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Response of Maize (*Zea mays* L.) to Blend (Nitrogen, Phosphorus, Sulfur, Boron) and Potassium Fertilizers Rates at Boloso Sore Woreda, Ethiopia

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ABSTRACT

Background: The declining soil fertility is a severe bottleneck for crop production in Ethiopia. The application of inorganic fertilizer helps to correct a site-specific nutrient deficiency.

Methods: The research was conducted at Achura kebele Farmers Training Center (FTC) from December 2020 to July 2021. Soil samples and crop data were collected and analyzed by standard procedures.

Result: The soil reaction revealed that the soil was moderately acidic (pH=5.68) and low in organic carbon, total nitrogen, available phosphorus, potassium, sulfur and boron. The result of this study indicated that the growth and yield of maize were significantly ($P<0.05$) affected by the combined effect of both blended (nitrogen, phosphorus, sulfur, boron) and potassium fertilizer rates. The highest grain yield (7200.9 kg ha^{-1}) was found from NPSB, 200 kg ha^{-1} + K, 50 kg $ha^{-1}$and the lowest was recorded from control.

Key words: Economic feasibility, Fertilizer, Yield.

INTRODUCTION

In the study area, maize accounts for about 30.5% of the area from cereal crops and about 7,368.1 ton of maize grain yield is produced on 2,532 ha with a productivity of 2.91 t ha^{-1} (BSWAO, 2020). Maize (*Zea mays* L.) is also the most widely cultivated cereal crop, covering 16.08% of the area and 25.81% of the production (CSA, 2016). However, the national and average results of maize for smallholder farmers is 3 t ha^{-1} (CSA, 2016) which is less than from world's average yield (5.6 t ha^{-1}) (FAOSTAT, 2017).

The above data showed that the average maize yield is less than the potential yield (15.8 t ha^{-1}) of maize (Van *et al*., 2013). Among several production constraints, low soil fertility, mainly nutrient deficiency, inadequate soil management practices (Tolera, 2016) and the application of a low rate of organic fertilizers (Sanchez, 2002) are responsible for this low productivity of maize.

According to the agricultural transformation agency of Ethiopia (ATA) (2016), elements like N, P, K, S, Zn, B and Cu are deficient in major Ethiopia soils. Besides this, recent studies conducted by Mesfin *et al.* (2021) indicated that OC, TN and available P and K were low in cropland in different areas of the Wolaita Zone. Blended fertilizers contain balanced nutrients with recommended amounts of macro and micronutrients to produce significantly higher yields in cereal crops than the blanket recommendation of DA .

Different studies showed that the application of newly introduced blended fertilizers had a significant difference in maize crops in various regions of Ethiopia. Mulisa (2019) reported that using fertilizers at a specific rate could improve maize production. However, in the wolaita zone, farmers are currently using 100 kg ha^{-1} NPSB and 100 kg ha^{-1} urea without K for maize production as a blanket recommendation, which may or may not be sufficient to meet the crop requirement. There is no information found on site-specific recommended rates of blended (Nitrogen, Phosphorus, Sulfur, Boron) and Potassium for maize. Therefore, this experiment was conducted to evaluate the response of maize in growth, yield and yield components to blended fertlizers.

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MATERIALS AND METHODS

The current research was conducted at Achura Kebele Farmers' Training Center (FTC), Boloso Sore Woreda, Wolaita Zone and Southern Ethiopia (Fig 1) from December 2020 to June 2021. Random surface soil samples were collected at a depth of 0-30 cm using an auger sample before sowing. The collected soil samples were air-dried and grounded.

