OPPORTUNITIES AND AGROTECHNIQUES FOR MIXED CROPPING OF BLACK PEPPER IN COCONUT GARDENS

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Black pepper *(Piper nigrum L.)*, is one of the major export earners among the various crops grown in India. Presently India is exporting about 40,000 tonnes of black pepper to different countries contributing nearly 46 per cent of the total export value of spices from India. Pepper is cultivated both as a monocrop and as a mixed crop in coconut and arecanut gardens in about 1,95,000 hectare area and producing 53,011 tonnes of black pepper. Of this, more than 90 per cent of the area and production of pepper is from Kerala. The productivity of pepper in India is the lowest in the world even though India has the largest area under this crop. The main reason for the low productivity of pepper is that most of the production comes from small and marginal holdings, where scientific cultivation practices are not followed. The estimated global demand for black pepper is 2.1 lakh tonnes by 2025 AD. In order to capture at least 50 per cent of global market, India should increase its production from the present level of 53,011 tonnes to 1.25 lakh tonnes. As the scope for increase in area is limited, the other alternative will be to cultivate pepper as mixed crop in the existing areca and coconut plantations and increase its productivity by following scientific production practices. Pepper is sufficiently shade tolerant; and is ideal for mixed cropping with coconut palms and can be conveniently trained to the palms once the stem grows to certain height. In this publication, efforts are made to explore the potentials of coconut plantations for mixed cropping with pepper

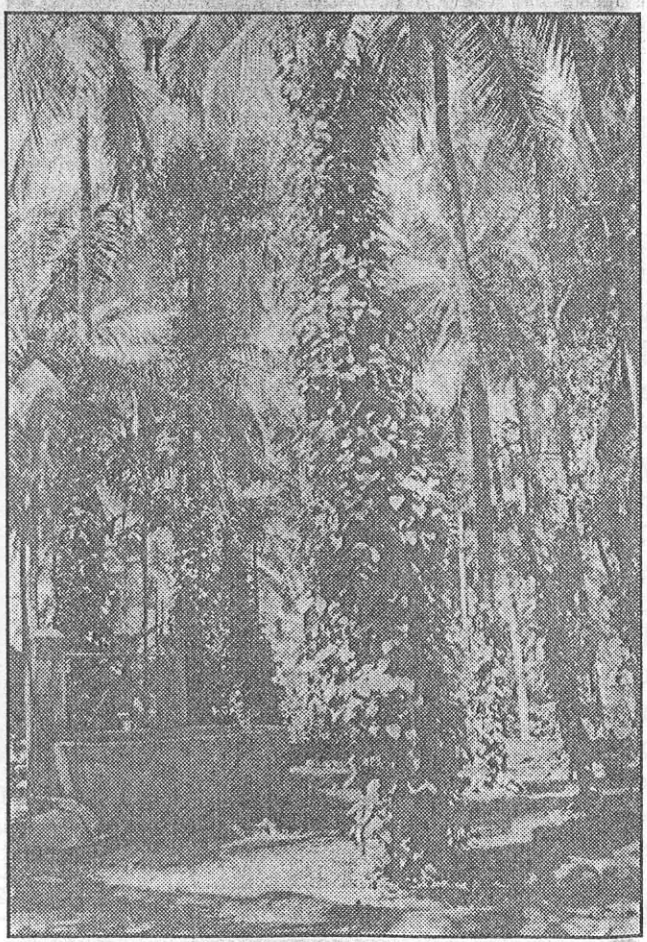

Fig. 1 : Pepper mixed cropped in homestead garden

Opportunities for mixed cropping in coconut gardens

In India, coconut is grown in an area of about 19,10,000 hectares mainly in Southern states such as Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. Coconut, which occupies the land continuously, utilizes the natural resources only to a very limited extent producing less than ten per cent of the potential dry matter production in the tropics. Studies conducted at Central Plantation Crops Research Institute (CPCRI), Kasaragod have shown that the effective root zone of an adult bearing coconut palm growing under normal management is confined laterally within a radius

