

FIELD EVALUATION OF FOLIAR BLEND MICRONUTRIENT FERTILIZER ON COTTON (*Gossypium hirsutum*) PRODUCTION IN KATSINA STATE, NIGERIA

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Authors' contributions

This work was carried out in collaboration between all authors. Author KAN designed the study, wrote the protocol and wrote the first draft of the manuscript. Author VOC and KAN reviewed the experimental design and all drafts of the manuscript. Authors KAN and COE managed the analyses of the study. Authors KAN and VOC performed the statistical analysis. All authors read and approved the final manuscript

ABSTRACT

During the 2013 and 2014 cropping season, field experiments were conducted to evaluate the effect of combined application of NPK fertilizer and FoliarBlend micronutrient application on yield and growth of Cotton at *Funtua* (longitude 07° 19'E, latitude 11° 32'N), in Katsina State, Nigeria. This study was done as a randomized complete block design with three replications. The treatments were T1 (500mls of FoliarBlend in 20 litres of water); T2 (20kgNPK/ha + 500mls of FoliarBlend in 20 litres of water); T3 (40kgNPK/ha + 500mls of FoliarBlend in 20 litres of water); T4 (60kgNPK/ha + 500mls of FoliarBlend in 20 litres of water) and control. Soil samples were collected for the determination of chemical and physical properties before planting. Data on growth parameters (plant height, number of leaves, number of nodes, & number of branches) and yield parameters (number of bolls & yield) were also collected and subjected to 2 ways Analyses of Variance (ANOVA) and means separated with Least Significant Difference(LSD) at P=0.05.

The study revealed that during wet season of 2013 cropping system, the results from the field evaluations showed that combined application rate of 40kgNPK/ha + 500mls of FoliarBlend in 20litres of water produced the highest number of leaves (36), plant height (76cm), number of branches (21), and number of nodes (30), compared to the least value of 30, 59.6cm, 18, and 21 respectively obtained in the control at *funtua* location. The study also revealed that application rate of 60kg NPK/ha + 500mls of FoliarBlend in 20 litres of water had the highest number of bolls (19) and yield (5.2 t/ha) compared to the least values of 13, and 2.13 t/ha obtained respectively in the control at *funtua* site. Similarly in the 2014 dry season, the same trend as in the 2013 was obtained with the application rate of 60kg NPK/ha + 500mls of FoliarBlend in 20 litres of water, given the

highest number of bolls (24) and yield (6.1 t/ha) compared to the least values of 15 and 2.75 t/ha obtained respectively in the control at funtua site.

Considering the overall result, it can be concluded that combined application rate of 40kgNPK/ha + 500mls of FoliarBlend in 20litres performed best with the highest values on the growth parameters, and while 60kgNPK/ha + 500mls of FoliarBlend in 20litres gave the highest yield and yield parameters than the sole application of either NPK or FoliarBlend.

Key words: NPK 15-15-15 fertilizer, Micro-nutrients Fertilizer, Yield, Cotton, Nigeria

Introduction:

Cotton (*Gossypium spp*) belongs to the family Malvaceae and it is usually considered to be an annual crop but can also be left in the field to continue to grow into a shrub. Cotton is a major cash crop and a veritable source of foreign exchange in the Northern part of Nigeria prior to the discovery of crude oil in commercial quantity (Ogunlela and Abed, 1982). It is the second most important commercial arable crop in the country ranking next to groundnut. It is produced almost entirely within the area bound by latitudes 7⁰ and 14⁰ N which comprises the country's savannah zone. The production of cotton in Nigeria was greater than all the other fibre crops like kenaf (*Hibiscus cannabinus*), jute (*Corchorus capsularis*,) etc, because the lint is of importance in textile industries and the cotton seeds for manufacture of vegetable oil, while the residue is used to produce cotton seed cake used in feeding livestock.

