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Effects of Blended (NPSZnB) and Urea Fertilizer Rate on Growth, Yield and Yield Components of Maize in Ultisols of Toke Kutaye District

Adane Adugna, Tolera Abera, Bezuayehu Tola, Tolcha Tufa, Hirpa Legesse and Tesfaye Midega

Ambo Agricultural Research Center, Ethiopia Institute of Agricultural Research, P.O. Box: 382, Ambo, West Showa, Oromia, Ethiopia

Abstract: Maize growers need balanced crop nutrition to maximize its yield potential and get the most out of their fertilizer investment. In practice, this requires making all of the required nutrients available to the maize crop by the right amount or rate. So, the objective was to determine the optimum blended (NPSZnB) and urea fertilizer rates on growth, yield and yield components of maize in Toke Kutaye district west Showa Zone. The experiment was laid out using randomized complete block design in factorial arrangement with three replications. The treatments consisting of four rates of blended (150, 200, 250, 300 kg NPSZnB ha^{-1}) and three rates of Urea (150, 250 and 350 kg ha^{-1}) were tested with negative control and blanket recommended NP (119/69 kg ha^{-1}) having a total of 14 treatments for 2018/2019 and 2019/2020 cropping seasons. Application of urea and blended fertilizer levels were significantly ($P<0.05$) affected almost all the growth, yield and yield components of maize in both year except thousand seed weight in 2018/2019 as compared to blanket recommendation and control. The highest mean grain yield (7592 and 5329 kg ha^{-1}) in both cropping seasons respectively were obtained from application of (350/200 kg Urea/NPSZnB ha^{-1}) while the lowest grain yield (1343 and 921 kg ha^{-1}) both in 2018 and 2019 respectively were obtained from control. The highest net benefit of EB 44140 ha^{-1} with marginal rate of return of 287 % was obtained from application of 350/200 kg Urea/NPSBZn ha^{-1} followed by net benefit of EB 39439 ha^{-1} with marginal rate of return 189% was obtained from application of 250/200 kg Urea/NPSBZn ha^{-1} in Toke kutaye district. Both higher grain yield and net benefit were obtained from application of 350/200 kg Urea/NPSBZn ha^{-1}. Therefore, application of 250/200 kg Urea/NPSBZn ha^{-1} was produced better yield and economical optimum for maize production in in Toke Kutaye district and similar agroecology.

Key words: Blended Fertilizer · Npsznb · Maize · Grain Yield

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important food crops in the world. Global acreage of maize was 188 million ha, of which 36% (68 million ha) were in developing and low-income countries in 2016 [1]. The role of maize to ensure rural food security is even higher in some of the least developed countries of sub Saharan Africa [2]. For example, over 55% of the daily calorie intake of Zambian households is derived from maize alone [3]. However, maize is not only a food crop for humans but used as feed and fodder for livestock production, driven largely by the rapid economic growth in Asia and Latin America [4]. It also has significant industrial importance as a raw material for bioethanol production, also in developing countries, alongside other crops [2]. In Ethiopia, maize is one of the top priority food crops selected to achieve food security, particularly in the major maize producing regions, western, north western and southern parts of the country. Currently, maize covers large cultivated area (2,128,448.91 hectares), next to teff and coming first of all cereals in production and productivity in this country [5]. Despite the large area under maize, the regional and national average yield of maize is about 3.94 t ha^{-1} [5] and 3.99 t ha^{-1} [6], respectively. This is by far below the world's average

Corresponding Author: Tolera Abera, Ambo Agricultural Research Center, Ethiopia Institute of Agricultural Research, P.O. Box: 382, Ambo, West Showa, Oromia, Ethiopia.

yield which was about 5.6 t ha^{-1} [7]. Meeting this increasing food-feed-energy demand is one of the major challenges of maize production sectors across the developing world, which are constrained by natural resource depletion and degradation, input scarcity, climate change and persisting poverty among the producers.

