



Effect of Blended Fertilizer Rate on Yield and Yield Components of Hybrid Maize Varieties under Irrigation Condition in Low Land Area of South Omo Zone

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ABSTRACT

Maize (*Zea mays* L.) is an important cereal crop in Ethiopia. However, the yield of this crop is limited due to a lack of varieties and blended fertilizer for varieties and site specification. The use of the right amount of fertilizer based on crop requirements has significant importance for sustainable crop production. A study was undertaken to investigate the effects of NPSB blended fertilizer rate for maize yield production at a Dasenech and Nyangatom districts in the lowland area of South Omo Zone, Southern Ethiopia during the 2019/2020 cropping season. The experiment was factorial with three maize varieties (BH-140, BH-540 and MH-140) and four NPSB blended fertilizer rates including kg ha⁻¹(none fertilizer, 50NPSB, 100NPSB, and 150 NPSB). Factorial combinations were used as twelve treatments laid out in a randomized complete block design with three replications. Phenological and growth parameters, as well as yield and yield components data, were collected and subjected to analysis of variance using the SAS software program. The result of analysis of variance revealed that the interaction effect of varieties and blended fertilizer rate highly significant difference in grain yield. The result indicated that the highest grain yield (3624.0 kg ha⁻¹) and net benefit (45,324 Eth-birr ha⁻¹) with MRR of 2123.529 % were obtained from BH-540 variety treated with 100 kg ha⁻¹ of NPSB fertilizer rates at Dasenech location. Whereas, at the Nyangatom location, the highest grain yield (4324 kg ha⁻¹) and net benefit (54,774 Eth-birr ha⁻¹) with MRR of 2968.47 % were obtained from MH-140 variety treated with 100 kg ha⁻¹ of NPSB fertilizer rates. Therefore, based on the yield response and economic analysis indicated, it is recommended BH-540 variety be treated with 100 kg ha⁻¹ of NPSB blended fertilizer rates for Dasenech location, while MH-140 variety treated with 100 kg ha⁻¹ of NPSB blended fertilizer rates for Nyangatom location and their similar soil conditions and agro-ecology.

Keywords: blended fertilizer, hydride maize varieties, profitability, maize grain yield

1. INTRODUCTION

In Ethiopia's agriculture, maize is one of the pillar cereal crops ranking first in total production and productivity, and second to teff in area coverage (FAOSTAT, 2017). Maize in Ethiopia is used directly for human consumption as food or local drinks. In addition, maize leaves are used for feed to animals and dry stalks are used as fuel and for the construction of fences (Akalu, 2015).

In the year 2017, maize was grown on about 322,714.36 ha of land in the SNNP Region from which 1,085,725.3 tons were produced, with a regional average yield of 3.36 t ha⁻¹. During the same year, 22,396.77 ha was covered with maize in South Omo Zone and about 53,973.28 tonnes were produced, making the zonal average yield 2.41t ha⁻¹ (CSA, 2017). This yield is far less than the attainable yield (7 to 8 t ha⁻¹) under good management conditions (MOANR, 2017). The low yield of maize in Ethiopia is attributed to several production constraints which include shortage of improved varieties, poor crop management practices, unbalanced nutrient application, diseases and insect pests (Orkaido, 2004).

Low soil fertility highly negatively affects the growth and development of maize as compared to other crops. As a result, it is often said "maize speaks" implying that maize cannot produce maximum yields unless sufficient nutrients are available (Delorite *et al.*, 1997). When the soil does not supply sufficient nutrients for normal plant growth application of supplemental nutrients is required. Response of maize plants to the

application of fertilizers varies from variety to variety, location to location, and also depends on the availability of the nutrients (Onasanya *et al.*, 2009).

Better matching fertilizer application recommendations to local climate, soil, and management practices help ensure that production can be intensified cost-effectively and sustainably Chimdessa (2016). Hence, understanding the plant nutrients requirement of a given area has a vital role in enhancing crop production and productivity on a sustainable basis. However, in the current study area all agro-pastoralist use their own local variety with no fertilizer application which results in poor grain yield in quality and quantity. Therefore, the main objective of the study evaluated the effects of NPSB blended fertilizer rates on yield, yield component, and its profitability of selected maize varieties under irrigated conditions in the lowland area of t South Omo zone..

2. MATERIALS AND METHODS:

2.1 Description of the study area

The field experiment was implemented in Dasenech and Nyangatom woreda of the lowland area of the South Omo zone during the 2019/20 cropping season. Astronomically, Dasenech woreda found lying roughly between 4°37'–4°48' North latitude and 35°56'–36°20' East longitude, and Nyangatom between 5°05'–5°21' North latitude and 35°55'–36°14' East longitude, respectively. The altitude of the areas varies between 353m.a.s.l-606m.a.s.l for Dasenech, and 380m.a.s.l-497m.a.s.l for Nyangatom district, respectively.

