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Department of Agriculture & Farmers Welfare
Ministry of Agriculture & Farmers Welfare, Government of India
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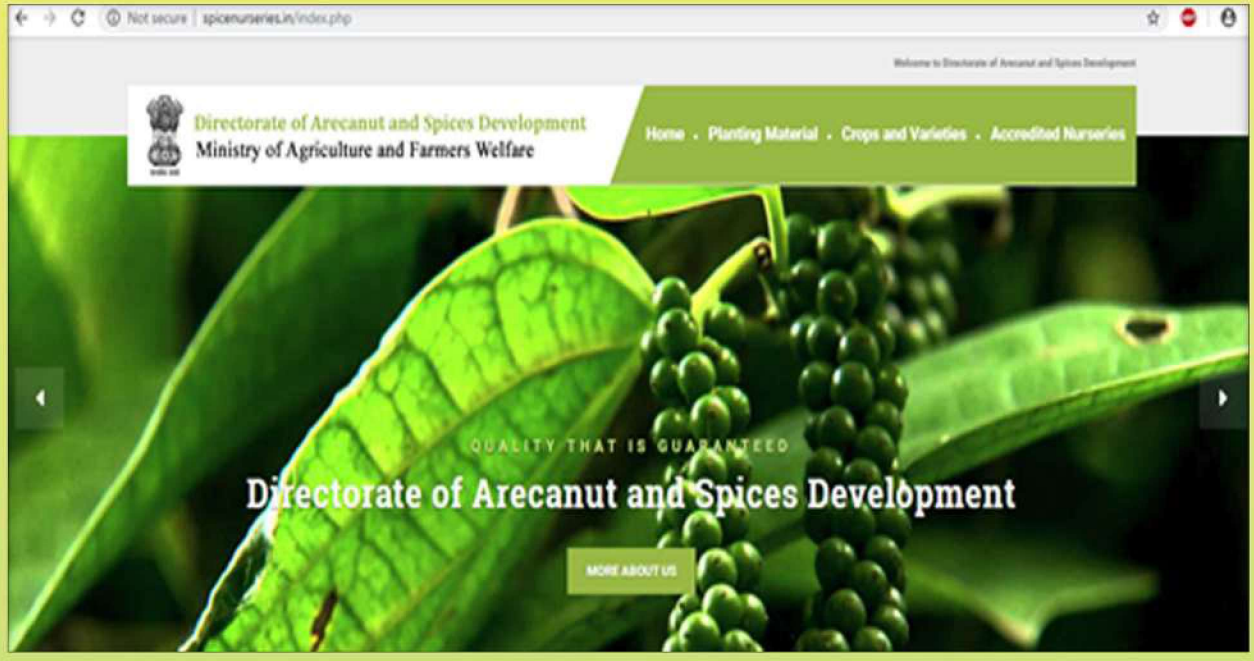

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Directorate of Arecanut and Spices Development
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Telephone: Office - 0495- 2369877, Director - 2765501, 2742888 (R)
Fax: 0495 – 2765777 E Mail : spicedte@nic.in

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Directorate of Arecanut and Spices Development
Ministry of Agriculture and Farmers Welfare
Government of India
Department of Agriculture and Farmers Welfare
West Hill P. O., Calicut - 673 005, Kerala.
Phone : (0495) 2369877, 2765501, Fax:(0495)2765777
e-mail : spicedte@nic.in, Web :www.dasd.gov.in

ARTICLES INVITED FOR INDIAN JOURNAL OF ARECANUT, SPICES AND MEDICINAL PLANTS

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The Journal contains popular articles on scientific cultivation, processing and marketing aspects of the above crops. Quarterly Market Reviews, Price Statistics, Forecast on Farm Operations etc. are also featured.

Instructions to contributors of Articles in the Journal

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Articles selected for publication will be given honorarium

Indian Journal of Arecanut, Spices & Medicinal Plants Vol. 25 (4) 3-5 (2023)

KOKUM: A MULTIPURPOSE TREE SPICE

Karanjalker Gourish and Rachana Kolambkar*

Introduction

Kokum, a member of the botanical family Clusiaceae, is scientifically known as *Garcinia indica* Choicy. Owing to its use in butter extraction, it is also called as Kokum butter tree. Kokum is one of the underutilized tree spices, believed to be originated in Western Ghat region of India. The species is naturally found distributed in Coastal regions of Goa, Karnataka, Maharashtra, Kerala, Andaman and Nicobar Islands, Orissa and North Eastern states. Owing to the bountiful goodness and multi-facet uses, species have been found remunerative and thus its cultivation has been started in a few parts of the country. The fruit is an economical part of the plant with huge uses making it an ideal multipurpose tree spice.

Uses of kokum fruits:

The fruit is juicy, having two lobed ovaries and is covered with reddish purple rind upon ripening. The whole fruit is of economical uses and each part may be processed into one or other product. It has a unique acidic flavor, which is a prerequisite to be used in various culinary items. It is used for imparting sour taste in many Indian cuisines. Dried kokum rind is traditionally used for preparing fish curry, vegetables and other cuisine items in Goa. Another types of products viz. salted kokum, sweetened kokum, pakali kokum etc. are commonly used in the traditional dishes of the West coastal parts of India. With the onset of monsoon the housewives of these regions get busy in preparing products of kokum, tamarind and fish, all in dried form, so that it is available during the rest of the year. The versatility of the spice could be judged by glancing the multi-facet uses as described hereunder.

Culinary uses: Kokum is processed into various products *viz. aamsul, aagal, syrup, solkadhi,* RTS, squash *etc*. *Aamsul* is the dried rind of kokum fruits. It is prepared by separating fruit rind from seeds, making into pieces and sundrying. *Aamsul* is added to fish curry to mask the fishy smell, in okra cuisines to get rid of watering and in elephant foot yam preparations for overcoming the astringency and itching. The *Aagal* is prepared from the juice extracted from the rind by pressing it in a hand operated or wooden basket press. This product is added during the preparation of *solkadhi*, along with coconut milk and served at table with meals. Seeds extracted after preparation of *aamsul* and *aagal* is used for the oil extraction and also for raising rootstocks for grafting. The juice extracted is processed into the syrup, squash, RTS *etc*. which are much preferred during the summer as the refreshing juice and for curing the gastric problems.

Medicinal value: Kokum is known to possess a good number of medicinal properties and thus, finds a mention in Ayurveda system of medicines. It is found to be effective in curing ailments such as piles, dysentery, tumours, pains, heart complaints and bilious affections (Haldankar *et. al.,* 2020). Nowadays, the changed lifestyle includes irregular meal timings, consumption of oily and junk foods, eating non-home foods, sedentary work habits and lack of exercise have contributed to the problem of obesity in many

* **Goa College of Agriculture (Affiliated to Goa University), Old Goa, Goa**

people, including the youth. Kokum has sought a lot of attention in recent past owing to presence of the compounds Hydroxycitric Acid (HCA) and Garcinol. This HCA compound is known to control the problem of obesity. It helps in preventing the fat accumulation and decreasing the cholesterol and triglyceride levels in the body. Kokum is also known to decrease gastric acidity, prevent mucosal damage and has a plausible function as an anti-ulcer agent. The anthocyanins found in fruits are known to be effective natural antioxidants and thus help to combat stress.

Industrial uses: Seed, which is the by-product of syrup and other products, could be used for extracting oils. Kokum seeds contain nearly 23-26% oil (Haldankar *et al.,* 2020). The oil may be used for preparation of the butter. Kokum butter has wide applications in confectionery, medicines and cosmetics. The fat is edible and is also used in soap, candle and ointments. Plain kokum, Salted kokum, Lonawala kokum, Pakali kokum, Kokum butter, etc. are few of the common trade forms of kokum which are being popularized among the people. The anthocyanin present in the fruit rind is used as natural colourant in food industry.

In spite of all these applications, kokum is largely underexploited in India. If exploited effectively kokum can help people setup large number of cottage industries. As the land available for food crops is decreasing day by day it is advisable to include kokum as species in cropping system or along the boundaries of the field.

Cultivation aspects:

Morphologically, kokum is tall, evergreen perennial tree, bearing round reddish fruits. Fruits are the economic parts and have shown wide potential as spice, medicine and as a crop of industrial importance. But, it is still on small scale cultivation and promotion is needed in this regard. Many leading State Agricultural Universities such as Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Kerala Agricultural University, Thrissur, University of Agricultural Sciences, Dharwad and central institutes *viz.* Indian Institute of Spice Research and ICAR-Central Coastal Agricultural Research Institute, Goa, have taken up researches regarding crop production, processing and improvement of kokum. The large scale cultivation of kokum is rarely found in Goa. The production of Kokum in Goa is estimated to be 10,200 tons from an area of 1200 ha (Korikanthimath and Desai, 2012). Mainly kokum trees are planted in the cashew orchards in very ignorable numbers. However, due to the multi-facet uses, many farmers have found the crop remunerative and thus its cultivation has been started in few parts of the region.

The kokum can be propagated by softwood grafting method for apparent true to type saplings. There have been promising varieties of kokum released by DBSKKV, Dapoli, *viz., Konkan Amruta* and *Konkan Hatis*. These varieties are superior in yield and quality that has boosted the production of kokum in the region. The grafts can be planted at the spacing of 7x7m or 8x8 m in a square system during the onset of monsoon by digging pit of 60x60x60 cm dimensions. The graft can be planted in the centre of the pit after incorporating 1-2 Kg of FYM per pit. The graft should be maintained with the staking and timely irrigation at an interval of a week during the initial stage. The fertilizers can be applied with 50g N, 25g P_2O_5 and 25g K_2O per plant during first year, which should be doubled every year till 10^{th} year (Haldankar *et al.,* 2020). The plant starts bearing at an age of 5-7 years after planting. The seasonal bearing of flowers is seen from December onwards and fruits become ready in May- June months. The fruits can be harvested from plant by beating with stick or selective pickings by climbing on the tree. The harvested fruits should be packed in wooden baskets or gunny bags after grading. The harvested fruits should be immediately processed within 10 days to avoid spoilage. In Goa, *amsul, agal* and s*olkadi* is prepared to serve in the meals. However, in Maharashtra the fruits are mainly processed into value added products like syrup, juices and RTS. The kokum can be an ideal component in the multistoried cropping system that can boost up the farm profitability. The crop has been ever in demand in the domestic markets of Goa as it is locally consumed on the daily basis.

Considering the high value of the plant, the

cultivation should be encouraged amongst the producers and stake holders. The crop cultivation is easy that can be taken up in any type of soil and topography with good drainage. Crop is least attacked by the pest and disease problems. The fruits can be processed in manifold products that could earn enormous profit. However, crop is limited with the features. The production of the fruit is available during monsoon which results in spoilage of the fruits. The occurrence of dioeciousness might result in the unproductive (fruit) male plants if not propagated by the vegetative method.

Conclusion: The products *solkadi*, *amsul* and *agal* are the main recipes of the kokum which are commonly consumed in Goa and Coastal region. The crop has been known to aid in many human ailments including obesity. In spite of vast applications, kokum is largely underexploited in India and more efforts are needed to encourage its production and marketing.

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XXXIV ANNUAL GROUP MEETING OF ICAR-ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES

Mukesh Sankar S, KS Krishnamurthy, Sharon Aravind, R Bharathan, John George and D Prasath*

AICRPS is the largest network of spices research covering 14 Agro-climatic zones and has 40 centres spreading across the country from Jammu & Kashmir to Kanyakumari. The XXXIV Annual Group Meeting (AGM) of ICAR-All India Coordinated Research Project on Spices (AICRPS) took place at UHS Bagalkot, Bengaluru campus, from 30th October- 1st November, 2023, with Spice researchers, experts, and students convening to discuss and promote advancements in the spice sector during 2022-23. The XXXIV Annual Group Meeting of Spices served as a platform for collaboration and innovation, showcasing the commitment of the spice industry to addressing challenges and driving growth. Dr. D. Prasath, Project Coordinator, ICAR-AICRPS welcomed the gathering of eminent scientists from various AICRPS centres across the country.

The workshop was inaugurated by Dr. S. V Suresha, Hon'ble Vice Chancellor, UHS, Bagalkot by watering a bush pepper plant on 30-10-2023 at COH, UHS Campus, Bengaluru. In his inaugural address, he emphasized on enhancing the export potential of spices by adopting Good Management Practices. Dr. Sudhakar Pandey, ADG (HS), ICAR in his presidential remark commented that spices have the potential for doubling farmers income. Dr. N. K. Krishnakumar, Former Deputy Director General (HS), was the Guest of Honour. He emphasized the need to address the pesticide residue in spices. Dr. V A Parthasarathy, former Director, ICAR-IISR emphasised on the genomic resources conservation of spices. Dr S B Dandin, former Vice Chancellor, UHS, Bagalkot opined on crop diversification. Dr. R Dinesh, Director, ICAR- IISR remarked that spices production has increased by 21% with an enhanced area of 10% but the declining productivity, soil health, adulterants, and lack of export surplus are the challenges faced by the spice sector.

During the inaugural session, the best AICRPS centre award was conferred to SKN, College of Agriculture, Jobner, Rajasthan. Shri. Ramakanth Ramachandra Hegde, a progressive farmer was honoured for his endeavour in conserving indigenous landraces and his contribution in developing farmer variety 'Sigandini'. A database on spice varieties -"Spice Var" was launched which gives detailed information on the significant characters of the spice varieties. About 15 technical bulletins in various regional languages and Annual Reports of the AICRPS were released during the occasion.

* ICAR-All India Co-ordinated Research Project on Spices, ICAR-IISR, Kozhikode, Kerala-673012.

Dr. Nirmal Babu, Former Director of ICAR-IISR, Kozhikode; Dr. SJ Eapen, Former Director of ICAR-IISR; Dr. Augustine Jerard, Project Coordinator (AICRPS Palms); and Dr. EVD Sastri, Head of Jaipur University and other delegates graced the occasion. Dr H P Maheshwarappa, DoR, UHS Bagalkot, proposed the vote of thanks. An exhibition showcasing the genetic diversity and varietal wealth of spices was exhibited.

The workshop was organized in seven Technical Sessions viz, AICRP on Spices Progress Report presentation, Genetic Resources and Crop Improvement, Crop Management, Crop Protection, Variety Release, Technology Transfer, and plenary Session. During the XXXIV AGM of Spices, four new spice varieties were identified for release:

Gujarath Ajwain-3 (high yielding Ajwain cultivar with an average seed yield of 1035 kg/ ha, greater number of umbels per plant and seeds per umbel with bold seed size)

Hisar Kalonji-12 (medium maturing, 145-150 days and high yielding nigella variety, seeds contains 24.84% total oil, showing moderately tolerant to root rot)

IISR Amrit (high yielding mango ginger variety having high yield potential (average yield 31 t/ha, potential yield 45.75 t/ha, bold and plumpy rhizomes, light yellow core having desirable flavour with myrcene (55.54 %) & β pinene (14.53%).

Kamakhya 1 (a black pepper variety with 2.14 kg dry yield, compact spike with higher quality under Assam condition, essential oil content (3.43%), piperine (5.1%), and oleoresin (9.36%).

Additionally, eight new spice technologies were unveiled, covering integrated pest and disease management for coriander, integrated management of cumin aphids, black pepper-based mixed cropping systems, biological control of soil-borne pathogens in black pepper, and intercropping of seed spices with vegetables.

1. A black pepper-based mixed cropping system, integrating elephant foot yam, exhibits exceptional productivity and profitability, with a remarkable benefit-to-cost ratio of 3.21. Ideal for Karnataka, Kerala, and Maharashtra.

2. Biological control of soil-borne pathogens in black pepper involves strategic applications of Trichoderma harzianum and Pochonia chlamydosporia, reducing the reliance on chemical pesticides in Karnataka, Kerala, and Maharashtra.

3. Pioneering the management of pseudostem rot in cardamom, employing Trichoderma harzianum and Pseudomonas fluorescens

Fig 1. New Varieties Identified in XXXIV AGM of AICRP on spices

Gujatat Ajwain 3 (GA-3)

Hisar Kalonji-12 (HKL-12)

IISR Amrit

Kamakhya-1

applications, promises effective control for cardamom cultivation in Karnataka, subject to strain deposition.

4. For seed spices, intercropping strategies, such as coriander with garlic, fennel with garlic, and fennel with carrot, showcase substantial productivity gains and profitability, recommended for Bihar, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Rajasthan, and Gujarat.

