Key to Double Productivity of Spices

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With an estimated production of 8202 thousand tons of spices during 2016-17 from 3705 thousand ha, India holds a major stake in the global spices market as a traditional producer, consumer and exporter of spices. The increase in spices production from 2015-16 to 2016-17 was the highest (17.4%) among horticulture crops production. In terms of export, a total of 10.07 lakh tons of spices and spice products valued at Rs. 19367.00 crore was exported from the country during 2016-17 contributing 8.70% to the total agricultural products export. Ninety percent of our spices production consumed within India which is an indication of huge domestic market.

The major challenges confronted in the spice production sector are climate change resulting in drought/excess moisture, soil and plant health management, emergence and epidemics of pests and diseases, adulteration competition from other major spice producing countries etc. In view of these challenges, there is a need to develop cutting edge technologies that are simple, cost-effective and farmer-friendly.

Improved Varieties of Spices

ICAR-IISR has released several high yielding and improved varieties of ginger, turmeric, cardamom, black pepper and nutmeg which have become very popular across the country. High piperine and oleoresin containing varieties of black pepper (IISR Girimunda and IISR Malabar excel) are also suitable for cultivation in high altitudes and plains, IISR Thevam and IISR Shakthi tolerant to Phytophthora foot rot disease, varieties Sreekara, Subhakara, Panchami and rot knot nematode tolerant variety Pournami are high yielding and suitable for all pepper growing locations of India. Ginger varieties, IISR Varada, IISR Mahima and IISR Rejatha with high essential oil and oleoresin content are suitable for growing all over India.

Climate changes, soil and plant health management, pests and diseases and adulteration competition are the major challenges in spice production sector

High yielding (Suguna, Suvarna, Sudharsana) and stable high curcumin yielding varieties (IISR Prabha, IISR Pragati, IISR Kedaram, IISR Prathibha and IISR Alleppey Supreme) developed by IISR are suitable for growing throughout India. Cardamom variety (IISR - Appangala-1) is preferred widely by the oil extraction industries, whereas IISR - Appangala-2 and IISR Vijetha are suitable for mosaic affected areas of Karnataka. Cardamom variety IISR Avinash is a rhizome rot tolerant variety. High yielding and high quality varieties of nutmeg (IISR Viswashree and IISR Keralashree) have also been developed. IISR Keralashree is the first

farmer's variety developed under Farmer's participatory breeding programme. Cinnamon varieties (IISR Nithyashree and IISR Navashree) have high shoot regeneration capacity with high bark oil and oleoresin content.

The institute is now linking their clients to these licensees who in turn meet their demand.

ICAR-IISR has issued 25 plant variety licenses to the clients till date.

Fig 1. Improved varieties of spices

Black pepper: IISR Thevam

Black Pepper: IISR Malabar Excel

Ginger: IISR Mahima

Turmeric: IISR Pragati

Nutmeg: IISR Keralashree

Cardamom: Appangala-1

Improved soil less method (Pro-tray) of healthy planting material production

Ginger & Turmeric

The major diseases in ginger and turmeric are soft rot caused by Pythium sp. and bacterial wilt caused by *Ralstonia solanacearum*. These pathogens are both seed and soil borne. Infection by these pathogens can be reduced by at least 50% through the use of disease free planting materials. A transplanting technique in ginger by using single bud sprouts (about 5 g) has been standardized to produce good quality planting material with reduced cost (Fig. 3). The advantages of this technology are production of healthy planting materials and reduction in seed rhizome quantity and eventually reduced cost on seeds.

Maintenance of pro-trays (30-60 days)

Transplant ready ginger plants

Turmeric- single bud/double bud plants

Turmeric plant from single bud

Turmeric plant from two buds

Fig. 2. Production of healthy planting material of ginger and turmeric using pro-trays

Black Pepper

Non-availability of healthy planting material is a serious problem in black pepper. The present technology is a solution to this (Fig 3). Single node cuttings of black pepper are planted in the trays and maintained under controlled greenhouse conditions and hardened under shade net green house. This nursery technique has enabled the production of disease free seedlings with ease for transportation and also enhances successful establishment of vines with vigorous growth.

Fig 3: Black pepper seedlings in pro-trays

Vertical Column Method for Quality Black Pepper

The continuous demand for quality planting material created a novel idea of producing orthotrope on vertical columns filled with composted coir pith and vermi compost fortified with bio- control agent *Trichoderma harzianum* in poly house (Fig. 4). The advantage of vertical column method is one can get three type of cuttings viz., normal single node cutting, laterals and top shoots.

