Journal of Agricultural Economics and Development Vol. 2(1), pp. 001-005, January 2013
Available online at http://www.academeresearchjournals.org/journal/jaed
ISSN 2327-3151 ©2013 Academe Research Journals

Full Length Research Paper

Growth, yield and economic performance of garlic (*Allium sativum* L.) as influenced by farm yard manure and spacing in Zaria, Nigeria

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Accepted 14 January, 2013

Two trials were conducted at the Teaching and Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria located on latitude 11°11N', longitude 7°38'E and 686 m above sea level in Northern Guinea Savannah Ecological Zone of Nigeria. The experiment was laid out in a split plot design replicated three times keeping farm yard manure (0, 10, 20 and 30 tonnes per hectare) as main plot treatments and spacing (10, 15, 20 and 25 cm) as sub plot treatments replicated three times. Results showed that spacing at 25 cm resulted in the highest mean yield, gross margin and cost benefit ratio. The application of manure at 10, 20 and 30 tonnes per hectare resulted in similar mean yield and gross margin. The cost-benefit ratio was highest when 10 or 20 tonnes of farm yard manure were applied. It can therefore be concluded that for sustainable production of garlic in the study area, application of 10 tonnes per hectare of farm yard manure with 25 cm spacing will enhance yield and profitability of garlic.

Key words: Garlic, farm yard manure, spacing, gross margin, cost- benefit ratio.

INTRODUCTION

Garlic (*Allium sativum* L.) is a bulb belonging to the family Alliaceae. It is the second most widely cultivated crop in the family after onion (*Allium cepa*), as reported by Purseglove (1972). The crop when fully grown is between 40 and 60 cm in height. It consists of an underground bulb and above ground vegetative part, which also consist of a flat as well as slender leaves. Rooting system is fibrous, while the bulb comprises small bulblets called cloves (Amans, 1989; Wadjito et al., 1988). Garlic originated from Central Asia about 3000 years and later spread to the Mediterranean regions (Tindal, 1986). The crop was later carried to Western countries by the French, Spanish and Portuguese explorers. Spain is the largest producer of the crop with over 100,000 tonnes per annum. Other important producing countries include Mexico, Egypt, Bulgaria, Romania, Poland, France, Japan and India. In Nigeria, garlic has been in cultivation for many years and is confined to the Sudan Savannah zone, especially in Kano, Sokoto, Kebbi and Borno states (Miko, 1999). Today however, the cultivation is expanding, principally as a result of the crops' high economic value. Garlic requires cool but dry weather, with moderate moisture for proper growth. It also requires well drained soil with high organic matter content. It is sensitive to high humidity, excessive moisture and high temperature, which limits the growth of the crop (Babaji, 1996). The crop has been known to have several food and medicinal uses. It is used for preserving meat and meat products, used as spices in salad and for seasoning of vegetables. Garlic extracts are generally used in curing whooping cough, lung diseases and stomach pain and child birth disorder. The extract could be used against ear-ache, hypertension, eye-sores, an antidote against poisons, as well as antibacterial (Debkitaniya et al., 1981). Garlic could also be used as an insecticide and could also reduce cholesterol level in human blood and as a repulsive to snakes.

Garlic production and bulb yield could be improved through proper farm yard manure application and proper spacing (Kusumo and Widjajanto, 1973; Lucero et al.,

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Table 1. Physical and chemical properties of farm yard manure and soil used for the study.

Property	Soil (cmolkg^{-1})	Farm yard manure (mg/kg)
pH (H_2O)	4.98	2.00
OC (%)	0.91	20.01
Total N (mg kg^{-1})	0.10	2.20
P (mg kg^{-1})	2.10	7.96
Exch. K (cmol kg^{-1})	1.82	6.84
Exch. Ca (cmol kg^{-1})	0.51	8.33
Exch. Na (cmol kg^{-1})	0.50	0.52
Exch. Mg (cmol kg^{-1})	1.35	2.40
Cu (mg kg^{-1})	6.01	27.68
Mn (mg kg^{-1})	9.01	7.95
Fe (mg kg^{-1})	9.00	11.97
Zn (mg kg^{-1})	5.03	187.00
Silt (mg kg^{-1})	12.76	NA
Clay (mg kg^{-1})	5.87	NA
Sand (mg kg^{-1})	82.11	NA
ECEC (mg kg^{-1})	9.18	NA

Source: Soil Science Department, ABU, Zaria.