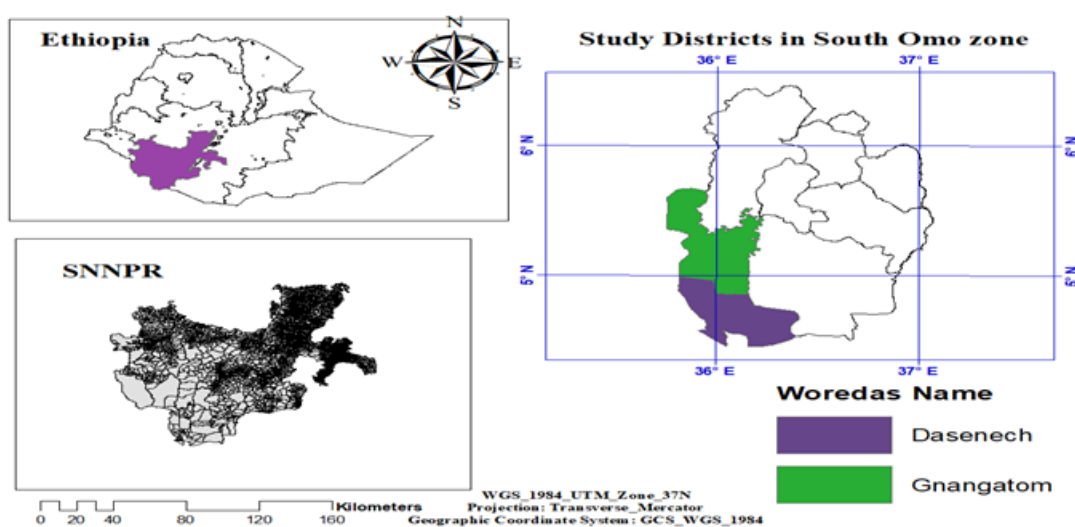


Figure 1: The study area map of Dasenech and Gngangatom woreda

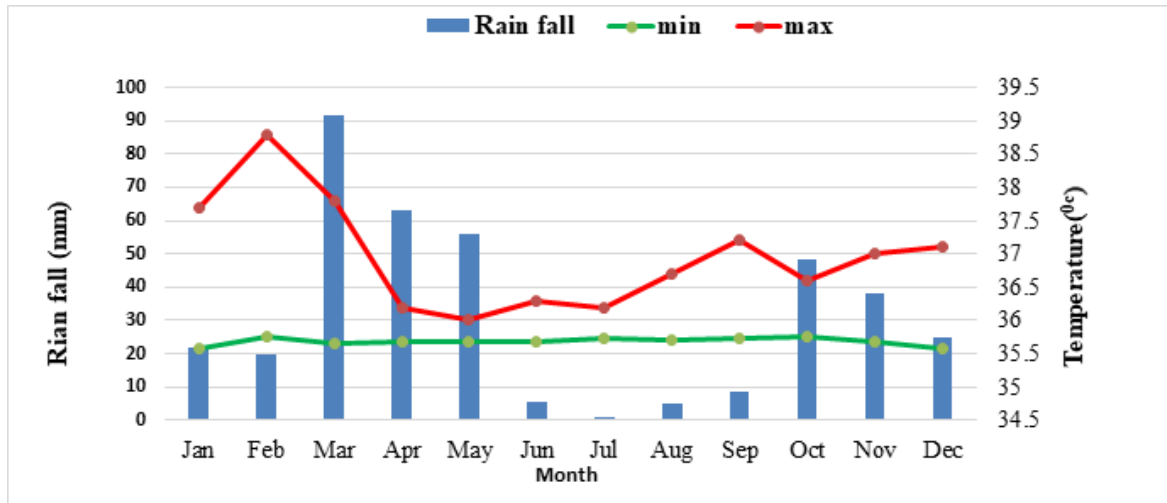


Figure 2. Monthly rainfall, minimum and maximum temperature at Dasenech district (2000-2019 G.C)

According to the districts' agricultural and natural resource office, the climate in these areas is dominantly a semiarid type. The districts have very small, erratic and variable rainfall and high ambient temperature. But at Nyangatom woreda no agro metrological data due to the absence of an agro metrology station. In Dasenech districts the rainfall pattern is bimodal, with a primary rainy season between March to May and secondary small rain between September to December (see figure 2). In these two woredas (administrative districts) the major livestock rearing, agro-pastorals widely practice rain-fed, flood retreat (nowadays very rarely) and irrigated agriculture. They grow Sorghum in number one place followed by Maize and horticultural crops like a banana.

2.2 Experimental design and treatments

The experiment was laid out factorial with three Open-pollinated maize varieties (Melkassa-6Q Melkassa-4 and Melkassa-2) and fertilizer rate formulated by four blended fertilizer rates including kg ha⁻¹ (none fertilizer, 50NPSB+ 100Urea, 100NPSB+ 100Urea and 150NPSB+ 100Urea). Factorial combinations were used as twelve treatments laid out in a randomized complete block design (RCBD) with three replications.

