NUTMEG (MYRISTICA FRAGRANS HOUTT) – THE TWIN SPICE – A REVIEW

T. Thangaselvabai, K.R. Sudha, T. Selvakumar and R. Balakumbahan

Krish Vigyan Kendra,
Tamil Nadu Agricultural University, Pechiparai- 629 161, India

Received: 13-09-2010 Accepted: 29-08-2011

ABSTRACT

The nutmeg is unique among tree spices as it is the donor of the two distinct spices, nutmeg and mace. Nutmeg is the seed kernel inside the fruit and mace is the covering (aril) on the kernel. Both mace and nutmeg are used as condiment and medicine. It is native of Indonesia (Moluccas Islands). In India it is cultivated in Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra, North East India and Andaman Islands. The area, production and productivity in our country is very low and it is mainly due to the non adoption of improved crop management and post harvest handling technologies, decline in area under cultivation and incidence of pest and diseases. Hence, the innovations made in various crop improvement, production, protection and post harvest handling techniques are reviewed here.

Key words: Nutmeg, Myristica fragrans Houtt, Crop improvement, Crop production, Crop protection, Post harvest handling.

Nutmeg the two in one spice is valued for its flavouring and medicinal properties. It is native of Moluccas Island and in India it is cultivated throughout Kerala, parts of TamilNadu, Karnataka, Goa, Assam and Andaman and Nicobar Islands. India produces about 11,424 tonnes of spice in an area of 15, 131 ha. and imports 1325 tonnes of nutmeg and 265 tonnes of mace (Haldankar and Rangwala, 2009). Under Indian conditions the production potential is very low i.e., 800 kg nutmeg and 125 kg mace/ha and the present production is not sufficient to meet the domestic requirement. Inadequacy of genuine and disease free planting materials of improved varieties/ genetically superior stock plants and non adoption of improved production technologies are the causes for the low productivity and quality. India depends on foreign countries notably Indonesia and Sri Lanka for supply of nutmeg. Hence, to attain self sufficiency and to arrest the drain on foreign exchange the area and production has to be increased through planting quality planting materials and adoption of improved production technologies.

Growth habit

Nutmeg is a dioecious or occasionally monoecious evergreen aromatic tree, usually 10-20 m in height (Shanmugavelu and Rao,1977) with spreading branches which carry oblong-ovate leaves, acute at apex and base, 5-15 cm long and 2-7 cm wide, of feathery structure, dark green and lustrous. (Vergheese,1990). Nazeem (1979) observed that the shoot growth in nutmeg is cyclical, a period of growth followed by quiescence. Six flushes were observed in a year. All the flushes were not seen in all the shoots, which resulted in continuous growth.
Two growth peaks were observed, in May-June and September.

The inflorescence of *M. fragrans* is an axillary raceme (Joshy, 1946). It is branched, in male plant and simple cyme in female plant (Joseph, 1980). Flowers are drooping, creamy yellow and fragrant. Though nutmeg is usually dioecious, five different types of trees viz., pure male, pure female and bisexual male, bisexual female and hermaphrodite were identified (Krishnamoorthy, 2000).

The flower is bracteate and bracteolate (Nair and Bahl, 1956). The perianth is receiving ten vascular traces and has postulated a pentamerous origin. The androecium consists of a solid column or androphore to which is attached 14-22 bilocular anthers. The single pistil is more or less flask shaped with a short to non-existent style and bilobed stigma. The ovule is single (Joshy, 1946; Sastri, 1954; Nair and Bahl, 1956). The fruit is pyriform and yellow in colour. The pericarp is fleshy when the fruit matures; it splits into two, exposing the scarlet-coloured net like aril covering the dark brown seed.