1982; Alecksiev, 1989). However, the response of the crop to cultural practices varies with locations. With good practice, it could be possible to obtain a yield of 20.5 t ha^{-1} (Maksoud et al., 1984). Despite the fact that garlic has been introduced to Nigeria for a long time and is well known as an important crop economically, the crop has been neglected in terms of comprehensive research attention which is sufficient to necessitate appropriate recommendations of production practice for maximizing the yield of the crop (Miko et al., 1995). Moreover, the present global economic recession has led to inflation, scarcity and high cost of chemical fertilizer making it unaffordable to most peasant farmers. Furthermore, the increasing concern on the effects of agrochemicals and chemical fertilizers on the environment makes organic manure a safer and better available alternative source of nutrients to crop (Aliyu and Kunchinda, 2003) It is in this light above that the research work was carried out to study the simultaneous effects of farm yard manure and spacing on the growth and yield of garlic.

MATERIALS AND METHODS

Two trials were conducted at the Teaching and Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria located on latitude 11°11N', longitude 7°38'E and 686 m above sea level in Northern Guinea Savannah Ecological Zone of Nigeria. The experiment was laid out in a split plot design replicated three times keeping farm yard manure as main plot treatments and intra-row spacing (5, 10 15 and 20 cm) as sub plot treatments replicated three times. Soil samples from the experimental site were taken at depths of 0-15 cm and 15-30 cm before planting. The bulk samples were then analysed for physical and chemical characteristics (Table 1). The soil was identified to be sandy loamy soil, fairly alkaline, low in organic carbon, low in total N and available P. A local cultivar of the crop called Dan Kwando was used. The matured bulbs are normally globular in shape with white scale leaves. The cloves which constitute the bulb normally have dark to light pink outer scale leaves.

The site of the experiment was ploughed, harrowed to a fine tilt, and then basins of size 2 × 1.5 m were marked. The small plots were bounded by bunds forming slightly sunken basins in order to retain water. Irrigation channels were made in between two strips of basins while a drainage channel was provided at the tail end of the field. The basins were then levelled and irrigated a day to planting. Two weeks before planting, farm yard manure were applied at the different rate, the bulbs were separated into individual cloves. The larger and medium sized cloves were then selected for planting in order to enhance germination and seedling establishment. The cloves were then soaked overnight to remove the scale leaves covering the cotyledons. Planting of the cloves were done manually, while replanting of non-germinated cloves was done a week later. Irrigation was done by surface flooding. The plots were irrigated immediately after planting, thereafter at two weeks interval, till two weeks to maturity of the crop, irrigation was stopped to allow uniform maturity. Weeding was done manually by both hand picking and hand hoe weeding. A narrow bladed onion hoe was used to minimise injury on seedlings. Two weeding were carried out: the first was three weeks after sowing, while the second was seven

Table 2. Growth and yield of garlic as influenced by farm yard manure and spacing at Samaru, Zaria in 2011 and 2012 dry seasons.

