Vol. 16(9), pp. 1239-1244, September, 2020
DOI: 10.5897/AJAR2020.14953
Article Number: 99E434D64777
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

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African Journal of Agricultural Research

Full Length Research Paper

Evaluation of blended fertilizer on growth performance and yield of onion (*Allium cepa* L.) at irrigated conditions Tselemti District North Western Tigray, Ethiopia

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Received 4 May, 2020; Accepted 7 July, 2020

Onion has economically important crop in the study area. However, its low production is due to poor soil fertility management. Thus, the present study was initiated to determine the optimal rate of blended fertilizer required for onion production. A field experiment was conducted for two consecutive years during 2018 and 2019 at farmer's field Tselemti district, the experiment had 8 treatments arranged in a randomized complete block design with three replications. The treatments were 7 levels of NPSB (25, 50, 100, 150, 200, 250 and 300 kg ha^{-1}), recommended rate of N and P (105 N and 92 P_2O_5 kg ha^{-1}), and a basal application of top dress N at rate of 69 kg ha^{-1} were applied for except the plot received recommended NP. The study results showed the application of blended fertilizer not significantly affected most of the crop parameters tested. However, they had a numerical difference among the treatments; since the highest (41157 kg ha^{-1}) and lowest (32650 kg ha^{-1}) marketable yields were obtained from a plot treated by 250 kg ha^{-1} plus a basal application of top dress N at rate of 69 kg ha^{-1} and from plots that received 50 kg ha^{-1} plus a basal application of top dress N at rate of 69 kg ha^{-1}, respectively. Therefore, experiment for onion production should carry out on omitting trial of blended fertilizer in the study area.

Key words: Blended fertilizer, onion, omitting trail, recommended NP.

INTRODUCTION

Onion (*Allium cepa L.*) belongs to the family Alliaceae and the genus *Allium* (Hanelt, 1990). It is one of the mostly vital vegetable crops commercially grown in the world (Grubben and Denton, 2004). Onion has economically important role in Ethiopia. The country has massive potential to produce the crop throughout the year both for domestic use and export market. Its production also contributes to commercialization of the

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rural economy and creates many job opportunity (Nikus and Mulugeta, 2010; Guesh, 2015).

Agriculture is the main driving force of Ethiopia's economy and long-term food security. It contributes 43% to the gross domestic product (GDP); employs nearly 85% of the total labor force and contributes about 90% of the national export earnings. The agricultural sector is dominated by small-scale farmers, accounting for 95% of the total area under crop cultivation and more than 93% of the total agricultural output (CSA, 2010).

Crops are the major agricultural commodities on which Ethiopians depend for their daily food. Onion is a major vegetable crop in Ethiopia. It is well adapted to highland and low land soils of the country. Its production in Ethiopia is 9.3 ton/ha and in Tigray region is also 6.3 ton ha^{-1} which is low when compared with the national average. This might be due to low fertility of the soil (CSA, 2018/2019).

Fertilizer usage is one of the instruments implemented as a means of raising production and income of farm and households. However, the extent to which fertilizers are used still differs considerably between various regions of the world. In Ethiopia, diammonium phosphate (DAP) and urea were the commonly used chemical fertilizers for crop production with having a common consideration of nitrogen and phosphorus were the major limiting nutrients for Ethiopian soils. Past researchers carryout many activities under agro-ecologies towards improvement of agricultural productivity using urea and DAP in Ethiopia. Plant growth and crop production require an adequate supply and balanced amounts of all nutrients, but the old practice that only uses urea and DAP lacks the use of micronutrients. Since deficiency of micronutrients is reported in tropical soils, necessitate the application of nutrient sources that reduce such deficiencies. This can only be achieved if the nutrient content of the fertilizer fits to the needs of the crops.

Onion requires intensive supply of plant available macronutrient, namely: nitrogen (N), phosphorus (P) and potassium (K) to attain maximum yield of bulbs because the plants have a shallow, sparsely branched root system and NPK fertilizer at rate 100:33:62 significantly influenced onion yield (Khokhar et al., 2004; Khalid, 2019).

As Khalid (2019) reveled application of micronutrient have a significant improvement on onion yield at a rate of zinc sulfate ($ZnSO_4$ at 0.5%), iron sulfate ($FeSO_4$ at 1.0%), and boron (B at 0.5%).

Blended fertilizers containing both macro and microelements may possess this characteristic. Even if the blended fertilizer formulas of each kebele have been developed, the rate of the blended fertilizer is still not determined. Therefore, Shire Soil Research Center proposes to determine the rate of balanced fertilizers containing nitrogen (N), phosphorus (P), sulfur (S), zinc (Zn), and boron (B) in blend form which recommended to ameliorate site specific nutrient deficiencies.

