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RESPONSE OF PERIWINKLE (*CATHARANTHUS ROSEUS* (L.) G. Don) TO NITROGEN, PHOSPHORUS AND POTASSIUM FERTILIZATION

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Periwinkle (*Catharanthus roseus* (L.) G. Don) is a medicinal plant of great value which came into prominence in recent years. It is a hardy, drought resistant crop which can easily adapt to marginal lands. It is widely cultivated in several parts of South India as a source of valuable alkaloids found in leaves and roots. Because of its great medicinal value coupled with consistent demand, there has been continuous expansion in its cultivation. However, no systematic work has been carried out to find out its nutritional requirement which is very important in maximising productivity (Gupta and Pareek, 1981). The crop is either not fertilized at all or fertilized with very limited quantities of organic and/or inorganic fertilizers. Preliminary studies conducted by many workers (Anonymous, 1979 Nambisan, 1980; Suresh, 1980) have clearly demonstrated the beneficial effect of fertilization in increasing the root and leaf yield of periwinkle. Investigations on nutritional requirements will go a long way in increasing productivity and profitability of this crop.

Materials and Methods

The experiments were carried out at the Horticultural Experiment Station, Hessaraghatta of the Indian Institute of Horticultural Research, Bangalore during 1980-81 and 1981-82 under protective irrigation on sandy loam soil of low fertility (0.48 to 0.58% organic C, 6.6 to 7.1 kg/ha available P, 116 to 129 kg/ha available K and 6.3 pH). There were 27 treatment combinations of three levels each of nitrogen (0, 60 and 120 kg N/ha, phosphorus (0, 40 and 80 kg P_2O_5/ha) and potassium (0, 40 and 80 kg K_2O/ha). Split-plot design was adopted with combinations of P and K levels in main plots and nitrogen in sub-plots in three replications. All phosphorus and potassium and half of nitrogen were applied at the time of transplanting and the remaining nitrogen was top-dressed 60 days thereafter. Forty-day-old seedlings were transplanted at 15 cm in rows 45 cm apart during first week of May during both the years and harvested after 300 days. The whole plant was uprooted carefully and separated into roots, leaves and stems and their dry mass recorded.

Observations on plant height, stem diameter, number of branches and dry matter production and distribution into different parts were recorded on five plants randomly selected from each plot at the time of harvest. Harvest index was calculated by dividing the leaf and root dry matter by the total dry matter production. To study the input output relationship, a second degree polynomial was fitted to the root and leaf yield data of both years.

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Results and Discussion

The growth and yield of periwinkle were higher in 1981-82 than in 1980-81 (Table 1 and 2) as a spell of continuous rains during September, 1980 affected the growth adversely due to excess soil moisture.

Response to nitrogen

Nitrogen fertilization had favourable effect on growth and productivity of periwinkle during both years. There was significant increase in plant height, branches per plant and stem diameter upto 120 kg N/ha although the difference between 60 and 120 kg N/ha was not significant with respect to branches per plant. Better growth with nitrogen fertilization led to higher dry matter production and its distribution into different plant parts. This in turn resulted in significant increase in the yield of roots, leaves and stems during both years. During 1980-81, root yield increased from 416 kg/ha without nitrogen fertilization to 535 and 535 kg/ha with 60 and 120 kg N/ha, respectively. The same trend was observed during 1981-82 also. Leaf and stem yields also followed almost similar trend except that the difference in leaf yield between 60 and 120 kg N/ha was not significant during 1981-82. It may be noticed that the magnitude of response from 0 to 60 kg N/ha was comparatively larger than that from 60 to 120 kg/ha. As the soil of experimental field was of low fertility status, it is natural to expect good response to nitrogen application. Response of periwinkle to nitrogen fertilization of 80 to 150 kg per ha was noticed at many places like Delhi (Anonymous, 1979); Ooty (Nambisan, 1980) and Bangalore (Suresh, 1980). Harvest index decreased slightly with nitrogen fertilization during both years. Root-shoot ratio also decreased due to nitrogen fertilization.

