

## **Effect of Sowing Date and Intra-Row Spacing on Growth and Yield of Groundnut at El Rahad Agricultural Scheme**

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### **ABSTRACT**

The effects of sowing date and intra-row spacing on growth and yield of groundnut (*Arachis hypogaea* L.) were evaluated over a 3-year period in the irrigated Rahad Scheme. The main effects of sowing date and intra-row spacing were significant but their interactions were not. Late sowing in August and September resulted in small plants with fewer pods, low biological and pod yields due to their development under the low temperatures of November, December and January. On the other hand, high number of pods was produced per plant at wide intra-row spacing but most of the pods were immature with poor shelling percentage and low 100-seed weight. This was attributed to the uneven maturity of groundnut at harvest where pods were initiated over a longer period of time particularly in the low plant population. Early sowing (June) and the high plant population (250000)plants/ ha) proved to be essential package components for the alternately branched variety (MH383) under irrigated vertisol of El Rahad Agricultural Scheme.

### **INTRODUCTION**

Groundnut is traditionally grown in the sandy soil of Western Sudan as a rainfed crop. The pod yield was in the range of 476 to 714 kg/ha but it has been consistently decreasing, since the drought and desertification of 1984. To ensure a more dependable supply of this commodity to the world market, groundnut was introduced in the irrigated vertisols of the Rahad Scheme, since its establishment in 1977. The Rahad Scheme (total area 126 000ha) is located at latitude 13° 31'-14° 25' N and longitude 33° 31' - 34° 32' E with a tropical and continental climate. The rainy season is between May and October

with a peak in August. The range of the mean annual rainfall is 300-550mm from north to south of the scheme (Hamada et al., 1988).

Groundnut yields of tenant farmers under irrigation vary from low to high (1200-3000kg/ha) and these low yields were partly attributed to late sowing (Nur and Elgasim, 1977) and/or low plant population (Ishag, 1970). The recommended sowing period for groundnut at El Rahad Agricultural Scheme is within June but farmers delay sowing up to August and September, and they use close intra-row spacing to compensate for the delayed sowing. Hence, seed broadcasting of more than triple the recommended rate, followed by ridging had been a popular practice with late sowing. Though references have been made in several occasions to the relationship between sowing period and intra-row spacings, direct experimental evidence for their interaction is very scanty. Moreover, previous investigations on groundnut have concentrated on the main effects of sowing date (Ishag, 1965) and plant spacing (Ishag, 1970) with no definite study on their interactions. The present study, therefore, is aimed at investigating the effects of sowing date, intra—row spacing and their interaction on growth and yield of groundnut, variety MH383, and their implications on the cropping systems at El Rahad Agricultural Scheme.

## **MATERIALS AND METHODS**

The experiment was conducted for three consecutive seasons, 1997/98, 1998/99 and 1999/2000, at the Rahad Research station, under soil conditions that were fully described by (Dawelbeit and Babiker, 1997) and are summarized as pH(8.4), EC(0.5 lmmho/cm),ESP(3-5%), clay(73%), organic-C(0.5%), total (588ppm) and NaHCO<sub>3</sub>-(8ppm). The treatments comprised 4 sowing dates x 5 intra-row spacings in a randomized complete block design with 4 replications. The sowing dates were the 15<sup>th</sup> June, 15<sup>th</sup> July, 15<sup>th</sup> August and 15<sup>th</sup> September. The intra-row spacings were 10, 20, 30, 40 and 50cm corresponding to a theoretical plant population of 250000, 125000, 82500, 62500 and 50000 plants/ha, respectively. Plot

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row distance of 0.8m x 8m long and the size was 5 rows x inter –row distance of 0.8m x 8m long and the harvested area was 3 rows x inter –row distance of 0.8m x 6m long. The variety used was MH383, an erect bunch-type, alternately branched and of medium maturity (130-150 days). Aldrex T( Registered Shell Chemical Product that contains 20% Aldrin, 50% Thiram and 30% inert substances) was used for seed- dressing against soil fungi and termites; being the major pests for groundnut at Rahad. Four kernels were sown per hill and were thinned to two seedlings three weeks later. Irrigation was performed at 14 day intervals but practically 3-5 irrigations were skipped depending on the intensity and duration of the rainfall. Hand-weeding was done when necessary but in 1998/99 and 1999/2000 due to the high rainfall and its uneven distribution, it was done untimely.