An estimated 0.6 – 0.8 million hectares of land is put to cotton production annually in Nigeria. The major cotton producing areas in the country are Katsina, Kaduna, Kano, Sokoto, Plateau, Bauchi, Borno, Adamawa, Zamfara, Kebbi and Jigawa States. The Gongola valley (that cuts across Adamawa and Taraba states) and the Plateau in the north-eastern zone constitute some of the major cotton producing areas in Nigeria. Production of cotton depends on various factors ranging from weather, cotton price, soil and nutrient availability, pests & diseases and problems of the textile industries. Pest and diseases control is highly necessary to enhance good field performance of cotton. However, the increased prices of farm inputs especially fertilizer and poor pricing of cotton lint as a result of the collapse of textile industries in Nigeria brought about the decrease in production of cotton in Nigeria (Prentice, 1992). However, the present Government is trying to resuscitate the textile industries in the country; as such, mass production of cotton is imperative for the survival of these industries.

Judicious application of fertilizers may boost cotton production several folds (100 to 300%), provided the crop is planted early. Fertilizer trials have shown that the application of Nitrogen and Phosphorus fertilizers can increase cotton yields, provided that the crop is protected against insect pests (Faulkner, 1974). Cotton showed tremendous response to nitrogenous fertilizers in all soil types, but its response to phosphate fertilizer is erratic and variable in most soils (Malik *et al* 1996). Optimum nitrogen application often plays a major role in determining a wide range of cotton plant yield variables including plant size, fruiting intensity, boll retention rate, boll size and

total boll number per plant (Sing *et al.*, 1998). However, nitrogen and phosphorus are highly mobile elements in the plant (Agbede, 2009). The phosphorus requirements of cotton are considered very low because of its deep root system and indeterminate growth habit (Muhammad, *et al* 2001).

Deficiency of N in cotton can reduce both vegetative and reproductive growth and induce premature senescence leading to potential yield loss (Gerik *et al.*, 1994). Alternatively; excess N promotes vegetative development often at the expense of reproductive development, especially at bloom or at early boll fill (Mullins and Burmester, 1990; Howard *et al.*, 2001; Tewolde and Fernandez, 1997). Excess N can indirectly affect lint yield by enhancing aphid (*Aphis gossypii* Glover) infestation, which can complicate cotton defoliation (Cisneros and Godfrey, 2001) and can cause sticky cotton problems because of aphid honeydew secretions (University of Arizona, 1999; Slosser *et al.*, 1999). Several variables, including early P accumulation, biomass, and lint yields, positively responded to P fertilization in calcareous soils (Bronson *et al.*, 2003). Reiter and Kreig (2000) reported some positive and notable P effects on lint fiber quality factors, although both lint yield and lint quality were driven more by moisture availability than by P. Several factors, including soil type, affect cotton response to P. The critical level of P is a function of actual concentration of the labile pool that in turn determines the available P at a given time during the growth of cotton (Crozier *et al.*, 2004). Potassium influenced cotton lint yield by affecting late season growth. The positive effect of K on lint quality characteristics have been documented in several reports (Bennet *et al.*, 1965; Pettigrew and Meredith, 1997; Pettigrew, 1999; Pettigrew, 2003). However, the information on foliar micronutrient fertilizer recommendation on cotton production in Nigeria is lacking. The aim of this study is therefore to develop the appropriate fertilizer formulation (inorganic and micronutrient) that is specific to cotton in soils of the cotton belt of North Western Nigeria.

Materials and Methods:

Characterization of the Study Area:

The study was conducted in Funtua Local Government Area of Katsina state of Nigeria. The study was conducted during wet seasons of 2013 and dry- season of 2014 at Funtua (longitude 07° 19'E, latitude 11° 32'N), in Katsina State, the North-east of Nigeria (Wikipedia).

The daytime temperature is 28-30 degrees. Climate of this area is arid with dry and hot summer. The mean annual rainfall is 1101.25mm and the growing period of 200 days. Rainfall pattern is bimodal with the major rainy season from May to October. The soils of the study area are classified mainly as Ferric luvisols according to FAO classification system (FAO, 1988) or Alfisols in USDA soil Taxonomy system (Soil Survey Staff, 1992). They are generally low in CEC owing to predominance of kaolinite in their clay fraction, low organic matter and inherent fertility. The soil characteristic of the experimental site is sandy loam in texture (Table 2).

Analysis of Foliar Blend Fertilizers

The FoliarBlend was subjected to laboratory analysis to determine the concentration of some essential relevant nutrients and elements considered toxic to crops, man and environment. The results as stated below show that the chemical properties of the product met the specifications and the minimum acceptable investigational allowance for organic fertilizers.

