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Plant Density Nitrogen Response and Correlation Studies in *Gossypium barbadense* Linn. var. "Suvin"

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Experiments were conducted to study the correlated effects of major nutrients on the dry matter production and seed cotton yield on the variety 'Suvin' *(G. barbadense* Linn.) in relation to row, plant spacing and nitrogen. Under normal conditions of growth the nutrient absorption by individual plants was least affected by population density. The quantum of N, P and K removed per unit area was found to be inversely related to plant spacing.. Dry matter production and seed cotton yield were directly related to the levels of N supplied and inversely to increased plant spacings. Yield capacity, dry matter efficiency, nitrogen capacity and nitrogen efficiency values were higher under 75 x 30 cm spacing with 80 kg N/ha. The analysis of direct and indirect effects showed that K and dry matter exerted maximum direct effects and, N and P maximum indirect effects *via* K on seed cotton yield.

Plant density per unit area plays an important role in the development of vegetative structure, initiation of fruiting points, uptake of nutrients and ultimately the yield capacity of plants. Matthews *et al.* (1972) reported that a population of 3.3 plants/m^2 was optimum for maximum yield. Hawkins and Peacock (1972) observed two plants/hill with a spacing of 60 cm between rows as optimum to get higher yield in 'Atlas' cotton. Voss *et al.* (1970) reported that the crop response for the applied N depends mostly on the past cropping, soil moisture stress and environmental factors. Tveitnes and Nyaas (1973) found linear seed cotton yield response for the applied N upto 60 kg/ha in black cotton soils and poor response for P and K in reddish brown soils. Nigam and Kotwani (1971) obtained maximum seed cotton yield in American cotton (*Gossypium hirsutum* Linn.) with 100-50-50 kg/ha of N, P and K, respectively in 60 x 60 cm spacing and reported no response with further increment of NPK under the same or closer or wider spacings. The present study consists of identification of the most favourable spacings for getting maximum seed cotton yield with fertilizer application and to study the general nature of the direct and indirect effects of NPK on dry matter production and seed cotton yield in *G. barbadense* Linn., variety 'Suvin'.

MATERIALS AND METHODS

Experiments were conducted in

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split-plot design for two years (1972-'73 and 1973-'74) in the winter season with the following treatments : (a) Three row spacings (60, 75 and 90 cm) in the main plots, (b) two plant spacings (30 and 45 cm) in the sub-plots, (c) combination of three varieties (MCU-5, Sujata and Suvin) and three N levels (0, 40 and 80 kg/ha) in the sub-sub plots. Each treatment was replicated twice in 9. 14 x 4.5 m plots. There were two plants/hill.

All plots received P_2O_5 and K_2O at 30 kg/ha over a basal dose of 20 tonnes of FYM at sowing. Nitrogen was applied in two equal split doses at 15 and 30 days after sowing. The initial soil analysis of the experimental field showed medium N (270 kg/ha), medium P_2O_5 (54 kg/ha) and high K_2O (1090 kg/ha) content. At first picking stage, plant samples were drawn from each plot, dried, weighed and analysed for N, P and K according to standard methods of Jackson (1967). Yield capacity, nitrogen capacity, dry matter efficiency and nitrogen efficiency were calculated as per the procedure of Dastur (1960).

The direct and indirect effects of NPK on dry matter production and seed cotton yield were calculated according to the methods given by Douglas and Lu (1959).

