Spices Propagation – Challenges and Opportunities to Meet Changing Climate

M. Anandaraj, D. Prasath and K. Kandiannan
Indian Institute of Spices Research(ICAR)
Kozhikode 673 012, Kerala, India.
Email: anandaraj@spices.res.in

Introduction

India cultivates more than 50 spices out of 109 spiceslisted by ISO, this is possible because of diverse agro-ecosystems present in the country. Spices export have registered substantial growth during the last five years, registering acompound annual average growth rate of 23% in value and 11% in volume and Indiacommands a formidable position in the World Spice Trade. During the 2012-13, a total of 7,26,613 tons of spices and spice products valuedRs.12112.76 crore (Table 1) (US$2212.13 Million) has been exported from India, registering anincrease of 26% in volume and 24% in rupee terms and 8.5% in dollar terms of value compared to previous year.

Table 1: Export of spices from India (2012-13)

Item	Quantity(Tonnes)	Value (Rs. in Lakhs)
Pepper	15,363	63810.29
Cardamom(S)	2,372	21215.04
Cardamom(L)	1,217	6254.59
Chilli	3,01,000	238060.90
Ginger	22,207	18725.14
Turmeric	88,513	55487.70
Coriander	35,902	20182.59
Cumin	85,602	115306.61
Celery	5,171	2977.26
Fennel	13,811	10466.12
Fenugreek	29,622	10488.12
Other Seeds (1)	18,442	11178.60
Garlic	22,872	6868.14
Tamarind	17,950	10753.15
Nutmeg & Mace	3,231	22591.87
Vanilla	55	682.73
Other Spices(2)	16,293	18773.15
Curry Powders/Paste	17,436	27515.66
Mint Products(3)	20,039	3,94,049.95
Spice Oils &Oleoresins	9,515	155888.19
(1) Include Mustard, Aniseed, Ajwanseed, Dill Seed, Poppy Seed Etc.		
(2) Include Asafoetida, Cassia, Saffron Etc.		
(3) Include Mint Oils, Menthol & Menthol Crystal.		
Total	**7,26,613**	**12,11,275.80**

Source : DGCI & S, Kolkata/Shipping Bills/Exporters return (Spices Board)

India is a traditional spice producer and supplier to the world spice market, in addition to its strong domestic consumption.On a global scale, the annual growth rate in spices

consumption is estimated at around 10%. At this rate, the India's demand by 2050 will be around 16.6 million tonnes. Estimated target of selected spices for 2050 are given Table 2. Each state cultivates one or other spice and India is known as _Land of Spices'. During 2012-13, we had 3.2 million ha in spices with a production of 5.9 million tonnes (Table 3). Andhra Pradesh, Rajasthan, Gujarat, Karnataka, Madhya Pradesh, Tamil Nadu, Assam, West Bengal and Uttar Pradesh are important spice producing states in India (Table 4). Like in many other crop production sectors, spices production also facing several challenges like competing crops, price fluctuations, no buyers in remote production centres like north east, less labour availability, non- adoption of available mechanisation due to undulating terrain/topography or crop architecture, climate change, soil degradation, less water availability for irrigation in certain spice zones, etc.,. Above all, non-availability of diseases free quality planting material in sufficient quantity is an important constraint that hampers the sustainable spice production in the country.

Table 2: Estimated production target for spices in India (Qty. in _000 tons)

Area	Total demand by 2050	Extra to be produced over the present production	Productivity to meet the total demand by 2050 (t/ha)
Black pepper	239.25	197.25	0.94
Cardamom (S)	79.07	63.20	0.99
Ginger	2152.49	1380.30	9.35
Turmeric	2882.15	1819.70	10.03

Table 3. Area and production of important spices in India (2012-13)

Crop	Area(_000ha)	Production (_000tonnes)
Pepper	200.279	40.62168
Ginger	155.063	755.6178
Chillies	804.792	1276.301
Turmeric	218.646	1166.843
Garlic	242.491	1228.324
Cardamom	89.006	15.816
Coriander	557.87	532.947
Cumin	593.98	394.328
Fennel	99.554	142.949
F. Greek	93.605	115.929
Ajwan	35.376	26.778
Dill / Poppy /Celery	33.47	32.642
Cinnamon /Tejpat	2.944	5.035
Nutmeg	17.485	12.57351
Clove	2.387	1.1051
Tamarind	58.428	202.574
Saffron / Vanilla	7.095	1.07421
Total	3212.471	5951.458

