per hectare followed by seed priming with Mn @ 500 ppm (21.9 q/ha) and foliar application of ZnSO₄ @ 0.5% (21.7 q/ha). Essential oil content in the seeds was not found significant in fennel. An average removal of micronutrients namely Fe, Mn, Cu, Zn and B by fennel crop were 1982.6, 1465.7, 333.8, 443.3 and 336.6 g/ha, respectively. In case of cumin, application of micronutrients has shown no significant results in terms of growth and seed yield (Fig. 22). However average micronutrient uptake by cumin crop was Fe-439.8 g/ha, Mn-201.8 g/ha, Cu-107.6 g/ha, Zn-22.2 g/ha and B-37.4 g/ha.

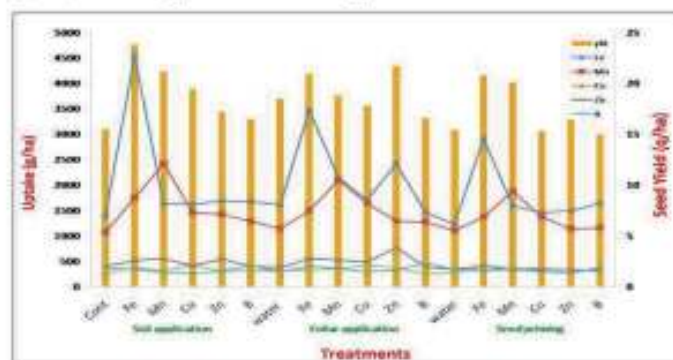


Fig. 21: Effect of various micronutrients on seed yield and nutrient uptake in fennel

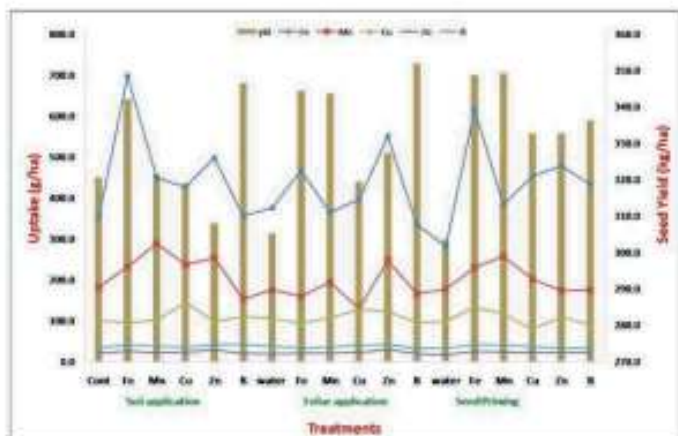


Fig. 22: Effect of various micronutrients on seed yield and nutrient uptake in cumin

Project 4 (CPT): 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 (2012-15)

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

Field surveys were conducted and the districts covered were Ajmer, Nagaur, Jodhpur, Jaisalmer, Kota, Baran, Pratapgarh, Udaipur, Tonk and Sawai Madhopur districts in Rajasthan; Mandsaur & Nimach districts in Madhya Pradesh and Banaskantha & Sabarkantha districts in Gujrat. In all 58 cumin fields at 18 locations in 6 districts, 18 coriander fields at 4 locations in 3 district, 22 fennel fields at 14 locations in 5 districts were surveyed. The disease severity range varied from field to field and cumin blight (0-46%), cumin yellowing (0-25%), wilt (3-12%), powdery mildew (0-4%), in coriander stem gall (0-90%), wilt (0-6%), powdery mildew (0-18%) whereas in fenugreek powdery mildew (0-70%), downy mildew (0-40%) and in fennel *Ramularia blight* (0-4%) were prevalent in major growing areas. During survey three cumin *Alternaria blight* isolates were also collected and maintained.

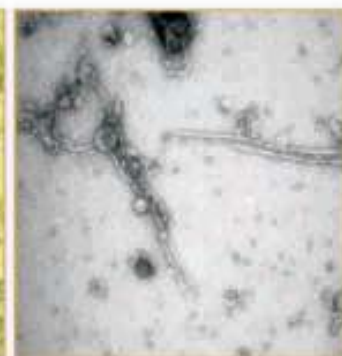
Four seed spice crops, viz. cumin (RZ-209), coriander (Ajmer Coriander-1), fenugreek (Ajmer Fenugreek-1) and fennel (AF-1) were raised at institute farm. Appearance and spread of different diseases were observed at weekly interval. In cumin, wilt disease was observed from early

to later crop stage. Rainfall during January – February seems to be the key component in initiation and development of powdery mildew and blight diseases with other climatic factors.

Cumin yellowing- A new disease of cumin : In cumin, some plants exhibited the yellowing which leads to no seed formation or very weak, vigourless seeds. Fresh yellowing cumin plant samples were tested at Indian Agricultural Research Institute (IARI), New Delhi in 2014 and confirmed again during 2015. The causal agent of the disease was detected to be a member (*Vanilla distortion mosaic virus* (VDMV) of family Potyviridae. *Sclerotium rot* disease reported first time in Ajmer, Rajasthan on coriander and the disease is caused by a fungus *Sclerotium sclerotiorum* (imperfect fungi).



Yellowing symptoms on cumin



Virus associated with cumin Yellowing disease

Root decaying- A new disease of coriander, fennel and nigella: During the disease surveillance at the institute fields, some plants of coriander, fennel and nigella were found light yellow in color and weak. On critical observation of these plant roots under microscope, nematodes were seen. For confirmation of associated nematodes the healthy and infected samples were sent at MPUAT, Udaipur (Rajasthan). Plant parasitic nematodes (*Hoplolaimus* spp. and *Tylenchorhynchus* spp.) were confirmed. The pathogenic nematodes found associated and caused root decaying disease at advance crop stage. If not treated the nematode causes withering and wilting of whole plants.

CPT-3: Survey & surveillance of insect pests in seed spices (2012-15)

(K. Kant, N.K. Meena, M.K. Vishal and S.R. Meena)

Survey of insect pests, natural enemies and pollinators on seed spice crops was conducted at Institute farm as well as major growing areas of Rajasthan and Gujarat. The majority of insect pests associated with seed spices and responsible for crop loss were sucking pests. Among sucking pests aphids and thrips contribute major population, beside it white fly, jassids, Nysus bug, Cletus bug were also important pests recorded on these crops. (Table 3.40) Sucking pests colonization on crop was noticed with lower population than previous year. Late migration of aphid and rain during the crop contributed lower pest/natural enemies development. Various phytophagous and predatory thrips species of different

Table 3.40 : Thrips species associated with various seed spice crops

Crop	Phytophagous Thrips Species	Predatory Thrips sp.
Cumin (<i>Cuminum cyminum</i> L.)	<i>Frankliniella schultzei</i> <i>Scirtothrips dorsalis</i> <i>Anaphothrips sudanensis</i>	<i>Aeolothrips</i> sp. <i>Haplothrips</i> sp.
Coriander (<i>Coriandrum sativum</i> L.)	<i>Thrips tabaci</i> <i>Frankliniella schultzei</i> <i>Scirtothrips dorsalis</i>	<i>Aeolothrips</i> sp.
Fennel (<i>Foeniculum vulgare</i> Mill)	<i>Scirtothrips dorsalis</i> <i>Thrips tabaci</i> <i>Frankliniella schultzei</i>	
Fenugreek (<i>Trigonella foenum-graecum</i>)	<i>Thrips tabaci</i> <i>Frankliniella schultzei</i>	<i>Aeolothrips</i> sp.
Dill (<i>Anethum graveolens</i> L.)	<i>Frankliniella schultzei</i> <i>Thrips tabaci</i> <i>Caliothrips indicus</i>	
Celery (<i>Apium graveolens</i> L.)	<i>Frankliniella schultzei</i> <i>Thrips tabaci</i> <i>Caliothrips indicus</i>	
Nigella (<i>Nigella sativa</i> L.)	<i>Scirtothrips dorsalis</i>	<i>Aeolothrips</i> sp. <i>Haplothrips</i> sp.
Anise (<i>Pimpinella anisum</i> L.)	<i>Frankliniella schultzei</i> <i>Thrips tabaci</i> <i>Scirtothrips dorsalis</i>	<i>Aeolothrips</i> sp. <i>Haplothrips</i> sp.
Ajwain (<i>Trachyspermum ammi</i> Sprague)	<i>Thrips tabaci</i>	<i>Aeolothrips</i> sp.

seed spice crop have been identified. Other important insect pests recorded were Seed wasp (*Systole albipennis*) in the crop of coriander and fennel. Among natural enemies complex predators coccinellids, syrphid fly and *Chrysoperla carnea* develop at flowering/full vegetative growth of the plant. Parasitoids *Aphidius* sp. was recorded as important parasitoides of aphids and *Oomyzus galerucae* (Fonscolombe) & *Aprostocetus* sp. (Eulophidae: Hymenoptera) of seed wasp recorded on the crops of coriander and fennel. Wild honey bee *Apis florea* and *Apis dorsata* were found as most important pollinators of all seed spice crops. Nematodes population were recorded from cumin roots causing damage to the crop from all growing areas.

Phytophagous Thrips



Frankliniella schultzei



Scirtothrips dorsalis

Predatory thrips



Aeolothrips sp.

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

(Y.K. Sharma, R.D. Meena, R. K. Solanki and R. K. Kakani)

Field experiments conducted for evaluation of cultural practices, foliar application of selected fungicides and plant extracts against fenugreek leaf blight revealed that planting of fenugreek in 1st week of November and foliage trimming at 45 and 60 DAS reduced the leaf blight and downy mildew diseases with higher seed and foliage yield. Foliar application of chlorothalonil, copper oxychloride and hexaconazole found most effective against *Alternaria* leaf blight, downy mildew and powdery mildew diseases of fenugreek, respectively. Among organic treatments, foliar application of neem oil and garlic extract reduced the fenugreek diseases (*Alternaria* leaf blight, downy mildew and powdery mildew) with higher seed yield.

Experiments conducted for the management of cumin diseases using seed treatment and soil application of selected chemicals and soil amendments indicated that seed treatment with *Trichoderma* and soil application

with *Trichoderma* + castor cake reduced the wilt/root rot incidence of cumin. The same treatments along with foliar spray of chlorothalonil followed by two sprays of propiconazole and picoxystrobin also reduced *Alternaria* blight of cumin by 76.6% over untreated control. Seed treatment with *Trichoderma*, soil application with castor cake and foliar spray with chlorothalonil followed by two sprays of difenoconazole and azoxystrobin was found most effective for the management of *Alternaria* blight of cumin.

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

(N.K. Meena, K.Kant, G. Lal, S. N. Saxena, S. Choudhary and M. A. Khan)

Relative efficacy of botanicals and bio-pesticides against aphid on coriander: In field experiment, twelve treatments (leaf extract of *Capparis decidua*, *Withania somnifera*, *Pongamia pinnata*, *Datura stramonium*, *Parthenium hysterophorus*, *Lantana camera*, *Ricinus communis*, *Annona squamosa* and fruit juice of *Citrullus colocynthis*, *Allium sativum*, cow urine and control) were evaluated for their relative bio-efficacy against aphid on coriander. The results showed that all treatments were found significantly superior over untreated control in reduction of aphid population. Whereas, the maximum percent reduction (70.10%) in aphid population was recorded on the plants treated with organic salt (bio-pesticide) @ 5ml/litre, followed by ker extract 10ml/litre and tumba fruit extract 10 ml/litre, which reduced 68.96 and 68.32% aphid population, respectively. Custard apple leaf extract (10ml/litre) was found least effective (44.60% reduction) followed by castor leaf extract (10 ml/litre) and Ashwagandha extract (10 ml/litre) against aphid. The remaining treatments were found moderately effective against aphid on coriander under field conditions.

Screening of different varieties of coriander against aphid under field conditions: A field experiment was conducted at NRCSS, Ajmer to screen twelve varieties of coriander against aphid under field conditions. The twelve varieties viz., Rajendra Swati, ACr-1, Gujarat Coriander-1, RCr-41, Pant Haritma, RCr-684, Sadhana, Swati, RCr-446, Sindhu, Gujarat Coriander-2 and RCr-436 were sown in

randomized block design and each treatment replicated three times. Results showed that, the infestation of aphids started in the month of December on all tested varieties. Initially aphid population was very low on all varieties and then gradually increased and reached to highest during second fortnight of January and again decreased gradually. The minimum aphid infestation was recorded on the variety Rajasthan Coriander-684 (23.66 aphid/plant) followed by ACr-1 (24.20 aphid/plant), whereas, maximum infestation was observed on variety Swati followed by Sadhna.

CPT/13.17.1: Impact of pollinators on yield and quality of coriander, fennel, ajwain & dill (2013-17)

(N.K. Meena, K. Kant, R. D. Meena, R. K. Solanki and S. S. Rathore)

Impact of insect pollinators on yield and quality of coriander: A field experiment was conducted to see the impact of insect pollinators on yield and quality of coriander. It was designed under cages (measuring 5x4x2.17 meters, length x width x height) made of GI pipes covered with insect proof nylon nets 40 mesh for bee pollination as well as without bee pollination. Results showed that, the coriander flowers were visited by 28 floral visitors of different orders and families during entire flowering period. Among these floral visitors, maximum population was noticed from Hymenoptera (10 species) followed by Diptera (7 species), Hemiptera (2 species), Coleoptera (4 species), Neuroptera (1 species) and Lepidoptera (4 species) on the crop. Honeybee species (*Apis florea*, *A. mellifera* and *A. dorsata*) were the most prominent pollinators of coriander followed by *Episyrphus balteatus*. The visit of these floral visitors started at morning by 08.00 hr with scanty in population, which gradually increased and reached to its maximum between 12.00-14.00 hr. The populations of prominent floral visitors ranged from 5.2 to 23.0 bees m², where, *Apis florea* (23.10 bees m²), *A. mellifera* (17.0 bees m²) and *A. dorsata* (7.19 bees m²) were recorded during peak hours. After that, the activity of all pollinators decreased subsequently and became negligible at 18.00 hr. The average foraging rate was higher in *A. mellifera* (5.0) than *A. dorsata* (3.92) and *A. florea* (2.91).

The highest yield of 2176.2 kg/ha was recorded from the plots caged with *A. mellifera* colony for bee pollination and which was 140.3% higher than control (without bee pollination (caged), where lowest yield 905.3 kg/ha was obtained. Highest average test weight 8.57 g was achieved in bee pollinated seeds, whereas, 7.92 g was recorded in control plots.

Impact of insect pollinators on yield and quality of fennel: An experiment was conducted on fennel crop, where 25 insect species (belonging to different orders and families) visited the flowers during entire flowering period. Among these insect visitors, Hymenoptera (7 species), Diptera (7 species), Hemiptera (3 species), Coleoptera (3 species), Neuroptera (1 species) and Lepidoptera (4 species) were noticed on crop. In fennel also, honeybees (*Apis florea*, *A. mellifera* and *A. dorsata*) were the most prominent pollinators during cropping season. The specimen of insect pollinators were collected by insect collecting net and preserved for identification and documentation. Foraging behaviour and abundance of eight most numerically abundant and important floral visitors (*Apis dorsata* F., *Apis florea* F., *Apis mellifera*, unidentified hymenoptera species-1, *Episyrphus balteatus*, *Ceratina sexmaculata*, *Eristalis* sp. 1 and *Musca* sp.1) were recorded. Activities of these pollinators started at 8.00 hr with lesser population, which increased gradually with the advancement of temperature and sunlight and reached to maximum (*Apis florea* 23.66 bee m², *A. mellifera* 17.13 bee m² and *A. dorsata* 8.10 bees m²) between 12.00 hr to 14.00 hr. Lates on the pollinator's population declined gradually and became negligible at 18.00 hr.

The highest yield 2130.65 kg/ha was recorded from the plots caged with *A. mellifera* colony for bee pollination, which was 183.7% higher than control (without bee pollination-caged), where, the lowest yield of 750.85 kg/ha was obtained. Test weight of bee pollinated seeds of fennel variety AF-1 was recorded 8.012/g, whereas lowest 7.05 g in control.

Management of honeybee (*Apis mellifera*) colonies: Colonies of *Apis mellifera* were managed by providing required necessary facilities round the year particularly summer season through regular monitoring and sanitation. Also provided shelter and suitable shading

during peak summer and artificial feeding (sugar syrup, manmade supplementary feeding etc.) as and when required.

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

BS-6: Quality profiling of coriander and fenugreek germplasm (2011-15)

(S.S. Rathore, S.N. Saxena and R. K. Kakani)

A data base on quality of fenugreek according to proximate analysis (Fig. 23 and 24) and medicinal compounds has been developed. Studied genotypes showed variation in ash percentage. Fenugreek oil has

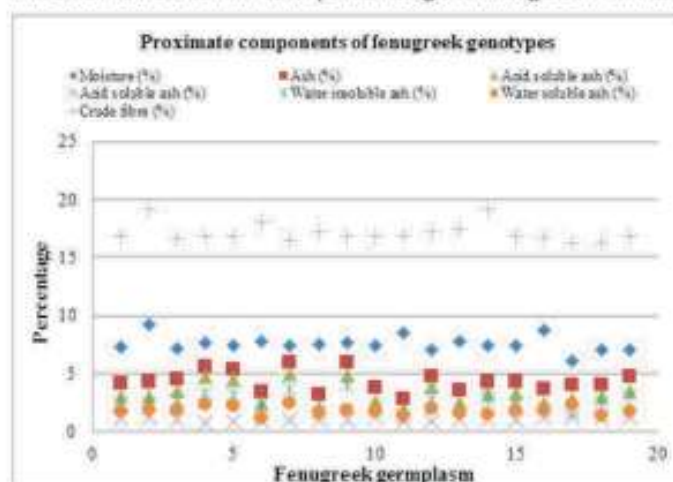


Fig. 23: Proximate components of fenugreek genotypes analyzed for its fitness for food oil blending. Dominant fatty acids in fenugreek seed oil were linolenic and linoleic acid (n-3 and n-6 fatty acid) which comes under Essential Fatty Acids (EFA) as well as PUFA and ranging between

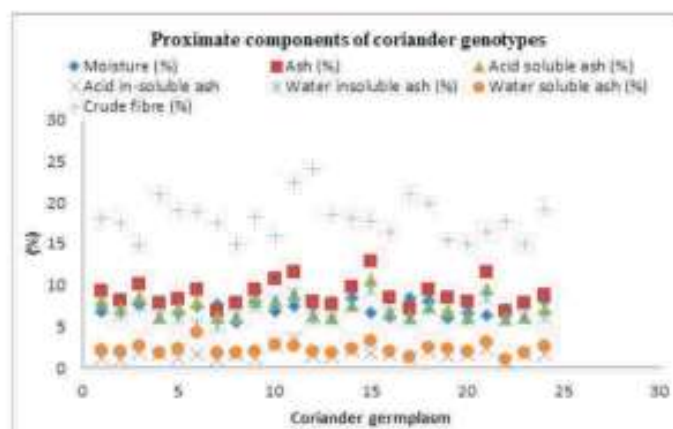


Fig. 24 : Proximate components of coriander genotypes

66.86 to 82.17 %. Other dominant fatty acids were Palmitic, Steric and oleic acid. Fenugreek seeds oil is highly rich in PUFA and EFA and it can add-up in other food oil. The n-6/n-3 ratio of fenugreek oil is near about ideal recommended ratio (1.0) for healthy diet (AFg-1). Other ratio i.e. ER (Elongation Ratio), DR (Desaturation Ratio), LDR (linoleic desaturation ratio), ODR (oleic desaturation ratio) were also observed for its quality (Fig. 25).

