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Growth Response of a Local Cultivar of Groundnut (*Arachishypogaea* L.) ToWeeding and Plant Spacing In a Forest-Savanna Transition Zone of Ghana

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Abstract: *Field experiments were carried out at the Plantation Section of the Faculty of Agriculture, KNUST, in the major (March) and minor (August) seasons of 2007 and major (May) season of 2008 to determine the growth response of groundnut to different times of weeding and plant spacing. The three trials involved a 3 x 4 factorial arrangement in a Randomized Complete Block Design with three replicates. The levels of different weeding times were No-weeding or control, weeding 2-3 weeks after planting, weeding 3-4 weeks after planting and weed-free, while the levels of plant spacing included 20 cm x 20 cm, 30 cm x 30 cmand 30 cm x 45 cm. Normal husbandry treatments including refilling, thinning, fertilizer application, control of pests and diseases and weeding were undertaken. Response variables measured were plant height, shoot dry matter per plant, number of branches and nodules per plant. The results of the study indicated that the weed-free treatment and widest spacing (30cm x 45cm) significantly (P<0.05) recorded the highest plant height, shoot dry matter, number of branches and nodules per plant.*

Key words: groundnut, spacing, weeding, time, cultivar

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I. Introduction

Groundnut (*Arachishypogaea*) is a day-neutral, leguminous annual herbaceous oil seed crop. It belongs to the Papilionoideae sub-family of the family Leguminosae (Norman *et al*., 1996). The cultivated groundnuts were introduced into Africa and West Africa by the Portuguese in the 16th century (Waele and Swanvelder, 2001).

Groundnut production in Ghana has nearly tripled in the last decade (168,200 t in 1995 to 420,000 t in 2005) primarily due to increases in the area under cultivation which increased from 180,400 in 1995 to 450,000 ha in 2005 (FAO, 2006). Average yields, however, continue to remain below 1.0 t ha^{-1} that is far below the potential yields of 2.0-3.0 t ha^{-1}.

Groundnut is an important food crop of the world. All parts of the peanut plant can be easily utilized. Groundnut provides farm income and an inexpensive source of high quality dietary protein and edible oil. Groundnut seeds contain high quality edible oil (50%), easily digestible protein (25%), carbohydrates (20%), vitamin E, niacin, folacin, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium (FAO, 2004).

Poor and untimely land preparation may cause serious weed problems and may lead to erosion (Frederick, 1985). According to Akobundu (1987), weeds are a major problem for farmers in the tropics. He further observed that the subsistence nature of farming in the tropics and the drudgery of peasant agriculture are principally due to the presence of weeds and the absence of modern methods of controlling them.

Agasimani*et al*. (1984) stated that in dry years, severe water deficits occurred in the narrow row first, resulting in plants smaller in both height and leaf area index.Proper spacing ensures adequate ventilation, reduces competition among plants for space and nutrients, and reduces transmission of diseases, facilitates weeding and movement in the farm and also reduces over-crowding and, therefore, allows interception of radiation by plant canopies. Generally, correct timing of weeding and proper spacing ensure proper growth of groundnut.

The main objective of this study was to determine the influence of weeding and spacing on growth of groundnut.The specific objective of the study was to ascertain the effect of weeding and spacing on plant height, shoot dry matter, number of branches and nodules per plant.

II. Materials and Methods

2.1 Experimental site

The experiment was conducted at the Plantation Section of the Faculty of Agriculture, Kwame Nkrumah University of Science and Technology, Kumasi, inApril, 2007, August, 2007 and July, 2008. The area falls within latitudes 6'35N -6'40N and longitudes 1'30W-135W and sited within the elevation of 250m- 300m above sea level. The region falls within the equatorial climate zone with a bimodal rainfall regime. The major season rains occur from mid-March to the end of July with a peak fall in June. The minor season rains commence in September and end in mid-November with a peak fall in October at which period dry desiccating harmattan winds blow across the area from the north. The rainfall regimes are separated by a period of dry weather from December to March. The area also has a mean temperature range of 21^{o}C to 30^{o}C(Meteorological Department of Kumasi Metropolitan Assembly – KMA, Kumasi, 2007). The land was previously cultivated to cassava and left fallowed for one year.

