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N. P AND K REQUIREMENT OF BLACK PEPPER

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Pepper *(Piper nigrum L.)* is one of the most important spice crops of India, especially in the state of Kerala. So also, the crop has great economic importance in such other countries as Indonesia, Malaysia and Brazil. But, in spite of its historical and economic importance, very little work has been done on the nutritional requirement of this crop. In Kerala, which accounts for nearly 95% of the area and production of pepper in the country, farmers mostly depend on the natural fertility of the soil, which is fast depleting, for growing their pepper plants. According to local availability, some organic matter may or may not be added to the plants. Sim (1971) has estimated that the total dry matter production in pepper was about 11426 kg per hectare in mature vines and the nutrient losses were 233 kg of N, 39 kg of P_2O_5, 200 kg of K_2O, 30 kg of MgO and 105 kg of Ca per hectare. These figures are more or less in conjunction with that reported by De Waard (1964). De Waard (1969) has reported that deficiency symptoms in pepper may be developed if the levels of N, P, K, Ca and Mg fall below 2.70, 0.10, 2.00, 1.00 and 0.02 per cent of dry matter respectively. He has also standardised the appropriate tissue for assessing the nutrient status of the crop and for the determination of critical values of each nutrient in pepper. Sushama *et al.* (1982 and 1984) found out that the first mature leaf at the distal end of plagiotropes is the best as an index for foliar diagnosis in pepper in relation to nitrogen, phosphorus and potassium and that the period just before flushing is the most suitable time for collecting the leaf samples for analysis. Pillai and Sasikumaran (1976) estimated N, P_2O_5, K_2O, CaO and MgO content in different plant parts such as roots, stem, leaves and berries. Based on this, they have estimated that one hectare of pepper plants (1200 vines) producing 1200 kg of black pepper require 34.00 kg N, 3.50 kg P_2O_5 and 32.00 kg K_2O annually for the production of berries alone. Mohankumaran and Cheeran (1981) also found that the lowest level of N tried (75 g per plant per year) gave the highest yield as compared to 150 g and 225 g of N. Raj (1972) reported that when inorganic fertilizers were applied in conjunction with trace elements to pepper in two soils of Sarawak (Malaysia), they were as efficient as organic manures and were more profitable due to the low cost per unit of nutrients contained in the inorganics. Raj (1973) again reported the results of two NPK fertilizer experiments from that country which proved that higher levels of nutrients did not register a corresponding increase in the yield of vines. Pillai *et al.* (1979) reported that continuous application of 60, 120 and 180 g of nitrogen per plant per year in conjunction with constant levels of P (40 g) and K (140 g) increased the spike production and yield of pepper. However, it was found that nitrogen application at the rate of 60 g per plant per year was superior to the other treatments.

In the absence of reliable data from field experiments in India, the present experiment with three levels each of the major nutrients was conducted at the Pepper Research Station. Panniyur, Kerala.

Materials and Methods

The soil of the experimental plot was gravelly silty clay loam of lateritic origin located on a moderately slopping terrain. Characterised by the presence of a high proportion of ferrugenous and lateritic gravels (44.40%), the soil was rather loose and friable. The soil depth varied from 74 cm at the top of the slope to 135 cm at the dip. Though rich in clay (37.50%) the soil was well drained due to the slopping terrain, high proportion of sand and gravel and a fairly high content of organic matter (2.13%). The soil contained 0.12 per cent total N, 0.11 per cent total P_2O_5 and 0.067 per cent total K_2O. The soil was acidic in reaction (pH 5.39) with a CEC of 7.49 me/100g.

The pepper vines were of the variety Panniyur 1 planted in 1971 and trained on *Erythrina indica* standards at a spacing of 2 m x 3.5 m. The experiment was laid out in a 3^3 factorial confounded design totally confounding NP^2K^2 and had two replications with five plants per plot. Each of the three nutrients (N, P_2O_5 and K_2O) was tried at three levels each viz., 50,100 and 150 g per plant per year over a uniform basal dose of 10 kg green leaves. There were 27 treatment combinations and the treatments were administered to the plants from 1974-75 to 1982-83. The sources of the nutrients were urea, single superphosphate and muriate of potash. The weight of green pepper obtained from each plant was recorded.