In seed, there is a massive vascular supply to the testa, tegmen and aril. Endosperm is oily and starchy (Sastri, 1955; Nair and Pillai, 1959). Nazeem (1979) obtained the highest pollen germination percentage of 96.9 in a nutrient medium containing four per cent sucrose, 25 ppm calcium nitrate and 75 ppm boric acid whereas Krishnamoorthy (1986) obtained 57.8 per cent pollen germination with 5 percent sucrose, 100ppm calcium nitrate and 200ppm magnesium sulphate.

**Flowering and Fruit Set**

Flowering pattern of male and female trees differ (Nazeem, 1979) In female trees, flowering continued to seven months, whereas in male trees, flowering was observed throughout the year. Highest flowering in both the cases was in July followed by October. The female flowers took 154 days for complete development. Male flowers took only about half the period taken by the female flowers to develop. Anther dehiscence occurred about 24 hours prior to anthesis. The stigmatic receptivity lasted for six days after anthesis; the highest is during the first three days. The chief agent of pollination is wind. The percentage of set varied among the trees and for different aspects. Highest fruit set is in trees on western and eastern aspects. (Nazeem, 1979). The fruits attained maturity in 206 to 237 days after fruit set. The developing fruits followed a sigmoid growth pattern (Nazeem and Nair, 1981).

**Crop improvement**

Crop improvement is very difficult in nutmeg and it is mainly because of the dioecy, long juvenile period, the difficulty in propagation and the single ovule in the female flower (Sriram, 1977.; Joseph, 1980; Krishnamoorthy and Rema, 1989) The breeding objective is to develop early and heavy bearing hermaphrodite types with high content of volatile oil. At present the crop improvement programme is limited to selection of mother plants based on their regular and heavy bearing nature. Selection of elite types involving biotechnological options and clonal multiplication of selected mother trees through epicotyl grafting/in vitro propagation techniques, avoiding a juvenile phase may result in a breakthrough in productivity (Rema and Krishnamoorthy, 1994; Ravindran et al. 2005; Sheeja et al. 2006; Parthasarathy et al. 2010).

**Genetic Resources**

The genus *Myristica* consists of about 300 species of which fifteen have been described from India. They are *M. fragrans*, *M. malabarica*, *M. magnifica*, *M. beddomei*, *M. contorta*, *M. longifolia*, *M. amygdalina*, *M. andamanica*, *M. attenuata*, *M. gibbosa*, *M. glabra*, *M. glaucescens*, *M. irya*, *M. kingie* and *M. prainii* (Nybe et al., 2006; Parthasarathy et al., 2010). Germplasm of nutmeg is being conserved at the Indian Institute of Spices Research, and the present holding is about 482 accessions. The Horticultural Research Station Pechiparai, TNAU and KKVP, Dapoli have a collection of 22 and 87 accessions respectively (Krishnamoorthy et al. 1997;
Variability
A high amount of variability has been reported in growth rate, productivity, size and shape of the leaf, flower size and shape and size of the fruit and seed (Shanmugavelu and Rao, 1977; Sirram, 1977; Krishnamoorthy, 1996; Haldankar et al., 1999; Haldankar et al., 2004; Sasikumar, 2009). Variability and inter character association for fruit number, fruit weight, seed plus mace weight, seed weight and mace weight were also studied by Krishnamoorthy et al. (1991) indicated high variances for fruit number per tree which had a significant negative correlation with mace weight; seed weight also had a very high positive significant association with mace weight. Sheeja et al. (2006) found considerable molecular variations and uniqueness among different nutmeg genotypes through RAPD markers. Selection will be effective in nutmeg if trees are selected with optimum fruit number and moderately good seed weight (Kumar et al. 2010; Parthasarathy et al., 2010).