The soil belongs to the Kumasi series, which is locally classified as Ochrosols or Ferric Acrisol. The soil is moderately shallow, red, well-drained, light clay and occurs at upper slopes.

2.2 Soil chemical properties

The experimental site had a pH of 5.6. It also contained 1.36% of organic carbon, 2.34% of organic matter, 0.10% of nitrogen, 0.36 Cmol/kg/Me/100g of potassium, 4.40 Cmol/kg/Me/100g of calcium, 2.00 Cmol/kg/Me/100g of magnesium and 20.00 ppm of phosphorus.The values for pH, organic matter and potassium were moderate, while the others were low (Table 1).

Table 1: Chemical properties of soil from experimental sites and guide to interpretation of levels

Nutrient	**Level**	**Rank/Grade**
pH	5.60	Moderately acidic
Organic carbon (%)	1.36	Low
Organic matter (%)	2.34	Moderate
Nitrogen (%)	0.10	Low
Potassium (Cmol/kg/Me/100g)	0.36	Moderate
Calcium(Cmol/kg/Me/100g)	4.40	Low
Magnesium (Cmol/kg/Me/100g)	2.00	Low
Phosphorus (ppm)	20.00	Low

Soil Research Institute, Kumasi (2007)

2.3 Climatic conditions at experimental sites

The total annual rainfall amount for 2007 and 2008 were 1999.1mm and 1160.9mm, respectively. Again, the total maximum annual temperatures for 2007 and 2008 were 377.5 ^{o}C and 384.1 ^{o}C, respectively, while the total minimum annual temperatures were 259.5 ^{o}C and 261.0 ^{o}C, respectively (Tables 2 and 3).

Table 2: Climatic data during the growth period of 2007

Month	**Rainfall (mm)**	**Temp. (°C)**		**Relative humidity %**	
		Max.	**Min.**	**0900hr**	**1500hr**
January	8.5	24.0	20.2	60	34
February	65.3	34.5	22.4	80	55
March	76.7	35.2	22.6	89	49
April	189.9	34.0	22.5	82	58
May	84.3	32.9	22.5	83	63
June	244.2	31.6	21.6	85	65
July	374.0	29.7	20.8	85	70
August	127.3	29.0	20.5	86	72
September	539.8	32.2	21.5	88	71
October	237.6	30.9	21.7	86	67
November	48.6	31.4	21.8	82	62
December	2.9	32.1	21.4	83	55
Total	**1999.1**	**377.5**	**259.5**	**989**	**721**

Meteorological Department of Kumasi Metropolitan Assembly – KMA, Kumasi(2007)

Table 3: Climatic data during the growth period of 2008

Month	Rainfall (mm)	Temp. (°C) Max.	Min.	Relative humidity % 0900hr	1500hr
January	0.0	33.3	19.2	48	32
February	61.7	34.6	21.7	79	49
March	134.1	34.2	22.6	81	53
April	117.1	33.3	22.9	83	59
May	185.8	33.0	22.8	82	59
June	179.8	31.4	22.5	85	64
July	45.0	28.8	22.3	88	68
August	114.5	29.5	20.8	88	69
September	148.9	30.0	21.3	87	68
October	95.8	31.3	21.6	85	62
November	30.7	32.7	22.2	84	55
December	47.5	32.0	21.1	84	53
Total	**1160.9**	**384.1261.0**		**974**	**622**

Meteorological Department of Kumasi Metropolitan Assembly – KMA, Kumasi (2007)

2.4Experimental design and treatments

Each of the three experiments was a 4x3 factorial, arranged in a Randomized Complete Block Design (RCBD) with three replications.

Factor A – Weeding regime
W0: No weeding
W1: Weeding 2-3 weeks after planting
W2: Weeding 3-4 weeks after planting
W3: Weed-free (weeding when necessary)

Factor B – Plant spacing
S1: Spacing of 20cm x20cm (250,000 plants/ha)
S2: Spacing of 30cm x30cm (111,111 plants/ha)
S3: Spacing of 30cm x45cm (74,740 plants/ha)

In all, there were thirty-six plots in each of the three trials carried out. The field was completely prepared into plots, each measuring 2.7m (intra-row) x 4.5m (inter-row) with 1m between plots and 2m between blocks. The area of the field was 656.5m^2.

