

Effects of Planting Dates on Yield and Quality of Garlic (*Allium sativum* L.) in Northern Sudan

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ABSTRACT

Field experiments were conducted for three consecutive seasons starting 1991/92 at Hudeiba Research Station, northern Sudan. Seven planting dates between 15 Sept. and 15 Dec, were tested. Planting in I Oct. resulted in the highest yield (10263 kg/ha). followed by 15 Sept. (9980)kg/ha) and then I Nov. (8860 kg/ha). The lowest yields were found in the late planting dates. The higher yields in early planting dates were due to the short days and low temperatures prevailing during the early stages of crop development to produce vigorous vegetative growth which is a prerequisite high garlic yields.

INTRODUCTION

Garlic (*Allium sativum* L.) is an important spice and medicinal plant. It is grown worldwide in temperate. Subtropical and high altitudes of tropical areas. The compound bulb, the main economic plant part. is composed of few to many bulblets (cloves) enclosed in a thin white membrane. Garlic is largely used as a condiment and flavouring agent in soups, stews. pickles and salads. Recently, world demand and consequently production of garlic ,has significantly increased. Such increase in popularity of garlic is attributed not only to its unique flavouring properties. but also to its many therapeutic and medicinal uses (August, 1990; Liu *et al.*. 1992; Jain *et al.*. 1993)

In the Sudan. garlic is the second important *Alliuml* species grown on commercial basis. Its total production is estimated as 10000 tons. It is predominantly grown under irrigation in Naher El-Neil State (El -Hassan area near Berber town). Northern State (Selaim basin) and as a rainfed crop in Darfour States Jabal Marra (Nourai. 2003).

Bulbing of garlic is induced by long days. and bulbs form more quickly under moderate than low temperatures. Thus. the planting date is major factor in determining productivity and quality of garlic. This study was conducted to determine the optimum planting dates which maximize yield and improve quality of garlic in northern Sudan.

MATERIALS AND METHODS

Field experiments were conducted for three consecutive seasons (1991/92, 1992 and 1993/94) at Hudeiba Research Station, Naher El-Neil State (17' 34' N, 33' 56' E and 350 m above sea level).

A local variety 'ElHassa' (average bulb weight of 23 g and 25 cloves/bulb) was used. Seven planting dates (15 Sept., 1 Oct., 15 Oct., Oct., Nov., 15 Nov., 1 Dec. and 15 Dec.) were tested. The treatments were arranged in a randomized complete block design with four replications. The bulbs, at the seed rate of 1080 kg/ha, were split into cloves just Prior to planting. The plants were raised at approximately 7.5 x 7.5 cm spacing in flat beds. The plant population was 648000 plants/ha. The gross plot area was 21 m² and the net harvested area was 16.4 m² . Nitrogen fertilizer, in the form of urea, was applied at the rate of 86 kg N/ha applied in equal doses; one and two months after planting. The plants were given one spray with Lannate 90% W.P. at 1.2 kg/ha during growing season against thrips.

The crop was harvested after full drying of foliage. The total yield per plot (16.4 m²) was determined and yield per ha was computed. The bulbs were graded into large (≥ 4.5 cm dia.), small (≤ 4.5 cm dia.) and physic injured bulbs. The average bulb weight, bulb diameter and number of cloves per bulb were determined in 10 bulbs randomly picked from each plot. Total soluble solids (TSS) were determined in 5 bulbs from each plot using a hand refractometer (Bellingham and Stanley, Ltd.). Analysis of variance, followed by Fishers' protected LSD at $P \leq 0.05$ were performed on the data.

RESULTS AND DISCUSSION

The effects of sowing date on garlic yields were highly significant ($P \leq 0.001$) in all seasons (Table 1). The garlic yields averaged over the three seasons indicated that the highest yield (10263 kg/ha) was obtained

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when garlic was planted in I Oct. while the lowest yield (3229 kg/ha) was obtained when garlic sowing was delayed to 15 Dec. Reduction in garlic yield of 3, 14, 28, 43, 58 and 69 resulted when the yields of garlic planted in 15 Sept., 15 Oct., 1 Nov., 15 Nov. 1 Dec., and 15 Dec., respectively, were compared with yield of garlic planted in 1 Oct. (Table 1). The high garlic yields obtained from early sowings (during the period 15 Sept. to 1 Nov.) were associated with an increased bulb and clove weight (Tables 2 and 3). The increases in garlic yields reported here as a result of early sowings are in accordance with the findings of Maksoud *et al.* (1993) Bhathal and Thakur (1986) Rahman and Talukder (1986) Norman and Shongwe (1995), Ali (1998b) and Mohamed Ali and El-Sayed (1999) who recorded high yields due to early garlic plantings.