Treatments	Plant height (cm)		Number of leaves per plant		Bulb height (cm)		Bulb diameter (cm)		Number of cloves per bulb		Bulb yield per plot (kg)		Bulb yield per ha^{-1} in tonnes	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Farm yard manure (t) ha^{-1}														
0	5.24^{d}	4.98^{d}	2.34^{a}	2.28^{a}	2.13^{a}	2.17^{a}	3.14^{a}	3.15^{a}	4.18^{d}	3.78^{d}	1.28^{c}	1.20^{c}	1.27^{b}	1.20^{b}
10	7.15^{c}	6.43^{c}	3.15^{a}	3.20^{a}	3.15^{a}	2.08^{a}	3.20^{a}	3.21^{a}	6.11^{c}	5.93^{c}	2.25^{a}	2.20^{a}	3.34^{a}	3.11^{a}
20	9.18^{b}	8.72^{b}	4.13^{a}	4.17^{a}	3.24^{a}	2.25^{a}	3.22^{a}	3.21^{a}	8.14^{b}	7.75^{b}	2.34^{a}	2.45^{a}	3.42^{a}	3.48^{a}
30	11.28^{a}	10.18^{a}	5.14^{a}	5.16^{a}	3.35^{a}	3.32^{a}	3.28^{a}	3.30^{a}	10.15^{a}	10.17^{a}	3.45^{a}	3.47^{a}	3.50^{a}	3.55^{a}
Spacing (cm)														
10	4.65^{d}	3.84^{d}	1.96^{c}	1.97^{c}	2.01^{a}	2.08^{a}	3.11^{a}	3.15^{a}	3.45^{d}	3.50^{d}	1.81^{c}	2.18^{c}	1.11^{b}	1.09^{b}
15	6.14^{c}	5.78^{c}	3.18^{b}	2.88^{b}	3.13^{a}	3.16^{a}	3.12^{a}	3.18^{a}	5.64^{c}	4.88^{c}	2.25^{a}	2.66^{a}	3.47^{a}	3.46^{a}
20	8.17^{b}	7.16^{b}	4.15^{b}	4.32^{b}	3.25^{a}	3.20^{a}	3.24^{a}	3.21^{a}	7.26^{b}	5.64^{b}	2.36^{a}	2.40^{a}	3.24^{a}	3.28^{a}
25	10.25^{a}	9.24^{a}	5.27^{a}	4.86^{a}	3.26^{a}	3.30^{a}	3.26^{a}	3.24^{a}	10.10^{a}	9.42^{a}	3.37^{a}	3.64^{a}	4.26^{a}	4.24^{a}
Interactions FYM x S	*	*	*	*	NS	NS	NS	NS	*	*	*	*	*	*

Means with the same letter(s) within a column are not significantly different at P = 0.05 Duncan's Multiple Range Test (DMRT). NS = Not significant at 5% level of significance; * = Significant at 5% level of significance.

weeks after sowing. No herbicide was used for this experiment. Maturity was generally observed when the crop leaves turned pale-green. This was later followed by wilting and leaf fall. The bulbs were then harvested carefully by digging out using a hand hoe. Harvested bulbs were weighed and allowed to cure for two weeks in the field. Parameters observed included plant height, number of leaves per plant, fresh bulb weight, dry bulb weight, bulb height, bulb diameter, number of cloves per bulb, fresh bulb yield per hectare and dry bulb yield per hectare. All data collected were subjected to statistical analysis of variance. Means were separated using Duncan's Multiple Range Test (Duncan, 1955).

To examine the profitability of the different rates of farm yard manure and spacing, the gross margin analysis and cost benefit analysis was done. The gross margin analysis is the difference between the total revenue and the total variable cost, that is,

GM = TR-TVC

Where GM = gross margin, TR = total revenue, and TVC = total variable cost.

The profitability index, also known as cost-benefits analysis which measures the rate of return on investment was calculated. It gives the amount of profit on any Naira invested in each of the treatments. It is expressed as:

Cost-benefit ratio = GM/ VC

Where GM = gross margin, and V.C. = variable cost of each of the treatments. The cost of the inputs and price of the products were obtained from market survey. The variable cost was that of manure and the revenue was the farm gate price of ginger which was at N95/kg (during the study, US$ = 159 Naira).

RESULTS AND DISCUSSION

Effect of farm yard manure on growth and yield characters of garlic

Table 2 shows that there was significant difference at P = 0.05 on plant height due to treatments, however there was no significant difference between treatments on number of leaves per plant, bulb height and bulb diameter among the treatment means. Number of cloves per bulb, bulb yield per plot and bulb yield per hectare produced significant difference at P = 0.05 among the mean values due to treatments. The control treatment where no farm yard manure was applied significantly produced lower mean values of plant height, number of cloves per bulb, bulb yield per plot and bulb yield per hectare. On the other hand, farm yard manure at 30 tonnes per hectare significantly produced higher mean values of plant height, number of cloves per bulb, bulb yield per plot and bulb yield per hectare at P = 0.05. An increase in farm yard manure significantly increased the mean values from the control among the treatments and this could be due to the fact that the control treatment did not receive any farm yard manure and so could not supply adequate nutrients for plants to grow and develop

Table 3. Economic analysis of garlic production as influenced by farm yard manure and spacing at Samaru in 2011 and 2012 dry seasons.