2.5 Plant culture

The land which had been under fallow for two cropping seasons from cassava cultivation was ploughed and disc harrowed two weeks after ploughing using a tractor.Seeds ofChinese Shitaochivariety of groundnut obtained from the Crop Research Institute (CRI) were tested for viability by percentage germination test. A hundred seed selected at random from the seed lot were sown in a shallow furrow and covered with soil lightly. Fourteen days after sowing, the number of germinated seedlings was counted. The percentage germination was computed by expressing the germinated seedlings as a percentage of the hundred seeds sown. The percentage germination of 90 was accepted for planting. Groundnut seeds were planted with two seeds per hill on 29th April, 2007, 15th August, 2007 and 2ndMay, 2008 in the 2007 seasons and the major season of 2008, respectively.

Filling of vacancies was done one week after sowing. Seedlings were thinned to one plant per hill two weeks after germination. Single superphosphate at a rate of 50 kg/ha was applied four weeks after planting by side dressing.Rodents were serious pests during the experiment and scare-crows were, therefore, used to ward them away. Weeds were managed as per the treatments imposed. Thus, plots with treatment W0 were not weeded throughout the study; plots with treatment W1 were weeded 2 -3 weeks after planting; plots with treatment W2 were weeded 3 -4 weeks after planting and plots with treatment W3 were kept weed-free throughout the experiment.

Harvesting was done at physiological maturity on 5th August, 2007, 25th November, 2007 and 24th July, 2008.

2.6Data collected

Data were collected two weeks after planting and at two weeks interval till harvesting for the three seasons. There were five (5) sampling periods. At each sampling period, five plants were sampled per plot for plant height, shoot dry matter per plant, number of branches and nodules per plant. Five plants were randomly

selected and tagged from each treatment. The height of each of the plants was measured with a metre rule from the ground level to the tip of the tallest leaf. The mean plant height was then computed by summing up the heights of the five tagged plants and then dividing the total height by five. The dry weights of the shoot (leaves and stems) were determined by oven-drying them at a temperature of 80^{o}C for 48 hours. The dry weight of the shoot was repeatedly taken until a constant weight was obtained. The mean shoot dry matter per plant was then computed by dividing the total weight of the five pants by five. The mean number of branches was calculated by dividing the total number of branches of the five plants by five. Five plants were randomly selected from each treatment and the number of nodules was counted with a hand lens. The mean number of nodules was then calculated by dividing the total number of nodules of the five plants by five.

2.7Data analysis

The data were subjected to analysis of variance using the Genstat Statistical package (Payne *et al*., 2009). The Least Significant Difference (LSD) at 5% probability was used to compare treatment means.

III. Results

3.1 Plant height

The weed-free treatment (W3) and the widest spacing (S3) significantly ($P<0.05$) increased plant height, while the least plant height was obtained in the No-weeding and the closest spacing at most of the sampling periods (Figures 1 and 2). Plant height increased with time in both seasons of 2007, but the rate at which it increased was faster at the first two sampling periods after which the increment reduced. Plant height was higher in the minor season than in the major season of 2007.