Analysis of FoliarBlend as validated by the Department of Soil Science, Faculty of Agriculture/Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria, February, 2012 is shown in Table 1.

Table 1: Analysis of FoliarBlend Product

Boron (B).....	0.002%
Cobalt (Co).....	0.002%
Iron (Fe).....	0.10%
Manganese.....	0.10%
Molybdenum (Mo).....	0.002%
Soluble Zinc (zn).....	0.05%

Derived from: Boric Acid, Cobalt MEA, Ferrous Sulphate, Manganese Sulphate, Ammonium Molybdate, Zinc Sulphate. The above laboratory data clearly confirms that FoliarBlend is rich sources of plant essential micronutrients for plant growth.

Field Trial

Soil auger was used to collect surface soil samples (0 -15cm) from the experimental site before planting and processed for routine soil analysis. Field preparation was done mechanically with one ploughing and harrowing, this was followed by manual ridging and mapping out of the plots. The plot size measuring 5m x 5m = 25m² with alley of 1m left in between plots was used. The experimental design was randomized complete block design with three replications. The treatments were T1 (500mls of FoliarBlend in 20 litres of water); T2 (20kgNPK/ha + 500mls of FoliarBlend in 20 litres of water); T3 (40kgNPK/ha + 500mls of FoliarBlend in 20 litres of water); T4 (60kgNPK/ha + 500mls of FoliarBlend in 20 litres of water) and T5 (control).

An improved variety of cotton (*Gossypium hirsutum*) SAMCORT 1 was planted on 90cm ridges, with intra- row spacing of 45cm. The seed rate was 4seeds per hole, giving a population density of 54,000 plants/ha and later thinned to two plants per stand.

The inorganic fertilizer (NPK 15-15-15) was applied at 3WAP as basal application (by placing in holes 5cm and 8cm away from the plant) immediately after thinning and then top dress with Urea at 8 weeks after planting. The micronutrient was applied as 500 mls of foliar blend fertilizer in 20 litres of water by spraying evenly around the base of the crop and upward, to cover the underside of the leaf. Three applications of the FoliarBlend micronutrient fertilizer were carried out at vegetative stage immediately after NPK fertilizer application; flowering initiation and boll formation respectively. All agronomical practices were duly observed.

The growth parameters measured included plant height; number of leaves, number of nodes and number of branches, while the yield parameters were number of bolls & yield. The data were subjected to ~~2 ways Analyses of Variance (ANOVA) and means separated with~~ Least Significant Difference(LSD) at P=0.05.

Results & Discussions:

Pre-Planting Soil Analysis

Results of physical and chemical properties of soils of Funtua are shown in Table 2.

The textural class of the soil is sandy loam with sand values of 580 g kg⁻¹; silt (220g kg⁻¹) and clay (150g kg⁻¹) (Table 1).The sandy nature of this soil is attributed to the granitic and gneissic origin of the parent materials. This contributes to low cationic retention and water holding capacity. The pH (water) is 6.0 suggesting that the soils may not have acidity problems and therefore will not require liming. The organic carbon content is low, with a value of 4.20 g kg⁻¹. While the total nitrogen and available phosphorus values were far less than the moderate fertility class. The Exchangeable cations (Ca, Mg, K and Na) values are moderate (Table 2).

Cation exchange capacity is low. In soils of low cation exchangeable capacity (CEC), cationic holding capacity will be low. However, because of the higher percent base saturation of the soils of this study area, nutrients are readily available to plants and small doses of fertilizer could produce significant crop responses (Table 2).

Table 2: Physical and Chemical Properties of soils of Funtua site, Katsina State.

