Original Research Article

Determining the best rate of blended NPKSZnB fertilizer for optimum onion yield and yield components in northwestern Tigray, Ethiopia

Abstract

Aim: The nutrient content of current fertilizer recommendations is unbalanced and is based on a very general and uniform recommendation for all soil and crop types, and their economic benefit is low. Therefore, this study was initiated to validate the recommendations regarding blended fertilizers applied to the soil and to identify the best fertilizer dose that ensures optimal yield and maximum economic return.

Study Design: The experiment was designed using a randomized complete block design with three replications and seven treatments.

Place and Duration of the study: The field experiment was conducted in the off-season of 2018 and 2019 in TahtayKoraro (two farmers), and Laelayadyabo (twofarmers) districts of Tigray regional state in northern Ethiopia.

Methodology: Seven treatments with NPKSZnB fertilizer rates (25, 50, 100, 150, 200, 250 and 300 kg·ha-1) were tested under irrigation conditions. Thus, for each plot nitrogen from urea was applied at a rate of 150 kg ha-1. Surface soil samples were collected before planting onion harvesting at a depth of 0-20 cm to analyze selected soil chemical properties such as pH, extractable electric conductivity (ECe), cation exchange capacity (CEC), total nitrogen (TN), available P and exchangeable bases (K, Mg, Ca, and Na).

Results: The use of different doses of NPKSZnB under irrigation conditions had a statistically significant$(P \leq 0.05)$impact on onion phenology, yield and yield components. The highest average onion yield (10,329 and 19,196 kg ha-1) was obtained after applying compound fertilizer doses of 200 and 250 kg ha-1 in TeahtayKoraro and LaelayAdyabo districts, respectively. However, the use of NPKSZnB fertilizer at a dose of 100 and 50 kg ha-1 for onion cultivation under irrigated conditions in T/koraro and L/adyabo districts was found to be economically viable. Therefore, growers in both districts should use NPKSZnB compound fertilizer at these rates for onion production.

Conclusion: Therefore, both districts should use NPKSZnB compound fertilizer at these rates for onion production.

Key words*:* - Blended Fertilizer, Economic Return, Irrigation, Onion, and Yield

1. Introduction

Agriculture has continued to keep its importance in Ethiopia's economic growth subsidizing about 42% of GDP, with 80% of employment and 70% of export earnings in 2014 [1].

The majority of Ethiopian farmers are small-scale producers– estimates shows about 94% of Ethiopian farmers rely on less than 5 hectares of land, of which 55% cultivate less than 2 hectares [2].

Crop productivity still remains very low relative to its potential yields, only averaging 2.21 t/ha between 2010 and 2014 [3].

Moreover, only 5% of the country's agricultural land is irrigated, largely leaving agriculture to the fate of unreliable and poorly distributed rains. According to [4], low productivity could be attributed to many factors including land degradation, small farm size, recurrent drought and poor farm technology.

Despite of the use of fertilizers in irrigated agriculture nation wise, its economic return is low. This is because the current fertilizer recommendation in Ethiopia is based on very general or more often a single recommendation.In the early 70s with an initial understanding that nitrogen and phosphorus are the major limiting nutrients, nationwide on-farm demonstrations trials were conducted and as a result a blanket rate of 100 kg ha^{-1} DAP or 50 kg urea ha^{-1}+ 100 kg DAP ha^{-1} were recommended irrespective of crop and soil types [5].

This blanket recommendation often fails to consider the differences in resource endowment (soil and crop types, climate) or make allowances for dramatic changes in input/output price ratio, thereby discouraging farmers from fertilizer application. Moreover, the blanket recommendation has favored the emergence of multi nutrient deficiency in Ethiopian soils [6-7], that in part may led to soil productivity decline experienced over recent past due to sub optimal fertilizer use in one hand and unbalanced fertilizer uses on the other. Absence of one or more nutrients despite continued use of N and P fertilizer as per the blanket recommendation can hold back crop productivity. This could explain, in part, the modest crop yield improvements observed over the last few decades in contrast to significant increases in fertilizer use and investment made in the country. Today, in addition to N and P; there exists a widespread deficiency of K, S, B and Zn in Ethiopian soils, while some soils particularly in Tigray are also deficient in Fe[8]. Therefore,future gains in food grain production will be more difficult and expensive bearing in mind the growing problem of multi nutrient deficiencies.