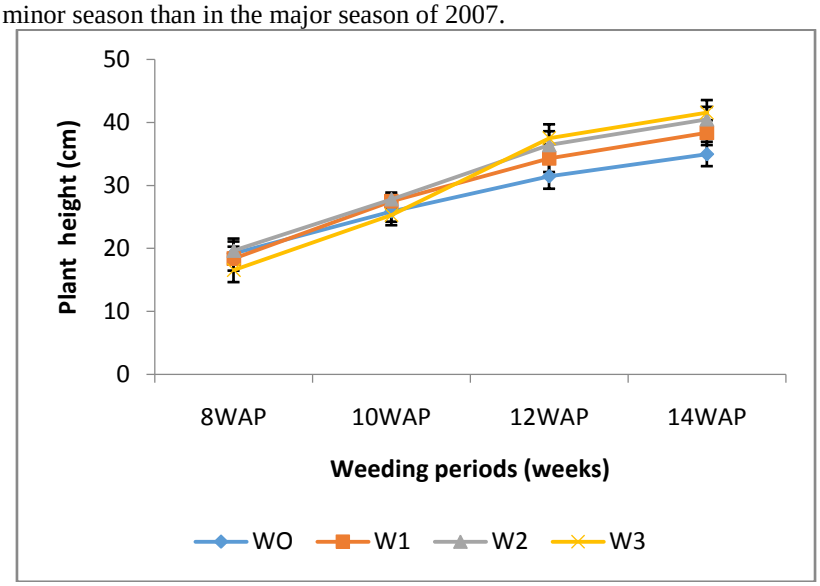

Fig 1a: Effect of weeding on plant height during the major season of 2007
Bars indicate LSD (5%).

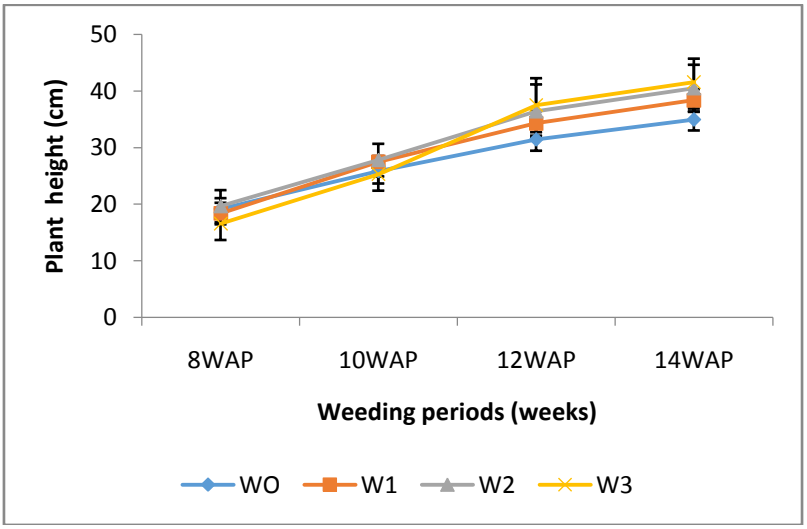

Fig 1b: Effect of weeding on plant height during the minor season of 2007
Bars indicate LSD(5%).

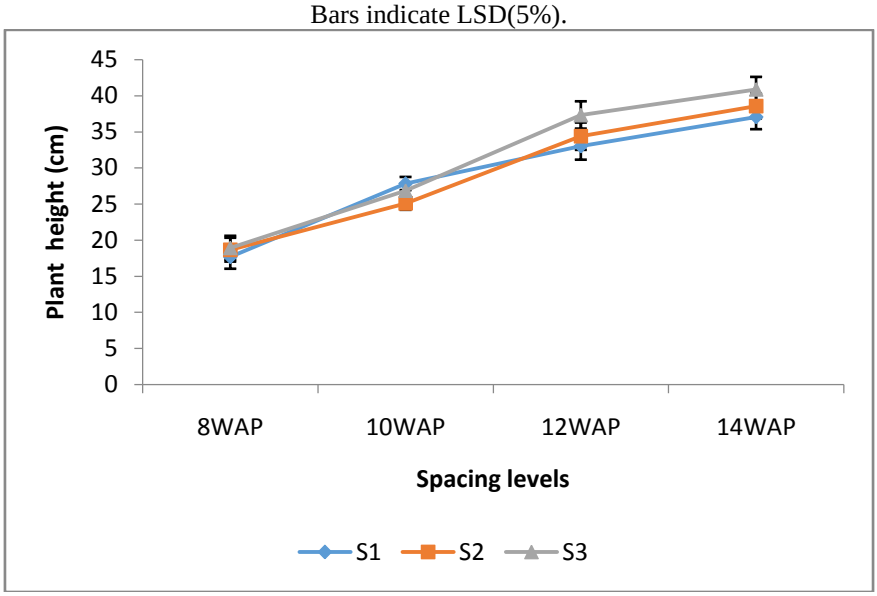

Fig 2a: Effect of spacing on plant height during the major season of 2007
Bars indicate LSD (5%).