Response to phosphorus

Growth and yield of periwinkle were significantly influenced by phosphorus fertilization. There was significant increase in plant height, stem diameter and dry matter production due to application of 40 kg P_2O_5/ha and further increase in phosphorus application had no significant effect. Higher growth and dry matter production of phosphorus fertilized plants were reflected in increased yield of roots, leaves and stems during both years. During 1980-81, root yield increased from 428 to 588 kg/ha with 40 kg P_2O_5/ha and further increase in phosphorus application decreased the root yield although it was significantly higher than the yield obtained without phosphorus fertilization. Similar trend was observed during 1981—82 except that there was no significant differences between 40 and 80 kg P_2O_5/ha. Leaf and stem yield also increased significantly at 40 kg P_2O_5/ha and further increase in phosphorus application had no additional advantage. As the experimental soil analysed low in available P, response to phosphorus application was expected. Nambisan (1980) and Suresh (1980) had observed significant response

Table 1

Growth, dry matter production and distribution in periwinkle as affected by N, P and K fertilization

Treatment	Plant height (cm)		Branches per plant		Stem diameter (cm)		Root mass (g/plant)		Leaf mass (g/plant)		Stem mass (g/plant)		Follicle mass (g/plant)		Total dry matter (g/plant)	
	1980–1981	1981-1982	1980–19S1	1981–1982	1980–1981	1981-1982	1980–1981	1931-1982	1980–1981	1981-1982	1980-1981	1981-1932	1980–1981	1981-1982	1980-1981	1981-1982
N kglha																
0	80.8	83.9	9.3	9.E	1.39	1.42	11.2	12.9	26.9	28.8	61.1	65.2	4.0	4.8	103.2	111.7
60	91.6	95.6	13.3	14.0	1.65	1.71	14.4	15.8	34.3	37.2	84.3	85.3	5.2	6.2	138.2	144.5
120	98.6	101.2	13.9	14.5	1.78	1.82	15.8	17.6	39.2	40.9	97.8	100.0	5.9	6.7	158.7	165.2
SEm±	0.7	0.9	0.4	0.3	0.02	0.03	0.3	0.4	1.0	1.1	2.4	2.7	0.2	0.3	4,2	5.3
CD (5%)	1.9	2.6	1.2	0.9	0.05	0.09	1.0	1.2	3.1	3.4	7.0	8.0	0.6	0.9	12.2	15.9
P_2O_5 *kglha*																
0	86.4	90.1	12.2	12.5	1.58	1.60	11.6	13.1	30.0	30.8	73.7	75.3	5.0	5.6	120.3	124.7
40	91.8	94.9	12.5	13.1	1.64	1.68	15.9	17.3	35.6	38.9	86.8	87.0	5.3	5.8	143.6	149.0
80	92.8	95.7	11.8	12.7	1.60	1.67	14.0	15.9	34.8	37.2	82.6	88.2	4.8	6.3	136.2	147.6
SEm±	0.7	0.8	0.4	0.4	0.02	0.02	0.3	0.5	0.9	1.0	2.0	1.6	0.3	0.4	3.0	4.1
CD (5%)	2.2	2.5	NS	NS	0.06	0.06	0.9	1.5	2.7	3.0	6.0	4.8	NS	NS	9.1	12.3
K_2O *kglha*																
0	89.0	91.2	11.6	12.0	1.51	1.55	13.0	14.5	31.3	34.3	79.5	80.5	4.7	5.2	128.5	134.5
40	90.9	95.2	11.7	13.2	1·64	1.70	14.0	16.2	34.8	34.8	76.6	82.8	5.3	6.5	130.7	140.3
80	91.0	94.3	13.3	13.1	1.67	1.70	14.5	15.6	34.3	39.8	88.0	87.2	5.1	5.2	141,9	145.8
SEm ±	0.7	0.8	0.4	0.4	0.02	0.02	0.3	0.5	0.9	1.0	2.0	1.6	0.3	0.4	3.0	4.1
CD (5%)	NS	2.5	1.2	1.2	0.06	0.06	0 9	1.5	2.7	3.0	6.0	4.8	NS	NS	9.1	12.3