Table 1. Effects of sowing dates on yield (kg/ha) of garlic.

Sowing date	Season			Mean	% change
	1991/92	1992/93	1993/94		
15 Sept.	14327.1	8375.0	7237.3	9979.8	-3
1 Oct.	12767.1	9382.3	8640.0	10263.1	-
15 Oct.	9731.4	8726.6	8122.7	8860.2	-14
1 Nov.	10220.0	7910.2	4111.8	7414.0	-28
15 Nov.	7475.7	5193.1	4851.4	5840.1	-43
1 Dec.	5989.3	3278.5	3816.8	4361.5	-58
15 Dec.	4940.0	1967.1	2779.4	3228.8	-69
S.E±	1077.2	686.4	1155.4	567.1	
Significance Level	***	***	***	***	
Season mean	9350.0	6404.6	5651.5		
Significance level		*			
S.E±		712.7			

*** Significance level at P = 0.05 and 0.001, respectively.

Table 2. Effects of sowing dates on garlic bulb weight (g)

Sowing date	Season			Mean
	1991/92	1992/93	1993/94	
15 Sept.	24.2	17.0	19.8	20.3
1 Oct.	31.6	15.3	22.4	23.1
15 Oct.	21.4	16.5	19.8	19.2
1 Nov.	13.8	18.5	18.6	17.0
15 Nov.	21.6	13.3	16.1	17.0
1 Dec.	16.7	11.7	15.5	14.6
15 Dec.	14.1	9.4	12.4	12.0
S.E±	2.3	1.7	2.0	1.2
Significance Level	***	***	***	**
Season mean	20.5	14.5	17.8	
Significance level		**		
S.E±		1.2		

** *** significant at $P = 0.01$ and $P = 0.001$, respectively.

The seasonal variations and effects of planting dates in garlic yields and quality were associated with temperatures prevailing during the growing season, Where cooler temperatures, particularly during the period November February (table 4) were conducive to higher garlic yields of good quality.

The effects of seasonal variations on garlic yield were very substantial (Table 1). The highest yield (9350 kg/ha) was recorded in 1991/92 season while the lowest yield (5652 kg/ha) was recorded in 1993/94 season sowing date on bulb quality indicated that early sowing.

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Table 3. Effects of sowing dates on garlic clove weight(g)

Sowing date	Season			Mean
	1991/92	1992/93	1993/94	
15 Sept.	0.81	0.65	1.00	0.82
1 Oct.	0.93	0.63	1.02	0.86
15 Oct.	0.73	0.60	1.02	0.78
1 Nov.	0.61	0.51	1.06	0.76
15 Nov.	0.62	0.46	0.85	0.66
1 Dec.	0.48	0.45	0.74	0.56
15 Dec.	0.58	0.05	0.58	0.54
S.E±	0.08	0.65	0.18	0.07
Significance Level	***	***		***
Season mean	0.68	0.56	0.90	
Significance level		***		
S.E±		0.4		

***Significant at P = 0.001

Table 4. Mean maximum and minimum temperatures (°C) prevailing during the period between garlic planting and bulb harvesting (Hudeiba Meteorological Station).

Season	Temperature	Months							
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
1991/92	Max.	41.9	39.5	34.8	29.1	27.0	26.6	34.8	39.5
	Min.	27.2	24.9	20.2	12.9	11.0	11.4	17.11	20.9
1992/93	Max.	40.6	39.5	34.4	29.1	12.9	30.0	35.9	39.7
	Min.	26.4	24.3	19.4	12.9	12.9	12.3	17.7	22.3
1993/94	Max.	42.1	40.3	36.2	33.0	33.1	31.4	33.7	41.5
	Min.	27.7	25.4	21.9	14.3	14.3	14.3	15.3	22.3

The interaction between seasons and sowing dates on garlic yields and bulb weight was highly significant (Table 1). Delaying the sowing date of garlic had a pronounced effect on garlic yields and bulb weight in cooler winter seasons (1991/92 and 1992/93 seasons) while it had no apparent effect on garlic yields and bulb weight in 1993/94 season when season was relatively warm (Table 4).

The effects of sowing date on bulb quality indicated that early sowing the percentage of large bulbs while delaying the garlic sowing after mid-October increased the percentage of small bulbs, which reduced the

quality of saleable garlic(Fig 1). Early sowing increased bulb diameter and improved garlic quality by increasing TSS (Fig.2) .