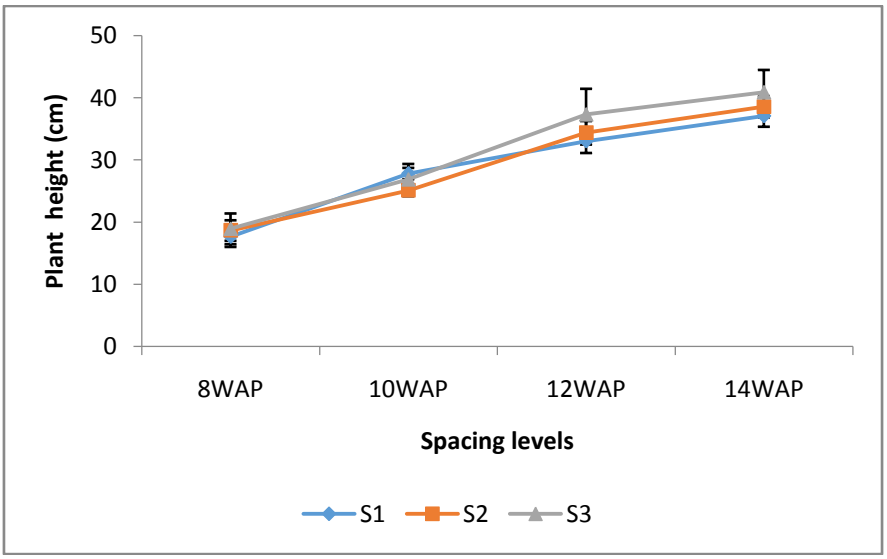

Fig 2b: Effect of spacing on plant height during the minor season of 2007
Bars indicate LSD (5%).

3.2 Shoot Dry Matter Production

Both weeding and spacing significantly ($P<0.05$) increased shoot dry matter per plant in both seasons of 2007 (Figures 3 and 4). The weed-free treatment (W3) and the widest spacing (S3) recorded the highest shoot dry matter per plant, while the least shoot dry matter per plant was produced by the No-weeding treatment (W0) and the closest spacing (S1) throughout the period. Shoot dry matter production per plant increased up to 10 weeks after planting (WAP) and declined thereafter in both seasons of 2007.

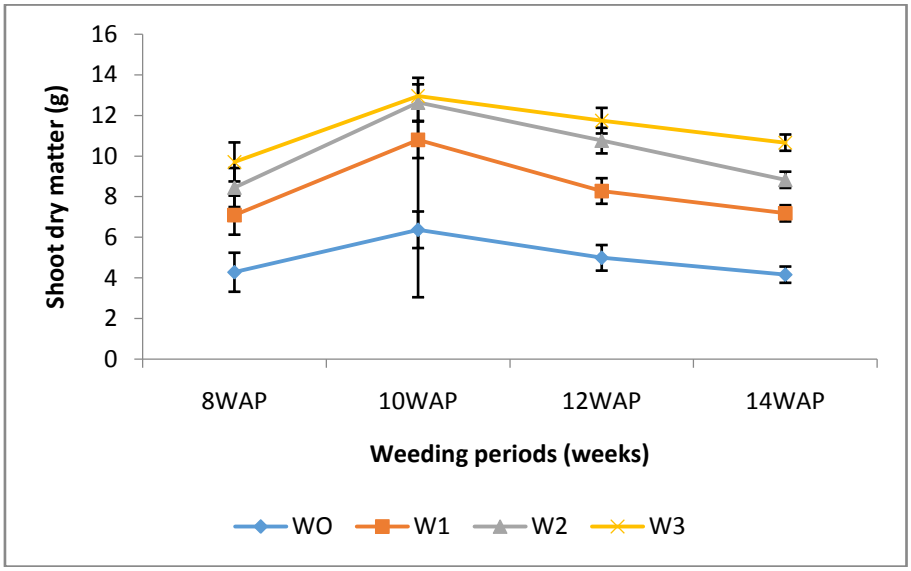

Fig 3a: Effect of weeding on shoot dry matter during the major season of 2007
Bars indicate LSD (5%).

