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Research paper

Evaluation of blended fertilizer type on improving the productivity of onion (*Allium cepa* L.) in Bena Tsemay district, Southwestern Ethiopia

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Depleting of soil fertility, inappropriate and imbalanced fertilizer application including different blended fertilizers are among the most important factors that reduce the productivity of onion. Therefore, the study was conducted to evaluate the blended fertilizer type effect on improving the productivity of onion in Bena Tsemay District, Southwestern Ethiopia. The study was conducted in the 2018 and 2019 cropping season and laid out in RCBD following three replications with spacing of 10cm and 20cm between plants and rows respectively. Control, (38N + 46P_2O_5) kg ha^{-1}, (182NPS+125Urea) kg ha^{-1}, (191NPSB+125Urea) kg ha^{-1} and (204NPSZnB+125Urea) kg ha^{-1} treatments were used for the experiment. The full dose of blended and P fertilizers was applied at planting time and urea was applied in two splits. The result was revealed that application of 191 kg ha^{-1} NPS+125 kg ha^{-1} Urea resulted in the highest total (30590.28 kg ha^{-1}) and marketable (28079 kg ha^{-1}) bulb yield, while the lowest total (18043.98 kg ha^{-1}) and marketable (15278 kg ha^{-1}) bulb yield were recorded from the nil. Moreover, the highest net benefits of 425585.8 ETB ha^{-1} and economic returns of 1119.76% were obtained in response to the application of 191 kg ha^{-1}NPSB+125 kg ha^{-1} Urea. Application of 191 kg ha^{-1}NPSB + 125 kg ha^{-1} Urea gives 45.59% yield increment and 43.46% increment in economic return over the control. Therefore, the application of 191 kg ha^{-1} NPSB+125 kg ha^{-1}Urea was recommended for the study area and similar agro-ecologies. Further investigation should be done on plant nutrient uptake and nutrient use efficiency and bulb chemical composition.

Key words: *blended fertilizer, economic return, productivity, soil fertility*

INTRODUCTION

Onion (*Allium cepa* L.) is a bulb crop belonging to the family Alliaceae. It is an essential bulb crop in Ethiopia and is taken in to consideration essential with inside the Ethiopian everyday diet. All the plant components are edible; specifically, the bulb is the maximum famous vegetable in stews. Onion is valued for its awesome pungency and shapes vital components for flavoring sorts of dishes, sauces, soup, sandwiches, and snacks as onion jewelry and famous over the

local shallot due to its high yield capability in line with unit location. It is later added and hastily turning in to well known amongst producers and consumers. The location under onion production in Ethiopia is growing now and again specifically because of its high profitability in line with unit location and simplicity of production, and will increase in small scale irrigation regions and broadly produced with the aid of using small scale farmers and business growers at some point of the year for local use and export market (Nigussie et al., 2015; MoANR, 2016). Onion is produced in Ethiopia under each rain-fed and irrigation. Ethiopia has a high capability to become advantageous from the onion, with the developing irrigated agriculture as onion contributed significantly to the countrywide economy, other than overcoming local demands (Lemma and Shimeles, 2003). Despite the enlargement of onion production, its productiveness in Ethiopia and the Southern vicinity of Ethiopia is low with 9.28 t ha^{-1} and 10.41 t ha^{-1} respectively (CSA, 2018) compared to the world's common yield of 17.30 t ha^{-1} (FAO, 2010); even tons decrease than different African countries (Nigussie et al., 2015; MoANR, 2016). Depleting soil fertility and weak agronomic practices which include unbalanced/flawed fertilization are most of the important constraints that affect vegetable production in Ethiopia (Fekadu and Dandena, 2006) and different components of the world (Pathak, 1994).

