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Influence of Soil Moisture and Added N on P Uptake

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The influence of soil moisture regimes, doses of added N and their interaction on the content and uptake of P by finger millet was investigated under pot and field conditions in red and black soils of Tamil Nadu with the variety CO. 10 as test crop at Tamil Nadu Agricultural University, Coimbatore. The P content of plants was in general not affected by the soil moisture regimes. Increased N application decreased the same. Plants in red soil contained higher P than those in black soil. P uptake was higher at higher levels of moisture and added N due to increased dry matter yield. The P uptake was maximum in red soils.

Plants require water for their normal growth and dry matter production. Given all the other inputs without water even highly fertile soils will be unproductive. The importance of N, especially its complementary role on the uptake and nutrition of other elements, in plant growth needs no emphasis. With a view to study the influence of soil moisture and added levels of N on P content and the uptake of P by finger millet (*Eleusine coracana* Gaertn.), investigations were carried out at Tamil Nadu Agricultural University, Coimbatorewith the variety CO.10 as test crop.

MATERIALS AND METHODS

Two pot experiments and a field investigation were conducted during 1974-75. The basic charscteristics of the experimental soils are presented in Table I.

Experiment I : A pot experiment was conducted under glass house conditions with red and black soils collected from Semmankuzhiyur and from the University farm respectively. The treatments consisted of four levels of N viz., 0 (N_0), 45 (N_1), 90 (N_2) and 135 (N_3) kg/ha as ammonium sulphate with a constant dose of 45 kg/ha each of P_2O_5 and K_2O as super phosphate and muriate of potash respectively. The five levels of soil moisture tried were maintaining the soil moisture at 100

TABLE I

	Experiment I		Experiment II & III
	Black soil	Red soil	(Red soil)
Clay per cent	44.48	16.35	13.74
Field capacity (per cent)	39.80	19.60	20.30
Wilting point moisture per cent	—	—	6.4
Available N (ppm)	89	70	72
Available P (ppm)	3.4	7.0	5.4
Available K (ppm)	285	135	148
pH	8.1	7.2	7.2

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TABLE II. Phosphorus content of Ragi plant at different growth stages (%)

Experiment I

Treatment		Tillering		Flowering		Post-harvest			
						Straw		Grain	
		Black	Red	Black	Red	Black	Red	Black	Red
M_1	N_0	0.15	0.43	0.16	0.26	0.20	0.40	0.28	0.31
	N_1	0.17	0.48	0.10	0.20	0.12	0.25	0.28	0.27
	N_2	0.12	0.50	0.14	0.20	0.08	0.20	0.25	0.25
	N_3	0.19	0.58	0.11	0.20	0.07	0.16	0.18	0.22
M_2	N_0	0.32	0.33	0.19	0.28	0.23	0.38	0.28	0.29
	N_1	0.28	0.32	0.14	0.21	0.09	0.23	0.27	0.28
	N_2	0.23	0.46	0.08	0.21	0.06	0.19	0.23	0.28
	N_3	0.23	0.54	0.08	0.24	0.07	0.16	0.22	0.25
M_3	N_0	0.29	0.35	0.24	0.19	0.29	0.28	0.31	0.27
	N_1	0.27	0.38	0.15	0.23	0.12	0.18	0.31	0.26
	N_2	0.26	0.40	0.13	0.20	0.10	0.19	0.30	0.26
	N_3	0.29	0.36	0.10	0.20	0.06	0.14	0.24	0.25
M_4	N_0	0.40	0.34	0.35	0.36	0.31	0.18	0.30	0.30
	N_1	0.36	0.43	0.20	0.21	0.08	0.21	0.28	0.29
	N_2	0.19	0.50	0.12	0.19	0.07	0.15	0.27	0.26
	N_3	0.21	0.50	0.10	0.21	0.05	0.15	0.26	0.26
M_5	N_0	0.33	0.47	0.30	0.26	0.40	0.44	0.30	0.26
	N_1	0.21	0.38	0.14	0.26	0.09	0.19	0.28	0.26
	N_2	0.21	0.57	0.13	0.25	0.10	0.18	0.26	0.24
	N_3	0.20	0.37	0.11	0.19	0.06	0.13	0.25	0.23

(M_1), 75 (M_2) and 50 per cent (M_3) field capacity throughout the crop growth and irrigating to field capacity whenever the surface layer dried up (M_4) corresponding to farmers practice and at the appearance of first perceptible symptoms of wilting (M_5). Ten kg soil was taken in glazed porcelain pots. There were three replications with 120 pots in all. The entire dose of fertilisers was added as basal application. Twentyone days old seedlings were transplanted at the rate of five hills per pot with two seedlings in each hill. After giving life irrigation moisture regimes were established as per the programme and the same were maintained by weighing the pots daily and adding required quantity of water. One of the replications (40 plots) was removed at tillering and another at flowering stage for soil and plant analysis. The third replication was maintained till maturity. Plant samples collected at tillering, flowering and post-harvest stages were analysed for their P content as per the method of Jackson (1967) and the P uptake was computed.