Soil texture was analyzed using the hydrometer method (Sahlemedhin and Taye, 2000). The soil pH value was measured potentiometrically using a pH meter with a combined glass electrode in a 1: 2.5 soil: water ratio (Carter 1993). The soil organic carbon was determined following the wet combustion method of Walkley and Black as outlined by (Sahlemedhin and Taye 2000). The total soil nitrogen was analyzed using the Kjeldahl digestion and distillation method (Jackson, 2003). The available phosphorous was determined by Bray and Kurz (1945). Available boron: was determined by using a Spectrophotometer method. The cation exchange capacity (CEC) of the soil was determined by the 1M ammonium acetate pH-7 method (Van Reeuwijk, 1993). The soil's exchangeable bases (K) were determined from the leachate of 1 molar ammonium acetate solution at pH 7 and were read using a flame photometer (Rowell, 1994).

Chemical fertilizers and urea were used as experimental materials, whereas KCl and urea were used as a source of Potassium and nitrogen, respectively. Hybrid (BH540) maize was used. The treatments consisted of a factorial combination of five rates of NPSB, (N,18.9%, P_2O_5 37.7%, S, 6.95%, B,0.1%), fertilizer (0, 50, 100, 150 and 200 kg ha^{-1}), with four rates of KCl, (0-0-60) (0, 47.76, 95.5 and 143.25) kg ha^{-1} which, contained totally 20 treatments.

The treatments were laid out in a randomized complete block design (RCBD) with three replications, 3 × 20 = 60 treatments and they were randomly assigned to each experimental plot (Table 1). The gross size of each field was 3 m × 3 m (9 m^2), consisting of four rows and with a space of 0.75 m × 0. 3 m between row and maize plants, respectively.

To measure ear diameter (cm), about five ears were taken randomly from the net plot area and then their diameters were measured at the middle of the ear with a caliper ruler. The mean value was recorded as ear diameter. A thousand kernel weight (g) was measured by taking about 1,000 kernels randomly and counting by using a kernel counter from the bulk of threshed kernels in each net plot. The area was then weighed using a sensitive balance level. Harvest Index (%) HI was recorded as the ratio of grain yield to total above-ground biomass yield and multiplied by 100% at harvest in each plot.

$$HI = \frac{\text{Grain yield}}{\text{TAGBY}} \times 100$$

Where;

TAGBY = Total above-ground biomass yield.

The mean separation was carried out using the least significant difference (LSD) test at a 5% level of significance when the variance analysis indicated substantial differences busing SAS software 9.2 versions (SAS, 2008).

RESULTS AND DISCUSSION

Pre-sowing soil physio-chemical properties

The soil of the study site has a proportion of 43% sand, 28% silt and 29% clay (Table 2). Thus, according to Bouyoucos's (1962) classification, its texture was sandy clay loam. Soil reaction was moderately acidic soil with a pH value of 5.84 (Table 2) at the surface and suitable for maize production (EthioSIS, 2013). This result is in line with, Shimeles (2006), who suggested that the lower pH values at the surface soil could be due to the seasonal soil.

The available phosphorus content of the soil in the study area was low (Bray and Kurz 1945) (8.42 mg/kg) and needs

Table 1: Details of treatment arrangements and their Nutrient composition.