To complete fill, the foundation hole for destiny nutrient control which incorporates the micro and macronutrients wishes exceptional interest to supply the most yield from the crop (Megersa, 2017). Using the most beneficial quantity of fertilizer nutrients significantly will enhance the productiveness of onion bulbs with the use of advanced cultivars (Assefa et al., 2015). This is due to the fact onion is most of the heavy feeders vegetable crop, because it needs for greater mineral fertilizers than different vegetables for its growth (Yohannes et al., 2013); and additionally, onions are greater at risk of nutrient deficiencies than different crops due to their shallow and unbranched roots, as a result, they require and regularly reply nicely to the addition of fertilizers (Brewster, 2008). The amount and onion bulb yield have improved as the extent of nitrogen and phosphorous have been enhanced which means that the most beneficial nutrient control has a nice contribution to yield development of onion production and productiveness specifically for the one's regions wherein a nutrient deficiency is critical (Simon *et al.,* 2015). In general, the effects of various nutrient controlling practices were proven that onion yield production and productiveness may be maximized with the aid of using making use of distinct plant nutrient control structures for the desired soil kinds at particular locations (Megersa, 2017). Hence, the financial feasibility of fertilizer practices is a vital detail in enhancing crop productiveness; green and within your budget use of fertilizer could be very essential due to the fact the enter constitutes a large share of the overall fee of producing vegetables (Greenwood, 1974). Therefore, attributable to the onions' heavy nutrient feeding nature, soil nutrient depletion and deficiency beneath the extensive irrigated cropping structure within the examine location (ATA, 2016), the most beneficial utility of fertilizer is essential to enhance and increase onion production and productiveness. However, little records at the examine location at the reaction of Bombay red onion variety to various kinds of blended fertilizers, that's essential to optimize fertilizer utility for more advantageous productiveness and high-satisfactory of the crop. Therefore, the experiment becomes performed to assess the reaction of onion to blended fertilizer kinds and to be in direction with the most beneficial blended fertilizer kind to enhance the productiveness of onion under irrigation in Bena Tsemay district, southwestern Ethiopia.

MATERIALS AND METHODS

Description of the study area

The experiment becomes performed in Bena Tsemay district, southwestern Ethiopia beneath irrigation on farmer's fields. The experimental site was positioned at a latitude of 5°23.251'N, a longitude of 36°59.004'E, and at an elevation of 547 meters above sea level.

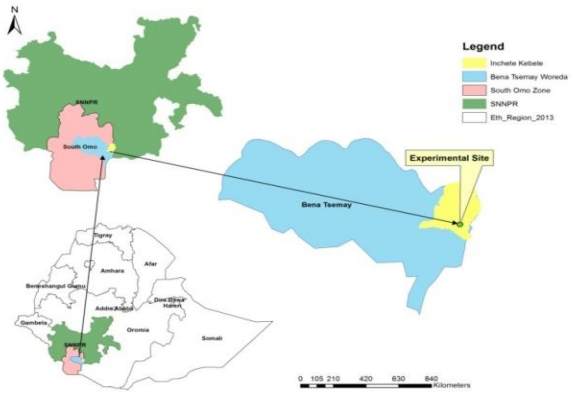

Figure 1. Map of the study area

Experimental Design and Treatments

The experiment becomes laid out via way of means of randomized complete block design (RCBD) following three replications with the plot size of 3m by 4m and spacing of 10cm, 20cm, and 40 cm among plants, rows, and beds respectively.

Table 1. Treatment set up of the experiment

	Nutrient (kg ha^{-1})				
Fertilizer (kg ha^{-1})	**N**	**P_2O_5**	**S**	**B**	**Zn**
Control	0	0	0	0	0
Recommended NP	38	46	0	0	0
182 NPS + 125 Urea	92	69	12.74	0	0
191 NPSB + 125 Urea	92	69	12.8	1.36	0
204 NPSZnB + 125 Urea	92	69	14.89	1.37	4.55

Urea, TSP, and Borax had been used as a supply of Nitrogen (N), Phosphorus (P), and Boron (B) fertilizers respectively. The complete dose of blended, B, and P fertilizers was applied at planting time. Urea was applied in two splits; half of at

planting time and half had been top-dressed at the growth stage as in step with advice for onion. Improved onion variety Bombay red was used for the test.

