

Productivity of Two Garlic (*Allium sativum* L.) Cultivars as Affected by Different Levels of Nitrogenous and Phosphorous Fertilizers in Sokoto, Nigeria

M.J. Kilgori, M.D. Magaji and A.I. Yakubu

Department of Crop Science, Usumanu Danfodiyo University, Sokoto, Nigeria

Abstract: Two field experiments were carried out during the 1997 and 1998 dry seasons at the Usumanu Danfodiyo University, Teaching and Research *Fadama* Farm Sokoto [13° 01'N Latitude and 5° 15'E Longitude, 350 meters above sea level}, in order to study the response of two garlic (*Allium sativum* L.) cultivars to varying nitrogen and phosphorus levels. A factorial combination of five nitrogen levels (0, 60, 120, 180 and 240 kg N ha⁻¹), three phosphorus levels (0, 22 and 44 kg P ha⁻¹) and two garlic cultivars (ex-Lugu and ex-Kofa) were laid out in a Completely Randomized Block Design and replicated three times. Data was collected on fresh and cured bulb yield and analysed. Application of 120 kg N ha⁻¹ produced the highest garlic yield. Increase in phosphorus levels from 0 to 44 kg P ha⁻¹ had no significant effect on yield. The cultivars ex-Lugu and ex-Kofa were similar in yield performance.

Key words: Nitrogen · phosphorus · cultivar and garlic yield

INTRODUCTION

Garlic (*Allium sativum* L.) belongs to the family Alliaceae. Other crops in the family are onion (*A. cepa* L.), leek (*A. ameloprisum* L.), shallot (*A. asacloicum* L.) and chive (*A. schoenoprasum* L.). Garlic is the second most widely used of the cultivated bulb crops after onions. It is an erect annual herb that can reach a height of 75-90 cm and grows during dry and mild winter season [1].

Garlic is believed to have originated in Central Asia (India, Afghanistan, W. China, Russia etc) and spread to other parts of the world through trade and colonization [2, 3]. According to FAO [4], production of garlic stood at about 10 million tonnes per annum which is only about 10% that of bulb onions. China is the world largest producer followed by South Korea. The world average yield of garlic is about 10 t ha⁻¹, but can go up to 19 t ha⁻¹.

Garlic is rich in sugar, protein, fat, calcium, potassium, phosphorus, sulfur, iodine, fibre and silicon, in addition to vitamins. Its pungent flavor makes it used mainly as a spice, seasoning and flavoring for foodstuff involving both green tops and bulbs. Its medicinal value is also well recognized in the control and treatment of hypertension, worms, germs, bacterial and fungal diseases, diabetes, cancer, ulcer, rheumatism etc. Dehydrated garlic and

extracts are fast replacing fresh bulbs for industrial and home usage in the production of drugs, insecticides and explosives [2].

Sokoto is among the leading garlic producing states in Nigeria. Production of the crop dates back several decades in the state. Garlic cultivation in Sokoto covers an area of over 11,277 ha producing about 73,908 metric tonnes per annum [5]. The main producing Local Government areas are Goronyo, Wurno, Gada, Gwadabawa, Rabah and Kware, where the crop is grown under irrigation during the cool dry season (Hamattan) in Nov-March. The traditional husbandry practices have resulted in 3-4 t ha⁻¹ yield as against the world average of 10-15 t ha⁻¹. At off-season same quantity of garlic is usually sold at twice or three times the value of onions. It is mostly exported to other parts of Africa, Middle East, Asia and Europe through various trade routes. A number of studies in various parts of the world have shown that garlic production can be improved through appropriate cultural practices [6-8]. Unfortunately, there is dearth of information on garlic production in Nigeria, except for some recent work at Samaru on spacing, fertilizer and irrigation requirements [9-11].

It is in view of this background that this study was undertaken with the aim of exploring opportunities to

improve the productivity of the crop through the choice of appropriate levels of nitrogenous and phosphorous fertilizers and suitable cultivar that maximizes the yield factors.

MATERIALS AND METHODS

Two field experiments were carried out during the 1997 and 1998 dry seasons (November to March) at Usmanu Danfodiyo University Teaching and Research *Fadama* Farm Sokoto, [13° 01'N Lat. 5° 15'E Long., 350 meters above sea level], in order to study the response of two garlic (*Allium sativum* L.) cultivars to varying levels of nitrogenous and phosphorous fertilizers.

The treatments consisted of five nitrogen levels (0, 60, 120, 180 and 240 kg N ha⁻¹) and three Phosphorus levels (0, 22 and 44 kg P ha⁻¹) with two garlic cultivars (ex-Lugu and ex-Kofa). The treatments were factorially laid out in Randomized Complete Block Design replicated three times. Land preparation was carried out 14-18th November and planting 13th December of each year. Each gross plot was 1.5 m wide and 2.0 m long (3 m²) consisting of ten rows, while the net plot was 0.9×1.4 m (1.26 m²) consisting of six inner row. The cultivars used were ex-Lugu and ex-Kofa garlic cultivars. While the ex-Lugu is popularly grown in Lugu Village of Wurno Local Government area of Sokoto State whose mature cloves have light pinkish outer skin, the ex-Kofa is a local garlic cultivar popularly grown in Kofa Village in Bebeji Local Government area of Kano State whose mature cloves have light pinkish covering scale.