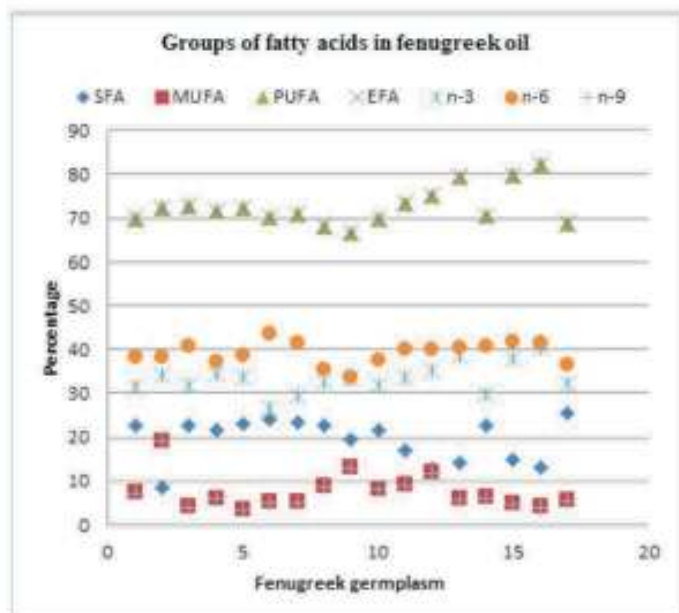


Fig. 25 : Oil quality characteristics of fenugreek oil

BS-7: Biochemical basis of defense mechanism in cumin (*Cuminum cyminum* L.) (2011-15)

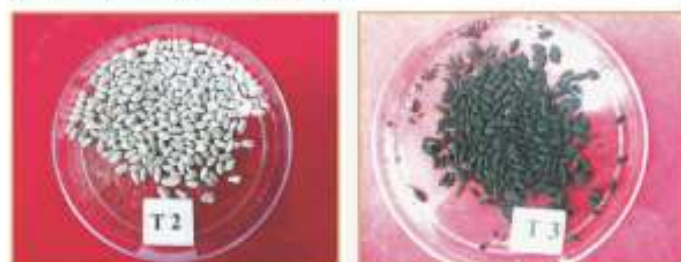
(S.S. Rathore, S. N. Saxena and Y. K. Sharma)

Biochemical basis of defense mechanism was studied in two genotypes (RZ 209 and GC 4) cumin. Germination percentage and seedlings health improved with the use of antioxidants as compared to control. Mortality at 30 DAS due to wilt disease, at 60 DAS and 100 DAS due to wilt and blight disease was found to controlled by antioxidant treatments. Antioxidant treatments triggered the PR proteins in roots which might have provided tolerance against fungal pathogens. Level of peroxidase and catalase enzymes also influenced by the use of these antioxidants. Antioxidants treatments increased plant vigour, growth and development. These antioxidants can be effective bio-alternates for harmful fungicides and chemicals.

BS-8: Physiological approaches for enhancing yield and quality in seed spices under biotic stresses (2012-15)

(S.N. Saxena, R. K. Kakani, S.S. Rathore, S. S. Meena and R. K. Solanki)

Seed priming and pelleting: The protocol of seed priming in cumin developed during preceding years was applied under field conditions. Hydro priming alone produced at par effect on seed yield and other growth parameters. Variety GC-4 found more responsive to seed priming. However, due to blight disease actual seed yield could not be harvested. Exogenous application of PGRs was found promising for yield and other morphological characters. Seed pelleting experiments revealed that priming effect can retain after coating the primed seeds with Activated Charcoal. In pot experiment coating with DE resulted better germination. Seed coating with DAP and AC in ratio of 1:9 and 2:8 and DAP, AC, DE in 1:1:1 ratio produces at par result with priming alone.



Primed and pelleted seeds of cumin

T₂, Diatomaceous earth T₃, Activated Charcoal

Effect of water stress on morpho-physiological parameters and fatty acids composition of fenugreek (*Trigonella foenum-graecum* L.) genotypes:

An experiment was conducted to investigate the effect of moisture deficiency on morpho-physiological parameters, seed yield, total oil content and fatty acid composition of thirteen fenugreek genotypes grown with moisture stress at different growth stages. Different fenugreek genotypes showed significant differences in plant fresh weight, shoot and root weight, shoot and root length, number of branches, number of pods and seed yield per plant. All the growth parameters were found to decrease in all the genotypes under water stress conditions. However, significant genotypic variation was recorded in response to moisture stress. Chlorophyll content was reduced when water stress was created by withholding irrigation at flowering stage (Table 3.41).

Genotypes showed variation in canopy temperature under non stress conditions which was narrowed under stress conditions. Water potential of all the genotypes reduced under stress conditions. Water stress at flowering and post flowering stage increased the oil content from a minimum of 3.29% in AFg-6 to a maximum of 5.31 in AM-327-3 (Table 3.41). GC-MS profiling of seed oil showed twenty two fatty acids and their methyl esters in most of the genotypes. Significant variation was observed in fatty acids composition. Linoleic acid (34-54%), linolenic acid (27-46%), stearic acid (0- 5%) and palmitic acid methyl ester (7-13%) were major contributors in all genotypes. Lenoleic acid drastically reduced from 49.57 to 34.85% and lenolenic acid increased from 31.69 to 37.66% in AFg-6 under stress conditions (Table 3.42). Stearic acid and palmitic acid methyl esters either reduced or unaffected under stress conditions.

Table 3.41 : Twig water potential (-MPa) of fenugreek genotypes as affected by water stress at flowering and post flowering stage

Genotypes	No stress	Water stress at flowering stage	Water stress at post flowering stage
AL-12	1.08	1.43	1.28
BZ-19	1.12	1.40	1.45
AFg-5	1.03	1.37	1.35
CL-32-17	1.02	1.30	1.58
AM-293	0.98	1.35	1.40
AFg-4	0.98	1.20	1.28
RMT-305	0.92	1.35	1.35
AFg-3	1.10	1.43	1.43
Hisar Sonali	1.02	1.38	1.38
AM-413	1.05	1.40	1.25
AFg-6	0.95	1.38	1.37
AM-327-3	1.02	1.32	1.35
AM-292	0.95	1.38	1.42
SEM	0.04	0.13	0.04
CD (P=0.05)	0.11	0.39	0.12
CV %	0.66	1.76	0.53

In this study significant genotypic variation was observed in response to water stress on morpho-physiological parameters including total oil and its composition. Interaction effect of genotypes and different stress conditions revealed that specific genotypes could be identified for a particular environment. Results also exhibited that a significant genotypic variation in fatty acids composition of fenugreek genotypes that may be utilize to introduce novelty of oils for developing new cultivars from non-established oil crops like fenugreek for innovative end-uses either sole or blended with other vegetable oils.

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 (2014-17)

(P.N. Dubey, S.N. Saxena, Y. K. Sharma K. Kant, Diwakar Y., O. P. Aishwath, B. K. Mishra and S.S. Rathore)

In all 85 samples for cumin from the districts of Ajmer, Nagaur, Jodhpur, Jaisalmer, Barmer, Pali, and Jalore (Rajasthan) & coriander from Mehsana (Gujarat), Kota and Ajmer (Rajasthan) were collected from the farmers and mandis during 2014-15. The facilities for analysis of Alkylenebis (dithiocarbamates) compounds were developed at the Institute laboratory, the method was standardised and dithiocarbamates were analysed in cumin samples. The location map for sample collection is presented below.



Table 3.42 : Total oil content of fenugreek genotypes as affected by water stress at flowering and post flowering stage

FAME	No stress		Water stress at flowering stage		Water stress at post flowering stage	
	Min.	Max.	Min.	Max.	Min.	Max.
Palmitic acid, methyl ester	9.5	13.1	7.6	11.8	8.6	12.4
Linoleic acid, methyl ester	39.2	50.6	34.7	53.1	34.9	54.4
Linolenic acid, methyl ester	30.0	45.2	28.0	46.0	27.1	43.5
Stearic acid, methyl ester	3.1	4.8	0.0	3.7	2.9	3.9

The samples were analysed for the dithiocarbamate residue status in the cumin samples. For the analysis of pesticide residues in cumin and coriander samples, modified methodology for the analysis of pesticide residues in cumin and coriander belonging to organophosphates, fungicides, pyrethroids, neonecotinides, carbamates and herbicides was developed, tested and standardised in collaboration with ICAR-NRC on Grapes, Pune and the samples were processed and analysed at Pune. 11 compounds in organophosphates, 15 under fungicides, 9 under pyrethroids, 3 neonecotinides, 3 carbamates, 9 herbicides and 3 others were detected during the analysis. Residue status in the cumin samples for these particular groups of pesticides were analysed and data was presented at respective fora.

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

(G. Lal and B. K. Mishra)

Under this project various value added products of seed spices were developed with the help of ICAR-CISH, Lucknow. The recipes of the products were standardized. The products developed are: Fenugreek-QPM biscuits (Sweet, salty & without sugar), Dill Parag, Fenugreek Tea and Dill Cider.

Storage studies: Storage studies of squashes and RTS made of fennel, coriander and dill carried out in the laboratory for one year to find out the shelf life and quality of the products. Study revealed that RTS can be stored up to two months and squashes up to one year without spoilage. No bacterial and fungal count was recorded up to this period and the products are safe for consumption.

Six patents (provisional) were filed for different value added products at Indian Patent Office, Dwarka, New Delhi under this project during reporting (Table 3.43).

Commercialization of technologies: Six technologies including coriander, fennel and dill squash and RTS have been commercialized on non exclusive basis. A memorandum of understanding (MOU) has been signed between ICAR-NRCSS, Ajmer and M/S HDN Farmers Combine, New Delhi in the presence of Director General, ICAR, New Delhi on 25th January, 2016. A sum of Rs. 3.00 lakhs were deposited by the said firm to the Institute for six technologies.



Table 3.43 : Patents applied for value added products.

S No.	ICAR Institute	Type of IPR protection (Patent/ Copyright/ Trademark/ PPVFRA)	Title of Technology/ Variety /or other IPR Protected	Application No. (as given by the granting authority)	Date of filing	Innovators
1.	NRCSS & CISH	Patent	Anti diabetic fenugreek -QPM biscuits	2877/DEL/2014	09.10.2014	G. Lal & Balraj Singh
2.	NRCSS & CISH	Patent	Methica (Fenugreek) Tea	2878/DEL/2014	09.10.2014	G. Lal, N. Garg, B. Singh & P. Yadav
3.	NRCSS & CISH	Patent	Vitamin C enriched Dill based Herbal Chew	2879/DEL/2014	09.10.2014	G. Lal, N. Garg, B. Singh & P. Yadav
4.	NRCSS & CISH	Patent	Coriander based squash & RTS	2880/DEL/2014	09.10.2014	G. Lal, N. Garg, B. Singh & S Kumar
5.	NRCSS & CISH	Patent	Fennel based squash & RTS	2881/DEL/2014	09.10.2014	G. Lal, N. Garg, B. Singh & Y. K. Kumar
6.	NRCSS & CISH	Patent	Dill based squash & RTS	2882/DEL/2014	09.10.2014	G. Lal, N. Garg, B. Singh & S. Kumar

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

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

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

Under this project different activities were carried out to disseminate the technologies with respect to improved varieties, production, protection and post harvest technologies of seed spices under TSP area and NEH region. During this period 03 exposure trips, 109 FLDs on seed spices technologies in TSP (0.20 ha area each) and 110 FLDs in NEH region (in 25 m² area each) were conducted under the project. In TSP area average yield increase of FLDs over local check/ practices ranged from 20.63% to 59.11%.



External Funded Projects

NMPB funded Project : Exploitation of seed spices as a potential source of natural antioxidants, essential oil and oleoresins for enhancing export of value added products

(Dr. S. N. Saxena)

Ninety one fennel and 145 coriander genotypes have been evaluated for total oil content and constituents. Three hundred and seventy fenugreek germplasm lines have been evaluated for total oil content and fatty acid methyl esters profiling (Table 3.44) and grouped as per major fatty acids methyl esters (FAME). Total phenol, flavonoid and antioxidant content have been evaluated and germplasm grouped as per phenolic compounds.

Table 3.44 : Major fatty acids (methyl esters) in 370 fenugreek germplasm lines

	RT	Min	Max	Mean	SD	CV
Palmitic acid	20.88	0.00	16.49	11.93	1.41	11.79
Linoleic acid	22.64	24.82	60.30	49.95	3.13	6.27
Linolenic acid	22.70	3.11	43.97	29.14	3.53	12.11
Stearic acid	22.81	0.00	7.53	4.38	0.59	13.40
Arachidic acid	24.77	0.00	2.21	1.50	0.25	16.85
Docosanoic acid	27.63	0.00	1.55	0.72	0.15	21.10

It is concluded that crop residues of seed spices can be utilized for essential oil extraction. Genetic variation in fatty acid composition of fenugreek (*Trigonella foenum-graecum* L.) seed oil and its suitability for human consumption has also been analyzed. The ratios of n-6 to n-3 fatty acids indicated that fenugreek seed lipids are a good source of PUFA. Extracts of cumin and coriander showed anti inflammatory activity (Carrageen induced acute inflammation study) at par with standard drug. Hence, may be a potential source for anti inflammatory activity. Both the extract showed significant antibacterial and antifungal activities.

DUS Project (PPV&FRA funded): To develop DUS testing guidelines of fennel and cumin and maintenance of reference varieties in coriander and fenugreek

(R.S. Meena, R. K. Kakani and Sharda Choudhary)

To develop DUS test guidelines for fennel (17) and cumin (9) varieties were sown at two locations NRCSS, Ajmer (Rajasthan) and DMAPR, Anand (Gujarat) in RBD with



three replications in the plot size of 3x2 m². Cumin varieties included were GC-1, GC-2, GC-3, GC-4, RZ-19, RZ-223, RZ-209, RZ-345 and RZ-341, whereas in fennel the varieties were Hisar Swarup, Azad Saunf-1, AF-1, GF-12, RF-205, RF-145, RF-281, Pant Madhurika, RF-125, GF-2, GF-11, RF-178, RF-101, RF-143, GF-1, Rajendra Saurabha and Co-1. The observations were recorded in fennel and cumin varieties as per standard guidelines for DUS testing. Maintenance of coriander (24) and fenugreek (18) varieties by caging and DUS characterization of coriander and fenugreek candidate varieties were also carried out.

Centrally Sponsored Scheme–MIDH Development programme on Seed Spices

(Y. K. Sharma, R.K. Kakani and G. Lal)

Production of quality planting material of seed spices

During 2015-16 TFL seed production of cumin variety GC-4, Coriander variety ACr-1 and AGCr-1, Ajwain variety AA-93, Fenugreek variety AFg-3, fennel variety AF-1 and AF-2,

Table 3.45 : Truthfully labeled (TFL) seed production of different seed spices

Crop	Variety	Production (Quintals)
Cumin	GC-4	35.41
Coriander	ACr-1	83.18
Coriander	AGCr-1	4.12
Fennel	AF-1	6.47
Fennel	AF-2	4.25
Fenugreek	AFg-3	59.51
Ajwain	AA-93	1.95
Nigella	AN-1	0.52
Nigella	AN-20	0.23
Anise	AAni-1	2.16
Kasuri methi	Pusa Kasuri	0.32
	Total	198.12

nigella variety AN-1 and AN-20 and anise variety AAni-1 have been taken at Farmer's field under Farmer's Participatory Seed Production Programme. The programme was taken at various farmers field located in Ajmer, Nagaur, Pali and Kota (Table 3.45).

Besides this, breeder seed production of fenugreek varieties AFg-1, AFg-2 and AFg-3, AFg-4, Fennel variety AF-1, Coriander variety ACr-1, Dill varieties AD-1 and AD-2, Ajwain varieties AA-1 and AA-93 and nigella variety AN-1 and AN-20 were also taken at NRCSS field (Table 3.46).

Table 3.46 : Breeder seed production of different seed spices

Crops	Variety	Production (kg)
Coriander	Ajmer Coriander-1	509.0
Fennel	Ajmer Fennel-1	200.0
Fenugreek	Ajmer Fenugreek-1	560.0
Fenugreek	Ajmer Fenugreek-2	300.0
Fenugreek	Ajmer Fenugreek-3	1255.0
Fenugreek	Ajmer Fenugreek-4	620.0
Ajwain	Ajmer Ajwain-1	16.0
Ajwain	Ajmer Ajwain-93	60.0
Dill	Ajmer Dill-1	70.0
Nigella	Ajmer Nigella-1	50.0
Nigella	Ajmer Nigella-20	10.0
Anise	Ajmer Anise-1	10.0
Celery	Ajmer Celery-1	3.0
	Total	3663.0

Total seed produced for different varieties of seed spices at NRCSS were 36.63 quintals of breeder seed and 198.12 quintals of TFL category.

01 National seminar, 01 district seminar, 03 farmers capacity building programs and 60 FLDs (on improved varieties and technologies of seed spices) were carried out under MIDH for effective transfer of technologies of seed spices to different stake holders.

Network/Platform Research Projects

AMAAS Project: Exploration of microbial diversity in seed spices through metagenomics approaches for crop improvement

(Sharda Choudhary and B. K. Mishra)

Soil samples were collected from rhizosphere of cumin and coriander of Jodhpur, Barmer, Jaisalmer, Pali, Ajmer, Kota, Bundi, Jhalawar, Baran districts of Rajasthan State and Udhampur, Radhapur, Gamdi, Satalpur, Fatehgarh,

Raper, Balasar, Ajar, Bhuj, Songarh, Murbi, Porbandar, Junagarh, Somnath, Rajkot, Surendra nagar, Mehsana of Gujarat State. A total of 96 bacterial isolates (NRCSS 1 to NRCSS 96) were isolated from the semi arid and arid zone of Rajasthan and Gujarat from rhizospheric soils of cumin and coriander seed spices. Among them all isolated bacterial strains (NRCSS1- NRCSS 96) were showing positive for catalase test, 25 bacterial isolates were phosphate solubilizers; 63 bacterial isolates were citrate utilizers, whereas 30 bacterial isolates showed auxin production; 59 showed amylase activities; 47 isolates were showed carbohydrate degradation activities



Bacterial and fungal cultures

Bacterial and fungal cultures from the collected soil samples

The biochemical assays use specific growth media, nutrients, chemicals or growth conditions to elicit an observable or measurable biochemical response from the isolated microorganisms. All bacterial isolates were characterized for these morphological and biochemical tests include: Gram staining, catalase test, IAA production, phosphate- solubilization, nitrogen fixing ability, carbohydrate (glucose) degradation, starch hydrolysis and citrate utilization. Sixteen unique microbial cultures identified based on morphological and biochemical characterization and in process for sequencing.

Consortia platform for high value compounds/ phytochemicals

(S. S. Rathore and S. N. Saxena)

Galactomannan studies on animals activity indicated that it acted as anti diabetic and anti lipidemic compound. An edible coating from seed spices extracts for increasing shelf life with health beneficial properties have been developed for fruits and vegetables. Suitability of nigella and fenugreek fixed oil has been tested for edible oil due to presence of high levels of EFA and PUFA.

Outreach programme on management of sucking pests in horticultural Crops

(K. Kant and P.N.Dubey)

Management of sucking pests using botanicals, biological agents and selected insecticides showed among insecticides carbosulfan, thiacloprid and emamectin benzoate proved most effective. In case of botanicals, application of neem cake in soil during seed sowing followed by spray of neem oil 2% showed most effective at both application. Marginal decline of predators coccinellids and aphids parasitoides *Aphidius* sp. population on both insecticides and botanicals treatments. However number of bee visit on the crop was not affected on the crop by different treatments. Mixing of adjuvant developed on plant of *Sapindus mucorasai* and *Dalbergia sissou* and APSA 2% proved significant enhanced efficacy in comparison to alone application of insecticide and botanicals.



Coccinella septumpunctata

Hippodamia variegata

Brumoides suturalis



Menochelus sexmaculata

Scymnus sp.

Ischiodon scutellaris



Episyphus balteatus

Eristalinus sp.

Orius tantius



Geocoris sp.

Aphidius sp.

