NITROGEN CO-REGULATED GROWTH, YIELD AND FIBRE QUALITY OF COTTON (GOSSYPIUM HIRSUTUM L.) UNDER DIFFERENT NUTRIENT COMBINATIONS
#9415

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ABSTRACT

Cotton has high requirements for nitrogen (N) phosphorus (P) and potassium (K), and the nutrients interact differently on yield and quality of this crop. This necessitates the precise combination of these nutrients to maximize yield and quality. Two cotton varieties (Bt cotton and a conventionally bred variety, HART 89M) were assessed for growth, yield and quality under different nutrient combinations in two contrasting environments in semi-arid Kenya. Nutrient combinations were NPK, NP, NK, PK, NPK + Zn + S and an unfertilized control. Treatments were laid out in split plot design and replicated three times, where varieties took the main plots while nutrient combinations assumed the sub plots. Nitrogen was applied at 150 Kg N/ha (urea, 46% N), P at 50 kg P/ha (single super phosphate, 20% P), K at 100 kg K/ha (muriate of potash, 60% K) while Zn and S were sourced from zinc sulphate. Crop phenology, growth traits, yield quality attributes were collected and analyzed using GenStat at 5% probability level. Variety Bt out-yielded HART 89M. Omission of N in all combinations delayed maturity. On the other hand, addition of N to either P, K or PK improved crop growth, yield and quality of cotton compared with treatments omitting N as well as the negative control. However, results did not show significant yield and quality improvement with the addition of Zn and S. Interactions between variety and nutrient combinations were marginal and inconsistent. Yield was a function of number of bolls (average $R^2 = 0.6892$) and bolls a function of the number of branches per plant (average $R^2 = 0.8741$). However, the recoverable lint quantity (% ginning out-turn) negatively associated with yield (average $R^2 = 0.8013$). These findings reinforce the importance of N in regulating growth, yield and quality of cotton. However, further studies are required to determine optimal NPK nutrient concentrations to maximize growth, yield and quality of cotton.

INTRODUCTION

Cotton is a cash crop that performs very well in ASALs providing a source of livelihood to the communities in these areas who may have limited economic opportunities to depend on. It is estimated that the current production in Kenya stands at 6,200 bales annually against a national requirement of 140,000 bales and against a potential of 260,000 bales. Some of the contributing factors to low yields at farm level include low soil fertility and water stress. Use of precision agriculture to efficiently manage crop nutrition is an important practice for optimum yields. This is because nutrients are easily lost via denitrification, surface run off, volatilization and leaching (Williams et al., 1999). Nitrogen has a strong effect in determining cotton yield variables such as plant size, number of flowers, boll retention rate, boll size and number of bolls per plant (Gerik et al 1994). Similar to N, P and K nutrition, as well trace elements also affect cotton growth and yield. However, N strongly interacts with other nutrients in crop growth and yield formation.

MATERIALS AND METHODS

Field experiments were conducted in the Agricultural Training Centre (ATC) farm and in farmers' field in Ndalani ward both in Machakos County. The treatments were different combinations of inorganic nitrogen, phosphorous and potassium and two contrasting varieties of cotton. Nutrient combinations were, NPK, NP, NK, PK, NPK+ Zn+ S and control was without the addition of fertilizer. Cotton varieties used as test crops were C571 BGII (genetically modified variety) and HART 89M (conventionally bred variety). Treatments were set out in a randomized complete block design with split plot arrangement and were replicated three times. Cotton varieties were allocated to the main plot and the different combinations of nutrients assumed the sub plots. N, P and K nutrients were supplied by urea, SSP and MOP respectively while zinc and sulphur micronutrients were supplied by zinc sulphate. The full dose of TSP (20 kg P ha^{-1}) was applied during sowing, while urea was applied in two splits as a 1/2 urea treatment was applied uniformly in rows at planting. The remaining 1/2 of each nitrogen fertilizer treatment was side dressed in the band during squaring.

