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Yield Response of Barley (Hordeum Vulgare L.) to NPS and Urea Fertilizers Rates at Alicho Wuriro Highland, Southern Ethiopia

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Abstract
Barley can be cultivated and gives better yields in a large number of environmental conditions, except in extreme high rainfall areas which limit the yields. The experiment was conducted at Alicho wuriro highland with the objective of determining the effect of determining the optimum rate of NPS and urea fertilizers rates on yield of food barley in 2016 and 2017. The soil is clay loam with pH 4.8, 0.308% N, 3.2 mg/L P, 11.2 mg/L K and 2.4% OC. Two factors, NPS rates (0, 50, 100, 150 and 200 kg/ha) and urea (0, 50 and 100 kg/ha) were combined in 5x3 factorial arrangements of RCBD in three replications. The grain yield was significantly affected due to NPS and urea fertilizers rates. The highest significant economic yield was obtained at the combination of 200 kg/ha NPS and 100 kg/ha urea as compared to other rates in both years. Generally, applications of 200 kg/ha NPS and 100 kg/ha is advised around Alicho wuriro highland.
Keywords: Food barley, NPS, urea, grain yield

Introduction

Barley can be cultivated and gives better yields in a large number of environmental conditions, except in extreme high rainfall areas which limit the yields (Getaneh, 2007). In Ethiopia, among cereals, barley is the fifth most important cereal crop next to teff, maize, sorghum and wheat (CSA, 2009). It is the staple food grain for Ethiopian highlanders, who manage the crop with indigenous technologies and utilize different parts of the plant for preparing various types of traditional food such as *Kita*, *Kolo*, *Beso*, *Enjera*, local beverage called *tela* and as an important raw material for many industries. The world has now "re-discovered" barley as a food grain with desirable nutritional composition including some medicinal properties, which is as a chemical agent known to lower serum cholesterol levels (Anderson *et al*., 1991). Its grain contains carbohydrate, starch, protein and small amount of fat (Martin *et al*., 2006).

Despite its multifaceted benefits the national productivity of barley (19.66qt/ha), remained lower compared to its attainable yield (CSA, 2016). This is mainly due to barley producers, especially, does not benefit from improved inputs like seed and fertilizer, and productivity is stagnant. In addition, the problem of soil erosion in the highlands contributes to low productivity. Now days some nutrients became deficient and needed to be applied to soil to meet plant nutrient requirement. The main nutrients that become depleted and therefore seriously limit soil productivity are nitrogen and phosphorus. The relatively weathered red soils are limited more by a lack of phosphorus, whereas black and less well drained soils are limited more by nitrogen. Nationwide fertilizer trials with cereals have indicated that more than 50% of the soils are highly responsive to the addition of nitrogen, 25% to phosphorus and a very few to potassium. In addition, the nutrient status of most soils is decreasing. Between 70% and 75% of the agricultural soils of the highland plateau area of Ethiopia are deficient in phosphorus (Duffera and Robarge, 1999). The reddish-brown soils of the Ethiopian highlands are highly deficient in phosphorus. Results from fertilizer trials have shown that yields could be doubled, in some cases tripled, with P application (Taye Bekele and Höfner, 1993).

However, the high costs of high grade, water-soluble P fertilizers, coupled with the high fixing capacities of these soils for P, present agronomic and economic constraints to crop production (Sahlemedhin Sertsu and Ahmed Ali, 1983). To supply sulfur commercial fertilizer, DAP is replaced by NPS. Since, the composition of newly introduced fertilizer differ from that of familiar fertilizer (DAP), the appropriate rate is not determined for barley production in the study area. Hence, this research aimed to determine the appropriate, NPS and urea rates for maximum yield of food barley.

Materials and Methods

Experimental Site Description

The experiment was conducted at Alicho wuriro highland from July to September in 2016 and 2017 consecutive years. Alicho Wuriro is one of a District in Siltie Zone and located at 07°56'96"N and 038°09'39''E, and 2814 m.a.s.l. The area receives a bimodal rainfall with an annual average rainfall of 1800 mm. Rainfall is distributed between the short rainfall season (March to April) and the main rainy season (June to September). The minimum and maximum temperature of the area is 10 and 24°C, respectively. The soil is clay loam with pH 4.8, 0.308% N, 3.2 mg/L P, 11.2 mg/L K and 2.4% OC.