Integrated use of suitable fertilizer types and cropping system are of key for sustainable crop production as proper combination of fertilizers and cropping system can increase crop yield by 50% [9]. Better matching fertilizer 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 as well as national food security. Optimum use of fertilizers to overcome the constraints of low nutrient recovery needs to replace such general and over-simplistic fertilizer recommendation with those that are rationally differentiated according to climate, soils and crop types, plant nutrient requirements and socio-economic circumstances of farmers.

Hence, different area specific blended fertilizers which contain those deficient nutrients were formulated by [8]. However,it should be noted that, other than indicating the soil fertility status and recommending the most appropriate blended fertilizers for each district, the atlas doesn't contain information about recommended fertilizer application rates. Therefore, the objectives of this project wereto promote sustainable intensification of the major vegetable production systems through development of crop and soil specific balanced fertilizer recommendation and to determinate the optimum fertilizer rates that would result in the highest onion yield, greatest postharvest attributes, and highest economical return for onion.

2. Materials and methods

2.1.Study area

LaelayAdyaboand TahtayKoraro district in the northwestern zone of Tigray region was purposely selected as a representative model. Field experiments were conducted for two consecutive seasons of 2018 and 2019 under irrigated conditions on two selected farmer's fields at Tahtaykoraro (Mai-dmu irrigation scheme) and Laelayadyabo(Meskebet irrigation scheme) districtsof northwestern Tigray, northern Ethiopia. These areas predominantly lie under semi-arid tropical belt of Ethiopia with a hot to warm agro-climatic zone with a mono-modal and erratic rainfall pattern. Mai-dmu and Meskebet irrigation schemes are found at around 30 km away to the west of Shire Indasilassie town and 15 km away to the southeast of Adi-daero town, respectively. The soil textureof the study area is characterized as sandy loam and loam.

2.2.Experimental design, treatments and procedures

The area was selected to conduct this study based on current situation of being NPKSZnB nutrients deficient [8].Based on the soil information data of [8] for each limiting nutrient identified, seven treatments (25, 50, 100, 150, 200, 250, 300 kg NPKSZnB ha^{-1}) were formulated and tested. The seven blended (NPKSZnB) fertilizer rates were compared to each other to determine one best fitted rate. Since, nitrogen is the most limiting factor for plant growth and found in a very low amount in the blended fertilizer it has to be added from urea; so, it was top dressed at a rate of 150 kg urea ha^{-1}. Blended fertilizers and half of urea were basal applied at planting while the rest urea was top dressed 45 days after planting. The test crop was also planted in rows with 40*20*10 cm spacing between ridges, double rows and plants, respectively. All crop management practices were applied as per the recommendation for the onion crop.

The treatments were laid out in Randomized Complete Block Design (RCBD) with three replications. Plot size of the trial was 3 m by 3 m for onion planted in rows, replicated 3 times on site and across two farmers' fields of each district.

2.3.Soil data collection

Before planting one representative composite soil sample was taken 0 to 20 cm depth from each farmer's fields using an auger. The collected samples were properly labeled, packed and transported to Shire soil research center. Particle size distribution was determined using the Bouyoucos hydrometer method [10]. The pH of the soil was measured in the supernatant suspension of a 1: 2.5 soil to water ratio using a pH meter [11]. Organic carbon was determined by the [12]. Total nitrogen was determined using the Kjeldahl method as described by [13] Available P was determined following the Olsen method [14] using ascorbic acid as reducing agent.

2.4.Crop data collection

Agronomic data like marketable yield, single bulb weight, bulb diameter, bulb length, leaf length, leaf number per plant, plant height and days to 90% maturity and planting date were collected.

2.5.Data Analysis

The collected data were subjected to statistical analysis. Analysis of variance (ANOVA) was carried out using SAS statistical software program [15]. Significant difference between and among treatment means were assessed using the least significant difference (LSD) at 0.05 level of probability [16].