The main reasons for the low self-sufficiency include soil nutrient depletion, soil erosion and erratic or low precipitation [8]. Declining soil fertility is one of the major challenges to crop production and productivity in Ethiopia [9]. High incidence of soil erosion, continuous cultivation of the same land, deforestation, inadequate application of organic and inorganic nutrient sources, abandoning of useful traditional soil fertility management techniques such as fallowing, crop rotation, shifting cultivation are some of the causes of soil fertility decline in the country [10, 11]. The low productivity of maize is due to inappropriate cropping systems, mono-cropping, nutrient mining, unbalanced nutrient application, removal of crop residues from the fields and inadequate re-supplies of nutrients have contributed to decline in crop yields [12].

Current fertilizer recommendation of maize in Ethiopia is based on very general crop specific guidelines or more often, a single recommendation for all crops (100 kg DAP (18-46-0) and 200 kg Urea (46-0-0) [13]. This blanket recommendation often fails to take into consideration differences in resource endowment (soil type, labor capacity, climate risk) or make allowances for dramatic changes in input/output price ratio, thereby discouraging farmers from fertilizer application [13]. Moreover, the nutrients in the blanket recommendation are not well balanced agronomically and its continued use will gradually exhaust soil nutrient reserves. Therefore, neither yields nor profits can be sustained using imbalanced application of fertilizers, as the practice results in accelerating deficiencies of other soil nutrients. Today, in addition to N and P, S, B and Zn deficiencies are widespread in Ethiopian soils, while some soils are also deficient in K, Cu, Mn and Fe [14].

To overcome the constraint of low nutrient recovery and optimize fertilizer use, there is need to replace such general and over-simplistic fertilizer recommendations with those that are rationally differentiated according to agroecological zones (soils and climate), crop types, nutrient uptake requirements and socio-economic circumstances of farmers. Better matching fertilizer application recommendations to local climate, soil and management practices helps ensure that production can be intensified in a cost-effective and sustainable way and, thereby, enhance regional food security [13]. The concept of balanced fertilization paves the way for optimum plant nutrient supply to realize full yield potential of crop. However, continuous use of imbalance fertilizers causes decline in soil fertility and yield reduction. The yield obtained by the farmers in the study areas is low mainly due to poor essential soil nutrient [15]. Nutrient mining due to sub optimal fertilizer use coupled with unblended fertilizer use favored the emergence of multi nutrient deficiency in Ethiopian soils [16-18] and resulted in stagnant crop production. To overcome this problem of nutrient deficiency balanced fertilizers containing N, P, S, B, Fe and Zn have been recommended for site specific nutrient deficiencies and thereby increase crop production and productivity, water and labor productivity [14]. The major recently recommended blended fertilizers for Oromia region by MOA and ATA are NPS, NPSB, NPSZn, NPSZnB, NPSFeZn and NPSFeZnB [15]. Although the type of required blended fertilizers are identified for the region, optimum rates of the major recommended blended fertilizer types for different crops, agro-ecologies and soil types are not yet determined for the region. Besides, it is quite essential to verify the soil fertility map for major crops grown in different agro-ecologies and on different soil types to increase and to improve quality of major crops grown in study area. Hence, the objective was to determine the optimum blended NPSZnB and urea fertilizer rate on yield and yield component of maize in west Showa zones of Toke Kutaye districts.

MATERIALS AND METHODS

Descriptions of the Study Area: The study was conducted on farmers' fields during 2018 and 2019 cropping seasons in humid highland agroecosystems of Toke Kutaye District western Oromia National Regional State, Ethiopia. It is located at 37°72'80" to 37°72'83" E longitude and 8°98'31" to 8°98'88" N latitude with altitude ranging from 2294 to 2303 meter above sea level. The mean annual rainfall is ranged 800-1100 mm. The mean minimum and maximum temperature of the area is 10 and 29 ºc, respectively [19]. The soils are very deep, well-drained, brown clay loam Ultisols [20].

