Response of garlic to nitrogen and phosphorus under irrigation in Lasta district

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Abstract

Crop production under irrigation systems is under pronounced challenges resulted in low yield in Waglasta zone of Amhara region for many reasons among which no or inefficient application of the major nutrients (nitrogen and phosphorus) took considerable share. Hence, a field experiment was conducted to study the effect of nitrogen (N) and phosphorus (P) on the growth and bulb yield of garlic at Lasta district Kechin Abeba irrigation scheme in 2013 and 2015. The treatments were arranged in a factorial combination of three rates of N (0, 46, 92, kg ha^{-1}) and four rates of P (0, 23, 46, 69, kg P_2O_5 ha^{-1}) in a randomized complete block design in three replications. All TSP (phosphorus source) was applied at transplanting whereas urea (nitrogen source) was applied in two splits (half at transplanting and the other half at 45 days after planting). Irrigation water was applied uniformly to all plots in furrow every six days. Agronomic data were collected and analyzed using SAS software and significant treatment means were separated using least significant difference at 5% level of significance. The effect of nitrogen and phosphorus was significant on plant height and bulb yield. Application of 92 kg N ha^{-1} and 46 kg P_2O_5 ha^{-1} increased bulb yield by 48.3% compared to the control and was economically dominant over the other treatments. Therefore, application of 92 N and 46 P_2O_5 kg ha^{-1} is an optimum rate for garlic production at Lasta District, Kechin Abeba irrigation scheme and similar agro-ecologies.

Keyword: Bulb yield, Garlic, Nitrogen, Phosphorus

Introduction

Garlic is one of the vegetable crops known worldwide for its production and economic value (Salomon, 2002). It is widely used around the world for its pungent flavor as a seasoning or condiment. It is a fundamental component of dishes in the world including Ethiopia. It is rich in sugar, protein, fat, calcium, potassium, phosphorus, sulfur, iodine, fiber, and silicon in addition to vitamin (Purseglove1, 979). The total area under garlic production is estimated to be over 17965 hectares (CSA, 2014). Many biotic and abiotic factors contribute for the low productivity

of garlic in Ethiopia including: declining soil fertility, insufficient and inefficient use of fertilizers, inappropriate agronomic practices, and in adequate pest and disease managements. Chemical fertilizers have been the prime means of enhancing soil fertility in small farm agriculture ((Thangavel et al., 2014). Nitrogen (N) and phosphorus (P) are often referred as the primary macronutrients because of the large quantities they are taken up by plants from the soil relative to other essential nutrients (Marschner, 1995). In order to improve garlic production, proper fertilizer application (type, time and rate) should be considered (Brewster and Butler, 1989). In the study area, garlic is produced as a cash crop and there was no fertilizer recommendation done so far for its production. Therefore, this research was conducted to determine the optimum rate of nitrogen and phosphorus fertilizers for garlic production in KechinAbeba irrigation scheme.

Materials and method

Description of the study site

A field experiment was carried out during 2013 and 2015 under irrigation in Kechin Abeba Lasta district, North Wollo Administrative Zone of the Amhara Region (Figure 1). The site is located 12°35’31.2’’N latitude and 39 ° 04’30’’E longitude. The altitude of the study area is 1856 m.a.s.l.