Varieties
Three cultivars were developed at Konkan Krishi Vidyapeeth (BSSKV). They are, Konkan Sugandha, Konkan Swad and Konkan Shrimathi. Konkan Sugandha is the only hermaphrodite variety released. It yields 2.63 kg dry seeds (526 seeds) per tree at the age of 15 years. The seed size is 5 g. and the average mace weight is 1.2g. Konkan Swad is a selection from the seedling population raised from the Ratnagiri collections. Average yield is 761 fruits/tree. Konkan Shrimathi yields 9kg nutmeg and 2kg mace/plant. The nut size is 14.0g and mace thickness is 2.10g (Haldankar and Rangwala, 2009). IISR-Vishwasree is a high yielding nutmeg selection from IISR, Kozhikode. It yields about 3122 kg nuts/ha (dry) and 480 kg mace (dry)/ha. This variety possesses 7.1 per cent oil in seed and mace, 13.0 per cent oleoresin in mace and 2.5 per cent oleoresin in seed. Butter content in seed is 30.9 per cent (Rema et al., 2003; Nybe et al., 2006; Parthasarathy et al., 2010).

Propagation
The general method of propagation in nutmeg is through seeds collected from regular bearing and high yielding trees, producing more than 10,000 fruits/tree/year and having 30g weight/fruit, 10g nut and 1g mace weight/fruit (Bavappa and Ruettimann, 1981; Chezhiyan et al., 1996). Well-matured seeds are collected from healthy well ripe fruits that are naturally split and harvested during June-July are used. Seeds are to be sown immediately after extraction as the germination falls when sown three days after extraction. They can be preserved in moist sand or moss for 3-7 days in poly bags or other containers having suitable rooting medium (Kannan, 1971; Mathew, 1992; Madhusudhanan and Babu, 1994; Gunasekaran et al., 2000). Nutmeg seeds loose germinability at moisture content below 45 per cent on dry weight basis (Sangakkara, 1985). Old seeds and those in which kernels rattle inside the shell will not germinate (Krishnamoorthy and Rema, 1989). The seeds are sown with the shell in the nursery beds and over which pandals are erected to provide shade. Seeds can be sown at a spacing of about 30 cm apart and 2.5-5.0 cm deep (Chezhiyan et al., 1996; Singh and Singh, 2008). Heavier seeds sown immediately after harvest i.e., during June recorded highest germination percentage and maximum vigorous seedlings (Mathew, 1992; Gunasekaran et al., 2000). Seeds commence germination in four to six weeks. The seeds generally do not germinate in hills above 1200 m MSL due to prevailing low temperature.

Germination commences from about 40th day and lasts for up to 90 days after sowing. The germinated sprouts must be transferred without much delay to polythene bags (30 cm x 15 cm) containing a mixture of soil, sand and well decomposed cow dung in the ratio 3:3:1 (Krishnamoorthy and Rema, 1988). Germination without seed treatment
is only 40-50 per cent (Prabhu, 1978). Seeds treated with 200 ppm gibberellic acid recorded 75% germination (Krishnamoorthy and Rema, 1988 KAU,2001) while, with thiourea recorded 88.28% germination (Haldankar et al.,2007). Seedlings are transplanted to the main field after 18 months (Kannan,1971; Shanmughavelu and Rao.,1977; Nair,1978).

**Vegetative propagation**

Nutmeg being a dioecious crop, proper ratio of female and male plants is to be maintained in the plantation. Vegetative propagation is the practical way to achieve this. Vegetative propagation techniques like stem cuttings, air layering, approach grafting, epicotyl grafting, budding and top working were tried in nutmeg with varying degree of success (Sundararaju and Varadharajan, 1956; Kannan,1973; Shanmughavelu and Rao.,1977; Rasalam, 1978; Mathew and Joseph, 1982; Mathew,1985; Rema and Krishnamoorthy,1990; Rethinam and Edison, 1991).

**Epicotyl grafting**

Epicotyl grafting has been found to be the most successful method (Krishnamoorthy and Mathew, 1985; Krishnamoorthy and Rema,1987; Haldankar et al., 1999) . At CPCRI, Kasaragod, the epicotyl grafting using M. beddomei as rootstock has given 48 per cent survival of grafts (Mathew and Joseph, 1982). A grafting success of 80 per cent was obtained during the month of August when M. fragrans was used as the rootstock (Krishnamoorthy, 1987). Nageswari et al. (2010) recorded 54% success when two leaved root stock is grafted with orthotropic scion.