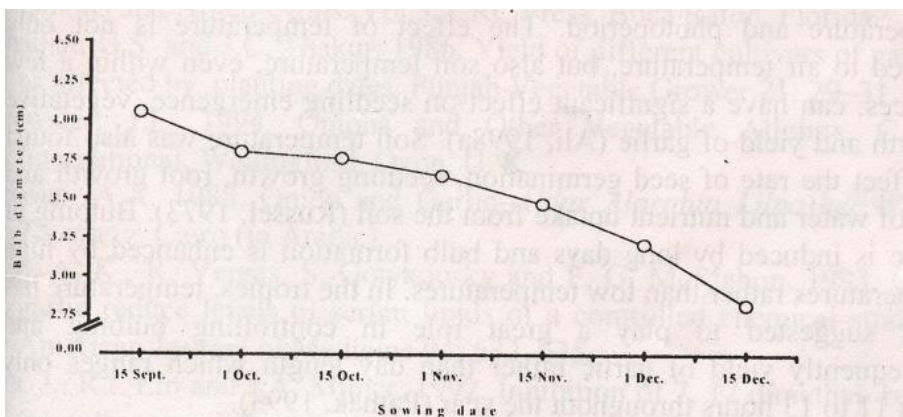


Fig. 1. Effects of sowing date on garlic bulb diameter (cm).

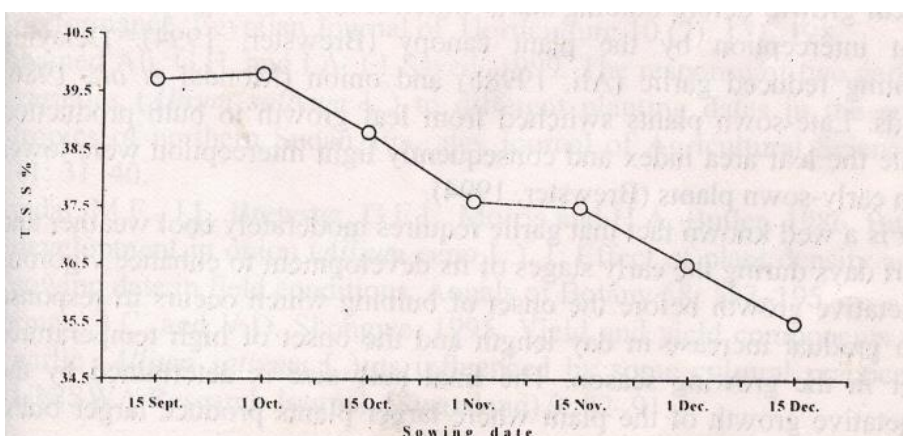


Fig. 2. Effects of sowing date on T.S.S. (%).

Data of cultural practices for the three seasons indicated that garlic crop sown on 15 Sept. required 7 hand weedings, 24 irrigations and stayed for 192 days in the field. In contrast, the late sown crop (15 Dec.) required 2 hand weedings, 11 irrigations and was harvested in 116 day (data not shown). The large number of hand weedings and irrigations recorded for early sowings were mainly due to the high temperatures which prevailed during September and October (Table 4) which

encouraged weeds growth and caused rapid soil dryness. Hence, garlic crop raised during early plantings required more hand weedings and irrigations.

Garlic production is affected by many environmental factors including temperature and photoperiod. The effect of temperature is not only limited to air temperature, but also soil temperature, even within a few degrees, can have a significant effect on seedling emergence, vegetative growth and yield of garlic (Ali, 1998a). Soil temperature was also found to affect the rate of seed germination, seedling growth, root growth and rate of water and nutrient uptake from the soil (Russel, 1973). Bulbing of garlic is induced by long days and bulb formation is enhanced by high temperatures rather than low temperatures. In the tropics, temperature has been suggested to play a great role in controlling bulbing and consequently yield of garlic rather than day length which ranges only from 11 to 13 hours throughout the year (Pathak, 1993).

Results of the experiments reported here indicated that early planting gave high garlic yields with improved quality. These increases in garlic yields could be attributed to raising garlic plants in conditions conducive to leaf growth before bulbing starts which resulted in high percentage of light interception by the plant canopy (Brewster, 1994). Delaying planting reduced garlic (Ali, 1998b) and onion (Mondal et al., 1986) yields. Late-sown plants switched from leaf growth to bulb production while the leaf area index and consequently light interception were lower than early-sown plants (Brewster, 1994).

It is a well known fact that garlic requires moderately cool weather and short days during the early stages of its development to enhance vigorous vegetative growth before the onset of bulbing which occurs in response to a gradual increase in day length and the onset of high temperatures later in the growing season. The final bulb size is determined by the vegetative growth of the plant where larger plants produce larger bulbs (Hassan, 1988).

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