Treatments and Experimental Procedures: The experiment was conducted on farmers' fields in Toke Kutaye District during 2018/19-2019/2020 cropping seasons for two consecutive years. The experiment was laid out in randomized complete block design with factorial arrangement in three replications. The experiment was designed based on the nutrient deficiency of the area which indicated in the soil fertility map of Oromia [15]. Accordingly, four rates of blended (150, 200, 250 kg NPSBZn ha^{-1}) and three rates of UREA (150, 250, 350 kg urea ha^{-1}) fertilizers with one NP blanket recommendation (200/150 kg Urea/diammonium phosphate ha^{-1}) and one negative control. So, the experiment consists of fourteen treatments combinations.

The plot size was 4.5 m x 4.5m (20.25m^2) and the net harvested plot size area was 13.5m^2. The spacing between rows and plants were 75cm and 25 cm, respectively. Maize variety (Jibat), well adapted in the study area was used as a test crop. Blended fertilizers were basal applied at planting and Urea was top dressed in twice (1/2 at knee height and the remaining ½ at blooming stage), whereas sources of NP blanket recommendation were P from Triple super phosphate (TSP) and N from urea. Maize was planted in rows with recommended spacing. Two seeds of maize per hill was planted and after emergence; thinned to one plant per hill to keep uniformity of the plant. During the different growth stages of the crop, all the necessary field management practices were carried out as per the research recommended practices for maize.

Soil Sampling and Laboratory Analysis: Soil samples were randomly collected from surface layer of the experimental field (i.e., 0-20 cm soil depth) to form composite before sowing and analyzed for the soil texture, pH, available P, total N, Cation exchange capacity (CEC) and Organic Carbon. The soil samples were air-dried and ground to pass 2- and 0.5-mm sieves (for total N). All samples were analyzed following standard laboratory procedures. Soil texture was determined using the Bouyoucos hydrometer method [21]. The pH of the soil was measured in the supernatant suspension of a 1:2.5 soil to water ratio using a pH meter [22]. Organic carbon (%) was determined by method as described by [23]. Available P was analyzed by employing the Olsen method using ascorbic acid as the reducing agent [24]. Total nitrogen was measured using Kjedahl method as described by [25]. CEC in cmol (+) kg-1 soil was determined by ammonium acetate method.

Plant Data Collection and Analysis: Central plants were used for data collection. Growth, yield and yield components of maize such as plant height, dry biomass, thousand seed weight, grain yield was collected and finally harvest index was calculated. The plant height from five randomly plants was measured from the base of the plant to upper top tassel of the plant and the average value was computed. Grain yield and dry biomass were determined after harvesting the entire net plot area of 13.5m^2 and converted to per hectare at 12.5% moisture level. The grain yield from the middle was recorded and adjusted by the standard formulae to grain yield per hectare basis. Thousand seed weights were determined by counting and weighing from the bulk of shelled grain at 12.5% moisture level and expressed in gram. Harvest index was calculated by dividing grain yield in kg per hectare for dry biomass in kg per hectare in percentage bases.

Data Analysis: Analysis of variance was carried out for the collected data following statistical procedures appropriate for the experimental design using SAS computer software version 9.3 [26]. Whenever treatment effects were significant, the means was separated using the least significant difference (LSD) procedures test at 5% level of significance [27].

Economic analysis: Economic analysis was performed to investigate the economic feasibility of the treatments (fertilizer rates) following [28]. The average yield was adjusted downwards by 10 % to reflect the difference between the experimental plot yield and the yield of farmers field. The average open market price for maize of EB 9 kg ha^{-1}, the official urea fertilizer price EB 14.04 kg ha^{-1} and NPSZnB EB 16.39 kg ha^{-1}.

RESULTS AND DISCUSSION

Soil Physicochemical Properties of the Experimental Site: Selected physicochemical properties of soil samples prior to the field experiment were presented in Table 1. Soil of the experimental fields were clay loam in textural distribution. The soil pH of the experimental site was slightly acidic [29]. The total nitrogen content of soil was 0.15 %, found in low range [29, 30]. The available phosphorus content of the soil was 14.14 ppm found in medium range [31]. The organic carbon and organic matter contents of the soil were 1.75 and 3.01 % and found in medium range [29, 30]. The cation exchange capacity of the experimental site was 33.32 cmol(+) kg^{-1} and found in high range. The soil properties of the experimental site were ranged from low to high ranges need management soil fertility using different fertilizer sources for sustainable maize production.