Data collection and analysis

Plant height**,** bulb diameter, and bulb yield (marketable, unmarketable, and total) data records had been accrued. The accrued records had been subjected to analysis of variance (ANOVA) usage of SAS model 9.1 GLM procedures, and Least Significant Difference (LSD) become used to separate means at $p<0.05$ probability levels of significance. Composite soil samples in zig-zag movement with the depth of 0-20 cm were collected from the experimental site before the experiment. The collected soil sample was air-dried and grounded to pass 2 and 0.5 mm (for total N) and sieved for the process of analyzing total N, available P, S, B, pH, organic carbon (OC), and texture.

Economic Analysis

The economic evaluation comprising partial budget analysis with dominance and marginal analysis was carried out. Marketable bulb yield was valued based on average market price collected from the local markets during two consecutive years of production for estimation of economic parameters. The average cost of 17.5 birrs per kg was considered for marketable bulb yield. The average cost of urea, NPS, NPSB, NPSZn, and TSP were 14.79, 14.39, 15.48, 15.48, and 15.85 birrs per kg respectively. A wage rate of 50 birrs a man per day was considered. The dominance analysis, which was used to select profitable treatments, was carried out first by listing the treatments in order of increasing costs that vary. When the net benefit of preceding treatments is found to be higher than the net benefit of subsequent treatment, it is considered as dominated (D).

The selected treatments by using this technique were referred to as un-dominated (Non-dominated) treatments. For each pair of ranked un-dominated treatments, a percentage marginal rate of return (% MRR) was calculated. The %MRR between any pair of un-dominated treatments denoted the return per unit of investment in crop management practices which is expressed as a percentage. The marginal rate of return (%MRR) was calculated as the ratio of differences between net benefits of successive treatments to the difference between total variable costs of successive treatments.

For a treatment to be considered as a worthwhile option to farmers, the marginal rate of return (MRR) needed to be between 50% and 100% (CIMMYT, 1988). However, the minimum acceptable rate of return for this experiment was considered as 100%. Some of the concepts used in the partial budget analysis were;

Gross margin (ETBha^{-1}) = Total revenue (ETB ha^{-1}) – Total Variable Cost (ETB ha^{-1})

NR = GM – TFC; Where NR = Net Return (ETB ha^{-1}) and TFC = Total Fixed Cost (ETB ha^{-1})

TCP = TVC + TFC; Where TCP = Total Cost of Production (CIMMYT, 1988).

RESULTS AND DISCUSSION

Soil Analysis

Analysis of soil sample collected before the experiment was done at soil laboratory of Areka Agricultural Research Centre. The soil of the experimental site has a proportion of 62% sand, 18% silt, and 20% clay; which was classified as sandy loam based on the soil textural triangle. The organic carbon of the experimental site was 1.248% done by Walkely Blacky methods Black (1965), which was rated as low, Tekalign et al., (1991). The pH of the experimental site was 6, which was implied that the soil of the experimental site was slightly acidic according to Tekalign et al., (1991) (Table 2). The soil of the experimental site has total nitrogen of 0.108% by Keljdal digestion and distillation followed by titration method, which showed that the experimental site has a low level of total nitrogen according to Debele (1982) and Tekalign et al., (1991). The experimental soil has available phosphorus of 29.355ppm analyzed by Olsen methods which were effective for both alkaline and acidic soil and extracted by 1M $NaHCO_3$, which was rated as very high according to Olsen (1954).

The soil of the experimental site has available boron of 0.598ppm done by dilute HCl methods in which most effective and efficient, most applicable for acidic, neutral, and alkaline soil, and more economical than that of hot water methods (only for alkaline soil), which was categorized under medium-level according to Westerman (1990); and 13.158ppm of sulfur exists in the soil in sulfate (SO_4) form which was done by turbidymetric methods of analysis (acidic and non-calcareous soil) and its extractant was calcium chloride dehydrate as sulfate, which showed that the soil has sufficient level of sulfur according to Marx et al., (1999).