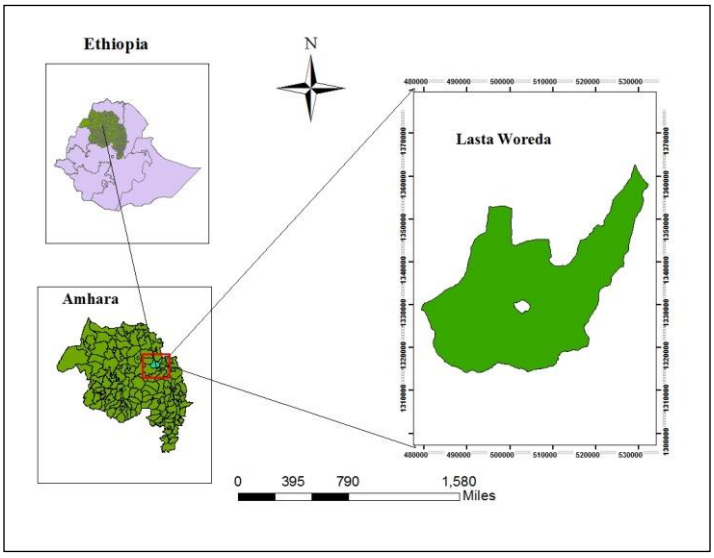

Figure1. Location of the study

Experimental design and treatments

The experiment was conducted using furrow irrigation system. The treatments consisted of three N levels (0, 46, and 92 kg N ha^{-1}) and four P_2O_5 levels (0, 23, 46, and 69 kg P_2O_5 ha^{-1}). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications in a factorial arrangement. The plot size was 6 m^2 (2 m X 3 m) and consisted of 10 rows. Distance between plots and blocks, were 0.5 m and 1 m; respectively while the distances between plants and rows were 0.2 m and 0.10m respectively. Urea and TSP were used as source of nitrogen and phosphorus fertilizers respectively. Nitrogen was applied by splitting: half at transplanting and half after 45 days of transplanting while the whole dose of phosphorus was applied once at transplanting. Agronomic practices such as weeding, cultivation and ridging were done uniformly to all treatments. Water was supplied at 6 days interval using furrow irrigation method. A local variety was used. Plant height, bulb yield, and biomass of garlic were recorded for each plot.

Data analysis

Collected data were subjected to statistical analysis using SAS Statistical Software version 9.0 and treatment mean differences were compared using the Fisher's least significant differences (LSD) test at 5% level of significance.

Soil analysis

A disturbed composite soil sample was collected from 0-20 cm, air-dried and sieved through 2 mm sieve to determine most nutrients while through 0.5 mm to determine Total Nitrogen and Organic Carbon. Soil pH was determined in H_2O using 1:2.5 soils to solution ratio using a combined glass electrode pH meter (Chopra and Kanwar, 1976). Organic carbon of the soils was determined following the wet digestion method as described by Walkley and Black (1934) while percentage organic matter of the soils was determined by multiplying the percent organic carbon value by 1.724. Total N was analyzed by the Kjeldahal digestion and distillation procedure (Bremner and Mulvaney, 1982), and Particle size distribution was analyzed by hydrometer method.

Partial budget analysis

The partial budget analysis was done to evaluate the economic feasibility of nitrogen and phosphorus application based on the manual developed by CIMMYT (1988). The cost fertilizer,

mean price of onion was collected from the district. For the purpose of partial budget analysis (sensitivity analysis), yields were adjusted to 90 of the actual yield collected from the field (reduced by 10%).

Results and discussion

The major soil properties including soil pH, soil organic matter, total nitrogen and soil texture of the study site are discussed below. The pH (pH water) (6.8) was neutral (Tekalign, 1991). The available P (2.6 ppm), soil organic matter (1.01%) and total nitrogen (0.062%) were rated as very low (Tekalign, 1991) and should be improved through organic and inorganic amendments for improved crop growth and yield. The textural class of the study soil was clay loam with 30% sand, 30% silt and 40% clay. The response of the test crop to nitrogen and phosphorus under irrigation was reflected to these major soil chemical and physical properties of the study sites.

Plant height

The result in Table 1 shows that plant height of garlic was not significantly influenced by nitrogen and phosphorus rates. However, relatively higher plant height (54.85 cm) was recorded from 92 N and 69 P_2O_5 ha^{-1} followed by 46 N and 23 kg P_2O_5 ha^{-1} (54.41 cm) while the minimum (45.36 cm) was found from the control plot. The result is in agreement with the findings of (Mulatu et al., 2014) who reported that application of Nitrogen at 46 and 69 kg N and P_2O_5 ha^{-1} increased the plant height significantly. (Adem and Tadesse, 2014) and (Khan et al., 2007) also reported that nitrogen at 46 kg N ha^{-1} increased the plant height significantly**.** The increment in vegetative parameters for garlic with the addition of N had a profound influence on the development of the crop. Application of adequate quantity of nitrogen ensures healthy plant growth that manifests through increasing vigor, size and deeper green color of foliage (Miko, 1999).