5. Integrated pest and disease management in coriander introduces innovative foliar sprays and treatments, ensuring stem gall and aphid control across various regions, including Bihar, Uttar Pradesh, Chhattisgarh, Rajasthan, Gujarat, Madhya Pradesh, and Uttarakhand.

6. Fennel benefits from a foliar application of iron and zinc, enhancing growth, yield, and quality. Recommended for Rajasthan, Gujarat, Uttar Pradesh, and Bihar.

7. Fenugreek sees improved yield and water use efficiency through a recommended fertigation schedule, boosting economic returns and benefit-to-cost ratio. Ideal for Tamil Nadu and Uttarakhand.

8. Integrated aphid management in cumin, featuring thiamethoxam sprays, proves effective against aphid infestation in Gujarat and Rajasthan.

These technologies collectively represent a transformative stride toward ecological safety, sustainability, and enhanced profitability for farmers across diverse agricultural landscapes.

The group meeting witnessed the presentation of seven new research programs on crop improvement, production, and protection by AICRP on spices, setting the stage for future research in the spice sector.

In the Plenary session of the XXXIV AGM of AICRPS held on 01 November 2023, Dr. Vikramaditya Pandey, Principal Scientist, ICAR, New Delhi, Dr Prakash Patil, Project Coordinator, AICRP (Fruits) and Dr. R Dinesh, Director, ICAR- IISR were the chairpersons. They reviewed the new projects to be initiated in AICRP in forthcoming years. They emphasized the importance of integrated farming approaches and sought networking with spice-allied sectors.

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WIDESPREAD INFESTATION OF WHITE AND RED MITES ON ARECANUT AND THEIR MANAGEMENT

Madhu. T. N[1]., Shivaji Hausrao Thube[3]., Saneera. E. K[1]., R. Thava Prakasa Pandian[1]., Rajkumar. M[2], and Bhavishya, A[2].

Introduction

Arecanut (*Areca catechu* L.) is commonly known as betel nut palm and an important commercial crop growing in coastal, plain and hilly regions of India. It is predominantly cultivated in states like Karnataka, Kerala, Tamil Nadu, West Bengal and Assam. India is the largest producer of arecanut worldwide, with a production of 15.65 lakh metric tonnes from an area of 7.8 lakh hectares and the production is almost doubled in 2020 as compared to 2010. The yield potential of arecanut is greatly influenced by both biotic and abiotic factors such as cultural operations, nutrients, pest and diseases, soil type and weather parameters. Among them, incidence of pest and diseases pose a serious threat and major limiting factor on arecanut production. The important insect pests includes white grub, inflorescence caterpillar, pentatomid bug and spindle bug; however, occurrence of non-insect pests like mites can also cause significant damage under favourable conditions. In addition, the incidence of mites (white and red mite) on arecanut usually occurs from March, when temperature begins to rise in the field conditions, continues up to June and the population gradually declined thereafter as monsoon prevails.

White or sorghum mite, *Oligonychus indicus* (Hirst) (Tetranychidae: Acarina) and red palm mite, *Raoiella indica* Hirst (Tenuipalpidae: Acarina) are phytophagous mites and polyphagous in nature. Both can cause economic damage to wide array of crops including palms, banana, sugarcane, sorghum, rice, cotton and others. Hitherto, these mites are considered as minor pest on arecanut as they appeared on summer months without inflicting significant damage on nut production. Presently, due to change in environmental conditions (*i.e.,* rise in temperature coupled with humidity) favouring the widespread infestation by mites on arecanut as well as create an alarming situation among the arecanut growers in coastal regions of Karnataka and Kerala. Based on our recent survey, field visits and farmers feedback, nearly 40%-60% increased incidence was observed on arecanut as compared to that of previous years. As summer period progress, these may spread to other parts of arecanut growing regions. Therefore, frequent monitoring and integration of pest management strategies are crucial to keep the population under check.

Damage symptoms

All the life stages of the mites predominantly

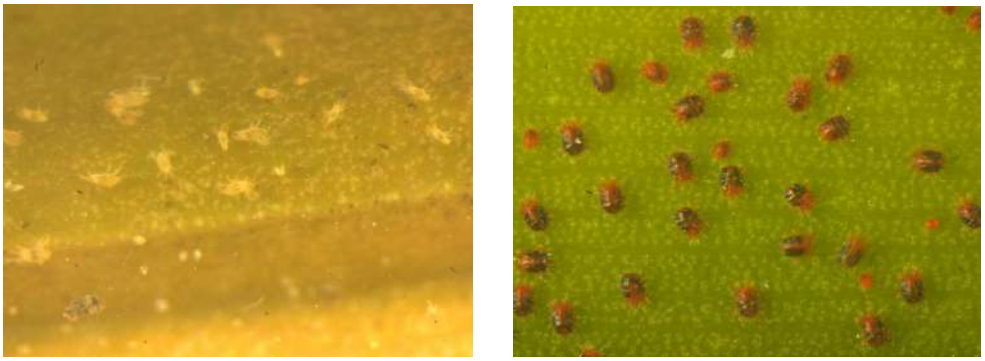

Fig.1. Infestation of white mite (left) and red mite (right) on arecanut leaves.

[1] ICAR-Central Plantation Crops Research Institute Regional Station, Vittal - 574 243.

[2] ICAR-Central Plantation Crops Research Institute, Kasaragod - 671 124.

[3] ICAR-Central Institute for Cotton Research, Nagpur - 440 010.

colonize on the under surface of the leaves to prevent direct exposure of the sun and they cause damage by piercing plant cells with their mouth parts (chelicerae) and sucking the plant juices (Fig.1). Mite feeding resulting in the formation of yellow speckles or blotches which coalesce to give a bronzed appearance. However, infestation of red mite can be easily identified based on the presence of reddish colonies of mites on lower surface of leaves. Further, reddish/pinkish stains appear after rubbing the infested leaves on fingers/palm. Whereas, infestation of white mites

Fig. 2. Mite infestation of young Arecanut plants.

can be identified by observing whitish webs on lower surface of leaves. Under severe infestation, the arecanut leaves become yellow and dry up later (Fig.2). Consequently, the ability of plants to produce quality nuts and its yield potential are greatly affected.

Biological suppression

In India, the predatory mite *Amblyseius channabasavanni* Gupta (Acari: Phytoseiidae) is known to feed on *R. indica* and developed rapidly and reproduced at a high rate (2.7 eggs / day). Whereas, the six spotted thrips, *Scolothrips sexmaculatus* provides natural control by feeding all stages of spider mites (Fig.3). However, the phytoseiid mite, *Neoseiulus longispinosus* (Evans), an Old-World species probably native to the Asian region, was found attacking *R. indica* in the Caribbean. The acaro-pathogenic fungus, *Hirsutella thompsonii* is another potential candidate that could be used in biological control. Therefore, conservation of natural enemies by means of heterogeneous landscaping may provide effective control against these mites. Furthermore, mass multiplication of these predatory mites need to be standardized and augmentative release at appropriate time period would be effective in long-term suppression of the pest.

Integrated Pest Management (IPM)

Farmers often inadvertently make mite infestation worse by spraying with insecticide sprays. Unfortunately, because they are not insects, conventional insecticides don't work on mites but do kill other beneficial insects such as predatory mites or thrips. Therefore, careful and holistic integration of all compatible pest management components need to be made for effective suppression of mite population.

- Provide proper irrigation to avoid stress to the palms during summer.
- Severely infested leaves should be removed from the garden.
- Soil test-based application of nutrients to improve the palm health.
- Monitoring the palms regularly during summer condition, because these mites are very tiny and can make big impact on palm health.

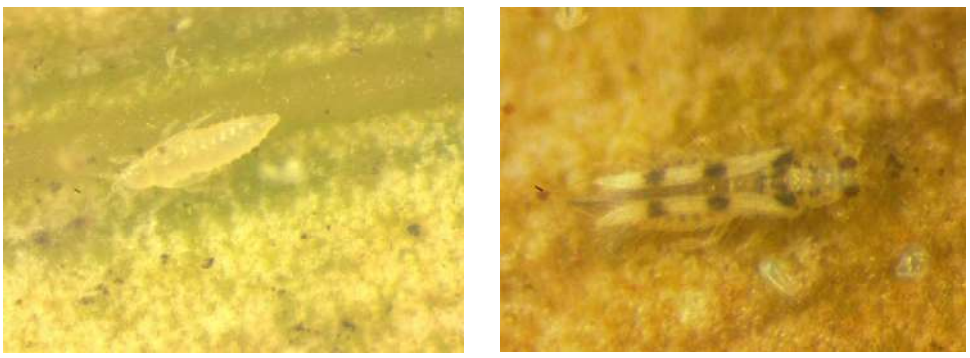

Fig. 3. Predatory thrips (*S. sexmaculatus*) feeding on spider mites. Nymph (left), Adult (right).

- Restrict the movement of ornamental palms and alternate host plants from endemic areas to new locations.
- Mass multiplication of predatory mites (*Amblyseius* spp. *Neoseiulus longispinosus*) prevalent in the location and timely augmentative release of predatory mites would be quite effective in the long-term pest suppression.
- These mites thrive in hot and dry conditions – the same conditions that stress plants and make them more vulnerable to spider mite damage. One way to address that is to water plants regularly and spray the leaves with a strong jet of water. This knocks adult spider mites, eggs, and larvae off the plant and quickly reduces the population. It also ruins their webbing, leaving them more vulnerable to predators.
- If infestation is low, spray neem oil emulsion (5 ml/litre water) two-times at 15 days interval.
- If infestation is severe, spray Wettable sulphur @ 2 gm/L; and as an *ad-hoc* recommendation, Spiromesifen 22.9SC @ 0.8 ml/L or Fenazaquin 10 EC @ 1 ml/L of water is advised.

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ARECANUT, ARECA LEAF AND BETEL QUID AS POTENTIAL WOUND HEALERS

S. Keshava Bhat*

Introduction

Wounds, if not treated well in time, generally aggravate and several microbes gain access to internal tissues and cause infection and such complications prolong the healing process. These microbes are mainly bacterial, viral or fungal origin. Hence, disinfection of wound is the primary requirement for its successful management. In this connection the herbs which possess antimicrobial properties will be of great help in hastening wound healing process by keeping the wounds sterile. Several polyherbal gels developed from different medicinal plants have been reported to possess antimicrobial and wound healing properties (Bhat *et al.,* 2007; Patel *et al.,* 2011; Fahimi *et al.,* 2015). Areca palm (*Areca catechu* L.) is one of such plants having lots of antimicrobial properties (Bhat *et al.,* 2017).

Certain tribal people in South India including Maharashtra use the nuts of areca palm to cure burn wounds since many years (Ayyanar and Ignacimuthu, 2009; Patil *et al.,* 2009; Korpenwar, 2012; Rathnavalli *et al.,* 2013). Enough scientific data are now available to substantiate the curative property of areca nut on such wounds.

Wound healing study of areca nut

Bharat *et al.* (2014) studied the wound healing property of the ethanolic extract of the nut of areca palm on Wistar albino rats by oral feeding of the extract at a dose of 100mg / kg body weight. The results showed that the wound contraction rate was significantly increased in areca nut extract fed groups compared to that of the control group from day 5 onwards and was comparable with that of the standard drug, silver sulfadiazine treated group. The period of epithelialization was also significantly faster in areca nut treated group (16 days) when compared to that of the control (23 days) and comparable with that of the standard drug (16 days). In dexamethasone delayed burn wound models also, wound contraction rate was significantly increased in areca nut extract treated group when compared to that of the control. In dexamethasone treated group the period of epithelialisation was 28 days whereas in dexamethasone + areca nut extract treated group it was reduced to 20 days.

Heals teeth extraction injuries

The extract of the nut of areca palm was also observed to heal the wounds formed while extracting teeth. It promoted the formation of new fibroblast cells and accelerated wound healing process. It was noticed that in Wistar albino rats the aqueous extract of areca nut at 50% and 100% concentrations effectively accelerated the healing process of wounds formed while extracting tooth (Chaowen *et al.,* 2023). The number of fibroblasts found on day 5 in the treatment involving 50% areca nut extract was 3 (18.8%) and in 100% extract it was 9 (56.3%), both differed significantly ($P < 0.05$) from that of control which was zero.

Efficacy of areca nut ointments

The ointment prepared with 2% ethanolic extract of the nut of areca palm was found to be equally efficient to that of the standard drug, silver sulfadiazine at 1% concentration. When such ointment was applied topically on burn wounds of Wistar albino rats complete epithelialization of the wounds occurred on the 16th day, whereas application of silver sulfadiazine also took almost same period (15.67 days) to get complete epithelialisation (Verma *et al.,* 2012). However, the control group without any treatment took much longer period (24.33 days) to reach that condition. Further, it was also observed that the arecanut extract hastened the healing process when such process was delayed by the application of wound healing suppressor like dexamethasone. In dexamethasone treated group, the rats took 28.33 days to get complete

* **Arecanut Research and Development Foundation, Varanashi Towers, Mission Street, Mangaluru- 575 001, Karnataka.**

epithelialization, whereas it took only 19.33 days when arecanut ointment was applied to such group.

In a study conducted on *Mus musculus*, the standard drug Povidone iodine ointment (5% concentration) took 14.8 days for successful wound healing, whereas the ointment prepared with 2% ethanol extract of the nut of areca palm took 13.25 days and 4% extract took only 12.8 days for complete healing (Vonna and Misrahanum, 2015).

In another study conducted to find out the wound healing property of the ointment prepared from the extract of the nut of areca palm on Sprague - Dawley rat it was noticed that the ointment prepared using 5.0% ethanol extract of areca nut fared better than the one prepared using 2.5% of the extract and found at par with that of the drug Neomycin Sulfate (Sandhiutami *et al.*, 2023). The time taken for the initiation of scab formation was 3 days in the Neomycin Sulfate treatment whereas it was 3 days with 5.0% and 4 days with 2.5% arecanut ointment, 5 days with negative control and complete scab formation was noticed at 6, 7, 8 and 10 days, respectively.

Even the gel formulation of areca nut extract was found effective in healing wounds. Sherliana *et al.* (2020) reported that the wound contraction rate was significantly faster ($P< 0.05$) in rats after day 4 of treatment with the gel formulation of ethyl acetate extract of the nut (2.0%) or the standard drug Bioplaceton (neomycin sulphate 0.5%) when compared to the control group without any treatment. Even arecanut gel was found slightly better than that of Bioplaceton as the former took 12 days for complete epithelialization whereas the latter took 14 days for such activity.

Topical applications of the gel, prepared by the combination of the extracts of the nuts of areca palm and chrysanthemum flowers, both at 50% level, and areca nut extract at 80% -chrysanthemum at 20% level, twice a day for seven days almost closed the traumatic ulcers formed on the buccal mucosa of Sprague–Dawley rats and the results were found similar to that of the positive control group treated with triamcinolone acetonide cream (Sari *et al.*, 2023).

Whether it is ointment, cream or gel, all the formulations were found equally effective in treating wounds. A comparative study was performed on Wistar albino rats to evaluate the wound healing effect of the ointment, cream and gel formulations of the methanolic extract (at 5% and 10% concentrations) of arecanut and compared the results with that of 1% Silver sulphadiazine cream (Prasad *et al.*, 2017). On day 12 of the treatment, the pro-healing potential of all the three formulations of arecanut extract at 10% concentration were reported to be at par with that of Silver sulphadiazine treatment and found significantly ($P< 0.01$) more effectively than that of the negative control. However, there was no significant variation between the three formulations.

Wound healing study of areca leaf

Apart from the nut of areca palm, its leaf also showed effective wound healing property. Abbasy *et al.* (2021) reported that the ointment prepared by using 10% hydroalcoholic extract of areca leaf fared better than the conventional ointment containing 1% silver sulfadiazine. The authors reported that on the 14th day, the wound contraction rate was significantly higher ($p < 0.001$) in rats treated with the ointment prepared using 10% areca leaf extract than in groups treated with 5% extract or negative control and significant at $p < 0.01$ in rats treated with 1% silver sulfadiazine.

Betel quid cures traumatic lesions of the oral cavity

Traumatic lesions in oral cavity generally formed either by biting the cheek or tongue by sharp teeth, brushing or by poorly fitting dentures. The extract of betel quid containing the nut of areca palm, betel leaf (the leaf of the tropical vine, *Piper betle*) and gambier (the extract of the leaf of the tropical shrub, *Uncaria gambir*) was reported to cure such lesions effectively. It was reported that the application of an oral mucoadhesive patch containing the ethanol extract of such chewing mixture significantly ($P\leq0.05$) reduced the size of traumatic ulcer lesions compared to the control (Suparno *et al.*, 2023). Complete healing of traumatic ulcer in

Wistar albino rat was achieved on the 7th day in the treatment group whereas it occurred on the 10th day in the control group.