RESULTS AND DISCUSSION

Yield analysis showed significant differences for variety x fertilizer treatmentsin the first year and for row spacings, plants pacings and variety x fertilizer treatment combinations in the second year. Pooled analysis revealed that the following treatments were best for growing the three varieties:(1)MCU. 5 (*G. hirsutum* Linn.) 40 kg N/ha with 60 x 30 cm spacing (seed cotton yield 2, 642 kg/ha), (ii) Sujata (*G. barbadense* Linn). 80 kg N/ha with 90 x 30 spacing (seed cotton yield 2,307 kg/ha) and (iii) Suvin (*G. barbadence* Linn.) 80 kg N/ha with 75 x 30 cm (seed cotton yield 2,793 kg/ha). Kanniyan and Marappan (1970) have given extensive report on the variety MCU-5 regarding its performance and quality characters. Nitrogen requirements and other aspects of MCU-5 and Sujata have been reported elsewhere (Anon. 1975). Suvin being an extra long staple quality cotton variety capable of spinning 120's count, comparitive studies could not be discussed on quantitative aspects in this paper, and studies were concentrated more on the variety Suvin though MCU-5 and Sujata were included for their comparative yield and fertilizer response studies.

The mean values of the pooled data from two years showed that the per plant uptake of N, P and K grown under closer and wider spacings were not significant, indicating that under normal conditions, the nutrients absorption appeared to be an independent process (under the soil conditions mentioned), is directly proportional to the quantity of nutrients supplied and least affected by the population densities. The range of N, P and K removal from the soil for N levels was 156 to 286, 88 to 130 and 364 to 486 kg/ha, respectively. The quantum of NPK removal per unit area was found to be inversely related to the plant spacings. Though N, P and K uptake differed quantitatively under different spacings, the pattern of their removal per unit area was found to follow similar trends under all N-levels (Fig. 1).

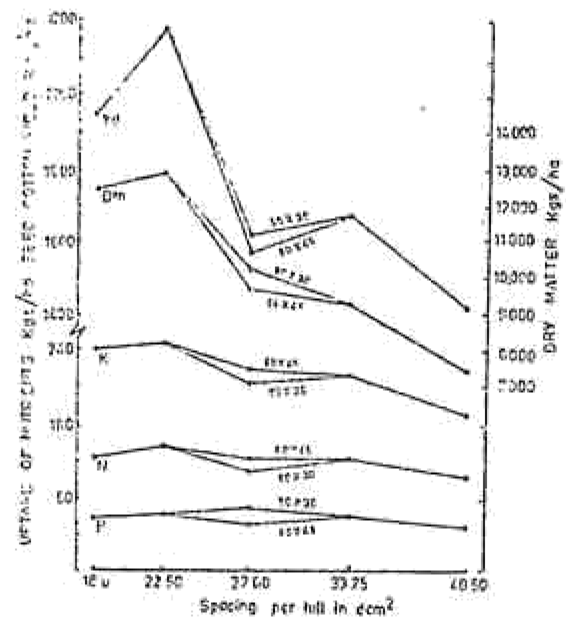

Fig. 1. Mean values Nitrogen (N), phosphorus (P_2O_5) and Potash (K_2O) uptake; Dry matter (Dm) production and seed cotton (Sc) yield/ha of 'Suvin'.

Dry matter production and seed cotton yield were directly related to increased spacings. The range of dry matter production and seed cotton yield for the three N levels were 9,021 to 13,345 and 1,420 to 2000 kg/ha, respectively and for the different spacings they were 7,176 kg to 12,825 and 1,401 to 2,171 kg/ha, respectively. The treatment 80 kg N/ha under 75 x 30 cm/hill spacing gave the maximum dry matter yield (14,405 kg/ha) and seed cotton yield (2,793 kg/ha) (Fig. 1). Any increase or decrease in spacing by 4.5 dcm^2/hill from the optimum of 22.5 dcm^2/hill resulted in reduction of 2 and 24 per cent dry matter and, 10 and 28 per cent of seed cotton yield, respectively. Further increase in spacing drastically reduced both dry matter production and seed cotton yields.