two m around the base of the palm (Kushwah *et al.* 1973). The vertical distribution of roots have shown that the top 30 cm layer soil was practically devoid of functioning roots and that about 86 per cent of the roots were found between 30 and 120 cm depth from the surface. However, the morphological features of the coconut palm necessitate its planting at 7.5 x 7.5 metre spacing. These observations indicate that 77.7 per cent of the total available land area in a pure stand of coconut is not effectively utilized by the coconut roots. The venetian structure and orientation of coconut leaves permit sizeable amount of solar radiation incident on the crown to penetrate to lower levels. The light intensity at ground level was always higher than 6,700 lux at all parts of the year (Nair, 1979). Of the solar radiation received, on an average about 50 per cent alone is intercepted by the coconut canopy. Making use of the underutilized soil space and solar radiation by the coconut canopy. Making use of the underutilized soil space and solar radiation in mono crop stands, a variety of crops having different stature, canopy shape and size and rooting habits can be mix planted to form compatible combinations. Such mixed plantations will intercept and utilize light at different vertical intervals and forage soil at different layers and columns maximizing biomass production per unit area of land, time and inputs.

Further, coconut being a perennial crop, the land planted with this crop remains committed to it for several decades. To meet the diverse needs of farm families for cash, food, fuel, fodder, fruits, vegetable and timber, there is only little or no prospects of bringing fresh land under cultivation of these crops. Land to man ratio in our country is fast narrowing and has already reduced the per head availability of arable land to less than 0.25 ha. The great majority of small farmers, therefore, have small sized holdings and income derived from such small holdings is invariably low. Besides, coconut, as mono crop, provides employment only for a part of year and farm families have to remain unemployed or have to go elsewhere searching employment. Present day crash in prices of coconut have further added to the sorrow of small and marginal holders of coconut. It is, therefore, imperative that the production, productivity and profitability of these small holdings are maximized considerably through more onfarm employment generation. Practicing mixed cropping in coconut plantation offers considerable scope for increasing production, productivity per unit area, time inputs by more efficient utilization of resources like sunlight, soil, water and labour. Pepper is commonly raised in homestead gardens as mixed crop in Kerala and Karnataka (Fig one & two) and over 90 per cent pepper is trained on coconut and arecanut trunks. Studies carried out at CPCRI and elsewhere have also revealed that pepper is the most