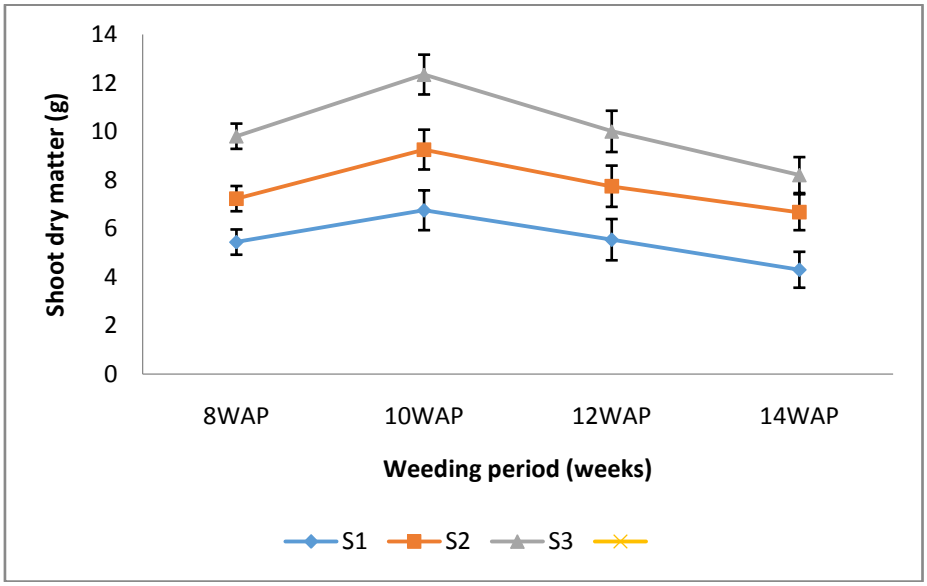

Fig3b: Effect of weeding on shoot dry matter during the minor season of 2007
Bars indicate LSD (5%).

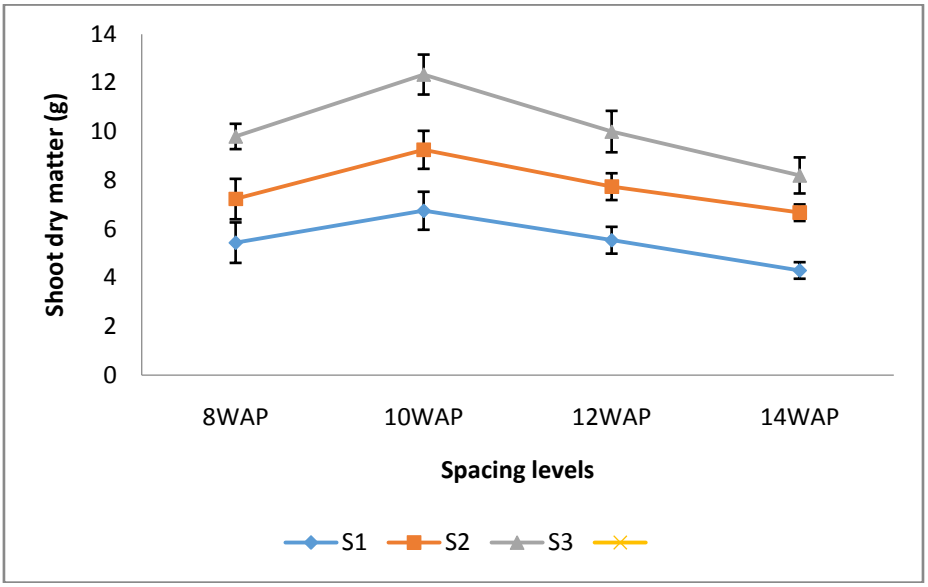

Fig 4a: Effect of spacing on shoot dry matter during the major season of 2007
Bars indicate LSD (5%).