Mummified aphids

Important natural enemies of sucking pests of seed spice crops

Consortium research platform (CRP) on Borers Management of seed borer (*Systole albipennis* Walker) in seed spice crops.

(K.Kant, P. N. Dubey, B. K. Mishra, N.K. Meena and S. R. Meena)

Study on development of diagnostic symptomology of borers on fennel, coriander and ajwain crops were conducted. Two important parasitoids of *Systole albipennis* identified as *Oomyzus galerucae* (Fonscolombe) (Eulophidae: Hymenoptera) and *Aprostocetus* sp. (Eulophidae: Hymenoptera). Management of borer on different seed spice crops showed that seed sown at 20th September recorded minimum infestation of borers in crops of fennel, coriander and ajwain. Intercropping with dill crop showed maximum protection from borer infestation and recorded only 5.6, 2.3 and 5.0 % infestation in comparison to 10.0, 4.6 and 8.6 % in control plot in crop of fennel, coriander and ajwain. Soil application of chlothianidin @ 0.5 a.i. Kg/ha during sowing showed maximum protection against borer followed by foliar application of imidacloprid 0.005% and abamectin 1.9EC @ 2ml/lit. Among different botanicals applied neem oil, insecticide soap was most effective in all crops. Post harvest management of borers using Modified Atmospheric Packaging with different gases was able to inhibit/ kill the immature stages of borer population present inside the seed.



Aprostocetus sp.

Oomyzus galerucae
(Fonscolombe)

Seed wasp (*Systole albipennis* Walker) parasitoides

Outreach Project on *Phytophthora*, *Fusarium* and *Ralstonia* diseases of Horticultural & Field crops

(Y.K. Sharma, R.D. Meena and R.K. Solanki)

Sub-project “Wilt Management in Cumin”: Survey was conducted in the Rajasthan (Ajmer, Nagaur, Jodhpur) and Madhya Pradesh (Mandsaur, Ratlam, Ujjain, Neemach). Total 30 plant samples showing wilt symptoms were collected and processed for isolation of casual organism.

Network project on organic horticulture: Development of organic production technologies for seed spices

(R.S.Mehta, B.K. Mishra, Ravindra Singh, O.P.Aishwath, Y.K. Sharma, Krishna Kant, S.S.Rathore)

In the project, organic practices of nutrient, insect pest and disease management on four cropping sequences comprising viz. clusterbean-cumin- summer solarisation, groundnut – fenugreek – green manuring, green gram - ajwain- summer fallow/summer solarisation, green gram -nigella-summer fallow/summer solarisation were undertaken. FYM, vermi-compost, bio-fertilizers, two insect-pest and two disease modules were applied. In fenugreek application of 100 % RDN, 2/3 by vermi-compost (VC), 1/3 by non-edible oil cake (NEOC) along with pest and disease management module-2 (Foliar spray of NSKE @ 5% + foliar spray of Insecticide soap @2% + foliar spray of *Verticillium lecanii* (10⁸ spore/g) + *Metarhizium anisopilae* (10⁸ + soil application of neem seed cake/mustard seed cake @ 500 kg/ha + foliar spray of garlic extract) resulted higher grain yield, microbial biomass carbon and soil organic carbon at 90 DAS and lower diseases severity which is comparable to application of 75% RDN, 2/3 by VC, 1/3 NEOC with application of bio-fertilizers. Application of 100 % RDN, 2/3 by vermi-compost (VC), 1/3 by NEOC along with pest and disease management module-2 exhibited 39.45 % higher grain yield of fenugreek over control. In ajwain, the highest grain yield (952 kg/ha), lowest disease severity (24.7 %) was obtained with application of 100 % RDN, 2/3 by vermi-compost (VC), 1/3 by NEOC along with pest and disease management (module-2) but highest oil content in ajwain (5.2%) was recorded with application of 100 % RDN, 2/3 by FYM, 1/3 by non-edible oil cake (NEOC) along with pest and disease management module-2. In nigella application of 100 % RDN, 2/3 by vermi-compost (VC), 1/3 by non-edible oil cake (NEOC) along with pest and disease management module-2 resulted highest grain yield (804 kg/ha) and lowest disease severity (24.3 %). In cumin, highest plant height of 32.33 cm at 75 DAS was obtained with application of 100 % RDN, 2/3 by FYM), 1/3 by non-edible oil cake (NEOC) along with pest

and disease management (module-1) (comprising of foliar spray of Karanj oil + neem oil (1:1 ratio) @ 2% (v/v)+*Verticillium lecanii* (10^8 spore/g)+ foliar spray of Azadirachtin 10000 PPM (3ml/lit Seed treatment with *Trichoderma viride* + Soil Application of neem seed cake/mustard seed cake @ 500 kg/ha + foliar spray of garlic extract but lowest disease severity was recorded in growing of cumin by RDF with conventional package.

Network Project on “Micronutrient management in horticultural crops (seed spices) for enhancing yield and quality”

(O. P. Aishwath, B. K. Mishra, P. N. Dubey, Harisha C.B. and R. D. Meena)

Seed germination study of coriander, fenugreek and nigella with various concentrations of micronutrients was carried out in the laboratory to find out threshold levels of micronutrients concentrations for seed priming and vigour index of their seedlings. Seedlings and vigour index was better with all the micronutrient except copper in coriander and fenugreek. However, nigella seedlings did not showed any definite trend. At field levels all the three crops showed significant response with seed priming, however extant of response was varied with respect to growth, yield and quality. The trend of response was better by foliar application followed by seed priming and soil application in general. Besides that, micronutrient played a significant role for the disease suppression in seed spices particularly downy and powdery mildew in fenugreek. Though, all the micronutrients more or less effective for disease suppression, however role of copper was prime among them. Nutrient content and their uptake in plant as well as soil availability was also worked out. Data seed spices production and productivity was overlaid on soil micronutrient availability map of India and also to delineate the crop boundary at district level.

Net work project on protected horticulture: Standardization of production technologies for seed spice under protected conditions

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

Different protection structures like, plastic sheet covered

high walk in tunnel, insect proof net covered high walk in tunnel, vertical plastic sheet wall protected the crop from frost as compared to open condition in major (cumin, coriander, fenugreek, fennel) and minor (dill) seed spices due to 2.5-3.0 °C higher temperature in insect proof net covered walk in tunnel and 6.5-8.9 °C higher temperature under plastic sheet covered walk in tunnel . Insect proof net covered walk in tunnel gave maximum seed yield of 2115.0 and 1525 kg/ha in coriander and dill whereas plastic sheet covered walk in tunnel gave maximum seed yield of 2688.0, 2763.0 and 665.0 kg/ha in fennel, fenugreek and cumin, respectively with low incidence of diseases and pest as compared to open conditions.



Insect proof net and plastic sheet covered walk in tunnels in coriander and fenugreek



Plastic sheet and insect proof net covered high tunnels in dill and fennel

In all the four crops (fennel, celery, dill and ajwain), the transplanting shock were minimum and lowest mortality of seedlings were recorded in the seedlings where the nursery was raised in pro-trays followed by soil less media. Very less weeds were recorded at transplanting with the plastic mulch with 8-10.5% less water application.

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

shade net or 75% black shade nets were equally effective for higher leafy biomass production during off season.



Off season production of coriander and fenugreek under shade net covered walkin tunnels

CRP on Agro-biodiversity: Seed Spices

Regeneration and characterization of ten seed spices germplasm.

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

Fenugreek, ajwain and fennel germplasm received from NBPGR have been evaluated and seed multiplication was also carried out successfully for these crops. Cumin germplasm was also received from NBPGR and planted at Ajmer and also at Mandore but the multiplication could not be achieved due to severe infection of blight.

- 375 lines of Fenugreek germplasm received from NBPGR out of which 362 germinated, observation on 22 morphological and pathological characters have been recorded and seeds were deposited to NBPGR.
- 30 ajwain lines were received out of which 26 germinated and seeds of these has been regenerated and deposited to NBPGR.
- 63 lines of fennel were received out of which 52 germinated, observation on 14 morphological characters have been recorded and seeds of these lines have been regenerated and deposited to NBPGR, New Delhi.

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

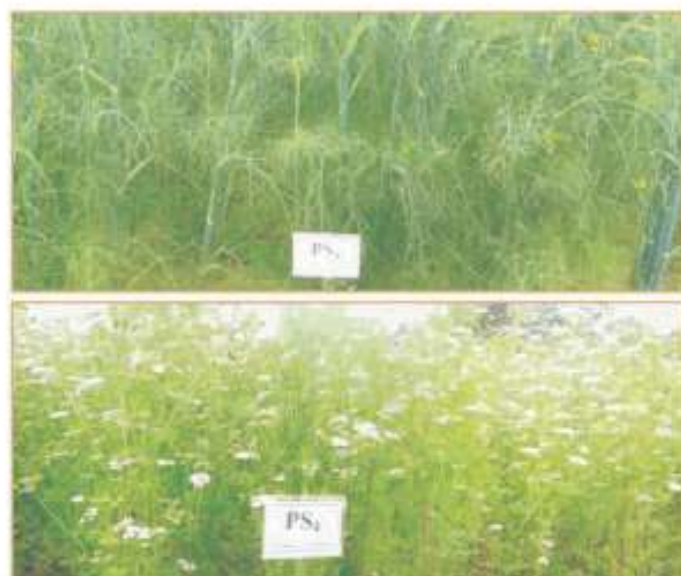
(G. Lal, N.K. Meena, R.D. Meena and Harisha C.B.)

A network project on organic farming for development of seed spices based cropping system under INM approach has been undertaken in coriander and fennel.

1. The performance of 75% organic with 25% inorganic

treatment (PS_1) recorded best followed by state recommendation with respect to plant growth and yield of coriander and fennel.

2. Eight cultivars of fennel and coriander each were tested under organic production system. Performance of GF-12 was best followed by AF-1 in fennel and in coriander the performance of Azad Dania-1 was best followed by Hisar Anand with respect to yield.
3. The IPM module M-3 (garlic extract 10 ml/lit + azadirachtin 0.03% EC @ 5ml/lit + tumba fruit extract 10ml/lit.) was found most effective against aphid on both the crops followed by M-2 (field sanitation + NSKE 5ml/lit + Ker extract 10 ml/li.).
4. 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 against thrips on both the crops followed by M-2 (field sanitation + NSKE 5ml/lit + Ker extract 10 ml/li.).
5. In coriander five different treatments were evaluated including soil solarization (21 days), *Trichoderma* (8 gkg⁻¹ seed as seed treatment + 2.5 kg ha⁻¹ as soil application), neem cake (0.5t/ha), castor cake (0.5t/ha) and control against *sclerotium* rot. Among the treatments soil solarization was found most effective (PDI 0.5) followed by *Trichoderma* & neem cake (PDI 2.0) while the disease (*Sclerotium* rot of coriander) was recorded maximum in control (PDI 9.5).



4. TECHNOLOGY ASSESSMENT AND TRANSFER

One of the prime activities of this research centre is to benefit the farmers, stakeholders and processing industry through transfer of the established technologies and knowledge by conducting training programmes, demonstration of new varieties and production technologies, organizing kisan mela and seed distribution melas, participation in exhibitions, field days in campus and off the campus. These activities were conducted with the participation of KVKs, State Department of Agriculture/ Horticulture/ Extension agencies/ NGOs. During the reporting period following activities were conducted by NRCSS:

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

4.1.1 Technology Dissemination through Frontline Demonstration of Seed spices: Under this programme, 60 Front Line Demonstrations (FLDs) in collaboration with Agriculture Department, Pokaran (Jaisalmer); KVK, Jhunjhunu; KVK, Gudamalani (Barmer); ARS, Jalore; KVK, Ajmer and State Department of Agriculture, Sikar, Nagaur and Kota on cumin (28), fenugreek (18), coriander (12) and fennel (02) were conducted. In the demonstration plots, improved varieties of cumin, fenugreek, coriander 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. Results of the FLDs in different locations revealed that yield of cumin under demonstrations was higher in the range of 13.84% - 100.00% than that of local check/ practices. The yield of fenugreek under demonstrations was 09.37% - 37.50% per cent higher as compared to crops grown with traditional practices and local varieties. The yield of fennel was 71.43% - 76.92% higher than the local check/ practices. Similarly the yield of coriander was recorded 03.22% - 116.67% higher than the yield with local check/ practices.

4.1.2 Technology Dissemination through Field Days: Seven Field Days were conducted in the cropping season at the time of maturity of crops to show the performance

of FLDs on different seed spice crops to nearby farmers at different places. The Field Days were conducted for fenugreek FLDs at Indali and Kukanwali (Nagaur), Dadia (Sikar), Varishpura (Jhunjhunu); for cumin at Bavatra, (Jalore), Gudamalani (Barmer) and Selvi, Pokaran (Jaisalmer) and for coriander at Toran (Kota). About 350 farmers were benefitted with these Field Days. The varieties and technologies of seed spices demonstrated at different places were compared with the local checks and practices followed by the farmers and discussed with the available beneficiaries and suggested to adopt the improved varieties and technologies for maximization of yield of high quality produce.

4.1.3 Technology Dissemination through Farmers' Trainings

Under transfer of technology programme, three farmers training programme at NRCSS, Ajmer; KVK, Jalore and KVK, Gudamalani (Barmer) were conducted during Rabi season of 2015-16 on production and post-harvest management of seed spices. The detailed report is given as under:

Farmers' training at NRCSS, Ajmer : A two days farmers training programme on "Modern technologies of seed spices production in semi-arid areas" was organized on 18-19 November, 2015 at National Research Centre on Seed Spices, Ajmer (Rajasthan). In all 60 farmers participated from different parts of the district. The subject matter experts advised the growers to adopt scientific technologies of vegetables and seed spices under protected structures to get higher yield with better quality produce. Line sowing, seed treatment, timely weeding and other field operations to get the maximum production and profit was also suggested. In two days deliberations covered all aspects of seed spices production like irrigation and water management, storage and processing, disease and insect management in seed spices, role of bio-fertilizer and macro element in seed spices and mechanization in seed spice crops by different scientists of ICAR-NRCSS, Ajmer.



Farmers' Training at KVK, Jalore : Two days farmers' training programme on "Plant protection and quality management of seed spices in arid areas" was organized at KVK, Jalore, Rajasthan on 16-17 February, 2016. Total 61 farmer from different places of Jalore district participated. Different aspects of seed spices production especially plant protection from biotic and a-biotic stresses, quality improvement and marketing & trade were covered by different speakers of NRCSS, ARS, KVK and State Department of Agriculture, Jalore.

Farmers' Training at KVK, Gudamalani, Barmer : One day farmers' training programme on "Post-harvest management and processing for value addition in seed spices" was conducted at KVK Gudamalani, Barmer, Rajasthan on 20th March, 2016. In all 96 farmer participants were present from different places of Barmer district. Deliberations on different aspects on seed spices production, protection, residue management, mechanization, post-harvest handling, processing for value addition, trade and marketing were delivered by various speakers of NRCSS, KVK, Gudamalani and officials of state department of agriculture.

Two days crop seminar on Improved Seed Production Technology for Tribal Farmers: During the *Rashtriya Kisan Beej Mela evam Krishak Mahatosav-2015*, two days crop seminar on "Improved Seed Spices Production Technology for Tribal Farmers" was organized during 28-29 September, 2015 at NRCSS, Ajmer. In this seminar 163 farmers and officials from KVKs from Dungarpur, Banswara and Pratapgarh participated. In the crop seminar, lectures were delivered by the scientific staff of NRCSS, Ajmer, KVK, Ajmer and officials from department of agriculture. During the seminar problems and prospects of seed spices in tribal area were discussed. Dr. Balraj Singh, the then Director, NRCSS, highlighted the important achievements made by NRCSS for promotion of seed spice cultivation in tribal area. He asked farmers to take newly developed varieties of seed spices for enhancing production and productivity of seed spices. He also advised farmers to take protected cultivation of seed spices and vegetables. Farmers from tribal area also gave their feedback on performance of seed spices in the tribal area.

Training programme on Good Agriculture Practices for production and handling of spices: In collaboration with JIFSAN, USA and CTC Cell Spice Board a two days training programme on Good Agriculture Practices for production and handling of spices was organised during 7-8 March, 2016 at Conference Hall of ICAR- NRCSS, Ajmer. In the training programme 87 participants comprising, scientists, RAs/SRFs, progressive farmers and officials of department of agriculture and horticulture, Ajmer attended. Two eminent speakers viz. Dr. Clarre Narrod and Dr. James Rushing from JIFSAN, USA delivered lecture on various aspects of Good Agriculture Practices in spices. Dr. Balraj Singh had translated all the lecturers in hindi to make presentations understandable for farmers.

4.2 Technology transfer in TSP area during 2014-15

Conducted 03 exposure trips of TSP farmers to NRCSS with 01 farmer's workshop during National Farmers Fair at NRCSS Ajmer. Conducted 109 FLDs on seed spices technologies in TSP (0.20 ha area each) and 110 in NEH region (in 25 m² area). In TSP area average yield increase of FLDs over local check/ practices ranged from 20.63% to 59.11%. Total beneficiaries were 446 during the reporting period.

4.3 Rashtriya Kisan Beej Mela and Krishak Mahaotsav-2015: *Rashtriya Kisan Beej Mela evam Krishak Mahatosav-2015* was organized on 28-30, September, 2015 at National Research Centre on Seed Spices, Ajmer, Rajasthan) by Professional Agriculture Management Services (PAMS), Bahadurgarh, Haryana and Indian Society of Seed Spices, ICAR-National Research Centre on Seed Spices, Ajmer (Rajasthan). The Mela and exhibition was inaugurated by Honorable Prof. Sanwar Lal Ji Jat, Minister of State for Water Resources, River Development and Ganga Rejuvenation, Govt. of India. Director, NRCSS highlighted the achievement made by NRCSS for enhancing productivity of seed spices in Rajasthan and India. He also advised farmers to use ACr-1 variety of coriander for higher yield and tolerance to stem gall. During the occasion 25 exhibition stalls of different agricultural products and inputs were displayed for the benefit of the farmers. In the inaugural function a book on



“Vyavsaik Krishi Ke Pariprekshya Me Masala Phasale”, a pamphlet on “Gunvattayukt Bijya Masala Phasalo Ki Utapdan Prodyogiki” and a bulletin on “Seed Spice diseases and their management” were released for the benefit of the farmers. About 3500 farmers, extension officials and delegates from different parts of Rajasthan and adjoining states participated in the Mela during three days. In the Kisan Gosthi, Scientists farmers’ interaction was held on farmer’s problem in respect to seed spices and other crops. Director, NRCSS, Ajmer suggested to farmers for inclusion of seed spices in their cropping system for realizing higher profit. Dr. R. H. Dahiya, Director, IHITC, Jaipur advised farmers to take seed spices with other horticultural crops so that resource use efficiency can be enhanced. During three days different sessions were organized for the benefit of the farmers. In different technical session scientists from IARI, New Delhi, NRCSS, Ajmer, KVK, Ajmer and department of agriculture, Ajmer participated and delivered lecture on different

aspects of seed spice production, crop raising, flower and vegetable cultivation and animal rearing. 25 exhibition stalls from different ICAR institutes of Rajasthan, development department and private agencies displayed their product and technologies for the benefit of the farmers.

4.4 Visits of spice stakeholders and farmers at NRCSS, Ajmer

During the year 215 groups comprising of various seed spice stake holders, farmers, exporter traders, students and extension officials visited the centre and research farm. Around 15000 farmers, students and extension officers from various parts of Rajasthan and adjoining states viz. Gujarat, MP, UP, Punjab, Haryana and Maharashtra visited the institute. Scientists and technical staff of NRCSS briefed about various aspects of seed spice production to the visitors itself. Seeing the performance of various technologies of seed spices production, all the stakeholder were benefitted.



