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Effect of Nitrogen and Phosphorus Fertilizer Rates on Yield and Yield Components of Shallot (Allium cepa L) at Gemechis and Daro Labu Districts, West Hararghe Zone

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Abstract
Shallot(Allium cepa L) is one of important cash crop in Ethiopia, The study was conducted at Gemechis and Daro labu districts of West Hararghe zone of Oromia region in 2013 - 2014 cropping season. to determine the optimum level of N and P fertilizer for optimum yield of Shallot yerus variety on soil of Gemechis and Daro labu districts of West Hararghe zone. five level of N , 0, 72, 92. 112 and 132 and six level of P, 0, 160, 180, 200, 220 and 240kg treatment combination were used, Shallot(Allium cepa) ythrus variety was used as test crop. At N value, analysis of variance showed that, none significance difference at plant height, average bulb weight, marketable yield and total yield, where as significance difference found among treatment, on unmarketable yield, but treatment 42 kg N ha-^{1} of and 132 kg P ha-^{1} was the highest mean with 41.35cm. treatment 132 kg N ha^{-1} and 240 kg P ha^{-1} was the highest mean of average bulb weight with 90.5gm at followed by 87.5gm on 92 kg N ha-^{1} and 240kg P ha-^{1}. treatment 92 kg N ha-^{1} and 160 kg P ha-^{1} was the highest means of marketable yield 23.0 tone/ha^{-1} followed 22.6 tone/ha^{-1}at treatment 92 kg N ha-^{1} and 220 kg P ha-^{1} of respectively. and the lowest means of marketable yield 21.95 tones ha^{-1} recorded by treatment 112 kg N ha-^{1} and 240 kg P ha-^{1}. treatment 92 N kg ha-^{1} and 160 kg P ha-^{1} was the highest mean of total yield of 23.45 tons ha^{-1} was obtained. Therefore, 92 kg N ha-^{1} N and 160 kg ha-^{1} of P fertilizer combination was recommended to the study area and similar agro ecology.
Keywords: Allium cepa, average bulb weight, Dap, marketable yield, Shallot, Urea

1.INTRODUCTION

Shallot (*Allium cepa*) is probably cultivated in all countries of tropical Africa including Ethiopia (Grubben and Denton, 2004). Onion is important in the daily Ethiopian diet and all the plant parts are edible, although the bulbs are widely used as a seasoning or a vegetable in various dishes. It is one of the most economically important olericultural products in the country. During 2006, the rainy season (Meher) about 16578.72 ha of lands were planted and more than 0.17million tons of bulbs were obtained with an average yield of 10.6 tons/ha (CSA, 2006). Onion and Shallot are one of the most important vegetable crops cultivated both under rain fed and irrigated condition in Gemechis and Daro labu district of western Hararghe, eastern Ethiopia. According to CSA (2006) census report *Allium cepa* L. is produced in 218.94 and 431.64 ha of land in main(Meher) and short (Belg) rainy seasons, respectively and the average yield of onion was 6.5 tons per ha which is far less than both from the national and world average yield of 10.5 and 13.4 tons per ha^{-1}, respectively (CSA,2006; FAO, 2006). A number of production constraints are responsible for such reduced bulb yield of which lack of specific fertilizer recommendation for the area is in the top list.

Nitrogen (N) and phosphorus (P) are often referred to as the primary macronutrients because of the probability of plants being deficient in these nutrients and because of the large quantities taken up by plants from the soil relative to other essential nutrients (Marschner, 1995). Nitrogen comprises 7% of total dry matter of plants and is a constituent of many fundamental cell components (Bungard et al., 1999). It is one of the most complex in. behavior, occurring in soil, air and water in organic and inorganic forms. For this reason, it poses the most difficult problem in making fertilizer recommendations (Archer,1988). Plant demand for N can be satisfied from a combination of soil and fertilizer to ensure optimum growth.

Three major essential plant nutrients, N, P and K were found increasingly in short supply in the soils of Eastern, Western and Southern Africa (Rao et al., 1998).Particularly N and P are deficient in many soils of tropical Africa (Richardson, 1968), which might also be true for many Ethiopian soils (Murphy, 1968). Phosphorus deficiency is one of the largest constraints to crop production in many tropical soils, owing to low native content and high P immobilization within the soil (Fairhust *et al*. 1999).Accordingly, Phosphorus fertilization is usually recommended in these soils. Phosphorus is essential for root development and when the availability is limited, plant growth is usually reduced. In onions, P deficiencies reduce root and leaf growth, bulb size and yield and canal so delay maturation (Brewester, 1994). In soils that are moderately low in P, onion growth and yield can be enhanced by applied P. Onions are more susceptible to nutrient deficiencies than most crop plants because of their shallow and un branched root system; hence they require and often respond well to addition of fertilizers(Brewester, 1994). Currently, for the research and the extension activities in the district, the

nationally recommended fertilizer rate of 92 kg N ha^{-1} and 200 kg P ha^{-1} is being used without considering soil characteristics of the area as limiting nutrient. Hence, there is an urgent need to identify the optimum N and P level for better productivity of Shallot in the area. In view of the aforementioned, the study was carried out to determine the optimum level of nitrogen and phosphorus fertilizer for optimum yield of Shallot variety on soil of Gemechis and Daro labu districts of West Hararghe zone and to assess leaf growth, biomass production and bulb yield under varying levels of nitrogen and phosphorus fertilizer.

