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Original article

EFFECT OF DEFOLIATION ON THE VEGETATIVE GROWTH PARAMETERS OF FOUR GROUNDNUT (*Arachis hypogaea* L.) VARIETIES

Joseph, S. U., Alonge, S. O*. and Adelanwa, M. A.

Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria

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ABSTRACT

Four groundnut (*Arachis hypogaea* L.) varieties (SAMNUT 21, SAMNUT 22, SMANUT 23 and SAMNUT 24) were investigated for the response of their vegetative parameters to defoliation treatments. The plants were subjected to 5 levels of defoliation: 0 (no defoliation), 25, 50, 75 and 100 % at 5 weeks after planting (WAP). The treatments were laid out in a completely randomized design with three replications. The plants were sampled at 4, 7 and 10 WAP for assessment of growth parameters (plant height, root and shoot dry matter, root nodule count). The results of this study revealed that, 75 % defoliation increased plant height in most varieties at 7 and 10 WAP. The control and 25 % defoliation were found to increase root nodules, shoot and root dry matter, and shoot and root relative growth rate (RGR) in most varieties. The 75 and 100 % defoliation levels were found to significantly reduce vegetative growth parameters except plant height (at 75 % defoliation) in groundnut varieties. The results also showed that, varieties SAMNUT 22 and SAMNUT 21 exhibited higher values in vegetative growth parameters than the other varieties, while SAMNUT 23 which showed the lowest values gave a good indication of tolerance to defoliation especially at 25 %. In conclusion, the impact of defoliation on vegetative growth parameters varies among the groundnut varieties and with defoliation levels. The 25 and 50 % defoliation could be used where the vegetative parts of the crop are targeted.

Key words: Defoliation, Groundnut, SAMNUT, Varieties, Vegetative growth parameters

***Corresponding author email address:** drsoalonge@yahoo.com

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the major oil seeds of global importance. The young groundnut pods and leaves are consumed as a vegetable; in West Africa the leaves are added to soups [1, 2]. The foliage is an important fodder, especially in the Sahel, it may be eaten fresh or as hay or silage. According to [3] during groundnut production, it may be damaged by hail, leaf feeders and defoliators, leaf disease, besides loss in

functional area due to wind, drought, grazing of animals, removal of leaves for fodder and as leafy vegetable.

Defoliation decreased leaf area and total dry matter production irrespective of genotypes in Mungbean [4, 5]. Leaf is the major source of assimilates to developing organs, young pods and seeds in crops [6, 7, 8]. Leaf removal may therefore influence total dry matter production and yield through photosynthates production and distribution into different parts depending on the magnitude of leaf removal [9, 10, 11]. A spatial defoliation pattern in wheat has a significant effect on photosynthetic parameters of injured leaves, but responses were dependent on plant developmental stages [12]. According to [13] defoliation in soybean at any stage of the crop at any level decreased the plant height. Also, [14] observed that in soybean, the growth parameters like root and shoot length, number of leaf per plant and leaf area index declined with increase in the defoliation level in all the stages of defoliation. Defoliation reduced nodules formation and nitrogen fixation in a 'Vaginia' and a 'Spanish' type peanut (*Arachis hypogaea*) [15]. Observation of [16] in maize showed that, when all leaves were removed at 10, 20, 30 days after 50 % silking, the rate of dry matter accumulation was reduced significantly within 10 days whereas, partial removal of leaves resulted in significant reduction within 20 days after the treatment.

Legumes are required to be properly protected from insects such as leaf eating insects and diseases which are common in tropical and sub-tropical countries where farmers do not protect their crops adequately [4]. According to [17], the foliar-feeding insects or foliar-fungal pathogens significantly reduced vegetative characters such as plant height, number of leaves, leaf area, leaf dry weight, stem dry weight and stand density in 'floorunner', 'sunrunner' and 'southern runner' peanuts (*Arachis hypogaea* L.).

A large number of species of caterpillar attack groundnut foliage, sometimes producing complete defoliation. This loss of leaves from mature plants may not be as serious as defoliation during the early growth stages of the plants [18]. Adult beetles and larvae feed on the pods and leaves of legumes causing numerous small holes, this injuries affect photosynthetic activities, delay plant development and reduce yield [19]. This crop of great economic importance is facing decline in growth and yield due to several factors of which leaves eating insects and diseases are part of the key factors. Therefore, the research was carried out to evaluate the response of some available groundnut varieties for their response to defoliation conditions.