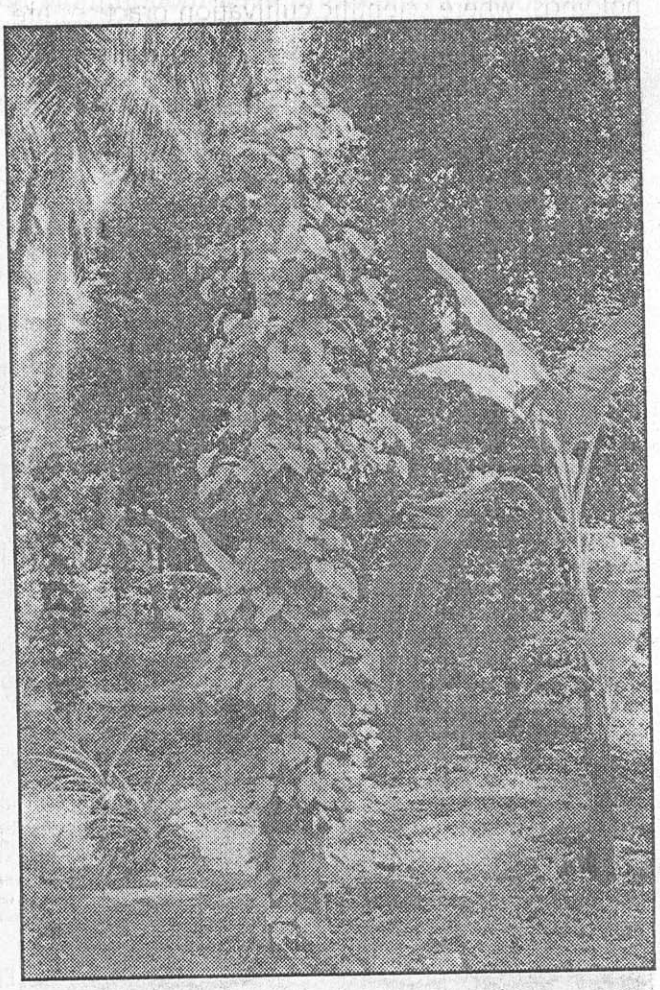

Fig. 2 : Black pepper mixed cropped in coconut based high density multi special cropping model

compatible perennial spice crop with coconut and can be profitably grown as mixed crop.

Climate and soil requirements for pepper

Pepper requires a warm and humid climate like coconut and arecanut. Though an annual rainfall of 2500 mm is ideal for proper growth of the crop, it can also come up well in low rainfall areas with good distribution. Very long spells of dry weather are unfavorable for crop growth. The plant tolerates a minimum temperature of 10° C and a maximum of 40° C, the optimum being 20-35°C. It can be grown up to an altitude of 1200 metre from sea level but lower altitudes are preferable.

Pepper prefers a light porous and well-drained soil rich in organic matter. Water stagnation in the soil, even for a very short period is injurious for the plant. So, coconut plantations established in heavy textured soils in locations where drainage facilities are inadequate should be avoided for pepper mixed cropping. Sites with slight to moderate slopes are ideal for pepper cultivation, as they promote drainage. Slopes facing south are to be avoided as far as possible. When such slopes are to be used for cultivation, the young plants are to be sufficiently protected from scorching sun during summer months.

Selection of pepper variety and multiplication

The improved varieties emerging from breeding programmes are to be tested as mixed crop in coconut gardens from time to time find out the best variety suitable for growing under coconut shade. Potty *et al.* (1979) evaluated the performance of six varieties of pepper in the multistoreyed cropping system and suggested that Karimunda and Panniyur-1 perform better under coconut based mixed cropping situations. In recent years, many new pepper varieties/hybrids have been released and CPCRI has already initiated field-screening trials of these varieties/hybrids as mixed crops in coconut garden. Till we get the information from this trial, varieties, which are proven to be highly productive alone, are to be cultivated. Mother plants which give regularly high yields and possess other desirable attributes such as vigorous growth, maximum number of spikes per unit area, long spikes, close setting of berries, disease tolerance etc are to be identified. Selected mother plants should be in the age group of 7-12 years. Rooted plants from these selected mother vines are propagated vegetatively from shoot cuttings. Separate the runner shoots (even terminal shoots also can be used) from the vines in February-March. These vines are grown over the rooting medium (consisting of cow dung-cor dust-sand in equal proportions) filled in a bamboo split piece. Tie each vine carefully to the bamboo using banana fiber, so that every node is in contact with the rooting medium. For rapid growth, add a nutrient solution consisting of one kg each of urea, super phosphate, muriate of potash as well as $MgSO_4$ (0.75 kg in 250 litres of water). Drench each vine once in every fifteen days with one litre of this solution. As the vines grow, the nodes get rooted, and each of these nodes is later separated and planted in individual polybags. After three months of planting in the bamboo, the rooted can be taken for planting in polybags. Arrange the polybag plants in a well-shaded area or in a shade house and give a spray of one per cent bordeaux mixture. The plants will be ready for field planting when new shoot is sufficiently grown up.

Agrotechniques for pepper mixed cropping

A spacing of 7.5 x 7.5 metre in the square system is recommended for coconut (175 palms/ha) but in the homestead gardens of Kerala, the density is much higher (200-250 palms/ha), whereas, in the Malnad region of Karnataka State, much wider spacings are adopted with densities as low as 120 palms/ha. For undertaking multiple cropping, the life span of coconut plantation can be divided into three phases. In the initial phase from planting to eight years age, there will be adequate space and light for intercropping with short statured annuals. Under no circumstances, perennial crops like pepper should be planted during this period, because they may overgrow the palms and affect their growth. In the second phase, from 8 to 20 years, there will

be very little penetration of light downwards and practically no cropping is possible during this period. In the third phase from 20 years onwards, pepper can be mix cropped in coconut gardens. By this time, the coconut palm attains a height of about six metres, and about 55 per cent of light is available below the palm canopy.