Components responsible for wound healing

The wound healing properties of the crude extract of the nut of areca palm and its two constituents namely arecoline and polyphenols were studied in Wistar albino rats on three wound models like excision, incision and dead space wound (Padmaja *et al.,* 1994). It was found that except arecoline, both polyphenol and crude extract promoted wound healing by increasing wound breaking strength, wound contraction percentage and level of hydroxyproline in the granulation tissue (Padmaja *et al.,* 1994). In another study also the polyphenol fraction of arecanut was found effective for wound treatment but not the commercial form of arecoline hydrobromide (Azeez *et al.,* 2007). These authors further suggested that the polyphenols of the nut of areca palm could be used to enhance the healing rate of burn wounds, leg ulcers and skin graft surgery.

The nut of areca palm contains as much as 29.8% polyphenols in it (Shivasankar *et al.,* 1976). There are reports to show that polyphenols of areca nut also inhibit the growth of several pathogenic bacteria (Miranda *et al.,* 1996; Amudhan, 2012). Such antibacterial property of polyphenol probably hastened the wound healing activity of this nut.

Conclusion

All these studies show that both the nuts and leaves of areca palm have immense potential for the management and treatment of wounds. Such natural resources, available in plenty, should be utilised fully for the production of herbal ointments to treat various types of wounds effectively. Scientists, traditional medical practitioners, pharmacists and drug manufacturers may join hands in this venture.

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ECO-FRIENDLY MANAGEMENT OF APHID, *Aphis gossypii* Glover IN ISABGUL

N. R. Patel[1], N. P. Pathan[2], B. K. Prajapati[3] and P. J. Patel[4]

Abstract

Eco-friendly management of aphid infestations in isabgul (*Plantago ovata* Forsk) crops over a three-year period (2019-20, 2020-21, and 2021-22) conducted at Seed Spices Research Station, SDAU, Jagudan, Gujarat. The pooled data from the three-year revealed that among the evaluated ten treatments neem leaf extract at a concentration of 10% (2.37) exhibited the most effective control of aphids, recording the lowest infestation levels among all treatments evaluated. Subsequently, treatments with *Beauveria bassiana* 1.15 WP (2.62) and *Lecanicillium lecanii* 1.15 WP (2.76) demonstrated relatively lower aphid infestations suggesting their potential as effective alternatives. Conversely, treatments involving garlic bulb extract at 5%, ipomoea leaf extract at 10%, azadirachtin at 1500 ppm, ginger extract at 5%, custard apple leaf extract at 10% and karanj oil displayed less efficacy in reducing aphid infestation, albeit performing better than the untreated control. In terms of isabgul seed yield, plots sprayed with neem leaf extract at 5% (511 kg/ha) yielded the highest seed production followed by those treated with *Beauveria bassiana* 1.15 WP (476 kg/ha) and *Lecanicillium lecanii* 1.15 WP (457 kg/ha) as well as garlic bulb extract at 5% (439 kg/ha), consistently across the three-year study period. Neem leaf extract at 10% provided the maximum benefit with a profitability cost-benefit ratio (PCBR) of 5.90. These findings contribute valuable insights to sustainable aphid management strategies in isabgul cultivation offering potential alternatives to chemical pesticides while maximizing crop yield and economic returns.

Keywords: Isabgul, neem leaf extract, *Beauveria bassiana, Lecanicillium lecanii* and garlic bulb extract.

Introduction

In recent decades, the global community has witnessed an increasing awareness and concern for environmental conservation and sustainable agricultural practices. As a consequence, the search for eco-friendly and sustainable solutions to manage agricultural pests has gained significant momentum. One such pervasive pest that poses a significant threat to crop yields and quality is the aphid species Aphis gossypii Glover. Isabgol (*Plantago ovata* Forst.) commonly known as psyllium, belongs to family Plantaginaceae and is native to Persia (Dhar *et al.,* 2005). Isabgol is an economically important medicinal plant commonly cultivated in different parts of India, Pakistan, Iran and some part of Europe (Singh *et al.,* 2009). In India, it is mainly cultivated in north Gujarat, western Rajasthan and Madhya Pradesh. The isabgol husk is an ayurvedic herb, used in health care for many centuries in South Asia, and is now widely used for its medicinal properties all over the world. Psyllium seed husk provide health benefits for diabetes, constipation, diarrhoea, inflammatory bowel disease, irritable bowel syndrome symptoms, abdominal pain, obesity, hypercholesterolaemia and lowering blood cholesterol level (Jalanka *et al.,* 2019, Clark *et al.,* 2020, Franco *et al.,* 2020). Furthermore, psyllium polysaccharides are potential natural antioxidant, anti-carcinogenic agent and also have antiulcerogenic property (Patel *et al.,* 2019). It is also added to shakes, juices, yogurt, syrups, soups, bread and even in ice creams to improve the fiber content of the food (Belorio and Gomez, 2022). Plantago seeds contains of 6.85% ash, 23.5% crude fiber, 8.7% protein and 50.65% carbohydrates (Pendse *et al.,* 1976). The yield of isabgol is mainly affected by biotic and abiotic factors. Aphid, *Rhopalosiphum maidis* (Fitch) is the major insect pest whereas the other pests

[1] **Associate Professor (Pathology), Seed Spices Research Station, S. D. Agricultural University, Jagudan**

[2] **Assistant Professor (Entomology), College of Horticulture, S. D. Agricultural University, Jagudan**

[3] **Assistant Professor (Pathology), College of Horticulture, S. D. Agricultural University, Jagudan**

[4] **Research Scientist, Seed Spices Research Station, S. D. Agricultural University, Jagudan**

viz. field cricket, *Gryllus* sp; whitefly, *Bemisia tabaci* (Genn.); aphid, *Aphis gossypii* (Glover) and termites, *Odontotermes obesus* Rambur and *Microtermes obesi* Holmgren are also reported on isabgol by Jindla *et al.* (1984), Farooqi and Sreeramu (2001) and Reddy (2009). The aphids are active sap suckers at bud and later causing considerable loss to the crop, and use of man-made insecticides for its control may reduce profit and export potential both. Aphids are reported to be the major pests of isabgol in Punjab and Madhya Pradesh (Upadhyay and Mishra, 1999) causing serious losses to crop. The current research concerning the management of isabgul aphid (*Aphis gossypii*) in Gujarat using bio-pesticides remains limited. As a consequence, there exists a gap in understanding eco-friendly management strategies that can efficiently control the infestation of *Aphis gossypii* in isabgul crop. To address this knowledge gap, the present study was undertaken to assess the bio-efficacy of various bio-pesticides against aphid infestation in isabgul, while also investigating their potential impact on indigenous natural enemies.

Materials and Methods

A field experiment was carried out during rabi 2019-20, 2020-21 and 2021-22 at Seed Spices Research Station, S. D. Agricultural University, Jagudan to find out an effective biopesticides against aphid infesting isabgul. The trial was laid out in a randomized block design (RBD) with ten treatments and three replications. The isabgul variety Gujarat Isabgul 4 was spaced with 30 cm row spacing. The size of each gross plot measured 4.00 m x 3.00 m. All agronomical practices were adopted to raise the healthy crop. A total of ten treatments *viz., Lecanicillium lecanii* 1.15 WP (0.004%), *Beauveria bassiana* 1.15 WP (0.004%), garlic bulb extract (5%), azadirachtin 1500 ppm (0.15%), ginger extract (5%), *Ipomoea* leaf extract (10%), neem leaf extract (10%), custard apple leaf extract (10%), karanj oil (20 ml/10 L) and untreated control. Three foliar sprays of each biopesticides were applied by means of manually operated knapsack sprayer.

First foliar spray was made at initiation of aphid and subsequent two sprays were applied after 10 days interval. For recording the observations, five plants were selected randomly from each net plot. Observations on aphid population were recorded before and after 3 and 7 days of application of different bio-pesticides sprays. The data thus, obtained were statistically analyzed after suitable transformation. Following aphid index given by Bank (1954) was fixed for estimating the population of aphid and the average aphid index was worked out by adopting following formula:

$$\text{Average aphid index} = \frac{0N + 1N + 2N + 3N + 4N}{\text{Total number of plants observed}}$$

Where, 0, 1, 2, 3, 4 are aphid index ,
N = Number of plant showing aphid index

Aphid Index	Degree of infestation
0	Plant free from aphid
1	Aphid present, but colonies did not build up. No injury due to pest apparent on the plant
2	Small colonies of aphid were present
3	Large colonies of aphid were present on tender parts. Counts of aphids in colonies were possible and tender plant part show damage symptoms due to aphids
4	Entire plant was covered by aphids. Counts of aphids in colonies were impossible and plant show damage symptom due to aphids

Results and discussion

Aphid index

The first-year (2019-20) data from pooled over periods and spray as presented in Table 1, demonstrated that neem leaf extract at 10% concentration (2.40) exhibited the most significant reduction in aphid infestation, followed by *Beauveria bassiana* 1.15 WP (2.62). Subsequently, *Lecanicillium lecanii* 1.15 WP, garlic bulb extract at 5%, ipomoea leaf extract at 10%, custard apple leaf extract at 10% and azadirachtin at 1500 ppm were identified as the next better treatments showing aphid infestations of 2.82, 2.89, 2.92, 2.96 and 3.03, respectively.

The second year (2020-21) data of pooled over periods and spray presented in Table 1. Notably, neem leaf extract at a concentration of 10% (2.16) and *Beauveria bassiana* 1.15 WP (2.43) were found to be the most efficacious in mitigating aphid infestations, exhibiting significantly lower aphid densities in comparison to other treatments evaluated in the study. Following closely were *Lecanicillium lecanii* 1.15 WP (2.56), garlic bulb extract at 5% (2.69), ipomoea leaf extract at 10% (2.76), and custard apple leaf extract at 10% (2.72). Although slightly higher than the neem leaf extract and *Beauveria bassiana* treatments, these alternative interventions demonstrated substantial effectiveness in curbing aphid populations in the target crop.

The third year (2021-22) data of pooled over periods and spray presented in Table 1 and concluded that neem leaf extract at a concentration of 10% (2.53) resulted in the least aphid infestation, with statistical significance. Subsequently, *Beauveria bassiana* 1.15 WP (2.79) demonstrated the second most effective aphid control among the treatments evaluated. It is worth noting that the trends observed in the treatment effects during the year 2021-22 were found to be more or less similar to those noticed in the previous years, 2020-21 and 2019-20.

The pooled over year data of 2019-20, 2020-21 and 2021-22 presented in Table 1. Among the various treatments evaluated, neem leaf extract at 10% concentration (2.37) exhibited the most effective control of aphids by recording the least infestation levels. The subsequent treatments that showed relatively lower aphid infestations were *Beauveria bassiana* 1.15 WP (2.62) and *Lecanicillium lecanii* 1.15 WP (2.76). Conversely, garlic bulb extract 5% concentration (2.89), ipomoea leaf extract at 10% concentration (2.89), azadirachtin at 1500 ppm concentration (2.99), ginger extract at 5% concentration (2.99), custard apple leaf extract at 10% concentration (2.92) and karanj oil (3.06) exhibited less efficacy in reducing aphid infestation, although they performed better than the untreated control.

Effect on predatory coccinellids in isabgul

Perusal of the data on population of predatory coccinellids in pooled over year revealed significant higher population in untreated control during 2019-20, 2020-21, 2021-22 and also remained at par with neem leaf extract 10% followed by *Beauveria bassiana* 1.15 WP.

Impact on seed yield of isabgul

Pooled over year data on seed yield of isabgul presented in Table 3 revealed that the seed yield of isabgul differed significantly in all the three individual years as well as in pooled analysis. The plots sprayed with T7 i.e neem leaf extract 5% (511 kg/ha) had obtained the highest seed yield of isabgul followed by *Beauveria bassiana* 1.15 WP (476 kg/ha) and remained at par with the treatment *Lecanicillium lecanii* 1.15 WP (457 kg/ha) as well as garlic bulb extract 5% (439 kg/ha) during 2019-20, 2020-21 and 2021-22.

Economics

Economics of various eco-friendly insecticides/ botanicals against aphid of isabgul was computed considering prevailing market price of seed yield of isabgul and cost of different treatments including labour charges (Table 4). Looking to the economic analysis of different treatments, neem leaf extract 10% treated plots gave maximum benefit (PCBR: 5.90) followed by *Lecanicillium lecanii* ($1x10^9$gcfu/g) @ 40g/10 litre water recorded 3.76 PCBR and ipomoea leaf extract @ 10% which gave higher additional income, net realization and PCBR.

Table 1: Effect of different treatments on aphid in isabgul

Tr. No.	Treatments	Aphid index			
		2019-20	2020-21	2021-22	Pooled over year
T_1	*Lecanicillium lecanii* 1.15 WP (1x10^{9}cfu/g) @ 40 g/10 L	1.68^{c} (2.82)	1.60^{bc} (2.56)	1.71^{bc} (2.92)	1.66^{f} (2.76)
T_2	*Beauveria bassiana* 1.15 WP (1 x10^{9}cfu/g) @ 40 g/10 L	1.62^{d} (2.62)	1.56^{cd} (2.43)	1.67^{c} (2.79)	1.62^{g} (2.62)
T_3	Garlic bulb extract @ 5%	1.70^{bc} (2.89)	1.64^{bc} (2.69)	1.71^{bc} (2.92)	1.69^{e} (2.86)
T_4	Azadirachtin 1500 ppm @ 40 ml/10 L	1.74^{bc} (3.03)	1.69^{b} (2.86)	1.75^{bc} (3.06)	1.73^{c} (2.99)
T_5	Ginger 5% extract	1.75^{b} (3.06)	1.69^{b} (2.86)	1.75^{bc} (3.06)	1.73c (2.99)
T_6	*Ipomoea* leaf extract @ 10%	1.71^{bc} (2.92)	1.66^{bc} (2.76)	1.72^{bc} (2.96)	1.70^{de} (2.89)
T_7	Neem leaf extract @ 10%	1.55^{e} (2.40)	1.47^{d} (2.16)	1.59^{d} (2.53)	1.54^{h} (2.37)
T_8	Custard apple leaf extract @ 10%	1.72^{bc} (2.96)	1.65^{bc} (2.72)	1.75^{bc} (3.06)	1.71^{d} (2.92)
T_9	Karanj oil @ 20 ml/10 L	1.76^{b} (3.10)	1.69^{b} (2.86)	1.79^{b} (3.20)	1.75^{b} (3.06)
T_{10}	Untreated control	1.92^{a} (3.69)	1.86^{a} (3.46)	2.01^{a} (4.04)	1.93^{a} (3.72)
S.Em.±	T	0.035	0.032	0.042	0.006
	P	0.021	0.021	0.029	0.151
	S	0.005	0.008	0.006	0.004
	Y	-	-	-	0.006
	TxP	0.019	0.027	0.020	0.012
	TxS	0.015	0.025	0.019	0.013
	PxS	0.007	0.011	0.008	0.012
	YxT	-	-	-	0.005
	YxP	-	-	-	0.006
	YxS	-	-	-	0.010
	TxPxS	0.021	0.036	0.027	0.020
	YxSxT	-	-	-	0.009
	YxSxP	-	-	--	0.009
	YxPxT	-	-	-	0.016
	YxSxPxT	-	-	-	0.028
C.D.at 5%	T	0.103	0.096	0.124	0.034
	YxT	-	-	-	NS
C.V. (%)		2.11	3.76	2.65	2.87

Figures in parenthesis are retransformed values, those outside $\sqrt{x}$ are transformed values,

DAS: Days after spray; Treatments means with the letter (s) in common are not significant by DNMRT at 5% level of significance