Experiment II : The second pot experiment was conducted with the soil collected from the University campus. The forms and levels of nutrients were the same as in experiment I excepting that N was applied in 2 split doses one at the time of planting and the other at flowering. The moisture treatments consisted of irrigating to field capacity at 20 (M_1), 40 (M_2), 60 (M_3), 80 (M_4) and 100 per cent (M_5) available soil moisture depletion. Each treatment was replicated thrice and there were 60 plots in all. Of these 3 replications one was removed at flowering stage and 2 were allowed till maturity. Soil moisture content between field capacity (estimated as per the method of Dastane, 1967) and 15 atmospheric pressure (determined with a pressure membrane apparatus) was taken as available soil moisture. Soil moisture regimes were maintained as under experiment I. Plant P content and P uptake were determined at flowering and post-harvest stages of the crop.

Experiment III : A field experiment in a split plot design with moisture levels as main plot treatments and N levels as sub-plot treatments was conducted during 1975 at the Milletbreeding station of the University farm. The treatments were the same as under experiment II. There were three replications with 20 plots of 5 x 1.5 m size in each. Twenty one days old seedling were planted at the rate of 2 per hill 15 cm apart on either side. After giving life irrigation the moisture regimes were maintained. Soil moisture content was determined periodically by gravimetric method and required quantity of water to bring the soil moisture content to field capacity was applied by regulating the flow through a 'v' notch. The P content of plant samples was estimated at flowering and post-harvest stages and the final P uptake by the crop was computed.

TABLE III. Phosphorus content of Ragi plant a different growth stages (per cent)

Experiment II

Treatment		Experiment II			Experiment III (mean values)		
		Flowering	Straw	Grain	Flowering	Straw	Grain
M_1	N_0	0.17	0.14	0.32	0.17	0.10	0.21
	N_1	0.20	0.07	0.32	0.18	0.08	0.19
	N_2	0.17	0.10	0.32	0.16	0.07	0.21
	N_3	0.17	0.11	0.32	0.17	0.07	0.20
M_2	N_0	0.19	0.11	0.31	0.15	0.10	0.20
	N_1	0.15	0.09	0.29	0.15	0.09	0.20
	N_2	0.18	0.08	0.28	0.15	0.08	0.18
	N_3	0.18	0.13	0.28	0.15	0.08	0.19
M_3	N_0	0.13	0.10	0.27	0.15	0.09	0.20
	N_1	0.14	0.08	0.28	0.14	0.08	0.21
	N_2	0.18	0.06	0.26	0.14	0.09	0.21
	N_3	0.12	0.10	0.27	0.15	0.09	0.20
M_4	N_0	0.13	0.06	0.25	0.14	0.09	0.18
	N_1	0.13	0.09	0.23	0.14	0.07	0.21
	N_2	0.13	0.07	0.25	0.15	0.08	0.19
	N_3	0.13	0.08	0.24	0.14	0.08	0.21
M_5	N_0	0.13	0.13	0.25	0.14	0.09	0.20
	N_1	0.13	0.11	0.23	0.12	0.09	0.20
	N_2	0.15	0.11	0.27	0.13	0.09	0.21
	N_3	0.19	0.11	0.28	0.13	0.09	0.22

RESULTS AND DISCUSSION

The details regarding the plant P content of samples analysed during the growth stages of the 3 experiments are presented in Tables II and III and that of P uptake in Tables IV and V. In

ABLE IV. Phosphorus uptake by Ragi at different growth stages (mg/pot)
Experiment I

Treatment		Tillering		Flowering		Straw		Grain		Total	
		Black	Red	Black	Red	Black	Red	Black	Red	Black	Red
M_1	N_0	15	43	24	62	30	58	21	6	51	64
	N_1	26	74	38	83	29	88	31	11	60	99
	N_2	20	84	63	110	33	104	38	31	71	135
	N_3	44	135	71	131	32	112	40	30	71	142
M_2	N_0	29	40	32	60	33	65	13	10	46	75
	N_1	38	89	35	79	23	70	28	37	51	107
	N_2	47	92	46	115	28	102	43	45	71	147
	N_3	47	116	43	156	37	112	53	66	90	178
M_3	N_0	37	45	34	49	24	49	10	17	34	66
	N_1	37	51	41	103	32	66	19	30	51	96
	N_2	38	79	54	106	35	77	33	25	68	102
	N_3	55	86	46	112	26	73	39	44	65	117
M_4	N_0	32	28	47	46	24	35	3	22	27	57
	N_1	29	65	53	60	17	37	22	20	39	57
	N_2	27	59	43	76	18	61	30	57	48	118
	N_3	30	54	47	116	19	76	45	49	64	125
M_5	N_0	24	39	33	37	23	43	33	13	56	56
	N_1	25	60	36	97	23	55	29	26	52	81
	N_2	39	67	54	115	30	77	29	51	59	128
	N_3	38	60	49	112	22	64	46	59	68	123

general, the influence of various soil moisture regimes maintained had no significant influence on the P content of plants. Though P was considered to be the only major nutrient whose plant concentration was reduced by soil drying (Jackson, 1972) distinct variations in the P concentration due to changes in soil moisture content could not be observed in the present investigations. Available information on this aspect goes to show that the P concentration of plants was influenced mostly under saturated soil conditions. As the soil moisture levels in these experiments were maintained at or below field capacity there might not be distinct variations in the P content of plants.