Fertilizer rate	Nutrient composition %				
	N%	P_2O_5%	S%	B%	K%
Control (no fertilize)	-	-	-	-	-
KCl, 47.76 ha^{-1} + urea, 100 kg ha^{-1}	46	-	-	-	25
KCl, 95.5 kg ha^{-1} + urea, 100 kg ha^{-1}	46	-	-	-	50
KCl, 143.25 kg ha^{-1} + urea, 100 kg ha^{-1}	46	-	-	-	75
NPSB, 50 kg ha^{-1} + urea, 100 kg ha^{-1}	55.45	18.85	3.475	0.05	-
NPSB, 50 kg ha^{-1} + KCl, 47.76 ha^{-1} + urea, 100 kg ha^{-1}	55.45	18.85	3.475	0.05	25
NPSB, 50 kg ha^{-1} + KCl, 95.5 ha^{-1} + urea, 100 kg ha^{-1}	55.45	18.85	3.475	0.05	50
NPSB, 50 kg ha^{-1} +KCl, 143.25 ha^{-1} + urea, 100 kg ha^{-1}	55.45	18.85	3.475	0.05	75
NPSB, 100 kg ha^{-1} + urea, 100 kg ha^{-1}	64.9	37.7	6.95	0.1	-
NPSB, 100 kg ha^{-1} + KCl, 47.76 ha^{-1} + urea, 100 kg ha^{-1}	64.9	37.7	6.95	0.1	25
NPSB, 100 kg ha^{-1} + KCl, 95.5 ha^{-1} + urea, 100 kg ha^{-1}	64.9	37.7	6.95	0.1	50
NPSB, 100 kg ha^{-1} + KCl, 143.25 ha^{-1} + urea, 100 kg ha^{-1}	64.9	37.7	6.95	0.1	75
NPSB, 150 kg ha^{-1} + urea, 100 kg ha^{-1}	74.35	56.55	10.425	0.15	-
NPSB, 150 kg ha^{-1} + KCl, 47.76 ha^{-1} + urea, 100 kg ha^{-1}	74.35	56.55	10.425	0.15	25
NPSB, 150 kg ha^{-1} + KCl, 95.5 ha^{-1} + urea, 100 kg ha^{-1}	74.35	56.55	10.425	0.15	50
NPSB, 150 kg ha^{-1} +KCl, 143.25 ha^{-1} + urea, 100 kg ha^{-1}	74.35	56.55	10.425	0.15	75
NPSB, 200 kg ha^{-1} + urea, 100 kg ha^{-1}	83.8	75.4	13.9	0.2	-
NPSB, 200 kg ha^{-1} + KCl, 47.75 ha^{-1} + urea, 100 kg ha^{-1}	83.8	75.4	13.9	0.2	25
NPSB, 200 kg ha^{-1} + KCl, 95.5 ha^{-1} + urea, 100 kg ha^{-1}	83.8	75.4	13.9	0.2	50
NPSB, 200 kg ha^{-1} +KCl, 143.25 ha^{-1} + urea, 100 kg ha^{-1}	83.8	75.4	13.9	0.2	75

phosphorous fertilizer. This may be due to the high P fixation of the soil, complete removal of crop residues and low input of organic amendments to the cultivated land in the study area. Thus, the soil indicates a crop response to P fertilizers to obtain optimum maize production. The result is in line with (Mesfin *et al*., 2021), who indicated the most cultivated land in the region showed low available soil phosphorus.

Soil organic carbon content was 1.14% having an organic matter content of 1.97% (with a conversion factor of 1.724. According to Tekalign, (1991), the composite sample could be rated as low. Soil organic matter content of the composite surface soil sample from the experimental area was found to be 1.97% (Table 2) and the rating is classified as low. This is may be due to the complete removal of crop residues and low input of organic amendments like compost to the cultivated land. The result is in line with (Tuma 2007), who indicated that intensive cultivation aggravates OM oxidation and reduces OC content. Regarding this fact, proper soil management practices such as adding crop residuals and compost were one the crucial practices to solve the problem.

The total nitrogen content of the experiment area before sowing was 0.19% (Table 2). According to EthioSIS (2013), TN content was low. The low total N contents may be associated with factors that cause a deficiency in organic matter. This indicates that the study area's soils are deficient. The CEC of the site was 11.72 cmol kg^{-1} (Table 2). According to the result obtained from the soil laboratory, the value of CEC was in the low range (Landon, 1991). This can be associated with the low OM content and the role of clay minerals which attract or adsorb many cations from the soil. This finding agrees with Kedir, (2015), who reported the variation in CEC is due to variation in OM.

The content of available potassium contents of the composite sample had 112.8 ppm (Table 2), indicating the soil is deficient in available potassium content (Horneck *et al*., 2011). The result is similar to (Mesfin *et al*., 2021), who indicated in their study, that cultivated land in Wolaita Zone

Table 2: Result of selected physico-chemical properties of experimental soil before sowing.