Table 4: State wise area and production of spices (2012-13)

State	Area(_000ha)	Production (_000tonnes)
Andaman Nicobar	1.65	2.98
Andhra Pradesh	292.82	1129.31
Arunachal Pradesh	10.05	61.60
Assam	93.05	261.56
Bihar	13.01	12.54
Chhatishgarh	11.67	8.32

Goa	0.73	0.23
Gujarat	551.67	882.14
Haryana	12.80	61.69
Himachal Pradesh	4.77	19.26
Jammu & Kashmir	4.15	1.08
Karnataka	265.12	502.46
Kerala	254.55	112.80
Madhya Pradesh	299.91	461.17
Maharashtra	116.52	106.47
Manipur	10.47	24.14
Meghalaya	16.84	74.82
Mizoram	20.65	114.98
Nagaland	9.77	39.17
Odisha	123.92	187.50
Puducherry	0.09	0.12
Punjab	18.37	68.21
Rajasthan	730.51	871.64
Sikkim	24.38	54.41
Tamil Nadu	157.33	426.38
Tripura	5.68	18.04
Uttar Pradesh	58.29	201.97
Uttarakhand	6.60	38.77
West Bengal	97.12	207.70
Total	3212.47	5951.46

SWOT analysis on spices production

A. **Strength**	B. **Weakness**
a. Large number of genotypes and improved varieties	a. Unorganised
b. Enthusiastic farmers/entrepreneurs	b. No-steady demand
c. Domestic demand and Export potential	c. Distance in transport
d. Easy improved method / techniques for planting material production	d. Price fluctuation
C. Opportunity	**D. Threat**
a. Export potential	a. Abiotic and biotic stresses
b. Intercropping	b. Competing countries
c. Scope of nursery in production centre	c. Destruction of habitat
d. Value addition	d. Indiscriminate use of pesticides

Spices Propagation

The life span of spices vary, crops like black pepper, cardamom, tree spices are perennials, ginger and turmeric is annual and some are seasonal. Most of the perennials and annuals propagated through vegetative means like cutting, grafting, budding, rhizome etc.,. The spices propagated vegetatively should not harbour any disease or pest. Traditional methods of planting material production may not be sufficient to meet large scale demands and also may carry pathogens and pest, to overcome this problem new ways of production is perfected.

Challenges in Propagation

- Viral diseases in black pepper and cardamom
- Rhizome rot complex in Zingiberaceous crops
- Low multiplication rates in conventional methods of seed/planting material production
- Large quantity of seed material requirement in ginger and turmeric
- Long distance transportation of seedlings/seed
- Sex problem in nutmeg

Black Pepper

The _cutting' is the main mode of propagation for commercial cultivation of black pepper. Seedlings take much longer to come to bearing than cuttings or layers and show genetic segregation. Farmers collect cuttings from 10-15 year old plants for field planting. Three node cuttings are taken from runner shoots of disease free plants after the pre-monsoon showers and planted at a distance of 30 cm away from the standard. These cuttings will get established after about three months when new shoots emerge. Establishment of cuttings depends on the prevailing climatic conditions. The rapid multiplication through bamboo method for production of large number of rooted cuttings under nursery conditions was developed (Bavappa and Gurusinghe, 1978). In this method, healthy and high yielding mother plants in the age of 5-12 years are selected during October – November and the runner shoots are kept coiled at the base of the vines to prevent any direct contact with soil and these runner shoots are removed during February – March and cuttings are taken and used for further multiplication in nursery. Split bamboos of 1.0 to 1.2m length of about 8-10 cm in diameter are arranged crisscross at an angle of 45° on the central support of horizontal poles placed along the length of nursery structure. The bamboos are then filled with a mixture of cattle manure and coir dust. The three node or single node cuttings rooted in the nursery is placed in the trench below the bamboo splits filled with potting medium and trained onto bamboo. The growing shoots are tied close to the medium filled in the bamboos to ensure proper contact for rooting. When the vines reach the top of the support the growing point is excised and 2 weeks later, shoots are severed near the base and divided into single-node rooted cuttings. The single nodes with sufficient root growth are planted in polythene bags filled with potting mixture. The multiplication ratio is 1:40. Another novel propagation technique in black pepper is the serpentine method. Rooted cuttings planted in polythene bags (20 x 10cm size with 200 gauge) are allowed tocreephorizontally and polythene bags with potting mixture are kept below the each node, the nodes are pressed into the mixture with small _V' shaped midribs of coconut leaves. Once twenty nodes get rooted in the bag, first 10 nodes are separated individually by cutting at the inter nodes and cut endsare pushed back into the potting mixture as it also produces roots. The polybags are watered daily. After three months these cuttings are ready for planting in the main field. The multiplication ratio is 1: 60. The advantages are- it is simple, cheap and quick and suited to small and marginal farmers, and sprouting is betterthan rapid multiplication technique (Thankmani et al. 2004). A new method of soil-less nursery mixture for black pepper multiplication using plug-trays (Fig 1) was standardised using composted coir pith and vermicompost fortified *Trichodermaharzianum* as potting medium forblack pepper nursery(Prasath *et al.* 2014).Use of *T. harzianum* andvermicompost enriched coir pith in blackpepper nurseries minimizes useof chemicals.