Fig. 4. a) Black pepper on vertical column (b) lateral branch

A

B

Diagnostics For Diseases Infecting Spices

Black pepper is infected by major two viruses (*Cucumber mosaic virus* and *Piper yellow mottle virus*) (Fig. 5) whereas cardamom is infected by two viruses (Cardamom mosaic virus and *Banana bract mosaic virus*) which are systemic in nature. Loop-mediated isothermal amplification (LAMP) and real-time LAMP based assays were developed for quick and sensitive detection of virus diseases of black pepper and cardamom. The technology can be used for certification of mother plants/planting materials of black pepper for freedom from viruses. A strain specific and sensitive technique based on Real Time Loop Mediated Isothermal Amplification (Real Time- LAMP) was developed for detecting *Ralstonia solanacearum* causing bacterial wilt in ginger.

Fig 5 a.Virus infected black pepper

Fig 5b. PCR result

Plant Health Management Technologies

(a) *Trichoderma harzianum,*

The production of black pepper is hampered by Phytophthora foot rot caused by *Phytophthora capsici*. The talc based bioformulation based on *Trichoderma harzianum* can be used successfully to manage Phytophthora. It can be used in Integrated Pest Management as well as under Organic farming system in crops like black pepper, ginger, cardamom and turmeric. There is a great demand for the product and IISR has already issued several licenses for its commercial production.

The talc based bioformulation based on Trichoderma harzianum can be used successfully to manage Phytophthora

(b) *Pochonia chlamydosporia*

Plant parasitic nematodes, especially root knot nematodes (*Meloidogyne* spp.), are widely prevalent in black pepper gardens of South India and cause significant damage to the plants. Currently they are managed through application of nematicides like phorate and carbofuran. Biological control of root knot nematodes using *Pochonia chlamydosporia*, a known nematode biocontrol agent, therefore, is highly relevant in this context (Fig 7).

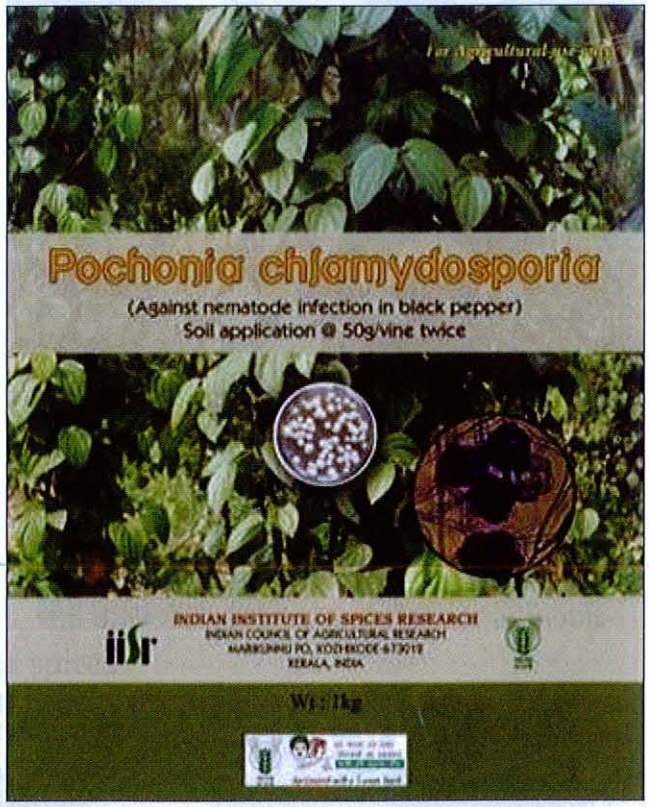

Fig 7. *Pochonia chlamydosporia*

Biocontrol Agents Through Encapsulation

The bio agents like *Bacillus amyloliquefaciens* specific to ginger and consortium of three microorganisms namely *Micrococcus luteus*, Enterobacter aerogenes and *Micrococcus* sp. for black pepper are successfully encapsulated and the delivery of a plant growth promoting rhizobacteria are made in to bio capsules by ICAR-IISR (Fig 8a & b). The encapsulation process

is simple, reduced cost and easy handling and transport, no harmful by products, storage at normal temperature with enhanced shelf life. Besides, this encapsulation technique can be used to deliver all kinds agriculturally important microorganisms. Patent for this delivery process has been filed and the technology has been commercialized by providing non-exclusive licenses to private companies.

Fig. 8. a) Gelatine capsules containing PGPR *Bacillus amyloliquefaciens* IISR GRB 35

8 b) Trichocap, the two branded products of *Trichoderma harzianum* & PGPR marketed by our licensee M/s Codagu Agritech, Kushalnagar, Codagu, Karnataka

Seed Coating Using PGPR

PGPR technology is a novel process of coating efficient strains of PGPR on seeds. Seed spices such as coriander (*Coriandrum sativum* L.), cumin (*Cuminum cyminum* L.), fennel (*Foeniculum vulgare* M.) and fenugreek (*Trigonella foenum-graecum* L.) cultivated predominantly in Rajastan and Gujarat have major constraints like low germination, slow initial growth and high susceptibility to diseases and frost. The seeds coated with PGPR exhibited longer shelf life and germination and remained intact even after 1 year of storage (Fig 9). The technology has wide applicability and can be extended to vegetable seeds imparting the appropriate crop specific bio-agent.