4.5 Training programmes organized at NRCSS, Ajmer

Title of training	Duration	Coordinators	Sponsoring agency	Participants
Possibilities and Prospects of Seed Spices in Assam region	April 23-24, 2015	Dr. G. Lal	NRCSS, Ajmer under TSP Project	20
बीजीय मसाला फसलों की उन्नत प्रौद्योगिकी	Aug 17, 2015	Dr. R. S. Mehta	MPCON Limited, Indore under RGPSA (MP)	50
बीजीय मसाला फसलों की उन्नत प्रौद्योगिकी	Aug 18, 2015	Dr. R. S. Mehta	MPCON Limited, Indore under RGPSA (MP)	50
बीजीय मसाला फसलों की वैज्ञानिक खेती	Sept 27-Oct 01, 2015	Dr. S. N. Saxena Mr. M. K. Vishal Mr. Diwaker, Y.	Project Director, ATMA, Hanumangarh	35
बीजीय मसाला फसलों के उत्पादन की उन्नत तकनीकियाँ	Sept 27-Oct 01, 2015	Dr. R. S. Mehta Dr. S. S. Meena Dr. A. K. Verma	Project Director, ATMA, Nagaur	35
बीजीय मसाला फसलों की उन्नत उत्पादन तकनीकी	Oct 05-09, 2015	Dr. G. Lal Dr. B. K. Mishra Dr. R.K. Solanki	Project Director, ATMA, Tonk	30
अर्द्ध शुष्क क्षेत्रों में बीजीय मसाला फसलों उत्पादन की नवीनतम तकनीकियाँ	Nov 18-19, 2015	Dr. N. K. Meena Dr. R.K. Solanki	National Horticulture Mission	50
बीजीय मसाला फसलों की उन्नत खेती	Dec 15-19, 2015	Dr. R. Singh Dr. P.N. Dubey Mr. H. Asangi	Project Director, ATMA, Bhilwara	30
संरक्षित खेती एवं प्रबन्धन	Dec 21-22, 2015	Dr. R. S. Mehta Dr. A. K. Verma	NHM, Department of Horticulture, Ajmer	100
फूलों की वियसायिक खेती एवं प्रबन्धन	Dec 28-29, 2015	Dr. B. K. Mishra Dr. Diwaker, Y.	NHM, Department of Horticulture, Ajmer	100
बीजीय मसाला फसलों की उन्नत खेती	Dec 29, 2015- Jan 02, 2016	Dr. P. N. Dubey Dr. N. K. Meena Dr. R. D. Meena	Project Director, ATMA, Jodhpur	50
बीजीय मसाला फसलों की उन्नत खेती	Jan 4-8, 2016	Dr. S.S. Rathore Dr. R. S. Meena Mr. Harisha, C.B.	Project Director, ATMA, Jodhpur	30
बीजीय मसाला फसलों की उन्नत खेती	Jan 12-14, 2016	Dr. Y. K. Sharma Dr. R. K. Solanki Dr. M. Vishal	ATMA, Neemach (MP)	22
रबी मौसम की फसलों के लिए उन्नत उत्पादन तकनीक	Feb 15-16 and Feb 17-18, 2016	Dr. R. S. Mehta	RACP, DD (Agri.), Ajmer	30+30
रबी मौसम की फसलों के लिए उन्नत उत्पादन तकनीक	Feb 19-20, 2016	Dr. R. S. Mehta	RACP, DD (Agri.), Ajmer	30
रबी मौसम की फसलों के लिए उन्नत उत्पादन तकनीक	March 1-2 and March 3-4, 2016	Dr. R. S. Mehta	RACP, DD (Agri.), Ajmer	30+30
GAP and GMPO for the production and handling of spices	March 7-8, 2016	Dr. R. S. Mehta	JIFASN, Spice Board Regional Station Jodhpur	70
बीजीय मसाला फसलों के उत्पादन की उन्नत तकनीक	March 17-19, 2016	Dr. K. Kant, Dr. S. Choudhary	NABARD and NIGB, Dewas, MP	22
बीजीय मसाला फसलों के उत्पादन की उन्नत तकनीकियाँ	March 21-23, 2016	Dr. R. S. Meena Dr. R. K. Solanki Dr. R. D. Meena	Project Director, ATMA, Nagaur	20
Farmers entrepreneurship training on essential oil & Oleoresin extraction	March 30, 2016	Dr. S. N. Saxena	Krishi Vikas Sansthan, Ajmer	25
Farmers training on Cryogenic grinding & packaging technique	March 31, 2016	Dr. S.N. Saxena Sh. Diwaker, Y	Krishi Vikas Sansthan, Ajmer	25

4.6 Radio/Television talks

Name of Scientists	Topic	Date and venue
Dr. Balraj Singh	Hello Kisan: मसालों की खेती एवं जल संरक्षण	DD Kisan on 24.06.2015
	Phone-in programme	AIR, Jaipur on 07.07.2015
	Hello Kisan: संरक्षित खेती	DD Kisan on 13.07.2015
	Hello Kisan: उद्यानिकी फसलों के हरितगृह एवं जाल गृह में संरक्षित खेती	DD Kisan on 31.08.2015
	Hello Kisan: मसालों की खेती	DD Kisan on 02.09.2015
	Phone-in programme	AIR, Jaipur on 03.11.2015
	कृषक प्रश्न मंच : मसालों की खेती	DD Kisan on 03.12.2015
	कृषक प्रश्न मंच : जल संरक्षण	DD Kisan on 10.12.2015
	Hello Kisan: मसालों की खेती	DD Kisan on 29.12.2015
	Dr. Gopal Lal	कृषक प्रश्न मंच : मसालों की खेती
कृषक प्रश्न मंच : जल संरक्षण		DD Kisan on 28.11.2015
Off season production of coriander (Hindi)		AIR, Jaipur on 30.11.2015
सांसद आदर्श ग्राम योजना		AIR, Jaipur on 30.11.2015
Dr. R. S. Mehta	Hello Kisan: मसालों की खेती एवं जल संरक्षण	DD Kisan on 24.06.2015
	Hello Kisan: मसालों की खेती	DD Kisan 2.09.2015
	Hello Kisan: मसालों की देखभाल	DD Kisan 25.11.2015
Dr. R. Singh	बीजीय मसाला फसलों की पौध उत्पादन एवं रोपाईः	AIR, Jaipur on 26.10.2015
	अधिक उत्पादन के लिए वरदान पर बातचीत	
	कृषक प्रश्न मंच : मसालों की खेती	DD Kisan on 28.11.2015
Dr. N.K. Meena	कृषक प्रश्न मंच : जल संरक्षण	DD Kisan on 28.11.2015
	बातचीत : खरीफ मौसम की फसलों में बीज एवं मृदा उपचार	AIR, Jaipur on 06.06.2015
	बातचीत : रबी मौसम की फसलों में कीट एवं रागों का प्रबंधन	AIR, Jaipur on 23.10.2015
	बातचीत : बीजीय मसाला फसलों की कटाई एवं मण्डारण	AIR, Jaipur on 23.03.2016
	कृषक प्रश्न मंच : मसालों की खेती	DD Kisan on 28.11.2015
Sh. S.R. Meena	कृषक प्रश्न मंच : जल संरक्षण	DD Kisan on 28.11.2015
	बीजीय मसाला फसलों के नाशक कीटों का समेकित प्रबंधन	AIR, Jaipur on 10.12.2015

4.7 Exhibition conducted/participated

ICAR-NRCSS is actively involved in dissemination of technologies developed by the institute among stakeholders and farmer community through various extension programmes. A team of scientists and technical staff of NRCSS participated in Kisan mela, exhibitions etc.

organized by different ICAR institutes, SAUs as well as state agricultural departments and exhibited seed spices technologies. A number of scientists, extension workers, students, farmers, public representatives visited the stall and interact with NRCSS staff to share the knowledge by seeing the live products and literatures. During the period, NRCSS participated in nine major events.



Rashtriya Sahkarya Masala Mela organized by Cooperative Society from 20-24 May, 2015, at Jaipur



Rashtriya Sahkarya Masala Mela organized by Cooperative Society from 18-22 June, 2015 at Ajmer



Agriculture Exhibition on 21 August, 2015 at SSB Ground (Seema Suraksha Bal) Pipra Kothi, Motihari, Bihar



Exhibition in kisan mela from 28-29 September, 2015 at NRCSS, Ajmer



Kisan Mela organized by Krishi Vigyan Kendra, Ajmer, 26 February, 2016 at Dantda Village, Ajmer



Kisan mela organized by SKN University, Jobner- Rajasthan on 2-3 March, 2016 at Jobner



Exhibition stall in Krishi Unnati Mela on 19-21 March, 2016 organized by IARI, Pusa, New Delhi



National Sheep & Farmer Fair-on March 28, 2016 organized by CSWRI, Avikanagar, Tonk



Exhibition stall in National Horticulture Board, Horti Sangam-2015 on 10-12 April, 2015 at Motihari, Bihar

5. TRAINING AND CAPACITY BUILDING

5.1 Students guided

Education (M.Sc. Student guided)

Name of student	Degree	Title of thesis	Guide
MJRP, University, Jaipur			
Miss Sonu	M.Sc. Ag (Hort.)	Effect of micronutrient and method of application on growth and yield of Fennel	Dr. Balraj Singh
Mr. Yogendra Singh	M.Sc. Ag (Hort.)	Effect of different levels of NPK under protected environments	Dr Gopal Lal
Mr. Jawahar Singh Jurjar	M.Sc. Ag (Hort.)	Effect of different levels of nitrogen and boron on growth and yield performance of fenugreek	
Mr. Hitendra Koli	M.Sc. Ag (Hort.)	Estimation of variability and core set development in fenugreek (<i>Trigonella foenum graecum</i> L)	Dr. R.K. Kakani
Mr. Mahendra Kr. Pasavan	M.Sc. Ag (Hort.)	Role of nitrogen supply in uptake and re-translocation of macronutrients in coriander on its growth stages	Dr. O.P. Aishwath
Mr. Lalit Patidar	M.Sc. Ag (Hort.)	Influence of integrated supply of AM, PSB, Azotobactor and inorganic fertilizer on growth, yield and quality in coriander (<i>Coriandrum sativum</i> L.)	Dr. S.S. Meena
Mr. Rohit Kumar	M.Sc. Ag (Hort.)	Genetic variability, divergence, correlation and path analysis in fennel germplasm	Dr. R. S. Meena
Mr. Kapil Sharma	M.Sc. Ag (Hort.)	Pollinators of coriander (<i>Coriandrum sativum</i>) and their impact on yield enhancement	Dr. N. K. Meena
Mr. Piyush Mehta	M.Sc. Ag (Hort.)	Effect of soil solarization on growth, yield and weed infestation in cumin	Dr. R. D. Meena
Mr. Sitaram Sharma	M.Sc. Ag (Hort.)	Studies on effect of gamma rays on fennel (<i>Foeniculum vulgare</i>)	Dr. A.K. Verma
Miss Divya Pareek	M.Tech	Identification and validation of simple sequence repeats (SSRs) in Coriander (<i>Coriandrum Sativum</i> L.)	Dr. Sharda Choudhary
Banasthali Vidyapeeth (NUWE), Jaipur			
Preksha Goswami	M.Sc. Biotechnology	Polymerase chain reaction based markers to assess the genetic divergence of celery (<i>Apium graveolens</i> L)	Dr. Sharda Choudhary
Jyoti Vidyapeeth Women's University, Jaipur			
Rajwati Panwar	M.Sc. Biotechnology	Microbial diversity analysis from fenugreek (<i>Trigonella foenum graecum</i> L.) growing fields	Dr. Sharda Choudhary

5.2 Training and Capacity Building Programmes Organized

5.2.1 Winter school on “Utilization of degraded land and soil through horticultural crops for improving agricultural productivity and environmental quality” NRCSS Ajmer

A 21-days ICAR sponsored Winter School on “Utilization of degraded land and soil through horticultural crops for improving agricultural productivity and environmental quality” was organized at NRC on Seed Spices, Ajmer, during 3-23 December, 2015. A total number of 26 participants attended the Winter School from various universities and institutions located across length and breadth of the country. In this Winter School 26 participants from 11 states were participated. Dr. T. Janakiram, Asstt. Dir. General (Hort. Sciences) and Dr Arushi Ajey Malik Collector & District Magistrate, Ajmer were the Guest of Honour and Chief Guest of the inaugural function held on 3rd December, 2015. All the aspects of Utilization of degraded land and soil through horticultural crops for improving agricultural productivity and environmental quality have been covered during the training period. The Winter school was divided into eight modules viz Land and soil degradation extent and evaluation; Plasticizing crops under various degraded situations; Stabilization and improvement in soil and land by the horticultural crops; Scope for sequestering additional soil carbon in degraded land and soils; Climate stabilization and improvement in environment & soil quality; Hi-tech horticulture for degraded lands; Disease and pest problems in horticultural crops in concern with degraded lands and Transfer of technologies and associated activities for control, regeneration and rejuvenation of degraded lands through horticultural crops. Director, ICAR-NRCSS, Ajmer and Dr G.N. Mathur distributed the certificates to the trainees during valedictory function.



5.2.2 National Seminar on “New Dimensional Approaches for Enhancement of Seed Spices Productivity and Profitability under Era of Climate Change” at NRCSS Ajmer: ICAR-National Research Centre on Seed Spices, Ajmer in Collaboration with Indian Society of Seed Spices (ISSS), Ajmer and DASD, Calicut organized a National Seminar on “New Dimensional Approaches for Enhancement of Seed Spices Productivity and Profitability under Era of Climate Change” during February, 2-3, 2016 at National Research Centre on Seed Spices, Ajmer with an objective for upliftment of livelihood income and prospective of Indian spice growers. Dr. Balraj Singh, the then Director, NRCSS and Chairman Organizing Committee, welcomed the Chief Guest, Dr. R.R. Hanchilal, Chairman, PPV&FRA, New Delhi, President, Dr. S.K. Malhotra, Commissioner of Agriculture and Horticulture, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi, Guest of Honours, Dr. M. Anandraj, Director, Indian Institute of Spice Research, Calicut, Dr. Nirmal Babu, Project Coordinator, AICRP Spices, IISR, Calicut and Dr. Homey, Cheriyan, Director, Directorate of Areca nut and Spices Development, Calicut and other dignitaries on and off the dais, delegates, press and media. He briefed about various research achievements of the centre made during last one and half decade. Dr. S. K. Malhotra, Commissioner Agriculture & Horticulture, GOI, New Delhi and President of the inaugural function delivered a key note address. Chief Guest of the inaugural function Dr. R.R. Hanchinal, Chairman, PPV&FRA, New Delhi in the inaugural address appreciated the efforts and progress made by ICAR-NRCSS in the field of seed spices research and development during last 16 years of its establishment. He was happy to know that NRCSS is maintaining more than 2500 germplasm lines of seed spices and acting as NAGS and appreciated efforts of NRCSS in respect to conservation and maintenance of these lines which are to be used in crop improvement programme. He also appreciated the efforts made by NRCSS for development of improved varieties of fenugreek, fennel, coriander, dill, ajwain, nigell and other seed spices. In this seminar more than 200 scientists, researchers and students participated during the 2 days deliberations.



5.2.3 District Seminars under MIDH: Two days District level Seminar was organized on "Quality production and post-harvest management of seed spices in tribal areas" at KVK, Banswara on 29th November to 1st December, 2015. In this seminar, more than 150 farmers, Scientists, SMS, Officers of State agriculture department and NGOs from Pratapgarh, Banswara and Dungarpur participated and got benefited. The seminar was organised by NRCSS, Ajmer under the financial umbrella of MIDH, DASD, Calicut. Another district level seminar on production, quality and postharvest management of seed spices in Madhya Pradesh was organized at Krishi Vigyan Kendra (RVSKVV, Gwalior), Neemuch (MP) during 27-28 December, 2015 under Mission for Integrated Development of Horticulture. Dr. Hari Patidar narrated a success story of AFG-3 fenugreek production in M.P. for which, seed was provided by NRCSS, Ajmer. He also

discussed with farmers as well as the officers of Agriculture Department, Govt. of MP, and made aware about the current programmes and schemes related to the agriculture launched by Govt. of India, as well as State Government. He asked the farmers to come forward for seed spice production for better economy.

5.2.4 Workshop on seed spices for state agriculture officers: A three days workshop on seed spices was organized during 27-29 October 2015 in collaboration of State Institute of Agriculture Management, Durgapura, Jaipur. Participants of the workshop were Agriculture Officers from State Agriculture Department. During three days deliberations were made on every aspect of seed spices production technologies with special emphasis on cryogenic grinding technology of seed spices. Live demonstration of cryogenic grinding technology was also made during the workshop.

5.3 Training and Capacity Building Programme Attended

5.3.1 Training (International)

Dr. Balraj Singh attended a self-learning e-course on "Climate Change, Impacts and Adaption: Basic Course" organized by APO, Tokyo, Japan during Feb.10-May 11, 2015

5.3.2 Training attended (National)

S. N. Saxena, N. K. Meena and S. R. Meena attended training on Good agricultural and good manufacturing practices for the production and handling of spices, conducted by Joint institute for food safety and applied nutrition, USA, Spice board and CII-Jubilant Bhartia Food and Agricultural Centre of Excellence under MIDH during March 7-8, 2016 at NRCSS, Ajmer

S. Choudhary attended a winter school on Advances in improvement of vegetable crops using biotechnological approaches, Division of Vegetable Sciences, during September 18 to October 8, 2015 at IARI, New Delhi.

R. K. Solanki attended summer School on RNA interference: As a tool for plant functional genomics and crop improvement, during May 6-26, 2015 at NRCPB, New Delhi.

R. D. Meena and S. R. Meena attended a winter school on Utilization of degraded land and soil through horticultural crops for agricultural productivity and environmental quality, during December, 3-23, 2015 at ICAR-NRCSS, Ajmer.

A. K. Verma participated in a winter school on novel genomic tools and modern genetics and breeding approaches for vegetable crop improvement, during Nov. 07-27, 2015 at ICAR-IIVR, Varanasi.

Harisha C.B. attended a Short course on Smart agro-input delivery approaches based on hydrogels and other polymeric carriers for improved crop health and productivity, Division of Agricultural Chemicals, during July 21-30, 2015 at ICAR-IARI, New Delhi.

S.R. Meena attended a training on Production protocol for bio control agents, during June 5-15, 2015 at NIPHM, Rajendra Nagar, Hyderabad

S.R. Meena participated in a short course on Recent advances in mass production of bio control agents at ICAR-during Sept. 1-10, 2015 at NCIPM New Delhi.

5.3.3 Seminar/symposium/workshop attended

During 2015-16 Scientists and technical officers were provided opportunities to attend international and national seminars/symposia/ workshops organized in India. The aim was to highlight the scientific achievements made by NRCSS in seed spices arena and simultaneously

impart latest research & development trends in agricultures and allied sectors. A total of 69 seminars/symposiums were attended by scientists of NRCSS to make lead /oral/poster presentation of their research progress at national and international fora. Details of capacity building programmes attended by NRCSS staff is mentioned in following list.