Yield capacity values were low (0.14 to 0.15) for high population densities and gradually increased with reduction in populations (Fig. 2). Brown (1971) in Acala 1517 C cotton observed increased seed cotton yields upto 30,000 plants/ha and reduction in yield with further population increase and attributed the reason to the poor setting of fruiting points especially in lower sympodia due to shade effects. In the present experiment, under six spacings, there were 48, 440 (60 x 30cm), 32,290 (60 x 45cm), 38,750 (75 x 30 cm), 25,830 (75x45cm), 32,290 (90x30cm) and 21,530 (90x45cm) hills/ha. Suvin, on account of its efficient vegetative structure compared to other barbadense types, produced significantly higher yields upto a high plant density of 38,750 plants/ha (75 x 30cm). Previous experiments have shown that two plants/hill was better than single plant/hill for higher yields. The mean values of yield capacity for the six spacings under three N levels showed that N levels did not influence the yield capacity, since the rate of increase in seed cotton yield was compensated by a proportionate increase in dry matter production and it was about 0.2.

The differences in nitrogen capacity values due to population densities and N levels were significant and varied from 6.87 to 9.45 and 6.80 to 9.96, respectively. Maintenance of balanced population under 22.5 dcm²/hill provided the maximum nitrogen capacity (9.45) and this spacing combined with N 80 kg/ha gave the highest nitrogen capacity value of 11.85 (mean values of three N levels Fig. 2).

Vegetative efficiency or dry matter efficiency increased with increasing N levels and decreased with increasing spacing up to 22.5 dcm²/ hill and was highest (0.61) with 80 kg N/ha. An increase or decrease in spacing beyond 22.5 dcm²/hill (75x30cm) resulted in 50 per cent reduction in vegetative efficiency. The mean values of vegetative efficiency also brought out that wider row spacing with closer plant spacing (90 x 30 cm/ hill) was better than closer row spacing with wider plant spacing (60 x 45 cm/hill) in providing optimum conditions for the plants, even though the unit area under the two spacings was same (27dcm²/hill) (mean of two N values - Fig. 2).

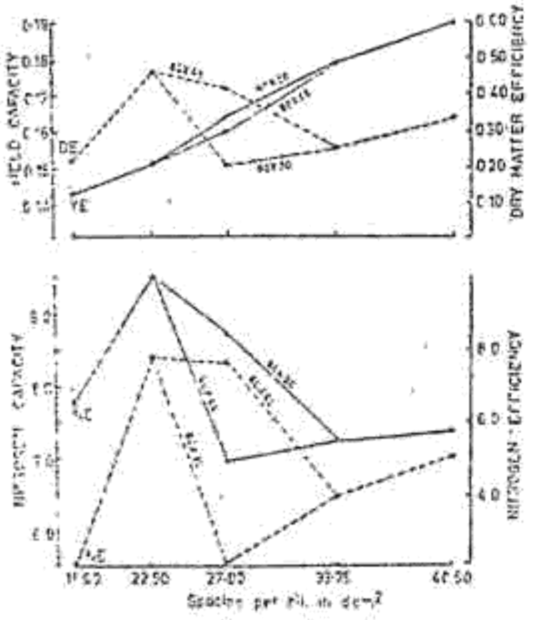

Fig. 2. Mean values of yield capacity (Yc). Dry matter efficiency (DE). Nitrogen capacity (NC) and Nitrogen efficiency (NE) for 'Suvin'.

Nitrogen efficiency values increased with increasing N levels. Plant population contributed more to nitrogen efficiency than N levels. With 22.5 and 27.0 dcm²/hill higer values of 7.79 and 7.63, respectively were recorded. Any increase or decrease in unit spacing beyond these two limits reduced the nitrogen efficiency almost by 50 per cent, whereas the vegetative efficiency was affected to a lesser extent (mean of two N values - Fig. 2).

The total NPK uptake and the dry matter produced/ha were plotted against seed cotton yield and from the conforming points correlation coefficients were calculated for the two kinds of environmental stress (1972-'73 and 1973-'74). Excepting two (significant at 5%) all other correlation coefficients showed one per cent significance.