PROPERTIES	VALUES
Sand (g/kg)	580
Silt (g/kg)	220
Clay (g/kg)	150
pH(H2O)	6.0

195	pH(KCl)	5.3
	Organic carbon (g/kg)	4.2
196	Nitrogen (g/kg)	0.053
197	Avail. Phosphorus (mg/kg)	0.90
198	Exchangeable Bases (cmol/kg)	
199	Ca	3.2
	Mg	1.1
	K	0.12
	Na	0.42
	Al	0.3
	CEC	5.3
	BS (%)	69.62
	Extractable Micronutrients (mgkg ⁻¹)	
209	Zn	1.37
211	Mn	9.73
212	Fe	5.40
	B	0.27

Growth and Yield Response of Cotton to FoliarBlend micronutrient application at Funtua site in Katsina state

growth and yield results obtained the 2013 rain- and 2014 irrigated seasons are presented in Figure 1, 2, 3&4

Plant height, Branch number, Node number and Leaf number increased in all treatments up to 40kg NPK/ha + 500 mls of FoliarBlend (Delwar et al, 2010). At 40kgNPK/ha + 500mls of FoliarBlend in 20 litres of water, the Plant height (76cm), Branch number (21), Node number (30) and Leaf number (36) per plant performed better than other treatments. This was followed by treatment of 20kgNPK/ha + FoliarBlend and FoliarBlend only respectively (Fig1). However, at 60kgNPK/ha , there was decline in Node number (24) and Leaf number (27.6), and this might be due to imbalanced nutrient concentration or toxicity caused by the higher nutrient concentration or due to their indirect effect physiologically, since node addition rates are primarily controlled by temperature and modulated carbon demand/supply (Reddy et al., 1997a, 2004).

During the irrigated season, the same trend as in wet season was obtained for the growth parameters(Plant height, Node number, Branch number and Leaf number) for all the treatments. (Fig 2). This result corroborated the findings of Makhdum et al, (2000), (Sing et al., 1998) and Tekalign & Fassil (2011), where Variety Arba and Acala produced higher plant height with increased N fertilizer rate up to 92 kg N ha⁻¹.

While, the application of 60kgNPKha⁻¹ + FoliarBlend gave the highest number of bolls formed (20/plant), and total yield (5.2 t/ha) during the rain-fed season, when compared to the other treatment levels, lowest was obtained in control plots (Fig 3 &4). This was followed by the application of 40kgNPKha⁻¹ + FoliarBlend and 20kgNPKha⁻¹ +FoliarBlend respectively. Same trend was obtained during the irrigated season (Fig 3&4).This was in accordance with the study by Soomro et al 2000, where data of 3 years showed that the seed- cotton yield, bolls per plant and boll weight were significantly highest when NPK applied is at the rate of 100-50-50 kg/ha

This results showed that under the highest NPK application yield was highest and growth lowest (i.e. Plant height, Node number, Branch number and Leaf number etc) possibly due to the competition between bolls and growing stems.