2.3. Experimental procedure and management

The land was ploughed twice, disked and harrowed once and ridged with 75cm by tractor, after which the furrow was corrected by labor. The two seeds were sown at 25cm intra-row spacing and 75 cm inter-row spacing. Thinning was done 15 days after emergence to maintain the target plant densities. Blended fertilizer rates were applied at planting and urea

fertilizer was applied at stem elongation at a constant rate (i.e., 50 Kg ha⁻¹). The gross plot size of the experiment was 5m x5m (25m²). The spacing between replications and plots was 2.0 m. Plots were furrow irrigated every 5-7 days from planting up to flowering and then every 8-10 days up to physiological maturity according to weather condition at Omorate location while at Weyito location, 6-8 days from planting up to flowering and then every 9-11 days up to physiological maturity according to weather condition. Three-time Ethiozinon (Diazinon) 60% E.C was applied at the rate of 1.5 L ha⁻¹ into the leaf using a knapsack sprayer to control fall armyworm. The first, second and third weeding and hoeing were performed 20, 45 and 65 days after emergence, respectively. The net harvestable row was 5 (five) excluding the border two rows.

2.4: Data Collection

2.4.1: Soil data

The soil sample was collected in which 1 Kg composite soil sample from each location for representative of all experimental plots before planting. Collected soil samples were air-dried at room temperature, grounded using mortar and pestle, and passed through a 2 mm diameter sieve for the analyses of selected physico-chemical soil properties using conventional laboratory methods. The laboratory analysis was carried out in Areka Agricultural Research Center, and the analyzed soil parameters include soil texture, soil pH, Total Nitrogen (TN), Organic carbon, available Phosphorus, available Potassium, available Sulfur and available Boron. Soil texture was determined by the Bouyoucos hydrometric method (Bouyoucos, 1962; Van Reeuwijk, 1992) after destroying OM using hydrogen

peroxide (H₂O₂) and dispersing the soils with sodium hexametaphosphate (NaPO₃). The pH of the soil was measured potentiometrically using a digital pH meter in the supernatant suspension of 1:2.5 soils to water ratio. Total N was analyzed using the Kjeldahl digestion, distillation and titration method as described by Black (1965) by oxidizing the OM in concentrated sulfuric acid solution (0.1N H₂SO₄), and whereas organic carbon was determined following the Walkley-Black wet digestion method as described by Ranst et al.(1999). Available phosphorus was determined by the Olsen procedure (Olsen *et al.*, 1954), and that of sulfate (SO₄²⁻) of soil samples was analyzed turbid metrically by calcium chloride dehydrate using the method described in the soil survey manual (USDA, 1984). Available Potassium was determined after extracting the soil samples by ammonium acetate (1N NH₄OAc) at pH 7.0, and Boron in the soil was done by dilute HCl methods.

2.4.2: Plant data

2.4.2.1: Growth parameters

Plant height was measured at the time of physiological maturity from central rows as the mean height of five randomly taken sample plants from the ground level to the apex of each plant. Ear height of five random plants was measured from the base of plants to the node bearing the uppermost useful ear and the average value was recorded in cm. The ear length of five randomly taken ears was measured from ears attached to the stalk to the tip of the ear in cm and the average was used.

2.4 .2.2: Yield components

The number of ears per plant was determined from five randomly sampled plants and the average value was considered. Total above-ground dry biomass yield (kg) was determined by taking the total weight of the harvest including the seeds from five central rows and sun drying the biomass to constant weight and converted to t ha⁻¹. Hundred seed weight (g) was weighted by taking the weight of hundred randomly sampled seeds from the five harvested central rows and adjusted to 12.5% moisture content.

2.4 .2.4: Grain yield

The five central rows per plot were harvested, sun-dried and threshed. The grain yield in kg from each plot was weighed using an electronic balance. Seed moisture content was measured with a moisture meter (DRAMINSKI SN: 10-860 Olsztyn) after which

the grain weight was adjusted to 12.5 % moisture level content and converted to t ha⁻¹. The adjusted yield was calculated using Kenneth (1995) formula.

$$\text{Adjusted grain yield (kg)} = \frac{\text{Actual yield (kg)} * (100 - \text{Actual moisture content})}{(100 - \text{standard moisture content of cereal (12.5 \%})}$$

Harvest index (HI) was computed as the ratio of adjusted grain yield to total above-ground dry biomass (Donald,1962).

$$\text{HI} = \frac{\text{Adjusted grain yield ton/ha}}{\text{above - ground dry biomass ton/ha}}$$

2.5. Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) appropriate to factorial experiment in a randomized complete block design (RCBD) using SAS software program version 9.2 (SAS, 2008) with a generalized linear model (GLM) procedure. Means were separated using the least significant differences (LSD) test at 5 % level of significance.