Plant height: The mean of plant height of maize is shown in Table 2. There was significant ($p \leq 0.05$) variations on plant height maize in both cropping seasons with application of blended and Urea fertilizer

Table 1: Selected soil physicochemical characterization of the experimental field before planting

Soil parameters	Value	Remark
Soil PH (by 1:2.5 soil water ratio)	6.5	Slightly acidic
Total Nitrogen (%)	0.15	low
Available phosphorus(ppm)	14.14	medium
Organic matter (%)	3.02	medium
Organic carbon%	1.75	medium
Cation exchange capacity(cmol(+) kg^{-1})	33.32	high
Soil texture		
Clay%	45	
Silt%	30	
Sand%	25	
Textural class	Clay loam	

Source: Tekalign (1991); Landon, (1991); Msanya *et al.* (2000)

Table 2: Effects of blended and Urea fertilizer on plant height and dry biomass of maize in Toke Kutaye district in 2018/19 and 2019/2020 cropping seasons

UREA and NPSZnB (kg ha^{-1})		Plant height (cm) 2018	2019	mean	Dry biomass (kg ha^{-1}) 2018	2019	mean
150	150	192^{cd}	187^{d}	$190d^{e}$	14721^{e}	9921^{f}	12321^{g}
150	200	194^{cd}	214^{abc}	204^{bc}	16474^{cde}	12432^{cde}	14453^{efg}
150	250	205^{abc}	198^{bcd}	201^{cd}	19116^{abcde}	12864^{bcde}	15990^{bcdef}
150	300	218^{ab}	195^{cd}	206^{abc}	18627^{abcde}	11746^{def}	15186^{def}
250	150	202^{bc}	207^{abcd}	204^{bc}	17857^{bcde}	13264^{abcd}	$15560c^{def}$
250	200	209^{abc}	199^{bcd}	204^{bc}	20810^{abcd}	13432^{abcd}	17121^{abcde}
250	250	212^{ab}	215^{abc}	213^{abc}	21294^{abc}	14911^{ab}	18102^{abc}
250	300	217^{ab}	214^{abc}	216^{ab}	19185^{abcde}	15467^{a}	17326^{abcd}
350	150	212^{ab}	216^{ab}	214^{abc}	16479^{cde}	13956^{abcd}	15020^{def}
350	200	216^{ab}	209^{abc}	213^{abc}	22731^{ab}	15198^{a}	18964^{a}
350	250	221^{a}	212^{abc}	216^{ab}	22795^{ab}	14267^{abc}	18531^{ab}
350	300	216^{ab}	220^{a}	218^{a}	22879^{a}	15363^{a}	19121^{a}
150	200	180^{d}	196^{cd}	188^{e}	15852^{de}	11027^{ef}	13440^{fg}
0	0	119^{e}	120^{e}	120^{f}	4010^{f}	2363^{g}	3187^{h}
LSD (5%)		16.52	22.7	12.6	5001.8	2210.1	2668.2
CV (%)		4.9	6.7	5.4	16.5	10.46	15.1

Means followed by the same letters are not significantly different ($P \leq 0.05$).

rates. Plant height of maize was significantly higher in all treated with blended and urea fertilizers compared to control. But there was no significant variation amongst all the rates of blended and urea fertilizer except with control in both years. Higher mean plant height (221 and 220 cm) of maize was recorded from application of 250/350 kg NPSZnB urea ha^{-1}, while lowest (119 and 120 cm) was recorded from control in 2018/2019 and 2019/2020 cropping seasons. Significantly higher combined over years mean of plant height (218cm) of maize was also recorded from the application of 300/350 kg Urea/NPSZnB ha^{-1}, while lowest (120cm) over years mean of plant height was recorded from control plot. This increment in plant height might be due to increase in cell elongation and more vegetative growth attributed to different nutrient contents of NPSZnB blended fertilizer. On the other hand, the least plant height in unfertilized plots might have been due to the low soil fertility level in the study area. Plant height increased as N increased, this could be attributed to a mere fact that higher rates of nitrogen may have caused rapid cell division and elongation [32].