2.6.Economic analysis (partial budget analysis)

To assess the costs and benefits associated with the different treatment rates, the partial budget technique of [16] was applied to economic yield results. According to this manual, experimental yields are often higher than the yields that farmers could expect using the same treatments; hence in economic calculations researchers have judged that farmers using the same technologies would obtain yields adjusted by 10% lower than those obtained by the researchers if the experiments are planted on representative farmers' fields, [16]. The daily labor costs were calculated by assuming 60 ETB per person and revenue was estimated by considering the prevailing market price which is 20 ETB per kg of yield. Fertilizer (NPKSZnB) cost was also 1781.64 ETB per 100 kg.

Average marketable yield (MY) (kg ha^{-1}): is an average yield hot pepper on each treatment

Adjusted yield (AjY): is the average yield adjusted downward by a 10% to reflect the difference between the experimental yield and yield of farmers' field.

AjY = MY - (MY * 0.1)

Gross field benefit (GFB) or Total revenue (TR): was computed by multiplying field/farm gate price that farmers receive for the crop when they sale it as adjusted yield.

TR = AjY * field/farm gate price of a crop

Total variable cost (TC): is the cost of inputs that were used for the experiment as mean current prices of the blendedNPKSZnB fertilizer, wage for fertilizers application and transport of fertilizers, were considered per hectare.

Net revenue (NR): was calculated by subtracting the total costs from the total revenue (gross field benefit) for each treatment.

$$NR = TR – TC$$

Marginal cost (MC) = change in costs between treatments.

Marginal benefit (MB) = change in net benefits between treatments.

Marginal rate of return: is percent marginal rate of return was calculated as changes in net benefit (raised benefit) divided by changes in cost (raised cost).

MRR (%) = (MB/MC) *100

3. Result and discussion

3.1 Initial soil fertility status of the study site (TahtayKoraro)

The soil analysis results of the surface soil samples collected from TahtayKoraro district before establishing the experiment showed that the surface soil was sandy loam [10] in texture with low exchangeable bases [18]. The surface soil was moderately acidic (pH= 6.5) tolow [11],low [19]organic carbon, low [19] total N, and low [14] available P contents (Table 1).

Table 1. Some soil physic-chemical properties of surface soil (0-20 cm) of the study site (TahtayKoraro)

Parameter	Values	Rating	References
pH (H_2O)	6.5	Moderate acidic	[11]
Organic carbon (%)	0.77	Low	[19]
Total N (%)	0.12	Low	[19]
$P_{(Olsen)}$ (mg kg^{-1})	7.3	Low	[14]
Exchangeable bases Sodium (Cmolc/kg)	0.3	Low	[18]
Exchangeable bases Potassium (Cmolc/kg)	0.2	Low	[18]
Exchangeable bases Magnesium	1-3	Medium	[18]

(Cmolc/kg)			
Exchangeable bases Calcium (Cmolc/kg)	2	Very low	[18]
Cation Exchange Capacity ($Cmol_c$ kg^{-1})	13.1	low	[18]
Soil texture (Sandy Loam, Sandy clay loam, Clay, Clay Loam, and Loam (%))	57.69, 28.85, 5.76, 3.85, and 3.85 Respectively	Sandy loam	[10]

3.2. Initial soil fertility status of the study site (LealayAdyabo)

The soil analysis results of the surface soil samples collected from LealayAdyabo district before establishing the experiment showed that the surface soil was sand in texture with low exchangeable bases [10]. The surface soil was moderately acidic (pH= 6.5) to low [11], low [19] organic carbon, low [19] total N, and low [14] available P contents (Table 2).