Table 2: Effects of different treatments on predatory coccinellids in isabgul

Tr. No.	Treatments	Predatory coccinellids/ plant			
		2019-20	2020-21	2021-22	Pooled over year
T_1	*Lecanicilliumlecanii* 1.15WP (1x10^{9}cfu/g) @ 40 g/10 L	1.77^{bcd} (3.13)	1.71^{c} (2.92)	1.78^{c} (3.17)	1.75^{bc} (3.06)
T_2	*Beauveria bassiana* 1.15WP (1 x10^{9}cfu/g) @ 40 g/10 L	1.78^{abc} (3.17)	1.72^{c} (2.96)	1.80^{bc} (3.24)	1.77^{b} (3.13)
T_3	Garlic bulb extract @ 5%	1.73^{cde} (2.99)	1.67^{cd} (2.79)	1.78^{c} (3.17)	1.73^{bcd} (2.99)
T_4	Azadirachtin 1500 ppm @ 40 ml/10 L	1.68^{e} (2.82)	1.63^{d} (2.66)	1.78^{c} (3.17)	1.70^{d} (2.89)
T_5	Ginger 5% extract	1.67^{e} (2.79)	1.62^{d} (2.62)	1.77^{c} (3.13)	1.69^{d} (2.86)
T_6	*Ipomoea* leaf extract @ 10%	1.72^{cde} (2.96)	1.67^{cd} (2.79)	1.77^{c} (3.13)	1.72^{cd} (2.96)
T_7	Neem leaf extract @ 10%	1.84^{ab} (3.39)	1.80^{b} (3.24)	1.84^{ab} (3.39)	1.83^{a} (3.35)
T_8	Custard apple leaf extract @ 10%	1.70^{de} (2.89)	1.65^{d} (2.72)	1.78^{c} (3.17)	1.71^{cd} (2.92)
T_9	Karanj oil @ 20 ml/10 L	1.68^{e} (2.82)	1.63^{d} (2.66)	1.76^{c} (3.10)	1.70^{d} (2.89)
T_{10}	Untreated control	1.85^{a} (3.42)	1.87^{a} (3.50)	1.86^{a} (3.46)	1.86^{a} (3.46)
S. Em.±	T	0.025	0.018	0.017	0.016
	P	0.007	0.007	0.004	0.017
	S	-	-	-	-
	Y	-	-	-	0.005
	TxP	0.023	0.023	0.013	0.012
	TxS	-	-	-	-
	PxS	-	-	-	-
	YxT	-	-	-	0.015
	YxP	-	-	-	0.007
	YxS	-	-	-	-
	TxPxS	-	-	-	-
	YxSxT	-	-	-	-
	YxSxP	-	-	-	-
	YxPxT	-	-	-	0.021
	YxSxPxT	-	-	-	-
C.D.at 5%	T	0.08	0.05	0.05	0.048
	YxT	-	-	-	NS
C.V. (%)		2.30	2.37	1.28	2.06

Figures in parenthesis are retransformed values, those outside are $\sqrt{x}$ are transformed values, DAS: Days after spray; Treatments means with the letter (s) in common are not significant by DNMRT at 5% level of significance.

Table 3: Seed yield of isabgul in different treatments

Tr. No.	Treatments	Seed yield			
		2019-20	2020-21	2021-22	Pooled
T_1	*Lecanicillium lecanii* 1 .15WP ($1x10^9$cfu/g) @ 40 g/10 L	428^{ab}	444^{ab}	498^{bc}	457^{bc}
T_2	*Beauveria bassiana* 1.15WP ($1 x10^9$cfu/g) @ 40 g/10 L	444^{ab}	464^{a}	522^{b}	476^{ab}
T_3	Garlic bulb extract @ 5%	423^{ab}	426^{ab}	469^{cd}	439^{bc}
T_4	Azadirachtin 1500 ppm @ 40 ml/10 L	294^{c}	364^{cd}	408^{g}	355^{de}
T_5	Ginger 5% extract	342^{ab}	365^{cd}	418^{fg}	375^{d}
T_6	*Ipomoea* leaf extract @ 10%	419^{ab}	419^{abc}	450^{de}	429^{c}
T_7	Neem leaf extract @ 10%	474^{a}	476^{a}	582^{a}	511^{a}
T_8	Custard apple leaf extract @ 10%	414^{ab}	401^{bc}	439^{ef}	418^{e}
T_9	Karanj oil @ 20 ml/10 L	292^{c}	331^{de}	352^{h}	325^{f}
T_{10}	Untreated control	264^{c}	285^{e}	261^{i}	270^{g}
	S.Em.±	33	18	9	13
	C.D.at 5%	99	54	25	36
	YXT	-	-	-	NS
	C.V.%	15.13	7.93	6.33	9.55

Treatments means with the letter (s) in common are not significant by DNMRT at 5% level of significance

Table 4: Protection Cost Benefit Ratio (PCBR)

Trt. No.	Quantity of materials (Kg or L/ha)	Cost of materials (Rs/ha)	Labour charges (Rs/ ha)	Total cost of treatment (Rs/ ha)	Yield (Kg/ha)	Gross realization (Rs/ ha)	Net realization (Rs/ha)	Net gain (Rs/ha)	PCBR
T_1	LL-6.0	1800.00	2130.00	3930.00	457	45700.00	18700.00	14770.00	3.76
T_2	Bb-6.0	2850.00	2130.00	4980.00	476	47600.00	20600.00	15620.00	3.14
T_3	Garlic-75	3750.00	3195.00	6945.00	439	43900.00	16900.00	9955.00	1.43
T_4	Aza-6.0	3000.00	2130.00	5130.00	355	35500.00	8500.00	3370.00	0.66
T_5	Ginger-75	6000.00	3195.00	9195.00	375	37500.00	10500.00	1305.00	0.14
T_6	Ipomoea-150	300.00	3195.00	3495.00	429	42900.00	15900.00	12405.00	3.55
T_7	Neem-150	300.00	3195.00	3495.00	511	51100.00	24100.00	20605.00	5.90
T_8	C.apple-150	300.00	3195.00	3495.00	418	41800.00	14800.00	11305.00	3.23
T_9	Karanj oil-3	1200.00	2130.00	3330.00	325	32500.00	5500.00	2170.00	0.65
T_{10}	-	-	-		270	27000.00	0.00	0.00	

Price of isabgul: Rs.100/kg; *L.lecanii* 1.15WP: Rs.300/kg.;Azdirachtin 1500ppm: Rs.500/L;
*B. bassiana*1.15WP:Rs.475/kg;Karanj oil: Rs. 400/L.; Garlic bulb: Rs. 50/kg, Ginger: Rs.80/kg,
Labour cost: Rs. 355/day (2 labours/spray/ha)

Conclusion

Among the ten treatments evaluated, neem leaf extract at 10% emerged as the most successful in reducing aphid populations, recording the lowest infestation levels. *Beauveria bassiana* 1.15 WP and *Lecanicillium lecanii* 1.15 WP also showed promise as alternative treatments with relatively lower aphid infestations. Moreover, the study demonstrated the positive impact of neem leaf extract at 5% on isabgul seed yield, yielding the highest seed production, followed by *Beauveria bassiana* 1.15 WP and *Lecanicillium lecanii* 1.15 WP as well as garlic bulb extract at 5%, consistently over the three-year study period. These findings provide valuable insights into the implementation of sustainable aphid management strategies in isabgul cultivation, offering eco-friendly alternatives to chemical pesticides while maximizing crop yield and economic returns.

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PEPPER PRODUCTION PROSPECTS 2023-24

Homey Cheriyan and K. Manojkumar*

Among the spice crops grown in India, black pepper (*Piper nigrum* L.) is one of the most ancient and traditional spice crop, which has been traded worldwide. The tropical evergreen forest of Western Ghats is the home of black pepper. Kerala, Karnataka and Tamil Nadu are the leading black pepper producing States in the country. The crop is the major source of income and employment for rural households in the predominantly pepper growing State of Kerala. In Karnataka, pepper is cultivated as a profitable mixed crop in coffee plantations and arecanut gardens. In Tamil Nadu also pepper is cultivated as a mixed crop in coffee/tea gardens mainly confined High-altitude regions.

In India, black pepper is cultivated in an area of around 2.99 lakh ha with a production of 1.17 lakh tonnes. Karnataka is the largest producer with a production of 80000 tonnes from an area of 2.08 lakh ha. The Statewise area, production and productivity of black pepper in India during 2022-23 are given in Table 1.

Table 1. Area, production and productivity of black pepper, Statewise in India 2022-23

State	Area ('000 ha)	Production ('000 tonnes)	Productivity (kg/ha)
Karnataka	207.811	80.805	389
Kerala	73.732	27.654	375
Assam	3.603	2.812	780
Meghalaya	2.083	2.339	1123
Tamil Nadu	7.465	1.642	220
Maharashtra	1.958	0.506	258
Goa	0.861	0.418	485
Tripura	0.372	0.403	1083
Andhra Pradesh	0.478	0.248	519
West Bengal	0.380	0.153	403
Andaman & Nicobar	0.138	0.037	268
Nagaland	0.080	0.030	375
Pondicherry	0.010	0.014	1400
Arunachal Pradesh	0.012	0.003	250
Mizoram	0.070	0.003	43
Total	**299.053**	**117.067**	**391**

* **Directorate of Arecanut and Spices Development, Calicut**

Black pepper is an export-oriented commodity and hence the price for black pepper is generally ruled by the production trend in the major producing countries.

Indian black pepper, which accounted for a major part of the global pepper, recently seems to be facing threat from other origins like Vietnam, Indonesia, Brazil etc. Since 2001, Vietnam emerged as a major competitor in the case of production and they offer the produce at competitive prices and this forced the major importers to distance Indian pepper. As a result of this, Indian pepper had lost its supremacy in the global pepper export market. Countrywise export of pepper in the World are given in Table 2.

Table 2. Pepper exports by producing countries

Quantity in MT

Country	Year 2022	Year 2023
Vietnam	231,988	264,094
Indonesia	29,554	23,818
Brazil	83,659	80,702
India	19,086	15,437
Malaysia	6,794	5,853
China	3,678	4,052

Source: International Pepper Community (2023), Jakarta (ipcnet.org)

In India, the production of black Pepper experiences annual fluctuations due to the vagaries of weather. The plant is very sensitive to climatic parameters especially the pattern of rainfall. Total rainfall and its distribution play an important role in black pepper cultivation and productivity. The flowering and fruiting in the plant synchronize with the rainy season indicating the importance of rainfall in this process. An annual rainfall of 2000 mm with uniform distribution is ideal. Rainfall of 70 mm received in 20 days during May-June is sufficient for triggering off flushing and flowering process in the plant, but once the process is set off there should be continuous shower until fruit ripening. Any dry spell even for a few days, within this critical period of 16 weeks (flowering to ripening) will result in low yield. Rainfall after stress induces profuse flowering. Growth of fruit bearing lateral shoots (plagiotrops) and photosynthetic rate are maximum during peak monsoon in India (June – July). A relative humidity of 60-95% is optimum at various stages of growth.

Considering the above facts, advance information about the production in the ensuing harvesting season is of considerable importance from the trade point of view as well as for formulation of future development programmes. Therefore, the Directorate of Arecanut and Spices Development (DASD), Calicut conducts quick surveys in the major pepper growing tracts of Kerala, Karnataka and Tamil Nadu to estimate the expected production of black pepper during the ensuing crop season. In 2023-24, the quick survey was conducted in these States during the months of October and November.

Methodology

The Survey was conducted in Karnataka, Kerala and Tamil Nadu. Sample size was selected in these States and no. of pepper standards included in the sample size are given below.

Table 3. State-wise sample size and no. of pepper standards covered

State	Sample size (no. plots visited)	Total no. of pepper standards included in the sample
Karnataka	46	106550
Kerala	66	40800
Tamil Nadu	26	31410
Total	**138**	**178760**

The information was collected through personal interview of the farmers, based on a pre-designed interview schedule, in the major pepper growing districts of these States. The field was subsequently inspected to verify whether the observed data aligns with the actual condition of the crop. The sample size was fixed in proportion to the area under cultivation in each district. The pepper gardens were selected from the list of pepper cultivators available at respective Krishi Bhavans in Kerala and office of Assistant Director of Horticulture (ADH) in Karnataka and Tamil Nadu. Krishi Bhavans under Department of Agriculture have helped in data collection in Kerala and ADH offices have helped in data collection in Karnataka and Kerala. The details of information collected include area under pepper, number of pepper standards, varieties grown, standards used, management practices, crop loss due to

pest/disease incidence and natural calamities, production obtained during the previous years, expected production for the ensuing season, reason for change in production, details of new planting, change in area under cultivation, source of planting material, awareness about various assistance, and other problems/suggestions. The change in production of pepper in each state was estimated based on the weighted average method.

KARNATAKA

In Karnataka, pepper is grown as a profitable mixed crop in coffee plantations and arecanut gardens. Pepper cultivation is mainly confined to the six districts *viz.* Kodagu, Chikmagalur, Hassan, Shivamoga, Uttara Kannada, Dakshina Kannada, etc. In Karnataka State, area estimates are being done based on a GPS-enabled mobile app from 2018-19 onwards. Data collected through mobile app is being reconciled at Village, Hobli, Taluk and District level by the respective officers from Agriculture, Horticulture, Sericulture, Water Resources, Directorate of Economics and Statistics and Revenue Depts. Pepper comes under non-CES (Crop estimation Survey) crops, and hence no crop cutting experiments are conducted to estimate the yield rates. Yield rates are assessed through oral enquiry of cultivators on sample basis.

In Karnataka, the Survey was conducted in five districts *viz*. Kodagu, Hassan, Chickmagalore, Shimoga and Uttara Kannada which together contribute about 91 % of the area under black pepper in the state. Sample size was fixed in proportional to area under cultivation in each districts.

Table 4. Districtwise area under pepper in Karnataka

Districts covered in the Survey	Area (ha)	% share to State total
Kodagu	103300	50
Chikmagalur	49815	24
Hassan	25508	12
Shimoga	5190	3
Uttara Kannada	4044	2
Total	**189423**	**91**
State total (Including other Districts)	**207811**	**100**

Source: Dept of Economics and Statistics, Karnataka

Table 5. Area surveyed in Karnataka

District	Area
Kodagu	Ponnampet, Virajpetta, Madikeri, Somwarpeta
Hassan	Sakleshpura
Chickmagalore	Mudigere, Koppa
Shimoga	Thirthahally, Sagar
Uttara Kannada	Sirsi

The field survey conducted in Karnataka state revealed that around 75 -80% of the area under pepper is covered by high yielding varieties Panniyur. Pepper is primarily trailed on Silver oak, resulting in higher productivity compared to other standards. As pepper is cultivated as a mixed crop in coffee plantations, on a large scale, most of the plantations are well managed.

As per the data collected during the field survey in Karnataka, it is estimated that production of black pepper in Karnataka is likely to increase by 10.2% this year (2023-24). The rainfall pattern received this year was favourable to the flowering and fruit setting of pepper. This coupled with good and systematic management practices adopted by the farmers have contributed mainly to the increase in production in all the districts surveyed. Most of the plantations have irrigation facilities and they usually irrigate the crop during the adequate time.

Thus the likely production of pepper in Karnataka during the year 2023-24 is estimated at 89007 tonnes as against the production of 80805 tonnes during the year 2022-23.

Arecanut it coffee garden in Karnataka

Pepper survey team in Karnataka

KERALA

Kerala is the second largest pepper producing state in the country. Small and marginal farm holdings dominate forming 80% of the total number of pepper farms in the state. Pepper is cultivated in almost every homestead or plot of land in the plain lands; and in high-ranges like Idukki and Wayanad, where pepper is extensively cultivated on a commercial scale.

In Kerala, the survey was conducted in only two districts *viz.* Wayanad and Idukki. These districts account for 62% of the area under pepper and 83% of total pepper production in the state.

As per the estimates provided by the Directorate of Economics and Statistics, Kerala the total area under pepper is 73732 ha with a plant population of 1111 standards per ha.

Most of the pepper area (50%) in Idukki district is covered by the local cultivars like Chengannoor, Neelamundi, Thevamundi,

Pepper survey team in Waynad

Table 6. Area under pepper in major districts of Kerala

Districts covered in the Survey	Area (ha)	% share to State total
Idukky	37202	50
Wayanad	8957	12
Total	**40452**	**62**
State total (Including other Districts)	**73732**	**100**

Table 7. Area surveyed in Kerala

District	Area
Idukki	Adimali, Rajakkad, Rajakumari, Nedumkantam, , Kattappana, Kumily, Chakkupallam
Wayanad	Mananthavady, Pulpally, Mullankolly, Meenangadi, Muttil and Thirunelli

Table 8. Estimated percentage change in production of pepper in the districts surveyed in Kerala

District	Change in production compared to last year (%)
Idukky	+8.22
Wayanad	+23.14
Kerala (Weighted Average)	+10.69

Narayakkodi, Aimpiriyan, Kuthiravally, Perumkodi etc. Karimunda covers 35% and Panniyur covers 15% of area under pepper in Idukki. In Wayanad district, around 90% of the area under pepper cultivation is covered by Panniyur variety. While silver oak is the primary support tree for pepper cultivation in Wayanad, Erythrina is the preferred choice in Idukki, followed by Jack, Kilinjil, and other jungle trees. Silver oak is rarely used as a support for pepper in Idukki. The majority of farmers primarily apply organic manures such as farm yard manure or compost. While chemical fertilizer use is limited among these farmers. However, it is prevalent in the cultivation of intercrops like cardamom, ginger and coffee.