Parameters	Values	Rates	Reference
Clay (%)	43		
Silt (%)	28		
Sand (%)	29		
Textural class	Sandy clay loam		Bouyoucos (1962)
pH (1:2.5 H_20)	5.84	Moderately acid	EthioSIS (2013)
OC(%)	1.14	Low	Tekalign, (1991)
OM (%)	1.97	Low	Tekalign (1991)
TN (%)	0.19	Low	EthioSIS (2014)
Av. P (ppm)	8.42	Low	Brady and Weil (2000)
Av. K (ppm)	112.8	Low	Horneck *et al*., (2011)
Av.S (ppm)	18.09	Low	EthioSIS (2014)
AB (ppm)	0.50	Low	Horneck *et al*., (2011)
CEC cmol kg^{-1}	11.72	Low	Landon (1991)

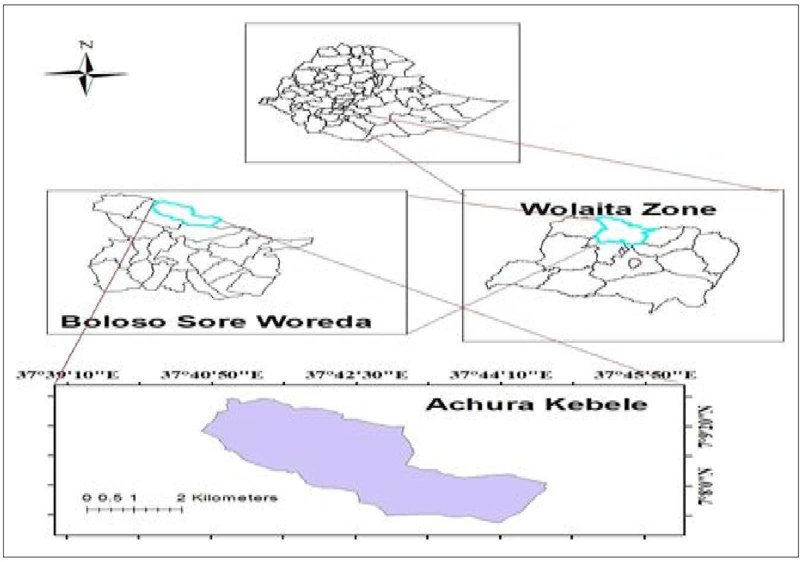

Fig 1: Map of the study site.

was low in available potassium content. Additionally, the result agrees with (EthioSIS, 2013), which recommended potash fertilizer for the study area and contradicted with (Murphy 1968) which stated that Ethiopian soils are rich in K and hence no need for K application.

The available sulfur content of the experimental area was 18.09 (ppm) (Table 2) and the soil has been rated as low. So the addition of fertilizer that contains S is relevant. This low content of S may be due to loss of OM and continuous cultivation, which results in intensive mining of S from the soil. Available Boron in the soil was 0.50 mg kg^{-1} (Table 2). According to Horneck *et al.* (2011), soil availability B content was rated as low, suggesting the application of fertilizer containing B. Intensive cultivation in the area was responsible for the low B content of the soil.

Plant height

As shown in Table 3, the interaction of NPSB and K fertilizer significantly ($p \leq 0.05$) affected the maize height. The maximum plant height (314.10 cm) was obtained from the application of 150 kg NPSB + 50 kg K kg ha^{-1}, while the minimum plant height (178.40 cm) was recorded from control treatments. According to this study, the combined application of NPSB fertilizer with K has significantly increased the plant height compared to the control. This indicated that as early discussed; the soil laboratory result showed that the soil of the study area was low in the amount of available P and K nutrients.