RESULTS AND DISCUSSION

Effect of different combinations of N, P and K nutrients on crop phenology

Different combinations of N, P and K nutrients had a significant *($P< 0.05$)* effect on the time taken to 50% boll formation. Fertilized plots took a significantly shorter period to form bolls unlike the negative control and the plot that omitted N nutrient Table 1. The results are similar with the previous findings, that nitrogen promotes and hastens vegetative growth (Brown 2002).

Table 1. Effect of fertilization on cotton boll formation.

Factor	Machakos ATC					Ndalani farm				
	Bl/f	Brs/p	Bls/p	Y/p (g)	GOT%	Bl/f	Br/p	Bls/p	Y/p (g)	GOT %
Variety										
Bt	91.0	34.0	34.0	62.7	40.9	85.0	25.0	19.0	31.0	44.0
HART	102.0	32.0	27.0	76.1	39.8	93.0	25.0	14.0	29.0	42.6
P value	<.001	0.309	0.055	0.107	0.781	0.027	0.804	0.387	0.308	0.654
LSD	1.242	7	7.872	20.54	14.77	5.403	13.9	22.773	5.3	11,37
Nutrient combinations										
NP	95.0	33.0	32.0	78.1	39.7	88.0	26.2	19.0	31.0	42.9
NK	95.0	34.0	34.0	70.7	40.8	87.0	26.9	20.0	30.0	43.9
PK	99.0	31.0	28.0	59.4	40.8	91.0	23.5	15.0	29.0	43.7
NPK	94.0	34.0	32.0	78.8	39.5	88.0	24.7	17.0	31.0	42.2
NPK+Zn+S	93.0	35.0	35.0	72.2	39.8	84.0	25.5	19.0	31.0	42.7
Control	102.0	31.0	22.0	57.0	41.4	96.0	22.3	11.0	28.0	44.3
P value	<.001	<.001	<.001	0.03	0.005	<.001	<0.001	0.011	0.01	0.021
LSD	1.17	1.50	4.46	15.43	1.04	2.49	1.98	4.76	2.20	1.23
Variety × nutrient interactions										
P. values	0.312	0.988	0.078	0.966	0.365	0.163	0.302	0.304	0.837	0.4

Means followed by the same letter within a column are not significantly different Bl/f-Boll formation, Brs/p –branches per plant, Bls-Bolls per plant, Y/p-Yield per plant and GOT % –ginning out turn percentage.

Effect of different combinations of N, P and K nutrients on the growth and yield components

This study found out that different combinations of N, P and K nutrients had a significant *(P≤ 0.05)* effect on the number branches, number of bolls, yield and the ginning out turn of the two cotton varieties Table 1. The results revealed that the total cotton yield was significant and positively correlated with number of bolls per plant Fig. 1a and b. On the contrary, a higher yield resulting from the application of different combinations of N, P, and K nutrients negatively correlated with the GOT% Fig. 1e and f. In addition, the number of branches were significant and positively correlated with the number of bolls Fig. 1c and d. The results agreed with those of (Munir et al., 2014) who found out that agronomic traits like number of bolls, number of branches majorly contributes to cotton yield and have effect on yield.