Table 2. Some soil physico-chemical properties of surface soil (0-20 cm) of the study site (LealayAdyabo)

Parameter	Values	Rating	References
pH (H_2O)	6.5-7.3	Moderate acidic to neutral	[11]
Organic carbon (%)	0.99	Low	[19]
Total N (%)	0.12	Low	[19]
$P_{(Olsen)}$ (mg kg^{-1})	11.2	Low	[19]
Exchangeable bases Sodium (Cmolc/kg)	0.33	Low	[18]
Exchangeable bases Potassium (Cmolc/kg)	0.31	Low	[18]
Exchangeable bases Magnesium (Cmolc/kg)	1.3	Low	[18]

Exchangeable bases Calcium (Cmolc/kg)	2.7	Low	[18]
Cation Exchange Capacity ($Cmol_c$ kg^{-1})	22.3	Moderate	[18]
Soil texture (Loam, Clay loam, Silt loam, and Clay (%))	75.76, 18.18, 3.03, and 3.03	Loam	[10]

3.3.Effects of NPKSZnBfertilizer on onion phonology, growth parameter and yield

Days to physiological maturity: Days to physiological maturity of onion under irrigation condition was statistically significantly (P $\leq$ 0.05) affected by different NPKSZnB fertilizer rates (Table 1) at both Tahtaykoraro and Laelayadyabo districts. The physiological maturity of onion was delayed for the plots received 100 and 200kg NPKSZnB ha^{-1}rates at Tahtaykoraro and Laelayadyabo districts, respectively (Table 3). Though it is in parity with the 200 and 250 kg NPKSZnB ha^{-1}maturity was hastened on plots that were treated with 25 kg NPKSZnB ha^{-1}at Tahtaykoraro, whereas days took onion to mature was shorter (mean days of 135) for plots received a rate of (250kg NPKSZnBha^{-1}) at Laelayadyabo district.

Table 3: Days to 90% physiological maturity and plant height of onion as influenced by blended NPKSZnBfertilizer rate under irrigation condition

Fertilizer rate (kg ha^{-1})	**Two years combined result**			
	Tahtaykoraro		**Laelayadyabo**	
	DM (days)	**PH (cm)**	**DM (days)**	**PH (cm)**
25 NPKSZnB (kg $ha-^{1}$)	118. 83a	38.60ab	136.83cd	34.30ab
50 NPKSZnB (kg $ha-^{1}$)	119. 67bc	37.77b	136.50bcd	35.30ab
100 NPKSZnB (kg $ha-^{1}$)	121.33c	40.33ab	135.33ab	31.03b
150 NPKSZnB (kg $ha-^{1}$)	120.83bc	41.70a	136.33abcd	37.20a
200 NPKSZnB (kg $ha-^{1}$)	119.83ab	39.67ab	137.50d	34.57ab
250 NPKSZnB (kg $ha-^{1}$)	120.50abc	38.13ab	135.00a	37.10a
300 NPKSZnB (kg $ha-^{1}$)	119.83bc	40.47ab	135.83abc	37.40a
Mean	120.26	39.52	136.19	35.27
LSD	1.00	3.89	1.47	6.05
CV	5.71	8.41	3.92	14.63

Where; DM= Days to 90% Maturity and PH= Plant height

*Urea was top dressed at equal level (150 kg ha^{-1} for all treatments

Plant Height: The analysis of variance revealed that plant height was statically significantly affected（P≤0.05）by different rates of NPKSZnB Fertilizer in the experimental site of the two districts. The highest and lowest onion plant height for Tahtaykoraro district were 41.70 and 37.77cm, whereasfor that of Laelayadyabo were 37.4 and 31.03 cm, respectively (Table 3). Though in statistical parity with some of the treatments, highest plant height was recorded from the blended fertilizer rate of 150and 300 kg ha^{-1}NPKSZnB, whereas the shortest plant height wasrecorded on plots received 50 and 100kg ha^{-1}NPKSZnBfor Tahtaykoraro and Laelayadyabo districts, respectively.

Leaf number per plant: The analysis of variance showed that number of leafs per plant was statically significantly (P≤0.05)affected by the different rates of NPKSZnBfertilizer at Laelayadyabo unlike to that of Tahtaykoraro district. The highest number of leafs per plant (33.53) was recorded from plots received 300kgha^{-1}blended NPKSZnBfertilizerrate, whereas the lowest number of leafsper plant 27.47 were recorded from 100kgha^{-1}NPKSZnBat Laelayadyabo (Table 4).