The estimated percentage changes in production of black pepper in the districts surveyed in Kerala are given in Table 8.

From the above table (Table 5), it is seen

that the production of black pepper in Kerala is expected to increase by about 11% this year owing to the increase in pepper production noticed in Idukki and Wayanad. Production of pepper in Idukki, the largest pepper producing district in the state, is expected to be increase by 8.22% and that in Wayanad, the second largest pepper producing district in Kerala is likely to increase by 23.14% during the crop season 2022-23. The increased pepper production in Kerala is primarily attributed to favorable weather conditions, less incidence of pests and diseases and improved management practices driven by the high market price of the commodity

Thus it has been estimated that the overall production of black pepper in Kerala is expected to increase by 10.69% this year (2023-24) as compared to last year (2022-23). The likely production of black pepper in Kerala during the season 2023-24 is estimated at 30610 tonnes as against the estimated production of 27654 tonnes during 2022-23.

Then major constraints in pepper cultivation as reported by the respondents are given below.

- higher cost of labour
- Non-availability of disease free planting materials of high yielding varieties
- non availability of labour for the cultural operations and harvesting

TAMIL NADU

Tamil Nadu is also a significant producer of pepper where it's cultivation is mainly confined to the Hilly zones like Nilgiris (Nilgiri District), Lower Pulneys (Dindigul District), Shevroys (Yercaud-Salem District), Kolli Hills (Namakkal District), Anamalai (Valparai -Coimbatore district), These five districts contribute about 90% of area under cultivation of pepper in Tamil Nadu.

Pepper survey team in Tamil Nadu

Table 9. Area under pepper in Tamil Nadu

District	Area (ha)	% share to State total
Namakkal	2517	34
Dindigul	1460	20
Salem	1454	19
The Nilgiris	992	13
Total	**6423**	**86**
State total (Total including other districts)	**7465**	**100**

As per the data provided by the Department of Economics and Statistics, Chennai, area under pepper in Tamil Nadu is 7465 ha. In Tamil Nadu, pepper is cultivated as a mixed crop in coffee / tea plantations. As it is grown as a mixed crop under–reporting /non-reporting of area coverage of pepper is a general practice in Tamil Nadu also. As per the survey conducted over the years, it is observed that only coffee/tea area is shown in the land records.

Field survey was conducted in the following areas.

Table 10. Area surveyed in Tamil Nadu

District	Area
Namakkal	Kolli Hills
Dindigul	Thadiyankudisai (Thandikudi)
Salem	Yercaud
Nilgiris	Gudallur

Now, Kolli Hills, a mountain range located in Namakkal District, is a high potential area of black pepper in Tamil Nadu. Here the cropping pattern is mainly Black pepper + coffee (70%) followed by black pepper + coffee + banana (25%) and as monocrop only by around 5%.

Major varieties /cultivars cultivated in Tamil Nadu are Panniyur and Karimunda. The field survey conducted in Tamil Nadu revealed that the pepper production in the state is to increase by 9.5%. The major reason attributed to the increase in production is the favorable weather conditions and good management practices.

Table 11. Expected production of black pepper during 2023-24 compared to 2022-23

State	Production 2022-23 (tonnes)	Estimated % change in production in 2023-24	Estimated production 2023-24 (tonnes)
Kerala	27654	10.7	30610
Karnataka	80805	10.2	89007
Tamil Nadu & Other States	8608	9.5	9426
Total	**117067**	**10.23**	**129043**

Thus the production of pepper in Tamil Nadu during the year 2023-24 is estimated at 9426 tonnes as against the estimated production of 8608 tonnes last year (2022-23).

CONCLUSION

Based on the study, it can be concluded that the production of black pepper in the country is expected to increase by about 10.23% r during the current harvesting season. Thus the total pepper production is expected to be 129043 tonnes during 2023-24, as against the estimated production of 117,067 tonnes during 2022-23.

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BRAINSTORMING SESSION ON "EFFECT OF ARECANUT CONSUMPTION ON HUMAN HEALTH"

A Multi-institutional Meeting on Arecanut and Human Health was jointly organized by ICAR- Central Plantation Crops Research Institute (ICAR-CPCRI), Kasaragod and Directorate of Arecanut and Spices Development (DASD), Kozhikode at ICAR-CPCRI, on 14th Nov, 2023. The purpose of the one-day event was to formulate research questions aimed at scientifically establishing the role of arecanut on health, involving researchers from reputable national organizations. Attendees included researchers from various fields, such as human medicine and plant metabolites, representing institutions like AIIMS, CSIR-CCMB, CSIR-CIMAP, CSIR-CFTRI, CSIR-NBRI, IISc, KMC, NITTE University, and SDM University, among others. The meeting was organized in hybrid mode with delegates from different parts of the country attending physically or joining over online.

Dr. K.B. Hebbar, Director of the host Institute (ICAR-CPCRI),welcomed the delegates and highlighted the need for evidence based research on arecanut and health so as to safeguard the interests of the millions of arecanut farmers. He highlighted some of the limitations in the earlier studies. Dr. Homey Cheriyan, Director, DASD, Kozhikode further elaborated the economic importance and said arecanut commerce accounted for INR 44,000 crores in India. Dr. K. Satyamoorthy, Professor, SDM University, Dharwad insisted the importance of systematic study not only to elicit sound evidence but also to publish the results in reputed journals. Dr. Prabhat Kumar, Hort. Commissioner, DAFW, Ministry of Agri. & Farmer's Welfare in his presidential address, while mentioning about the use of arecanut from Vedic period, stressed the need for impartiality in assessing the impact of arecanut on human health. He also agreed that a comprehensive road plan for the research in this aspect is very much essential. The deliberations were made under the following themes.

Session 1: Clinical Epidemiology and Public Health

A systematic review of available reports is being performed by Dr. PrasannaMithra P, KMC Mangalore and a group. From the findings he had highlighted the limitations of earlier studies Prof. Sameer Bakhshi, Professor, Department of Medical Oncology, AIIMS, New Delhi, talked about epidemiological association and biological plausibility. From various studies, he has pointed out the biasness in sampling, little number of cases in each study and significantly elevated odds ratios. He suggested robust case control/ cohort studies, in vitro and in vivo models. He also suggested areas where arecanut cessation and rates of OSMFs requires to be correlated to arrive at a meaningful conclusion. Dr. Praveen K. Shetty,KS Hegde Medical Academy, NIITE, Mangalore in his interaction highlighted the infrastructure support for arecanut research at NITTE University. Dr. Ravi KiranOngole fromManipal College of Dental Sciences Mangalore, Manipal while studying OSMF trying to establish if trace elements could be the causal factors. During the discussion opinion came forward regarding the assessment of the role of heavy metals such as arsenic.

Session 2: Metabolites and Metabolomics

Dr. Debasis Chakrabarty from CSIR-NBRI, Lucknow briefed the importance of establishing metabolites and metabolic pathways associated with arecoline content. Further importance of phytochemical constituents of arecanut and bioactive properties on human health were discussed by Dr. S. Nagarajan, CSIR-CFTRI, Mysore. Joining online, Dr. Karuna Shankar from CSIR-CIMAP, Lucknow stressed that concentration dependent studies are lacking. CSIR-CIMAP would be contributing in metabolite profiling of arecanut besides in pre-clinical safety/toxicity studies on the phytochemicals of arecanut. NMR-MS –based detection systems in blood metabolomics could be a subject of interest to Dr.Sujeet K. Mewar from AIIMS, New Delhi.

Session 3: Neurosciences

Dr. B.N. Srikumar, NIMHANS, Bangalore, discussed if arecanut extract could be used in therapeutics to treat neuropsychiatric disorders. His views have been strongly agreed by Dr. Radhika M. Sherkhane, SDM University, Dharwad, that basic in vivo animal studies should be taken up to collect systematic evidence.

Session 4: Cellular and Molecular Sciences

Dr. K. Thangaraj from CSIR-CCMB, Hyderabad, stressed the importance of selecting samples under different categories along with 'only arecanut chewers'. Categorization of stem cell lineages by arecanut and its active chemical constituents was discussed by Dr. Ajay Kumar Olli, SDM University, Dharwad. Prof. P. Kondaiah, IISC, Bangalore discussed about the Activation of cellular signaling pathways and regulation of gene expression by areca nut extracts. He added that arecanut induced pJNK is dependent on ROS and independent of TGFβ. Dr. K. Satyamoorthy from SDM University, Dharwad opined that arecanut with so much of polyphenols should be good to health as well as it could be a de-addiction agent. He added that a three dimensional system able to mimic what happens with arecanut and its extract is essential to be developed.

General points during discussion

- In depth analysis of biological effects of arecanut consumption
- Systematic study on anticancerous property of high concentration of arecoline
- Wound healing ability of the arecanut extract
- Quantitative determination is essential. Microbiological studies to be undertaken
- Characterization of Arecanut, classification of varieties and age groups of arecanut based on the alkaloid content, and batch constancy is essential. Critical dose of arecoline
- Potential of gene editing in knocking-out undesirable trait if any
- Processing of arecanut to reduce arecoline-an option
- Consensus should be there regarding extraction method
- Animal experiment is most crucial than cell line studies
- Clinical study and basic study hand in hand
- Identifying appropriate collaborator and preparation of a viable research project
- A chewing register with uniform information is very essential and need to be maintained in all places.
- A framework is to be prepared in 3-4 days and to finalize the network project proposal.

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सुपारी और मसाले के लिए जनवरी–मार्च, 2024 के कृषि कार्य

सुपारी

पौधशाला

- जनवरी में सुपारी के बीजों की लभ्यता के अनुसार पूरे साल सिंचित स्थितियों में रखे गए बागों में अंकुरण नहीं हुए तो उनमें पुनः रोपाई की जा सकती है। 3 महीने की आयुवाली पौधों को प्राथमिक नर्सरी से द्वितीय नर्सरी या पॉली बैगों में पुनः रोपाई करें। द्वितीय नर्सरी में क्यारियॉ 150 से.मी. चौडाई, 15 से.मी. ऊॅचाई और सुविधानुसार लंबाई में बनाया जाए। पौधों की प्रतिरोपाई करते समय 30–45 से. मी. की दूरी होनी चाहिए।
- द्वितीय नर्सरी में आधार खुराक के रूप में सडे हुए गोबर की खाद 5 टन प्रति हेक्टर की दर से प्रयोग करें। होस/स्प्रिग्लर/फाइन मिस्टिंग से क्यारियों में रोज सिंचाई करें।
- नियमित रूप से निराई करें और दुर्बल पोधों को हटाए।
- पौधशाला में छॉव जाल/सुपारी के पत्तें/प्लेटड नारियल पत्तों से छॉव दें और छॉव जाल को ठीक स्थान पर रखने के लिए नियमित निगरानी करें।
- पौधशाला में रखे पाइपों/खंभों से नीचे पड़ने से बचने के लिए जालों को चुस्ती से बॉध लें।
- मार्च के दौरान पौधशाला के पूरे भाग को इस तरह ढॅक लें ताकि हल्का धूप मिल सकें।

नया बाग

- हर पेड़ को 20 लीटर प्रतिदिन की दर से 5 दिनों में एक बार होस सिंचाई या रोज़ ड्रिप सिंचाई करें।
- यदि तरूण पौधों को छॉव देने के लिए रखे गए नारियल पत्ते सड़ गए या नष्ट हुए तो नए सामग्रियों से छॉव देना चाहिए।
- खरपतवार निकालने के बाद काटे गए खरपतवार और पत्तों को कतारों के बीच के ऊसर मिट्टी में बिखरा दें ताकि ये पल्वार के रूप में काफी लाभप्रद होगा, साथ ही मिट्टी की जैविक क्षमता में वृद्वि भी हो जाएगी। नए बागों में प्रति कि.ग्रा. गोबर खाद के साथ हरे पत्ते या कॉयर खाद से पल्वार करने से गर्मी के मौसम में बागों में नमी का संरक्षण कर सकता है और मिट्टी की भौतिक गुणों में वृद्वि लाई जा सकती है।
- मिट्टी तथा नमी के अनुरक्षण के लिए कोंटूर बंटिंग, टेरासिंग आदि उपायों को अपनाया जा सकता है।
- केले और अन्य छायेदार पेड़ों को अंतराफसल के रूप में लगाकर सूर्यताप से बचा लें। *काजुरीना* या *ग्लिरिसिडिया* को भी सीमा में छॉव के लिए और हवा से बचाने के लिए लगाया जा सकता है।

पुराना बाग

जनवरी के दौरान पके बेरियों की तुड़ाई और सुखाना जारी रखा जाए। सूखे नटों के छिलका निकालना और श्रेणीकरण करें। पश्चिमी तटों में फरवरी के सूखे मौसम में अच्छी बढ़ोत्तरी एवं उपज मिलने के लिए 6 दिनों में एक बार की दर से बागों में सिंचाई करें। पानी की किफायती प्रयोग के लिए ड्रिप सिंचाई करें। 4 से 7 दिनों में एक बार 175 लीटर पानी की दर से होस सिंचाई करें। ड्रिप सिंचाई के द्वारा 20 लीटर पानी प्रति पेड़ प्रति दिन दिया जा सकता है। सिंचित बागों में 50 ग्राम नत्रजन, 70 ग्राम पोटाश और 20 ग्राम फोसफोरस प्रति ताड़ की दर पर उर्वरकों का प्रयोग करें।

सुपारी के बागों को दक्षिण–पश्चिम धूप के दुष्प्रभाव से संरक्षण के लिए तने के हरे भाग को सूखे पत्तों या पत्तियों से और अपारदर्शी पॉलिथीन कवर से ढॅक लें या चूने का लेपन करें। पेड़ों के आधार में जैविक पल्वार, हरे या सूखे जंगली पत्ते, सुपारी पत्तियॉ आदि से पल्वार करने से मिट्टी की नमी बनायी रखी जा सकती है और मिट्टी को हल्के खोदने से वायु संचार और पानी के अवशोषण में वृद्वि होगी। गुच्छों में डाइबैक देखा जाए तो इसका नियंत्रण करें।

सामान्यतः गर्मी के महीनों में कीटों का प्रकोप अधिक होगा, इसलिए निगरानी करना बहुत महत्वपूर्ण है। माइट और पुष्पक्रम सूँडियों का नियंत्रण किया जाए। सुपारी के पेड, विशेषकर खुले बागों में होनेवाले, माईट का आक्रमण का शिकार होते हैं।

स्पिंडल बग का प्रकोप मुकुट के अविकसित पत्तों में काली रेखाओं के रूप में देखा जा सकता है। संक्रमित क्षेत्रों के सुपारी पेड़ों के स्पिंडिल में डिमेथोयेट (रोगर 30 ई सी) 15 मि.लि प्रति 10 लिटर पानी की दर पर छिड़कने से इस कीट को प्रभावपूर्ण ढंग से रोका जा सकता है। दिन के धूप के घंटों को छोड़कर, बहुत महीन छिड़काव करना चाहिए।

माइट्स के आक्रमण को रोकने के लिए पत्तियों के निचले सतह पर डाइमेथोएट (रोगर 30 ई सी) 1–5 मि.लि. प्रति लीटर पानी की दर पर छिड़कना चाहिए। यदि कीटों का संक्रमण फिर भी देखा जाएँ तो, 15–20 दिनों के अंतराल में छिड़काव दुहराया जाएँ। कई कोलियोप्टीरन कोक्सिनेल्लिड्स माईट को खा लेते हैं।