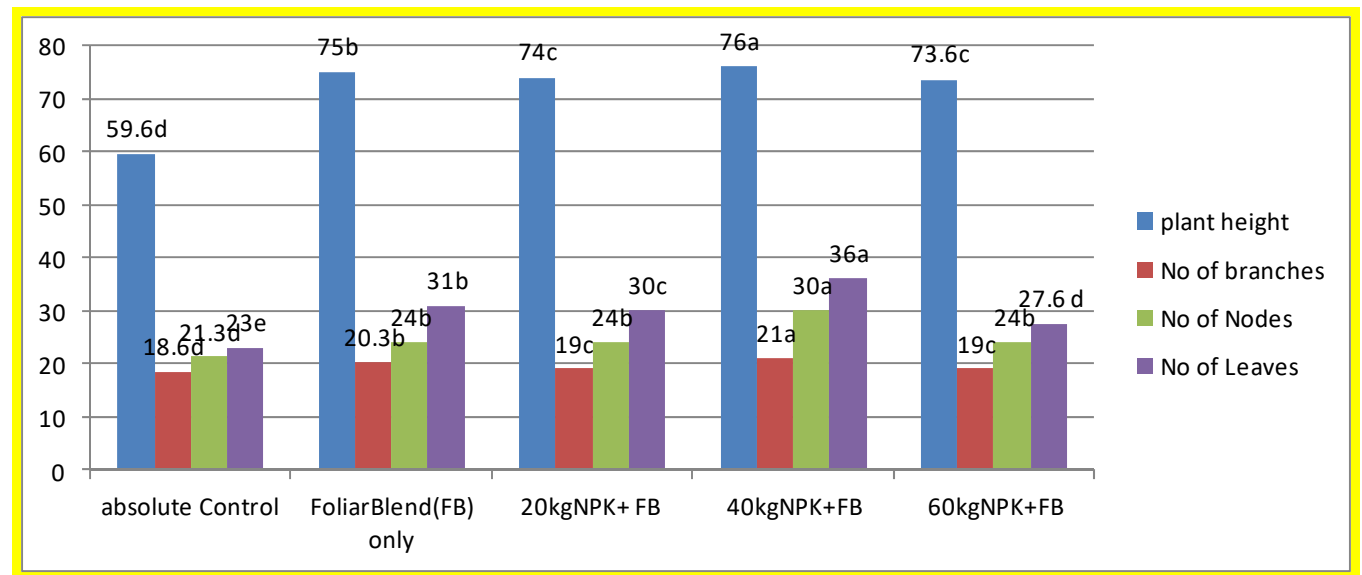


Fig 1: The growth response of the cotton plant to FoliarBlend micronutrient fertilizer in Funtua site, Katsina state under 2013 rain-fed season

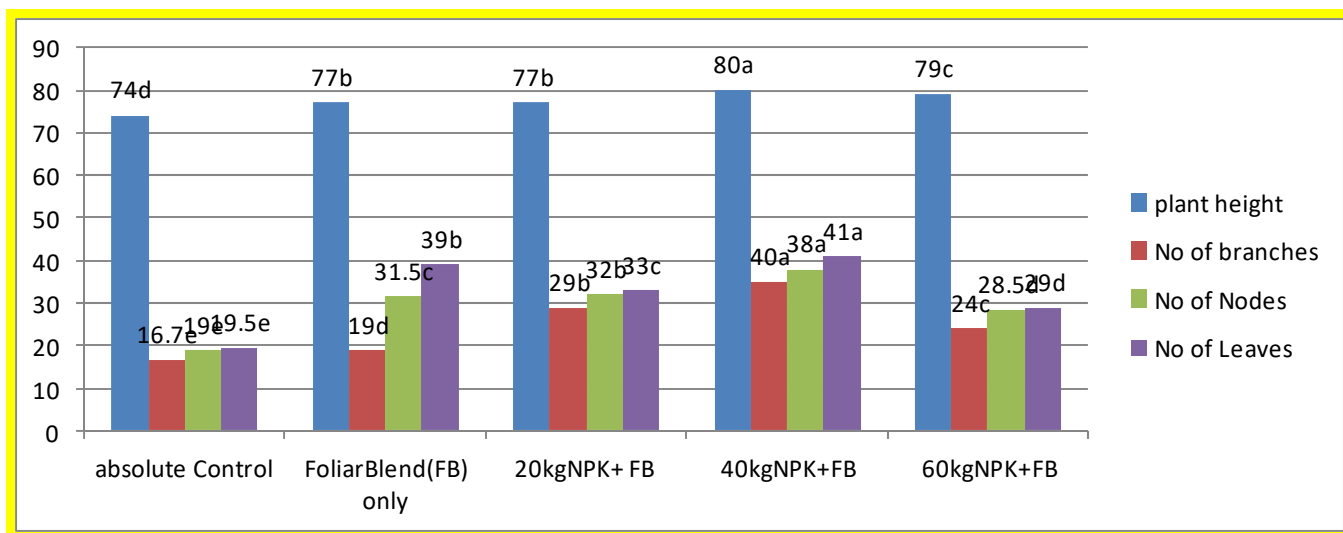


Fig 2: The growth response of the cotton plant to FoliarBlend micronutrient fertilizer in Funtua site, Katsina state under 2014 irrigated season