Table 4: Number of leafs per plantand leaf length of onion as influenced by blended NPKSZnBfertilizer rate under irrigation condition

Fertilizer rate (kg ha^{-1})	**Two years combined result**			
	Tahtaykoraro		**Laelayadyabo**	
	LN (numbers)	**LL (cm)**	**LN (numbers)**	**LL (cm)**
25 NPKSZnB (kg ha-^{1})	21.87	31.83ab	28.50a	28.27d
50 NPKSZnB (kg ha-^{1})	22.57	31.00b	31.40ab	33.80c
100 NPKSZnB (kg ha-^{1})	22.90	31.83ab	27.47b	35.70bc
150 NPKSZnB (kg ha-^{1})	23.13	34.00a	31.53ab	36.67ab
200 NPKSZnB (kg ha-^{1})	22.37	31.17b	27.77b	33.90c
250 NPKSZnB (kg ha-^{1})	21.83	31.23b	31.60ab	38.97a
300 NPKSZnB (kg ha-^{1})	22.40	32.80ab	33.53a	38.53a
Mean	22.44	31.98	30.26	35.12b
LSD	NS	2.67	4.45	2.51
CV	12.42	7.11	12.55	30.12

Where; LN= Leaf number per plant and LL= Leaf length
*Urea was top dressed at equal level (150 kg ha^{-1} for all treatments

Leaf length: According to the analysis of variance the different levels of blended NPKSZnB fertilizer were statically significantly (P≤0.05) affected onion leaf length at Tahtaykoraro and Laelayadyabo districts (Table 4).Though it is statistically equal with some of the treatments, the longestleaf length at Tahtaykoraro (34.00 cm) and Laelayadyabo (38.97 cm) were recorded from the blendedNPKSZnB fertilizer rates of 150and 250 kg ha^{-1}, whereas the shortest leaf length (31.00 cm)and (28.27 cm) were recorded for plots received 50and 25 kg ha^{-1}NPKSZn fertilizer, correspondingly.

Bulb Length: The bulb length of onion was statically significantly ($P \leq 0.05$) affected by the different rates of blendedNPKSZnB Fertilizer at both districts (Table 5). The highest onion bulb length for Tahtaykoraro and Laelayadyabo (4.76 and 5.10 cm) were recorded in response to NPKSZn fertilizer applied at the rates of 200 and 250 kg ha^{-1}, whereas the lowest bulb length (4.23and 4.60 cm) were from plots received 25 kg ha^{-1}NPKSZn fertilizer, respectively.Though the trend is inconsistent, it indicated that onion bulb length increases with upturning of the blended NPKSZnB fertilizerrates at both study areas.

Table 5: Bulb lengthand bulb diameter of onion as influenced by blended NPKSZnBfertilizer rate under irrigation condition

Fertilizer rate (kg ha^{-1})	**Two years combined result**			
	Tahtaykoraro		**Laelayadyabo**	
	BL (cm)	**BD (cm)**	**BL (cm)**	**BD (cm)**
25 NPKSZnB (kg ha-^{1})	4.23b	8.59ab	4.60b	8.33b
50 NPKSZnB (kg ha-^{1})	4.37ab	8.34b	4.63b	8.43b
100 NPKSZnB (kg ha-^{1})	4.48ab	8.31b	4.87ab	8.07bc
150 NPKSZnB (kg ha-^{1})	4.47ab	8.33b	4.87ab	9.33a
200 NPKSZnB (kg ha-^{1})	4.76a	8.79ab	4.78ab	7.53c
250 NPKSZnB (kg ha-^{1})	4.32ab	8.45ab	5.10a	7.97bc
300 NPKSZnB (kg ha-^{1})	4.40ab	8.87a	5.03a	7.57c
Mean	4.43	8.52	4.84	8.18
LSD	0.45	0.50	0.46	0.65
CV	8.61	12.39	17.25	20.90

Where; BL= Bulb Length, BD= Bulb Diameter, SBWt= Single bulb weight, and MY= Marketable yield
*Urea was top dressed at equal level 150 kg ha^{-1} for all treatments

Bulb Diameter: The analysis of variance showed that, at both study areas onion bulb diameter was statistically significantly ($P \leq 0.05$)affected by rates of NPKSZnBfertilizer under irrigation condition. Likewise, [20] reported a significant difference in bulb diameter obtained due to the application of N and P.