2. MATERIALS AND METHODS

2.1 Description of the study area

The field experiment was conducted at two location, Mechara research on station and Gemechis districts, in 2012 - 2013 cropping season. Mechara research on station is located 434 km from the east of Addis Ababa in Daro Labu District of West Hararghe Zone in Oromia Regional State. It is 115 km from Ciro town (Zonal Capital) at latitudinal and longitudinal positions are 40'19.114 N and 80'35. E respectively.

The center is located in moist mid altitude (Md- altitude) agro-ecology and its altitude is 1760 m.a.s.l with annual average temperature and rainfall 16^0c and 963 mm respectively.
Gemachis districts

2.2. Planting and agronomic practices

Shallot ythrus (*Allium cepa* L.) variety, was used for the study material. The Seed was sown in a nursery on a well prepared seed bed. When seedlings were at the 3 to 4 leaf stage or 12 to 15 cm height, they were transplanted in the experimental field. Planting was done on ridges of about 25 cm high, adopting the recommended spacing of 40 cm between water furrows, 20 cm between rows on the ridge and 10cm between plants. The plot size was 2m x 2m and a total of 19 plants were planted per row. A distance of 0.5 m was maintained between plots and 1 m between Blocks. All cultural practices were employed as per the regional recommendations.

2.3. Treatments and experimental design

The experiment was conducted at rain fed condition in 2014 cropping season. Transplanting was done end of June and harvesting was carried out end of October. The treatments were factorial combination arrangement in a Randomized Complete Block Design with three replications in split plot design of five levels of Urea (0, 33.1, 42.3, 51.5 and 60.7 kg ha^{-1}) and six levels of Phosphorus (0, 76.8, 86.4, 96, 105.6 and 115.2 kg ha^{-1}). The source of fertilizer for Nitrogen, Phosphorous, were Urea and Di-ammonium Phosphate, respectively (DAP) The treatment combinations were five level of nitrogen were assigned in main plot and six level of phosphorus as sub plot. The full dose of P and half dose of N fertilizer were applied at transplanting and the remaining half dose of N was side-dressed at 45 days after transplanting.

2.4. Soil laboratory analysis result before and after harvesting

Table 1. Soil Physical and chemical properties of analysis result at two location for different parameters at pre sowing at Sororo and Cafe hara in 2013 - 2014.

Sites/PA	Av. P	Total N	PH	Ec	Particle size analysis%				OC	OM	C:N
					Sand	Silt	Clay	class			
Sororo	8.69	0.156	6.15	0.32	22	14	64	Clay	3.6	6.21	23.08
Cafe hara	18.4	0.227	6.72	0.28	24	14	52	Clay	3.62	6.24	15.95

At two location, soil laboratory analysis results before planting in table 1. indicated that the soil was Clay, basic in reaction with medium total nitrogen, low available phosphorus, high organic matter. The soil PH was slightly acid to neutral, Ec has high cation exchange capacity at two sites, Cafe hara and Sororo, respectively. At Sororo, C/N ratios content has high where as low at Jilbo and high soil structure at OC at two site, respectively. after harvesting soil analysis result showed that, at Sororo, the amount of P was increased and at Cafe hara was decreased.

2.5. Soil Sampling

The soil sampling was done before transplanting of seedlings, from five entire location of representative at depth of 0 - 30cm then mixed to form composite sample. The composite sample was sub-divided into working samples for analysis. Soil analysis for specific parameters was carried out at soil laboratories.

2.6. Data collection

2.6.1. Total bulb yield (t ha^{-1}):

The total bulb yield was measured as the total weight of both marketable and unmarketable bulbs produced by all plants at central four rows per plot. The total weight of the bulbs were measured using digital balance after

curing and it was converted into t ha^{-1}.

2.6.2. Gross average bulb yield (kg ha^{-1}) (AvY): Is an average yield of each treatment.

Adjusted yield (kg ha^{-1}) (A_jY):

Is the average yield was adjusted downward by a 15% to reflect the difference between the experimental yield and yield of farmers. This is due to, under experimental condition there was optimum plant population, better crop management and small plot size.