Plant growth and development may be retarded if any of nutrient elements is less than its critical value in the soil or not adequately balanced with fertilization [33]. Plant growth and development may be 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 [29]. Dassalegn *et al.* [13] found that effect of N rates under blended fertilizer of PKSZnB with highly significantly effect on plant height as compared to negative control and standard control (92 N, 69 P2O5) kg ha^{-1} when N levels increased from 0, 46, 92, 138, 176 and 222 kg ha^{-1}. Similarly, Kinfe *et al.* [33] reported that blended fertilizer significantly increased plant height as compared to the recommended NP

Table 3: Effects of blended and Urea fertilizer rates on grain yield, thousand seed weight and harvest index of maize in 2018, 2019 cropping seasons and combined over years in Toke Kutaye district

Urea and NPSZnB (Kg ha^{-1})		Grain yield (kg ha^{-1})			Thousand seed weight (g)			Harvest Index (%)		
		2018	2019	Mean	2018	2019	Mean	2018	2019	mean
150	150	3981.7^{e}	3153^{e}	3567^{f}	335.6	288.7^{abc}	312^{ab}	28^{e}	32^{b}	30^{d}
150	200	4897.9^{de}	4050^{bcde}	4474^{e}	329.0	308.4^{ab}	319^{ab}	30^{cde}	32^{b}	31^{bcd}
150	250	5440.8^{cd}	4055^{bcde}	4748de	377.8	301.3^{abc}	340^{a}	29de	32^{b}	30^{cd}
150	300	5416.1^{cd}	3712de	4564^{e}	357.1	278.8^{abc}	318^{ab}	29^{cde}	31^{b}	30^{cd}
250	150	6030^{bc}	4689^{abcd}	5360^{cd}	335.6	264.7^{bc}	300^{bc}	34^{a}	35^{ab}	35^{a}
250	200	6704.7^{ab}	4709^{abc}	5707^{bc}	363.6	281.4^{abc}	322^{ab}	32^{abc}	35^{ab}	34^{ab}
250	250	6564.4^{ab}	5031^{ab}	5798^{abc}	350.4	276.9^{abc}	314^{ab}	31^{abcde}	33^{b}	32^{abcd}
250	300	5716.4^{bcd}	5162^{a}	5439^{cd}	365.6	259.9^{c}	313^{ab}	30^{bcde}	33^{b}	32^{abcd}
350	150	6674.7^{ab}	4674^{abcd}	5674^{bc}	341.2	271.2^{bc}	306^{abc}	32^{abc}	33^{b}	33^{abc}
350	200	7592.2^{a}	5329^{a}	6461^{a}	332.2	297.3^{abc}	315^{ab}	34^{a}	35^{ab}	35^{a}
350	250	7193.5^{a}	4697^{abcd}	5946^{abc}	364.6	303.5^{abc}	334^{ab}	32^{abcd}	33^{b}	32^{abcd}
350	300	7141^{a}	5216^{a}	6179^{ab}	350.4	305.7^{ab}	328^{ab}	32^{abcd}	34^{ab}	33^{abcd}
200	150	5280.1^{cd}	3818^{cde}	4549^{e}	371.8	318.5^{a}	345^{a}	33^{ab}	35^{ab}	34^{ab}
0	0	1342.7^{f}	921^{f}	1132^{g}	324.6	211.1^{d}	268^{c}	34^{a}	34^{a}	34^{ab}
LSD (5%)		1051	986.75	708.3	NS	43.9	14.8	3.48	8.3	3.2
CV (%)		10.96	13.9	12.3	10.89	9.2	10.7	6.6	14.5	8.6

Means followed by the same letters on the same column are not significantly different at 5 % probability level

fertilizers and the control. Thus, the results indicate that blended fertilizers application has enhanced the maize vegetative growth. As the application of blended and urea fertilizers rates increased, plant height also increased, especially the treatments that treated with high urea fertilizer which stimulates the vegetative growth of plants. Likewise, Mitiku and Haileyesus [34], Besufikad and Tesfaye [35] reported that mean plant height of maize increased as the rate of nitrogen increases.