MATERIALS AND METHODS

The research was carried out in the Botanical garden, Department of Biological Sciences, Ahmadu Bello University, Samaru (latitude 11^0 11'N, longitude 07^0 38'E, altitude 686m above sea level), Zaria, located in the Northern Guinea Savannah agro-ecological zone of Nigeria. Garden top soil and river sand were collected and mixed (1:1) thoroughly, sterilized by heat, cooled and used to fill the polythene bags (used as pots). The seeds of the four groundnuts varieties (SAMNUT 21, SAMNUT 22, SAMNUT 23 and SAMNUT 24) were collected from Legume and Oilseeds Section, Institute for Agricultural Research, Samaru-Zaria. The seeds were sown after being pre-treated with Apon Star (Thiamethoxam: 200 g/kg, Mefenoxam: 200 g/kg, Difenoconazole: 20 g/kg) at the rate of 10 g per 4 kg of groundnut seeds, Four (4) undamaged seeds were sown per polythene bag and

thinned to two plants in each polythene bag at two weeks after planting (WAP). Pots soils were watered to field capacity at two days interval until harvest. The groundnut plants were subjected to five different levels: (0 (control), 25, 50, 75 and 100 %) of defoliation treatment from the basal portion at 5 WAP. The treatments were replicated thrice and each replicate comprised of 8 pots. The pots were laid out in a completely randomized design. Single superphosphate (P_2O_5) fertilizer was applied at planting at the rate of 22 kgP_2O_5/ha.

One polythene bag was sampled per each replicate of treatments at 3 weeks interval starting from 4 WAP. The plants in the sampled bag were removed from the soil, washed in tap water and then air-dried on a clean table in the laboratory. Three of the washed plants from each treatment were selected for measurement of growth parameters. The height of the plants were measured using metre rule from ground level to the tip of the plant (central stalk was used) at 4, 7 and 10 WAP. Root nodules of the sampled plants from the treatment replicates were counted at 10 WAP. Also, the sampled plants were cut into roots and shoot with razor blade, each part of the samples were placed in a labeled envelope and oven dried at 70^{o}C to a constant weight and the dry weight was measured using Metler balance. Relative growth rate (RGR) was computed using the formula:

$$RGR = \frac{\log_e W2 - \log_e W1\ (g/g/wk)}{T2 - T1}$$

where : W1= Dry weight of plant at time one, W2= Dry weight of plant at time two, T1= Time one and T2 = Time two.

Data obtained from the study were subjected to analysis of variance (ANOVA) using SPSS version 21. Significant differences in treatments means were separated using Duncan multiple range test (DMRT).

RESULTS

Plant height

Most of the defoliation treatments resulted in comparable plant height in each variety on each sampling date. However, at 7 WAP in SAMNUT 24 the highest plant height (24.47 cm) due to 75 % defoliation was significantly higher than that due to 50 and 100 % defoliation. At 10 WAP 100 % defoliation resulted in significantly higher plant height (30.07 cm) than that of other treatments.

The 75 % defoliation treatment resulted in the highest plant height in variety SAMNUT 21(21.00 cm and 16.30 cm) and SAMNUT 23 (22.20 cm and 22.97 cm) at 7 and 10 WAP respectively), in SAMNUT 24 (24.47 cm) at 7 WAP and in SAMNUT 22 (25.50 cm) at 10 WAP (Table 1). On the other hand, 50 % defoliation treatment resulted in the lowest plant height in varieties SAMNUT 21 (12.30 cm and 16.67 cm) and SAMNUT 23 (12.50 cm and 15.33 cm) at 4 and 7 WAP respectively (Table 1). Plant height at 10 WAP appeared to increase with increase in defoliation intensity and the increase was significant in all the varieties except in SAMNUT 21 (Table 1).