**Soft wood grafting**

The grafting method developed at Regional Coconut Research Station, Bhatye, Maharashtra provides scope for grafting nutmeg for prolonged period. May was the best month for soft wood grafting with maximum success of 80 per cent. The retention of leaves on rootstock did not influence the success of softwood grafting (Haldankar et al., 1999).

**Approach grafting**

In India, successful approach grafting has been done on root stocks of *M. fragrans*, *M. malabarica* and *M. beddomei* (Sundararaju and Varadharajan, 1956; KAU, 2001). Those on *M. beddomei* and *M. malabarica* developed into low spreading trees. The trial on approach grafting at KAU registered about 95% success (KAU, 2001) while, at HRS, Kanyakumari revealed 82.2% success (Thangaselvabai et al., 2010). Haldankar et al. (1999) reported that the approach grafts can be prepared throughout the year and maximum percentage of graft success was recorded on *M. malabarica*, (30-100%), and in *M. fragrans* it was 40-90 per cent.

**Budding**

Forket method of budding was tried in *M. fragrans* and *M. beddomei* and observed that success was very low (4 %) in both the cases. It was noted that maximum bud take was in May, which coincided with the flushing season in nutmeg. The buds remained alive without sprouting even after one year (Mathew and Joseph 1979; Beena, 1994).

**Top working**

The sex of nutmeg tree can be identified only 7-8 years after planting, when they begin to flower. Generally, male and female trees are produced in 1:1 ratio. Since a single male tree is sufficient for every 20 female, trees for pollination. The rest of the unproductive male trees can be made productive by converting them into female trees by top working. Trials on topping of male trees indicated that cutting the trees above the first tier during August was found to be the best with regard to sprout production and reducing the time for sprouting. Successful graft union was obtained by wedge grafting during March with scion shoots having mature leaf and full green stem and stock having two months growth (Rema et al., 2000; Rema et al., 2009).

**In situ budding**

In situ budding can be done on plants within 2-5 years of planting. Orthotropic scion shoots from elite mother trees are budded on seedlings of two
years after planting in the main field. The rootstock and scion should be at the bark slipping stage. Budding is done just above the first whorl lower of leaves during July. In order to achieve a quicker bud burst, stumping the plant two months after budding was found most effective. Maximum success with patch budding on *M. fragrans* and forked method on *M. beddomei* was obtained (Beena, 1994; Alice and Beena, 1995).

**In vitro propagation**

Nutmeg is highly recalcitrant to tissue culture specially owing to the heavy leaching of phenolics and literature on its in vitro propagation is scanty. Hongsaranon. *et al.* (1992) obtained new shoots from apical bud which cultured on MS medium adding with 0.1 IBA, 1.0 BA and 0.5 mg GA/litre. While, Babu *et al.* (1992) observed in vitro proliferation of nutmeg aril (mace) in a nutrient medium supplemented with NAA and BA. Direct somatic embryogenesis was achieved in leaf explants of juvenile plants and also from intact and fragmented zygotic embryos in MS media with kinetin, 2,4-D, NAA and activated charcoal 0.3-0.5% (Iyer *et al.*, 2000; Iyer, 2007; Iyer *et al.*, 2009). AM media at half strength of major nutrients and full strength of micronutrients with a hormonal combination of BAP, NAA and 2,4-D at 1mg/l and 0.5 mg/l respectively, found to be best for initial culture establishment of seedling explants. Phloroglucinal (40mg/l) in combination with IBA (2mg/l) gave superior results in the induction of roots in established shoot tip cultures (KAU,2001). Micro grafting using *in vitro* produced shoots as scion and two month old invitro /invivo seedling as root stock was found successful in nutmeg (KAU, 2001).