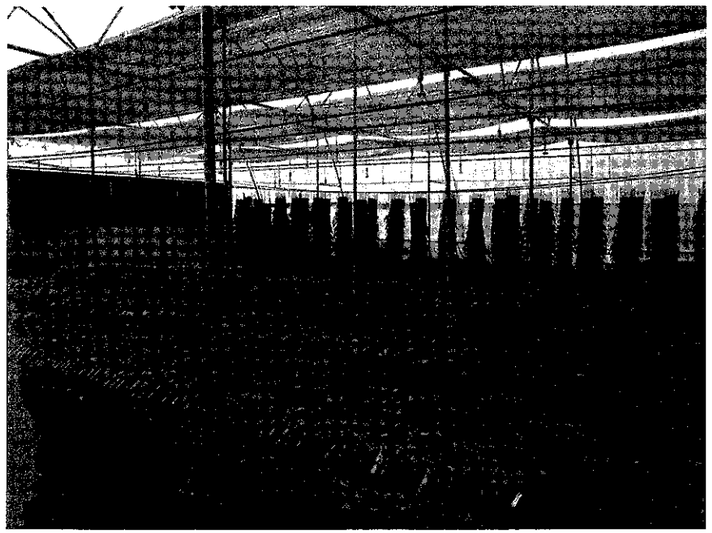


Fig 1. Black pepper multiplication with plug-trays

Fig 2. Black pepper vines on beds containing rooting medium

In this method the vines are allowed to be trail horizontally on a bed of rooting medium (Fig 2) and individual nodes are separated after sufficient growth. Yet another modification is to grow the vines on vertical columns that ensures faster growth (Fig 3) and this method hastens the production of lateral branches.

The major advantages of soil free rooting medium is the avoidance soil borne pathogens such as *Phytophthora capsici, Radopholus similis* and *Meloidogyne incognita.* Thus production of pathogen free quality planting material is assured. As the potting mixture is light and porous enhanced rooting all along the medium occurs and ensures better establishment in the field. As the roots are compactly packed in the soft rooting medium it also prevents abrasions of roots during long distance transport. As the weight of the cutting is less compared to potting mixture filled bags, it can be easily carried after uprooting from trays.

Fig 3. Black pepper vines on vertical column containing rooting medium

Cardamom

Cardamom is propagated either through seeds or vegetative means and being a cross-pollinated crop the seedling population is not uniform. Only 35 per cent of the plants are good yielders in a plantation raised from seedling population. Hence, vegetative propagation is normally adopted for multiplication of elite clones(Fig 4). Vegetative propagation can be either through suckers or tissue culture. Suckers from elite clones can be used for establishing plantations capable of high productivity. Plants raised from suckers come to bearing earlier than suckers. Suckers should not be used in areas where*katte* and other virus diseases (such as *Kokke kandu* and Niligiri necrosis) are common. High yielding varieties/selections are generally multiplied in isolated clonal nurseries. Virus free high yielding plants are selected and subcloned for further multiplication. For rapid multiplication following timely agro techniques has to be followed (Korikanthimath 2002).