Prior to planting, garlic bulbs were split into the individual cloves that were soaked in water over-night. The cloves were planted upright with epical tip exposed at 10 cm inter row spacing according to the treatment structure. The field was irrigated before sowing in order to provide good clove-soil-water contact. Subsequent irrigations were given at 7 days intervals. Fertilizer was applied according to treatment structure in form of Urea (45-46%N), N.P.K. (20-10-10) and single super phosphate (18% P₂O₅, ha⁻¹). A basal dose of half the nitrogen rate and full doses of the phosphorus and potassium were applied at planting. The second half dose of the nitrogen was applied at four weeks after sowing.

There was no incidence of either insect pests or disease in the crop throughout the growth period in both seasons except for the nut sedge (*Cyprus rotundus*). Weeding was done thrice each season manually by hoe weeding and hand picking. Bulbs were harvested when the leaves turned yellowish green and had started

withering. The harvested bulbs were spread in single layers in an open space in two weeks time for curing.

Data collected on fresh and cured bulb yield from the net plot was subjected to analysis of variance as described by Snedecor and Cochran [12] using a Microcomputer Statistical Programme (MSTAT) [13]. Significant differences were further analysed using Least Significant Difference test (L.S.D.).

RESULTS AND DISCUSSION

The mean monthly minimum and maximum temperatures recorded across the two seasons ranged from 10.02 to 27.81°C and 25.40 to 40.53°C, respectively, while the mean relative humidity ranged from 34.78 to 52.83 percent. Laboratory analysis of soil samples from experimental site indicated the soil to be sandy loam, low in nitrogen, phosphorus and cation exchange capacity, moderate in available cations and acidic in reaction.

Fresh bulb yield: Fresh bulb yield of garlic during 1997 and 1998 and combined analysis as affected by the treatments are shown in Table 1. Application of increasing rates of nitrogen had significant effect on fresh bulb yields. It was observed that in 1998 and combined increasing levels of nitrogen from 0 to 120 kg ha⁻¹ resulted in significant increase in fresh bulb yield. Further increase to 240 kg N ha⁻¹ reduced the yield. The highest fresh bulb yield of 8.4 ton ha⁻¹ was recorded with 120 kg N ha⁻¹ in 1998.

Application of varying rates of phosphorus had no significant impact on fresh bulb yield during the two seasons and combined analysis. The two cultivars were at par in fresh bulb yield during the two seasons and combined. No significant interactions were observed.

Cured bulb yield: Effects of nitrogen, phosphorus and cultivar on cured bulb yield of garlic in 1997 and 1998 seasons and combined analysis are shown in Table 2. Increasing levels of nitrogen had significant effect in cured bulb yield. In 1998 and combined analysis the cured bulb yield significantly increased with increase in nitrogen from 0 to 60 and 120 kg N ha⁻¹. Higher dosage of 180 and 240 kg N ha⁻¹ reduced the bulb yield. The highest yield of 6.7 ton ha⁻¹ was recorded with 120 kg N ha⁻¹ in 1998. This is in contrast with the report of Sadaria *at al.* [14] working on garlic cv G1 in Gujarat India, who reported that different nitrogen treatments had no significant effects on bulb yield. Similarly Kibreab and Hiranburana [15] in a two-year trial, carried out in

Table 1: Fresh bulb yield (kg ha⁻¹) as affected by rate of nitrogen, phosphorus and cultivar during 1997 and 1998 seasons and combined analysis at Sokoto

Treatments	Fresh bulb yield		
	1997	1998	Combined
Nitrogen (kg ha⁻¹)			
0	8131	4416b	6273b
60	7522	8047a	7785a
120	8140	8364a	8243a
180	7811	6658a	7234ab
240	7289	7271a	7280ab
Significance	ns	**	*
L.S.D.	1567	2162	1321
Phosphorus (kg ha⁻¹)			
0	7698	6430	7064
22	7429	7376	7403
44	8208	7048	7628
Significance	ns	ns	ns
L.S.D.	1214	1675	1023
Cultivar			
Ex-Lugu	8121	6980	7550
Ex-Kofa	7436	6923	7180
Significance	ns	ns	ns
L.S.D.	991	1367	835
Interaction			
N*P	ns	ns	ns
N*C	ns	ns	ns
P*C	ns	ns	ns
N*P*C	ns	ns	ns

Means in a column followed by same letter (s) within a treatment group are not significantly different, *, ** = Significant at 5% and 1% levels of probability, respectively

Thailand compared 4 levels of N-fertilization and reported that in both years, there was no response to increasing levels of nitrogen.