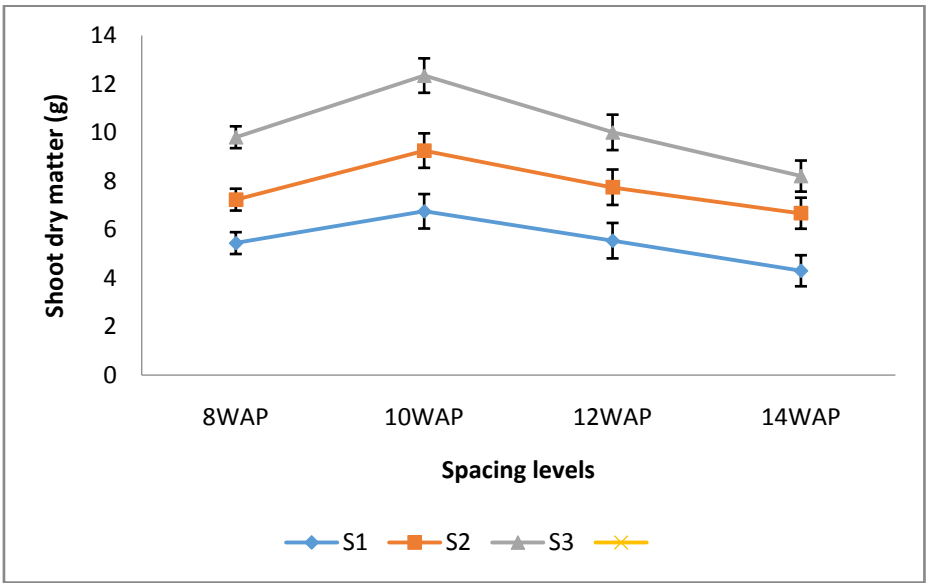

Fig 4b: Effect of spacing on shoot dry matter during the minor season of 2007
Bars indicate LSD (5%).

3.3 Number of branches and nodules per plant

In 2007 major season, the weed-free treatment (W3) and the widest spacing (S3) gave the highest number of branches and nodules per plant, while the No-weeding or control (W0) and the closest spacing (S1) recorded the least number of branches and nodules per plant (Table 4). A similar trend was observed in 2007 minor season.The results for 2008 showed a similar trend as in the 2007 trials, except that spacing did not significantly ($P>0.05$) affect the number of branches per plant in 2008 major season (Table 4).

Table 4: Effect of weeding and spacing on number of branchesand nodules per plant in 2007 major and minor seasons and 2008 major season

Treatment	No. of branches per plant			No. of nodules per plant		
	Mar. 2007	Aug. 2007	May 2008	Mar. 2007	Aug. 2007	May 2008
Weeding						
W0	4.49	5.62	5.39	60.20	52.40	63.60
W1	5.98	5.89	7.33	117.10	111.80	124.00
W2	5.90	5.73	6.78	135.90	131.20	143.10
W3	6.67	6.88	7.89	162.80	156.40	169.90
LSD (5%)	0.34	0.27	1.27	20.42	20.30	20.07
Spacing						
S1	5.56	5.44	6.42	104.50	99.00	110.30
S2	6.03	6.08	6.88	126.00	118.60	131.70
S3	6.43	6.57	7.25	126.50	121.30	133.50
LSD (5%)	0.29	0.23	1.10	17.69	17.58	17.38
Grand mean	6.01	6.03	6.85	119.00	113.00	125.20
CV	5.70	4.50	18.90	17.60	18.40	16.40

IV. Discussion

4.1 Plant height

The study revealed that plant height increased with time in the experiment of the three seasons. The study gave a mean plant height of 32.78cm and 38.83cm for March, 2007 and August, 2007, respectively (Figures 1 and 2). The results are in agreement with work by Kochhar (1986) who observed that the general plant height of groundnut was within a range of 30 to 60cm. Plant height was comparatively high in August, 2007 probably due to the higher rainfall (777.4mm) recorded in 2007 minor growing season as against 328.5mm in the major season of 2007 during the active vegetative growth period of the plant. The highest plant height of 38.68cm and 41.56cm in March, 2007 and August, 2007, respectively which was associated with the weed-free treatment (W3), could be caused by a reduction in competition for available resources like nutrients and water. The widest spacing (30cm x 45cm) gave the highest plant height of 39.67cm and 40.88cm in March, 2007 and August, 2007, respectively. The results obtained were probably due to a lower plant population and less interspecific competition for available resources. This observation agrees with the work on confectionery groundnut by Kathirvelan and Kalaiselvan (2007) who stated that plant height increased linearly with wider row spacing because of reduced interspecific competition.