Rooted cuttings of pepper raised in polybags may be planted in 0.5m³ pits at a distance of one m away from the bole of the palm on the Norther side. The pits have to be half filled with a mixture of farm-yard-manure or compost, five kg neem cake and top soil. The soil around the pit may be treated with 50 g *Trichoderma* culture as a precaution against foot rot of pepper. Vines may be trained on to the palm as and when they grow and tied to the trunk for the first two years. In the later years, aerial roots of pepper vines itself get attached with coconut trunk. Both crops are to be adequately manured to prevent competition for nutrients between crops. Fertilizers at the rate of 100:40:140 g of N, P_2O_5 and K_2O respectively have to be applied for a grown up vine every year in two equal split doses during May and September along with the recommended dose of fertilizers for coconut. The recommended fertilizer dose for adult coconut palm is 500 g N, 320 g P_2O_5 and 1200 g K_2O/palm/year applied in two split doses@one-third in May-June and two-third in September-October. Fertilizer for pepper may be applied @ five kg/vine/year during May-June. Vermicompost @two-three kg/vine/year also can be applied. Wood ash may be used in potash deficient areas (Krishnakumar, 2002). In the early years of planting, banana may be grown as an intercrop to provide shade to young plants and protect them from drying up during summer months. However, it is not recommended beyond three years as it may compete with pepper and reduce the yield. Mixed cropping of pepper should be practiced under assured water supply conditions throughout the year in regions where rainfall distribution is unimodel. The establishment, growth and yield under irrigated condition will be very good. Perfo-irrigation is preferable as it wets the entire surface. Perfo-irrigation at the rate of 20 mm irrigation once in a week has found to be optimum for pepper in a coconut based high-density mutlispecies cropping model at Kasaragod. Even pepper can be drip irrigated along with coconut at the rate of 30-35 litres of water/day/palm depending on weather conditions. Pepper has 10-12 adventitious roots, grows to a length of three-four m, and penetrates to a depth of one-two m with an extensive mat of surface feeding roots. Care should be taken not to damage the surface roots of pepper while doing cultural operations for coconut and fertilizer application.

Disease and pest management

Adoption of integrated management practices for diseases and pests is very essential in coconut-pepper mixed cropping system. The microclimate in the mixed crop models provides ideal environmental conditions for multiplication and survival of pests and disease causing microbes. Regular monitoring and adoption of timely control measures will help to control pests and diseases and realize optimum yields. Adoption of integrated disease management practices was found to bring down incidence of *Phytophthora* foot rot from 6.1 to 1.9 per cent and slow decline from 6.4 to 2.2 per cent (Sadanandan *et al.*, 1993). The major diseases and pests of black pepper and their control measures are described below:

Diseases

Seventeen diseases have been identified in India both as major and minor causing yield loss in black pepper. *Phytophtora* foot rot, slow decline and anthracnose diseases are important in most of the regions.

Phytophthora foot rot:

Earlier the disease was referred to as quick wilt disease of black pepper, based on the sudden wilting and death of the vine. It is caused by *Phytophthora capsici*. The disease is reported to occur in all major tracts of black pepper. All parts of plant are prone to infection and as such, both foliar, collar and root infections cause varying degrees of damage. Foliar infections are more

severe in areca-black pepper and coconut-black pepper mixed cropping systems. The infection starts as water soaked spots on the lower surface and later enlarges rapidly to 25-70 per cent of the lamina. Foot rot infection on the main stem at the ground level causes sudden death. Infection occurs as wet patches at the foot region and the rooting progresses both upwards and downwards causing varying degrees of rotting of the main stem. This also induces foliar yellowing, dropping and gradual of leaves, breaking off of tender stems at the nodal region and spike shedding ultimately leading to vine death. This fungus also causes feeder root rot resulting in decrease in the canopy size, foliar yellowing and gradual vine death. An integrated disease management involving cultural, biological and chemical methods of control is suggested to tackle this problem (Sarma *et al.*, 1988) .