**Field Preparation and Planting**

In India, seedlings are planted during South West monsoon. The pits of 90cm³are filled with top soil and compost or well decomposed farmyard manure and nutmeg plants are planted at a spacing of 7.5-8m. Ten per cent of males may be retained for pollination and the remaining male trees may be either removed or converted to females by top working. (Singh and Singh, 2008; Haldankar and Rangwala, 2009). Grafted plants are to be planted in pits of 75cm³size and at a spacing of 5x5m. A male graft has to be planted for every 20 female grafts in the field (Rema *et al.*, 2003; Anandaraj *et al.*, 2005).

**After Care**

Nutmeg is a shade loving plant (Kannan, 1971). Young as well as grown up plants require certain amount of shade. Locations with permanent natural shade will be the optimum. For open space, artificial shade is provided by growing *Glyricidia* sp. Dadap (Bavappa and Ruettimann, 1981), banana, *Acacia* sp and Subabool (Krishnamoorthy, 1987; Pruthi, 2001). Lopping of branches may be done at later stages to regulate shade.

As an intercrop in coconut plantations, nutmeg is planted in between two rows of coconut so as to accommodate 50-60 plants per acre (Varghese *et al.*, 1990; Remany, 2004). In arecanut plantations raised with a spacing of 2.7x2.7m nutmeg can be planted at every third row of arecanut so that within the square formed by the four nutmeg plants there are nine arecanut seedlings (Pruthi, 2001). In the Andaman and Nicobar Islands,
combinations of coconut or arecanut + nutmeg + robusta coffee + or forest trees + nutmeg + robusta coffee + pepper have been found successful (Rao, 1991). A spectacular yield increase of coconut palm and thereby total yield per unit area can be obtained by intercropping nutmeg in coconut plantation. Integration of tree spices viz., nutmeg, clove and *Garcinia* in coconut based cropping system is found profitable (Rethinam, 2010). Nutmeg as intercrop/ mixed crop in agro forest based cropping system found economically viable (Thangaselvabai *et al*., 2007; Thangaselvabai *et al*., 2010).

Regular weeding and mulching keep the field clean and conserves moisture. Cover crops like *Mimosa* sp. and *Stylosanthes* sp. may also be cultivated for suppressing weed growth. (Bavappa and Ruettimann, 1981) Application of herbicide mixture (gramoxone and fenoxone) checked weeds up to six months (Anandaraj *et al*., 1989). Seedlings are be irrigated periodically during summer (Kannan, 1971; Shanmugavelu and Rao, 1977, Rema *et al*., 2003; Anandaraj *et al*., 2005). In general, four year old plants require 20 l. of water per plant thrice in a week and the quantity of water is to be increased at later stages of growth (Krishnamoorthy, 1987). Dripping of 8-10 litres of water/day/plant found to enhance the yield by 18- 20% (Thangaselvabai *et al*., 2010).

**Nutrient Management**

While studying the influence of macro and micronutrient deficiencies on the foliar level of nutrients, the flowering shoots registered significantly higher C/N ratio in leaves than that of non-flowering shoots. The flowering shoots always registered a relatively higher P/S, Ca/S, N/P and N/K ratio and a lower foliar level of Ca/Mg, N/P and N/K ratios (Philip, 1986; KAU, 2001).