4.2 Shoot dry matter per plant

Results indicated that shoot dry matter production per plant increased in the weed-free (W3)and widest spacing (S3) more than it did in the other treatments (Figures 3 and 4). The highest shoot dry matter production per plant recorded by the weed-free treatment could be attributed to the higher number of branches per plant and reduced competition for resources and space, which encouraged the production of more vigorous plants with more shoots. Work by Kalra*et al*. (1984) supports this claim. The results also agree with the work of Chaniyara*et al*. (2001) who found that lesser interplant competition for resources, which resulted in more partitioning efficiency and overall growth of the plants could account for higher shoot dry matter in the widest spacing. Results showed that shoot dry matter increased, reached a peak and then declined with time in the three seasons of the experiment. The increment could be due to adequate production of vegetative components such as leaves, stems and overall gain in dry matter yield. Contrary, leaf fall (senescence), competition and mutual shading of leaves could result in a reduction in shoot dry matter during the later stages of growth. This collaborates with the work done on confectionery groundnut by Sathyamoorthi *et al.* (2007) who stated that shoot dry matter changes with time. Furthermore, the experiment of 2008 major season characterized by the lowest amount of rainfall (Table 3) did better than the trial of 2007 in shoot dry matter per plant probably because the former was more efficient in dry matter partitioning. Suitable soil conditions, inherent soil fertility and the residual influence of applied fertilizer in the preceding season could contribute to the results.

4.3 Number of branches per plant

At maturity, the highest number of branches per plant of 6.67, 6.88, and 7.89 for March, 2007, August, 2007 and 2008 major season, respectively was found in the weed-free treatment (W3). The greatest value (Table 4) recorded by the weed-free treatment could be attributed to less competition for nutrients, moisture, space and irradiance. The results also showed that the highest number of branches per plant (6.43, 6.57 and 7.25) for March, 2007, August, 2007 and 2008 major season, respectively was found in the widest spacing (S3). This

observation is consistent with the findings of Kathirvelan and Kalaiselvan (2007) who observed that under the widest spacing, there could be more feeding zone that may have encouraged lateral growth resulting in the production of more number of branches per plant. Conversely, Kathirvelan and Kalaiselvan (2007) noted that close spacing (20cm x 20cm) could intensify intra-plant competition and reduce the feeding zone, which could result in lower number of branches per plant.

4.4 Number of nodules per plant

Results of this work showed that the number of nodules per plant increased under the weed-free treatment and the widest spacing (Table 4). Adequate supply of soil nutrients, moisture, and oxygen may have encouraged ramifying root system, activities and populations of rhizobia. This finding is in collaboration with work by Ramesh and Sabale (2001) who observed an extensive root growth and development and an increased number of nodules per plant through the supply of adequate resources.

V. Conclusion and Recommendation

5.1 Conclusion

The results of the study revealed that the weed-free and widest spacing (30cm x 45cm) treatments consistently had the highest plant height, shoot dry matter per plant, number of branches and nodules per plant in the experiment of the three seasons.

5.2 Recommendation

The study was conducted in a semi-deciduous forest zone with 'Ochrosol' type of soil. The variety of groundnut used throughout the study was "Chinese Shitaochi". It is, therefore, recommended that further work should be conducted in multi agro-ecological zones to expand varietal (Mani pinta, Atebubu local, Nkoranza local, Dagomba, hypogaea) response to weeding and spacing. The treatments applied were weeding (No-weeding or control, weeding 2-3 weeks after planting, weeding 3-4 weeks after planting and weed-free) with spacings of 20 cm x 20 cm, 30 cm x 30 cm and 30 cm x 45 cm. It is recommended that in further work, treatments should be modified to study varietal responses to treatment application. Treatment modification should include weeding 1-2 weeks after planting, weeding 4-5 weeks after planting, weeding 5-6 weeks after planting, 20 cm (intra-row) x 10 cm (inter-row), 30 cm (intra-row) x 10 cm (inter-row)and 40 cm (intra-row) x 20 cm (inter-row).

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