Response of Selected Wheat (*Triticum Aestivum* L.) Varieties to Nitrogen Applied at Different Growth Stages

M N Njuguna[1]* PA Kamau[2], RK Wanjogu[3] and Munene Macharia[1]

[1]*Kenya Agricultural and Livestock Research Organization Food Crops Research Centre – Njoro, P.O. Box Private Bag Njoro -20107 Njoro, Kenya*

[2] *Department of Agriculture & Natural Resources, Kenya Methodist University, P.O. Box 267-60200 Meru, Kenya*

[3]*Mwea Irrigation Agricultural Development Centre, P.O. Box 210-10303 Wang'uru, Kenya*

Corresponding email: njugunamichaeln@yahoo com

Abstract

In Kenya wheat is ranked second after maize as source of food and feed. Despite its importance, wheat production has stagnated in the last decade. Its annual domestic demands stand at 900,000 MT against production of 300,000 MT. Low productions is mainly due to low nitrogen use among other causes. Methods of nitrogen application were evaluated on wheat varieties (K Tai, K Sunbird and K Wren) grain yield and yield components. Field trials were laid out in RCBD replicated three times in a split plot arrangement in Njoro (2,164 m asl) and Mau Narok (2,690 m asl.) in 2011/2012 cropping season. Main plots consisted of wheat varieties and sub plots consisted of split nitrogen application at sowing (GS 0), tillering (GS 22) and stem elongation (GS 30). Parameters measured were grains/main spike, biomass, harvest index, thousand kernel, and grain yield benefit. There were significant variety yield differences (<P0.05) in Mau Narok with K. Tai giving the highest grain yield 2842 kg/ha, K. Wren (2674 kg/ha) and K. Sunbird (2560 kg/ha). Split application of nitrogen significantly influenced grain yields (6132.0 kg/ha) in Njoro and (3034.0 kg/ha) in Mau Narok. There were no interactions (varieties x nitrogen application). Kenya Tai was the best variety in both sites. Split application of nitrogen increased wheat yield output. Split application of N at GS 22 and GS 30 was the best method. Further research is required to evaluate different N application rates at different growth stages on the newly released varieties.

Keywords: *Application, growth stages, nitrogen, wheat*

IJPP 6(4): 8-14

Introduction

Wheat is the most important cereal in the world after maize with annual production of 607, maize 784 and rice 651 million MT respectively while annual wheat consumption is ≤ 552 million (Food and Agriculture Organization Corporate Statistical Database [FAOSTAT], 2007). In Kenya wheat is ranked second after maize (FAOSTAT, 2009) and is an important source of food for human food and livestock feed. Despite its importance, wheat production (300,000 MT) accounts for only a third of domestic requirements (900,000 MT) (Onsongo, 2003). Low use of nitrogen (N) fertilizers in wheat farming among the small scale farmers has been cited as the cause for low/poor production among other production constraints (Onsongo, 2003). Nitrogen is the most important fertilizer element that can play a major role in the improvement of wheat production in Kenya. High responses have been reported when wheat crop is supplied with nitrogen through the soil at increasing application levels. It influences growth and development of vegetative crop parts above the ground (Parvez, 2009) and is considered a serious yield limiting factor (Braz *et al*., 2006). Its interaction with the method of application influences important yield components such as tillers and spikes per unit area (Ataur *et al*., 2011) Late or split applications of nitrogen to wheat improve thousand kernel weight (TKW) tremendously (Khan, Hassain, Jan & Qadoos (2011) postulate that kernel size of wheat is more responsive to method and timing of N application, rather than amount of N fertilization hence contribute to the final grain yield. Application of nitrogen can be largely dependent on the prevailing environmental conditions. When extra N is added as insurance to increased crop yield, there is increased potential for lodging and diseases development. The aim of these field trials was to generate information on wheat grain yield response to fertilizer N applied at different growth stages to the three new wheat cultivars K. Tai, K. Wren and K. Sunbird