A fertilizer schedule of 1 kg each of ammonium sulphate, super phosphate and muriate of potash along with 50 kg of compost per year to mature plants was recommended for Tamil Nadu conditions by Shanmugavelu and Rao (1977). While, Kennedy *et al*., (2002) recommended a fertilizer dose of 100 kg FYM, 400: 320: 1200g NPK and 50g each of *Azospirillum* and Phosphobacteria for Shereroyos and Thangaselvabai *et al*., (2010) recommended 50 kg FYM, 500: 300:1000g NPK and 100g each of *Azospirillum*, Phosphobacteria and *Pseudomonas* per plant in two split doses for Kanyakumari region, the high rainfall zone of TamilNadu. A fertilizer schedule of (20:18:50g) of NPK along with 15 kg of compost per year during the first year of planting which is to be gradually increased to 500:250:1000g NPK and 50 kg of compost per year from 15th year onwards (KAU, 1993; Rema *et al*., 2003; Haldankar and Rangwala, 2009). Under Andaman and Nicobar Islands conditions a dose of 400:320:400g of NPK respectively for an adult tree per year is recommended (Rao, 1991).

The whole quantity of organic manures may be applied in one dose just at the commencement of monsoon in May-June. The fertilizers should be applied at least in two doses, one in May-June along with the organic manures and again in September-October. The manures should be applied in shallow trenches dug around the plant. As a large number of roots are seen almost on the surface of the soil, trenches should not be deep or very near to the plant. About 8 to 10 cm deep and 15-20 cm wide trenches may be taken about 10-20 cm away from one year old plant. The distance from the base of the plant to the trench should be increased every year and for a 15-year-old plant it should be about 1 to 1½ m. The trench should be covered after application of manures (Pruthi, 2001; Nybe *et al*., 2006; Singh and Singh, 2008).

**Crop Protection**

**Pests**

No serious insect pests are noticed on nutmeg. Occasionally, mealy bugs and scale insects attack tender portions of the stem and cause drying of parts by sucking sap. Black scale (*Saissetia nigra*), white scale (*Pseudaulacaspis cockerelli*) and the shield scale (*Protopulvinaria mangiferae*) infest tender stems and leaves especially in the nursery.
and sometimes young plants in the field. Scales feed on plant sap and severe infestations cause the shoots to wilt and dry. The scale insects controlled by spraying dimethoate 0.05% or monocrotophos 0.05% (Pruthi, 2001; Rema et al., 2003; Anandaraj et al., 2005).

**Diseases**

**Die back** (*Diplodia sp*)

The disease is characterized by drying up of mature and immature branches from the tip downwards. Pruning of the affected branches and application of Bordeaux paste checks the disease (Wilson and Sathiyarajan, 1974; Suganthy and Kalyanasundaram, 2010).

**Thread blight** (*Marasmius pulcherima; Marasmius equicrinus.*)

The fungus causes two types of blights. The first is a white thread blight wherein fine white hyphae aggregate to form fungal threads that traverse along the stem underneath the leaves in an irregular manner causing blight in the affected portions. The second type horse hair blight, fine black silky threads of the fungus form an irregular, loose network on the stems and leaves. These strands cause blight of leaves and stems. Both the diseases are severe under heavy shade. In severely affected gardens, Bordeaux mixture 1% spraying may be undertaken in addition to phyto sanitation and shade regulation (Nair et al., 1977; Haldankar and Rangwala, 2009).

**Fruit rot** (*Phytophthora sp. and Diplodia natalensis*)

In the case of fruit rot, the infection starts from the pedicel as dark lesions and gradually spreads to the fruit, causing brown discoloration of the rind resulting in rotting. In advanced stages, the mace also rots emitting a foul smell have been isolated from affected fruits. Spraying of Bordeaux mixture 1% or 0.2% copper oxychloride is recommened when the fruits are half mature to reduce the incidence of the disease (Ramakrishnan and Damodaran, 1954; Rao et al., 1976; Nair et al., 1977; Sankaran et al., 1980; Haldankar and Rangwala, 2009).

**Shot hole** (*Colletotrichum gloeosporioides.*)

Necrotic spots develop on the lamina, which are encircled by a chlorotic halo. In advanced stages the necrotic spots become brittle and fall off resulting in shot holes. A prophylactic spray with Bordeaux mixture 1% is effective against the disease (Menon and Remadevi, 1965; Nair et al., 1977; Sankaran et al., 1980; Radhakrishnan, 1986).