Objectives

(1) To determine site specific blended fertilizer rates for onion production;
(2) To validate soil fertility map based blended fertilizer in the study site.

MATERIALS AND METHODS

Area description

The field experiment was conducted for two consecutive years during 2017 and 2018 under irrigated conditions at Tselemti district in Medihnalem kebele, North Western zone of Tigray regional state (Figure 1). The geographical location of the study area is: 13°37'4" N and 38° 12' 40' E of latitudes and longitudes, respectively. The study area is located at an altitudinal range of 1310 m as l, in a semi-arid climatic zone and has mixed crop-livestock farming system (OoARD, 2020).

Topographically, the area has 70% sloppy areas and30% flat areas indicating which is characterized by rugged, plains, river valleys and plateau topography in its southern and western parts (OoARD, 2020).

According to the agro-climatic classifications of Ethiopia, Tselemti district fall in dry to moist *Kolla*, dry to wet *Weyna Dega* and moist to wet *Dega* (Hurni, 1998). The particular site is characterized as dry-moist *Kolla* (Darcha et al., 2015; Redda and Abay, 2015).

Experimental design, treatments and biological material

The field experiments contained a total of eight (8) treatments. The treatments were seven (7) levels of NPSB blended fertilizer (25, 50, 100, 150, 200, 250, 300 kg ha^{-1}) plus a basal application 69 kg ha^{-1} top dress, one (1) rate of recommended NP (105 kg ha^{-1} N, 92 kg ha^{-1} P). Hint, a 100 kg of NPSB is an equivalent to 18 kg of N, 36 kg of P_2O_5, 7 kg of S, and 0.54 kg of B. The treatments were laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size was 3 m×3.2 m (9.6 m^2). The spacing between plant rows, plots and replications was 0.4, 0.5 and 1 m, respectively. "Bobay red" variety of onion was used for this trial. All recommended cultural practices (plowing, weeding, pesticides, etc.) for onion was done as per the recommendation of the study area. The experimental trial was conducted for two consecutive irrigation season at two farmers' field.

Soil sample collection and analysis

Before planting surface composite soil sample was collected from experimental site for site characterization and the soil sample was taken at a depth of 0 to 20 cm, auger was used for collecting the disturbed sample. The collected sample was properly labeled, packed and transported to the Shire Soil Research Center and prepared for analysis according to the standard procedures.

Soil texture was determined using the Bouyoucos hydrometer method (Bouyoucos, 1962). The pH and electrical conductivity (EC) (1:25 soil to water suspension) of the soil were measured using a pH meter (Rhoades, 1982) and the method described by Jackson (1967), respectively. Thus, ECe was mathematically determined using conversion factor on soil texture (Hazelton and Murphy, 2007).

Organic carbon (OC) (%) was determined following the wet

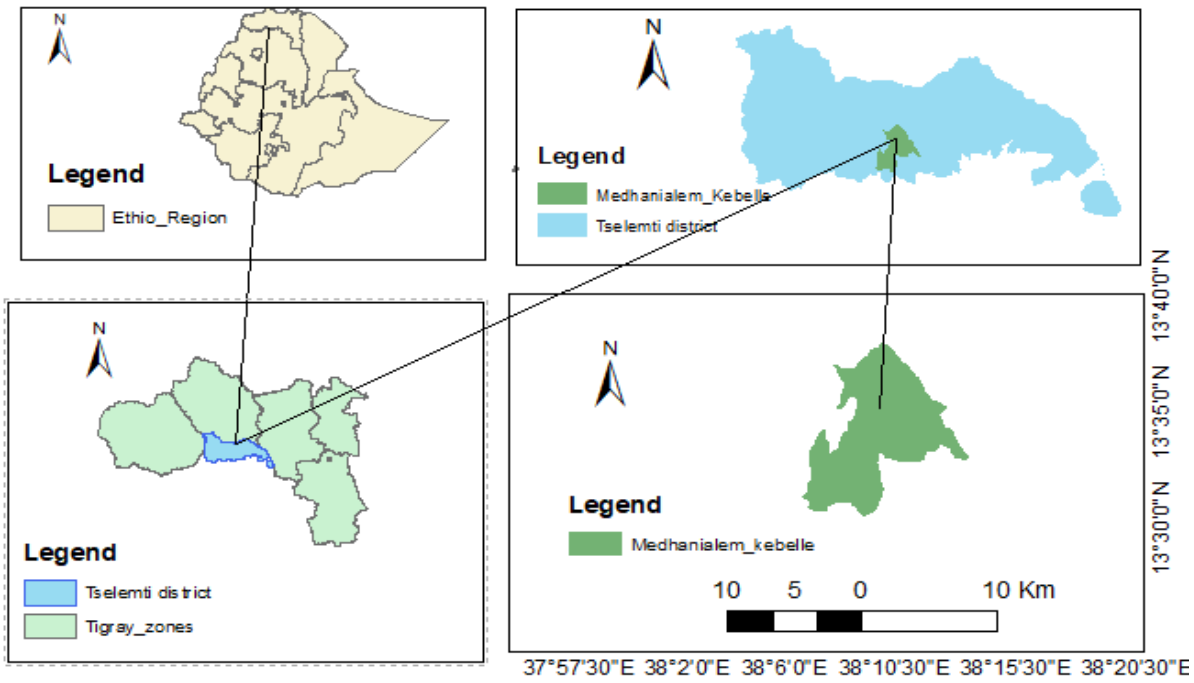

Figure 1. Location of the study area.