मसाले

काली मिर्च

पौधशाला

पोट्टिंग मिश्रण तैयार करके 30–45 दिनों तक सौरीकरण के लिए रखें। सौरीकृत पोट्टिंग मिश्रण को मिट्टी संदूषण से बचाने के लिए जैवीक नियंत्रण एजेंट यानी *ट्राइकोडेर्मा हर्जियानम* या टी.विरिडे (1 ग्राम प्रति कि.ग्रा.पोट्टिंग मिश्रण की दर से), *स्यूडोमोनास फ्लूरोसेन्स* (स्ट्रेयिन पी 1) (20 ग्राम 1 लिटर पानी में विलीन करें और 50 मि लीटर प्रति कि.ग्रा.पोट्टिंग मिश्रण), वी ए एम/ए एम एफ (100 सीसी प्रति कि.ग्रा.पोट्टिंग मिश्रण) से मिला देना चाहिए (जैवीक नियंत्रण एजेंट को नर्सरी मिश्रण से मिला दें, यद्यपि सौरीकृत नहीं किया गया है)।

15 x 10 से. मी. के आकार वाले पोली बैगों (काफी छिद्र सहित) में उपचारित नर्सरी मिश्रण भरा दें। मुख्य बेलों से भूस्तारियों को हटाकर रखें। ज्यादा कोमल या ज्यादा कठोर बेलों को मत लें। इन भूस्तारियों को दो या तीन गॉठों के साथ काटा जाना चाहिए। यदि इनके साथ पत्ते है तो, इन्हें निकालना चाहिए, और तना के साथ पत्ते का थोड़ा–सा डंठल भी रखें। काटे हुए बागों को स्यूडोमोनास (250 ग्राम 750 मि.ली. पानी में) 20 मिनट तक रखना चाहिए। उपचारित गॉठों को एक बैग में 3–5 की दर से लगाया जाए और 20 मिनट तक मिस्ट चेंबर में ऊष्मायित करें। जब गॉठें अंकुरण शुरू होता है, इन्हें मिस्ट चेंबर से बाहर निकालें।

इनमें अमुकुलित या रोग संक्रमित गाँठों को हटा दें । निम्न तापमान और उच्च नमी को बनाए रखने के अनुकूल तरीके से सिंचाई करें। एक पक्ष के अंतराल में पौधों को *स्यूडोमोनास फ्लूरोसेन्स* 2% स्ट्रेयिन पी 1 या ऐ ऐ एस आर–6) का छिड़काव करके उपचार करें। मीली बग से संक्रमित गाँठों को क्लोरपाइरिपोस 0.075% से उपचारित करें। यदि गोल थ्रिप्स या स्केल कीट देखा जाए तो डाइमेथोएट(0.05%) का छिड़काव करें। यदि फाइटोफ्तोरा रोग देखा जाए तो पोटासियम फोस्फोनेट 0.3% या मेटालाक्सिल मैंकोजेब 0.125% (1.25 ग्राम प्रति लीटर) का छिड़काव पाक्षिक अंतराल में करें। पत्तों में एकांतर रूप से 1% बोर्डो मिश्रण और 0.2% कोप्पर ओक्सीक्लोराइड छिड़का दें। रोग के फैलाव को रोकने के लिए रोग संक्रमित बैगों को हटा दें। पौधे परजीवी निमेटोड से होने वाले जड़ रोग संक्रमण (जड़ गलन) के परिणामस्वरूप पौधों की वृद्वि खराब होकर पत्तियॉ पीले हो जाती है और कभी–कभी जड़ कलमों के पत्तियों में अंतःशिरा क्लोरोसिस होती है। इसके निवारक उपाय के रूप में, नर्सरी मिश्रण को 1–2 ग्राम/कि.ग्रा. मिट्टी, सब्सट्रेट के प्रति ग्राम 10^6 सीएफयू कवक युक्त उत्पाद वाले टाल्क आधारित जैविक नियंत्रण एजेंट जैसे, *पोचोनिया क्लामिडोस्पोरिया, ट्राइकोडेर्मा हर्जियानम* से उपचारित किया जा सकता है। रोग संक्रमण के लिए नर्सरी को नियमित रूप से जॉच करें। यदि कुछ है तो, ऐसे तीव्र संक्रमित बैगों को नर्सरी से हटाना चाहिए। रोपाई के समय नीम खली 1 कि.ग्रा./गड्ढे की दर पर प्रयोग करने से भी निमेटोड संक्रमण को रोका जा सकता है।

बाग

बेलों के बीच वाली जगहों में और आधार भागों में निराई करें और सूखे पत्तों से पल्वार करें। पुराने पौधों से लटकने वाले बेलों को हटा दें।

तरुण बेलों को सूख जाने से बचाने के लिए ढ़ँक लें। फाईल्लोडी और स्टंट (वाइरल) रोग का निरीक्षण करें और संक्रमित पौधों को हटा दें।

परिपक्वता के निशानी के रूप में जब बेल के एक या दो फल हरे रंग से नारंगी या लाल रंग के हो जाएगा, तब तुड़ाई शुरू करें। काली मिर्च को सुखाने केलिए हमेशा साफ–सुथरे माध्यमों को अपनाना चाहिए

यानी, हाथ से या यांत्रिक थ्रेषर से बेरियों को अलग कर दें । साफ उपज मिलने के लिए क्रान्क्रीट की स्वच्छ जमीन, बाँस की चटाई या पॉलिथीन शीट पर बिछाकर सुखाना चाहिए ।

नया बाग

काली मिर्च बेलों को चढ़ाने के लिए अप्रैल माह में मुरिक्क् (*एरित्रीना वरीगोटा*) कारायम या किलिंजिल (*गरुगा पिन्नेट्टा*), *ऐलान्थस* स्पी., *ग्लिरीसीडिया* स्पी. कटहल का पेड़ आदि को आधारी पेड़ों के रूप में रोपित करें। ऊँची इलाकों में दलाप (*ई.लिथोस्पेर्मा*) और सिल्वर ओक (*ग्रेविल्लिया रोबस्टा*) को सहारे वाले पेड़ों के रूप में उगाया जा सकता है। जहॉ गाल वास्प देखा जाता हैं वहॉ *एरित्रीना सुबुमब्रान्स* आधार पेड़ के रूप में उपयोग करें। आधारों को मिट्टी में दृढ़ रखने के लिए मिट्टी को अच्छी तरह से दबाया जाना चाहिए। काली मिर्च की रोपाई करने के 2–3 वर्ष पहले सिल्वर ऑक और कटहल के पौदों की रोपाई करें। समतल में 3 x 3 मीटर की जगह दें। आधारों के पौदों को 40–50 से.मी गहरी छोटे छेदों में रोपाई करें। ढ़लान में पौधों के बीच में 2 मीटर और कतारों में 4 मीटर की जगह दें। मानसून शुरू होने तक सहारे वाले पेडों की सिंचाई करें।

अदरक

परिपक्वता की निशानी देखते ही अदरक की कटाई करें। बीज सामग्री के रूप में उपयोग करने के लिए पहले से चिह्नित पौधों की कटाई अलग से करना चाहिए।

आवश्यकतानुसार बीज सामग्री के लिए रोगमुक्त मोटी प्रकन्दों को चुनना चाहिए । चुनी हुई प्रकन्दों को मृदु गलन रोग से बचाने केलिए रोगनिवारण उपाय के रूप मे सर्वप्रथम डाइथेन एम–45, 3 ग्राम प्रति लिटर पानी की दर से या बाविस्टिन 2 ग्राम प्रति लीटर पानी में 30 मिनट तक उपचारित करना चाहिए । यदि बीज प्रकन्द राइजोम स्केल से प्रभावित है तो उसे भी 0.05% मालथयोन या डिमेथोएट से उपचारित करना चाहिए। सतह की आर्द्रता को हटाने के बाद बीज प्रकन्दों को 10–15 से.मी.गहरे गड्ढों में सुविधानुसार खुले रूप में रखकर लकडी के तख्तों से ढॅकना चाहिए। हवा आने जाने केलिए तख्तों में एक छोटा छेद रखना चाहिए और शेष भाग पर मिट्टी से लेप कर देना चाहिए ।

हल्दी

खेती के सभी मुख्य केन्द्रों में कटाई जारी रहेगी। हल्दी में आकर्षक रंग एवं विशेष गंध लाने के लिए कच्ची हल्दी की ताजा खोदी गई राइजोम संसाधित करना जरूरी है। अधिकतम सूखी हल्दी प्राप्त करने के लिए 37 हफ्तों की परिपक्वता में कटाई करना लाभप्रद होगा । लेकिन मूल्य वर्धित उत्पादों के द्वारा आर्थिक लाभ प्राप्त करने के लिए 29 हफ्तों की परिपक्वता के बाद हल्दी की कटाई की जा सकती है। छोटी प्रकन्दें और बल्बें साफ पानी में झाग और सफेद धुआँ आने तक (विशेष गंध के साथ) अलग अलग उबालना चाहिए। इसके बाद 10–15 दिनों तक इन्हें धूप में शुष्क एवं कड़ा होने तक सुखाना चाहिए।

बीज सामग्री के लिए सुविकसित, स्वस्थ एवं रोगमुक्त प्रकन्दों को चुन लेना चाहिए । इन प्रकन्दों को कोप्पर ओक्सीक्लोराइड से उपचारित करके अगले बुआई मौसम तक शीतल एवं सूखी जगह पर रखना चाहिए।

मिर्च

काली मिट्टी में 20–25 दिनों और लाल दुमट मिट्टी में 7–15 दिनों के अंतराल में सिंचाई करना चाहिए। फल–वेधकों के नियंत्रण के लिए (*स्पोडोप्टीरा लिटयूरा, हीलियोतिस एर्मिजेरा*) फेरोमोन ट्राप के ल्यूर को बदलना चाहिए। बागों की सीमा में सूर्यकांति पौधों की रोपाई करने से ओविपोसिटिंग मोत जैसे कीटों को आकर्षित करके मुख्य फसलों को रोग संक्रमण से बचाया जा सकता है। विषैले बेइट (Bait) (8:1:1 चोकर, जागरी और क्लोरीपाइरीफोस) (25 कि ग्रा प्रति हेक्टर की दर से) पौधों के पास रखने से आप्रवासी स्पोडोप्टीरा सूँडियों को नियंत्रित करने में प्रभावपूर्ण सिद्ध हुआ है। फल–वेधकों के संक्रमण की प्राथमिक अवस्था में *बासिल्लस तुरिन्जिएन्सिस* (*बीटी*) का छिड़काव पत्तों में करें (उदाहरण के लिए दिपल का प्रयोग 4 मि.लीटर प्रति लीटर की दर से या एक लीटर प्रति हेक्टर की दर से छिड़का दें)। रोग की फैलाव की स्थिति में इन्डोक्साकार्ब 1 मि.लीटर प्रति लीटर या स्पिनोसाड 0.3 मि.लीटर प्रति लीटर की दर से छिड़काव करना प्रभावपूर्ण है। रोग संक्रमण की प्राथमिक अवस्था में स्पोडोप्टीरा और हेलीकोवेर्पा के लिए न्यूक्लियार पोलीहेड्रोसिस वाइरस (NPV) 500 LE प्रति हेक्टर से प्रयोग करना प्रभावपूर्ण है।

डाइ– बैक और फल गलन को नियंत्रित रखने के लिए 1.5 ग्राम काप्तान या 2.5 ग्राम मेंकोजेब या कोप्पर ओक्सीक्लोराइड 3 ग्राम प्रति लीटर पानी की दर से छिड़कना चाहिए । 10–15 दिनों तक धूप में रखने के बाद मिर्च की पहली तुड़ाई की जानी चाहिए। खुली जगहों पर बिछाने से संदूषण/रंग फीके पड़ जाने की संभावना है। इससे बचने के लिए यांत्रिक मिर्च ड्रायर/सोलार मिर्च ड्रायर का उपयोग करें। हमेशा पोलिथीन शीट या साफ सूखे हुए फर्श पर सुखाना चाहिए। सूखे फलियों को 8–10% तक की नमी में रखना चाहिए।

वृक्ष मसाले

जायफल और लौंग के लिए नियमित सिंचाई करनी चाहिए और इसका सख्त पालन करना चाहिए। तरुण पौधों को घूप से बचाने के लिए पर्याप्त छाया करनी चाहिए । लौंग और जायफल की फसलों की तुड़ाई और सुखाई जारी रखी जाए।

वानिला

मौसम और आवश्यकता के अनुसार सिंचाई जारी रखी जाए। हमेशा कार्बनिक सामग्रियों से पल्वार करना चाहिए। जहाँ आवश्यक हो, बेलों को सहारे वाले पेडों से बाँधना चाहिए। पुष्पण के दिनों में सुबह 6 बजे से 1 बजे तक कुशल कारीगरों से परागण कराना चाहिए। यदि स्लग और घोंधे पौधों को नुकसान पहुँचाते तो हाथ से पकड़कर नष्ट करना चाहिए। इसके लिए गीला थैलियाँ नीचे बिछाना चाहिए इससे दिन में ये कीट इसके नीचे रहेंगे। नारियल के छिल्के से पलवार नहीं करना चाहिए क्योंकि इसके अंदर रहकर ये कीट बेलों को नुकसान पहुँचाएँगे। आसानी से सड़नेवाली सामग्रियों से पतला पलवार करना चाहिए। वानिला क्यारियों के अंदर मुर्गियों का प्रवेश बंद करें क्योंकि वे पल्वार सामग्रि को खरोचकर जडों को नुकसान पहुँचाएँगे।

यदि प्ररोहाग्र सड़न या पुष्पसमूह सड़न देखा जाए तो इसके फैलाव को रोकने के लिए बेलों पर 0.2% कार्बन्डाजिम का छिड़काव करें। वाइरल संक्रमण की निशानी वाली बेलों को तुरंत ही हटाकर नष्ट करना चाहिए। कटाई जारी रखी जाएगी। गुणवत्तावाली सूखी बीन्स प्राप्त करने के लिए बीन के पतले अग्र भाग पर हल्के पीले रंग आने पर कटाई करनी चाहिए ।

बीजीय मसाले

धनिया

रोपाई के 90–100 दिनों के बाद चौथी सिंचाई करें। रोपाई के 105–110 और 115–125 दिनों के बाद क्रमशः पॉचवीं और छठी सिंचाई करें। चूर्णीय फफूंद एवं एफिड के नियंत्रण के लिए सिफारिश किए गए कीटनाशियों/फफूँदनाशियों का प्रयोग करें।

जब कम से कम 50% बीज परिपक्व होकर भूसे रंग से पीले रंग में बदल जाते हैं, तब फसल की कटाई कर सकता है। कटे हुए फसल को इस तरह से बंडलों में रखा जाना चाहिए ताकि बीज पर सीधे धूप न पडे, जिससे इसके अच्छे रंग और सुगंध नष्ट होने से बचा सके। कटाई के बाद बीजों को छड़ी से हल्के धड़कन से और विनोयिंग से अलग किया जाता है।

सौंफ

मिट्टी में अनुकूल नमी नहीं है तो 15–20 दिनों के अंतराल में सिंचाई करनी चाहिए। रामुलेरिया ब्लाइट के नियंत्रण के लिए 0.2% मैन्कोजेब 75 w.p या डाइथेन M–45 का 0.2% विलियन छिड़का दें। अच्छे प्रभाव के लिए 1 मि.लीटर साबुन विलियन प्रति लीटर पानी की दर से छिड़का दें। आवश्यकतानुसार 10–15 दिनों के अंतराल में 2–3 बार छिड़काव करें। यदि एफिड का आक्रमण देखा जाए तो क्रमिक कीटनाशियों का छिड़काव करना चाहिए। फसल की अवधि 170–180 दिन है। सारे फल एक साथ नहीं परिपक्व होने के कारण आर्थिक पैदावार के लिए 10–15 दिनों के अंतराल में 4–5 बार तुड़ाई की जानी चाहिए। इसकी फलियॉ पूर्णतः परिपक्व होने से पहले, यानी फलगुच्छ का रंग हरीले पीत रंग हो जाने पर इसकी तुड़ाई की जा सकती है। कटे हुए फल, खासकर हरे सौंफ के लिए काटे फल, अच्छी तरह से वातित परिस्थितियों में छाया में सुखाया जाए।

जीरा

दूसरे पक्ष में निराई करनी चाहिए और यदि मौसम सूखा है तो पौधों की सिंचाई करनी चाहिए। मौसम बादल से भरा हुआ है तो सिंचाई स्थगित करना चाहिए। चूर्णी फफूँद से बचाव केलिए 300 मेश सल्फर चूर्ण 25 किलो ग्राम प्रति हेक्टेयर की दर से छिड़काव करना चाहिए या 15 दिनों के अंतराल में सुबह में 0.25%