Materials and Methods

The field trials were conducted in Njoro (2,164 m asl) and Mau Narok (2,690 m asl.) sites in 2011/2012 cropping seasons to evaluate three newly released wheat varieties K. Tai, K. Sunbird and K.Wren response to N applied at different growth stages. The trials were laid out in a randomized complete block design (RCBD) in a split plot arrangement replicated three times. Main plots consisted of the three wheat test varieties. Seed was dressed with Gaucho® 350 FS (imidacloprid) to protect the crop against soil born pests and initial control of cereal aphids at early growth stages. Wheat was sown in the main plots using an experimental plot seeder at 100 kg/ha. Fertilizer DAP (18:46:0) was applied at 100 kg/ha to supply starter plant nutrients at sowing (GS 0). The sub plots consisted of N applied as single or split applications at 60 kg N/ha at tillering (GS 22) and stem elongation (GS 30) (Zadoks, Chang & Konzak (1974). Crop management was done according to recommendations (KARI, 2005). Five plants were randomly selected and tagged at tillering for harvesting at physiological maturity. The parameters measured and analyzed included, grains/main spike, biomass accumulation harvest index (HI), thousand kernels weight (TKW) and grain yield. Harvesting of the plots was done by cutting with a sickle, main spikes of the tagged plants were threshed using single head thresher, seeds counted and recorded, the harvested plants from plots were threshed using plot thresher, grain moisture adjusted to 12%, weighed and recorded, grains were counted, weighed and recorded. Data was analyzed using (SAS, 1994). Analysis of Variance (ANOVA) was conducted at (5%) to determine any significant differences between the treatment means. Least Significant Level (LSD) was used to separate the treatment means.

Results

In the results shown in Table 1 grains/main spike were significantly different ($P<0.05$) among varieties in Njoro. Harvest index, biomass accumulation and grain yield were not significant ($P>0.05$) among the varieties varieties. In Mau Narok site, grains per main spike, thousand kernel weights and grain yields were significantly different among the three varieties while biomass accumulation and harvest index were not significant.

In Table 2, methods of nitrogen application did not have any influence on yield determinants namely grains/main spike, biomass accumulation, harvest index, and thousand kernel weight in Njoro site. However, nitrogen application at different growth stages had positive influence on grain yield and subsequent yield benefits in both Njoro and Mau Narok sites.

In Mau Narok site, only biomass accumulation, grain yield and subsequently yield benefits were significantly ($P<0.05$) influenced by N application at different growth stages**.**

Discussion

From the results presented in Table 1 Njoro and Mau Narok, there were no significant differences ($P>0.05$) in biomass accumulation and HI among varieties, K. Tai, K. Sunbird and K. Wren. This could have been caused by the unfavourable weather conditions. However, grains/main spike and TKW were significantly ($P<0.05$) different among varieties in both Njoro and Mau Narok sites. Variety K. Sunbird had the highest number of grains/main spike (52.8 grains) followed by K.Tai (49.5), and K. Wren (47.8), while K. Wren had the highest TKW of 46.5 g followed by K. Tai, (43.09 g) and K Sunbird (41.34 g) in Njoro. Variety K. Sunbird had the highest grains/main spike (50.1 grains) followed by K. Tai (47.0 grains) and K. Wren (45.4 grains) while K. Wren had the highest TKW (41.9 g) followed by K. Tai (38.8 g) and K. Sunbird (37.3 g) in Mau Narok. The results showed that the test varieties had different genetic potential for the two parameters under Njoro and Mau Narok conditions. Similar results are reported by Newton, (2011) where different test varieties showed different TKWs although they were grown under the same environment. Grain yields were not significantly different ($P>0.05$) among varieties in Njoro, but K. Tai gave the highest grain yield of 2.8 t/ha followed by K. Wren (2.7 t/ha) and K. Sunbird (2.6 t/ha) in Mau Narok**.** The discrepancy may have been due to inadequate soil moisture and high temperatures in Njoro compared to relatively lower temperatures in Mau Narok (higher altitude). The results are consistent with Barmen (2012) who reported different grain yields levels from the same test varieties when they were grown under different environmental conditions.

Table 1: Means of variety grain yield and yield components in Njoro (2,164 m asl) and Mau Narok (2,690 m asl.)