Table 2. Some physicochemical properties of the soil before the experiment

Soil Properties	Composition
Sand (%)	62
Silt (%)	18
Clay (%)	20
Textural class	Sandy loam
pH (1:2.5)	6
OC (%)	1.248
TN (%)	0.108
Available P (ppm)	29.355
B (ppm)	0.598
S (ppm) as SO_4	13.158

Blended fertilizer type impacts bulb diameter, marketable yield, and total yield; but blended fertilizer type did no longer affect plant height and unmarketable yield. The highest bulb diameter (22.38cm) become recorded from treatment which

Table 3. Onion yield and yield traits as influenced by blended fertilizer type in Bena Tsemay district

Treatments	PH (cm)	BD (cm)	MY (kg ha^{-1})	UnY (kg ha^{-1})	TY (kg ha^{-1})
Control	34.46	17.97^{b}	15278^{c}	2766.2	18043.98^{c}
Recommended NP	35.23	19.88^{ab}	21956^{b}	2141.2	24097.23^{b}
182 kg ha^{-1} NPS + 125 kg ha^{-1} Urea	37.17	22.38^{a}	20512^{b}	2361.1	22872.69^{b}
191 kg ha^{-1} NPSB + 125 kgha^{-1} Urea	36.96	18.99^{b}	28079^{a}	2511.6	30590.28^{a}
204 kg ha^{-1}NPSZnB + 125 kg ha^{-1} Urea	35.35	18.78^{b}	19838^{bc}	2673.6	22511.58^{bc}
$LSD_{0.05}$	NS	2.91	5029.9	NS	4720.4
CV (%)	5.4	7.90	12.64	31.02	10.61

Means values with different letters in the column are significantly different ($p<0.05$). Whereas; PH= Plant Height in centimeter, BD= Bulb Diameter in centimeter, MY= Marketable Yield, UnY= Unmarketable Yield, TY= Total Yield and kg ha^{-1}= kilogram per hectare

Table 4. Partial budget analysis of blended fertilizer type effect experiment on onion in Bena Tsemay district

Variables	Treatments			
	Control (no fertilizer)	Recommended NP	182 kg ha^{-1} NPS+ 125 kg ha^{-1} Urea	191 kg ha^{-1}NPSB + 1
Average Yield (kg ha^{-1})	15278	21956	20512	2807
10% Adj. Yield (kg ha^{-1})	13750.2	19760.4	18460.8	25271
Total Revenue (ETB ha^{-1})	240628.5	345807	323064	442244
TVC (ETB ha^{-1})	0	8752.19	16319.41	16658
Net Benefit (ETB ha^{-1})	240628.5	337054.81	306744.59	42558

10%Adj. Yield= Marketable Yield Adjusted to 10% downward; TVC= Total Variable Cost; ETB= Ethiopian Birr

Table 5. Partial budget analysis including dominance and marginal analysis of blended fertilizer type effect experiment on onion in Bena Tsemay district

Variables	Treatments				
	Control	Recommended NP	182 kg ha^{-1} NPS+ 125 kg ha^{-1} Urea	191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea	204 kg ha^{-1} NPSZnB + 125 kg ha^{-1} Urea
10% Adj. Yield (kg ha^{-1})	13750.2	19760.4	18460.8	25271.1	17854.2
TVC (ETB ha^{-1})	0	8752.19	16319.41	16658.45	25553.51
Net Benefit (ETB ha^{-1})	240628.5	337054.81	306744.59	425585.8	286894.99
Dominance Analysis	-	ND	D	ND	D
MRR (%)	-	1101.74	-	1119.76	-