Treatments	Mean Yield	Total variable cost	Revenue	Gross margin	Cost-benefit ratio
M0 × S10	1.36[c]	79,600	129,057	49,457	0.62
M0 × S15	4.28[b]	78,000	406,531	328,531	4.21
M0 × S20	4.03[b]	75,400	382,479	307,079	4.07
M0 × S25	5.25[b]	75,300	498,631	423,331	5.62
M10 × S10	3.55 [b]	89,800	337,012	247,212	2.75
M10 × S15	11.17[a]	89,000	1,061,589	972,589	10.93
M10 × S20	10.51[a]	87,700	998,782	911,082	10.39
M10 × S25	13.71[a]	87,650	1,302,093	1,214,443	13.86
M20 × S10	3.80[b]	94,900	360,525	265,625	2.80
M20 × S15	11.95[a]	94,500	1,135,653	1,041,153	11.02
M20 × S20	11.25[a]	93,850	1,068,465	974,615	10.38
M20 × S25	14.67[a]	93,825	1,392,937	1,299,112	13.85
M30 × S10	3.88[b]	106,912	368,362	261,450	2.45
M30 × S15	12.21[a]	113,456	1,160,341	1,046,885	9.23
M30 × S20	11.49[a]	116,728	1,091,692	974,964	8.35
M30 × S25	14.98[a]	118,364	1,423,218	1,304,854	11.02

M = farm yard at the different rates, and S = spacing at the different rates. Means with the same letter(s) within a column are not significantly different at P = 0.05 Duncan's Multiple Range Test (DMRT).

properly, resulting into lower performances, hence lower mean values. However, 30 tonnes of farm yard manure treatment adequately provided nutrients that enabled the plants under it to photosynthesise very well thereby helping to translocate and partition more assimilates which made them to produce higher mean values on the characters studied. This observation is in line with works of Bababe et al (1998) and Akoun (2004).

Effect of spacing on growth and yield characters of garlic

Table 2 shows that there was significant difference at P = 0.05 among the treatment means on plant height and number of leaves per plant due to spacing. However there was no significant difference among the treatment means due to spacing on bulb height and bulb diameter. Significant difference was equally observed on number of cloves per bulb, bulb yield per plot and bulb yield per hectare among the treatment means at P = 0.05. The control treatment of 10 cm spacing significantly gave lower mean values on the above mentioned characters studied. On the other hand, 25 cm spacing significantly produced higher mean values on the above mentioned characters observed.

The above observation could be that the closer the spacing, the more the competition among the plants for water, soil nutrients, space, light, etc., hence making them not to be adequately comfortable in photosynthesising very well. However, those plants that were widely spaced in treatment of 25 cm spacing got adequate water, nutrients, space, light, etc., which enabled them to perform better than the rest of the treatments. This observation is in line with the works of Amans (1989) and Wadjito et al. (1988).

Interactions between farm yard manure and plant spacing

Significant interactions were observed between farm yard manure and spacing on plant height, number of leaves per plant, number of cloves per bulb, bulb yield per plot and bulb yield per hectare at P = 0.05. However, there was no significant interactions on bulb height and bulb diameter at P = 0.05 during the period under review.

Economic analysis of farm yard manure and spacing on ginger production

From the economic analysis in Table 3, spacing at 25 cm resulted in highest mean yield, gross margin and cost benefit ratio. The application of manure at 10, 20 and 30 tonnes per hectare resulted in similar mean yield and gross margin when the garlic plants were spaced at 25 cm. The cost-benefit ratio was highest when 10 or 20 tonnes per hectare of farm yard manure were applied at 25 cm spacing.

From the results of these trials, it can therefore be concluded that for sustainable production of garlic in the study area, application of 10 tonnes per hectare of farm yard manure with 25 cm spacing will enhance yield and profitability.

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