Variety	Grains/main Spike	Biomass (g) (5 plants)	HI (%)	TKW (g)	Grain yield (Kg/ ha)
		Njoro			
K. Tai	49.5b	177.9	42.4	43.1b	2.9
K.Sunbird	52.8a	174	42.1	41.3b	2.6
K. Wren	47.8b	171	43.1	46.5a	1.1
Mean	50.0	174.3	42.5	43.6	2.2
LSD (0.05)	2.938	NS	NS	3.3	NS
CV (%)	12.0	16.6	18.3	6. 6	50.38
S E ±	1.09	5.27	1.42	0.52	199.46
		Mau Narok			
K. Tai	47b	59.4	26.2	38.8b	2.8a
K.Sunbird	50.1a	56.5	26	37.3b	2.6c
K. Wren	45.4b	55.5	26.6	41.9a	2.7b
Mean	47.5	57.2	26.3	39.3	2.7
LSD (0.05)	2.79	NS	NS	3.02	105
CV (%)	12.0	17.7	18.3	6.6	5.7
S E	1.04	1.85	0.88	0.47	28.18

Means in the same column followed by the same letters (a,b,c,) are not significantly different at α=0.05

In Table 2, application of N at different growth stages (GS) had no significant ($P>0.05$) effect on grains/main spike, biomass, HI and TKW in Njoro, but there were significant differences ($P<0.05$) in grain yield and yield benefits in Njoro site due to N application at different growth stages. Split application nitrogen at (GS 22 and GS 30) gave the highest grain yield (6132 kg/ha) and subsequently the highest yield benefit (2961 kg/ha). There were significant differences ($P<0.05$) in biomass accumulations and grain yield due to N application at different GS in Mau Narok. The low yields may have been caused by poor soil moisture content in both Njoro and Mau Narok such that the crop was not able to absorb applied nitrogen. These results are in concurrence with Silva, *et al.* (2011) and Gul *et al.* (2012) findings where nitrogen application at different GS increased grain yields significantly (P<0.05). Split N application at (GS 22 and GS 30), gave the highest grain yield (6.1 t/ha), followed by GS 30 (5.6 t/ha), GS 22 (5.1t/ ha) and GS 0 (3.2 t/ha) in Njoro; while splits application of nitrogen gave the highest grain yield of 3.0 t/ha followed by nitrogen application at GS 30 (2.8 t/ha), GS 22 (2.6 t/ha) and GS 0 (1.6 t/ha) respectively. The high yields realized in Njoro compared to Mau Narok may have been due to slightly more rainfall received in Njoro during the crop growth period compared to Mau Narok. Similar findings have been reported by Tayebeh, Abbas & Seyed (2011) and Wiederholt (2012) who found out that when N was applied in two splits under favourable moisture conditions higher yields were realized.

In our study, the most appropriate growth stage for N application as a single dose appeared to be at (GS-30), although Lopez, Bellido & Lopez (2006) and Njuguna, Munene, Mwangi, Waweru, & Akuja (2010) have reported that N use efficiency is realized when applied at between tillering and stem elongation growth stages.

Table 2: Effect of methods of nitrogen application on grain yield and yield components in Njoro and Mau Narok

Methods of nitrogen application	Grains/ main spike	Biomass (g) (5plants)	HI (%)	TKW (g)	Grain yield t/ ha	Grain yield benefits (t/ha)
Njoro						
0	48	148.4	43.9	52.1	3.2c	-
GS22	50.9	180.5	48.5	53.2	5.1b	1.9
GS30	48.6	173.3	46.2	50.9	5.7ab	2.5
Split	51.2	177.7	48.9	53.6	6.1a	2.9
Mean	49.7	169.9	46.9	52.5	5.0	
LSD (0.05)	NS	NS	NS	NS	0.6	
CV(%)	12.1	17.0	15.9	5.5	21.8	
Mau Narok						
0	45.6	48.2b	26.2	39	1.6d	-
GS22	48.3	59.6a	26.5	38.9	26c	0.9
GS30	46.1	59.5a	25.4	40.1	2.8b	1.3

Split	48.7	55.3a	26.9	39.2	3.0a	1.4
Mean	47.2	55.7	26.3	39.3	2.5	
LSD (0.05)	NS	6.19	NS	NS	0.09	
CV (%)	12.12	18.21	18.32	6.57	6.15	

Means in the same column followed by the same letters (a,b,c,d) are not significantly different at α=0.05.