Leaf area and leaf area index

Maize leaf area and leaf area index was significantly ($P<0.05$) affected by the main effect and their interaction of NPSB and K fertilizer application. However, the maximum (8783.8 cm^2) leaf area and (3.90) leaf index were recorded from 200 kg NPSB + 75 kg K ha. In comparison, the minimum (4650.1 cm^2) leaf area and (2.07) leaf area index were recorded from the control. Moreover, the application of NPSB with K had a statistical difference compared to the same used rate of NPSB without K application. For example, the application of NPSB, 200 kg with K, 70 kg/ha was, increased leaf area by (33.21%) and leaf area index by (33.10%) as compared to the same used rate of NPSB at 200 kg ha without K (Table 3). This could be related to applying adequate blended NPSB with K fertilizers as proven macro and micronutrients to the plant, which encouraged cell elongation and more vegetative growth of maize.

Ear length and diameter

The result of this study indicated that there was a significant ($P<0.05$) variation in main and interaction effects on ear length and diameter in response to applied blended NPSB and K fertilizer in the study area (Table 3). Thus, the longest (24.20 cm) and (6.4 cm) ear length and ear diameter were recorded from the application of (200 kg NPSB + 75 kg K ha^{-1}), respectively (Table 3). The variation in ear length and diameter might be

Table 3: Response of growth parameters to combined application of NPSB and K fertilizer rates.

Treatments	Growth parameters				
	PH (cm)	LA (cm^2)	LAI	EL (cm)	ED (cm)
Control	178.40e	4650.1i	2.07i	10.60j	2.10g
KCl 47.76 + 100 Urea	205.10cd	4709.5i	2.09i	11.03ij	2.13g
KCl 95.5 + 100 Urea	207.10cd	4929.4ghi	2.19ghi	11.40ij	2.47g
KCl 143.25 + 100 Urea	228.10c	4837.9i	2.15i	12.40hij	2.70f
NPSB 50 + 100 Urea	215.20c	4876.9hi	2.17hi	12.30ij	2.13g
NPSB 50 + KCl 47.76 + Urea 100	210.7cd	5073.5ghi	2.26ghi	12.87hij	3.70f
NPSB 50 + KCl 95.5 + Urea 100	227.4c	5282.5fghi	2.35fghi	13.67ghij	3.80ef
NPSB 50 + KCl 143.25 + Urea 100	217.50c	5179.2fghi	2.30fghi	13.60hij	4.03ef
NPSB 100+ Urea 100	228.20c	5405.8fghi	2.40fghi	14.20fghi	4.00ef
NPSB 100 + KCl 47.76 + Urea 100	285.40ab	5452.5fghi	2.42fghi	16.00efgh	5.00cd
NPSB 100 + KCl 95.5 + Urea 100	286.10ab	5833.7defg	2.60defg	18.50cde	5.90ab
NPSB100 +KCl 143.25 + Urea 100	305.14ab	6653.8bcde	2.95bcde	17.26def	5.80ab
NPSB 150 + Urea 100	291.40ab	5776.4efgh	2.57efgh	14.50fghi	4.40de
NPSB 150 + KCl 47.76 + Urea 100	305.24ab	5983.1cdef	2.67cdef	16.53efg	5.60be
NPSB 150 + KCl 95.5 + Urea 100	314.10ab	6835.3bc	3.04bc	21.40abc	6.43a
NPSB150 + KCl 143.25 + Urea 100	275.40b	7020.3b	3.12b	20.30bcd	6.00ab
NPSB 200 + Urea 100	236.4c	6593.7bcde	2.93bcde	14.53fghi	4.40de
NPSB 200 + KCl 47.76 + Urea 100	294.10ab	6689.9bcd	2.97bcd	16.67efg	5.70b
NPSB 200 + KCl 95.5 + Urea 100	279.40ab	8604.3a	3.82a	22.10ab	6.40a
NPSB 200 + KCl 143.25 + Urea 100	301.34ab	8783.8a	3.90a	24.20a	6.00a
LSD	35.992	905.53	0.4028	3.5019	0.6910
CV	8.57	9.19	9.20	13.53	9.34

LSD=Least Significant Difference ($p<0.05$), cm=Centimeter, CV=Coefficient of Variation, PH=Plant height, LA=Leaf area, LAI=Leaf index, EL= ear length ED=Ear diameter means values followed by the same letter (s) within the column were not significantly different at 0.05 probability level.

related to the applied balanced nutrient content and the role of Potassium in the utilization of this nutrient.

