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Response of Plant and Ratoon Plantain Crops to K_2O Fertilization in the Rain Forest Zone of Cross River State

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Abstract: Nutrient potassium is critical in plantain (*Musa* species cv. AAB) nutrition. It plays a key role in the vegetative growth and bunch development. Application of 300 kg aureate of potash (K_2O) per hectare was beneficial in the plant crop, while the highest rate (400 kg K_2O/ha) enhanced growth and favorable yield components (number of hands and fingers/bunch, finger mass, girth and length). Plants fertilized with 400 kg K_2O/ha were the tallest (3.5m), had largest pseudostem girth (56-58cm) with the highest (11-12) number of functional leaves at flowering and attained flowering stage after 9 months of vegetative growth. Bunch mass, bunch yield/ha and yield components were significantly (P = 0.05) the highest at 300 kg k_2O/ha in plant crop and at 400 kg K_2O/ha in ratoon crop. The heaviest bunches were 8.8 and 9.8 kg/plant in plant and ratoon crops, respectively, giving the respective corresponding bunch yields of 14.66 and 16.33 tonnes/ha. Application of 400 kg K_2O/ha appeared adequate for sustainable production of false horn plantain in the high rainforest zone of Cross River State.

Key words: Fertilizer % Plantain % Rainforest % Ratoon crop

INTRODUCTION

Smallholder commercial cultivation of plantain in Nigeria is expanding at a vary fast rate to meet the continuously increasing demand for the crop especially in the expanding urban centres [1].

Several soils supporting plantain in West Africa including those in Nigeria are of low productivity [2-4] and comprise about 70% of the tropical soils on which plantain is grown [5].

The predominantly low yield of plantain and the characteristic rapid yield decline of the crop under field conditions in West Africa is usually attributed to soil fertility constraints [6-8]. Appropriate agronomic practices such as fertilizer application and mulching plantain with organic materials have enhanced the productivity of the crop [9]. However, potassium, which is one of the major elements required by plantain is often the most important limiting nutrient element in many tropical soils [9] especially in the plantain zone particularly due to luxury or excessive uptake of the nutrient by the crop [10].

Potassium may be added to the soil through the return of crop residues and ash or through inorganic fertilizers and organic manures. However, under intensive and continuous cultivation, fertilizers appear to be the most dependable source for the production of plantain. Information is currently lacking on potassium requirement of the crop especially in the high rainforest area of Cross River State which is one of the major plantain producing areas. This paper reports efforts at bridging such an information gap.

MATERIALS AND METHODS

The study was conducted at the Crop Research Farm of the University of Calabar (05° 32’ and 04° 27’ N and 07° 15’ and 09° 28’ E 37 meters above sea level, in the rainforest zone of Cross River State. The area has mean relative humidity 85%, annual rainfall 2000-2500 mm, the maximum and minimum temperatures 33 °C and 33 °C and 23 °C, respectively. The land was cleared manually using a machete and tilled with a spade. Plot size measured 3.0 m x 10.0 m (30.0 m^2) separated by 1.0 m wide paths. Treatments evaluated were control, 100, 200, 300 and 400 kg muriate of potash (K_2O) per hectare with three replications in a randomized complete block design.

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Plantain plots were established on 20 June 2005 and terminated after harvest of the first ratoon crop. Suckers were planted in 0.3m x 0.3m x 0.3m holes at 2.0m x 3.0m (1666 plants per hectare). All plots were mulched with sawdust at 20 tonnes/ha one week after planting the suckers. Mulch was applied in such a way that entire plots and paths were completely and permanently covered with 3 ± 0.5 cm thick sawdust mulch layer throughout the duration of the experiment. The K_2O rates applied to plant and ratoon plantains were split applied in six equal installments at 3, 6, 9, 12. 15 and 18 months after planting (MAP) for the maximum uptake by the crop. Fertilizer was applied per plant 2-3 cm deep in a ring 50 cm away from the base of the plant and covered completely.