Dry Biomass Yield: The mean biomass yield of maize is indicated shown in Table 2. There were significant ($p \leq 0.05$) variations among blended and urea fertilizer rates on dry biomass yield maize in both cropping seasons. Significantly higher mean dry biomass yield of maize was obtained with application of blended and Urea fertilizers compared to control. Non-significant variation amongst all the rates of applied blended and urea fertilizer except with control in both years. The highest dry biomass yield (22879 and 15467 kg ha^{-1}) were recorded from application of 300/350 and 300/250 kg Urea/NPSZnB ha^{-1}, while lowest biomass yield (4010 and 2363 kg ha^{-1}) were recorded from control. Highest combined mean of dry biomass yield (19121 kg ha^{-1}) of maize was recorded from application of 300/350 kg Urea/NPSZnB ha^{-1} while lowest (3187 kgha^{-1}) mean dry biomass yield was recorded from control. When the biomass yield of both cropping seasons compared, higher biomass yield was measured in 2018 cropping season, this was may be because of continuous vegetative growth of maize crop until the rainfall withdrew [33]. It is a known fact that plants require huge amounts of N nutrients compared to all other essential nutrients. Therefore, the low yields in unfertilized plots might have been due to reduced leaf area development resulting in smaller radiation interception which further translates to low efficiency in the conversion of solar radiation to maintain efficient photosynthesis.

Likewise, Dassalegn *et al.* [13] reported that significantly higher biomass yield of maize at the rate of 46 kg N ha^{-1} under blended fertilizer of PKSZnB as compared to negative control, standard control (92 N, 69 P2O5) kg ha^{-1} and 222 kg N ha^{-1} at N treatments under blended arranged from 0, 46, 92, 138, 176 and 222 kg N ha^{-1}. Similarly, Kinfe *et al*. [33] blended 250 kg NPSZnB ha^{-1} fertilizer gave higher dry biomass yield of maize. AS the rates of urea and blended fertilizer increases in both cropping season the biomass yield of maize also increased. Mekuannet and Kiya [36] reported that mean dry biomass yield of maize was significantly higher with higher rates of nitrogen and increase by 5.6 and 9.9% from the application of 87 and 130.5 kg N ha^{-1} over 43.5 kg N ha^{-1} fertilizer rates.

Grain Yield: The mean grain yield of maize is shown in Table 3. There were significant ($p \leq 0.05$) variations among blended and urea fertilizer rates on mean grain yield of maize in both cropping seasons. The mean grain yield of maize was significantly higher with application of blended and Urea fertilizers as compared to control.

Table 4: Effects of urea and blended (NPSZnB) fertilizer rates on economic feasibility of maize production

Urea (kg ha^{-1})	NPSBZn (kg ha^{-1})	Grain yield (kg ha^{-1})	Adjusted grain yield (kg ha^{-1})	Gross field benefit (EB ha^{-1})	Urea cost (EB ha^{-1})	NPSZnB cost (EB ha^{-1})	TCV (EB ha^{-1})	Net benefit (EB ha^{-1})	Value to cost ratio	MRR (%)
0	0	1132	1018	9166	0	0	0	9166		
150	150	3567	3211	28895	2106	2458.5	4565	24331	5.33	2160
200	150	4549	4094	36847	2808	2458.5	5267	31581	6.00	6170
150	200	4474	4027	36240	2106	3278	5384	30856	5.73	
250	150	5360	4824	43412	3510	2458.5	5969	37444	6.27	626
150	250	4748	4273	38457	2106	4097.5	6204	32254	5.20	
250	200	5707	5136	46227	3510	3278	6788	39439	5.81	189
150	300	4564	4107	36967	2106	4917	7023	29944	4.26	
350	150	5674	5107	45962	4914	2458.5	7373	38590	5.23	
250	250	5798	5218	46963	3510	4097.5	7608	39356	5.17	
350	200	6461	5815	52332	4914	3278	8192	44140	5.39	287
250	300	5439	4895	44056	3510	4917	8427	35629	4.23	
350	250	5945	5351	48158	4914	4097.5	9012	39147	4.34	
350	300	6179	5561	50046	4914	4917	9831	40215	4.09	