Aliudin [16] in Indonesia, using varying rates of nitrogen reported that the relationship between nitrogen rate and bulb yield (dry weight) was quadratic with the maximum yield at 172.81 kg N ha⁻¹. In Chile Escaff and Aljarou [17] reported that 90 kg N ha⁻¹ had no effect on yield or quality of garlic. But in a second fertilizer experiment with varying rate of nitrogen, the application of up to 150 kg ha⁻¹ increased the yield and quality of the bulbs. Maksoud *et al.* [18] from Egypt also reported significant favourable effects of nitrogen application on yield. These workers observed that the addition of N at 360 kg ha⁻¹ increased the yield of cured marketable bulbs from 12.4 to 20.5 t ha⁻¹ in one trial and from 13.6 to 17.3 t ha⁻¹ in another trial.

Table 2: Cured bulb yield (kg ha⁻¹) as affected by rate of nitrogen, phosphorus and cultivar during 1997 and 1998 seasons and combined analysis at Sokoto

Treatments	Cured bulb yield		
	1997	1998	Combined
Nitrogen (kg ha⁻¹)			
0	6102	3584b	4843b
60	5911	6439a	5913a
120	6422	6692a	6557a
180	5956	5326a	5641ab
240	5658	5817a	5688ab
Significance	ns	**	*
L.S.D.	1252	1729	1056
Phosphorus (kg ha⁻¹)			
0	6028	5176	5602
22	5673	5901	5787
44	6328	5638	5983
Significance	ns	ns	ns
L.S.D.	970	1339	818
Cultivar			
Ex-Lugu	6324	5584	5954
Ex-Kofa	5695	5560	5627
Significance	ns	ns	ns
L.S.D.	792	1094	668
Interaction			
N*P	ns	ns	ns
N*C	ns	ns	ns
P*C	ns	ns	ns
N*P*C	ns	ns	ns

Means in a column followed by same letter(s) within a treatment group are not significantly different; *, ** = Significant at 5% and 1% levels of probability, respectively

In Chile, Ruiz [19], reported that increasing rates of applied nitrogen from 0 to 150 kg ha⁻¹ increased bulb yield from 4.6 to 10.6 t ha⁻¹. The bulb quality also increased with increasing nitrogen application up to 225 kg ha⁻¹. Carvalho *et al.* [20] in Brazil in a trial with 3 rates of applied N (0-120 kg ha⁻¹), 4 rates of K (0-160 kg ha⁻¹), observed various effects of N and K reported that total and marketable bulb yields were affected only by N. The highest yields were obtained with 70-76 kg N ha⁻¹. Arboleya and Garcia [21] from Canelones, Uruguay in a trial with garlic with N at 0, 75, 150 and 225 kg ha⁻¹ observed that marketable bulb yield increased from 4.66 t ha⁻¹ at 0 kg N ha⁻¹ to 8.04 t ha⁻¹ at 225 kg N ha⁻¹. At Samaru (Nigeria), Babaji [9] observed that N application increased almost all growth and yield parameters of garlic significantly and that the maximum yield of 15 t ha⁻¹ was recorded with 90 kg N ha⁻¹. In

another trial [22], the growth and yield parameters increased with increasing N rates up to 150 kg N ha⁻¹; higher rates of N to 225 kg ha⁻¹ decreased them. Bichi [10] on the other hand, recorded significant increase in bulb yield with the application of 75 kg N ha⁻¹ while clove weight increased only at 150 kg N ha⁻¹ beyond which there was a significant reduction.

Application of increasing levels of phosphorus had no significant effect on cured bulb yield during the study. This is in agreement with the findings of Escaff and Aljaro [17], they recorded no significant effect on the growth and yield of garlic with the application of 41.11 kg P ha⁻¹ during bulbing and root growth. Minard [23] on the other hand, reported 114.75 kg P ha⁻¹ as optimum for increased final bulb yield among other parameters. He attributed this effect to the influence of phosphorus on root development, which led to effective nutrients uptake and water absorption. Borabash and Kochina [24] also recorded significant increase in assimilating leaf area; photosynthetic productivity and final bulb yield with the application of 39.27 kg P ha⁻¹ to garlic crop. Hilman and Noordiyati [25], however, reported that several levels of phosphorus tested on garlic did not significantly affect most growth and yield parameters. However a significant increase in bulb dry weight was recorded with the application of 150 kg ha⁻¹ of triple super phosphate. Minard [23] recorded the highest garlic bulb yield with the application of 210 kg N ha⁻¹ and 114.75 kg P ha⁻¹. He reported that the increase was as a result of favourable effects of both nitrogen and phosphorus on growth and development of the crop. Escaff and Aljaro [17] recorded significantly higher bulb yield in garlic with the application of 150 kg N ha⁻¹ in combination with 32.72 kg P ha⁻¹. Hilman and Noordiyati [25] also recorded significantly higher yields of underground bulbs of garlic among other parameters with the application of 90 kg of N and 39.27 kg P ha⁻¹. The cultivars ex-Lugu and ex-Kofa cured bulb yields werenot significantly different in both seasons and at combined level. No significant interaction was observed.

CONCLUSIONS

Based on the results obtained from this study it is suggested that a combined application of 120 kg N ha⁻¹ and 22 kg P ha⁻¹ for both the ex-Lugu and ex-Kofa cultivars can result in good yield of garlic in Sokoto under similar soil and weather conditions as used in the trial.

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