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EFFECT OF VARIETY, SPACING AND SUPPORT MATERIAL ON NUTRITION AND YIELD OF BLACK PEPPER (*PIPER NIGRUM* L.)

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Abstract: A field experiment was conducted with two varieties of black pepper to study the influence of spacing and type of support (standard) on nutrition and yield. During a six year period since planting, soil chemical characteristics were not influenced by variety, spacing and type of standard. The variety Karimunda accumulated more K, Ca and Mn in the leaf compared to Panniyur-1. A depressing effect on foliar Ca level was noticed in vines trailed on *Garugapinnata*. Closer spacing down to 2 m x 2 m did not affect the vine yield adversely. Three to four-fold increases in yield were obtained by trailing the vines on teak pole instead of on trees. The decrease in yield of the vine trailed on *Erythrina indica* and *Garugapinnata* as compared to that on teak pole (non-living standard) was discussed in the light of probable competitive interactions between the crop vine and support tree as in mixed cropping system.

INTRODUCTION

Black pepper (*Piper nigrum* L.) is an export-oriented spice crop in India. Low yield of this crop in this country as compared to that in other pepper producing countries like Brazil, Indonesia and Malaysia has been mainly due to the poor management practices. Very little information is available on the agronomic as well as nutritional aspects of this crop. Investigations of the nutritional aspects were mainly carried out in Sarawak (De Waard, 1969; Sim, 1971; Raj, 1973) and recently in India (Wahid *et al.*, 1982; KAU, 1984). Menon *et al.* (1982) reported the superiority of non-living support over live standards for trailing the vine. The present study is aimed at evaluating the yield performance and nutrition of black pepper varieties as influenced by spacing and type of support.

MATERIALS AND METHODS

A field experiment was started in 1979 with 18 treatments replicated four times and was continued up to 1985. The treatments included the factorial combinations of two most popular black pepper varieties (Panniyur-1 and Karimunda); three standards (vine supports) namely, teak pole, *Erythrina indica* and *Garuga pinnata* and three spacings namely, 2 m x 2 m, 2.5 m x 2.5 m and 3 m x 3 m. The plot size was six standards per plot. Two rooted cuttings were planted at a distance of 30 cm from each support. NPK fertilisers were applied at the rate of 100 g N, 40 g P_2O_5 and 140 g K_2O per standard per year uniformly for all treatments commencing from the third year of planting the cuttings. In the first and second years, one-third and one-half the dose respectively were given. In addition, 9 kg of farm yard manure and 500 g of lime were applied per standard per year. The vines commenced flowering by third year after planting. The data on yield and yield attributes were collected during 1984 and 1985. The spikes were harvested during January-February each year and threshed to separate the green berries. The number of spikes produced as well as the length of spikes were also recorded at the time of harvesting.

Soil and leaf sampling

Soil and leaf samples were collected in October, 1985. One soil core to a depth of 25 cm was removed from the vine basin of each of the six standards at a radial distance of 30 cm from the vine and pooled for that treatment in that replication. This method was followed as it was observed from an earlier radioisotope study that most of the active roots of the black pepper vine are confined to within 30 cm area around the plant (Sankar, 1985; Sankar *et al.*, 1988). The soil samples were air-dried and passed through 2 mm sieve prior to chemical analysis.

First fully matured leaves were collected from fruiting branches around the vine as suggested by De Waard (1969) for chemical analysis. The leaves were dried at 70°C in a hot air oven, powdered in a mill with stainless steel blades and stored in polythene bottles.

Chemical analysis

The soil samples were analysed for pH (1:2.5 soil-water ratio), organic carbon, available P (Bray-1), available K, exchangeable Ca and Mg (Jackson, 1958) and diacid (0.05 *N* HC1 + 0.025 N H_2SO_4 extractable Cu (Baker and Amacher, 1982) and Mn (Cox, 1968). The same extract was used for the determination of Fe also. Phosphorus was estimated colorimetrically by molybdenum blue method (Jackson, 1958), K by flame photometry, S by turbidimetry and Ca, Mg, Fe, Mn and Cu by atomic absorption spectrophotometry.

The leaf samples were analysed for N (microkjeldahl) and other major and micronurrients. For the determination of P, K, Ca, Mg, S, Fe, Mn and Cu, the samples were pre-digested with perchloric-nitric acid mixture (1:1 v/v). The nutrient elements in the digests were analysed following the same methods as for soils except that P was measured by vanadomolybdophosphoric yellow colour method (Jackson, 1958).

RESULTS AND DISCUSSION

Statistical analysis of the soil data did not indicate significant differences in soil characteristics as influenced by the variety, spacing and type of standard. Therefore, the general mean values obtained for different soil variables are presented (Table 1). The soil at the exprimental site was acidic laterite (Oxisol) containing 0.7% organic carbon. Among the micronurrients, very high content of extractable Cu (11 ppm) was obtained. The extractable Cu content of nearby uncropped area was found to be very less (2.5 ppm). The accumulation of copper in the soil basin of the vines may be due to the fall-out from annual Cu fungicidal (Bordeaux mixture) sprays. However, there is no evidence to show that there was increased uptake of this nutrient by the crop (Table 2).