D= Dominated; ND= Non-Dominated; MRR (%) = Marginal Rate of Return in percent

gets 182 kg ha^{-1} NPS and 125 kg ha^{-1} urea, even as the lowest (17.97cm) bulb diameter become recorded from control, however, there has been statistical parity on bulb diameter in among treatment one, two, four and five. The highest marketable yield (28079 kg ha^{-1}) become recorded from treatment which gets 191 kg ha^{-1} NPSB and 125 kg ha^{-1} urea, while the lowest marketable yield (15278 kg ha^{-1}) become obtained from the control treatment (Table 3). The total yield of onion become affected via way of means of blended fertilizer type of which the very best total bulb yield (30590 kg ha^{-1}) become recorded in reaction to utility of 191 kg ha^{-1} NPSB and 125 kg ha^{-1} urea, even as lowest total bulb yield (18044 kg ha^{-1}) become recorded from the control (Table 3).

Plant Height

Analysis of variance becomes revealed that the height of the onion did not show a statistically significant difference among treatments including the unfertilized (absolute control) treatment. This result become agreed with plant height become no longer statistically notably affected ($P \geq 0.05$) via way of means of the blended fertilizer rates (Mebrahtom et al., 2020). This result becomes within the line of an agreement with the locating of phosphorus utility and its interaction with nitrogen did no longer notably affect the height of onion (Tekeste et al., 2018) and additionally the absence of significant variation in plant height of onion because of application of various rates of phosphorus on vertisols of central Ethiopian highlands (Abdissa et al., 2011).

Bulb Diameter

Analysis of variance become revealed that blended fertilizer type influences bulb diameter of onion, of which maximum bulb diameter (22.38cm) become recorded in reaction to the application of 182 kg ha^{-1} NPS + 125 kg ha^{-1}urea, showing 19.71% increment over the control treatment (17.97cm) Table (3). The result of this examination becomes in

agreement with the maximum bulb diameter become recorded in reaction to utility of 138 kg ha^{-1}P_2O_5, showing 19% increment over the control treatment (Tekeste *et al.,* 2018). Similarly, Ghaffoor et al. (2003) additionally suggested that the nitrogen dose of 120 kg ha^{-1} N proved the nice for the maximum bulb diameter of onion. Likewise, applying nitrogen in increasing rate constantly expanded the bulb diameter of onion throughout the growing intra-row spacing (Guesh, 2015).

Marketable Yield

Analysis of variance becomes revealed that the marketable yield of onion as affected by blended fertilizer type. The maximum marketable yield (28079 kg ha^{-1}) become recorded from treatment which gets 191 kg ha^{-1} NPSB + 125 kg ha^{-1} urea, even as the lowest marketable yield (15278 kg ha^{-1}) become obtained from the absolute control treatment, that's in statistical parity with reaction to utility of 204 kg ha^{-1} NPSZnB + 125 kg ha^{-1} urea (Table 3). In conformity with the result of this experiment, the application of nitrogen at the rate of 103.5 kg ha^{-1} N and phosphorus at the rate of 138 kg ha^{-1} P_2O_5 ended in better total and marketable bulb yields over the control (Tekeste *et al.,* 2018). The present finding was in line with an agreement with the application of N: P_2O_5: S fertilizer with the rate of 105:119.6:22 kg ha^{-1} gives the highest marketable yield of onion over the nil (Muluneh *et al.,* 2018). Additionally, the report showed a significant increase in marketable bulb yield of onion with the combined application of 100:50:50NPK kg ha^{-1} over the control (Ghaffoor et al., 2003).

Unmarketable Yield

Analysis of variance becomes revealed that blended fertilizer types did not significantly influence the unmarketable bulb yield of onion. Similarly, Mebrahtom *et al.,* (2020) suggested that the unmarketable bulb yield of onion did no longer notably have an effect via way of means of blended fertilizer rates. This conformed with the finding of onion's unmarketable yield had no longer been notably motivated via way of means of Nitrogen and Phosphorous (Tibebu *et al.,* 2014).