Suckers were managed in such a way that only one daughter sucker was maintained to succeed the mother plant after harvest. Weeds were removed regularly by hand pulling and hand hoeing. Soil was added at the base of plants to control high mat. Dead and diseased leaves were pruned regularly while bamboos and wooden poles were used to prop hearing plants to prevent lodging or breaking of pseudostems due to wind and heavy bunches. Data on vegetative growth parameters (plant height, girth, live leaves, time of flowering) and bunch yield indices (bunch mass, number of hand and fingers per bunch, finger mass, girth and length) were recoded for plant and ratoon crops and analyzed statistically using analysis of variance (ANOVA) technique. Duncan's multiple range test (DMRT) was used to separate significant means at 5% level of probability.

RESULTS AND DISCUSSION

Result showed that pseudostem height, girth, number of functional leaves on the plant at flowering and time from planting to flowering significantly (P = 0.05) varied among the treatments and were most favourable in plant and ratoon plants fertilized with 400 kg K_2O/ha and lowest in control (Table 1). Plant and ratoon crop plants were taller than control plants by 23 cm and 17 cm respectively and had five more functional leaves at flower initiation, indicating rapid vegetative growth at this fertility level. Plants in this treatment also attained the flowering stage in 3-7 months earlier than those in control plots which grew slowly over a long vegetative phase.

Superior vegetative growth of plantains in plots treated with 400 kg K_2O/ha could be an indication of adequate K nutrition in addition to possible improvements in physical and biotic soil conditions in those plots. Luxuriant growth of plantain in terms of rapid leaf production and plant vigour attributed to a mulching effect and optimum nutrient uptake was similarly reported by Obiefuna [1], Salau *et al.* [11] and Swennen [7]. Poor growth of the crop represented by the late flowering in control plots could be attributed to low soil fertility status. Bunch mass and yield components of plant and ratoon crops except the number of hands per bunch, responded positively to K_2O fertilization and all the plants significantly (P = 0.05) out-yielded those in control plots. Plant crop fertilized with 300 kg K_2O/has produced significantly (P =0.05) the heaviest bunches with superior bunch characteristics and the highest bunch yield per hectare, while significantly (P = 0.05) the lowest bunch mass with inferior yield components and correspondingly the lowest bunch yield per hectare were produced in non-fertilized plots (Table 2).

Plant crop fertilized with 300 kg K_2O/ha exhibited rapid vegetative growth and early flower initiation which resulted in early bunch harvest four months before harvesting non-fertilized plantains. Sucker growth represented by the height of the succeeding sucker at harvest of the plant crop was very rapid in plots fertilized with 300 kg K_2O/ha. This level of K_2O fertilization stimulated fast growth of the succeeding ratoon, early flowering and early bunch maturity/harvest and shortest production cycle of only nine months between the plant and ratoon crop harvests. The production cycle was however longer by 12 months in zero K_2O plots indicating slow plantain growth possibly due to reduced soil fertility in those plots. A similar growth pattern of the crop attributed to low soil nutrient content was obtained by Salau *et al*. [11] and Robinson [10].

The highest K_2O rate (400 kg K_2O) per hectare was more effective at the ratoon crop stage than any other rate applied. Significantly (P = 0.05) the heaviest bunch masses and hence the highest bunch yield per hectare were recorded at this level of K_2O fertilization except the number of economic hands per bunch (Table 3). The bunches produced at the highest K_2O rate were 3.6 kg heavier than those produced in control plants resulting in 6.0 tonnes/ha (60%) higher yield, harvested six months earlier than ratoon plants in control plots.

Ratoon crop plantain required higher K_2O fertilizer than plant crop for favourable vegetable growth and good bunch yield. High K_2O requirement at the ratoon crop stage might be due to soil nutrient depletion during cropping, suggesting that the crop responds to high K_2O fertilization if the soil fertility potential is low.

