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Effect of foliar fertilization on wheat *Triticum aestivum* (l) in marginal areas of Eastern Province, Kenya.

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1 SUMMMARY

This field study was conducted to determine the effect of foliar fertilization on bread wheat (var. Chozi) grain yield (GY) and quality under limiting soil moisture regimes at Katumani a marginal area of the Eastern Province- of Kenya. The trial was laid out in a randomized complete block design and replicated four times. Plant nutrients were sprayed at tillering as foliar urea (46-0-0) 20 kg N ha^{-1} 20kg N ha^{-1} + Bayfolan® (11-8-6) 5 l ha^{-1}, 30 kg N ha^{-1} , 30 kg N ha^{-1} + Bayfolan® 5 l ha^{-1} , Bayfolan® 5 l ha^{-1} and 0 (no spray). Starter fertilizer was supplied at sowing at 100kg ha^{-1} (NPK 18.46.0)). Results indicated that urea application at 20kg N ha^{-1} increased (GY) significantly ($P<0.05$) while 30kg N ha^{-1} increased thousand kernel weight (TKW) and grain protein (GP) significantly ($P<0.05$). It was concluded that foliar application of urea is beneficial to wheat crop under limiting moisture conditions. Farmers can use foliar application of urea at 20 kg N ha^{-1} for wheat production in these areas.

2 INTRODUCTION

Eighty percent of Kenya is classified as Arid and Semi-Arid lands (ASAL) with low and erratic amounts of rainfall ranging between 500mm and 1000mm annually. (Jaetzold and Schmidt, 1982). These rains result in short growing seasons which are unsuitable for production of conventional wheat (*Triticum aestivum* L) varieties. The wheat variety Chozi was developed and selected for drought tolerance. However a wheat production package (KARI, 2003) for this variety had to be developed for these conditions. For crops to achieve their full yield potential, they must be supplied with adequate amount of Nitrogen (N) during the growing season (Angus *et al.*, 1998). Fertilizers are required to supply nutrient elements, to provide reasonable growth and production (Tisdale and Werner, 1975). Commercial foliar fertilizers when applied during the period of low soil moisture are rapidly absorbed through foliage therefore enhancing crop yield and quality (Smith *et al.,* 1992) hence increasing yield components (Parvez *et al.,* 2009), GY (Abad *et al.,* 2004) and quality (Borjian and Emam, 2001). In Kenya, to increase food production will require intensification of wheat production in the traditional wheat growing areas and its introduction in non traditional growing areas. The main objective of this study was to determine the effect of foliar fertilization on wheat GY and quality in marginal areas of Eastern Kenya.

3 MATERIALS AND METHODS

In order to determine the effect of different sources of plant nutrient (nitrogen) applied at tillering to bread wheat variety Chozi recommended for the marginal areas on GY and quality, a field trial was planted in 2005 and 2006 crop seasons at Katumani –Machakos. It is situated at (1° 35' S 37°14'E),1600

meters above sea level, annual rainfall 500-1000mm, mean maximum temperature 24.7^{0}C and mean minimum temperature 13.7^{0}C (KARI, 2010) with soils predominantly sandy-to-sandy loams over clayey sub-soil (Luvisols) (Christian *et al.,* 2004). The field trial was laid out in a randomized complete block design replicated four times. Plots of 6.0 m x 1.5 m were hand planted with wheat seed at the rate of 100kg/ha. The rows were spaced at 30 cm x drill. Furrows were opened by dragging a stick on the soil surface by hand. Starter nitrogen and phosphorus were supplied at sowing at 18 kg N ha^{-1} and 46 kg P_2O_5 ha^{-1} in form Diammonium phosphate (18-46-0). Fertilizer was drilled by hand in the furrows and stirred to mix with soil to avoid seed scotch. Seed was drilled by hand and covered with thin a layer of soil. Plant nutrients were sprayed at the tillering stage (GS 22) (Zadoks *et al.,* 1974) as foliar urea (46-0-0) 20 kg N ha^{-1}, 20kg N ha^{-1} + Bayfolan (11-8-6) 5 l ha^{-1}, 30 kg N ha^{-1}, 30 kgN ha^{-1} + Bayfolan 5 l ha^{-1} , Bayfolan 5 l ha^{-1} and 0 (no nutrient spray). Weeds, insect pests, and diseases were managed as per the recommendations (KARI, 2003). A one-meter square quadrant was taken as the harvested area. Counts were taken on plant height, plants/m^2 , tillers/m^2 and spikes/m^2. Harvesting was done by cutting with a sickle. Threshing was done by a small plot thresher and cleaned using an experimental winnowing machine. Whole (GP) was determined and (GY) weights taken at 13.5% moisture content. Thousand seeds were counted and weighed. Data were analysed using (SAS, 1994) subjected to ANOVA and LSD was used for separation of means.