Table 1. Pre-sowing physicochemical properties of soil.

Parameter	Values	Ratings	Reference
% Sand	21	-	-
% Silt	19	-	-
% Clay	60	-	-
Textural class	Clay	-	-
OC (%)	0.866	Low	Tekalign (1991)
Total N (%)	0.075	Very low	Tekalign (1991)
pH	6.07	Slightly acidic	Jones (2003)
ECe (dS/m)	1.69	Non saline	Richards (1954)
Ava. P (ppm)	0.16	Very low	Cottenie (1980)
CEC [cmol(+)/kg]	41.4	Very high	Landon (1991)
Exchangeable bases			
Na[cmol(+)/kg]	0.6	Medium	FAO (2006)
K [cmol(+)/kg]	0.23	Low	FAO (2006)
Mg [cmol(+)/kg]	5.2	High	FAO (2006)
Ca [cmol(+)/kg]	18.3	High	FAO (2006)

oxidation method as described by Walkley and Black (1934). Total nitrogen was determined using Kjeldahl method as described by Bremner and Mulvaney (1982). Available P was determined by employing Olsen et al. (1954) method.

Determination of cation exchange capacity CEC at pH 7 was carried out with Ammonium Acetate method as described by Chapman (1965). The amount of exchangeable cations potassium (K) and sodium (Na) was determined by flame photometer as described by Gupta (2000); while exchangeable calcium (Ca) and magnesium (Mg) were determined by titration method (Tucker and Kurtz, 1961). The parameters analyzed in the laboratory are listed in Table 1.

Agronomic data collection and analysis

Data collected for the experiment were days to 90% maturity, plant height (cm), marketable yield (kg ha^{-1}), unmarketable yield (kg ha^{-1}),

and total yield (kg ha^{-1}). Data were collected for the experiment on yield and yield components related parameters on plot basis and converted to hectare.

Statistical analysis

The collected data were subjected to statistical analysis of variance (ANOVA) using SAS version of 9.0 (SAS, 2002). Significant difference between and among treatment means were assessed using the least significant difference (LSD) at 0.05 level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Evaluation of NPSB on onion phenological parameter

Days to 90% physiological maturity

Result showed that days to 90% maturity were not statistically significantly affected (P ≥0.05) by the rates of blended fertilizer, but they have numerical difference among the treatments (Table 2). This result happen to be due to the fact that fertilizers does not have an impact on physiological maturity on single variety unless with variety difference (Tekulu et al., 2019).

Therefore, the longest days to maturity was recorded for plots received a blended fertilizer rate of 25 kg/ha (NPSB) + 69 kg/ha N top dress, while the shortest days to 90% maturity was recorded for plot received 300 kg/ha (NPSB) + 69 kg/ha N top dress (Tekulu et al., 2019).

Evaluation of NPSB on onion yield and yield component parameter

Plant height

Result showed that plant height was not statistically significantly affected (P ≥ 0.05) by the blended fertilizer rates, but there have been numerically difference among the treatments (Table 2).

Therefore, the longest plant height was recorded for plots received a blended fertilizer rate of 300 kg/ha (NPSB) + 69 kg/ha N top dress (T8), while the shortest plant height was recorded for both plots received 100 kg/ha (NPSB) + 69 kg/ha N top dress on onion at Tselemti district.

This result is contradictory with the findings of Morsy et al. (2012) and Nasreen et al. (2007) who reported that onion plant height significantly increased as nitrogen fertilizer rates increased.

Marketable yield

As the analysis of variance revealed that marketable yield was not statistically significantly affected (P ≥ 0.05) by the blended fertilizer rates, but they have numerical difference among the treatments (Table 3).

Therefore, the highest marketable yield (41157 kg/ha) was recorded for plots received a blended fertilizer rate of 250 kg/ha (NPSB) + 69 kg/ha N top dress (T7), while the lowest marketable yield (32650 kg/ha) was recorded for both plots received 50 kg/ha (NPSB) + 69 kg/ha N top dress on onion. This non significance result for marketable onion yield occurs due to the low amount of nitrogen in blended fertilizer and uniform to dress application of urea (69 kg/ha N).