Table 1: Influence of K_2O fertilization on vegetative growth of plant and first ratoon plantains (cv. 'Agbagba') at flowering stage

	Plant crop				First ratoon plants			
Treatment	Pseudostem height (cm)	Girth at 1 m height (cm)	Number of live leaves on the plant	Time to 50% flowering (MAP)	Pseudostem height (cm)	Girth at 1 m height (cm)	Number of live leaves on the plant	Time to 50% flowering (MAP)
Control	300c	41d	6.2c	13.0b	333b	38c	6.8c	25.5a
100kg/k_2O/ha	342b	47c	8.8b	10.8c	344b	50b	9.6b	18.2a
200kg/k_2O/ha	343b	51b	8.7b	10.4c	342c	51b	7.4c	19.8c
300kg/k_2O/ha	353a	54a	10.8a	9.5d	34a	57a	10.0b	16.3d
400kg/k_2O/ha	353a	56a	11.0a	9.3d	350a	58a	11.8a	18.5c

Figures followed by the same letter in the same column are not significantly different at 5% level of probability according to Duncan's Multiple range test (DMRT)

Table 2: Influence of K20 fertilization on bunch mass, yield components and bunch yield of plant crop of false horn plantain (cv. 'Agbagba')

Treatment	Bunch mass (kg/plant	Number of hands/ bunch	Number of finger/bunch	Individual finger mass (g)	Finger girth (cm)	Finger length (cm)	Height of primary sucker at harvest (cm)	Time to 50% harvest (MAP)	Bunch yield (tones/ha)
Control	5.8c	6.0a	28.7c	155c	13.9c	13.8b	124d	16.0a	9.70c
100kg/k_2O/ha	6.9b	6.7a	31.7b	176c	14.6b	15.9a	188c	15.2b	11.50b
200kg/k_2O/ha	7.2b	6.7a	33.0a	172c	14.3b	16.2a	220b	14.0b	12.00b
300kg/k_2O/ha	8.8a	6.7a	34.0a	2.2a	15.8a	16.9a	228a	12.5b	14.66a
400kg/k_2O/ha	8.2a	6.7a	32.3b	195a	15.3a	16.8a	226a	13.3d	13.66a

Figures followed by the same letter in the same column are not significantly different at 5% level of probability according to Duncan's multiple range test (DMRT)

Table 3: Influence of K_2O fertilization on bunch mass, yield components and bunch yield of first ratoon crop of a false horn plantain (cv. 'Agbagba') in Calabar

Treatment	Bunch mass (kg/plant	Number of hands/ bunch	Number of finger/bunch	Individual finger weight (cm)	Finger girth (cm)	Finger height (cm)	Time to 50% harvest (MAP)	Bunch yield (tones/ha)
Control	6.2d	6.0a	32.0d	160e	15.8b	14.3c	27.3b	10.33d
100kg/k_2O/ha	7.3c	6.7a	32.7d	201b	16.8b	16.2b	25.4c	12.16c
200kg/k_2O/ha	7.5c	6.0a	33.7c	198c	16.5bsss	15.5c	23.6d	12.50c
300kg/k_2O/ha	9.0a	6.7a	40.0b	210a	17.2a	17.0a	22.6e	15.66a
400kg/k_2O/ha	9.8a	7.7a	43.3a	220a	78.8a	18.8a	22.2e	16.33a

Figures followed by the same letter in the same column are not significantly different at 5% level of probability according to Duncan's multiple range test (DMRT)aaa

The best growth and favourable yield components recorded at 300kg K_2O/ha in the plant crop, could be due to favourable soil nutrient conditions at the initial stage of establishment as the land was fallowed for over five years before the commencement of this trial.

As the crop progressed into the ratoon stage, a highest K_2O rate (400 kg K_2O/ha) was required to compensate for nutrient depletion arising from plantain uptake as well as leaching losses and other wastages. A comparison between the plant and ratoon crop yields showed that ratoon crops appeared better than plant crops in all the corresponding treatments except the control plots where nutrient loss was obviously compounded by absence of K_2O.

CONCLUSION

Optimum K_2O fertilization is beneficial to plantain as the crop has a heavy requirement for the nutrient. Fertilizer K enhanced vegetative growth and sustained high bunch production. Application of 300 kg K_2O/ha to the plant and 400 kg k_2O/ha at the ratoon stage appeared adequate for sustainable productivity of plantain in the rainforest zone of Cross River State.

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