Control measures

a) Cultural practices: Rooted cuttings from disease free mother vines alone are to be used for new plantings. All infected/dead vines along with root system are to be removed and burnt. Wherever water stagnation is a problem, sufficient drainage should be provided. To avoid soil splash and consequent disease initiation and spread, a green manure crop or legume cover in the plantation may be grown and mulched around the vine to reduce the disease incidence. Minimum tillage operation involving no root damage and pruning off of the runner shoots lying on the ground before the onset of monsoon may be ensured.

b) *Biological control:* Soil amendments with neem cake, cotton seed and groundnut suppress *P. capsici* population in the field. *Talaromyces wartmani* and *Penicillium* strains were found anatognistic to *P. palmivora* (Dutta, 1984). Incorporation of *Trichoderma* fungus in the plant basins @50g/vine prior to planting of vines or just before the monsoon period in established plants is found beneficial in disease suppression.

c) *Chemical control:* Prophylactic application of Bordeaux paste to the collar once during May-June period and spraying the foliage and drenching the soil with one per cent Bordeaux mixture or 0.2 per cent copper oxychloride twice as pre-monsoon and post-monsoon treatments reduce the disease (Sarma and Ramachandran, 1984).

Slow Decline Disease

This was earlier known as slow wilt. Fungal nematode complex coupled with soil moisture stress and malnutrition are associated with this disease. In the absence of spatal segregation of *Phytophthora* and nematodes in the soil under field condition, a judicious strategy that can check the combined infections is to be adopted. Application of neem cake at one kg/vine or phorate at three g a.i./vine twice a year has been found effective against nematodes. Recovery of 45 per cent of slow decline affected vines with metalaxyl + phorate treatment was reported (Anon. 1989b).

For control of the burrowing nematode, *Radopholus similis* and root knot nematode, *Meloidogyne incognita*, the following measures are to be adopted.

- ✧ Use nematode free rooted cuttings for raising new plantations
- ✧ For the nematode infected vines apply phorate/carbofuran@1 g.a.i per vine twice in an year during May-June and October-November. The chemicals are to be applied around the vines in shallow basins and covered with soil.
- ✧ Apply bacterial suspensions of 1.2×10^8 cells of *Bacillus* macerans or *B. circulars* prior to planting of vines or just before the monsoon period in established plantations.

Anthracnose

Leaf spot and berry split caused by *Colletotrichum gloesporioides* (Penz.) Sac. is becoming increasingly important in plantations where prophylactic plant protection measures with bordeaux mixture against *Phytophtora* infection are not adopted. Infection occurs on leaves causing angular to irregular brownish spots with a chlorotic halo. Infection of stalks as dark spot results in spike shedding. Infection of tender berries causes darkening of the pericarp, affects their

subsequent development and occasionally dries up resulting in chaffey berries. Hence, it is also named pollu, the hollow berry. To check the disease, spray three rounds with one per cent bordeaux mixture during June-July, late July and late August months.

Insect Pests

Pollu beetle (Longitarsus nigripennis Mots)

The pollu beetle is the most destructive pest of black pepper in the plains of Malabar area. The loss reported to be due to this pest is as high as 6-40 per cent. Three rounds of spray of endosulfan or quinalphos or methylparathion at 0.05 per cent during May, July and September is the most effective method of control of this pest.

Top shoot borer (Cydia hemidoxa Meyr.)

Top shoot borer is a serious pest of black pepper, especially in younger plantations. This pest is reported to cause shoot damage to an extent of 48 per cent in one-year-old plantation. Spraying of monocrotophos (0.05 per cent) during June and September was found effective in controlling this pest (Anon. 1990).

Leaf gall thrips (Liothrips kamyi Bagn.)