Table 1. Chemical characteristics of soil basins of black pepper

Chemical property	Mean value
pH	5.85
Organic carbon (%)	0.70
Bray-1 P (ppm)	8.5
Exchangeable K (ppm)	244.5
Exchangeable Ca (me/100 g)	1.5
Exchangeable Mg (me/100 g)	0.59
Available S (ppm)	20.2
Extractable Fe (ppm)	5.1
Extractable Mn (ppm)	4.2
Extractable Cu (ppm)	11.0

In contrast to the soil charasteristics, the nutrient composition of the vine leaf was found to be influenced by the variety and type of support but not spacing. The data on the foliar nutrient levels of the vine as influenced by the variety are presented in Table 2. Significant differences in the foliar levels of K, Ca and Mn were observed between the two varieties studied. In all these cases, var. Karimunda was found to accumulate more of these nutrients than Panniyur-1.

The influence of type of standard was seen on the Ca levels of the vine leaves. The vine absorbed more Ca when trailed on teak pole (Table 3). The cropping system in which vines are trailed on teak pole may be considered as monoculture as opposed to the mixed system wherein the vines are trailed on live support, *Erythrina indica* or *Garuga pinnata*. The latter may also be viewed as one of agroforestry systems in which the trees serve as supports for the vines. The presence of an associated plant species in this system may be expected to lead to either complementary or competitive interaction between the plant species. Of the two plant species, *Erythrina* is a leguminous plant capable of fixing atmospheric nitrogen. Despite this, the N nutrition of the vine trailed on it was not improved. The results also indicated a depressing effect on Ca levels of vines when trailed on *Garuga pinnata* as compared to those trailed on teak poles.

The effects of variety, support material and spacing on the yield attributes are presented in Table 4. It was observed that Panniyur-1 produced longer spikes than Karimunda. Significant differences were also observed in the production of spikes in these two varieties. More spikes were produced by the var. Karimunda in both years than Panniyur-1. Nevertheless, the yield of berry was more from Panniyur-1 than from Karimunda as evidenced from the significant difference in threshed weight of berries in the second year. The length and production of spikes were improved when the vines were trailed on teak pole. Both varieties performed better when trailed on teak pole than on live supports. The results indicated that three to four fold increases in yield could be obtained if vines were supported on teak pole rather than on live standard like *Erythrina indica* or *Garuga pinnata.*

It is important to note that the vines trailed on teak pole had maintained comparable foliar levels of nutrients (or better in the case of Ca) than those trailed on live supports inspite of higher yields and hence biomass production. This indicates that nutrient levels in the teak pole-trailed vines were

Table 2. Varietal differences in the foliar nutrient composition of black pepper

Nutrient	Variety		CD (0.05)
	Panniyur-1	Karimunda	
(%)			
N	3.07	2.98	NS
P	0.19	0.20	NS
K	2.95	3.13	0.17
Ca	0.89	1.08	0.12
Mg	0.62	0.70	NS
S	0.12	0.12	NS
(ppm)			
Fe	166.3	153.5	NS
Mn	265.5	356.1	47.3
Cu	28.0	29.1	NS

NS : Not significant

Table 3. Foliar nutrient composidon of black pepper vine as influenced by the support material

Nutrient	Support material			CD (0.05)
	Teak pole	£. *indica*	G. *pinnata*	
(%)				
N	2.94	2.98	3.17	NS
P	0.187	0.197	0.202	NS
K	3.00	3.05	3.07	NS
Ca	1.10	0.97	0.89	0.14
Mg	0.69	0.64	0.65	NS
S	0.117	0.120	0.116	NS
(ppm)				
Fe	175	162	144	NS
Mn	332	289	310	NS
Cu	27.5	30.5	28.6	NS

NS: Not significant

not affected by concentration diludon and that there was an increased uptake of soil nutrients by the vines to cope with the nutrient demands. Indirectly, the results point to competitive interactions between the support tree and the crop vine leading to the supression of yield and overall dry matter production. Such effects can be expected when two or more species share the same space (Willey, 1979). In so far as the foliar nutrient levels in teak pole trailed and tree-trailed vines were similar excepting for Ca, it is reasonable to conclude that the supression of growth in vines trailed on tree supports is not of competition for nutrients alone but some other factors such as the decreased light intensity under the erythrina canopy, as well. This assumption is justifiable because the variety Panniyur-1 is relatively less shade tolerant than the other popular variedes.

The different spacing treatments were not found to influence yield or yield attributes. These results indirectly show that closer plandng (2 m x 2 m) would considerably increase the black pepper yield per unit area due to increased vine population. However, some more years' data are required before more meaningful conclusions could be drawn on this aspect.

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Table 4. Effect of variety, type of standard and spacing on yield and yield attributes in black pepper

Treatment	No. of spike/standard		Spike length (cm)		Threshed weight (g/standard)	
	83-84	84-85	83-84	84-85	83-84	84-85
Variety						
Panniyur-1	222.3	234.5	11.44	9.85	1419.8	1724.4
Karimunda	471.4	457.9	8.41	7.46	1361.1	1341.9
CD (0.05)	81.9	103.1	0.57	0.51	NS	315.8
Standard						
Teak pole	669.2	668.1	10.94	9.09	2626.2	2756.8
E. indica	193.0	196.8	9.46	8.71	753.1	922.7
C. pinnata	178.4	173.7	9.38	8.15	792.0	920.7
CD (0.05)	100.4	126.3	0.69	0.62	420.6	386.8
Spacing						
2 m x 2 m	340.9	354.1	9.61	8.63	1402.8	1636.1
2.5 m x 2.5 m	349.6	326.0	10.18	8.51	1377.8	1552.5
3 m x 3 m	350.1	358.6	9.97	8.82	1390.7	1410.9
CD (0.05)	NS	NS	NS	NS	NS	NS

NS : Not significant

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