This result is contradictory with the findings of Muluneh (2016) who reported that onion yield significantly increased as blended fertilizer rates increased.

Unmarketable yield

Unmarketable yield was not statistically significantly affected (P ≥ 0.05) by the blended fertilizer rates, but they have numerical difference among the treatments (Table 3).

Hence, the maximum unmarketable yield (1273.1 kg/ha) was recorded for plots that received a blended fertilizer rate of 300 kg/ha (NPSB) + 69 kg/ha N top dress (T8), while the minimum unmarketable yield (520.8 kg/ha) was recorded for both plots received 25 kg/ha (NPSB) + 69 kg/ha N top dress on onion trial.

Total yield

The ANOVA result revealed that total yield was not statistically significantly affected (P ≥ 0.05) by the blended fertilizer rates, but they have numerical difference among the treatments (Table 3).

Hence, the highest total yield (42378 kg/ha) was recorded for plots received a blended fertilizer rate of 250 kg/ha (NPSB) + 69 kg/ha N top dress (T7), while the lowest total yield (33507 kg/ha) was recorded for both plots received 50 kg/ha (NPSB) + 69 kg/ha N top dress on onion experimental examination.

CONCLUSIONS AND RECOMMENDATIONS

Application of different rates of blended fertilizer does not significantly affect most of the crop parameters tested, such as crop phonology, growth parameters, yield and yield components at both sites in the two consecutive years.

Therefore, it can be concluded that even though blended fertilizer does not have significant difference among the treatments in all agronomic attributes, but there is a numerical increment when blended fertilizer rate increases. Therefore, based on the results of the study, it can be recommended that further study should

Table 2. Mean values of two year as regards as days to 90% maturity, plant height of onion as influenced by different levels of blended fertilizer (NPSB) during 2018/2019.

TRT code	Treatments	DPM (days)	PH (cm)
1	Recommended NP (105 kg/ha N, 92 kg/ha P)	109.22	45.11
2	25 kg/ha (NPSB) + 69 kg/ha N top dress	110.11	45.73
3	50 kg/ha (NPSB) + 69 kg/ha N top dress	109.44	45.36
4	100 kg/ha (NPSB) + 69 kg/ha N top dress	109.56	43.78
5	150 kg/ha (NPSB) + 69 kg/ha N top dress	109.78	47.07
6	200 kg/ha (NPSB) + 69 kg/ha N top dress	109.67	47.18
7	250 kg/ha (NPSB) + 69 kg/ha N top dress	109.67	46.64
8	300kg/ha (NPSB) + 69 kg/ha N top dress	108.89	48.62
Mean		109.54	46.19
LSD(P≤0.05)		NS	NS
P-value		0.99	0.19
CV (%)		2.98	7.95

DPM= Days to 90% physiological maturity, PH= plant height, LSD= least significant difference, CV= coefficient of variance, ns= non-significant; means followed by the same letters are not significantly different (P ≥ 0.05) according to LSD tests.

Table 3. Mean values of two year as regards as Marketable yield, Unmarketable, and Total yield of onion as influenced by different levels of blended fertilizer (NPSB) during 2018/2019

TRT code	Treatments	MY (kg/ha)	UMY (kg/ha)	TY (kg/ha)
1	Recommended NP (105 kg/ha N, 92 kg/ha P)	34861.0	1207.2	36068.0
2	25 kg/ha (NPSB) + 69 kg/ha N top dress	33105.0	520.8	33626.0
3	50 kg/ha (NPSB) + 69 kg/ha N top dress	32650.0	856.5	33507.0
4	100 kg/ha (NPSB) + 69 kg/ha N top dress	34167.0	795.1	34962.0
5	150 kg/ha (NPSB) + 69 kg/ha N top dress	35023.0	822.9	35846.0
6	200 kg/ha (NPSB) + 69 kg/ha N top dress	38831.0	929.4	39760.0
7	250 kg/ha (NPSB) + 69 kg/ha N top dress	41157.0	1221.1	42378.0
8	300kg/ha (NPSB) + 69 kg/ha N top dress	39005.0	1273.1	40278.0
Mean		36099.97	953.27	37053.24
LSD(P≤0.05)		NS	NS	NS
P-value		0.83	0.23	0.78
CV (%)		13.22	12.30	13.76

MY= Marketable yield, UMY= unmarketable yield, TY= total yield.

be conducted on split application of blended fertilizer, further studies should be conducted on omitting trail on nutrients of blended formula and soil test based application of blended fertilizer should be done on site specific conditions because the availability of the element may vary depending on the nature of the soil type.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The institutional support of Agricultural Growth Program (AGP II) under Tigray Agricultural Research Institute (TARI) for its financial support of this study is highly cherished. The authors also thank Shire Soil Research Center (SSRC) for providing laboratory facilities.

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