The N, P and K contents in the soil and plant parts were analysed using standard techniques.

Statistical analysis of the data was carried out as per Panse and Sukhatme (1954). The pooled analysis was done in the manner of a split-plot design with years as the sub-plots.

Results and Discussion

Analysis of the annual yield data as well as the pooled data for eight years has shown that there was no significant interaction between the various combinations of the three nutrients (Table 1). Significant increase (at 1 % level) in yield was noticed in the case of potassium application. As the interactions between the various treatment combinations were insignificant, the effect of each individual nutrient alone was discussed.

a) Effect of nitrogen

The effect of the three levels of nitrogen (50, 100 and 150 g per vine per year was not significant. However, the pooled means showed that there was a reduction in the yield (though not significant) with the increase in the levels of nitrogen. This is in agreement with the results reported by Raj (1973), Pillai and Sasikumaran (1976) and Mohankumaran and Cheeran (1981). The negative response of the plant to higher levels of nitrogen has been attributed to the excessive vegetative growth induced at these levels. At higher levels of nitrogen, the uptake of the nutrient increases, which in turn might have accelerated the vegetative growth at the expense of flower and berry formation. Sushama *et al.* (1982) observed negative correlation between N content of leaf and yield at higher levels of N application. The ill effects of higher levels of nitrogen was not seen counteracted by increased doses of phosphorus and potassium upto 150 g each (Table 2). So. it can be concluded that the lowest levels of nitrogen, i. e., 50 g per plant per annum will be quite sufficient for Panniyur 1 pepper plants growing on soils containing moderate to high levels of nitrogen.

b) Effect of phosphorus

As in the case of nitrogen, the three levels of phosphorus tried too did not register any significant difference in respect of yield. But, higher levels of the nutrient (100 and 150 g) gave higher yields than at the minimum dose (50 g per plant per year). However, the increase in yield with increase in the level of the nutrient did not follow a regular pattern but followed Mitcherlich's law. The highest yield was obtained (7.912 kg) from plants receiving 100 g P_2O_5/plant/year (Table 2). Since there are only three levels of phosphorus, the highest yield estimated by quadratic regression will be at 100 g P_2O_5/vine. Though this was not significantly higher than the yield obtained with P level at 50 g per plant (6.820 kg), application of P_2O_5 at the rate of 100 g per plant seems to be economically optimum as the cost benefit ratio is most favourable in this case. Here, it may also be mentioned that yield was the highest for P, level at all levels of N and K (Table 2).

c) Effect of potassium

The effect of different levels of K_2O was significant at 1% level, both K_3 (150 g) and K_2 (100g) being on par between themselves but superior to K_1 (50 g). However, the mean yield at K_3 was higher than that at K_2 level. Thus the response to this element followed a curvilinear pattern and by applying quadratic equation, the maximum yield of 8.094 kg could be obtained with K_2O applications at the rate of 166.5 g per plant. However, confining to the experimental results alone and based on cost benefit ratio, the highest level K_2O (150 g per plant per year) was found to be economically optium,

Thus, it emanates from the discussion that application of 50 g N 100 g P_2O_5 and 150 g K_2O per vine per year is optimum and economical in soils moderately rich in organic matter. Vines receiving this treatment combinations have given an average green pepper yield of 10.71 kg (Table 3) green pepper per vine per annum (equivalent to approximately 3.5 kg dry pepper.

Table 1

Pooled analysis of Variance of green berry yield of pepper (kg/vine)

Source	df	SS	MS	F
Block	5	566 6352	11.327	—
N	2	86.7324	43.366	1.82
P	2	90.3027	45.513	1.90
NP	4	36.4746	9.1186	0.38
K	2	230.6054	115.3027	4.84**
NK	4	245.8281	61.4570	2.58
PK	4	27.0176	6.7544	0.28
NPK	6	357.1211	59.5202	2.50
Error (a)	24	271.5509	23.8146	—
Years (Y)	7	5779.4316	828.4902	69.95**
NY	14	127.449	9.1016	0.77
PY	14	133.1504	9.5107	0.80
KY	14	546.1307	39.0097	3.23**
Other inter-actions	140	1480.8424	10.5774	0.89
Error (b)	189	2238.4473	11.8436	—