$A_jY = A_vY - (A_vY * 0.15)$

2.6.3.Total cost

is the cost of fertilizer used for the experiment. The price was based on price during planting. The costs of other inputs and production practices such as labor cost for land preparation, planting, weeding, crop protection, and harvesting were assumed to remain the same or the difference were insignificant among treatments.

2.6.4. Marketable bulb yield (tonha^{-1}):

marketable bulb yield was the yield recorded from all plants in the central six rows per plot and was converted to yield of t ha^{-1} which were greater than 3 cm in diameter (Morsy *et al*., 2012). The marketable bulb yield weight standard for Ethiopia is grouped as over sized (above 160g), large (100-160g), medium (50-85g), smaller sized (21-50g) (Lemma and Shimeles, 2003).

2.6.5. Unmarketable yield (tonha^{-1})

was recorded as the total weight of damaged, physiological disordered, discolored, pest damaged, splitted, thick necked, rotten and small bulbs (below 20g) after curing that are discarded as unmarketable bulb (Lemma and Shemels, 2003; Morsy *et al*., 2012).

2.6.6. Data analysis

All data were subjected to analysis of variance using SAS(Statistical Analysis System) version 9.1 Mean separation was done using Least Significant Difference (LSD) at 5% probability level. Correlations between parameters were done when deemed applicable

3. RESULTS AND DISCUSSION

3.1. Plant height

Treatment 72 kg N ha^{-1} and 180 kg P ha^{-1} was significantly increase plant height (31.5cm) at Sororo PA, But at Cafe hara and mean of two sites analysis result showed that at 72 kg of Urea and 180 kg of Dap was the highest mean plant height was recorded. however, treatment 0 kg N and 0 kg P was the least mean of plant height at all sites. The influence of Phosphorus levels and its interaction with nitrogen was significant(in Table 3) this result was agreement with. Bungard et al. (1999) stated that N is a constituent of many fundamental cell components and it plays a vital role in all living tissues of the plant. No other element has such an effect on promoting vigorous plant growth.

This could be attributed to the increase in the vegetative growth of the onion plants through its effect in the synthesis of the different components of protein required for leaf development.

Table 2. The mean analysis result of Agronomic and growth traits of influenced by nitrogen and phosphorus on yield and yield component of Shallot at Sororo PAs of West Hararghe, 2014.

Treatments N(kg ha^{-1})	Plant height (cm)	Av. bulb wt (gm)	Mark yield tone/ha-1	Unmark yield tone/ha-1	Total yield /ton/ha-1
0	25.2b	53b	14.1b	1.6a	15.7b
72	31.63a	78.4a	21.2a	0.76b	21.94a
92	31.84a	88.8a	22.76a	0.73b	23.52a
112	32.25a	82.4a	20.06a	0.70b	20.77a
132	33.0a	90a	21.0a	0.62c	21.62a
P(kg ha^{-1}					
0	21.3c	49.9b	16.5b	1.62b	17.7b
160	29.5b	87.4a	22.64a	0.65a	23.29a
180	31.5ab	80.2a	20.18a	0.74a	20.91a
200	33.0a	79.4a	20.10a	0.60a	20.73a
220	33.1a	85.5a	20.80a	0.73a	21.53a
240	33.56a	91	22.63a	0.73a	23.36a
CV	11.5	22.29	25.23	23.98	24.44
N x P	*	Ns	Ns	Ns	*

NS and *: no significant at P>0.05, significant at P≤0.05, respectively, *= Significant, difference among treatments

3.2. Average bulb weight

The average bulb weight of Shallot was increase 90 gm at 132 kg N ha^{-1} and 240 kg P ha^{-1}. Nitrogen fertilization

significantly increased average bulb weight and Phosphorus fertilization and its interaction with N was significantly influence either bulb fertilization and its interaction with N significantly influence bulb weight. Regardless of the rate, N fertilization increased bulb diameter by about 1.2% in reference to 72 kg N ha-^{1} and 160 kg P ha-^{1} (86 gm), which may be linked to the increase in dry matter production and allocation to the bulb. This was in agreement with Nasreen et al. (2007) who reported a significant increase in the diameter of bulbs due to the application nitrogen rates. Onion bulb size can be increased by application of N during the growing period(Rice et al., 1993). In the this study, the mean bulb weight was positively and strongly correlated with bulb length and diameter signifying that N fertilization increased bulb weight

Table 3. The mean analysis result of agronomic and growth traits effected by nitrogen and phosphorus rates on yield and yield component of Shallot at Cafe hara PAs of West Hararghe zone, 2014.