Bulb yield

The interaction of nitrogen and phosphorus fertilizers significantly affected the total bulb yield. The maximum bulb yield (7.11 t ha^{-1}) was obtained from plots fertilized with nitrogen and phosphorus at the rate of 92 N 46 P_2O_5 kg ha^{-1} followed by 46 N and 46 P_2O_5 (6.7 t ha^{-1}) (Table

1). However, further increase of nitrogen and phosphorus rates showed a decreasing trend of the bulb yield (Table 2). The minimum average yield (4.8 t ha^{-1}) was obtained from the control plot. This yield increment might be due to the fact that nitrogen supply increase the rate of metabolism that in turn results in a synthesis of more carbohydrate and high bulb yield (Miko, 1999). The result is also in line with the findings of (Farooqui et al., 2009) and (HORE et al., 2014) who reported that application of nitrogen at rate of 92 N kg h^{-1} increased the total bulb yield of garlic.

Table 1. Effects of nitrogen and phosphorus fertilizer application on growth and yield of garlic

Fertilizer (Kg ha^{-1})		Plant height (cm)			Bulb yield (Q ha^{-1})			Biomass yield (Q ha^{-1})		
N	**P_2O_5**	Year-1	Year- 2	Combined	Year-1	Year-2	Combined	Year-1	Year-2	Combined
0	0	47.66	43.40	45.36	57.99	41.87	47.93	67.54	51.45	59.50
46	0	54.40	45.60	50.00	57.63	50.72	54.18	63.26	60.83	62.04
92	0	51.96	47.86	49.91	61.61	57.43	59.52	67.24	69.72	68.48
0	23	48.93	45.13	47.03	52.57	47.91	50.24	65.09	60.47	62.78
46	23	56.56	52.46	54.51	61.55	58.26	59.90	73.14	70.00	71.56
92	23	55.93	51.93	53.93	51.78	68.40	60.09	57.60	83.54	70.56
0	46	47.33	44.06	45.86	54.35	48.43	51.39	63.09	63.22	63.16
46	46	50.10	46.00	48.05	73.96	59.27	66.61	84.78	73.85	79.31
92	46	54.00	53.26	51.96	67.28	74.89	71.09	79.09	86.19	82.64
0	69	47.66	43.60	45.63	54.52	42.50	48.51	62.85	53.54	58.19
46	69	52.43	48.33	50.38	52.58	57.15	54.87	60.68	67.50	64.08
92	69	56.90	52.80	54.85	73.44	58.68	66.06	77.26	72.98	75.12
	LSD (5 %)	10.47	11.66	11.09	18.24	14.90	12.18	22.99	17.27	14.09
	CV (%)	9.17	8.60	6.37	18.05	16.94	18.28	19.93	15.12	17.91

Partial budget analysis

The partial budget analysis of the research showed that applying 92 kg N/ha and 46 kg P_2O_5 ha^{-1} had highest net benefit of 188326.5 ETB ha^{-1} with MRR of 4173.73% and followed by 46 kg N ha^{-1} and 46 kg P_2O_5 ha^{-1} with a net benefit of 177361.4 ETB ha^{-1} and MMR of 2506.82% (Table 2).

Table 2. Partial budget analysis result of the research

Fertilizer (kg ha^{-1})		Yield*	Gross benefit*	Cost*	Net benefit*	MRR%
Nitrogen	P_2O_5					

application of nitrogen and phosphorus at the rate of 92 kg N and 46 kg P_2O_5 ha^{-1} had 2.21 t ha^{-1} yield advantage over the control (no fertilizer). Application of 92 kg N ha^{-1} and 46 kg $P_2O_5ha^{-1}$ gave the highest economic return followed by 46 kg N ha^{-1} and 46 kg P2O5 ha^{-1}. Therefore, the combination of 92 kg N ha^{-1} and 46 kg P_2O_5 ha^{-1} is recommended for Kechin Abeba irrigation scheme and similar agro-ecologies to produce maximum yield garlic yield. Further work on integrated nutrient management for further increase in productivity is crucial.

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