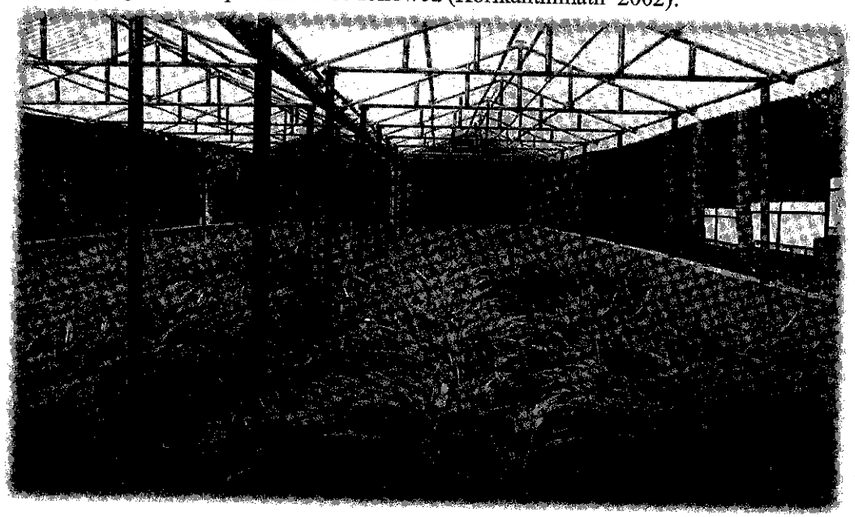
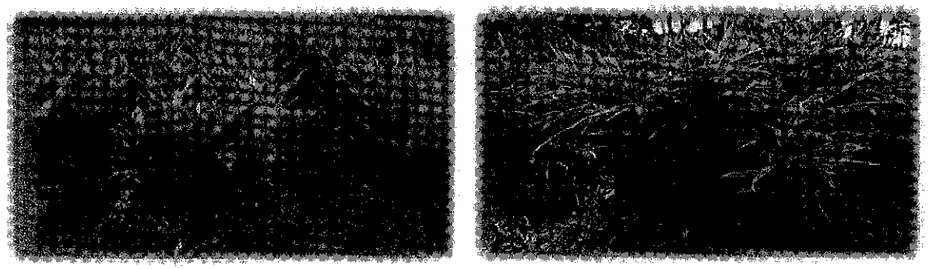


Fig 4. Cardamom nursery

Ginger & Turmeric

Ginger and turmeric (Fig 5) are propagated vegetatively by portions of rhizomes known as seed rhizomes and among inputs, seed material requirement vary between 1500 to 2500 kg ha^{-1} or even more depending on rhizome size and seed alone accounts for about 40% of total cost of production(Anandaraj and Sudharsshan 2011). In order to obtain good germination, proper storage of early season seed rhizomes is essential. The seed rhizomes should be stored appropriately so that rotting, shriveling, dehydration and sprouting can be avoided until the next season. Maintaining a storage temperature of 22-25°C make the growing buds fat and strong and temperature higher than 28°C in the long run make the buds thin and weak.



Turmeric Ginger

Fig. 5. Conventionally grown seed crop of turmeric and ginger

In order to reduce the seed requirement, a new method of raising seedlings (Fig 6) from a seed piece (5 to 10 g) with single or double buds placed on a plug trays filled with rooting medium and kept for a month. This method enables easy long distance transport of diseases free seedlings and other advantages of reduced seed rate and better establishment without yield reduction in a lesser duration (by 30 days) in the main field compared to conventional method.

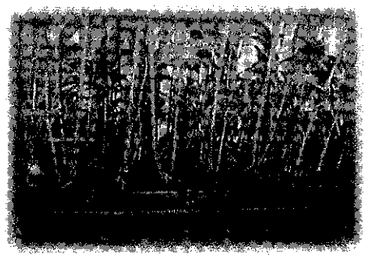
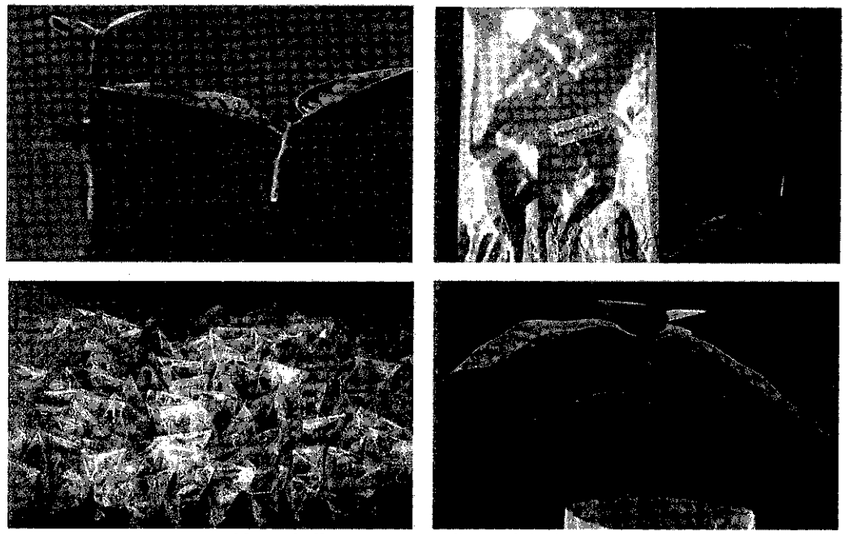