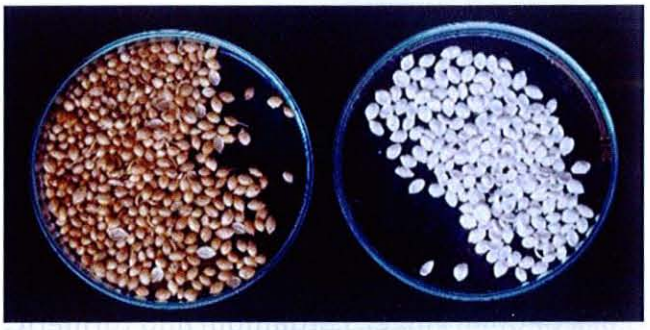

Fig 9. Uncoated and coated seeds of coriander

Crop –specific Micro Nutrient Formulations For Major Spices

Majority of soil samples used in the spice growing areas are encountering fertility issues due to acidity, nutrient imbalances and deficiencies of secondary and micro nutrients that becomes yield limiting. Besides crop specific, soil pH based micro nutrient mixtures for foliar application in black pepper, cardamom, ginger, and turmeric crops which guarantees 10 to 25% increase in yield and quality have also been developed. The technology comes at very low cost and hence is very farmer friendly. The micronutrient technologies have been licensed to several entrepreneurs for large scale production and commercialization (Fig 10)

Fig 10. Designer micro nutrient formulations for spices

Green Technologies for Spices Cultivation

Nutrient management plans for spices have been standardized for organic farming systems and organic packages have been developed for black pepper, ginger and turmeric integrating composts, oil cakes, biofertilizers/ PGPRs and biocontrol agents.

Soil solarization coupled with CaCl2 and PGPR application showed good control of bacterial wilt of ginger even in sick field conditions. Similarly, integrated management involving application of site specific nutrient management, PGPRs and micronutrient application helped in sustaining the yield of virus affected black pepper plantations.

An entomopathogenic fungus, *Lecanicillium psalliotae*, effective in controlling the cardamom thrips was potentially identified and evaluated for agro-climatic conditions in Kerala and Karnataka. The technology is ideal for adoption in organic farming. A new species of group I multiple *nucleopolyhedrovirus* (NPV) infecting Spilarctia obliqua, a polyphagous pest of ginger, turmeric and other crops was also identified as potential bio-agent.

Processing And Value Addition

A simple technique of hormone treatment was developed to split open nutmeg fruits without exposure to soil to prevent aflatoxin contamination, a mechanical unit for production of white pepper from black pepper, a renewable solar energy cooking unit for turmeric curing, a hand-held electronic nose for determining quality of cardamom based on essential oil content and antioxidant activity of spices for its nutraceutical potentials are developed and passed on the end users.

A freeze dried powder extracted from fresh turmeric juice showed enhanced bio availability of curcumin indicating its potential for developing a product as nutraceuticals.

Spice Processing Through Entrepreneurship Development

ICAR-IISR has set up a business planning and development (BPD) unit, a business incubation centre designed to promote entrepreneurs and equip them into profitable business ventures. A high-end spice processing facility with state of the art facilities for cleaning and grading black pepper and production of spice powders established at ICAR-IISR Farm, Peruvannamuzhi is compliant with national and international quality requirements. ICAR-IISR periodically organizes entrepreneurship development programme (EDP) for the stake holders to identify suitable entrepreneurs for steering forward the operations of the processing facility.

New Perspectives in Spices Research

The estimated growth rate for spices demand in the world is around 3.2%, which is just above the population growth rate. The per capita demand for spices is expected to increase many fold by 2050. With this increase, production levels to meet the local and global demand are estimated to be increased by 2.7-5.7 folds from the present levels.

Therefore, we need to continuously strive to increase spices productivity by enhancing input use efficiency, and reducing post-harvest losses with an eye on reducing the cost of production. A well-reasoned and cohesive application of cutting edge research, institutional support for development and creative policy initiatives can ensure a vibrant spices sector in the country.

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While there is little scope for enhancing the area under spices in the traditional belts of the country, we need to focus on newer niches where the potential for spices cultivation is immense. This includes exploring possibilities like spreading to non-traditional areas in the North Eastern Hill Region (NEHR) where opportunities and skill sets for the future exists.

In addition, research programmes are to be intensified in the area of high value compounds in spices for possible drug formulations and to develop Nutrigenomics and Pharmacogenomics as a composite technology in the area of bio active compounds.

Nurturing and improving sound techniques on precision farming, protected cultivation and urban horticulture can help in surmounting the challenges posed by other growing countries.