2.6. Economic Analysis

The cost of other production practices like, watering and weeding was assumed to remain the same or insignificant among the treatments. Analysis of the marginal rate of return (MRR %) was carried out for non-dominated treatments, and the MRRs were compared to a minimum acceptable rate of return (MARR) of 100% to select the optimum treatment (CIMMYT, 1988). The net benefit per hectare for each treatment is the difference between the gross benefit and the total variable costs. The average yield was adjusted downward by 10% to reflect the difference between the experimental field and the expected yield at farmers' fields and with farmer's practices from the same treatments (CIMMYT, 1988)

3. RESULTS AND DISCUSSION

3.1: Physico-Chemical Properties of the Experimental Soil before Planting

Laboratory analysis result of selected soil Physico-chemical properties before planting was indicated in table 2 below. The result indicated that the soil texture class of the study site in Dasenech was sandy clay loam (sand 44 %, silt 28% and clay 28%), and in the Nyangatom sites, it was found to be clay loam (sand 38%, silt 30% and clay 32%) (Table 1). The pH of the sites was in the moderately to slightly acidic range (6.0-6.6) (Ethio SIS, 2014; Tekalign, 1991). The organic

carbon content of the soils was 0.9% and 0.23% for Dasenech and Nyangatom sites, respectively. In addition, the soils of the study sites contained total nitrogen content of 0.08% for Dasenech and 0.02% for Nyangatom; and available Phosphorus contents of 6.15 mg Kg⁻¹ for Dasenech and 6.68 mg Kg⁻¹ for Nyangatom, respectively. The result showed that available Potassium, Sulfur and Boron content; for Dasenech site was 58.90 mg Kg⁻¹, 2.14 mg Kg⁻¹ and 0.16 mg Kg⁻¹, respectively and For Nyangatom was 54.43 mg Kg⁻¹, 18.19 mg Kg⁻¹ and 0.26 mg Kg⁻¹, respectively. As it can be observed from the table below, soils of the Dasenech sites were dominated by sand fractions or coarse texture until 20 cm depth, and hence they consequently retain few nutrients and have a low

water-holding capacity (Berry et al., 2007). Therefore, soil management practices which lead to an increase in the fine fraction, lighter but more frequent irrigation and fertilization are generally helpful in improving soil properties and crop productivity (FOA, 2014). In addition, as per the ratings by Ethio SIS (2014), total nitrogen, available phosphorus and potassium were found to be very low and organic carbon was found to be low in the two study sites. Similarly, available Sulfur and Boron are also in a very low to low range (Ethio SIS, 2015). Therefore, this, in general, tells us that getting crop yields from all these two study locations would no more be easy without significant fertilization of the soil.

Table 1: Laboratory analysis result of selected soil Physico-chemical properties before planting

| physical parameters | Dasenech | Nyangatom |
|------------------------------|------------------------|------------------|
| | Value | Value |
| soil texture | | |
| Sand (%) | 44.00 | 38.000 |
| Silt (%) | 28.00 | 30.00 |
| Clay (%) | 28.00 | 32.00 |
| Textural class | sandy clay loam | clay loam |
| Chemical parameters | | |
| pH | 6.03 | 6.25 |
| Total Nitrogen (%) | 0.08 | 0.020 |
| Available Phosphorus (mg/Kg) | 6.15 | 6.68 |
| Available Potassium (mg/Kg) | 58.90 | 54.43 |
| Available Sulfur (mg/Kg) | 2.41 | 18.19 |
| Available Boron (mg/Kg) | 0.16 | 0.26 |
| Organic Carbon (%) | 0.90 | 0.23 |

Table 2: main effect of the mean value for plant height and ear height of hybrid maize research conducted in south Omo zone during 2020 cropping season.

| Treatments | Dasenech location | | Nyangatom location | |
|--|-------------------|-----------------|--------------------|-----------------|
| | Plant height (cm) | Ear height (cm) | Plant height(cm) | Ear height (cm) |
| Varieties | | | | |
| MH-140 | 186.75b | 82.00b | 245.65a | 121.58a |
| BH -140 | 199.33a | 104.83a | 221.13b | 119.72ab |
| BH-540 | 204.00a | 108.08a | 221.70b | 114.53b |
| LSD(0.05) | 6.57 | 3.95 | 17.36 | 6.11 |
| Blended Fertilizer Rate (kg/ha) | | | | |
| 0 | 171.11d | 82.17d | 208.31b | 110.64c |
| 50NPSB+ 100Urea | 190.33c | 93.17c | 229.31a | 112.53c |
| 100 NPSB+100Urea | 206.67b | 104.17b | 234.02a | 119.60b |
| 150 NPSB+100Urea | 218.67a | 113.72a | 246.33a | 131.67a |
| LSD(0.05) | 7.59 | 4.57 | 20.04 | 7.06 |
| CV (%) | 3.95 | 4.75 | 8.93 | 6.09 |