At harvest, data were collected on total dry weight and pod yield per harvested area (14.2m<sup>2</sup> ). The air dry weight of hay (roots+ stems+ leaves) and of pods were determined and harvest index (HI( was obtained by dividing the dry weight of pods by the total dry weight. The shelling percentage (the weight of kernels expressed as a percentage of the weight of pods) and the 100 — seed weight were determined by hand shelling of 1/2kg of pods from each treatment of the different replications. The percentage of mature pods per plant was determined by the ( shell —out) method (Ahmadi *et al.*, 1987) where pods were opened and the internal shell colour was observed, pods with brown to black internal shell colour were considered mature.

Analysis of variance (SAS,1985) were computed on data of all measured attributes to test treatment differences and their interactions.

## RESULTS

The only vertisolic limitation at the experimental site being the very high clay content (73%). These soils are therefore prone to water-logging particularly in seasons with very high and uneven distribution of rainfall. The analysis of variance on pod yield indicated significant differences due to the main effects of sowing date and intra-row spacing, but their interactions were not (Table 1). High pod yield was

obtained in 1997/98 compared to both 1998/99 and 1999/2000 (Table 1). On average, pod yield was consistently high in June sowing and low in July, August and September across seasons and intra-row spacings (Table 2), however, in 1999/2000 differences between July and August sowings were not significant (Table 1). Highest pod yield

Table 1. Effect of sowing date and intra-row spacing (cm) on groundnut pod yield(kg/ha) for seasons 1997/98 , 1998/99 and 1999/2000.

Sowing date	1997/98						1998/99						1999/2000					
	Intra – row spacing (cm)						Intra – row spacing (cm)						Intra – row spacing (cm)					
	10	20	30	40	50	Mean	10	20	30	40	50	Mean	10	20	30	40	50	Mean
June	4725	4063	4136	4256	3995	4235	3749	3618	3619	3098	2708	3358	3276	2749	2361	2304	2124	2563
July	3749	3042	3022	2648	2589	3010	3020	2499	2239	1848	1900	2301	2606	1968	1568	1263	1083	1698
August	2226	1898	1828	1617	1460	1806	2421	2265	1406	1328	1458	1775	2109	1874	1536	1250	1067	1567
September	1601	859	504	484	465	783	755	677	469	391	313	521	896	833	729	573	469	700
Mean	3075	2466	2373	2251	2127		2486	2265	1933	1666	1595		2222	1856	1548	1347	1186	
Mean (season)	2458						1989						1632					
SE for spacing (±)	170						165						85					
SE for sowing date (±)	152						148						76					
C.V(%)	26						33						21					

was obtained at 10 cm intra-row and the lowest at 50 cm across seasons and sowing dates (Table 3). Accordingly, the delayed sowing of groundnut to July, August and September decreased the pod yield by 31, 49 and 80 percent, respectively, compared to that of June sowing. On the other hand, intra-row spacings of 20, 30, 40 and 50 cm decreased the pod yield by 15, 25, 32 and 37 percent, respectively, compared to that from 10 cm intra-row spacings. Accordingly, the magnitude of yield differences due to sowing dates was dramatically high as compared to that of intra-row spacings (Tables 2 and 3).

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Table 2. Effect of sowing dates on total dry matter (TDM), pod yield, number of pods/plant, 100-seed weight, percent shelling, harvest index (H.I) and mature pods% per plant averaged across seasons.