The highest bulb diameter (8.45 cm at Tahtaykoraro and 9.33 at Laelayadyabo) were recorded in response to the blended fertilizer rates of 300 and 150 kg NPKSZnBha^{-1} rates, correspondingly.

Similarly, the lowestonion bulb diameters (8.31at TahtayKoraroand 8.33cmLaelayAdyabo)were recorded fromplots received 100 and 25 kg NPKSZnBha^{-1} rates, respectively (Table 5).

Single bulb weight: According to the analysis of variance onion single bulb weight was statically significantly ($P \leq 0.05$) affected by different NPKSZnBfertilizer rates at both study areas. Highest onion single bulb weight; 2901 and 320 g at Tahtaykoraro and Laelayadyabo, respectivelywere obtained in response to the 300 kg NPKSZnBha^{-1} fertilizer rate under irrigation condition (Table 6). Likewise, the lowest onion single bulbweight; 211and197 gwere recorded from plots received 50 and 25 kg NPKSZnBha^{-1} for the two study areas, respectively. Single bulb weight of onion was increasing with an increase in the rate of blended NPKSZnB fertilizer at both study areas.

Table 6: Single bulb weight and marketable yield of onion as influenced by blended NPKSZnB fertilizer rates under irrigation condition

Fertilizer rate (kg ha^{-1})	**Two years combined result**			
	Tahtaykoraro		**Laelayadyabo**	
	SBWt (g)	**MY (kg)**	**SBWt (g)**	**MY (kg)**
25 NPKSZnB (kg ha-^{1})	218bc	6841c	197b	13190b
50 NPKSZnB (kg ha-^{1})	211c	7578bc	240b	15736ab
100 NPKSZnB (kg ha-^{1})	216c	9535ab	273ab	17647a
150 NPKSZnB (kg ha-^{1})	230bc	9380ab	270b	18731a
200 NPKSZnB (kg ha-^{1})	264ab	10329a	250b	15806ab
250 NPKSZnB (kg ha-^{1})	237bc	9128abc	300ab	19196a
300 NPKSZnB (kg ha-^{1})	290a	10233a	320a	16401ab
Mean	238	9003.32	264	16672.48
LSD	47	2339.50	55	4235.90
CV	16.77	22.17	16.73	21.67

Where; SBWt= Single bulb weight and MY= Marketable yield
*Urea was top dressed at equal level (150 kg ha^{-1} for all treatments

Marketable yield: Yield of onion was statically significantly ($P \leq 0.05$) affected by rates of blended NPKSZnB Fertilizer at the two districts. The present study results are in orthodoxy with, [21], who reported that the bulb yield of irrigated onion was significantly improved by application of nitrogen fertilizer.

Although with some inconsistent trend, yield improvement was observed with increasing rate of applied blended fertilizer (Table 6). The highest marketable yields;10329and 19196kg ha^{-1}at Tahtaykoraro and Laelayadyabo, respectively were recorded in response to the application of

200 and 250 kg ha^{-1} blended fertilizer.Lowest marketableyields; 6841 and 13190 kg ha^{-1} at Tahtaykoraro and Laelayadyabo, correspondingly were obtained in response to the lowest rate of blended fertilizer which is 25kg ha^{-1} for both districts. In contrast to this, [], found a result of no significance effect of blended fertilizer rates on marketable yield due to similar nitrogen top dressing application.

3.2. Economic analysis (partial budget analysis)

According to the result of this study the onion yield was significantly affected by different rates of NPKSZnB fertilizer. The maximum onion yield at T/koraro and L/adyabo were recorded form plots received200 and 250 kg NPKSZnBha^{-1} (Table 7). However, the marginal rate of return showed thatwhen using this type of blended fertilizer for onion there is no further economic earning beyond the rates of 100 and 50 kg NPKSZnB ha^{-1} at T/koraro and L/adyabo districts, respectively (Table 5). Thus, application of 100 and 50 kg ha^{-1}NPKSZnBfertilizer for onion is economically beneficial compared to the other rates.