Number of kernels per ear

There was a significant variation at (P<0.05) in the Number of kernels per ear among treatments. Thus, the highest average number of kernels per ear (469.00) was recorded from the combined application of NPSB with K at a rate of (200 and 50 kg ha^{-1}) followed by (200 and 75 kg ha^{-1}) and (150 and 75 kg ha^{-1}) while, the lowest (155.90) was obtained from control (Table 4). However, the result implied that the application of balanced fertilizer NPSB with K had significant deference from NPSB without K application treatments. For instance, NPSB 200 kg ha with K 75 kg ha application increased maize number of kernels per ear by 54% compared to the same rates of NPSB 200 kg ha^{-1} without K (Table 4). This could be related to the effect of applied nutrient content in (NPSB and K) compared to without K. Moreover, Potassium plays multiple functions in plant growth and development (Sultana *et al*., 2015).

Thousand-grain weight

The output of the field experiment indicated that there were significant differences (P<0.05) in thousand-grain weight in response to the combined application of NPSB with K fertilizer application (Table 4). The maximum (539.80 gm) grain weight was obtained from the application of (NPSB, 200 kg ha^{-1} with K, 50 kg ha^{-1}), while the minimum value was recorded from the control (Table 4). This may be related to the role of used potassium fertilizer in balanced NPSB. It ensures the utilization of applied nutrients and improves seed quality by activating the work of enzymes.

This output is similar to the findings of Mulisa (2019), the highest (425.31 gm) thousand-grain weights was recorded from the application of 250 NPS + 150 urea+ 100 KCl kg ha^{-1} while the lower (300.78 gm) thousand-grain weights were recorded from the control treatment.

Above-ground dry biomass yield

The analysis of variance in this study revealed that there were highly significant (P<0.0170) differences among fertilizer rates on biological yield). The maximum amount of biological yield (17838 kg ha^{-1}) was obtained under the application of 200 NPSB + 100 kg urea + 50 K kg ha^{-1} and the minimum biological yield (8415 kg ha^{-1}) was obtained from the control (Table 4). Besides, balanced fertilizer NPSB and K-applied treatments had statistically significant differences from only NPSB without K-application treatments. For example, NPSB 200 kg ha^{-1} with K 75 kg ha^{-1} increased maize biological yield by 15.47% compared to the same used rates of NPSB at 200 kg ha^{-1} without K applied treatment (Table 4).

Table 4: Response of yield and yield parameters to combined application of NPSB and K fertilizer rates.