Fig 6. Ginger seedlings in pro-trays

Nutmeg

The nutmeg is propagated both by seeds and vegetatively by grafting or budding(Fig 7). Nutmeg is a dioecious plant occasional monoecious plants have been reported and seed propagation is not in vogue. Fully ripe, tree-burst fruits are to be used for raising nurseries. Farmers can also use grafted plants. *Myristica beddomei* and *M. malabarica* are related to nutmeg also can be used as rootstocks besides nutmeg. For raising seedlings for planting or as rootstocks, naturally split healthy fruits are harvested during June-July and the seeds are extracted and sown immediately.

Since the orthotropic and plagiotropic shoots can be used for grafting the resultant plants have a different growth pattern. Orthotropic shoots give rise to erect growing plants whereas plagiotropic (lateral) shoots give rise to bushy spreading plants. However, these may be induced to develop orthotropic shoots by bending above 90 degrees. Bush grafts are advantageous for high density crops. Grafts of elite high yielding trees can be prepared by epicotyle grafting instead of planting seedlings. Wherever seedlings have been established and trees are poor yielders or predominantly male, top working by budding or grafting can be done to get desired trees.



Vegetative propagation of Nutmeg

Summary

India is a traditional spice producer and supplier to the world spice market, in addition to its strong domestic consumption. On a global scale, the annual growth rate in spices consumption is estimated at around 10%. At this rate, the India's demand by 2050 will bearound 16.6 million tonnes. Climate change in terms of erratic monsoon and increased summer temperature are immediate challenges for black pepper. The severity of virus symptom expression is attributed to temperature stress. Starting the nursery with virus indexed mother vines is the starting point for production of healthy plantations.Non-availability of diseases free quality planting material in sufficient quantity is an important constraint that hampers the sustainable spice production in the country. Efficient production techniques for various vegetatively propagated spices are standardised. In this endeavor it is also essential to supply pest and disease free quality seed with proper certification to avoid disease spread particularly virus. The various methods of detecting pathogen and pest and standards for quality of spices planting material are elucidated in the recent book on diagnostics (Singh *et al.* 2013). A holistic approach in this direction is essential to supply quality material to farmers. 'Seed village' concept is also being adopted in many places to enhance the production of these materials.

References

Anandaraj, M. and SudharshanM. R.(2011). Cardamom, Ginger and Turmeric.In: *Soils, Plant Growth and Crop Production*, [Ed. Willy H. Verheye], in *Encyclopedia of Life Support Systems (EOLSS),* Developed under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, [http://www.eolss.net]

Bavappa, K.V.A. and Gurusinghe P. de S.(1978). Rapid multiplication of black pepper for commercial planting. *J. Plantation Crops*. **6**: 92–95

Korikanthimath,V. S.(2002). Agronomy and management of cardamom.In:[Eds. Ravindran, P.N. and Madhusoodanan, K. J.].*Cardamom – The genus*Elettaria. Taylor & Francis, London.pp. 91–128.

Prasath, D. Vinitha, K.B., Srinivasan, V., Kandiannan, K.and Anandaraj, M.(2014). Standardization of soil-less nursery mixture for black pepper (*Piper nigrum* L.) multiplication using plug-trays. *J. Spices Aromatic Crops.* **23** : 1–9.

Singh, H. P., Anandaraj, M. and Bhat A. I.(2013). Advances in Horticulture Biotechnology-Diagnostics for Horticulture Crops, VolumeVII.pp364. Westville Publishing House, New Delhi.

Thankamani, C. K., Mathew, P. A. and Kandiannan, K.(2004). Production of healthy black pepper rooted cuttings. *Indian J Arecanut, Spices and Medicinal Plants***6**(4): 135–136.

****