N(Kg/ha^{-1})	Plant height (cm)	Av. bulb wt (gm)	Mark yield tone/ha-1	Unmark yield tone/ha-1	Totalyield /ton/ha-1
0	23.7b	56.1b	17.4b	1.1b	18.8b
72	31.63a	78.4a	21.2a	0.76a	21.94a
92	31.84a	88.8a	22.76a	0.73ab	23.52a
112	32.25a	82.4a	20.06a	0.70ab	20.77a
132	33.0a	90a	21.0a	0.62b	21.62a
P(kg ha^{-1})					
0	24.3c	56.8c	16.7b	0.93b	17.7b
160	29.5b	87.4a	22.64a	0.66a	23.29a
180	31.5ab	80.2b	20.18a	0.74a	20.91a
200	33.0a	79.4b	20.10a	0.60a	20.73a
220	33.1a	85.54b	20.80a	0.63a	21.53a
240	33.56a	91	22.63a	0.66a	23.36a
CV	11.5	22.29	25.23	23.98	24.44
N X P	*	*	Ns	*	*

3.3. Marketable yield(tonha^{-1})

Marketable yield was significance difference found among treatments, application of N and P combination, but treatment 92 kg N ha $^{-1}$ and 160 kg P ha $^{-1}$ was the highest mean of with 23.4 ton ha^{-1} followed by 92 kg N ha $^{-1}$ and 180 kg P ha $^{-1}$, (22.8 ton ha^{-1}.) the least mean of marketable yield was 17.2 ton at 0 N and 0 P treatments. This result showed that application of N and P is direct relation with growth (Birhanu. A,*et all*,2014) and the lowest mean of marketable yield was recorded by 0 kg N and 0 kg P, 18. 5 ton ha^{-1}.

3.4. Unmarketable yield(tonha^{-1})

Interaction of Nitrogen and Phosphorus on yield of Shallot was significance difference among treatment, treatment combination of 72 kg N ha $^{-1}$ and 160 kg P ha^{-1} was the highest mean unmarketable yield was 0.74 ton ha-^{1}. This association indicates that an increased photosynthetic area in response to N fertilization had substantially contributed to enhance onion productivity that could be through the production of more assimilates. Similar results were also reported by Nasreen et al. (2007).

Table 4. The mean combined analysis result of Agronomic and growth traits effected by nitrogen and phosphorus rates on yield and yield component of Shallot at Gemechis and Daro labu districts of West Hararghe zone,2014.

Urea Kg/ha-1	Plant height (cm)	Av. bulb wt (gm)	Mark yield tone/ha-1	Unmark yield tone/ha-1	Total yield /ton/ha-1
0	25.7b	61b	16.9b	1.2b	18.1b
72	38.71a	78a	22.73a	0.75a	23.49a
92	38.05a	88a	22.99a	0.71a	23.68a
112	37.36a	82.4a	21.71a	0.71a	22.43a
132	38.54a	90a	22.34a	0.61a	22.95a
Dap(kg/ha)					
0	27.3b	46b	18.1b	1.2c	19.3b
160	36.83a	87.5a	23.20a	0.59b	23.80a
180	39.09a	81.24a	22.31a	0.68ab	22.99a
200	38.88a	79.5a	22.0a	0.71ab	22.71a
220	38.12a	85.5a	22.56a	0.78a	23.34a
240	37.90a	91a	22.10a	0.72a	22.83a
CV	7.93	22.29	12.39	21.41	11.91
NXP	*	*	*	*	*

Ns and *: no significant at P>0.05, significant at P≤0.05, respectively, *= Significant, difference among treatments

3.5. Total yield (tonha^{-1})

The total yield of Shallot was significantly difference at ($P \leq 0.05$) affected by Nitrogen and Phosphorus, their interaction was significant. The highest yield (23.5 tons ha-^{1}) was obtained at 92 kg N ha-^{1} and 160 kg P ha-^{1} which was followed by (22.99 ton ha^{-1}) 92 kg N ha-^{1} and 180 kg P ha-^{1}, while minimum (tons ha^{-1}) was recorded from control plots(18.1ton ha-^{1}). The results are in close conformity with the findings of Kulvinder (1990) who found that highest nitrogen rates resulted in maximum yield.

4. CONCLUSION AND RECOMMENDATION

In this study, it was observed that the application of beyond 92 kg N ha-^{1} and 200 kg P ha-^{1} was disadvantageous because it reduced dry matter content From the current investigation, and application rate for of 92 kg N ha-^{1} and 160 kg P ha^{-1} enhanced the growth of Shallot and resulted in optimum fresh total and marketable bulb yield on the Clay soil of Sororo/Gemechis and Cafe hara/Daro labu east Ethiopia. This rate is lower than the current nationally recommended rate of 92 kg N ha-^{1} and 200 kg P ha-^{1}. Application of P fertilizer is not advisable as the soil has adequate level for normal onion plant performance. So it was is advisable for better grown of shallot plant and to ensure high yield and good quality of Shallot bulbs in Clay soil at the same times it was economically advisable to use 92 kg ha^{-1} of N and 160 kg ha^{-1} of P amount fertilizer for better return.

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