3.2. Effects of Blended Fertilizer Rate on Growth Parameters of Maize Varieties

3.2.1: Plant height at maturity

In this study at Dasenech and Nyangatom location, plant height was significantly ($P < 0.01$) affected by the main effects of varieties and blended fertilizer rate, while was not significantly ($P < 0.05$) affected by their interaction of varieties with blended fertilizer rate (Table 2). The tallest plant height (204.0cm) and (245.7cm) were measured from BH-540 and MH-140 varieties at Dasenech and Nyangatom sites, respectively. Whereas, the lowest plant height (186.8cm) and (221.13cm) were measured from MH-140 and BH-140 variety at Dasenech and Nyangatom sites, respectively. This specifies that morphological variation was observed among maize varieties in a different location. The possible reason for varieties showed different responses for different locations might be due to environmental influences causes of their significant differences. This result was in agreement with the finding of Tolera *et al*, 2017 who reported that hybrid maize varieties different responses for a different locations.

With regards to NPSB blended fertilizer rate. The tallest plant height (218.7cm) and (246.3cm) were measured from 150 kg NPSB/ha blended fertilizer rate at Dasenech and Nyangatom sites, respectively. While, the shortest plant height (171.1cm) and (208.3cm) were measured from h zero fertilizer application at Dasenech and Nyangatom location, respectively (Table 2). In general, these results showed that an increase in plant height with an increased blended fertilizer rate from 0 to 150kg NPSB/ ha blended fertilizer application (Table 2). This increment in plant height might be due to an increase in cell elongation and more vegetative growth attributed to different nutrient content. This result was in line with Landon (2991) who indicated that plant growth and development retarded significantly if any of the nutrient elements is less than its threshold value in the soil or not adequately balanced with other nutrient elements. Similarly, Jeet *et al.*, (2012) obtained that, the tallest plant height at the highest fertilizer rate might be fertilizer has a beneficial effect on plant metabolism which affects the physiological process of the crop and thereby increases the growth parameters.

3.2.2: Ear height (cm)

Analyst of variance showed that ear height was significant variations ($p \leq 0.01$) among the main effect

of varieties blended fertilizer rate, whereas their interaction was not significantly influenced at both sites (Table 2). Maximum ear height (108.08cm) and (121.6cm) were measured from BH-540 and MH-140 varieties at Dasenech and Nyangatom sites, respectively. Whereas, the minimum ear height (82.00cm) and (114.5cm) were measured from MH-140 and BH-540 variety at Dasenech and Nyangatom sites, respectively. As blended fertilizer rates increased from 0 to 150 kg ha⁻¹ ear height was increased (Table2). This study was conforming to the finding by Mekuannet & Kiya (2020) reported that blended fertilizers increased similarly ear height of maize increased.

3.2.3: Ear length (cm)

Analyst of variance showed that ear length was significant variations ($p \leq 0.01$) among the main effect of varieties blended fertilizer rate, whereas their interaction was not significantly influenced at both sites (Table 2). Maximum ear lengths (27.33cm) and (28.88cm) were measured from BH-540 and MH-140 varieties at Dasenech and Nyangatom sites, respectively. Whereas, the minimum ear height (24.00cm) and (26.98cm) were measured from BH-140 variety at Dasenech and Nyangatom sites, respectively. This trait also showed that blended fertilizer rates increased from 0 to 150 kg ha⁻¹ ear length was increased (Table2). This result was in agreement with the finding by Onasanya (2009) who reported that, the height ear length was obtained from fertilizer treated with compared to zero fertilizer on maize crops

3.3. Yield and yield components

3.3.1: Above ground dry biomass yield (kg ha⁻¹)

The main effects of varieties and blended fertilizer rate showed a highly significant ($P < 0.01$) effect on above-ground dry biomass, while their interaction effect was not significantly influenced on above-ground dry biomass (Table 3). The highest above-ground biomass (13658kg/ha) and (13897kg/ha) were recorded from BH -540 and MH -140 variety at Dasenech and Nyangatom locations, respectively. Whereas, the lowest above-ground biomass (12175kg/ha) and (13897kg/ha) were recorded from BH -540 and MH-140 variety at Dasenech and Nyangatom locations, respectively. Above-ground biomass (11733kg/ha) and (12205kg/ha) were recorded from BH-140 variety at Dasenech and Nyangatom locations, respectively (Table 3). This result showed that the responses of above-ground biomass yield to locations is quite different among and

within varieties. This result was in agreement with Ahmed *et al.* (2003 who report that above-ground biomass was affected by the main effect of varieties and locations.