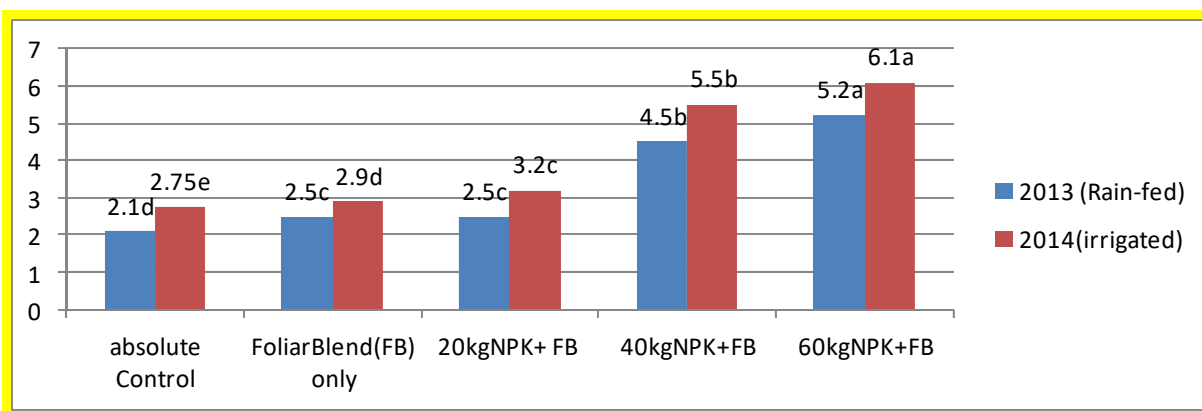


Figure 3: Effect of various treatment combinations of FoliarBlend on the Yield of Cotton (t/ha) at Funtua under Rain-fed 2013 and Irrigated 2014

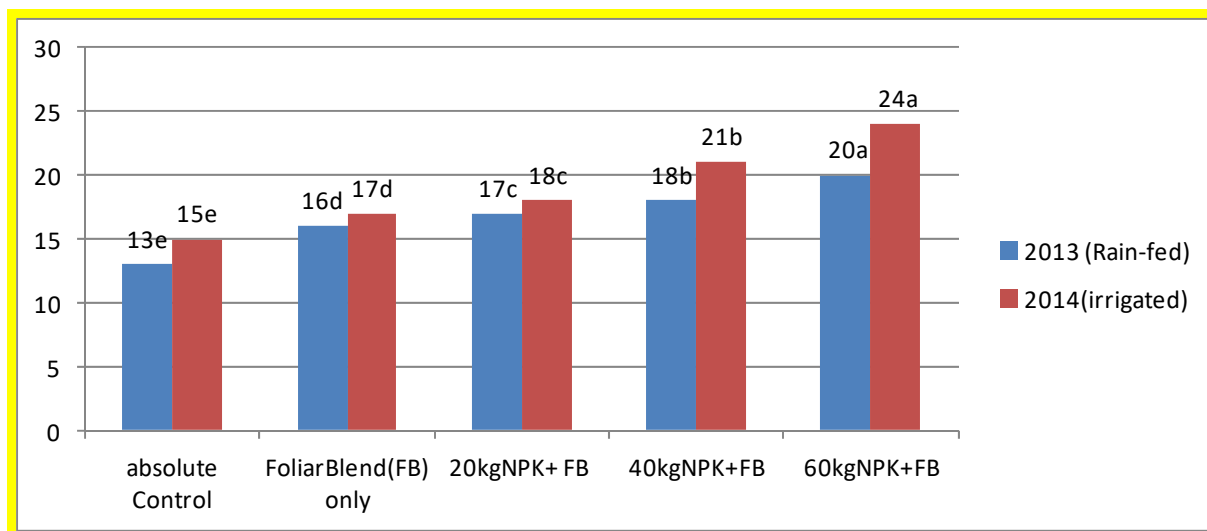


Figure 4: Effect of various treatment combinations of FoliarBlend on the number of bolls at Funtua in 2013 rain-fed and under irrigation 2014

CONCLUSIONS

The growth parameters of variety SAMCORT 1 were enhanced positively by the application of 40KgNPKha⁻¹ + FoliarBlend during the both seasons (rain-fed and irrigated) in Funtua site. While, application of 60kgNPKha⁻¹ + FoliarBlend to cotton on the field showed that under prevailing climatic and field conditions with good management practices, the yield of seed-cotton can be greatly improved. This implies that under the highest NPK application yield was highest and growth lowest (i.e. Plant height, Node number, Branch number and Leaf number etc) possibly due to the competition between bolls and growing stems.

Conclusively, under the prevailing poor climatic and soil conditions, fertilization at 40Kg NPKha⁻¹ (15:15:15) + FoliarBlend is adequate for optimum growth, while 60kgNPKha⁻¹ + FoliarBlend gave the optimum yield of cotton (*Gossypium hirsutum*)

COMPETING INTERESTS

Authors have declared that no competing interests exist

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