Overall observations (Table 2) show that N application to wheat crop in two splits i.e. (GS-22) and (GS-30), gave the highest yield benefits in both sites. The yield benefits were calculated as follows;

Yield Benefit = Yield (treated plots) – Yield (control plots)

Results obtained hence indicate that nitrogen is more beneficial to the crop when applied in two splits rather than in a single dose.

Conclusion

From the results it can be concluded that K Tai had the highest response to N fertilizer application in terms of grain yields, yield components. Split application of N at tillering and stem elongation to wheat gave the highest grain yield compared to the other methods (growth stages) of N application. It was observed that in both sites, most of the yield determinants were not generally responsive to methods of N application.

Recommendations

It is recommended that variety K Tai in this study was the best wheat in terms of grain yields and responsiveness to nitrogen fertilizer application and may be recommended to farmers for production. Farmers could apply nitrogen to their wheat crop in two splits applications at tillering and stem elongation (GS 22 and GS 30) in order to achieve highest grain yield. More work will be needed on the new varieties, K. Tai, K. Sunbird and K Wren along with other varieties to establish their nutrient use efficiency under different agro ecological zones and management practices.

References

Barmen, C.B, (2012). Climate conditions for wheat growing. eHow.com.

Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), (2009). Kenya Production Potential. Kenya wheat database. Faostat (http://faostat.org/site/526/default.aspx).

Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), (2007). http://faostat.fao.org/site/526/default.aspx.

Gul, H., Saeed, B., Khan Z.A., Haleema, B., Parveen, L., & Badshah, N. (2012). Morphological and some yield attributes in cultivars of wheat in response to varying planting dates, and nitrogen application. *ARPN Journal of agricultural and biological sciences.* 7 (2), 100-109.

Kenya Agriculture Research Institute (KARI) (2005). Crop Management: *In Crop Production Handbook for*

Wheat, Oil crops and Horticulture, Nairobi, KARI.

Khan, M.M., Jan, A., Hassain, N., Jan, M.T., & Qadoos, M. (2011). Rainfed wheat response to tillage and nitrogen. *Sarhad J. Agric.* 27 (4): 519-532.

Lopez, L., Bellido, L.R.J., & Lopez, B.F.J. (2006). Fertilizer Nitrogen Efficiency in Durum Wheat under Rainfed Mediterranean Conditions: Effect of Split Application. *Agron. J.* 98. 55- 62.

Njuguna, M.N., Munene, M., Mwangi, H.G., Waweru, J.K., & Akuja, A.K. 2010). Effect of seeding rate and nitrogen fertilizer on wheat grain yield in marginal areas of eastern Kenya. *Journal of Animal and Plant Sciences*, 7(3), 834-840. Website http://www.biosciences.elewa.org/JAPS:

Onsongo, M. (2003). *Kenya Grain and Feed Wheat Uptake*. USDA Global.

Pavez, S.D. (1989). Effect of seed size and sowing rate of wheat on plant development and some yield components. *Simiente.* 59 (1-2) 21-29.

SAS, (1994). *SAS. Users, Guide Statistics*. SAS Institute Inc. Cary, NC.

Silvina, I. G., Hugo, O.C., & Santiago, J.S. (2005). Biomass production, nitrogen accumulation and yield in wheat under two tillage systems and nitrogen supply in the argentine rolling pampa. *World Journal of Agricultural Sciences*, 1 (1), 36-41.

Silva, T.R.B., Schmidt, R. Silva, C. A. T., Fernando, N., Favero, F., Polentine, J.P. (2011). Effect of Trinexapac-ethyl and nitrogen fertilization on wheat growth and yield. *Journal of Food and Agriculture & Environment*, 9 (1) 596-598.

Tayebeh, A., Abbas, A., & Seyed. A.K. (2011). Wheat yield and grain protein response to nitrogen amount and timing. *Australian Journal of Crop Science*, 5(3)330-336.

Zadoks, J.C., Chang, T.T., & Konzak, C.F. (1974**).** A decimal code for the growth stages of cereals. *Weed Research*, 14, 415-421