5.3.3.1 Conference / Seminar/ Symposia/ Workshop/ Meetings etc.

Name of participant	Name of event	Period
Balraj Singh	National workshop on protected cultivation of horticultural crops, ITM University, Gwalior.	April 10, 2015
	4 th National seminar and exhibition on spices and herbs organized by NNS Media Group, New Delhi.	April 18, 2015
	Doordarshan Advisory Committee Meeting at DD Kendra, Jaipur.	May 5, 2015
	Directors, Vice Chancellor's Conference at NASC Complex New Delhi.	May 15-16, 2015
	First shadow committee meeting on spices & culinary herbs (CCSCH 2), Udyog Bhawan, New Delhi.	June 8, 2015
	Farmer's fair & national symposium on climate change and smart agriculture technologies at RVSKVV, Gwalior, MP.	June 13, 2015
	4 th National conference on potential of plastic industry in northern India with focus to plasticulture (micro irrigation and post-harvest management), FICCI, Chandigarh.	June 26, 2016
	Farmer fair at KVK, Baghra, Muzaffarnagar (UP).	June 27, 2015
	Board of management meeting of MPUA&T, Udaipur (Raj.)	Dec 9, 2015
	Board of management meeting at Agricultural University, Jodhpur.	2015-16
Balraj Singh and S. S. Rathore	Directors, Vice Chancellor's conference at NASC Complex New Delhi.	Jan. 24-25, 2016
	National workshop on forward thinking for agricultural development in Western India, organized by FAO, APAARI, NAARM in collaboration with SDAU at Sardar Krushinagar, Gujarat.	Feb. 10-12, 2016
Balraj Singh, S S. Meena, B. K. Mishra and P. N. Dubey	National symposium on climate change and smart agriculture Technologies, College of Agriculture, Gwalior (MP).	June 13, 2015
G. Lal	National Symposium on Agriculture resource management for sustainability and eco- restoration, ICAR-CIAH, Bikaner.	Mar. 11-13, 2016
	Discussion and preparation of technical programme for new centers of network project on organic farming (NPOF) - meeting of principal investigators (PI) at ICAR-IIFSR, Modipuram.	April 24-25, 2015
	10 th annual group meeting of ICAR-network project on organic Farming at MPUAT, Udaipur, Rajasthan.	Aug. 19-21, 2015

G. Lal and Y.K. Sharma	The ninth annual review meeting of MIDH programmes implemented through the DASD, Calicut held at the Dr. YSR Horticultural University, Tadepalligudem (AP) during	June 19- 20, 2015
G. Lal, Y. K. Sharma, R. K. Kakani, R. S. Meena and R. K. Solanki	XXVI Workshop of All India Coordinated Research Project on Spices at Indian Institute of Spices Research, Kozhikode, Kerala.	Oct. 4- 7, 2015
G. Lal, R. S. Mehta, Diwakar, Y. and Harisha C.B.	Symposium on spices and aromatic crops (SYMSAC -VIII) towards 2050 - strategies for sustainable spices production [™] organized by Indian Society for Spices, Kozhikode, Kerala, at TNAU, Coimbatore.	Dec. 16-18, 2015
S. N. Saxena and Y. K. Sharma,	Workshop on seed spices in collaboration of state Institute of agriculture management, Durgapura, Jaipur at ICAR-NRCSS, Ajmer.	Oct. 27-29, 2015
R. K. Kakani, R.S. Mehta and M.K. Vishal	3 rd International plant physiology congress on challenges and strategies in plant biology research, Convention Centre, JNU, New Delhi, India.	Dec. 11-14, 2015
Y.K. Sharma	Workshop to develop a clear road map for agricultural development to Western Dry Region of Rajasthan CAZRI, Jodhpur.	Nov. 6, 2015
	Mid-Term Review - ICAR Regional Committee No.VI Meeting with State Representatives at CAZRI, Jodhpur.	Nov. 7, 2015
	VC of SAUs and ICAR Directors conference at NASC Complex.	Jan. 23, 2016
Y.K. Sharma, S.S. Meena and B.K. Mishra	National symposium on sustaining agricultural productivity in arid ecosystem: challenges and opportunities (Sapco-2015), Regional Research Station, Central Arid Zone Research Institute, Leh.	Aug. 19-22, 2015
R. K. Kakani	Workshop on CRP on agro-biodiversity at NBPGR, New Delhi.	Oct. 14, 2015
	31 st meeting of state seed-sub committee for agricultural and horticultural crops for the state of Rajasthan, Jaipur.	Dec. 22, 2015
	Workshop on competency development for human resource development nodal officers of ICAR at NAARM, Hyderabad.	Feb. 10-12, 2016
R. S. Mehta	Pre seminar meeting for finalizing technical programme of Golden Year Celebrations & National Seminar on Planting material production in spices at DASD, Calicut, Kerala.	Aug. 19, 2015
	Review meeting of progress of agricultural activities held at Collectorate Auditorium, Ajmer (Rajasthan), organized by Department of Agriculture, Govt. of Rajasthan.	Oct. 09, 2015
	State level seminar on advance seed spice production technology on spices held at CAZRI, Jodhpur (Rajasthan).	Feb. 20-21, 2016
R. S. Mehta and S.S. Meena	National symposium on vegetable legumes for soil and human health, Indian Institute of Vegetable Research, Varanasi (UP).	Feb. 12-14, 2016.

Ravindra Singh	Meeting of ZREAC Zone III meeting, RARI, Durgapura, Jaipur.	Sept. 8-9, 2016
Ravindra Singh and Sharda Choudhary	National conference on microbes in extreme environments: Diversity and Translational Applications (MEEDTA-2015), Srinagar-Garhwal (Uttara Khand).	Oct. 30-31, 2015
S.S. Meena, S.S. Rathore, B. K. Mishra and R. D. Meena	National symposium on modern agro-technologies for nutritional security and health, Nauni, Solan.	April 21-23, 2015
O.P. Aishwath	80 th Annual convention of Indian Society of Soil Science and national seminar on developments in soil science, University of Agricultural Sciences, Bangalore.	Dec. 5-8, 2015
	National conference on natural resource management in arid and semi-arid ecosystem for climate resilient agriculture and rural development. SKRU, Bikaner, Rajasthan.	Feb. 17-19, 2016
B.K. Mishra	22 nd Academic Council Meeting, Bhagwant University, Ajmer.	May 16, 2015
	ICAR- Rajbhasha Hindi Sangoshthi, NASC complex, Pusa, New Delhi.	Nov. 07, 2015
	24 th Academic Council Meeting, Bhagwant University, Ajmer.	Nov. 30, 2015
B.K. Mishra and P.N. Dubey	International conference on agriculture, veterinary & environmental sciences-2015, Vijayawada, Andhra Pradesh.	July 24 - 25, 2015
	National conference on innovative research in agriculture, food science, forestry, horticulture, aquaculture, animal sciences, biodiversity, environmental engineering and climate change, JNU, New Delhi.	Oct. 31- Nov., 2015
	Indian ecological society international conference -2016, natural resource management: ecological perspective, Sher-E-Kashmir University of Agricultural Sciences & Technology of Jammu, J& K.	Feb. 18-20, 2016
P.N. Dubey	Awareness cum training program for cultivation and development of coriander seeds: coriander cultivation and practices Akluj, Sholapur, organized by Spice Board, Mumbai, Maharashtra.	June 30, 2015.
	IJTA 2 nd International conference on agriculture, horticulture & plant sciences, Shimla, H.P.	Dec. 26-27, 2015
R.S. Meena	10 th review meeting of DUS testing, MPKV, Rahuri .	Feb. 26-27, 2016
N. K. Meena	Brainstorming on integrated pest management in major crops organized by NCIPM, NASC complex, New Delhi .	Feb.16-17, 2016
N.K. Meena and R.D. Meena	International symposium on "next generation approaches for sustainable development of hill and upland horticulture, Sikkim University, Gangtok, Sikkim.	Nov. 5-7, 2015



R.D. Meena	National workshop on rapid diagnostic tools for <i>Phytophthora</i> , India Institute of Horticultural Research (ICAR), Bangalore, Karnataka (India).	Sept. 8, 2015
	International symposium on <i>Phytophthora</i> : taxonomy, genomic, pathogenicity, resistance and disease management held at India institute of horticultural research, Bangalore, Karnataka.	Sept. 12, 2015
	International conference on plant pathogens and people challenges in plant pathology to benefit humankind, New Delhi.	Feb. 23-27, 2016
M.K. Vishal	Workshop of nodal officers of ICAR research data repository for knowledge management, IASRI, New Delhi.	Aug. 04-05, 2015
	Innovation clubs and bankers workshop, NABARD, Jaipur.	Feb. 24, 2016
	4 th NKN-annual workshop at JNTU, Hyderabad.	Jan. 21-22, 2016
A.K. Verma, Harisha, C.B. and Honnappa Asangi	National seminar on harmonizing biodiversity and climate change: Challenges and opportunity (NSBC-2015)" organized by Andaman Science Association, Port Blair, Andaman and Nicobar Islands.	April 17-19, 2015
S.R. Meena	Kisan Mela, Krishi Vigyan Kendra, Muzaffarnagar (U.P).	June 27, 2015
	Kisan Mela, CAZRI, Jodhpur (Raj.).	Sept. 24, 2015
	Kisan Mela, Krishi Vigyan Kendra (S.K.N. Agricultural University), Dantra, Dist-Ajmer (Raj.).	Feb. 26, 2016
Balraj Singh, Gopal Lal, S.N. Saxena, Y.K. Sharma, R. K. Kakani, R.S. Mehta, Ravindra Singh, K. Kant, S.S. Meena, O.P. Aishwath, B.K. Mishra, P.N. Dubey, S.S. Rathore, R.S. Meena, N. K. Meena, R.K. Solanki, Sharda Choudhary, R. D. Meena, M.K. Vishal, A.K. Verma, Diwakar Y., Harisha C.B, S.P. Maheria, M.A. Khan, S.R. Meena.	Workshop cum brainstorming session on strategies to strengthen seed spices plant genetic resources and burning issues of cumin and coriander, NRCSS, Ajmer.	May 27, 2015.
	Rashtriya Kisan Beej Mela evam Krishak Mahotasv-2015, ICAR-National Research Centre on Seed Spices, Ajmer	Sept. 28-30, 2015
	National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, NRCSS, Ajmer.	Feb. 2-3, 2016.

6. AWARDS AND RECOGNITIONS

6.1 Awards

Zee News Rajasthan Agriculture Award-2016 conferred to ICAR-National Research Centre on Seed Spices, Ajmer

On 23rd January, 2016 ICAR-National Research Centre on Seed Spices, Ajmer was awarded with the prestigious Zee Rajasthan News Agriculture Award-2016 in a function organized at SIAM, Durgrapura, Jaipur. Dr Balraj Singh, the then Director of the Centre received the award for outstanding contribution towards the field of Horticulture from the Hon'ble Agriculture Minister, Rajasthan State Shri. Prabhu Lal Saini. Other dignitaries present in the function were Shri Kuldeep Raka, Secretary and Commissioner Agriculture and Horticulture, Rajasthan and Shri Purshottam Vaishnav, Head Zee New Rajasthan. Hon'able Agriculture Minister appreciated the activities carried out by the centre and also referred the outstanding



performance of stem gall resistant variety Ajmer Coriander-1 in Hadoti regions. Dr Balraj Singh thanked Zee News for selecting ICAR-NRCSS, Ajmer for this prestigious award, Later he presented significant achievements and ongoing research programmes on seed spices research and development at State and National level.

Individual awards

Name of Personnel	Name of Award	Given by (Organizer/ Place)
G. Lal	Best Seed Spices Worker Award	President, ISSS, Ajmer on February 2, 2016.
Y.K. Sharma	Best Scientist Award of NRCSS (2015-16)	Director, NRCSS on Republic day function, 2016.
S.S. Meena	Young Scientist Award-2015	Society for Agriculture and Arid Ecology Research, ICAR-CIAH, Bikaner, 11-13, March, 2016.
Harisha C.B.	Best Young scientist of NRCSS (2015-16)	Director, NRCSS on Republic day function, 2016.
Diwakar Y	Best Men Athlete Award First place in 100 m sprint First place in Long Jump First place in men 4 x 100 m relay race Second place in High Jump Second place in Javelin throw and Third place in Shot put throw First place in 100 m sprint Third place in Long Jump	Western Zone sports and games meet held at ICAR - CSWRI, Avikanagar during 20-24, November, 2015. ICAR Inter Zonal Sports and Games Meet at CAZRI, Jodhpur held during 8-12 Feb, 2016



6.2 Recognition

Balraj Singh

- 'Dr. Kirti Singh Gold Medal Award in "Vegetable Science" by Horticultural Society of India in 2015.

G. Lal

- Co-Chairman, Transfer of Technology Session: XXVI workshop of All India Coordinated Research Project on Spices during 4th to 7th October 2015 at Indian Institute of Spices Research, Kozhikode, Kerala.

S.N. Saxena

- Chief Guest for the programme on "Ozone Day" celebration in Dayanand College, Ajmer on Sept. 16, 2015.
- Best Research Paper Award by Indian Society of Seed Spices, Ajmer on Effect of cryogenic grinding on recovery of diosgenin content in fenugreek (*Trigonella foenum-graecum* L.) genotypes. *Inter. J. of Seed Spices*. 3(2): 26-30.
- Best poster award on Effect of moisture stress on chlorophyll content, canopy temperature, water potential and seed oil yield of fenugreek (*Trigonella foenum-graecum* L.) genotypes. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.
- Best poster award on Analysis of total phenolics and antioxidant activity in seed and leaf extracts of cumin genotypes. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

Best poster award on Effect of cryogenic grinding on volatile and fatty oil constituents of cumin (*Cuminum cyminum* L.) genotypes. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

Y.K. Sharma

- Best poster award on Cumin wilt caused by more than one species of *Fusarium* in India: A new report based on survey of Gujarat, Rajasthan and Madhya Pradesh States. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

Joint Secretary, Indian Society of Seed Spices

R.S. Mehta

- Secretary, Indian Society of Seed Spices, Ajmer for 2014-15.

Rapporteur in the Technical session on "Mechanization and Processing" in National Seminar on New Dimensional Approaches for enhancement of seed spices productivity and profitability under era of climate change held at NRCSS, Ajmer during 2-3 Feb, 2016.

K. Kant

- Rapporteur in Technical Session IV- National Seminar on New Dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change", during 2-3 February, 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India

O. P. Aishwath

- Best poster award on Isolation of zinc solubilizers from coriander rhizosphere and their efficacy. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.



- Distinguished Scientist Award in the field of Soil Science on the occasion of National Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences held during 12-13 December, 2015 at RVSKVV, Gwalior.
- Leadership award conferred by Soil Conservation Society of India in 25th National conference on natural resource management in arid and semi-arid ecosystem for climate resilient agriculture and rural development, during Feb. 17-19, 2016 at SKRAU, Bikaner, Rajasthan.

Rapporteur in Technical Session II: Crop Production, of National Seminar on "New Dimensional Approaches for Enhancement of Seed Spices Productivity and Profitability under Era of Climate Change" during 2-3 February, 2016.

R. Singh

- First Best Oral presentation award on Climate Resilient Technologies for Seed Spices in Semi-Arid Conditions of Rajasthan authored by Ravindra Singh, Balraj Singh and Gopal Lal. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.
- Rapporteur in plenary session cum valedictory function in National Seminar on "New Dimensional Approaches for enhancement of seed spices productivity and profitability under era of climate change" held at NRCSS, Ajmer during 2-3 Feb, 2016.

B.K. Mishra

- First Best oral paper presentation award for- Influence of plant growth promoting rhizobacteria on growth and yield of Isabgol (*Plantago ovata* Forssk.)" presented by Brijesh K. Mishra (2016). In: National Symposium on Agriculture Resource management for sustainability and Eco- restoration held on 11-13 March 2016 at ICAR-CIAH, Bikaner.
- First best poster presentation award for - "Isolation of zinc solubilizers from coriander rhizosphere and their efficacy" presented by O.P.Aishwath, B.K. Mishra, R.D. Meena Dharmesh Jain and A.N. Ganeshmurthy in the crop production session of National Seminar on New Dimensional Approaches for enhancement of seed spices productivity and profitability under era of climate change held at NRCSS, Ajmer during 2-3 Feb, 2016.
- Member of Academic Council of Bhagwant University, Ajmer for two years w.e.f. 18 February, 2015 and participated in two Academic council meetings during 2015-16.
- Chairman of the Technical Session-II in National Conference-AFHABEC-2015 organized by Krishi Sanskriti at J.N.U., New Delhi from 31-1 November, 2015.
- Rapporteur in the Technical session on "Scientist- Farmer-Industry Interface in National Seminar on New Dimensional Approaches for enhancement of seed spices productivity and profitability under era of climate change held at NRCSS, Ajmer during 2-3 Feb, 2016.
- Rapporteur in the plenary session cum valedictory function in National Seminar on New Dimensional Approaches for enhancement of seed spices productivity and profitability under era of climate change held at NRCSS, Ajmer during 2-3 Feb, 2016.

Rapporteur in the 1st Technical session in National Symposium on Agriculture Resource management for sustainability and eco- restoration held on 11-13 March, 2016 at ICAR-CIAH, Bikaner

P.N. Dubey

- Fellow award of Indian Society of Seed Spices 2015-16 for outstanding contribution in the field of seed spices & other areas of agricultural research during National Seminar on New dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change. 2-3 Feb., 2016 at ICAR-NRCSS, Ajmer.
- First oral presentation award on Modified QuEChERS multi residue analysis protocol for coriander seeds authored by P.N. Dubey, T.P. Ahammed Shabeer, K.Kant, S.N. Saxena, S.S. Rathore and Diwaker, Y. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.



- Chairman of Technical Session-II in "National Conference on Innovative research in Agriculture, Food Science, Forestry, Horticulture, Aquaculture, Animal Sciences, Biodiversity, Environmental Engineering and Climate change" during 31-1 November, 2015 held at Jawaharlal Nehru University, New Delhi, India and Organized by Krishi Sanskriti.
- Rapporteur of Technical Session on Scientist-Farmer-Industry Interface in "National Seminar on New Dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change", during 2-3 February 2016 jointly Organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

N.K. Meena

- Best poster presentation award on organic control of aphids in coriander (*Coriandrum sativum* L.) in semi-arid region of Rajasthan. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

R.K. Solanki

- Best poster award on Cumin wilt caused by more than one species of *Fusarium* in India: A new report based on survey of Gujarat, Rajasthan and Madhya Pradesh State. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

Fellow award of Indian Society of Seed Spices 2015-16 for outstanding contribution in the field of seed spices & other areas of agricultural research during National Seminar on New dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change. 2-3 Feb., 2016 at ICAR-NRCSS, Ajmer.

M.K. Vishal

- First prize in debate competition in Vigilance Awareness week
- Runner up for Discuss throw event at West Zone sports tournament at Avikanagar, 2015
- First prize in the Essay Writing Competition in Hindi Diwas Pakhawara celebration

A.K. Verma

- First oral presentation award on Acute exposure of gamma rays on seed germination and seedling growth of cumin (*Cuminum cyminum* L.) authored by A.K. Verma, K.S. Reddy, P. Dharsekar, R.K. Solanki and Balraj Singh In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India
- Second in PowerPoint presentation in Hindi, organised during Hindi Pakhwada

Harisha C.B.

- Nominated member of NHB nursery accreditation team by Director, NRCSS for accreditation of commercial fruit nurseries under NHB scheme for Ajmer district during 20-21 August, 2015.

S.P. Maheria

- Best poster presentation award on Effect of water conservation on productivity of *Nigella* (*Nigella Sativa* L.) authored by S. P. Maheria, G. Lal, R.S. Mehta and M K Vishal. In: National seminar on new dimensional approaches for enhancement of seed spices productivity and profitability under era of climate change, during 2-3 February 2016 jointly organized by ICAR-NRCSS, Ajmer, DASD, Calicut and ISSS, Ajmer, India.

S.R. Meena

- First Prize in Oral Power point Presentation entitled "बीजीय मसालों का उचित भंडारण, आवश्यकता एवं उपयोगिता" during Rajbhasha Hindi Pakhwara on dated 15-30 September 2015.



7. LINKAGES AND COLLABORATIONS

Linkages and collaborations has been found to be a vital 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. NRCSS has been a key functionary towards collaboration and linkages with various ICAR Institutes, State Agricultural Universities, Central and State government organizations and other agencies working on the same aspects of seed spices research and development in the country. NRCSS is always encouraging collaborative research work with parallel institutes or Universities. During the period of report NRCSS have established collaboration and linkages as mentioned below.

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

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

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

ICAR-Central Plantation Crops Research Institute, Regional Station, Guwahati.

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

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

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

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

ICAR-Central Sheep and Wool Research Institute, Avikanagar.

ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, AP.

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

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

ICAR-ATARI, Jodhpur, Rajasthan.

ICAR-ATARI, Barapani, Meghalaya.

ICAR-Indian Institute of Horticulture Research, Bengaluru.

ICAR-National Bureau of Agriculturally Important Micro-organisms, Mau, UP.

ICAR-National Research Center on Grapes, Pune.

ICAR-Central Soil Salinity Research Institute, Karnal.

ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur.

ICAR-Central Institute of Sub-Tropical Horticulture, Lucknow.

ICAR-Indian Institute of Farming Systems Research, Modipuram.

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

ICAR-NRC for Orchids, Pakyong, Sikkim.

Spices Board, Cochin, Kerala.

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

State Agriculture Department of Rajasthan and Gujarat.

State Horticulture Department of Rajasthan and Gujarat.

Central Agricultural University, Campus Pasighat.

SAU's i.e. SKRAU, Bikaner; MPUAT, Udaipur; SKN Agricultural University, Jobner; Kota Agricultural University, Kota; Jodhpur Agricultural University, Jodhpur; SDAU, Dantiwara; CCS HAU, Hisar; PAU, Ludhiana; SKUAT, Sri Nagar; APHU, Hyderabad; UAS, Dharwar and NDUAT, Faizabad.

College of Horticulture & Forestry, Jhalawar.

KVKs: Ajmer, Banswara, Barmer, Bundi, Chomu, Dungarpur, Gudamalani, Jalore, Jhunjhunu, Mandor, Pokhran, Pali, & Pratapgarh.

Farmers, NGOs and KVKs.

8. PUBLICATIONS

International Journals

1. Balasubramanian, S., Roselin, P., Singh, K. K., Zachariah T. J. and Saxena, S.N. 2015. Post harvest processing and benefits of black pepper, coriander, cinnamon, fenugreek and turmeric spices. *Critical Reviews in Food Science and Nutrition* 56(10):1585-1607.
2. Barnwal, P., Singh, K. K., Sharma, A., Choudhary, A. K. and Saxena, S. N. 2015. Influence of pin and hammer mill on grinding characteristics, thermal and antioxidant properties of coriander powder. *J. Food Sci. Technol.* 52(12):7783-7794.
8. Choudhary, S., Meena, R.S., Singh, R, Vishal, M.K., Jethra, G., Saini, M. and Panwar, A. 2015. Analysis of diversity among cumin (*Cuminum cyminum*) cultivars using RAPD markers. *Indian J. Agri. Sc.* 85(3):409-413.
9. Choudhary, S., Singh, R., Meena, R.S. and Jethra, G. 2016. Secondary and tertiary structure prediction of fenugreek (*Trigonella foenum-graecum*) protein. *Legume Research* 39(1):48-51.
10. Diwakar, Y., Shah, P.G., Singh, B., Harisha, C.B., Rathore, S.S., Dubey, P.N. and Saxena, S.N. 2016. GC aided method for extraction and quantification of dithiocarbamate residues in cumin seeds *Int. J. Seed Spices* 6(1):78-81.

National Journals

1. Agrawal, D., Sharma, L.K., Rathore, S.S., Zachariah, T.J. and Saxena, S.N. 2016. Analysis of total phenolics and antioxidant activity in seed and leaf extracts of cumin genotypes. *Int. J. Seed Spices* ,6(1): 43-49.
2. Aishwath, O.P. 2016. Macro-nutrient requirement and uptake distribution in some important cultivars of coriander for nutritional budgeting. *Int. J. Seed Spices*, 6(1): 11-16.
3. Barnwal, P., Singh, K.K., Sharma, A., Chaudhary, A.K., Zachariah, T.J. and Saxena, S.N. 2015. Selected physical and mechanical properties of black pepper seed (cv. Panniyar-5). *Int. J. Seed Spices*,5(2):20-25.
4. Barnwal, P., Singh, K.K., Sharma, A., Chaudhary, A.K., Zachariah, T.J. and Saxena, S.N. 2016. Thermochemical and antioxidant properties of cryogenically ground turmeric powder. *Int. J. Seed Spices*, 6(1):1-10.
5. Bontha, V., Tomar, B.S., Singh B. and Behera, T.K 2015. Effects of methods and time of pollination on seed yield and quality parameters in cherry tomato grown under different protected conditions. *Indian J Hort.* 72(1):61-66.
6. Choudhary, S. and Jethra, G. 2015. Deciphering protein structure identified in cumin (*Cuminum cyminum* L.). *Applied Biological Research* 17(3):225-230.
7. Choudhary, S., Jethra, G., Sharma, R.S., Tripathi, A., Mishra, J. and Pareek, D. 2015. Rapid and reliable method for high quality RNA isolation from major seed spices. *Journal of Plant Dev. Sci.* 8(2):79-82.
11. Dubey, P.N., Bhaskar, B.P., Chandran, P., Singh, B. and Mishra, B.K. 2016. Geochemistry of some ferruginous soils of Kerala, India. *J. Applied and Natural Science* 8(1):196-207.
12. Dubey, P.N., Kant, K., Ahammed Shabeer T.P., Saxena, S.N., Rathore, S.S. and Diwakar, Y. 2016. Multi residue evaluation protocol for coriander (*Coriandrum sativum*) seeds. *Int. J. Seed Spices* 6(1):82-85.
13. Godara, A.S. and Singh, R. 2015. Weed control efficiency of post emergence herbicides and their effect on productivity of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.]. *Legume Research* 38(3):415-418.
14. Jat G. S., Singh B., Tomar, B. S. and Ram, H. 2015. Comparative performance of growth, flowering behaviour and fruit development traits in parental lines of bitter gourd (*Momordica charantia*) cv. pusa hybrid-1. *Seed Research.* 42 (2):139-145.
15. Kumar, V., Tomar, B.S., Dadlani, M., Singh, B. and Kumar S. 2015. Effect of fruit retention and seed position on the seed yield and quality in pumpkin (*Cucurbita moschata*) cvPusa Hybrid 1. *Indian J Agri Sci* 85(9):86-89.
16. Kaddi, G., Tomar, B.S., Singh B. and Parihar, S.S. 2015. Physiological maturity and its influence on seed yield and quality in cucumber (*Cucumis sativus*) under different growing environments. *Indian J Agri*

- Sciences*. 85 (7): 960–4.
17. Kaddi, G., Tomar, B.S., Singh B. and Bontha, V. 2015. Influence of seed extraction methods on seed quality in cucumber (*Cucumis sativus*) cv. Pant Shankar Khira-1. *Progressive Horticulture*. 47(1): 116-121.
 18. Kakani, R.K., Singh, G. and Saxena, S.N. 2015. Genetic divergence in fenugreek (*Trigonella foenum-graecum*). *Int. J. Seed Spices* 5(1):37-40.
 19. Karel, A., Parvateesam, M. and Mishra, B.K. 2016. Effect of rhizobium, arbuscular mycorrhiza and rhizobacterial isolates on fenugreek (*Trigonella foenum-graecum*) growth and mycorrhiza population. *Int. J. Seed Spices* 6(1):50-53.
 20. Kumar, S., Saxena, S.N., Mistry, J.G. Fougat, R.S., Solanki, R.K. and Sharma, R. 2015. Understanding *Cuminum cyminum*: An important seed spice crop of arid and semi arid regions. *Int. J. Seed Spices* 5(2):1-19.
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9. RAC, IRC AND IMC MEETINGS

9.1 शोध सलाहकार समिति (आर.ए.सी.) की बैठक

पांचवीं शोध सलाहकार समिति की दूसरी बैठक दिनांक 9-10 मार्च, 2016 को रा.बी.म.अनु.केन्द्र में पूर्व निदेशक (रा.बी.म.अनु.केन्द्र, अजमेर) डॉ. बी.बी. वशिष्ठ की अध्यक्षता में आयोजित की गई। आर.ए.सी. बैठक में अन्य सदस्य डॉ. जाककी राम, ए.डी. जी.(एच.एस.2) केब-2 (भा.कृ.अनु.प) नई दिल्ली, डॉ. जितेन्द्र कुमार निदेशक डी.एम.पी.आर. आनन्द, डॉ. ई.वी.डी. शास्त्री, प्रोफेसर, रारी दुर्गापुरा, डॉ. ए.एन. मौर्य पूर्व निदेशक कृषि विज्ञान संस्थान, बी.एच.यू. वाराणसी, डॉ. आर.सी. दाधीच, पूर्व प्रोफेसर सस्य विज्ञान विभाग, एम.पी.यू.ए.टी, उदयपुर, डॉ. बलराज सिंह, निदेशक भा.कृ.अनु.प.— रा.बी.म.अनु.केन्द्र, तथा डॉ. गोपाल लाल, प्रधान वैज्ञानिक सदस्य सचिव, आर.ए.सी. उपस्थित थे। केन्द्र द्वारा चलाई जा रही विभिन्न गतिविधियों कि झलक निदेशक रा.बी.म.अनु.परिषद द्वारा प्रस्तुत की गई। डॉ. वशिष्ठ ने



गत वर्ष किये गये कार्यों की प्रशंसा की। उन्होंने वैज्ञानिकों से आग्रह किया कि व बीजीय मसाला फसलों के विकास के लिये नई किस्मों का लक्ष्यीकरण, कुशल उत्पादन और सुरक्षा प्रौद्योगिकी के लिए कार्य करें। डॉ. टी.जानकीराम, संस्थान कि प्रभावशाली उपलब्धियों कि प्रशंसा की तथा साथ ही संस्थान को राष्ट्रीय संस्थान के दर्जे का उन्नत संस्थान बनाने कि कामना की। आने वाले समय में अनुसंधान की गतिविधियों की बेहतरी के लिये आर.ए.सी. अध्यक्ष तथा अन्य सदस्यों द्वारा विभिन्न सिफारिशें दी गई।

9.2 संस्थान अनुसंधान परिषद की बैठक—

अनुसंधान की एक्स.वी. (1) तथा (2), संस्थान अनुसंधान परिषद(आई.आर.सी.) बैठक डॉ. बलराज सिंह, निदेशक भा.कृ.अनु.प.— रा.बी.म.अनु.केन्द्र, की अध्यक्षता में 3 जून, 2015 तथा 3-4 अगस्त 2015 को अनुसंधान परियोजनाओं की समीक्षा तथा विचार विमर्श हेतु आयोजित की गई।

बैठक में नई परियोजनाओं के प्रस्तावों को भी भलि-भांति देखा गया तथा विचार विमर्श किया गया व औपचारिक रूप से



अनुमोदित किया गया। 3-4 अगस्त, 2015 को आयोजित आई.आर.सी. की 15वीं (P) बैठक में तीन बाह्य सदस्यों (डॉ. प्रतिम कालिया, प्रधान वैज्ञानिक एवं अध्यक्ष, वनस्पति विज्ञान विभाग, आई.ए.आर.आई., पूसा, नई दिल्ली, डॉ. आर.एन. पाण्डेय, प्रोफेसर एवं अध्यक्ष, प्लांट पैथोलॉजी विभाग, बी.ए.सी.ए., आनंद कृषि विश्वविद्यालय, आनंद, गुजरात और डॉ. ए.यू. एमीन, प्रभारी, सी.आर.एस.एस., एस.डी.ए.यू., जगुदान, मेहसाणा, गुजरात) को आमंत्रित किया गया। डॉ. वाई.के. शर्मा, प्रभारी, पी.एम.ई. सेल ने पांचवीं आर.ए.सी. (प्रथम बैठक) द्वारा दी गई सिफारिशों के बारे में विस्तार से बताया तथा दिये गये सुझावों / सिफारिशों को अनुसंधान कार्यक्रमों में शामिल करने पर विचार-विमर्श किया गया। प्रत्येक अनुसंधान परियोजना की प्रगति की समीक्षा की गई तथा उस पर चर्चा की गई। अध्यक्ष, अन्य सदस्यों के धन्यवाद प्रस्ताव के साथ कार्यक्रम का समापन हो गया।

9.3 संस्थान प्रबंधन समिति बैठक

तेरहवीं संस्थान प्रबंधन समिति की बैठक का आयोजन दिनांक 27 अगस्त, 2015 को डॉ. बलराज सिंह (निदेशक, रा.बी.म.अनु.केन्द्र) की अध्यक्षता में किया गया। बैठक में सदस्यों डॉ. आर.सी. दाधीच, पूर्व प्रोफेसर, उदयपुर, डॉ. बी.डी. शर्मा, अध्यक्ष, फसल उत्पादन विभाग, सी.आई.ए.एच., बीकानेर, डॉ. कृष्ण कान्त, प्रधान वैज्ञानिक, रा.बी.म.अनु.केन्द्र, अजमेर और श्री रवीन्द्र सिंह, प्रशासनिक अधिकारी, रा.बी.म.अनु.केन्द्र, अजमेर और सदस्य सेक्रेटरी ने बैठक में भाग लिया।

चौदहवीं आई.एम.सी. बैठक का आयोजन डॉ. बलराज सिंह, निदेशक, रा.बी.म.अनु.केन्द्र की अध्यक्षता में दिनांक 18 जनवरी, 2016 को किया गया। अन्य सदस्य डॉ. आर.सी. दाधीच, डॉ. बी.डी. शर्मा, डॉ. कृष्ण कान्त, श्री एस.सी. शर्मा, वित्त व लेखा विभाग, अदिकानगर एवं श्री भीम सिंह, सहायक प्रशासनिक अधिकारी, रा.बी.म.अनु.केन्द्र व सदस्य सेक्रेटरी ने आयोजन में भाग लिया।

10. विशिष्ट आगतुक



Prof. Sanwar Lal Jat, inaugurating exhibition during Kisan Mela



Dr. R. S. Paroda, inaugurating Auditorium of NRCSS



Dr R.R. Hanchinal and Dr. S. K. Malhotra, in the National Seminar

क्रमांक	नाम	पद और भ्रमण दिनांक
1.	प्रो. सांवरलाल जाट	जल संसाधन: नदी विकास और गंगा संरक्षण राज्य मंत्री भारत सरकार, 28 सितम्बर 2015 और 5 दिसम्बर, 2015.
2.	श्री सुरेश रावत	पुष्कर और संसदीय सचिव विधायक, राजस्थान सरकार 5 दिसम्बर, 2015
3.	डॉ. आर. एस. परोदा	टी.ए.ए.एस., नई दिल्ली के अध्यक्ष, 27 मई 2015 और 25 जनवरी 2015
4.	डॉ. एस. अख्यपन	महानिदेशक, आई. सी. ए. आर., नई दिल्ली 25 जनवरी, 2016
5.	आर. आर. हनचल	अध्यक्ष, पी.पी.वी. एवं एफ.आर.ए., नई दिल्ली 27 मई 2015 और 02 फरवरी 2016
6.	डॉ. एन. के. कृष्ण कुमार	डी.डी.जी. (एच.एस.) आई. सी. ए. आर., नई दिल्ली 25 जनवरी 2016
7.	डॉ. टी. जानकीराम	ए.डी.जी. (एच.एस.) आई. सी. ए. आर., नई दिल्ली 03 दिसम्बर, 2015 और 9 मार्च 2016
8.	डॉ. एस. के. मल्होत्रा	कृषि और बागवानी आयुक्त, भारत सरकार 02 फरवरी, 2016
9.	डॉ. एस. बी. दानदीन	बाहरी कुलपति, भगवंत विश्वविद्यालय, बगलकोट (कर्नाटक) 27 मई, 2015
10.	डॉ. एम. आन्दराज	निर्देशक, आई.आई.एस.आर., कालीकट 02 फरवरी 2016
11.	डॉ. आर. सी. अग्रवाल	रजिस्ट्रार जनरल पी.पी.वी. एवं एफ.आर.ए., नई दिल्ली 02 फरवरी 2016
12.	डॉ. एच.पी. सिंह	बाहरी डी.डी.जी. (एच.एस.) आई. सी. ए. आर., नई दिल्ली 19 जनवरी, 2016
13.	डॉ. बी.बी. वशिष्ठ	अध्यक्ष: आर.एस.सी. एवं बाहरी निर्देशक एन.आर.सी.एस.एस. अजमेर 9 मार्च, 2016
14.	डॉ. रजितेन्द्र कुमार	निर्देशक डी.एम.ए.पी.आर., आनन्द 02 फरवरी, 2016
15.	डॉ. आर.आर. मट्ट	निर्देशक, (ए) काजरी जोधपुर 27 मई, 2015
16.	डॉ. एम.एन. उस्मान	सहायक निर्देशक: मसाला बोर्ड, जोधपुर 07 अगस्त, 2015
17.	डॉ. एस. एस. नकवी	निर्देशक, सी.एस.डब्ल्यू आर.आई : अदिकानगर 28 सितम्बर, 2015
18.	डॉ. एस. एस. सिंधु	हैड, फूलों की खेती के विभाजन, आई.ए.आर.आई., नई दिल्ली 28 सितम्बर, 2015
19.	डॉ. आर. एस. धईया	निर्देशक आई.एच.आई.टी.सी. जयपुर 28 सितम्बर, 2015
20.	श्री दिलीप पचार	प्रधान, पीसांगन 28 सितम्बर, 2015
21.	श्री रामचन्द्र चौधरी	अध्यक्ष, सरस डेयरी, अजमेर 30 सितम्बर, 2015 और 25 जनवरी 2016
22.	डॉ. बी.जे. वर्मा	उप निर्देशक क्षेत्रीय केन्द्र मसाला बोर्ड, गुजरात 27 अक्टूबर, 2015
23.	डॉ. शीतल प्रसाद शर्मा	राज्य के कृषि प्रबंधन संस्थान के निर्देशक जयपुर 27 अक्टूबर 2015
24.	प्रो. एन.के. शर्मा	विस्तार निर्देशक, जोधनेर 05 दिसम्बर 2015
25.	श्री वी.के. शर्मा	उपनिदेशक, (एग्रीकल्चर एक्सटेंशन) अमेर 05 अजमेर 05 दिसम्बर, 2015
26.	प्रो. अनुप कुमार	प्रधान, डी.ए.वी. विश्वविद्यालय, अजमेर 19 जनवरी, 2016
27.	डॉ. निर्मल बाबु	पी.सी., ए.आई.सी.आर.पी. ऑन स्पाईसेस, कालीकट 02 फरवरी 2016
28.	डॉ. आई. जे. माथुर	विस्तार निर्देशक, एम.पी.यू.ए.टी., उदयपुर 02 फरवरी 2016
29.	डॉ. क्लारे नारोड	जे.आई.पी.एस.ए.एम., यू.एस.ए 08 मार्च 016
30.	डॉ. जेम्स रशींग	जे.आई.पी.एस.ए.एम., यू.एस.ए 08 मार्च 016
31.	डॉ. वेनु गोपाल	मसाला बोर्ड, कोचीन 08 मार्च, 2016
32.	प्रो. सी.बी. गेना	बाहरी कुलपति, महाराजा गंगा सिंह विश्वविद्यालय, बीकानेर, 28 मार्च 2016
33.	डॉ. ए.एन. मौर्य	बाहरी निर्देशक, कृषि विज्ञान संस्थान, बी.एच.यू. वाराणसी 9 मार्च 2016
34.	डॉ. एन.एन. सिंह	सचिव, टी.ए.ए.एस. और बाहरी कुलपति बिरसा कृषि विश्वविद्यालय, रांची 19 जनवरी 2016

II. महिला सशक्तिकरण

महिलाओं को शिकायत सेल के लिये चार बैठक वर्ष 2015-16 के दौरान आयोजित की गई। विभिन्न मुद्दों जैसे सफाई, स्वास्थ्य, व्यक्ति विकास, महिलाओं की सुरक्षा, यौन उत्पीड़न के बारे में बैठक के दौरान चर्चा की गई। सभी स्टाफ सदस्यों कार्यकर्ताओं और संविदात्मक कर्मचारियों सहित घटना में सक्रिय भागीदारी के लिये आमंत्रित किया गया था।