Table 2

Two way tables for green berry yield (kg/vine)

	N1	N2	N3	Mean
P1	6.966	6.753	6.921	6.820
P2	8.696	7.784	7.255	7912
P3	8.088	6.899	6.466	7.151
Mean	7.917	7.085	7.151	

	N1	N2	N3	Mean
K1	6.713	6.610	5.616	6.310
K2	7.026	7.793	7.723	7.514
K3	10.010	6 853	7.312	8.058
Mean	7.917	7.085	7.151	

	P1	P2	P3	Mean
K1	6.334	6.664	7.344	6.310
K2	6.781	8.245	8.824	7.514
K3	7.344	7.516	8.007	8.058
Mean	6.820	7.912	7,151	

CD (0.05) for comparing main effects = 1.187

CD (0.05) for comparing values in two way table — 2.056

Table 3

Green yield of pepper (kg/vine) during different years receiving graded doses of N, P and K

NPK Treatment combination	1975-76	76-77	77-78	78-79	79-80	80-81	81-82	82-83	Mean
111	6.34	4.23	6.16	7.13	4.73	0.82	12.11	2.78	5.54
112	7.05	4.08	4.70	12.44	10.00	0.92	003	9.09	7.16
113	6 03	5.67	2.59	18.54	819	2.38	15.75	5.01	8.02
121	9.03	6.88	7.08	23.18	9.60	1.19	8.95	4.99	8.86
122	5.10	5.34	6.23	11.15	10.43	0.48	9.02	3.68	6.48
123	6.30	7.48	7.09	17.85	16.46	1.64	17.53	11.32	10.71
131	8.18	6.80	4.38	8.87	5.84	0.86	9.84	1.21	5.75
132	630	3.76	8.47	11.37	10.38	0.48	6.50	11.38	7.38
133	6.65	9.08	8.19	19.65	20.07	0.99	17.34	7.50	11.18
211	8.70	6.11	4.45	10.45	5.64	0.82	8.26	3.36	5.97
212	5.98	3.29	6.70	13.03	9.53	0.72	10.84	4.69	6.85
213	4.20	3.04	6.92	9.08	10.11	1.42	15.21	5.32	6.91
221	4.56	2.93	3.85	11.75	8.66	1.30	7.27	7.03	5.92
222	8.87	2.76	12.33	19.43	15.56	1.51	8.65	6.37	9.56
223	5.78	3.71	3.48	14.14	12.09	0.96	19.08	4.05	7.91
231	7.95	8.74	4.98	14.42	10.92	1.11	11.73	3.44	7.95
232	6.34	2.91	6.36	16.20	8.47	1.09	12.42	2.04	6.98
233	3.46	3.07	6.44	9.37	6.37	1.18	9.16	7.16	5.78
311	9.88	7.30	3.20	16.56	6.25	0.97	7.08	8.79	7.50
312	5.75	860	5.65	10.57	8.00	0.88	5.04	5.53	6.25
313	6.30	5.19	4.56	14.32	9.41	1.31	9.80	4.96	6.98
321	7.13	5.03	4.83	10.26	8.38	0.11	4.84	1.46	5.26
322	5.06	5.68	4.66	16.96	11.25	1.11	14.27	10.31	8.66
323	7.08	5.10	5.34	14.54	7.39	2.13	14.36	7.20	7.89
331	3.90	4.13	4.42	6.33	4.47	0.93	2.74	5.92	4.11
332	6.49	7.06	6.09	18.39	10.63	1.31	12.07	3.83	8.23
333	4.00	2.95	4.18	12.61	13.48	1.05	11.69	6.60	7.07

Summary

An experiment, to identify the optimum levels of N, P and K for black pepper was conducted at the Pepper Research Station, Panniyur, Kerala in 3^3 factorial design completely confounding NP^2K^2. Analysis of the data collected for eight seasons showed that the economically optimum level of nutrients was 50, 100 and 150 g of N, P_2O_5 and K_2O respectively per vine per annum.

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