आर्द्र सल्फर (केरातेन) का छिड़काव करना चाहिए । एफिड्स के नियंत्रण के लिए 0.03% डाइमेथोएट (एक मि.ली.प्रति लीटर पानी की दर से) छिड़कना चाहिए। 20–25 दिनों के अंतराल में सिंचाई करनी चाहिए। 80–90 दिनों की परिपक्वता में फसल कटाई के लिए तैयार हो जाता है। बीजों को बिखरने से बचाने के लिए कटाई सुबह के समय में की जाए।

मेंथी

20–25 दिनों के अंतराल में पौधों की सिंचाई करनी चाहिए। एफिड, थ्रिप्स और जसिडों के नियंत्रण के लिए किसी भी प्रणालीगत कीटनाशक का छिड़काव करें। यदि आवश्यक है तो, 10–15 दिनों के बाद छिडकाव दुहराना चाहिए। जहॉ चूर्ण फफूँद देखें, इसके नियंत्रण केलिए 5% सल्फर चूर्ण 15 कि.ग्राम प्रति हेक्टर की दर से करे और रोमिल फफूँद के नियंत्रण के लिए 1% बोर्डो किश्रण का छिडकाव करें। फसल की कटाई तब करें, जब फली पीली हो गई हों और निचली पत्तियॉ गलने लगी हों।

अजवाइन

1–2 बार जुताई के बाद 2 या 3 बार गुड़ाई करके पाटा चलाकर प्रतिरोपण के लिए मिट्टी तैयार करना चाहिए। प्रथम पखवाड़े में पौध का प्रतिरोपण करना चाहिए। मिट्टी तैयार करते समय 25–30 मेट्रिक टन गोबर की खाद प्रति हेक्टेयर की दर पर और प्रतिरोपण के पहले 40 कि.ग्राम नत्रजन, 40 कि.ग्राम फोसफोरस और 20 कि.ग्राम पोटाश प्रति हेक्टेयर की दर से मिला देना चाहिए। अच्छी तरह जड़ पकड़ने के लिए प्रतिरोपण के बाद पौध की सिंचाई करनी चाहिए। 15–20 दिनों के अंतराल में सिंचाई दोहरानी चाहिए। प्रतिरोपण के 20–25 दिनों के बाद पहली गुड़ाई की जानी चाहिए।

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FARM OPERATIONS FOR ARECANUT & SPICES
JANUARY-MARCH, 2024

ARECANUT

Nursery

- Based on the availability of seed nuts, in January re-sowing can be done in ungerminated bags in nurseries, which are in operation throughout the year with water facilities. Sorting and repotting of 3 months old sprouts from primary nursery to secondary nursery or into poly bags. Secondary nursery beds of about 150 cm width, 15 cm height and with convenient length can be prepared and a spacing of 30-45 cm may be given for replanting sprouts.
- The secondary nursery should be given a basal dose of decomposed farmyard manure @ about 5 tonnes per ha. Watering daily through hose/sprinkler/fine misting.
- Regular weeding and removal of weak seedlings
- Overhead shade maintenance with shade net/ thatched areca leaves/plaited coconut leaves may be provided in the nursery and regular supervision of shade net position should be done.
- Tie the nets tightly without bending over the permanent pipes and pillars in the nursery.
- During March the entire nursery area may be covered to allow filtered sunlight.

Young garden

- Hose irrigation may be given once in five days or drip irrigation on daily basis @ 20 litres/palm/day.
- If the existing plaited coconut leaves provided as shade to young seedlings decomposed or damaged, replace with new one.
- After weeding, the cut weeds and palm leaves can be spread over the barren soil in between rows, which will act as mulching material and enrich the organic content of the soil. Mulching with green leaves/coir compost/5 kg FYM will conserve the moisture in the young garden during summer and enrich the physical properties of the soil.
- Measures such as contour bunding, terracing etc. can be taken up in sloppy lands for soil and moisture conservation.
- Shade management with intercropped banana and other shade trees in the borders to reduce the effect of sun. Casuarina and Glyricidia are also being grown in borders for shade and as wind breaks.

Old garden

During January harvesting and drying of ripe nuts may be continued. Also dehusking dry nuts and grading may be done. It is necessary to irrigate the garden during long dry spell in west coast once in 6 days during February for proper growth and yield. For efficient water use, drip irrigation is recommended. Hose irrigation may be given once in 4 to 7 days at the rate of 175 litres of water per application. 20 litres of water/ palm/day may be applied through drip irrigation system. In the irrigated gardens application of fertilizers to supply 50 gm N, 20 gm P_2O_5 and 70 gm K_2O per palm may be carried out.

South west side of arecanut garden may be protected from sun scorch by wrapping the green portions of the stem with dry areca leaves, leaf sheaths or opaque polythene film or painting with lime. Application of organic mulches, green/ dried forest leaves, areca husk etc. to the base of the palm helps in conservation of soil moisture, loosening heavy soils, increasing aeration and water intake. Inflorescence die back may be noticed and controlled.

Generally, attack of pests will be more during summer months and so surveillance is very important. Control for mite and inflorescence caterpillar may be taken up. Arecanut palms particularly those under exposed conditions, may show symptoms of mite attack.

Incidence of spindle bug can be noticed on the newly unfurled leaves on the crowns as linear black streaks. Spraying the spindles of areca palms in infected areas with dimethoate

(Rogor 30EC) 15 ml/10 L of water will effectively control pest. Very fine spraying must be done, avoiding the sunny hours of the day.

Against mite attack spray the under surface of leaves with Dimethoate (Rogor 30 EC) @ 1.5 ml/L of water. Repeat spraying at an interval of 15-20 days if there is recurrence of pest. Many Coleopteran coccinellids are predators against mites.

PEPPER

Nursery

Prepare the potting mixture and put for solarization for 30 to 45 days. Mix the solarized potting mixture with biocontrol agents viz. *Trichoderma harzianum* or *T. viride* (1 g per kg of nursery mixture), *Pseudomonas fluorescens* (Strain P1) (20 g dissolved in 1 litre water and 50 ml of this solution to be used for one kg of nursery mixture) and VAM/AMF (vesicular arbuscular mycorrhiza /arbuscular mycorrhizal fungi) @ 100 cc per kg of nursery mixture, *Pochonia chlamydosporia* (1-2 g/ kg of nursery mixture). Such solarized nursery mixture mixed with above biocontrol agents would prevent root infection in the pepper cuttings. (The biocontrol agents can also be mixed with nursery mixture, even if it is not solarized).

Fill the polybags of size 15 x 10 cm (with enough perforations) with treated nursery mixture. Separate the runner shoots from the mother plant. Avoid using, too tender or too woody shoots. Cut the selected runner shoots into 2 to 3 node pieces. Leaves, if any are clipped off leaving a small portion of petiole on the stem. Treat the cuttings with cut ends dipped in *Pseudomonas formulation* (250 g in 750 ml water) for 20 minutes. Plant treated cuttings @ 3 to 5 per bag and incubate in mist chambers for 20 days. When cuttings start sprouting, they are taken out or removed from the mist chamber.

Remove unsprouted and infected cuttings, if any from the nursery. Water the plants at the required frequency so as to maintain low temperature and high humid conditions. Spray and drench the plants at fortnightly interval with 2% *Pseudomonas fluorescens* (Strain P1 or IISR-6). Drench the infested bags with Chlorpyriphos 0.075%, if mealy bugs damage is noticed. Spray with dimethoate (0.05%), if gall thrips or scale insects incidence is noticed. Spray with 0.3% Potassium phosphonate or Metalaxyl mancozeb 0.125% (1.25 g/litre) at fortnightly interval, if *Phytophthora* disease incidence is noticed. Alternatively spray the foliage with 1% Bordeaux mixture and drench with 0.2% copper oxychloride. Remove bags with infected cuttings to prevent spread of disease. Root infection (root rot) due to plant parasitic nematodes would result in poor growth, foliar yellowing and sometimes interveinal chlorosis of leaves of the rooted cuttings. As a preventive measure, nursery mixure may be fortified with talc based formulation of biocontrol agents such as *Pochonia chlamydosporia* or *Trichoderma harzianum* @ 1-2 g/ kg of soil, the product containing 10^6 cfu fungus/g of substrate. Regularly check the nursery for nematode infection, if any, and remove such bags with severely infected cuttings from the nursery. Application of neem cake @ 1 Kg /Pit at the time of planting may also prevent nematode infestation.

Plantation

Undertake slash-weeding of the interspace and hand-weeding at the basins of the vines and mulch the basins with dry leaves. Remove hanging shoots in older plants.

Cover the young vines so as to prevent drying. Inspect and remove plants showing symptoms of phyllody and stunt diseases (viral).

Harvesting may be done by observing the right maturity as indicated by the colour change in one or two berries in a spike from green to orange or red. Always ensure threshing of pepper by hygienic means either manually or using mechanical pepper thresher. Use only clean floor made of concrete, bamboo mats or polythene sheet surface for drying to get clean produce.

New plantation

During the month of April, plant live standards like "Nadan Murikku" (*Erythrina variegata*), Karayam or Kilinhil (*Garuga pinnata*), *Ailanthus* sp., *Glyricidia* sp., Jack fruit tree *etc*. are suitable live standards / supports recommended

for trailing pepper. In high altitude areas, Dadap (*Erythrina lithosperma*) and Silver oak (*Grevillea robusta*) can be successfully used as standards for pepper. *Erythrina subumbrans* may be used as standarad in areas where gall wasp is noticed. The soil should be well pressed to keep the standards firm in the soil. Seedlings of Silver oak, Jack etc. are to be planted 2-3 years before planting pepper. The spacing recommended is 3 x 3 m on plain lands. The cuttings of standards are to be planted in narrow holes of 40 to 50 cm depth. On sloppy land, 2 m between plants in rows across the slope and 4 m between rows. Irrigate the standards till the monsoon starts.

GINGER

Harvesting Ginger may be done after seeing the indication of maturity. Harvest the already marked plants separately for seed purpose.

Select plumpy rhizomes, free from disease as seed materials to the extent required. The selected seed rhizomes are first treated with Dithane M-45 @ 3 g/L or Bavistin @ 2 g/L for 30 minutes as a prophylactic measure against soft rot disease. If the seed rhizomes are infested with rhizome scale they may also be treated with 0.05 % Malathion/Dimethoate. After draining the surface moisture the seed rhizomes are put loosely in pits of convenient size upto a height of 10 to 15 cm from the top and covered with wooden planks. A small hole is provided in the plank for aeration and the surface plastered with mud.

TURMERIC

Harvesting may be in progress in all the major centres of cultivation. Curing of raw turmeric rhizomes freshly dug out of earth is essential both for the development of an attractive yellow colour and characteristic aroma. For maximum recovery of dry turmeric, it is beneficial to harvest the rhizomes at about 37 weeks maturity, but for economic retrieval of the value-added products, rhizomes can be harvested at 29 weeks maturity. The fingers and bulbs are boiled separately in pure water until froth and white fumes appear in plenty and then they are drained and dried in the sun for 10-15 days until they become dry and hard.

Select well developed, healthy and disease free rhizomes for seed purpose. Treat the rhizomes in Copper oxychloride and store in cool dry place till the next sowing season.

CHILLI

Irrigate once in 20-25 days in black soils and once in 7 to 15 days in red loamy soils. Change the lure of pheromone traps for monitoring pod borers (*Spodoptera litura, Heliothis armigera*). Planting sunflower along the borders can attract ovipositing moths, thereby saving the main crop from infestation. Use of poison baits (8:1:1 bran, jaggery and chloripyriphos) and placing them close to the plants proved effective in controlling immigrating *Spodoptera* caterpillars (25 kg bait is sufficient for one ha). Foliar spray with *Bacillus thuringiensis* (Bt) at recommended dose (for example, a product such as dipel can be applied @ 4 ml/litre, ie, 1 litre/ha with power sprayer) at early stage of pod borer infestation can provide effective control. In case of epidemic situations, application of indoxacarb @ 1 ml per litre or spinosad @ 0.3 ml per litre will be effective. Also, for *Spodoptera* and *Helicoverpa,* application of nuclear polyhedrosis virus (NPV) @ 500 LE per ha at the early stage of the pest infestation proved to be an effective control.

Spray Captan 1.5 gm or Mancozeb 2.5 gm or Copper Oxychloride 3 gm/litre of water to control die-back and fruit rot disease. Start first picking of Chilli and then the produce is exposed to sun for 10-15 days. Spreading on open yards leads to contamination/discoloration. To avoid this, use mechanical Chilli drier/Solar Chilli drier wherever possible. Always dry in polythene sheets/or clean drying yard. The moisture content of the dried pod is to be kept between 8-10 %.

TREE SPICES

Nutmeg and clove may require regular irrigation and has to be very scrupulously followed. Young plants may be given adequate protection from exposure to sun. Harvesting and curing of Clove and Nutmeg may be continued.

VANILLA

Irrigation to be continued based on weather condition and necessity. Always ensure adequate mulch material with organic debris.

Tying of vines with the standard to be continued as and when required. Pollinate the flowers manually between 6 am to 1 pm on the day of flowering. If slugs and snails found damaging the vines, collect them manually and destroy. For this spread wet gunny sacks around the base as slugs and snails will come and hide inside the sack during day time. Avoid mulching with coconut husk as these insects may hide inside and damage the vines. Use only decomposable mulch and that too lightly. Always avoid the entry of chicken inside the vanillary as they may damage the roots by scratching the mulch materials.

If shoot tip rot or inflorescence rot is found spray the vines with 0.2 % Carbendazim to reduce the disease spread. Vanilla vines exhibiting any viral symptoms are to be immediately removed and destroyed. Continue harvesting. Harvest when light yellowing is observed at the distal end of the bean to ensure better quality of cured beans.

SEED SPICES

CORIANDER

Fourth irrigation may be given 90-100 days after sowing. Fifth and sixth irrigation should be given 105-110 days and 115-125 days after sowing respectively. To control the powdery mildew and aphids spraying of pesticides/fungicides is recommended.

The crop can be harvested when 50 % of the seeds mature as indicated by the change of straw color to yellow and should be kept in bundles down in such a way to avoid direct sun rays on the seeds to get good colour and also to avoid loss of flavour. After drying the harvested material, the seeds are separated by light beating with stick and winnowing.

FENNEL

Crop may be irrigated at an interval of 15-20 days if optimum moisture is not available in the soil. To control *Ramularia* blight at the initial stage, spraying of 0.2 % Mancozeb 75 WP may be done or spraying of 0.2 % solution of Dithane-M-45 is effective to control this disease. Add 1 ml soap solution / litre of water for better efficacy. Subsequently, 2-3 sprayings should be done at an interval of 10 to 15 days on neem basis. Spray any systemic insecticide to control aphid, if observed.

The duration of the crop is 170-180 days. All the fruits do not mature at a time and therefore resort to four to five harvestings at 10 to 15 days interval for economic yield. Harvesting must be done before the fruits are fully ripe, that is when the umbels attain a greenish yellow colour. The harvested umbels may be dried in the shade under well aerated conditions particularly for green fennel.

CUMIN

Weeding may be done and crop should be irrigated if clear weather condition prevails. Irrigation must be postponed if cloudy weather condition prevails. To control powdery mildew, dust 300 mesh Sulphur @ 25 kg/ha in early morning hours or spray wettable Sulphur (Kerathane) @ 0.25 % at 15 days interval. For the control of aphids, spray Dimethoate 0.03 % (one ml. per litre of water). Irrigation may be followed at an interval of 20-25 days.

The crop will be ready for harvest in about 80 to 90 days maturity. Harvesting may be done in the early morning hours to prevent shattering of seeds.

FENUGREEK

Crop should be irrigated at an interval of 20-25 days. To control the aphid, thrips & jassids, spray any systemic insecticides. Repeat the spray after 10-15 days based on necessity. Powdery mildew wherever noticed may be controlled by dusting Sulphur @ 15 kg/ha and against downy mildew, spray Bordeaux mixture 1%. The crop should be harvested when the pods have become yellowish and lower leaves start shedding.

CELERY

Land should be prepared by 1-2 ploughings followed by 2 or 3 harrowing and planking for transplanting. Seedlings may be transplanted during first fortnight. 25-30 MT of FYM per ha is mixed in the soil at the time of land preparation and 40 kg Nitrogen, 40 kg Phosphorous and 20 kg Potash/ha applied as basal dose before transplanting. Seedlings may be irrigated after transplanting for better establishment. Irrigation may be repeated after 15-20 days interval. First intercultural operation/hoeing should be done 20-25 days after transplanting.