Table 7: Partial budget analysis of blended NPKSZnBfertilizer for onion at T/koraro and L/adyaboditricts

Fertilizer rate (kg K/ha)	FC (Birr)	TLC [Birr]	TVC [Birr]	MY (kg/ha)	AjY (kg/ha)	TR [Birr]	NR [Birr]	MRR (ratio)	MRR (%)
Tahtaykoraro district									
25 NPKSZnB (kg ha^{-1})	445.41	30	475.41	6841	6156.9	123138	122662.6	0	0
50 NPKSZnB (kg ha^{-1})	890.82	60	950.82	7578	6820.2	136404	135453.2	26.90	2690.43
100 NPKSZnB (kg ha^{-1})	1781.64	120	1901.64	9535	8581.5	171630	169728.4	36.05	3604.80
150 NPKSZnB (kg ha^{-1})	2672.46	150	2822.46	9380	8442	168840	166017.5	D	D
200 NPKSZnB (kg ha^{-1})	3563.28	210	3773.28	10329	9296.1	185922	182148.7	D	D
250 NPKSZnB (kg ha^{-1})	4454.1	270	4724.1	9128	8215.2	164304	159579.9	D	D
300 NPKSZnB (kg ha^{-1})	5344.92	330	5674.92	10233	9209.7	184194	178519.1	D	D
Laelayadyabo district									
25 NPKSZnB (kg ha^{-1})	445.41	30	475.41	13190	11871	237420	236944.6	0	0
50 NPKSZnB (kg ha^{-1})	890.82	60	950.82	15736	14162.4	283248	282297.2	95.40	9539.68
100 NPKSZnB (kg ha^{-1})	1781.64	120	1901.64	17647	15882.3	317646	315744.4	35.18	3517.72
150 NPKSZnB (kg ha^{-1})	2672.46	150	2822.46	18731	16857.9	337158	334335.5	20.19	2018.98
200 NPKSZnB (kg ha^{-1})	3563.28	210	3773.28	15806	14225.4	284508	280734.7	D	D
250 NPKSZnB (kg ha^{-1})	4454.1	270	4724.1	19196	17276.4	345528	340803.9	63.18	6317.62
300 NPKSZnB (kg ha^{-1})	5344.92	330	5674.92	16401	14760.9	295218	289543.1	D	D

Where; FC= Fertilizer cost, TLC= transport and labor cost, TVC= Total variable cost, MY= marketable yield, AjY= Adjusted yield, TR= Total Revenue, NR= Net revenue and MRR= marginal rate of return.

Note: -TVC = FC + TLC

AjY = MY- (MY*10%)

NR = TR-TVC

MRR= MRR is the ratio of $(NR_n - NR_{n-1}) / (TVC_n - TVC_{n-1})$ *where n is number of treatments*

4. Conclusion and recommendation

The use of different doses of the NPKSZnBblended fertilizer influenced most of the examined parameters of onion cultivation, such as: yield and yield components are significant in both study areas. The marketable yield showed an increasing trend with increasing compound fertilizer dose. The highest average marketable onion yield was achieved after application of blended fertilizer at rates of 200 and 250 kg ha^{-1}in TahtayKoraro and LaelayAdyabo districts. Likewise, the lowest average marketable onion yield was, including in plots where a dose of 25 kg ha^{-1} of blended fertilizer was applied in both communities. In summary, NPKSZnBblended fertilizer improves the yield and yield components of onions by supplementing missing nutrients in the blended. The 200 and 250 kg NPKSZnB ha^{-1} rates resulted in higher onion yields at T/koraro and L/adyabo districts, respectively. However, economically the NPKSZnB fertilizer at rates of 100 and 50 kg ha^{-1} for onion was found to be profitable. Therefore, based on the results of the study it can be recommended that;

- ✓ Since the blended NPKSZnB fertilizer improved onion production and productivity farmers should use in their cropping system.
- ✓ This type of blended fertilizer should be usedat rates of 100 and 50 kg ha^{-1} for onion production under irrigation condition in T/koraro and L/adyabo districts, respectively.
- ✓ For further study researchers can use these rates as a bench mark.