Treatments	Maize yield and yield components				
(Fertilizer rates kg ha^{-1})	NKPE	TGW Gm	GY kg ha^{-1}	BY kg ha^{-1}	HI %
Control	155.90h	244.55i	2111.0i	8415.0h	25.13f
KCl 47.76 + 100 Urea	159.23h	244.55i	2385.0i	8418.0h	28.32f
KCl 95.5 + 100 Urea	175.90gh	289.73i	3464.0gh	8414.0h	41.12ab
KCl 143.25 + 100 Urea	165.90gh	279.73hi	3237.0h	8891.0h	36.43bcde
NPSB 50 + 100 Urea	182.57gh	296.40ghi	3870.0gh	10404.0g	37.15bcde
NPSB 50 + KCl 47.76 + Urea 100	212.57gh	299.73ghi	3864.0gh	10400.0g	37.25bcde
NPSB 50 + KCl 95.5 + Urea 100	235.90fg	312.73fgh	4157.7fg	11055.0g	37.80bcde
NPSB 50 + KCl 143.25 + Urea 100	205.90gh	299.73ghi	3871.0fgh	11421.0g	33.80bcde
NPSB 100+ Urea 100	284.23ef	326.07efgh	4844.4ef	13498.0f	35.95cde
NPSB 100 + KCl 47.76 + Urea 100	307.33e	342.73defgh	5477.3de	14094.0ef	39.02cde
NPSB 100 + KCl 95.5 + Urea 100	429.24abc	342.73defgh	5794.6cd	16167.0bcd	35.92cde
NPSB 100 + KCl 143.25 + Urea 100	344.00de	339.40defgh	5256.9de	14951.0de	35.06cde
NPSB 150 + Urea 100	381.00cd	382.73cde	5811.1cd	14094.0ef	41.25ab
NPSB 150 + KCl 47.76 + Urea 100	392.00bcd	386.07bcde	5922.4cd	17135.0ab	34.64ab
NPSB 150 + KCl 95.5 + Urea 100	379.13cd	436.07bc	6270.5bc	17163.0ab	36.54bcde
NPSB 150 + KCl 143.25 + Urea 100	460.23ab	452.60b	6935.9ab	17342.0ab	39.96abc
NPSB 200 + Urea 100	304.00ef	346.07defgh	5504.3de	15447.0cd	35.65cde
NPSB 200 + KCl 47.76 + Urea 100	434.80abc	362.73defg	5573.8cde	16145.0bcd	34.50cde
NPSB 200 + KCl 95.5 + Urea 100	450.00abc	539.80a	7200.9a	16734.0abc	42.97a
NPSB 200 + KCl 143.25 + Urea 100	469.00a	396.07bcd	6786.7ab	17838.0a	38.11bcde
LSD (0.05)	71.104	67.972	747.59	1323.2	4.86
CV %	14.06	11.84	9.21	5.98	8.11

LSD= Least significant difference (p<0.05), cm= Centimeter, CV= Coefficient of variation, Means values followed by the same letter (s) within the column were not significantly different at 0.05 probability level. NKPE= Number of kerneals per ear, TKW= Thousand grain weight, GY= Grain yield, BY= Biological yield, HI= Harvesting index.

Grain yield

There were significant differences at ($P<0.05$) in grain yield in response to the combined application of NPSB and K fertilizer application in the study area (Table 4). The highest grain yield (7200.9 kg ha^{-1}) was obtained in the application of 200 kg NPSB ha^{-1} with 50 kg K ha^{-1}, whereas the lowest (2111.0 kg ha^{-1}) grain yield was obtained from the control treatment (Table 4). Therefore, this response could be due to an adequate supply of N, P, K, S and B application in the form of NPSB and KCl and the role of potassium fertilizer, which might have played an essential role in the overall function of plant growth. Supporting this, before sowing soil surface sample analysis, the study area was low in soil fertility status and available K had found at a low level. In conformity with this result, (Mulisa, 2019) reported that the maximum amount of biological yield (18521.50 kg ha^{-1}) was obtained under the application of 250 NPSB + 100 kg urea + 100 KCl kg ha^{-1} and the minimum biological yield (7675.4 kg ha^{-1}) was obtained from the control treatment. Similarly, Dagne (2016) confirmed that blended fertilizer application significantly increased maize biological yield compared to control and recommended NP.

This result is supported by Mulisa (2019), who reported that the highest harvest index (47%) was recorded from the application of 250 NPSB + 100 urea + 100 KCl kg ha^{-1} and the lowest (38%) was received from the control treatment.

Harvest Index

Harvest index was highly significantly ($P<0.0170$) influenced by the combined application of blended NPSB with K (Table 4). According to the interaction effect, the highest value of HI (42.97%) was obtained due to 200 kg blended NPSB ha^{-1} combined with 50 kg K ha^{-1}, whereas the lowest (25.13%) was obtained from the control treatment (Table 4).

CONCULSION

Therefore, this study concluded that most soil's physical and chemical properties were found at low levels at the surface and maize growth, yield and yield components were significantly affected by the combined application of blended NPSB and KCl fertilizers at the study site. Thus, treating the soil with organic amendments such as compost and bio-fertilizers and adding residuals improve the soil fertility for better crop production.

Conflict of interest: None.

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