जागरूकता भाषण डॉ. बलराज सिंह, तात्कालीन निदेशक एन. आर.सी.एस.एस. द्वारा दिया गया था। डॉ. शारदा चौधरी वैज्ञानिक और सचिव महिला शिकायत सेल की रोकथाम और काम के स्थान पर उत्पीड़न के नियंत्रण के संबंध में वैज्ञानिक दिशा-निर्देशों के बारे में विस्तार से बताया। प्रश्नोत्तरी कार्यक्रम खेत आयोजित किया गया था और पुरस्कार विजेता के लिये वितरित किये गये। एक नवाचार दृष्टिकोण भारतीय कृषि में महिला किसान के कठिन परिश्रम को कम करने के लिये

आवश्यक है क्योंकि महिलाओं को खेती गतिविधियों में एक बड़ी भूमिका निभा महिलाओं उपयुक्तता अवधारणा के साथ कृषि मशीनीकरण बीज मसाले की खेती के साथ-साथ फसल और फसल कटाई के बाद प्रबंधन भी आवश्यक है। एन.आर.सी.एस. एस. नियमित रूप से प्रशिक्षण और कार्यशालाओं खेत महिलाओं के लिये ज्ञान और कौशल को प्रभावित करने के लिये आयोजित कर रहा है। स्वच्छ भारत मिशन के दौरान, महिलाओं को परिवार के सदस्यों के साथ ही खेत जानवरों के स्वास्थ्य में सुधार लाने में साफ सफाई और स्वच्छता की भूमिका के बारे में समझाया गया। घर के पोषण खाद्य सुरक्षा धारण शिक्षित और प्रशिक्षित महिलाओं द्वारा यह सुनिश्चित किया जा सकता है और एन.आर. सी.एस.एस. महिला किसान प्रशिक्षण कार्यक्रम के अध्ययन से इस दिशा में बहुत कुछ कर रही है।



International Womens Day Celebrations (8 March, 2016)



College girls and progressive women farmers participation at NRCSS

12. अवसंरचना विकास

12.1 योजना मद के अंतर्गत कार्य

मैसर्स राजस्थान इलेक्ट्रानिक्स एवं इन्स्ट्रुमेन्ट्स लिमिटेड, जयपुर द्वारा रु 83,46,450/- की लागत के 105 किलोवाट पावर ग्रिड से जाडे सौर ऊर्जा संयंत्र का कार्य संस्थान की छत पर शुरू किया गया।

रूपये 11,80,584/- की लागत से सभागार में पुश बैक कुर्सियों का थियेटर के अनुरूप स्थापित किया गया। ये 171 कुर्सियाँ जालाराम मेक जे.ए.सी. 405 मॉडल की स्टैंडर्ड हेवी ड्यूटी की हैं जिसमें दाहिने हाथ पर लेखन पैड भी लगा हुआ है।



12.2 गैर-योजना मद के अंतर्गत कार्य

केन्द्रीय लोक निर्माण विभाग के माध्यम से रु 12.00 लाख की अनुमानित लागत से खलियान की फर्श का पुर्न-निर्माण कार्य प्रारंभ किया गया। इस कार्य ने पुराने कार्यालय भवन के समीप स्थिति खलियान की फर्श का नवीकरण तथा नेट हाउस के पास कच्चे फर्श पर सुधार का कार्य सम्मिलित हैं।

उत्तर-दक्षिण सड़क पर नाले से लेकर बाउन्ड्री तक तथा मौसम विज्ञान प्रयोग रोड पर बेर बगीचे से बाउन्ड्री तक एल.ई.डी. बल्ब लगाये गये।

1/2 एकड़ क्षेत्र में सूक्ष्म सिंचाई सह उर्वरक सिंचन प्रौद्योगिक प्रखण्ड पर लता मंडप का निर्माण किया गया जिसमे बीजीय मसालों का गैरमौसमी उत्पादन दो स्तरीय खेती प्रणाली में किया जायेगा।

लगभग एक हेक्टेयर क्षेत्र में बेर के बागीचे को पंक्षी सुरक्षा जाल से ढका गया है जिसके लिए ढलवा लोहे की 17.5 फीट ऊँची पाइपों को जमीन में लगाया गया है जिससे की दिन में पंक्षियों से तथा रात में चमगादड़ों से फल नुकसान को रोका जा सकेगा।



13. कार्मिक

13.1 वैज्ञानिक

1.	डॉ. बलराज सिंह	निदेशक (26, मार्च, 2016 तक)
2.	डॉ. गोपाल लाल	प्रधान वैज्ञानिक (बागवानी) और अभिनय निदेशक (27 मार्च 2016से)
3.	डॉ. एस.एन. सक्सेना	प्रधान वैज्ञानिक (पादप शरीर क्रिया विज्ञान)
4.	डॉ. आर.के. काकाणी	प्रधान वैज्ञानिक (पादप प्रजनन)
5.	डॉ. वाई.के. शर्मा	प्रधान वैज्ञानिक (प्लांट पैथोलॉजी)
6.	डॉ. आर.एस. मेहता	प्रधान वैज्ञानिक (कृषि विज्ञान)
7.	डॉ. रविन्द्र सिंह	प्रधान वैज्ञानिक (कृषि विज्ञान)
8.	डॉ. कृष्ण कांत	प्रधान वैज्ञानिक (कीट विज्ञान)
9.	डॉ. ओ.पी. एश्वथ	वरिष्ठ वैज्ञानिक (मृदा विज्ञान)
10.	डॉ. एस.एस. मीणा	वरिष्ठ वैज्ञानिक (बागवानी)
11.	डॉ. बी.के. मिश्र	वरिष्ठ वैज्ञानिक (कीटाणु विज्ञान)
12.	डॉ. पी.एन. दूबे	वरिष्ठ वैज्ञानिक (कृषि रसायन विज्ञान)
13.	डॉ. आर.एस. मीणा	वरिष्ठ वैज्ञानिक (पादप प्रजनन)
14.	डॉ. एन.के. मीणा	वैज्ञानिक (कीट विज्ञान) आर.जी.पी. 7000
15.	डॉ. आर.के. सोलंकी	वैज्ञानिक (पादप प्रजनन) आर.जी.पी. 7000
16.	डॉ. शारदा चौधरी	वैज्ञानिक (जीव विज्ञान) आर.जी.पी. 7000
17.	श्री एम.के. विशाल	वैज्ञानिक (कृषि सांख्यिकी)
18.	डॉ. आर.डी. मीणा	वैज्ञानिक (प्लांट पैथोलॉजी)
19.	डॉ. ए.के. वर्मा	वैज्ञानिक (मसाला, वृक्षारोपण औषधिय और सुगंधित पौधे)
20.	श्री हरिशा सी.बी.	वैज्ञानिक (मसाला, वृक्षारोपण औषधिय और सुगंधित पौधे)
21.	श्री होनप्पा आसगि	वैज्ञानिक (मसाला, वृक्षारोपण औषधिय और सुगंधित पौधे)
22.	श्री दिवाकर वाई.	वैज्ञानिक (मसाला, वृक्षारोपण औषधिय और सुगंधित पौधे)

13.2 तकनीकी

1.	श्री एस.पी. महेरिया	मुख्य तकनीकी अधिकारी
2.	श्री एम.ए. खान	मुख्य सहायक तकनीकी अधिकारी
3.	श्री एस.आर. मीणा	वरिष्ठ तकनीकी अधिकारी
4.	श्री जी.के. त्रिपाठी	वरिष्ठ तकनीकी अधिकारी
5.	श्री पी.के. अग्रवाल	वरिष्ठ तकनीकी
6.	श्री अजीत सिंह	वरिष्ठ तकनीकी
7.	श्री एस.आर. बलई	वरिष्ठ तकनीकी

13.3 प्रशासनिक, लेखा एवं लेखापरीक्षा

1.	श्री भीम सिंह	सहायक प्रशासनिक अफसर
2.	श्री सुनील कुमार अग्रवाल	सहायक वित्त और लेखा अधिकारी
3.	श्री संजीव शर्मा	सहायक
4.	श्री आर.के. कवारिया	उच्च श्रेणी लिपिक
5.	अमित कुमार गुप्ता	निम्न श्रेणी लिपिक
6.	मुकेश कन्डारी	निम्न श्रेणी लिपिक

13.4 कुशल कर्मचारियों का समर्थन

- | | | |
|----|-------------------|----------------------------|
| 1. | श्रीमति सरला देवी | कुशल कर्मचारियों का समर्थन |
| 2. | श्री पुखराज परोदा | कुशल कर्मचारियों का समर्थन |

13.5 अध्ययन अवकाश—

- | | | |
|----|--------------------|---|
| 1. | श्री होनप्पा आसंगि | वैज्ञानिक (मसाला, वृक्षारोपण औषधिय और सुगंधित पौधे) |
|----|--------------------|---|

13.6 हस्तांतरण / चयन—

1. डॉ. बलराज सिंह ने 26मार्च,2016 को निदेशक एन. आर.सी.एस.एस., अजमेर के पद से राहत मिली और उन्होंने जोधपुर कृषि विश्वविद्यालय में कुलपति का पद में शामिल हुये।
2. श्री दिवाकर को 31 मार्च, 2016 को एन.आर.सी.एस. एस., अजमेर से तबादला हुआ, उन्होंने सी.पी.सी.आर. आई कासरगोड, करेला में वैज्ञानिक पद पर शामिल हुये।

13.7 पदोन्नती

1. डॉ. रविन्द्र सिंह वरिष्ठ वैज्ञानिक, प्रधान वैज्ञानिक खबरदार परिषद के कार्यालय आदेश के पद पर पदोन्नत किया गया। 2पी.एस./2015-एयू-28 अप्रैल 2015, डब्ल्यू.ई.एफ. 14 सितम्बर, 2013.

2. डॉ. ओ.पी. ऐश्वथ वैज्ञानिक(एस.एस.) प्रधान वैज्ञानिक खबरदार परिषद के कार्यालय आदेश के पद पर पदोन्नत किया गया। 6-89/2012-एयू, दिनांक 25 फरवरी 2016 / डब्ल्यू.ई.एफ. 3 अक्टूबर 2006.
3. डॉ. कृष्णकांत वरिष्ठ वैज्ञानिक प्रधान वैज्ञानिक खबरदार परिषद के कार्यालय आदेश के पद पर पदोन्नत किया गया। 2पी.एस./2015-एयू-28 अप्रैल 2015.

13.8 शोक—

एस.एस. राठौड वरिष्ठ वैज्ञानिक का आकस्मिक निधन 13 मार्च 2016 को हो गया। एन.आर.सी.एस.एस. परिवार ने गहरा शोक व्यक्त किया। भगवान उनके परिवार को शोक सतप्त, साहस और धैर्य प्रदान कर सकते हैं।

14. LIST OF ON GOING RESEARCH PROJECTS

लिस्ट ऑफ आउटगोइंग रिसेच प्रोजेक्ट एज ईन 14-15 ए.आर.

परियोजना:- बीजीय मसालों की उत्पादकता बढ़ाने के लिए हितधारकों में ज्ञात एवं दक्षता में सुधार

सी.पी.डी. (21 बीजीय मसालों में डाटाबेस का निर्माण एवं विकास)

(पी.आई.: एम.के. विशाल:2011-15)

एस.एस./13.16.1- टी.एस.पी. एवं एन.इ.एच के मध्य कार्यशाला, परिक्षण, सेमिनार एवं प्रदर्शन के द्वारा फसल कटाई की तकनीकियाँ एवं बीजीय मसाला उत्पादन का प्रसार

बाह्य वित्तपोषित परियोजनाएं

1. मुख्य सर्वर्धित उत्पादों का निर्यात बढ़ाने के लिए बीजीय मसालों में सम्भावित स्रोतों में प्राकृतिक एन्टिऑक्सीडेंट, आवश्यक तेल एवं ओलिवरेजिन्स का उत्खनन: एस.एन. सक्सेना (पी.आई.)
2. बीजीय मसालों फसलों में इस परिक्षण के निर्देश (आर.एस. मीणा)
3. बीजीय मसालों में केन्द्र द्वारा घोषित परियोजना- एम.आई. डी. एच विकास कार्यक्रम

नेटवर्क एवं प्लेटफार्म शोध परियोजना

1. राज. एवं गुजरात के शुष्क एवं अर्द्धशुष्क क्षेत्रों से बीजीय मसालों (धनिया एवं जीरा) में जीवाणु की विविधता का उत्खनन (एस. चौधरी पी.आई.)
2. उद्यानिकी फसलों में चुसने वाले कीटों का प्रबन्ध आउटरीच कार्यक्रम (के.कांत पी.आई.)
3. नहीं होती हिन्दी मेरे से इस लाइन की
4. नेटवर्क परियोजना कार्बनिक उद्यानिकी के अधिन बीजीय मसालों कार्बनिक उत्पादन तकनीकियों का विकास पी.आई. -आर.एस.मेहता
5. उद्यानिकी एवं खेत वाली फसलों में फाइहोपथोरा, फ्यूजेरियम एवं रालस्टोनिया में आउटरीच परियोजना, वाई. के. शर्मा
6. फाइटोकेमिकल्स/उच्च गुणवत्ता तत्व- एस.एस.राठौड पी.आई. एस.एन. सक्सेना
7. उपज एवं गुणवत्ता बढ़ाने के लिए उद्यानिकी फसलों (बीजीय मसालों) में सुक्ष्मपोषकतत्वों का प्रबन्ध

8. बीजीय मसालों में नियन्त्रित परिस्थिति में उत्पादन तकनीकियों का निर्धारण (पी.आई. रविन्द्र सिंह)

9. बीजीय मसालों के दस जननद्रव्य में पुनर्जीवन एवं अभिलाक्षीकरण - आर.के. काकाणी

10. जैविक खेती में नेटवर्क परियोजना - जी.लाल

परियोजना-4 सुरक्षित बीजीय मसाले उत्पादन के लिए कुशल फसल सुरक्षा प्रौद्योगिकियों का शोधन एवं विकास

सी.पी.टी.1-बीजीय मसालों में मौजूदा एवं उभरती हुई बीमारीयों का सर्वेक्षण एवं निगरानी

(पी.आई. - आर.डी. मीणा को.-पी.आई. वाई.के. शर्मा, एम.के. विशाल एवं एस.आर.मीणा-2012-15)

सी.पी.टी./13.13.1 मैथी एवं जीरे में उभरती हुई समस्याओं का प्रबन्ध

(वाई.के. शर्मा को.-पी.आई. आर.डी. मीणा-2013-16)

सी.पी.टी./13.17.1 धनिया, सौंफ अजवाइन एवं सोवा की गुणवत्ता एवं उपज पर परागणों का प्रभाव

(पी.आई. - एन.के. मीणा को.-पी.आई. के. कान्त 2013-17)

परियोजना-5 बीजीय मसालों में फसल कटाई के बाद मूल्य सर्वर्धन, प्रसंस्करण तकनीकियों का शोधन एवं विकास

बी.एस.-6 धनिया एवं मैथी में जननद्रव्य में गुणवत्ता का प्रोफाइल तैयार करना। (पी.आई. - एस.एस. राठौड: को. -पी.आई.एस.एन. सक्सेना: 2011-2015

बी.एस.-7 जीरे में (साइनम क्यूमिनम एल) में बचाव प्रतिक्रियाओं का जैव रासायनिक आधार

पी.आई. एस.एस. राठौड: 2011-2015

बी.एस.-8:- जैविक प्रतिरोधों के मध्य मसाला फसलों में गुणवत्ता एवं उपज बढ़ाने के लिए कार्य की दृष्टिकोण (-पी.आई.एस.एन. सक्सेना को.-पी.आई. एस.एस. राठौड 2012-2015

सी.पी.डी/13.8.1:- बीजीय मसालों से मूल्य संवर्धित उत्पादों का विकास

पी.आई. जी.लाल को.पी.आई.बी.के. मिश्रा-2014-17

बी.एस/14.5.1 राजस्थान एवं गुजरात के धनिया एवं जीरा बुवाई वाले क्षेत्रों में कृषि-रसायनों का मूल्यांकन एवं निगरानी (पी.एन. दूबे: को.पी.आई एस. एन. सक्सेना, दिवाकर वाई, एस.एस. राठौड एवं के.कान्त: 2014-17



Externally Funded Projects

S.No.	Title
1.	Exploitation of seed species as a potential source of natural antioxidants, essential oil and oleoresins of enhancing export of value added products, S. N. Saxena (PI)
2.	DUS testing guideline in seed spices crops. R. S. Meena (PI)
3.	Centrally Sponsored Scheme -MIDH Development programme on Seed Spices. Y.K. Sharma (PI)

Network/Platform Research Projects

S.No.	Title
1.	Exploration of microbial diversity in seed spices (cumin and coriander) in arid and semiarid regions of Rajasthan and Gujarat. S. Choudhary (PI)
2.	Outreach programme on management of sucking pests in horticultural crops (ORP-SP). K. Kant (PI)
3.	Consortium research platform on borers in network mode. K. Kant (PI)
4.	Development of organic production technologies for seed spices under net-work project on organic horticulture. R. S. Mehta (PI)
5.	Outreach project on <i>Phytophthora</i> , <i>Fusarium</i> and <i>Ralstonia</i> diseases of horticultural & field crops. Y.K. Sharma (PI)
6.	Phytochemicals/hi-value compounds. S.S. Rathore (PI) now S.N. Saxena (PI)
7.	Micronutrient management in horticultural crops (Seed Spices) for enhancing yield and quality. O.P. Aishwath (PI)
8.	Standardization of production technologies for seed spices under protected conditions Ravindra Singh (PI)
9.	Regeneration and characterization of ten seed spices germplasm. R.K. Kakani (PI)
10.	Network project on organic farming. G. Lal (PI)

15 अन्य सूचनाएँ

15.1 रा.बी.म.अ. केन्द्र, स्थापना दिवस समारोह

आईसीएआर- रा.बी.म.अ. केन्द्र, अजमेर ने 19 जनवरी, 2016 को अपना 16वाँ स्थापना दिवस मनाया। डॉ. एच.पी. सिंह, पूर्व उप-महानिदेशक (बागवानी), भाकृअनुप, नई दिल्ली समारोह के मुख अतिथि रहे। उन्होंने इस अवसर पर स्थापना दिवस व्याख्यान भी प्रस्तुत किया। समारोह में डॉ. एन.एन. सिंह, सचिव टीएएएस, पूर्व कुलपति, बिरसा कृषि विश्वविद्यालय, साबोर, बिहार, विशिष्ट अतिथि के रूप में मौजूद रहे। इस कार्यक्रम में रा. बी.म.अनु. केन्द्र के वैज्ञानिकों एवं कर्मचारियों सहित, राज्य के कृषि विभाग, कृषि विज्ञान केन्द्र, दयानंद महाविद्यालय से पधारे अतिथियों ने भी कार्यक्रम में शिरकत की। राजस्थान के विभिन्न क्षेत्रों के प्रगतिशील बीजीय मसाला उत्पादकों ने भी भाग लिया। इस कार्यक्रम में केन्द्र के निदेशक, डॉ. बलराज सिंह, ने मुख्य अतिथि सहित सभी उपस्थिति मेहमानों, अधिकारियों, कर्मचारियों व किसानों का स्वागत किया तथा केन्द्र द्वारा सम्पादित एवं वर्तमान में चल रहे विभिन्न अनुसंधान कार्यक्रमों, परियोजनाओं के तहत चल रहे कार्यों का विस्तृत ब्यौरा दिया। स्थापना दिवस व्याख्यान के माध्यम से डॉ. एच.पी. सिंह ने बागवानी के क्षेत्र में अपना अनुभव एवं भविष्य में संभावनाएँ पर अपना मत प्रकट किया। इस अवसर पर डॉ. एन. एन. सिंह ने भी अपने विचार रखे एवं केन्द्र के वैज्ञानिकों एवं कर्मचारियों से रूबरू हुए। कार्यक्रम का समापन डॉ. वाई. के. शर्मा के धन्यवाद भाषण के साथ हुआ।