EB= Ethiopian Birr, D=dominated, maize grain price EB =9 kg ha^{-1}, NPSBZn price EB=16.39 kg^{-1}, Urea price EB=14.04 kg^{-1}

Significantly higher grain yield of maize was obtained with higher rates of nitrogen fertilizer. Mekuannet and Kiya [36] reported that higher grain yield (11.7 and 11.3 t ha^{-1}) was obtained from variety BHQPY545 with application of higher 87 and 130.5 kg N ha^{-1} fertilizer rate in 2019 cropping season. The highest mean grain yield of 7592, 5329 and 6461kg /ha^{-1} in 2018, 2019 and combined over years with application of 350/200 kg Urea/NPSZnB ha^{-1}. The highest grain yield (7592, 7193 and 7141 kg ha^{-1}) were obtained from application of 350/200, 350/250 and 350/300 kg Urea/NPSBZN ha^{-1}, respectively (Table 3). Similarly, Mekuannet and Kiya [36] reported that combined application of 150 kg NPS with 87 and 130.5 kg N ha^{-1} was produced significantly higher grain yield (10.7 and 10.4 t ha^{-1}) of maize. Mean grain yield of hybrid maize varieties was increased as N increased [37].

The lowest mean grain yield (1343 and 921 kg ha^{-1}) of maize in 2018 and 2019 cropping seasons were obtained from control. Bakala [38] reported that significantly higher gran yield of maize was obtained with application of 200 Kg NPSZnB + 150.2 N ha^{-1} fertilizer rate. Similarly, Dessalegn *et al*. [13] found that effect of N rate at the of 46 kg N ha^{-1} under blended fertilizer of NPKSZnB significantly higher grain yield maize crop as compared to negative control and standard control 92/30 NP kg ha^{-1}. Non consistent increased mean, grain yield of maize was with increased fertilizer starting from the treatment 150/150 to 350/200 kg Urea/NPSZnB ha^{-1}, then decreased. The increase in grain yield could be attributed to beneficial effect of yield contributing characters and positive interaction of nutrients in the blended fertilizer. It was known that plants required huge amount of N nutrient as compared to all essential nutrients [33]. Likewise, Jafer [39] found that better grain yield from application of blended fertilizer as compared to recommended NP and unfertilized plot. Similarly, Olusegun [40] reported that higher grain yield of maize was obtained with application of the combination of N at 90 kg ha^{-1} and P at 30 kg ha^{-1}. Significantly higher grain yields of (3.20 and 2.97 t ha^{-1}) maize were obtained with application of 300 kg NPSZnB ha^{-1} while the lowest from control at Laelay Adiyabo and Medebay Zana districts [33].

Thousand Seed Weight: The mean thousand seed weight is indicated in Table 3. The mean thousand seed weight of maize was non significantly (P>0.05) affected by application of blended and urea fertilizer rates in 2018/2019 cropping season while significantly (P<0.05) affected in 2019/2020 cropping season and combined over years. (Table 3). Thousand seed weight of maize did not show any variations among application of blended and urea fertilizer levels. Highest thousand seed weight (378 and 318 g) in 2018 and 2019 were obtained with application of 150/250 kg Urea/NPSZnB ha^{-1} and 200/150 DAP/ Urea ha^{-1} respectively. While the lowest (325 and 211 g) in 2018 and 2019 were obtained from the control. Similarly, Dagne [41]; Tekle and Wassie [42] found that application of blended fertilizers significantly increased thousand seed weight as compared to the control.