The highest above-ground biomass (14256kg/ha) and (14583kg/ha) were recorded from 150 kg/ha of NPSB fertilizer rate at Dasenech and Nyangatom locations, respectively. Whereas, the lowest above-ground biomass (11633kg/ha) and (12105kg/ha) were recorded from zero NPSB fertilizer rate at Dasenech

and Nyangatom locations, respectively. Above-ground biomass (11733kg/ha) and (12205kg/ha) were recorded from BH-140 variety at Dasenech and Nyangatom locations, respectively (Table 3). This result is in accordance with Mekuannet and Kiya, (2020) who reported that a significant disparity was observed in biomass yield of maize due to blended fertilizer rate and the highest blended fertilizer rate level was given higher above-ground biomass yield, whereas the lowest biomass yield was found where treated with the lowest NPS level.

Table 3: main effect of the mean value for plant height and ear height of hybrid maize research conducted in south Omo zone during 2020 cropping season.

| Treatments | Dasenech location | | Nyangatom location | |
|--|-------------------|----------------------|--------------------|---------------------|
| | Ear length (cm) | Dry biomass (kg/ ha) | Ear length (cm) | Dry biomass (kg/ha) |
| Varieties | | | | |
| MH-140 | 26.25ab | 12883b | 28.88a | 13897a |
| BH -140 | 24.0b | 12175c | 26.98b | 12205c |
| BH-540 | 27.33a | 13658a | 28.12ab | 13268b |
| LSD(0.05) | 1.188 | 414.69 | 2.52 | 433.89 |
| Blended Fertilizer Rate (kg/ha) | | | | |
| 0 | 25.08c | 11633d | 21.18c | 12105c |
| 50NPSB+ 100Urea | 26.93bc | 12333c | 25.38b | 13383b |
| 100 NPSB+100Urea | 28.98ab | 13400b | 25.49b | 12422c |
| 150 NPSB+100Urea | 30.78a | 14256a | 31.39a | 14583a |
| LSD(0.05) | 2.53 | 478.84 | 2.92 | 501.01 |
| CV (%) | 9.25 | 3.8 | 11.52 | 3.91 |

Table 4: Mean values for the effect of the interaction of blended fertilizer rate on the grain yield of hybrid maize varieties at Dasenech and Nyangatom, South Omo Zone during 2019/ 20 cropping season

| Varieties | Blended fertilizer rate (kg/ha) | Dasenech location | | Nyangatom location | |
|-------------------|---------------------------------|---------------------|-------------------------|---------------------|-------------------------|
| | | Grain yield (kg/ha) | Hundred seed weight (g) | Grain yield (kg/ha) | Hundred seed weight (g) |
| BH-140 | 0 | 1900.0g | 26.50j | 2002.3f | 29.17f |
| | 50NPSB+ 100Urea | 2325.3de | 28.50i | 2215.7de | 31.97def |
| | 100 NPSB+100Urea | 2314.7de | 30.50g | 2157.3ef | 33.66cde |
| | 150 NPSB+100Urea | 2242.7defg | 34.00def | 2086.7ef | 38.00ab |
| BH-540 | 0 | 2450.7cd | 33.50ef | 2008.0f | 35.17bcd |
| | 50NPSB+ 100Urea | 2293.3def | 29.83h | 2392.0def | 33.67cde |
| | 100 NPSB+100Urea | 3624.0a | 36.17a | 3000.0c | 31.50ef |
| | 150 NPSB+100Urea | 2726.7bc | 35.67ab | 2309.3def | 31.00ef |
| MH-140 | 0 | 1938.0fg | 34.50cd | 2417.3def | 36.83abc |
| | 50NPSB+ 100Urea | 2224.0defg | 33.33f | 3480.0b | 32.83de |
| | 100 NPSB+100Urea | 3080.0b | 35.17bc | 4324.0a | 39.83a |
| | 150 NPSB+100Urea | 2020.0efg | 34.18de | 3020.0c | 33.17de |
| LSD (0.05) | | 362.91 | 26.50j | 465.25 | 3.48 |
| CV (%) | | 8.87 | 1.21 | 10.54 | 6.07 |

3.3.2: Grain yield (kg ha⁻¹)

The main effects of varieties and blended fertilizer rate, as well as their interaction, showed a highly significant ($P < 0.01$) effect on grain yield (Table 3). This result showed that the responses of grain yield to blended fertilizer rate are quite different among and within varieties. Tolera *et al.* (2017) who reported that there is a genetic variability for maize grain yield to fertilizer level and obtained the genotype with fertilizer level interaction was significant. The highest grain yield (3624kg/ha) and (4324kg/ha) were recorded from BH-540 and MH-14 variety with 100 kg NPSB /ha at Dasenech and Nyangatom location, respectively and the lowest grain yield (1900kg/ha) and (2002kg/ha) were recorded from BH-140 variety with 0kg NPSB /ha at Dasenech and Nyangatom location, respectively (Table 3). All tested varieties produced significantly higher mean grain yield as compared to maize varieties planted without blended fertilizer application rate. The higher mean grain yield advantage which was ranged from 22.4 to 90.7% was achieved with 100kg/ha blended fertilizer application as compared to maize varieties planted without fertilizer application in Dasenech location, while in Nyangatom location mean grain yield advantage of 10.7 to 115.9% were achieved from hybrid maize varieties planted with blended fertilizer application as compared to zero (Table 4). This result was in agreement with Tolera *et al.* (2017) who obtained that, mean grain yield advantage of 24 to 66% was achieved from hybrid maize varieties planted with blended fertilizer application as compared to control. Mekuannet and Kiya, (2020) who reported that, grain yields were increased from in maize varieties at fertilizer application levels with compared to without fertilizer application. Similarly, Singh and Daoudi (2017) reported that the grain yield of maize varieties was increased as fertilizer increased until a certain level. Dagne (2016) also verified that application of blended fertilizer on maize crop as brought significantly highest grain yield as compared to control, standard control of NP and recommended NP + Cu +Zn. Additionally, Jafer (2018) found better grain yield from the application of blended fertilizer compare to recommended NP fertilizer and unfertilized plot.