15.2 सतर्कता जागरूकता सप्ताह-2015 का आयोजन

रा.बी.म.अनु केन्द्र, अजमेर में दिनांक 26-31 अक्टूबर 2015 को सतर्कता जागरूकता सप्ताह के रूप में मनाया। इस वर्ष सतर्कता जागरूकता सप्ताह का मुख्य फोकस प्रीवेन्टीव विजिलेन्स : एज ए टूल ऑफ गुड गवर्नेंस रहा। इस सप्ताह के भीतर केन्द्र में कई गतिविधियाँ जैसे शपथ ग्रहण, निबंध लेखन, वाद-विवाद प्रतियोगिता, टिप्पणी लेखन, आदि आयोजित की गयी। वाद-विवाद प्रतियोगिता, निबंध लेखन तथा टिप्पणी लेखन का विषय क्रमशः सुशासन के उपकरण के रूप में निवारक सतर्कता सुशासन में सतर्कता जागरूकता की भूमिका तथा सतर्कता जागरूकता : एक आम आदमी का कर्तव्य। रा.बी.म.अनु केन्द्र, अजमेर के कर्मचारियों ने इन प्रतियोगिताओं में भाग लिया तथा विजेताओं को पुरस्कृत किया गया। सप्ताह के दौरान सतर्कता

जागरूकता से संबंधित लिखित पोस्टर्स मुख्य-मुख्य स्थानों पर लगाये गये। 31 अक्टूबर, 2015 को प्रीवेन्टीव विजिलेन्स एज ए टूल ऑफ गुड गवर्नेंस पर एक संगोष्ठी आयोजित की गयी। संगोष्ठी में पूर्व निदेशक डॉ. बलराज सिंह ने सतर्कता से संबंधित विभिन्न मसलों को मध्यनजर रखकर एक वक्तव्य रखा तथा कर्मचारियों को अपने अनुसंधान केन्द्र इस तरह की व्यवस्थाएँ बनाए रखने पर बल दिया।



Debate competition on Preventive vigilance as a tool of good governance

15.3 राजभाषा हिन्दी पखवाड़ा- 15-30 सितंबर, 2015

राष्ट्रीय बीजीय मसाला अनुसंधान केन्द्र, अजमेर (राजस्थान), पर विगत वर्षों की तरह इस वर्ष भी राजभाषा हिन्दी पखवाड़ा 15-30 सितंबर, 2015 के दौरान मनाया गया। पखवाड़ा का शुभारम्भ 15 सितंबर, 2015 को राजभाषा क्रियान्वयन समिति की बैठक के साथ हुआ जिसमें डॉ. बलराज सिंह, निदेशक, रा.बी.म.अनु. केन्द्र ने अध्यक्षता की। केन्द्र पर भाषा हिन्दी के प्रगामी प्रयोग हेतु सुझावों पर चर्चा की गयी। 19 सितंबर, 2015 को संस्थान में कार्यरत वैज्ञानिक, अधिकारी एवं कर्मचारियों के बच्चों की हिन्दी में अभिरुचि हेतु बाल प्रतियोगिता का आयोजन किया गया जिसमें हिन्दी काव्य पाठ, प्रश्नोत्तरी, हिन्दी में पत्र लेखन तथा स्वरचित कविता पाठ की प्रतियोगिता हुई। सफल बाल प्रतिभागियों को पुरस्कृत किया गया। 21 सितंबर, 2015 को एक दिवसीय राजभाषा हिन्दी संगोष्ठी एवं पॉवर पॉइंट प्रस्तुतीकरण किया गया। हिन्दी पखवाड़े के दौरान अनेक प्रतियोगिताओं का जैसे वाद-विवाद, तत्काल/आशुभाषण, टिप्पणी-लेखन, कर्मचारी वर्ग हेतु हिन्दी लेखन प्रतियोगिता, निबंध लेखन का आयोजन किया गया। इन



प्रतियोगिताओं में संस्थान में कार्यरत वैज्ञानिक, अधिकारी, कर्मचारी एवं अनुसंधान अध्येता वर्ग के लोगों ने हिस्सा लिया। निदेशक महोदय 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। राजभाषा हिन्दी के प्रगारी डॉ. बृजेश कुमार मिश्र ने विभिन्न कार्यक्रमों के सफल आयोजन हेतु केन्द्र के निदेशक डॉ. बलराज सिंह के मार्गदर्शन को रेखांकित करते हुए निर्णायक मण्डल के सदस्यों डॉ. बलराज सिंह, डॉ. गोपाल लाल, डॉ. आर. के. कांकाणी, डॉ. युगल किशोर शर्मा तथा डॉ. रविन्द्र सिंह का विशेष आभार व्यक्त किया। और समस्त वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को इस हिन्दी पखवाड़ा कार्यक्रम को सफल बनाने के लिए धन्यवाद दिया।

15.4 राजभाषा संगोष्ठी जलवायु परिवर्तन के सन्दर्भ में पर्यावरण सुरक्षा की चुनौतियाँ एवं कृषि पर प्रभाव

दिनांक 5 जून, 2015 को विश्व पर्यावरण दिवस के अवसर पर एक वैज्ञानिक परिचर्चा का आयोजन किया गया। संस्थान के सभी वैज्ञानिकों, अधिकारियों एवं कर्मचारियों ने जलवायु परिवर्तन के संदर्भ में पर्यावरण संरक्षण की चुनौतियाँ एवं कृषि पर प्रभाव विषय पर अपने अनुभवों तथा सामूहिक प्रयासों पर चर्चा में भाग लिया।

जलवायु परिवर्तन एक लंबे समय से चल रहे अवैज्ञानिक प्राकृतिक दोहन का नतीजा है जिसका त्वरित समाधान संभव नहीं है। इसका समाधान केवल प्राकृतिक एवं वैज्ञानिक तरीकों के उपयोग द्वारा पर्यावरण संरक्षण से ही किया जा सकता है। इस अवसर पर विभिन्न वक्ताओं ने परिचर्चा में भाग लिया एवं पर्यावरण संरक्षण हेतु विभिन्न तथ्यों पर जानकारी दी। पर्यावरण परिवर्तन से कृषि पर होने वाले कुप्रभावों पर मनन किया गया एवं कृषि को पर्यावरण परिवर्तन के दुष्प्रभावों से बचाने हेतु विभिन्न उपायों पर चर्चा की गयी। एकमत से पर्यावरण संरक्षण, पारिस्थितिकी तंत्र को संरक्षित करने हेतु विचार प्रकट किये गये। संगोष्ठी में जल, मृदा, वन, वायु, भोजन एवं उर्जा के तर्क संगत उपयोग पर बल दिया गया। चर्चा उपरान्त यही हल निकाला कि, अब से भी अगर हम पर्यावरण संरक्षण को मनोयोग से करने का प्रयास करें तो भविष्य में आने वाली कई प्राकृतिक आपदाओं को कम कर सकते हैं। इस उपलक्ष्य में कृषि विज्ञान में हिन्दी के प्रयोग को बढ़ाने के लिए एक दिवसीय राजभाषा संगोष्ठी का भी आयोजन किया।



15.5 जय किसान-जय विज्ञान सप्ताह समारोह

भारत के पूर्व प्रधानमंत्री, भारत रत्न श्री अटल बिहारी वाजपेयी एवं स्वर्गीय श्री चौधरी चरण सिंह की जयंती के अवसर पर रा.बी. म.अनु. केन्द्र, अजमेर, राजस्थान में 23-29 दिसंबर, 2015 को जय किसान –जय विज्ञान सप्ताह के रूप में मनाया गया। यह समारोह देश के उन महान नेताओं का किसानों के उत्थान के लिए विज्ञान को बढ़ावा देने जैस योगदान को मध्य नजर आयोजित किया गया। जय किसान-जय विज्ञान सप्ताह 2015 के उद्घाटन समारोह में राबीमअनु केन्द्र के पूर्व निदेशक, डॉ. बलराज सिंह ने अपने स्वागत भाषण में श्री अटल बिहारी वाजपेयी एवं स्वर्गीय श्री चौधरी चरण सिंह को याद किया तथा उनके द्वारा देश के विकास में किये गये कार्यों पर प्रकाश डाला। उन्होंने चौधरी चरण सिंह द्वारा किये गये जोत का समेकन के माध्यम से खंडित भूमि जोत समस्या का समाधान सुनिश्चित करने को भी सराहा, साथ ही उन्होंने सड़क कोरीडोर निर्माण जैसे बड़ी परियोजना को लागू करवाकर किसानों को अपने उत्पादों का परिवहन में सहायता के लिए श्री अटल बिहारी वाजपेयी के प्रयासों को भी सराहा।



15.6 मेरा गांव मेरा गौरव (एमजीएमजी)

मेरा गांव मेरा गौरव कार्यक्रम रा.बी.म.अनु. केन्द्र के 4-4 वैज्ञानिकों के समूह में कुल 5 टोलियां बनाई जो केन्द्र के आस-पास के 25 गांव में, जिनमें प्रत्येक टोली के पास पाँच गांव रखकर कार्य प्रारंभ किया। इसमें सर्वप्रथम प्रत्येक गांव का आधार भूमि सर्वेक्षण किया गया तथा बाद में आवश्यकतानुसार चयनित गांव में फसल काल के दौरान किसानों को कृषि से संबंधित नई तकनीकियाँ सुझाई, कुछ गांवों के किसानों को केन्द्र परिसर पर दो दिवसीय प्रशिक्षण दिया गया। कुछ गांवों में किसानों को प्रदर्शन भी दिये गये तथा फिल्ड डे भी कराये गये।

15.7 स्वच्छ भारत अभियान

राष्ट्रीय स्वच्छ भारत मिशन के तहत रा.बी.म.अनु. केन्द्र, अजमेर, राजस्थान द्वारा गत वर्ष अक्टुबर 2015 तक सफाई, जागरूकता से संबंधित कई कार्यक्रम संस्थान परिसर, बाहर, आस-पास

सड़क एवं नजदीकी गाँवों में स्वच्छता जागरूकता कार्यक्रम सम्पन्न किये गये इस कार्यक्रम से केन्द्र के कर्मचारियों ने अपने कार्यालय समय के अतिरिक्त कुल 109 घंटे काम भी किया।



15.8 भाकृअनप स्थापना दिवस समारोह

रा.बी.म.अनु. केन्द्र, अजमेर में 16 जुलाई, 2016 को केन्द्र के वैज्ञानिकों, तकनीकी अधिकारियों एवं प्रशासनिक कर्मचारियों द्वारा भारतीय कृषि अनुसंधान परिषद् का 88वाँ स्थापना दिवस मनाया गया। इस अवसर पर केन्द्र के निदेशक ने देश को खाद्यान उत्पादन में आत्मनिर्भर बनाने में आईसीएआर एवं एनएआरएस (नार्सी) की भूमिका पर प्रकाश डाला। उन्होंने प्राकृतिक स्रोतों का पारिस्थितिक एवं आर्थिक फायदे के लिए विवेकपूर्ण उपयोग करने पर बल दिया। लक्षित उपलब्धि के लिए अनुसंधान एवं विकास की गतिविधियों को निर्धारित समय के अंतर्गत मिशन मोड में पूर्ण करने पर जोर दिया। वैश्वीकरण एवं व्यवसायिकरण के इस युग में युवाओं को कृषि, खासकर संरक्षित खेती एवं सब्जियों एवं बीजीय मसालों के मूल्य वर्धित के क्षेत्रों में आगे आने की जरूरत बताई।



15.9 राष्ट्रीय विज्ञान दिवस

28 फरवरी, 2016 को केन्द्र ने स्कूल एवं महाविद्यालय के छात्रों



के साथ मिलकर केन्द्र परिसर में राष्ट्रीय विज्ञान दिवस का आयोजन किया। कार्यक्रम में वैज्ञानिक-छात्र वातचीत सत्र रखा जिसमें छात्रों द्वारा पूछे जाने वाले प्रश्नों का वैज्ञानिकों ने जवाब दिया। इसमें छात्रों को कृषि में जैव-प्रौद्योगिकी का प्रयोग व अंतरिक्ष प्रौद्योगिकी के क्षेत्रों में प्राप्त उपलब्धियों के बारे में जानकारी दी गयी।

15.10 विश्व मृदा स्वास्थ्य दिवस

आईसीएआर-रा.बी.म.अनु. केन्द्र ने कृषि विज्ञान केन्द्र, उप-निदेशक (कृषि विस्तार), अजमेर व भिनाय पंचायत समिति के संयुक्त तत्वाधान में 5 दिसम्बर, 2015 को केन्द्र परिसर में विश्व मृदा स्वास्थ्य दिवस का आयोजन किया। कार्यक्रम के उद्घाटन समारोह में भारत सरकार के जल संसाधन, नदी विकास एवं गंगा संरक्षण राज्य मंत्री प्रो. सांवर लाल जाट मुख्य अतिथि रहे। प्रो. जाट ने अपने सम्बोधन भाषण में लोगों से इस दिन को सच्ची भावना के साथ मृदा के वास्तविक महत्व को समझकर मनाने पर जोर दिया। इस अवसर पर रा.बी.म.अनु. केन्द्र, केवीके एवं राज्य कृषि विभाग ने लगभग 250 मृदा स्वास्थ्य कार्ड माननीय मंत्री जी के कर कमलों द्वारा किसानों को बंटवाए।



15.11 राष्ट्रीय एकता दिवस

देश की एकता एवं अखंडता के लिये राष्ट्रीय एकता दिवस.....



महिनों के औसतन तापमान, आपेक्षित आर्द्रता, वाष्पन तथा वर्षा-2014

वर्ष -2014 महिना	औसत तापमान (°C)		आपेक्षित आर्द्रता (%)		वाष्पन (एमएम/डे)	कुल वर्षा (एमएम)
	न्यूनतम	अधिकतम	7.40 एएम	2.40 पीएम		
जनवरी	6.5	21.7	74.1	56.7	1.7	0.0
फरवरी	8.9	24.4	73.1	48.1	2.5	9.0
मार्च	14.7	30.8	66.2	41.5	4.2	0.0
अप्रैल	22.3	36.7	67.3	45.6	7.4	12.0
मई	28.1	38.0	65.8	45.1	10.6	29.0
जून	31.0	40.2	30.4	37.1	13.2	0.0
जुलाई	28.3	35.2	27.6	34.6	7.5	43.7
अगस्त	26.0	31.7	93.6	81.3	4.8	203.6
सितम्बर	24.8	31.9	91.4	84.5	4.9	197.0
अक्टुबर	21.4	34.3	88.0	77.2	6.0	0.0
नवम्बर	13.2	30.7	84.5	51.1	4.0	0.0
दिसम्बर	7.4	24.3	81.8	66.7	2.2	0.0
औसत	19.4	31.6	70.3	55.8	5.8	494.3

महिने का औसतन तापमान, आपेक्षित आर्द्रता, वाष्पन तथा वर्षा-2015

वर्ष -2015 महिना	औसत तापमान (°C)		आपेक्षित आर्द्रता (%)		वाष्पन (एमएम/डे)	कुल वर्षा (एमएम)
	न्यूनतम	अधिकतम	7.40 एएम	2.40 पीएम		
जनवरी	7.3	21.5	84.9	72.5	1.4	16.0
फरवरी	10.4	27.3	86.3	76.5	3.1	2.0
मार्च	16.7	29.0	89.5	68.6	3.7	63.0
अप्रैल	25.1	37.2	85.4	60.9	8.1	10.0
मई	29.9	41.5	82.1	69.0	14.9	0.0
जून	28.9	37.6	88.6	81.2	10.1	75.5
जुलाई	26.9	32.8	91.4	83.5	5.0	202.0
अगस्त	25.4	32.0	91.7	79.2	5.1	97.0
सितम्बर	25.5	35.1	90.0	64.1	7.1	0.0
अक्टुबर	19.9	35.0	87.4	53.0	5.2	0.0
नवम्बर	14.8	30.1	88.3	62.5	3.7	0.0
दिसम्बर	6.6	24.9	91.1	58.3	2.6	0.0
औसत	19.8	32.0	88.1	69.1	5.8	465.5

RFD Report - Annual Consolidated Achievements (April 1, 2014 to March 31, 2015) of NRCSS, Ajmer

S. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Targets / Criteria value					Achievements	Performance		Percent achievements against Target values of 100% Col.
							Excellent	Very good	Good	Fair	Poor		Raw Score	Weighted Score	
1	Production and post harvest management of seed spices	44	Development and standardization of production and protection technology in seed spices through applied and basic research including post harvest management and value addition	Development and standardization of technology for enhancing production and quality	Number	20	100%	90%	80%	70%	60%	6	100	20	120.0
			Transfer of technology	Development/Refinement of technologies for plant protection measures including post harvest management and value addition	Number	12	4	3	2	1	0	4	100	12	133.3
2	Conservation of seed spices genetic resources / germplasm for sustainable use	36	Collection, characterization and evolution of seed spices genetic resources Evolving high yielding varieties/Improved lines of seed spices Breeder / multihybrid/labelled seed production	Number of germplasm lines collected/evaluated	Number	15	240	200	160	120	80	248	100	15	124.0
			Publication of the research articles in the journals having the NAAS rating of 5.0 and above	Number of lines entered in the (conducted) multi location/location testing	Number	11	8	6	4	2	0	11	100	11	183.3
			Timely publication of the Institute Annual Report (2013-2014)	Quantity of seed produced	Quartals	10	15	16	13	10	7	20.7	100	10	129.4
			Utilization of released plan fund	Research articles published	No.	3	5	4	3	2	1	9	100	3	225.0
3	Publication/Documentation	5	Timely submission of Draft RFD for 2014-2015 for Approval	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	08.07.2014	27.06.2014	100	2	
4	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	93	90	100	100	2	
5	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 20, 2014	May 21, 2014		May 15, 2014	100	2	
6	Enhanced Transparency / Improved Service delivery of Ministry/Department	3	Timely submission of Results for Rating from Independent Audit of Implementation of Citizens' / Clients' Charter (CCC)	On-time submission	Date	1	May 1 2014	May 2 2014	May 5 2014	May 6 2014	May 7 2014	26 April, 2014	100	1	
			Independent Audit of Implementation of Grievance Redress Management (GRM) system	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	100	100	2	
7	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Degree of success in implementing GRM	%	1	100	95	90	85	80	100	100	1	
			Implementation of agreed milestones of approved Mitigating Strategies for reduction of potential risk of corruption (MSC)	Date	Date	2	Nov 1 2014	Nov 2 2014	Nov 3 2014	Nov 4 2014	Nov 5 2014	Sept. 25, 2014	100	2	
			Implementation of agreed milestones for ISO 9001	% of implementation	%	1	100	90	80	70	60	100	100	1	
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of implementation	%	2	100	95	90	85	80	100	100	2	
				% of implementation	%	2	100	90	80	70	60	100	100	2	



Certificate of Registration

Certificate No: 140103019101

This is to Certify that the Management System of the

NATIONAL RESEARCH CENTRE ON SEED SPICES

TABIJI, AJMER, PIN - 305 206, RAJASTHAN, INDIA

*Has been assessed and found to be in accordance with the requirements of
standard detailed below*

ISO 9001:2008

This Certificate is valid for the following scope

**“Providing Laboratory Analysis, Seed Spices Research and
Development and Consultancy, Training and Transfer
of Technologies to Stakeholders”**

Initial Registration Date	03 rd Jan. 2014	Issue Date	03 rd Jan. 2014
1 st Surveillance on or before	03 rd Dec. 2015	Valid Until	02 nd Jan. 2017
2 nd Surveillance on or before	03 rd Dec. 2016		

*To check validity of the certificate please
visit www.isoindia.org or call at given numbers*



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NRCSS



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