Harvest Index: The application of blended and urea fertilizers had significant (P<0.05) effects on harvest index of maize (Table 4). The highest harvest index (34%) of maize was realized from the application of 250/150, 350/200 kg urea/NPSZnB ha^{-1} and control as compared to other blended fertilizer rates while the lowest (28%) harvest index of maize was realized from application of 150/150 kg urea/NPSZnB ha^{-1} in 2018/2019 cropping season. In 2019 cropping season, the highest(35%) harvest index of maize was realized from the application of 250/150 kg, 250/200, 350/200 kg urea/NPSZnB ha^{-1} and recommended rate as compared to other blended fertilizer rates while the lowest (31%) harvest index of was realized from application of 150/300 kg urea/NPSZnB ha^{-1}. The highest (35%) harvest index of maize combined over year was realized from the application of 250/150 and 350/200 kg urea/NPSZnB ha^{-1} while the lowest (30%) harvest index of maize was obtained from application of 150/150 kg, 150/250 and 150/300 kg urea/NPSZnB ha^{-1}, but statistically par with control and recommended fertilizer rate. In contrary, Kinfe *et al*. [33] reported that harvest index of maize was found to be highest in blended fertilizer treatments.

Effects of Blended and Urea fertilizer rate on Economic Feasibility of Maize Production: The partial budget analysis result is indicated in Table 4. Higher net benefit EB 44140 ha^{-1} with marginal rate of return of 287% and value to cost ratio of EB 5.39 per unit of investment was obtained from application of 350/200 kg urea/NPSBZn ha^{-1}followed by net benefit of EB 39439 ha^{-1} with marginal rate of return of 189 % and value to cost ratio of EB 5.81 per unit of investment was obtained from application of 250/200 kg urea/NPSBZn ha^{-1}. The highest marginal rate of return 6170 and 2160 % were obtained with combined application 200/150 and 150/150 kg urea/NPSZn ha^{-1} fertilizer rates. Similarly, higher marginal rate of returns of 242 and 255% were obtained from application of 150 kg NPSZnB ha^{-1} at Laelay Adiyabo and Medebay Zana districts [33]. The lowest net benefit of EB 9166 ha^{-1} was obtained from the control plot. In most cases, farmers prefer the highest profit (with low cost and high income). The optimum net benefit of maize was obtained from application of 250/200 and 250/150 kg Urea/NPSZnB ha^{-1}. Similarly, Mekuannet and Kiya [36] reported that higher net benefit EB 85458 ha^{-1} with a higher marginal rate of return 1659% was obtained from the combined application of 150 kg NPS with 87 kg N ha^{-1}. Therefore, application of 250//200 and 250/150 kg Urea/NPSZnB ha^{-1} would be advisable for farmers in the study area for maize production and alternatively application of 350/200 kg urea/NPSBZn ha^{-1} is also recommended for resource rich farmers

CONCLUSION

Maize production and productivity have been limited mainly due to declining soil fertility, unbalanced application of plant nutrients and application of fertilizer without soil test-based crop response and use of inappropriate fertilizer recommendations. Replenishment of deficient fertilizer nutrients based on soil test is a good strategy to improve maize crop production and productivity in sustainable way. The combined application of blended (NPSZnB) and urea fertilizers rates significantly improved maize yield and yield components of maize in Toke Kutaye district. Application of urea and blended fertilizer rates was produced maximum mean of grain yield (7592 and 5329 kg ha^{-1}) both were recorded from 350/200 kgha^{-1} Urea/NPSZnB fertilizers in 2018 and 2019 cropping seasons. The highest net benefit of EB 44140 ha^{-1} was recorded from application of 350/200 kg Urea/NPSBZn ha^{-1} with marginal rate of return 287% followed by net benefit of EB 39439 and 37444 ha^{-1} with application of 250//200 and 250/150 kg Urea/NPSZnB ha^{-1}. Therefore, application of application of 250//200 and 250/150 kg Urea/NPSZnB ha^{-1} were recommended alternatively for maize production in Toke kutaye district and similar agroecologies.

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