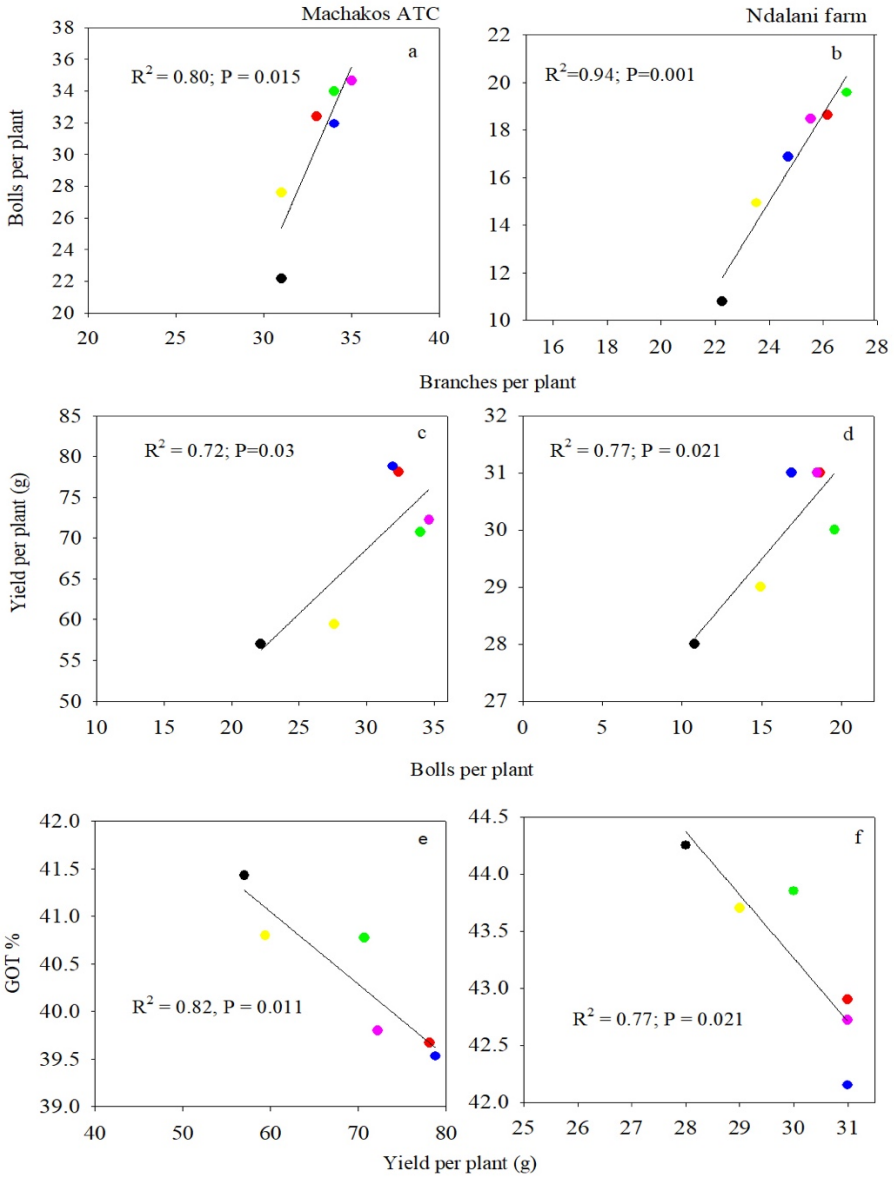

Fig. 1. a and b = Positive relationship between the number of branches and the number of bolls per plant; c and d = Positive relationship between the number of bolls and the yield per plant; e and f = Negative relationship between the yield and the ginning out turn percentage.

CONCLUSION

Nutrients play a very important role in growth, yield and fibre quality of cotton. N nutrient accelerates cotton crop growth, increases the number of branches, number of bolls and consequently the yield. Precision cotton nutrient management, therefore, is a very important practice that will ensure supply of the right nutrients, with right amounts and at the right time in order to increase the seed cotton yield. In addition, supply of nutrients at their optimum levels will ensure positive relationships that increase yield and counteract negative relationships that may lower the seed cotton yield and fibre quality.

REFERENCES

Brown, H.B., 2002. Cotton history, species, varieties, morphology, breeding. culture, disease, marketing and uses. 2nd edition. Chawla offset printers, New Delhi.

Gerik T.J., Jackson, B.S., Stockle, C.O., Rosenthal, W.D. 1994. Plant nutrition status and boll load of cotton. Agronomy Journal 86:514-518.

Munir, M.K. Growth and yield response of cotton to various agronomic practices. M.Sc. Thesis, Faisalabad University of Agriculture, Faisalabad, Pakistan. 2014.

Raun, W.R., Johnson, G.V. 1999. Improving Nitrogen Use Efficiency for Cereal Production. Agronomy Journal 91, Pages 357-363