Sowing date	TDM (kg/ha)	Pod yield (kg/ha)	Pods Per plant	100-Seed Wt.(g)	Shelling %	H. I %	Mature Pods% Per plant
June	5857a	3385 a	32a	47a	58a	58a	73a
July	4248b	2336b	27b	45b	57a	55a	72 a
Aug.	3881c	1716c	20c	42c	55a	44bc	73 a
Sep.	1983d	0668 d	32a	40d	58a	34c	78b

Means followed by the same letter(s) within each column do not differ significantly at the level of 0.05 according to Duncan's Multiple Range Test (DN(RT)).

Table 3. Effect of intra-row spacing on total dry matter (TDM), pod yield, number of pods/ plant, 100-seed weight, percent shelling, harvest index (HOI) and mature pods% per plant averaged across seasons.

Intra-row spacing (cm)	TDM (kg/ha)	Pod yield (kg/ha)	Pods/ Per plant	100-Seed Wt.(g)	Shelling %	H. I %	Mature Pods% Per plant
10	4436a	2594 a	15d	48a	66a	57a	88a
20	4103ab	2196 b	17d	45b	61ab	54a	83b
30	4113ab	1951 c	23c	44b	58ab	48a	77c
40	3638b	1755 cd	26b	41c	54bc	48a	69d
50	3551b	1636 d	32a	39d	46c	46a	56e

Means followed by the same letter(s) within each column do not differ significantly at the probability level of 0.05 according to Duncan's Multiple Range Test (DNRT).

The total dry matter and yield components were affected by the Sowing date (Table 2) and intra-row spacing (Table 3). Thus total dry matter (kg/ha), 100-seed weight and harvest index were decreased by delayed sowing and widening of intra-rows (Table 2). Shelling percentage was decreased by widening intra-rows (Table 3) but not affected by sowing dates ( Table 2). The percentage of mature pods was increased by September sowing (Table 2) but was decreased by widening intra-row spacing (Table 3). The number of pods per plant was decreased by delayed sowing with percentage reduction of 14, 37, and 65 for July, August and September, respectively (Table 2). Wider

intra-rows increased the number of pods per plant by 16, 59, 76 and 120 percent for 20, 30, 40 and 50 cm intra-row spacing, respectively, compared to that of 10 cm (Table 3).

### **DISCUSSION**

Data have shown significant seasonal variability as indicated by pod yield decrease of 19 and 34 percent for 1998/99 and 1999/2000, respectively, compared to 1997/98. Both seasons had the highest rainfall where 60 and 70 percent of the total annual rainfall was confined to the period of 25<sup>th</sup> July-30<sup>th</sup> August for 1998/99 and 1999/2000, respectively. Under these conditions of high rainfall and poor drainage, water logging and less efficient hand-weeding have contributed in decreasing the pod yield for both seasons. Hence, year x sowing date interaction was exhibited due to the pod yield differences between July and August sowings of 1999/2000 being insignificant as compared to the other seasons. This was attributed to the high rainfall for this season (400mm), in particular where flooding had masked the differences between the two sowing dates. The effect of temperature on the seasonal variability of pod yield was ruled out, because no major differences in temperatures were recorded between seasons. On average, pod yield was consistently high in June sowing and low in July, August and September sowings. The differences due to sowing dates may be attributed to the varying climatic factors within the growing season, being (130-150 days) for NH383 groundnut variety. This was in consistence with (Gibbons, 1980) who reported that the time from sowing to harvest is independent of photoperiod but dependent on temperature and that the mean daily temperature of 30 °C was optimum for acceptable yield in the Sudan. Others (Saxena *et al.*, 1983) reported that growth of groundnut was limited by temperature above 33°C. In addition to temperature, the high relative humidity of July and August was found (Ishag, 1965) to increase the rate of flowering of groundnut in the Sudan. Accordingly, pod yield of more than 3 tonnes/ha was achieved by June sowing, probably because of a good combination of better crop establishment at the

early growth stages (15<sup>th</sup> June-15<sup>th</sup> July, a relatively dry period). optimum temperature throughout the growing season and high relative humidity to enhance flowering in July and August. On the other hand, delaying of sowing date to July and August resulted in significantly low yields due to less favourable climatic factors confounded with poor crop establishment due to water logging.