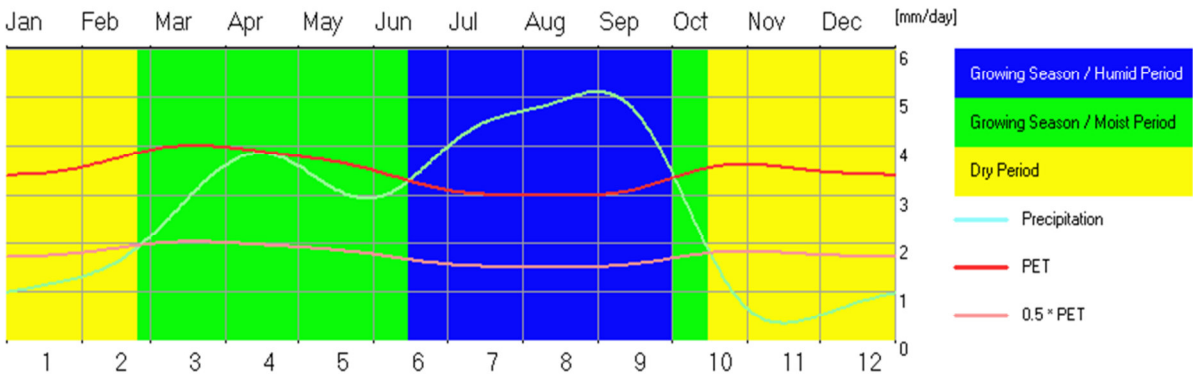

Figure 1. Vegetation period of the experimental site

Experimental Design and Treatments

A factorial combination of two factors, NPS (18% N, 33%P and 9% S) with five levels (0, 50, 100, 150 and 200 kg/ha) and urea with three levels (0, 50 and 100 kg/ha) laid in randomized complete block design (RCBD) with three replications. The experimental land was plowed three times and prepared very well before time of sowing. The area of each plot was 4mx4m. The seed was hand drilled at the rate of 120 kg/ha in the row spacing of 0.2 m apart. The full rate of NPS was drilled based on the treatments in the rows and incorporated with the soil before sowing the seed. Also, the indicated rates of urea were applied in three splits (at sowing, 45 days after emergence and 60 days after emergence). The experimental field was kept free of weed by hand weeding throughout the growth period.

Result and Discussion

NPS fertilizer influenced grain yield of barley significantly ($p< 0.05$). As NPS rate increased, also the grain yield increased. For instance in 2016, application of the highest level (200 kg/ha) resulted in the highest record of grain yield (48.76 Qt/ha) while the smallest (28.25 Qt/ha) was recorded due to control (0 kg/ha NPS) (Table 1). Similarly in 2017, the highest grain yield was recorded due to application of the highest level of NPS. Studies have indicated that phosphorus enhanced root system which provides greater root-soil contact and eventually higher uptake of phosphorus and other important and low mobility nutrients and absorption of higher concentration of mineral nutrients (Zafar *et al.,* 2003).

Correspondingly, the grain yield was significantly increased by urea application in both 2016 and 2017. Accordingly, application of 100 kg/ha urea increased the grain yield by 7.30% and 10.03% compared to the control in 2016 and 2017 respectively (Table 1). Similarly, Zebarth *et al.* (2009) and Pervez *et al.* (2009) revealed that application of nitrogen fertilizer significantly increased spike length, number of grains spike^{-1}, 1000 grain weight and grain yield.

Table 1. Main effect of NPS and urea rates on grain yield (Qt/ha) food barley in two seasons

Treatments	Mean ± SE	
	2016	2017
Urea (kg/ha)		
0	39.67±1.19b	32.83 ±1.36b
50	40.06±1.19ab	36.89±1.36a
100	42.57±1.19a	36.49±1.36a
NPS(kg/ha)		
0	28.25±1.40c	13.84±1.26c
50	39.87±1.40b	35.73±1.26b
100	40.90±1.40b	38.05±1.26ab
150	46.06±1.40a	43.70±1.26a
200	48.76±1.40a	45.67 ±1.26a

Also, the combined effect of NPS and urea fertilization resulted in significant difference of grain yield in both seasons. Combined application of NPS and urea resulted in higher yield compared to application of either fertilizer alone. For instance, highest yield (55.51 qt/ha) was recorded due to application of 200 kg/ha NPS with 100 kg/ha urea while the same rates of fertilizers alone resulted in lower yield in both seasons. Hence, combined application of NPS and urea has yield advantage over application of these fertilizers alone for respective rates. Phosphorus plays a vital role in physiological and developmental process in plant life and favorable effect of this important nutrient might have accelerated the growth process that increases nitrogen uptake in plants (Fatima *et*

al., 2007)

Table 2. Interaction effect of NPS and urea rates on grain yield (qt/ha) of food barley in two seasons

Treatments		Grain yield (Mean ± SE)	
Urea	NPS	2016	2017
	0	22.29±2.16h	21.18±1.43e
	50	34.38±2.16efg	36.94±1.43c
0	100	37.13±2.16fg	36.56±1.43c
	150	39.69±2.16fg	34.21±1.43c
	200	40.47±2.16fg	38.30±1.43c
	0	26.62±2.16h	29.95±1.43d
	50	42.19±2.16def	34.79±1.43c
50	100	48.00±2.16cd	37.35±1.43c
	150	36.59±2.16g	49.26±1.43b
	200	46.89±2.16cde	51.51±1.43b
	0	35.84±2.16g	35.00±1.43c
	50	36.05±2.16g	36.22±1.43c
100	100	37.56±2.16fg	34.19±1.43c
	150	46.89±2.16cde	50.10±1.43b
	200	56.51±2.16a	55.93±1.43a
CV		19.08	19.35

Conclusion and Recommendation

From this study, it is possible to conclude that there was significant effect of NPS fertilizer rates on grain yield of food barley. Also, there was significant effect due to the urea fertilizer rates on grain yield of the food barley.

The combined fertilization of NPS and urea fertilizers showed significant effect on the grain yield of food barley. The combined fertilization of high level of NPS and urea showed the highest record of grain yield. In conclusion, this study shows that the applications of combined fertilization of NPS and urea have significant effect on grain yield of food barley. Hence, the current study recommends that the combined application of 200 kg/ha NPS and 100 kg/ha urea for high yield of food barley in the study area and similar agro ecologies.

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