**Seedling wilt**

Seedling wilt is a serious problem in nurseries. This results in 5-40 per cent mortality of the seedlings. (Nair et al., 1977). The leaves of the affected plants loose natural lustrue, tend to droop and collar of seedlings show discolouration and decay. Several fungi viz., *Cylindrocladium sp.*, *Fusarium sp.*, *Colletotrichum sp.*, *Rhizoctonia bataticola* and *Phytophthora sp* have been implicated (Philip et al., 1973; Rahman et al., 1981; Raju and Leelavathy, 1987).

**Leaf spot** caused by *Cladosporium oxysporum* has been reported from Dapoli (Lawate et al., 1986). Bavistin (0.2%) application controls the disease.

**Harvest and Yield**

Fruiting commences from fifth or sixth year but may take even eight or nine years. (Vergheese, 1990). Optimum productivity is attained in about 15 years. Fruits are reported to ripe in 6-9 months after flowering (Nazeem, 1979). In India, fruits that split on the tree exposing crimson coloured aril are harvested (Nair et al., 1977). In Konkan region, the peak harvesting period is confined from June to October, whereas in Kerala it is June-July (Nybe et al., 2006). The average yield of a good tree in full bearing is reported to be 3000 fruits between 15th and 30th year of growth. Average weight of a single fruit is 60g of which the seed weighs 6-7g, mace 3-4 g and the rest pericarp. Ratio of mace to nutmeg is 1:8. Fruits are collected from the tree by hand or with hooked sticks or allowed to fall naturally on the ground and are gathered every day (Krishnamoorthy, 1987).
Processing

After harvest, the pericarp/outer fleshy rind is removed and the mace, which envelops the shell, is peeled off. The “blades of mace” as the peelings are called are flattened by hand or between boards and are spread out to dry in the sun. In good dry weather, the drying operation is accomplished in two or three days. Sun drying leads to a certain amount of colour fading. To prevent such bleaching artificial drying is often resorted to. Exceptional care must be taken to prevent mace getting mouldy. A perfect sample of mace should consists of entire double blades, not broken, flattened and of large size, horny in texture and not too brittle and of a good, clear and bright colour. Nut is left in the shell and dried in the sun or in drying ovens. Drying is complete when the seed rattles (Nybe et al., 2006).

In Kerala the harvesting season coincides with the monsoon season. So sun drying often becomes impossible. Freshly harvested mace can be blanched in water at 75°C for 2min to retain the scarlet colour. This is followed by hot air drying at 55-65°C which takes about 3-4hrs for drying to a moisture level of 8-10% (Anandaraj et al., 2005). Nutmeg loses about 25 per cent of their weight by drying. Shell is then cracked with wooden hammers or mechanically in specially designed machines and discarded or used as fuel and the nutmeg removed and dried (Nybe et al., 2006).

The aromatic ethers which are the chief components that determine the flavor and drug action in nutmeg oil was maximum one month prior to the fruit splitting stage. In mace oil it was found to be high two months prior to the fruit splitting stage. So if nutmeg and mace oils are intended for medicinal purpose, then it may be worthwhile to harvest fruits at the sixth month for extracting kernel oil and at the fifth month for extracting mace oil (Manoj, 1990).

Conclusion

The literature reviewed here highlighted the improved nutmeg production technologies. Since, increasing productivity, reducing the cost of production and extending area to nontraditional regions are going to be the major thrust areas for the future; promotion of export oriented varieties with high production potential, production of sufficient quality planting material, adoption of high tech production protocols are going to provide strength to profitable nutmeg farming and to meet the challenges of global competition.

References


Manoj, A.M. (1990). Quality characteristics of nutmeg and clove at different stages of maturity. MSc. (Hort) thesis, Kerala Agricultural University, Vellanikkara, Thrissur.