Under normal conditions of growth (1973 - '74) correlation coefficients showed higher values than that of slightly below normal season(1972-'73). Seasonal conditions exerted little influence on the correlation between seed cotton yields and other characters (Table I).

The analysis of direct and indirect effects of NPK and dry matter production on seed cotton yield showed that K and dry matter production exerted the maximum direct effects and, N and P the maximum indirect effects via K obviously indicating the influence of K on N and P uptake which were found to be directly proportional to dry matter production and seed cotton yield (Table II).

TABLE I. Correlation coefficients between different characters under two kinds of environmental stress (1972-'73 and 1973-'74 seasons)

Season	Character	P	K	Dry matter	Seed cotton yield
1972-'73	Nitrogen	0.73**	0.44**	0.77**	0.79**
1973-'74	(N)	0.68**	0.79**	0.65**	0.67**
1972-'73	Phosphorus		0.49**	0.59**	0.74**
1973-'74	(P)		0.94**	0.91**	0.88**
1972-'73	Potash			0.53**	0.47*
1973-'74	(K)			0.93**	0.94**
1972-'73	Dry matter				0.88**
1973-'74	(Dm)				0.96**

* Significant at 5% level

** Significant at 1% level

The direct and indirect effects of N, P and K on dry matter production and seed cotton yield showed that K exerted maximum direct effect under normal conditions of growth, but under below normal conditions, N exerted maximum direct effect (Table III). Thus, better environmental conditions helped in better K absorption, which in turn influenced N absorption and contributed more towards dry matter production and seed cotton yield; otherwise, higher N uptake contributed more towards dry matter production and less towards seed cotton yield.

TABLE II. Direct and indirect effects of N, P, K and Dry matter on seed cotton yield in two seasons.

Season	Direct effect of	Indirect effect via N	P	K	Dry matter	Total
1972-'73	N 0.05	—	0.25	0.03	0.51	0.79
1973-'74	N—0.10	—	—0.26	0.60	0.44	0.67
1972-'73	P 0.35	0.04	—	—0.04	0.39	0.74
1973-'74	P—0.38	—0.07	—	0.73	0.61	0.88
1972-'73	K—0.07	0.02	0.17	—	0.35	0.47
1973-'74	K 0.77	—0.08	—0.36	—	0.62	0.94
1972-'73	Dm 0.67	0.04	0.20	—0.04	—	0.88
1973-'74	Dm 0.67	0.07	—0.35	0.71	—	0.96

1972-'73 P^2x5 =0.23

1973-'74 P^2x5 =0.15

TABLE III. Direct and indirect effects of N, P and K on seed cotton yield and dry matter production in two seasons

Season	Direct effect	On seed cotton yield — Indirect effect via N	P	K	Total
1972-'73	N 0.50	—	0.24	0.04	0.79
1973-'74	N —0.20	—	—0.14	1.01	0.67
1972-'73	P 0.34	0.37	—	0.04	0.74
1973-'74	P —0.20	—0.14	—	1.22	0.88
1972-'73	K 0.09	0.22	0.16	—	0.47
1973-'74	K 1.29	—0.16	—0.19	—	0.94
1972-'73 P^2x5 = 0.96					
1973-'74 P^2x5 = 0.03					
		On Dry matter production			
1972-'73	N 0.67	—	—0.01	0.10	0.77
1973-'74	N —0.14	—	0.19	0.61	0.65
1972-'73	P —0.02	0.49	—	0.12	0.59
1973-'74	P 0.28	—0.10	—	0.74	0.91
1972-'73	K 0.24	0.30	—0.01	—	0.52
1973-'74	K 0.78	—0.11	0.26	—	0.93
1972-'73 P^2x4 = 0.36					
1973-'74 P^2x4 = 0.15					

Low Px^2 values indicated that the effect of three major nutrients was predominant and effect of other nutritional factors was very small towards dry matter production and seed cotton yield.

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