Table 2

Productivity of periwinkle as affected by N, P and K fertilization

Treatment	Root yield (kg/ha)		Leaf yield (kg/ha)		Stem yield (kg/ha)		Harvest index		Root-shoot ratio	
	1080-81	1980-82	1980-81	1981-82	1980-81	1981-82	1980-81	1981-82	1980-81	1981-1982
N kg/ha										
0	416	536	1155	1302	2252	2392	0.37	0.37	0.128	0.125
60	535	671	1554	1692	3030	3138	0.35	0.37	0.118	0.120
120	585	703	1795	1817	3500	3632	0.35	0.35	0.114	0.117
SEm±	13	15	64	67	51	47	0.02	0.02	0.005	0.004
CD (5%)	38	44	192	200	151	140	NS	NS	NS	NS
P_2O_5 *kg/ha*										
0	428	536	1365	1486	2662	2792	0.35	0.35	0.110	0.108
40	588	698	1603	1692	3126	3227	0.36	0.38	0.127	0.129
80	520	676	1534	1633	2994	3143	0.36	0.36	0.122	0.125
SEm±	11	16	37	34	35	40	0.02	0.02	0.004	0.003
CD (5%)	33	48	111	102	105	120	NS	NS	0.012	0.009
K_2O *kg/ha*										
0	480	578	1401	1511	2829	2917	0.34	0.36	0.117	0.115
40	518	648	1543	1646	2960	3092	0.37	0.36	0.122	0.126
80	538	684	1558	1654	2991	3153	0.34	0.37	0.120	0.121
SEm±	11	16	37	34	35	40	0.02	0.01	0.004	0.003
CD (5%)	33	48	111	102	105	120	NS	NS	NS	0.009

to phosphorus application at 50 kg P_2O_5/ha. Harvest index showed an increasing trend with phosphorus application although it was not significant. Root-shoot ratio increased significantly with phosphorus application.

Response to potassium

Growth and yield of periwinkle increased significantly due to potassium application. Plant height, branches per plant and stem diameter increased significantly during both years except plant height which increased only during 1981-82. The increase was mostly limited upto 40 kg K_2O/ha and the difference between 40 and 80 kg K_2O/ha was generally not significant. In the case of total dry matter production and its distribution into different parts, there was significant increase from 0 to 80 kg K_2O/ha and the difference between 0 and 40 kg/as well as that between 40 and 80 kg K_2O/ha were not significant in most of the cases. Potassium application at 40 kg K_2O/ha significantly increased root, leaf and stem yields and further increase in potassium to 80 kg K_2O/ha had no significant effect. Response to potassium fertilization was naturally expected due to its low status in the experimental field soil. Harvest index did not exhibit any definite trend in response to potassium application. However, root-shoot ratio significantly increased at 40 kg K_2O/ha (0.126) as compared to that of control (0.115).

Response analysis

As the interaction effect was not significant, a second degree polynomial without the interaction term was fitted with levels of N, P_2O_5 and K_2O as independent variables and root or leaf yield as dependent variable (Table 3). The equation was a good fit as indicated by high coefficient of determination (R^2 90.8% to 93.7%). The physical optimum levels of N, P_2O_5 and K_2O for root and leaf yields were almost the same during both years. However, economical optimum level was comparatively higher for root yield than for leaf yield. The expected root and leaf yields at optimum NPK combinations were around 800 and 1800 kg, respectively. It was quite clear that optimum NPK requirement varied depending on the product for which periwinkle was grown and it was always higher for root yield than for leaf yield.

Summary

Investigations carried out at the Indian Institute of Horticultural Research, Bangalore, from 1980 to 1982 indicated that nitrogen, phosphorus and potassium fertilization significantly increased the growth and productivity of periwinkle. The optimum N, P and K requirement for root yield (100, 40 and 50 kg/ha of N, P_2O_5, K_2O respectively) was found to be comparatively higher than that for leaf yield (80, 30 and 60 kg/ha of N, P_2O_5 and K_2O respectively).

Table 3

Response functions and optimum levels of N, P and K for periwinkle

Response function	R^2	Physical optimum (kg/ha)			Economic optimum, (kg/ha)			Yield at economic optimum (kg/ha)
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	
Root yield								
1980—81 $Y = 337.8+2.5702N+6.8415P+4.1318_2K_2-0.0097N^2-0.0712P^2-0.0297K^2$	91.8	132.5	47.8	69.6	94.9	42.0	64.3	797.7
1981—82 $Y = 439.6+3.0818N+2.7135P+1.7313K-0.0110N^2-0.0206P^2-0.0160K^2$	90.7	140.1	65.9	54.1	106.9	45.5	44.4	768.6
Leaf yield								
1980—81 $Y = 968.6+7.9667N+4.7875P+4.0722K-0.0279N^2-0.0959P^2-0.0280K^2$	93.7	142.8	51.0	72.7	97.0	35.7	53.3	1843.4
1981-82 $Y = 1084.7+5.0620N+5.3668P+6.5140K-0.0170N^2-0.0439P^2-0.0392K^2$	90.8	148.9	61.1	84.4	73.7	27.7	70.5	1752.9

The price of N, P_2O_5, K_2O and periwinkle root and leaf were taken as Rs. 5.11, 5.87, 2.17, 7.00 and 2.00, per kg, respectively

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