Increments of added N was found to result in general a reduction in the P content of plants. These effects were more pronounced in straw and grain. Increased dry matter accumulation on aocount of increased N applications and consequent dilution effects might be partly responsible to the decreased P concentration at higher levels of added N.

In experiment I the P content of plants in red soil was distinctly higher than the black soil. This might be due to the relatively higher available P content of red soils and efficient utilisation of the added P presumably due to light texture and reduced P fixation in the red soil.

TABLE V. Phosphorus uptake by Ragi

Treatment		Experiment II (mg/pot)				Experiments III (kg/ha)		
		Flowering	Straw	Grain	Total	Straw	Grain	Total
M_1	N_0	33	51	34	85	3.3	5.8	9.2
	N_1	45	28	37	65	3.5	7.2	10.7
	N_2	51	54	47	100	3.0	9.3	12.3
	N_3	48	75	80	155	4.5	9.6	14.1
M_2	N_0	41	35	35	70	3.2	6.1	9.2
	N_1	54	38	42	79	3.2	7.4	10.6
	N_2	63	34	51	84	3.6	6.4	10.0
	N_3	70	62	64	126	3.5	7.4	10.9
M_3	N_0	39	34	27	61	2.3	5.7	8.0
	N_1	46	26	34	60	2.9	6.8	9.7
	N_2	39	28	39	67	3.7	7.2	10.9
	N_3	45	48	50	98	3.2	5.7	8.9
M_4	N_0	31	21	31	52	2.4	3.6	6.0
	N_1	38	41	29	70	2.3	5.1	7.4
	N_2	45	40	43	82	3.0	6.0	9.1
	N_3	46	35	46	81	3.2	7.5	10.8
M_5	N_0	27	44	12	56	2.7	3.5	6.1
	N_1	33	44	20	64	2.5	5.1	7.6
	N_2	36	53	35	87	3.3	4.9	8.2
	N_3	48	68	41	109	3.1	5.0	8.1

Significantly higher P uptake was observed in experiments I and II under higher levels of moisture supply. In experiment III, similar trend was observed eventhough the differences were statistically non-significant. As P is the element which is necessary for the initial establishment/growth of the plant, soil moisture influence on P uptake could be recognised even at the tillering stage of the crop. Enhanced P uptake due to higher moisture supply was reported earlier by Vyas (1964). Increased P uptake at higher moisture levels might be due to increased dry matter yield associated with higher moisture availability. This could be further explained from the fact that the dry matter yield was maximum under M_1 and M_2 (the higher levels of moisture employed) at tillering, flowering and final stages of the crop and straw in experiment I. Correspondingly the P uptake was maximum in this experiment under these two moisture regimes at the tillering stage of the crop and in straw, same trend was in evidence at flowering and post-harvest stages though statistical significance was lacking. In experiment III also higher P uptake under soil moisture was observed.

In all the three experiments effect of added N levels on the P uptake by the crop was well in evidence at all stages of crop growth wherein an increase in N application increased the P uptake.

Similar observations were reported by Saxena (1970) and Sharma and Singh (1973) in oat and barley. This increased P uptake with N was associated with increased dry matter yield due to N application. This observation was further supported by the positive correlations obtained between the available N content of soil at pre-planting stage and those of dry matter yield and P uptake in all the three experiments.

In experiment I, P uptake was maximum in red soil at all growth stages of the crop. This was due to the fact that the available P content of red soil was relatively higher than that of the black soil and dry matter yield was also higher in red soil and hence a higher P uptake.

REFERENCES

DASTANE, N.G. 1967. A practical manual for water use research. Nava Bharat Prakashans. Poona.4.

JACKSON, D.K. 1972. The mechanism of plant response to irrigation. Report. Welsh soils discussion group. 13, 229.

JACKSON, M.L. 1967. *Soil chemical analysis*. Prentice-Hall of India. (Pvt.) Ltd. New Delhi.

SAXENA, M.C. 1970. Studies on the availability of soil and fertilizer phosphate as effected by moisture and fertilizer supply. Agrochemica. 14, 516.

SHARMA, R.B. and R.M. SINGH. 1973. Effect of soil moisture regimes phosphorus and nitrogen on N and P uptake by barley [*Hordeum vulgare* L] Indian J. agric. Sci. 43, 58.

VYAS, K.K. 1964. Availability and uptake of phosphorus by wheat under different moisture and organic matter levels. Cur. Sci. 33, 756.