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Effect of macronutrient fertilizer mixtures on quality parameters and agronomic efficiency in cotton (Var. CO 14)

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Abstract

A field study was conducted to assess the effect of macronutrient fertilizer mixtures over the quality parameters and nutrient use efficiency of cotton at Tamil Nadu Agricultural University, Coimbatore. The treatment comprised of fertilizer mixtures of different sources for particular macronutrient (for nitrogen (urea and calcium nitrate), for phosphorus (single superphosphate), for potassium (muriate of potash and sulphate of potash) and for nitrogen and phosphorus (mono ammonium phosphate, di ammonium phosphate and ammonium sulphate phosphate)). It was observed that in cotton, agronomic efficiency was considerably increased due to application of calcium nitrate containing fertilizer mixture (calcium nitrate + di-ammonium phosphate + muriate of potash). No significant difference was recorded in quality parameters of the fiber whereas protein and oil content was increased by the application of sulfur containing fertilizer mixtures (calcium nitrate + di-ammonium phosphate + sulphate of potash and urea + di-ammonium phosphate + sulphate of potash respectively).

Keywords: Macronutrient, fertilizer mixture, fibre quality, cotton, seed quality

Glossary of abbreviations: **ASP:** Ammonium Sulphate Phosphate, **CN:** Calcium Nitrate, **DAP:** Di Ammonium Phosphate, **EC:** Electrical Conductivity, **K:** Potassium, **MAP:** Mono Ammonium Phosphate, **MOP:** Muriate of Potash, **N:** Nitrogen, **NS:** Non Significant, **P:** Phosphorus, **SOP:** Sulphate of Potash, **SSP:** Single Super Phosphate, **TNAU:** Tamil Nadu Agricultural University

Introduction

Clothing is one of basic need for human beings. Major raw material for clothing comes in the form of cotton fibre. Hence cotton crop has a sound necessity and economic background. The demand for cotton never decreases and is ever increasing due to increase in population and dynamic fashion trends. Cotton from cultivation to the final product cloth comprises of numerous hard work, processes and technique. It is an expenditure process too. Hence various innovations in the field of production, technology and processing are desired. Studies in various aspects should be carried out to increase the productivity. Fertilizers are basic need for the growth and yield of the crop as they supply necessary nutrients required by the plant. Many studies regarding fertilizers have been done for cotton but an appropriate macronutrient fertilizer mixture has not been recommended for cotton so far. This stands the major objective of this experiment.

Materials and Methods

The experiment was conducted in a farmer's plot near Coimbatore with coordinates 10°59'16.8"N, 76°51'43.2"E. The average annual of temperature and rainfall in Coimbatore is 26.3°C and 618 mm. The experiment soil was slightly alkaline (pH - 7.8), non-saline (EC – 0.20 dSm⁻¹) and non-calcareous (CaCO₃ - 1.27%). Texture of the soil was sandy clay loam with a bulk density of 1.34 Mg m⁻³. Soil was low in available nitrogen, medium in phosphorus and high in potassium (150:10:612). Experiment was conducted during the period August-2019 to January-2020. The variety used for the experiment was CO-14 (Parentage: (MCU 5 / TCH 92-7) / MCU 5 -1) (Duration: 150 days). Treatments consisted of various macro nutrient fertilizer mixture combinations from T1 to T10 which were replicated thrice. Each combination provides same recommended dose of NPK with different fertilizer sources like