3.3.2: Hundred Seed Weight (kg ha⁻¹)

The main effects of varieties and blended fertilizer rate, as well as their interaction, showed a highly significant ($P < 0.01$) effect on grain yield (Table 3). The maximum hundred seed weight (36.17g) and

(39.83g) were recorded from BH-540 and MH-14 variety with 100 kg NPSB /ha at Dasenech and Nyangatom location, respectively and the minimum hundred seed weight (26.50g) and (29.17g) were recorded from BH-140 variety with 0kg NPSB /ha at Dasenech and Nyangatom location, respectively (Table 3). This finding was slightly similar to Onasanya *et al.* (2009) who found that the lowest thousand seed was obtained from zero blended fertilizer application with compared to fertilizer application.

3.3.5. Harvest index

Harvest index is a measure of the physiological productivity potential of a variety. A crop can convert the dry matter into economic yield. The main effects on harvest index were significant for both varieties and plant densities ($P < 0.01$) while, the interaction effect was not significant (Table 3). The maximum harvest index (0.2321) and (0.239) were recorded from were recorded from BH -540 and MH -140 variety at Dasenech and Nyangatom locations, respectively. The minimum harvest index (0.1644) and (0.175) were recorded from BH -540 variety at Dasenech and Nyangatom locations, respectively. With regards to NPSB blended fertilizer rate, the maximum harvest index (0.208) and (0.232) were recorded from 50 NPSB kg/ha and 100NPSB kg/ha at Dasenech and Nyangatom location, respectively and the minimum harvest index (0.165) and (0.1167) were recorded from 150NPSB kg/ha fertilizer rate at Dasenech and Nyangatom location, respectively. Similarly, Ahmad *et al.* (2003) who indicated that there was a significant variation in harvest index due to varieties. Orkaido (2004) also found that different rates of inorganic fertilizer rate had a significant effect on maize harvest index.

3.4: Economical Analysis

The most important step in performing partial budget analysis is the proper identification of data on the costs and benefits associated with the alternative technologies. It is known that farmers apply fertilizer to get profit. Achieving the goal of yield increment depends not only on the kind and amount of fertilizer but also on the cost of the fertilizer, seed and price of the yields (Black, 1992). All variable costs were calculated based on the current price of grain yield, Labor to apply fertilizer and blended fertilizers and urea as per the information obtained from local markets. The cost of Labors was 50 Birr/day, while NPSB and Urea were 17, 16 and 15 Birr kg⁻¹, respectively.

Table 6: Summary of partial budget analysis of the effects of blended fertilizer rates rate on maize varieties at Dasenech location

| Varieties | Blended fertilizer arte (kg/ha) | Av. Yield kg/ha | 10% Adj. yield | Gross Field Benefits (ETB/ha) | Total variable cost (ETB/ha) | Net Benefit (ETB/ha) | Dominance analysis | MRR% |
|---------------|---------------------------------|-----------------|----------------|-------------------------------|------------------------------|----------------------|--------------------|----------|
| BH-140 | 0 | 1900 | 1710 | 25650 | 0 | 25650 | D | |
| | 50NPSB+100Urea | 2325.3 | 2092.77 | 31391.55 | 2750 | 28641.55 | D | |
| | 100 NPSB+100Urea | 2314.7 | 2083.23 | 31248.45 | 3600 | 27648.45 | D | |
| | 150 NPSB+100Urea | 2242.7 | 2018.43 | 30276.45 | 4,450 | 25826.45 | D | |
| BH-540 | 0 | 2450.7 | 2205.63 | 33084.45 | 0 | 33084.45 | | |
| | 50NPSB+100Urea | 3080 | 2772 | 41580 | 2750 | 38830 | | 479.27 |
| | 100 NPSB+100Urea | 3624 | 3261.6 | 48924 | 3600 | 45324 | | 2123.529 |
| | 150 NPSB+100Urea | 2726.7 | 2454.03 | 36810.45 | 4,450 | 32360.45 | D | |
| MH-140 | 0 | 1938 | 1744.2 | 26163 | 0 | 26163 | D | |
| | 50NPSB+100Urea | 2224 | 2001.6 | 30024 | 2750 | 27274 | D | |
| | 100 NPSB+100Urea | 2293.3 | 2063.97 | 30959.55 | 3600 | 27359.55 | D | |
| | 150 NPSB+100Urea | 2020 | 1818 | 27270 | 4,450 | 22820 | D | |