The effect of delayed sowing on pod yield was more pronounced in September sowing, where the low temperatures of November, December and January have retarded the vegetative growth, the rate of flowers appearance, pegging and fruit development resulting in dwarf plants with fewer pods, lower biological and grain yields. This was in agreement with the findings of Nur and Elgasim (1977). The effect of increased plant population by closer spacing was significant but the magnitude of the response was lower than that of the sowing date. Thus, within the range of plant population of 50000 to 250000 plants/ha investigated, variety MH383 was responsive to plant population. This was in support of Ishag (1970) who reported that maximum yield of groundnut was achieved by planting density above 200000 plants/ha, even though the present recommended plant population for Gezira is 170000 plants/ha.

The sowing date x intra-row spacing interaction was insignificant for all seasons, even though being the main focus of this study. Accordingly, yield losses due to delayed sowings cannot be compensated by closer intra-row spacing or a higher plant population. Conversely, wider intra-row planting or a low plant population and poor yield cannot be improved, solely by early sowing of June. Maximum yields were, therefore, obtained by the additive effects of both early sowing (June) and the higher plant population (250000 plants/ha) rather than their interacting effects. Though, in most field crops, i.e., cotton, the high rate of vegetative growth being a prerequisite for yield maximization (Jackson, 1967) and could compensate for the late sowing.

The contribution of the high vegetative growth of June sowing in enhancing the productivity under the low plant population (50 cm

intra-row) was limited, hence, pods from the lately developed branches were of low yield attributes. On the other hand, both early sowing (June) and the high plant population (10 cm intra-row) emerged as the optimum combination, because narrowing of rows has curtailed the formation of the lately unproductive branches and consequently more assimilates were diverted to pod filling. The low number of pods/plant, 100—seed weight and H.I. were attributed to the decrease in temperature with delayed sowing. Such unfavorable low temperatures retarded both the vegetative and the reproductive growth, resulting in an inefficient dwarf plants, with few pods, low 100-seed weight due to the short filling period as reported by Nur and Elgasim 1977 and consequently a low H.I. was exhibited. The high percentage of mature pods from September sowing may have been due to the inhibition of growth of branches, flowers and gynophores by the gradual decrease in temperature and therefore, only pods that were relatively old have survived. The increased number of pods per plant due to the widening intra-row spacing was attributed to the indeterminate growth habit of the plant that gives more pegs and pods in a large space. Each plant was able to produce more than 300 flowers but only 15 percent of them gave rise to mature pods as reported by Smith (1954). However, most of the large number of pods per plant, associated with wider intra-row spacing was immature with poor shelling and lower 100-seed weight. This is a characteristic of the groundnut plant, that pods are initiated over a long period of time but many of them being immature when the crop is harvested . Thus, yield potential is lost by the artificially shortened filling period for the immature pods. Such a limitation can either be alleviated by the breeding of new varieties of groundnut from which all pods can mature evenly or which can respond to narrow intra-row spacing (250000 plants/ha) with few pods per plant but high yield per hectare Despite, an insignificant sowing date x intra-row spacing interaction revealed by this investigation for the alternately branched groundnut variety NIH 383, farmer's practice wide intra-row spacing with early sowing in June but close intra-row spacing with August and

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September sowing. These traditional farmer's practices were misconceptionally based on their experience with cotton where sowing date x plant population interaction was documented and also with the sequentially branched rainfed groundnut variety Barberton which is more responsive to plant population with delayed sowing. Unlike MH383, in the sequentially branched forms, most of the crop comes from early nodes on the earliest branches and so the pods tend to be of similar age.

In conclusion, early sowing within June and the high plant population (250000 plants/ha) proved to be essential package components for the alternately branched groundnut variety MH383 at El Rahad Agricultural Scheme environment. The recommendation on plant population should, therefore, be adopted regardless of the sowing date, hence, sowing date x plant spacing interaction was not exhibited.

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