बाज़ार समीक्षा
(जुलाई-सितंबर, 2023)

सुपारी

जुलाई से सितंबर, 2023 के दौरान सूखी सुपारी के भाव थोडा उतार-चढ़ाव के साथ ऊंचे स्तर पर था। जुलाई से सितंबर के दौरान कोषिक्कोड बाज़ार में सुपारी का औसत भाव पिछले तिमाही (अप्रैल-जून, 2023) के 35854 रुपए प्रति क्विंटल से 38269 रुपए प्रति क्विंटल तक बढ़ गया। सिरसी और पणजी बाजारों में भी तेजी का रुख रहा। पणजी में सुपारी के भाव में उल्लेखनीय वृद्धि देखी गई, जो जुलाई की शुरुआत में 36500 रुपये प्रति क्विंटल से बढ़कर सितंबर, 2023 के अंत में 39500 रुपये प्रति क्विंटल हो गई। सुपारी का ऊंचा भाव मुख्य रूप से कर्नाटक राज्य में पत्ती धब्बा रोग के कारण उत्पादन में हुई कमी के कारण थी।

काली मिर्च

समीक्षाधीन तिमाही के दौरान काली मिर्च के भाव में बढ़ाव का रुख रहा। कोची टर्मिनल बाज़ार में मलबार गारबल्ड काली मिर्च (एमजी-1) के भाव में 12,100 रुपए प्रति क्विंटल की वृद्धि हुई। वैसे ही, इस अवधि के दौरान कोषिक्कोड (नाडन) और कोट्टयम बाज़ार में इसके भाव में क्रमशः 11,600 और 11,000 रुपए प्रति क्विंटल की वृद्धि हुई।

अदरक

लगभग सभी बाजारों में अदरक का भाव बढ़ गया। कोची बाज़ार में सूखे अदरक का भाव जुलाई, 2023 के प्रथम सप्ताहांत के 27,000 रुपए प्रति क्विंटल से बढ़कर सितंबर, 2023 के अंतिम सप्ताहांत के दौरान 33,000 रुपए प्रति क्विंटल हो गया। यही वृद्धि की प्रवृत्ति कोषिक्कोड़ बाज़ार में भी देखी गई। अदरक के भाव में वृद्धि मुख्य रूप से 2022-23 फसल सीजन के दौरान कम उत्पादन के परिणामस्वरूप बाजार में हुई आपूर्ति की कमी के कारण हुई।

मिर्च

अधिकांश बाजारों में सूखी मिर्च के भाव में मिश्रित रुझान देखा गया। विशेष रूप से गुंटूर बाजारों में, समीक्षा अवधि के भीतर 500 रुपये प्रति क्विंटल की कमी हुई। ब्याड़ागी बाजार में डब्बी एवं कड्डी किस्म के मिर्च के भाव में गिरावट दर्ज किया गया। इस अवधि के दौरान डब्बी मिर्च का भाव प्रति क्विंटल 42,509 रुपये से घटकर 41,669 रुपये और कड्डी का भाव प्रति क्विंटल 33,009 रुपये से घटकर 32,269 रुपये हो गया।

हल्दी

विभिन्न बाजारों में हल्दी के भाव में बढ़ोतरी का रुझान देखा गया। गया। निज़ामाबाद बाज़ार में जुलाई से सितंबर, 2023 तक हल्दी (फिंगर) के भाव में प्रति क्विंटल करीब 3,752 रुपए की वृद्धि हुई। कोच्चि बाजार में भी हल्दी के भाव में 2,000 रुपये प्रति क्विंटल की वृद्धि हुई। चेन्नै और दिल्ली में इसके भाव में क्रमशः 6000 और 900 रुपए प्रति क्विंटल की वृद्धि हुई।

लहसुन

समीक्षाधीन अवधि के दौरान लगभग सभी बाजारों में लहसुन के भाव में वृद्धि हुई। मध्य प्रदेश के प्रमुख लहसुन उत्पादक क्षेत्र मंदसौर में, लहसुन के भाव में वृद्धि दर्ज की गई। इसका भाव, प्रति क्विंटल 6,650 रुपए से 9,900 रुपए तक बढ़ गया। इस वृद्धि का मुख्य कारण 2022-23 फसल सीजन में लहसुन के कम उत्पादन है।

बीजीय मसाले

समीक्षाधीन अवधि के दौरान बीजीय मसालों में जीरे का भाव चेन्नै में आसमान छू गईं, लेकिन ऊंझा में गिर गया। उंझा बाजार में जुलाई से सितंबर, 2023 के दौरान जीरे का भाव प्रति क्विंटल 58,625 रुपये से घटकर 56,125 रुपये हो गया। ऊंझा में दर्ज की गई धनिया के भाव में उतार-चढ़ाव का रुख देखा गया, जैसा कि संलग्न तालिका में देखा जा सकता है।

जायफल /जावित्रि और लौंग

समीक्षाधीन अवधि के दौरान जायफल और जावित्रि के भाव में वृद्धि की प्रवृत्ति देखी गई। छिल्का रहित जायफल का भाव प्रति क्विंटल 42,500 रुपए से 45,000 रुपए तक बढ़ गया । जावित्रि का भाव प्रति क्विंटल 1,40,000 रुपए से 1,50,000 रुपए तक बढ़ गया । सितंबर, 2023 के अंत तक लौंग के भाव 5000 रुपये प्रति क्विंटल तक बढ़ गईं।

भारत तथा विदेश के प्रमुख बाज़ार केन्द्रों में सुपारी और मसाले के साप्ताहिक थोक भाव नीचे सारणी में दिया गया है।

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MARKET REVIEW

(July to September, 2023)

ARECANUT

The prices of Arecanut (dry) ruled at higher levels with minor fluctuations during the period from July to September 2023. Average price of arecanut in Kozhikode market was increased to Rs. 38,269/quintal during the quarter July to September from the average price of Rs. 35,854/quintal recorded during the previous quarter (April to June 2023). Prices in Sirsi and Panaji markets also showed an upward trend. In Panaji, the wholesale price of arecanut witnessed a significant increase, rising from Rs. 36,500 per quintal at the beginning of July to Rs. 39,500 per quintal by the end of September 2023. The high prices of arecanut was mainly due to the decrease in production due to the incidence of Leaf Spot Disease (LSD) in Karnataka State.

BLACK PEPPER

During the period under review, the black pepper prices exhibited an increasing trend. The price of Malabar Garbled Black Pepper (MG-1) in the Cochin terminal market has shown an increase of Rs. 12,100 per quintal. Likewise, in Kozhikode (Nadan) and Kottayam markets also, prices increased by Rs. 11,600 and Rs. 11,000 per quintal respectively during the period under review.

GINGER

Ginger prices have escalated in almost all the markets. In the Kochi markets, the prices of dry ginger increased to Rs. 33,000 per quintal by the last weekend of September 2023, up from Rs. 27,000 per quintal in the first weekend of July 2023. The same upward trend in prices was also observed in the Kozhikode market. This escalation in ginger prices was primarily due to a market supply shortage as a result of the reduction in production during the 2022-23 crop season.

CHILLY

Dry Chilli prices experienced a mixed trend across most markets. Specifically, in the Guntur market, there was a reduction of Rs. 500 per quintal within the review period. The Byadagi market also recorded a decrease in the price of the Dubby and Kaddi variety of Chilli. The prices of Dubby chilli decreased from Rs. 42,509/ quintal to Rs. 41,669/quintal and that of Kaddi chilli decreased from Rs. 33,009/ quintal to Rs. 32,269/quintal during the period under review.

TURMERIC

Turmeric prices displayed an increasing trend across different markets. In the Nizamabad market, the price of turmeric (finger) shown an increase of approximately Rs. 3,752 per quintal from July to September 2023. In Cochin market also, turmeric prices increased by Rs. 2,000/ quintal. In Chennai and Delhi markets, the prices increased by Rs. 6,000/quintal and Rs. 900/quintal respectively.

GARLIC

Garlic prices increased in almost all the markets during the quarter under review. In Mandsaur, a key garlic-producing region in Madhya Pradesh, the price of garlic exhibited an upward trend. The price per quintal rose from Rs. 6,650 to Rs. 9,900 per quintal. This increase was primarily attributed to the low garlic production reported during the 2022-23 crop season.

SEED SPICES

Among seed spices, cumin prices skyrocketed in Chennai market but in Unjha market, the prices got dropped down during the period. In the Unjha market, the price of cumin decreased from Rs. 58,625 per quintal to Rs. 56,125 per quintal during the period from July to September 2023. Coriander price recorded in Unjha shown a fluctuating trend, as seen in the accompanying table.

NUTMEG, MACE & CLOVES

The prices of Nutmeg and Mace showed an increasing trend during the quarter under review. The price of nutmeg without shell had increased from Rs. 42,500 to Rs. 45,000 per quintal. Price of Mace increased from Rs.140000 to Rs. 15,0000 per quintal. Clove prices increased by Rs. 5,000/quintal by the end of September 2023.

Week-end wholesale prices of arecanut and spices recorded in the major market centers of India are appended in the following tables.

WEEKLY WHOLESALE PRICES OF ARECANUT

KERALA **(Rs /quintal)**

Month	Week	Kochi	Kozhikode	Thalassery	Kasaragod
		Dry	Dry New	New	Dry (Old)
July-23	1st	29500	37000	37300	47500
	2nd	29500	38000	37300	47500
	3rd	29500	38200	38400	47500
	4th	29500	38000	38400	47500
Aug-23	1st	29500	39000	39500	43000
	2nd	29500	39000	39500	43000
	3rd	29500	39000	39500	42500
	4th	29500	39000	38700	42500
Sept-23	1st	29500	38500	39000	46000
	2nd	29500	38500	38800	45500
	3rd	29500	38300	38200	46500
	4th	29500	37500	38000	46000
	5th	29500	37500	38000	45500

Source: District Economics and Statistics Office, Ernakulam, Kasargod; Regional Statistical Office, Kozhikode.

TAMIL NADU, KARNATAKA & GOA **(Rs /quintal)**

Month	Week	Chennai	Sagar	Goa
		Rashi	Red Arecanut	Chali (old)
July-23	1st	35000	38868	36500
	2nd	35000	39871	36900
	3rd	35000	39679	37300
	4th	35000	41889	38100
Aug-23	1st	35000	42120	39100
	2nd	35000	40719	39500
	3rd	36000	40576	39500
	4th	36000	41211	39500
Sept-23	1st	37000	40735	39500
	2nd	37000	40670	39500
	3rd	37000	39324	39500
	4th	36000	39304	39500
	5th	36000	39725	39500

Source: Economics & Statistics , Chennai; Directorate of Marketing, Goa, APMC, Sagar.

WEEKLY WHOLESALE PRICES OF BLACK PEPPER (Rs /Qunital)

Month	Week	Kochi		Kozhikode		Kottayam
		MG-1	Ungarbled	Nadan	Wayanadan	
July-23	1st	51300	49200	48000	49000	49000
	2nd	52000	49800	48400	49400	49000
	3rd	52800	50200	48400	49800	49000
	4th	59100	58000	56500	57500	57000
Aug-23	1st	61800	59000	57200	58200	58000
	2nd	62000	60400	57200	58200	60000
	3rd	61600	59500	57300	58300	64000
	4th	66200	64100	62600	63600	65000
Sept-23	1st	65500	63600	62400	63400	64000
	2nd	65500	63500	62400	63400	65000
	3rd	65500	63500	62400	63400	65000
	4th	63200	62100	60800	61800	61000
	5th	63400	60300	59600	60600	60000

Source: IPSTA. Kochi; District Economics & Statistics, Kottayam ;Regional Statistical Office, Kozhikode

WEEKLY WHOLESALE PRICES OF GINGER (Rs /Quintal)

Month	Week	Kozhikode	Kochi	Chennai
		Fresh	Dry	Dry (white)
July-23	1st	23000	27000	28000
	2nd	23000	27000	29000
	3rd	23000	27000	32000
	4th	27500	27000	33000
Aug-23	1st	31000	27000	34000
	2nd	31000	27000	35000
	3rd	31000	32500	36000
	4th	33500	33000	36000
Sept-23	1st	33500	33000	36000
	2nd	33500	33000	36500
	3rd	33500	33000	37000
	4th	33500	33000	36000
	5th	33500	33000	36000

Source: Regional Statistical Office, Kozhikode; Economics & Statistics, Ernakulam; Dept of Economics & Statistics, Chennai

WEEKLY WHOLESALE PRICES OF CHILLI (Rs /Quintal)

Month	Week	Guntur	Byadagi		Delhi	Chennai	
			Dabbi	Kaddi		Ramnad	Samba-II
July-23	1st	21500	42509	33009	21500	26000	17500
	2nd	21000	42129	32189	21500	27000	18000
	3rd	22000	41069	31569	21500	28000	18800
	4th	22000	38029	31269	21500	28000	18900
Aug-23	1st	21500	41589	32509	25500	29000	18900
	2nd	21500	41169	31009	25500	29000	18900
	3rd	21500	41269	32209	25500	29000	18900
	4th	21500	41629	32269	25500	29000	18900
Sept-23	1st	20500	42009	32699	25500	29000	18900
	2nd	21500	42569	32489	25500	28000	18900
	3rd	21500	41469	32209	26200	27000	18900
	4th	21200	41589	32509	25500	27000	18900
	5th	21000	41669	32269	25500	26000	18900

Source: Agmarknet.gov.in, Dte. of Marketing, Delhi; Dept. of Economics and Statistics, Chennai

WEEKLY WHOLESALE PRICES OF TURMERIC (Rs /Quintal)

Month	Week	Nizamabad	Kochi	Chennai		New Delhi
		Finger	Dry	Erode	Salem	Nizamabad
July-23	1st	7025	11000	9600	11000	11400
	2nd	8383	11000	9600	11500	12100
	3rd	9798	11000	10000	12000	12100
	4th	10500	11000	10400	12000	12100
Aug-23	1st	11500	11000	10400	13000	11500
	2nd	10485	11000	12000	16000	11500
	3rd	10565	12000	13000	16500	11500
	4th	11619	12500	13500	17000	11500
Sept-23	1st	10279	12500	13500	17000	12210
	2nd	11250	12500	13500	17000	12000
	3rd	10788	12500	13500	17000	12000
	4th	10355	13000	13500	17000	12300
	5th	10777	13000	13500	17000	12300

Source: Agmarknet.gov.in, Dept of Economics and Statistics, Chennai; Economics and Statistics, Kochi; Directorate of Marketing, Delhi

WEEKLY WHOLESALE PRICES OF MAJOR SEED SPICES & GARLIC (Rs /Quintal)

Month	Week	Coriander	Cumin		Garlic
		Unjha	Chennai No.1	Unjha FAQ	Mandsaur
July-23	1st	5750	53000	58625	6650
	2nd	6200	55000	55000	8500
	3rd	6250	59000	58000	7900
	4th	7500	60000	56250	8400
Aug-23	1st	6705	60000	58250	9200
	2nd	7000	62000	57625	9000
	3rd	7000	62000	57625	9000
	4th	7000	62000	51500	9070
Sept-23	1st	5750	62000	52125	9200
	2nd	5750	62000	56250	9800
	3rd	5750	62000	55125	NA
	4th	5750	64000	56250	9900
	5th	5750	64000	56125	9900

Source: Agmarknet.gov.in, Dept of Economics & Statistics, Chennai

WEEKLY WHOLESALE PRICES OF NUTMEG & CLOVE (Rs /Quintal)

Month	Week	Thrissur			
		Nutmeg		Mace	Cloves
		With shell	Without shell	Yellow	
July-23	1st	24000	42500	140000	100000
	2nd	24000	44000	150000	100000
	3rd	25000	44000	150000	100000
	4th	25000	44000	150000	100000
Aug-23	1st	24000	44000	150000	100000
	2nd	24000	44000	160000	100000
	3rd	26000	47000	150000	100000
	4th	26000	47000	150000	100000
Sept-23	1st	26000	45000	150000	100000
	2nd	26000	46000	150000	105000
	3rd	26000	46000	150000	105000
	4th	25000	45000	150000	105000
	5th	24000	45000	150000	105000

Source: Economics and Statistics, Thrissur.

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    - Name of the authors.
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    - Subject matter
    - Conclusion
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