urea, calcium nitrate (CN), single superphosphate (SSP), murate of potash (MOP), sulphate of potash (MOP), diammonium phosphate (DAP), ammonium sulphate phosphate (ASP) and mono ammonium phosphate (MAP). Treatment details are given in Table X. T1 comprised of general practices as followed by farmers in the area, whereas T9 was assigned as untreated control. For the preparation of macronutrient fertilizer mixture individual fertilizers were taken separately according to soil test based recommendation (60:30:30 kg N, P₂O₅ and K₂O ha⁻¹) and mixed prior to application in the field. 50% of the recommended dose of N and K were applied 40-45 days after sowing. Plot size adopted was 4x3 m and a spacing of 90x45 cm was followed. From each plots five random plants were selected and tagged for taking observations. Irrigation and other cultivation practices were followed accordingly, crop protection measures were taken and need based pesticide application were done. Three to four pickings were done at harvest stage. Seed cotton was shade dried and moved for ginning. Ginning was carried out mechanically and quality properties like fibre length, fibre strength, fibre fineness etc. were found out. Facilities in department of cotton, TNAU, Coimbatore were used to find out quality parameters of the lint. STATEX compact high volume instrument was used to measure quality

properties. Agronomic efficiency was calculated using the following formula and expressed in kg kg⁻¹:

$$\text{Nutrient use efficiency (kg kg}^{-1}\text{)} = \frac{\text{Yield (fertilized plot)} - \text{Yield (control plot)}}{\text{Dose of fertilizer applied}}$$

The experimental data obtained were subjected to statistical analysis (Panse and Sukhatme, 1978) [4]. Differences between treatment means were compared by using the least significant difference at the 0.05 probability level.

Results and Discussion

Lint quality

Upper hand mean fibre length of the cotton lint varied from 34.5 to 36.1 mm within treatments and lowest value was recorded in untreated control (34.5 mm) (Table 1). There was no significant difference among the treatments. Values for fibre strength extended from 21.8 to 23 g/tex. Control recorded a value of 21.8 g/tex which was the lowest, even though significant differences were not observed. Micronaire is used to indicate fineness of fibre. The values ranged from 4.27 to 4.33 with control recording 4.27 micronaire. Here also no significant differences were observed.

Table 1: Effect of macronutrient mixtures on fibre quality of cotton

Treatments	Fibre length (mm)	Fibre strength (g tex ⁻¹)	Uniformity Index (%)	Fibre fineness (Micronaire)
T1 - Urea + DAP + MOP	35.50	21.90	84.70	4.29
T2 - Urea + SSP + MOP	35.60	22.00	84.30	4.30
T3 - Urea + DAP + SOP	35.50	22.10	83.80	4.30
T4 - Urea + MAP + SOP	35.70	22.00	82.40	4.30
T5 - CN + DAP + MOP	35.90	22.40	84.20	4.31
T6 - CN + DAP + SOP	35.70	22.30	84.30	4.28
T7 - Urea + DAP + CN + SSP + MOP	36.10	23.00	85.60	4.33
T8 - CN + ASP + MOP	35.80	22.10	82.70	4.30
T9 - Control	34.50	21.80	84.70	4.27
SEd	0.75	0.52	1.32	0.09
CD (p= 0.05)	NS	NS	NS	NS

The treatments had minimum or no effect over fibre quality parameters like fibre length, fibre strength, fibre fineness and uniformity index. This was because fibre quality is more of a genetic character. Watts *et al.*, 2017 [8] showed that nitrogen source had minimal effect over fibre quality. Nitrogen sources had no effect over micronaire, fibre strength, fibre length and uniformity (Watts *et al.*, 2014) [9]. Tewolde and Fernandez (2003) [7] reported that phosphorus has no significant role over fibre properties. This is in line with our present results. Numerically higher but non-significant differences were seen in case of treatments containing calcium nitrate. Similar results were reported by Sawan *et al.*, 1997 [5] where calcium

application resulted in numerical improvement of fibre properties.

Seed quality: Fig. 1 illustrates oil and protein content of the cotton seed. The oil content ranged from 15.82% to 16.97% and the maximum oil percentage of 16.97% was registered by the application of CN + DAP + SOP (T₆), which was *on par* with Urea + DAP + CN + SSP + MOP (T₇) (16.89%), CN + ASP + MOP (T₈) (16.38%), Urea + SSP + MOP (T₂) (16.36%), Urea + DAP + SOP (T₃) (16.32%) and Urea + MAP + SOP (T₄) (16.31%). The control treatment (T₉) registered less oil content (15.82%).