Leaf gall thrips is a persistent pest occurring throughout Kerala. This infests leaves of black pepper and induces the formation of tubular marginal leaf galls within which they live. Among the insecticides tested, monocrotophos (0.05 per cent) and dimethoate (0.05 per cent) were effective in controlling the pest (Devasahayam, 1990).

Scale insects

Scale insects sometimes cause severe damage to black pepper vines in certain areas especially at higher altitudes. The infestation is seen in the form of encrustations on stems, berries, and becomes more severe during summer months. Scale insects suck the plant sap resulting in yellowing and withering of infested shoots and in severe cases the vines dry up. This can be controlled by dimethoate spraying at 0.05 per cent concentration (Anon. 1989a).

Harvesting

Pepper is a climbing vine and usually grows as tall as coconut. But the height of pepper vine is to be restricted to four metre by pruning. This helps in harvesting of coconuts by climbing the tree up to the pepper height with the help of ladder by the climbers without damaging pepper vines on the trunk.

Pepper begins to yield in the third year and comes to full bearing by 7th or 8th year. The yield declines after 15 years but vines have been found to yield even upto 60 years under good management practices. It flowers during April-May and comes to maturity after six-eight months. During this period, dry spells will adversely affect the pepper yield. Therefore, vines are to be irrigated and optimum moisture maintained in the soil. Harvesting is done manually when two or three berries in a spike turn red in colour. Separate the berries and sun dry for seven-ten days till they turn black in colour. The recovery of black pepper from the fresh is around 33 per cent. On an average one kg dry pepper can be obtained from a single vine trained on coconut palms.

References

Anonymous. 1989a. Black pepper package of practices, National Research Centre for Spices, Calicut. pp. 16.

Anonymous. 1989b. Annual Report for 1987. National Research Centre for Spices, Calicut. pp.83.

Anonymous. 1990. Annual Report for 1989-90. National Research Centre for Spices, Calicut. pp.61.

Dutta, P.K. 1984. Studies on two *Phytophthora* disease (Koleroga of arecanut and black pepper wilt) in Shimoga district, Karnataka state. Ph. D thesis, Dept. of Plant Pathology, Univ. of Agril. Sciences, Bangalore, College of Agric., Dharwad 580 005. pp 121.

Devasahayam, S. 1990. Field evaluation of six insecticides for the control of leaf gall thrips (*Liothrips kamyi* Bagnall) on black pepper. *Entomon*, 15: 137-138.

Krishnakumar, V., 2002. Organic cultivation of pepper. *Plant Hort. Tec. 3(3):* 53-54.

Kushwah, B.L., Nelliat, E.V., Markose, V.T. and Sunny, A.F., 1973, Rooting pattern of coconut (*Cocos nucifera* L.) *Indian J. Agron* 18:71-72.

Nair, P.K.R. 1979. Intensive Multiple Cropping with Coconut in India, Principles-Programmes-Prospects. Verlag Paul Parcy-Berlin and Hamburg. Adv. In Agron. And Crop Sci. 6. 147p. (ICRAF, Nairobi, Kenya)

Potty, N.N, Radhakrishnan, T.C. and Asokan, P.K. 1979. A note on the early growth and performance of six varieties of pepper in the multistoreyed cropping programme in coconut gardens. Agric. Res. J. Kerala 17(1) : 151-152.

Sadanandan, A.K., Jose Abraham, Anandaraj, M. and Hamza, S. 1993. Effect of coconut-pepper mixed cropping on soil fertility and crop productivity. In : Advances in coconut research and development, pp 433-435, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

Sarma, Y.R. and Ramachandran, N. 1984. Quick wilt disease of black pepper. CPCRI Extension Folder No.6, Central Plantation Crops Research Institute, Kasaragod, Kerala, India.

Sarma, Y.R. Premkumar, T., Ramana, K.V. Ramachandran, N. and Anandaraj, M. 1988. Disease and pest management in black pepper nurseries. Indian Cocoa, Arecanut and Spices J. 11:45-49.