References

1. Outlook, A. E. (2011). African Economic Outlook 2011. *Africa and its Emerging Partners. African Development Bank (AfDB). Abidjan: Côte d'Ivoire*.
2. Beyene, L. M., Shiferaw, B., Sahoo, A., &Gbegbelegbe, S. (2016). Economy-wide impacts of technological change in food staples in Ethiopia: A macro-micro approach.
3. World Bank Group. (2014). *the World Bank Group A to Z 2015*. World Bank Publications.
4. CSA (Central Statistical Agency), 2014a. Comprehensive food security and vulnerability analysis. The Federal Democratic Republic of Ethiopia.
5. Howeler, R. H., Ezumah, H. C., &Midmore, D. J. (1993). Tillage systems for root and tuber crops in the tropics. *Soil and Tillage Research*, *27*(1-4), 211-240.
6. Girma, T., Peden, D., Abyie, A., &Wagnew, A. (2003). Effect of manure on grazing lands in Ethiopia. *East African Highlands Mountain Research and Development*, *23*(4), 156-160.
7. Wassie, H., & Mamo, T. (2013). The effect of potassium on the yield s of potato and wheat grown on the acidic soils of Chencha and HagereSelam in Southern Ethiopia. International Potash Institute. *Research findings e-ifc*, (35).
8. EthioSIS (Ethiopia Soil Information System). Soil fertility status and fertilizer recommendation atlas for Tigray regional state, Ethiopia. 2014.
9. Zia, M.S., Gill, M.A., Aslam, M. and Hussain, M.F. 1991. Fertilizer use efficiency in Pakistan. Progressive farming, (11):35-8.

10. Bouyoucos, G. J. (1962). Hydrometer method improved for making particle size analyses of soils 1. *Agronomy journal*, *54*(5), 464-465.
11. Lamond, R. and Whitney. D.A. (1992). Management of saline and sodic soils. Kansas State University, Department of Agronomy MF-1022.
12. Walkley, A., and Black, I.A. (1934). An examination of the method for determining soil organic matter and proposed chromic acid titration method. Soil Science, (37):29-38.
13. Bremner, J.M. and Mulvaney, C.S. (1982). Nitrogen - Total. *In* A.L. Page, R.H. Miller and D.R.Keeney (eds.). *Methods of soil analysis. Part 2-Chemical and microbiological properties*. *Agronomy,* 9 (2): 595-624. *American Society of Agronomy*. Madison, Wis
14. Olsen, R., Cole, S., Watanabe, F., and Dean, L. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *United States Department of Agriculture* Circ. 939.
15. SAS. (2002). SAS/STAT User's Guide, Version 9.1.3. SAS institute Inc., Cary, NC.
16. Gomez and Gomez H. (1984). Statistical analysis for agricultural research. John Willy and Sons Inc. pp.120-155.
17. CIMMYT (International Center for Maize and Wheat Research). 1988. from Agronomic Data to Farmer Recommendations: An Economics Training Manual. Completely Revised Edition, Mexico, DF.79 pp.
18. FAO, 1984a. Assistance to Land Use Planning Ethiopia: Geomorphology and Soils. Field Document AG DP/ETH/78/003. The United Nations Development Programmed and Food and Agriculture Organization. FAO, Rome.
19. Tekalign Tadese. (1991). Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa, Ethiopia, and Subtropics. Longman Scientific and Technical, Essex, New York. 474p.
20. Tekeste, N., Dechassa, N., Woldetsadik, K., Dessalegne, L., & Takele, A. (2018). Influence of nitrogen and phosphorus application on bulb yield and yield components of onion (L.). *The Open Agriculture Journal*, *12*(1).
21. Aklilu, S. (1994, March). Onion research and production in Ethiopia. In *I International Symposium on Edible Alliaceae 433* (pp. 95-98).

22. Solomon, M., Kinfe, T., Tewolde, B., Tsadik, T., Weldegebreal, G., Gebresemaeti, K., & Goitom, A. (2020). Evaluation of blended fertilizer on growth performance and yield of onion (Allium cepa L.) at irrigated conditions Tselemti District North Western Tigray, Ethiopia. *African Journal of Agricultural Research*, *16*(9), 1239-1244.