Fig 1: Effect of macronutrient mixtures on oil content (%) and protein content (%) in cotton seed

The protein content (%) in cotton seed ranged from 14.91% to 16.89%. The protein was maximum in the treatment Urea + DAP + SOP (T₃) (16.89%), which was followed by Urea + MAP + SOP (T₄) (16.71%), Urea + SSP + MOP (T₂) (16.60%) and Urea + DAP + CN + SSP + MOP (T₇) (16.45%) which were *on par* with each other. The lowest value was obtained in control (T₉) (14.91%) Ahmad and Abdin (2000) [1] in an experiment in rapeseed showed that combined application of N and S resulted in increased oil and protein content. Application of S has resulted in higher oil content in canola (Ahmad *et al.*, 2007) [2]. This indicates the role of S in enhanced protein and oil content of cotton. Thus treatment supplied with SOP recorded higher oil content. According to study conducted by Sawan *et al.*, 2001 [6], it was found that, seed protein content decreased slightly due to application of calcium. On the other hand, protein yield increased because seed yield was increased due to calcium application

Agronomic Nutrient Use Efficiency

Data on agronomic use efficiency is presented in Table 2. Application of CN + DAP + MOP (T₅) registered maximum value of 14.12 kg kg⁻¹, whereas treatments Urea + DAP + CN + SSP + MOP (T₇) (11.44 kg kg⁻¹) and CN + ASP + MOP (T₈) (11.29 kg kg⁻¹) were *on par*.

Different treatments had a significant effect over agronomic phosphorus use efficiency. Highest value was recorded with the application of CN + DAP + MOP (T₅) (28.24 kg kg⁻¹). This was followed by Urea + DAP + CN + SSP + MOP (T₇) (22.89 kg kg⁻¹) and CN + ASP + MOP (T₈) (22.58 kg kg⁻¹) which were *on par*.

Potassium use efficiency was found maximum for the treatment combination CN + DAP + MOP (T₅) (28.24 kg kg⁻¹). This was followed by Urea + DAP + CN + SSP + MOP (T₇) (22.89 kg kg⁻¹) and CN + ASP + MOP (T₈) (22.58 kg kg⁻¹) which were *on par*.

Table 2: Effect of macronutrient mixtures on agronomic nutrient use efficiency (kg kg⁻¹) of cotton

Treatments	Nitrogen use efficiency	Phosphorus use efficiency	Potassium use efficiency
T1 - Urea + DAP + MOP	7.94	15.89	15.89
T2 - Urea + SSP + MOP	8.42	16.84	16.84
T3 - Urea + DAP + SOP	6.19	12.39	12.39
T4 - Urea + MAP + SOP	5.72	11.45	11.45
T5 - CN + DAP + MOP	14.12	28.24	28.24
T6 - CN + DAP + SOP	10.97	21.95	21.95
T7 - Urea + DAP + CN + SSP + MOP	11.44	22.89	22.89
T8 - CN + ASP + MOP	11.29	22.58	22.58
T9 - Control	-	-	-

Agronomic efficiency shows the productivity improvement gained by the use of nutrient input (Fixen *et al.*, 2015) [3]. The data on agronomic nutrient use efficiency showed significant difference between the treatments. Highest nutrient use efficiency in case of nitrogen, phosphorus and potassium was registered for treatment CN + DAP + MOP.

Conclusion

Macronutrient mixture played a significant role in increasing agronomic nutrient use efficiency of cotton. Highest N, P and K use efficiency was recorded by treatment CN + DAP + MOP (14.12, 28.24 and 28.24 kg kg⁻¹). The genetic character of the crop is less affected by the mixture but non-significant improvements were observed in treatments containing calcium nitrate. Seed oil and protein content was increased in treatments containing sulphur as SOP. CN + DAP + SOP improved oil content whereas, urea + DAP + SOP improved protein content.

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