4 RESULTS AND DISCUSSION

Results from this study indicated that urea foliar application had significant ($P<0.05$) differences in GY, plant height, tillers/m^2, spikes/m^2 , TKW and GP in both seasons 2005, and 2006. Urea combined with Bayfolan did not increase GY in both seasons (Tables 1&2), compared to urea applied alone. Bayfolan alone had no effect on GY and yield components ($P>0.05$) compared to the control. There are potential benefits of providing N to cereals via foliage as urea solutions. Among these benefits are reduced nitrogen losses through denitrification and leaching when root capacity for absorption is impaired by low soil moisture or saline soil conditions. Foliar application of dilute urea solutions have been preferred over soil applications under root stress conditions for supplying N to wheat. Concentrations of up to 30% of urea can be used safely when applied with low volume sprayers (De. Geus, 1973). Urea foliar sprays on wheat in soil moisture deficient areas have been found to increase GY by over 25% (Swaminathan, 1968). In this study foliar application of urea at tillering at 20 kg N ha^{-1} significantly ($P<0.05$) increased the number of tillers/m^2 from 210.8 to 230.2 and 184.8 to 230.1, spikes/m^2 from 184.8 to 217.2 and 167.3 to 215.4 in 2005 and 2006 respectively, similar results have been reported by Parvez *et al.,* (2009).

Table 1: Effect of foliar fertilization of Bayfolan and Urea on plant height, tillers/ m^2, spikes/ m^2, TKW, grain protein and grain yields in marginal areas of Eastern Province - Kenya (2005 cropping season)

Foliar fertilizer rate/ha	Plant height	Tillers m^2	Spikes m^2	TKW	Grain protein	Yield (kg ha^{-1})	Yield benefit (kg ha^{-1})
Control	72.4b*	210.8d	184.8c	45.3b	15.6bc	793.1b	-
Bayfolan 5lts	76.1ab	216.7c	205.2b	45.3b	15.7bc	805.1b	12.1
Urea 20kg	77.1a	230.2a	217.2a	46.0ab	16.4b	916.9a	123.8
Urea 20kg +Bayfolan5l	79.5a	219.6c	214.8a	46.9ab	15.9bc	868.1b	63.0
Urea 30kg	78.3a	218.6c	213.1a	47.4a	17.4a	848.3b	55.2
Urea 30kg + Bayfolan5l	77.9a	224.0b	207.2b	46.5ab	16.6ab	856.3b	63.2
CV (%)	20.5	23.7	22.3	4.0	4.2	12.5	
LSD (5%)	5.5	4.4	10.0	1.5	1.0	78.6	

*Means in each column followed by the same letters in the same column are not significantly different at the 5% level.

Table 2: Effect of foliar fertilization of Bayfolan and Urea on plant height, tillers/ m², spikes/ m², TKW, grain protein and grain yields in marginal areas of Eastern Province - Kenya (2006 cropping season)

Foliar fertilizer rate/ha	Plant height	Tillers m²	Spikes m²	TKW	Grain protein	Yield (kg ha⁻¹)	Yield benefit (kg ha⁻¹)
Control	76.2a*	186.7bc	167.3c	45.4c	15.7c	820.3d	-
Bayfolan 5lts	76.2a	216.6b	184.3bc	45.4c	15.6c	870.3c	50.0
Urea 20kg	77.8a	230.1a	215.4a	46.2b	16.1b	975.1a	154.7
Urea 20kg +Bayfolan5l	77.6a	224.6ab	204.8b	46.7b	15.8c	935.5b	115.2
Urea 30kg	77.8a	218.4b	184.3bc	47.5a	17.2a	940.6b	120.3
Urea 30kg + Bayfolan5l	77.7a	221.2ab	197.5b	46.8b	16.9ab	900.4c	80.1
CV (%)	4.3	17.6	22.1	5.4	5.8	23.7	
LSD (5%)	1.5	8.8	19.3	1.2	1.1	31.8	

*Means in each column followed by the same letters in the same column are not significantly different at the 5% level.

GY also significantly ($P<0.05$) increased from 793.1 to 916.9 kg/ha and 820.3 to 975.1 kg/ha, an increase of 16% and 19 % over the control in 2005 and 2006 respectively, Abad *et al.,* (2004) has reported similar results.

In this study when urea was sprayed at 30kg N ha⁻¹, significantly ($P<0.05$) increased TKW from 45.3 to 47.4 and 45.4 to 47.5 in 2005 and 2006 cropping seasons, similar results have been reported by Martin, (2006). Urea sprayed at 30kg N ha⁻¹ also significantly ($P<0.05$) increased GP from 15.6 to 17.4 and 15.7 to 17.2 in 2005 and 2006 respectively, Borjian and Emam, (2001) have reported similar results. GP content increased with higher fertilization levels in this study and according to Salah, (2006) this improves rheological properties of dough and baking quality

5 CONCLUSION

It was concluded that application of urea at the rate of between 20 and 30 kg N ha⁻¹ at tillering of wheat at Katumani is beneficial to crop. These results demonstrate that there is potential for increasing/expanding overall national wheat production through introduction of suitable varieties and foliar N fertilizer application in marginal areas. Farmers can use urea foliar sprayed to increase their yield and improve grain protein content for higher crop production

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