Total Bulb Yield

Analysis of variance become revealed that total bulb yield of onion as influenced by blended fertilizer type, of which highest total bulb yield of 30590 kg ha^{-1} become recorded in reaction to application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} urea, while the lowest total bulb yield of 18044 kg ha^{-1} become recorded from the absolute control which is in statistical parity with response to the application 204 kg ha^{-1} NPSZnB + 125 kg ha^{-1}urea (Table 3). Thus, the maximum total bulb yield obtained in response to application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} urea exceeded the minimum total bulb yield obtained at nil application of the fertilizers by 41.01%. In conformity with the consequences of this examination, onion has responded nicely to the application of nitrogen and phosphorus fertilizers, and their interaction to influence the yield of the crop (Tekeste et al., 2018). The result become consistent with the finding of fertilizer application significantly enhanced the bulb yield of onion in all nutrient elements (NPKS) over the control (Amin et al., 2007). The result was also in conformity with the finding of almost all growth and yield parameters of onion had been significantly affected by different rates of NPS fertilizer application (Muluneh *et al.,* 2018). Moreover, boron additionally impacts growth parameters that have expanded yield and yield-associated parameters of onion, wherein it will increase the total bulb yield by 7.75% over control treatment (0 boron) (Bhat et al., 2018).

Economic Analysis

Partial budget analysis of blended fertilizer type impact on onion test in Bena Tsemay district was revealed that the highest net return (425585.8 ETB ha^{-1}) was obtained in response to application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea, while the lowest net return (240628.5 ETB ha^{-1}) was obtained from unfertilized treatment (nil treatment). Application of 191 kg ha^{-1}NPSB + 125 kg ha^{-1} Urea gives 43.46% higher return over the nil one (240628.5 ETB ha^{-1}); followed by treatment with recommended NP with net return of 337054.81 ETB ha^{-1} (Table 4).

Dominance and Marginal (MRR) Analysis

Dominance analysis revealed that treatment that gets Recommended NP and 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea has been un-dominated. This indicated that growth within side the overall fee of those treatments will increase the net advantage proportionally; which means advantage have been more than the lower total costs. The highest marginal rate of return of 1119.76% was obtained from the application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea followed by Recommended NP with MRR of 1101.74% (Table 5). Therefore, both 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea with MRR of 1119.76% and Recommended NP with MRR of 1101.74% were accepted according to CIMMYT (1988).

CONCLUSION

Depleting of soil fertility, inappropriate and imbalanced fertilizer application including different blended fertilizers are many of the maximum critical elements that lessen the productiveness of onion within side the observed location in particular and within side the place in comparison to the crop ability and different African countries. Therefore, the experiment was carried out to evaluate the impact of various blended fertilizer types on enhancing the productiveness of onion in Bena Tsemay district, southwestern Ethiopia under irrigated conditions. The finding of this study has found out that onion reacted nicely to the application N, P, B, S, or even Zn than the nil one. However, the application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea resulted in the highest total and marketable bulb yield of onion, and the lowest total and marketable bulb yield of onion have been recorded from the

nil. Moreover, based on economic analysis, additionally, the best net advantage (425585.8 ETB ha^{-1}) and economic returns/marginal rate return of 1119.76% have been recorded in reaction to application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea followed by Recommended NP. Application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea gives 45.59% yield increment and additionally, 43.46% increment in economic return over the control. Therefore, we advise the application of 191 kg ha^{-1} NPSB + 125 kg ha^{-1} Urea for farmers and investors in the observed location and comparable agro-ecologies because it changed in to best for enhancing onion productiveness and cost-effectiveness. Further research needs to be finished on plant nutrient uptake and nutrient use efficiency, bulb chemical composition, and over the location.

AUTHOR CONTRIBUTIONS

Merdikios Malla; conceptualization, information search, and wrote the manuscript. The research proposal was prepared and the final manuscript was revised by Genanaw Tesema and Atinafu Tunebo.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

ETHICS APPROVAL

Not applicable

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