Where: Av.Yield=Average yield, 10% Adj. yield= Adjusted yield, TVC=Total Variable Cost and MRR% =marginal rate of return, MRR = change in net income / change in cost x 100 Costs and returns (income) are described in Birr ha

Table 7: Summary of partial budget analysis of the effects of blended fertilizer rates rate on maize varieties at Nyangatom location

| Varieties | Blended fertilizer arte (kg/ha) | Av. Yield kg/ha | 10% Adj. yield | Gross Field Benefits (ETB/ha) | Total variable cost (ETB/ha) | Net Benefit (ETB/ha) | Dominance analysis | MRR% |
|---------------|---------------------------------|-----------------|----------------|-------------------------------|------------------------------|----------------------|--------------------|---------|
| BH-140 | 0 | 2002.3 | 1802.07 | 27031.05 | 0 | 27031.05 | D | |
| | 50NPSB+100Urea | 22157.3 | 19941.57 | 299123.6 | 2750 | 296373.6 | D | |
| | 100 NPSB+100Urea | 2157.3 | 1941.57 | 29123.55 | 3600 | 25523.55 | D | |
| | 150 NPSB+100Urea | 2086.7 | 1878.03 | 28170.45 | 4,450 | 23720.45 | D | |
| BH-540 | 0 | 2008 | 1807.2 | 27108 | 0 | 27108 | D | |
| | 50NPSB+100Urea | 2392 | 2152.8 | 32292 | 2750 | 29542 | D | |
| | 100 NPSB+100Urea | 3000 | 2700 | 40500 | 3600 | 36900 | D | |
| | 150 NPSB+100Urea | 2309.3 | 2078.37 | 31175.55 | 4,450 | 26725.55 | D | |
| MH-140 | 0 | 2417.3 | 2175.57 | 32633.55 | 0 | 32633.55 | | |
| | 50NPSB+100Urea | 3480 | 3132 | 46980 | 2750 | 44230 | | 625.416 |
| | 100 NPSB+100Urea | 4324 | 3891.6 | 58374 | 3600 | 54774 | | 2968.47 |
| | 150 NPSB+100Urea | 3020 | 2718 | 40770 | 4,450 | 36320 | | 1270.17 |

Where: Av. Yield=Average yield, 10% Adj. yield= Adjusted yield, TVC=Total Variable Cost and MRR% =marginal rate of return, MRR = change in net income/change in cost x 100 Costs and returns (income) are described in Birr ha

The selling price of maize at the local market around the South Omo Zone area was taken as Birr 15 kg⁻¹ for grain yield. The highest net benefit (45324 Eth-birr) and MRR value of (2123.529%) was obtained from BH-540 variety with treated with 100 kg ha⁻¹ of NPSB blended fertilizer rate for Dasenech location (Table 6). Whereas at the Nyangatom location, the highest net benefit (54774 Eth-birr) and MRR value of (2968.47%) were obtained from MH-140 variety with treated with 100 kg ha⁻¹ of blended fertilizer rate (Table 7). The result shows the highest MRR have highest net benefit per ha.

4: CONCLUSION AND RECOMMENDATION

The current study was undertaken to investigate the effects of NPSB blended fertilizer rate for maize yield production at Dasenech and Nyangatom districts in the lowland area of South Omo Zone during the 2019/2020 cropping season. The experiment was factorial with three maize varieties (BH-140, BH-540 and MH-140) and four NPSB blended fertilizer rates including kg ha⁻¹ (none fertilizer, 50NPSB, 100NPSB, and 150 NPSB). Factorial combinations were used as twelve treatments laid out in a randomized complete block design (RCBD) with three replications. Phonological and growth parameters, as well as yield and yield components data, were collected and subjected to analysis of variance using the SAS software program.

The result of analysis of variance revealed that the interaction effect of varieties and blended fertilizer rate highly significant difference in grain yield. The result showed that, the highest net benefit (45324 Eth-birr) and MRR value of (2123.529%) were obtained from BH-540 variety with treated with 100 kg ha⁻¹ of NPSB blended fertilizer rate for Dasenech location. Whereas at the Nyangatom location, the highest net benefit (54774 Eth-birr) and MRR value of (2968.47%) were obtained from MH-140 variety with treated with 100 kg ha⁻¹ of blended fertilizer rate. Therefore, based on the yield response and economic analysis indicate that BH-540 varieties and MH -140 variety treated with 100 kg ha⁻¹ of NPSB blended fertilizer can be recommended to Dasenech and Nyangatom location, respectively and other similar agro-ecologies

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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