Shoot dry matter

Defoliation, especially at 75 and 100 % decreased shoot dry matter thereby the control treatment resulted in the highest shoot dry matter at 7 and 10 WAP in varieties SAMNUT 21 (5.27 g and 8.83 g respectively) and SAMNUT 24 (5.27 g and 8.60 g respectively) while at the same period in SAMNUT 23 (6.10 g and 9.73 g respectively) the highest shoot dry matter was due to 25 % defoliation

treatment (Table 2). On the other hand, 100 % defoliation treatment resulted in the lowest shoot dry matter at 7 WAP in all the varieties and in SAMNUT 22 (4.30 g) and SAMNUT 24 (3.30 g) at 10 WAP (Table 2). Defoliation effect on shoot dry matter was significant (P 0.05) in all the groundnut varieties except SAMNUT 21 at 10 WAP (Table 2).

Table1: Effect of Defoliation on the Plant Height (cm) of four Groundnut Varieties

Variety (V)	Defoliation (D) level (%)	Age of Plant (WAP) Plant Height (cm) 4	7	10
SAMNUT 21	0	15.73a	19.43a	16.13a
	25	15.87a	19.27a	10.90a
	50	12.30b	16.67a	14.40a
	75	15.83a	21.00a	16.30a
	100	13.57ab	19.03a	16.20a
	Mean	14.67	19.08	14.79
	SE ±	1.02	1.92	2.72
SAMNUT 22	0	18.50a	25.30a	21.13ab
	25	16.40ab	23.87ab	17.17b
	50	15.80b	22.73ab	19.60ab
	75	17.13ab	24.33ab	25.50a
	100	15.23b	20.00b	25.50a
	Mean	16.61	23.25	21.78
	SE ±	0.79	1.31	1.79
SAMNUT 23	0	14.77ab	18.10b	17.00a
	25	17.17a	18.20b	20.30a
	50	12.50b	15.33b	17.33a
	75	15.40ab	22.20a	22.97a
	100	14.83ab	16.80b	22.93a
	Mean	14.93	18.13	20.11
	SE ±	1.17	1.15	2.03
SAMNUT 24	0	14.50b	21.27ab	21.00b
	25	13.53b	20.27abc	14.33c
	50	12.83b	17.30bc	24.40b
	75	16.10ab	24.47a	24.50b
	100	19.20a	14.53c	30.07a
	Mean	15.23	19.57	22.86
	SE ±	1.04	1.78	1.58
	Interaction (VxD):	S	Ns	Ns

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≥ 0.05), using DMRT. S= Significant, NS= Not Significant, WAP= Weeks After Planting

Root Dry Matter

Defoliation treatment had significant effect on the root dry matter of only one variety each at 4 and 7 WAP. The 25 % defoliation treatment resulted in the highest root dry matter at 4 and 10 WAP in varieties SAMNUT 22 (0.13 g and 1.87

g respectively) and SAMNUT 23 (0.17 g and 1.07 g respectively). On the other hand, 75 % defoliation treatment resulted in the lowest root dry matter at 7 and 10 WAP in varieties SAMNUT 21 (0.60 g and 1.03 g respectively) and SAMNUT 23 (0.37 g and 0.50 g respectively) (Table 3).

At 10 WAP, root dry matter decreased with increase in defoliation percentage in all varieties and the decrease was significant in varieties SAMNUT 22 and SAMNUT 24.

Table 2: Effect of Defoliation on the Shoot Dry Matter of four Groundnut Varieties.

		Age of plant (WAP) Shoot dry matter (g)		
Variety (V)	Defoliation (D) level (%)	4	7	10
SAMNUT 21	0	1.10ab	5.27a	8.83a
	25	0.73b	3.70b	6.30a
	50	0.87b	4.63ab	6.70a
	75	1.37a	3.73b	6.97a
	100	1.00ab	2.53c	7.47a
	Mean	1.01	3.97	7.25
	SE ±	0.12	0.33	1.21
SAMNUT 22	0	0.83ab	4.93a	7.53ab
	25	1.00a	4.53ab	8.67a
	50	0.60b	5.40a	7.37a
	75	0.87ab	4.63ab	7.60ab
	100	0.80ab	2.90b	4.30b
	Mean	0.82	4.48	7.09
	SE ±	0.09	0.55	1.07
SAMNUT 23	0	1.00b	5.30ab	8.90a
	25	1.20ab	6.10a	9.73a
	50	1.47a	4.60ab	8.47a
	75	0.90b	3.23b	3.97b
	100	0.93b	3.07b	9.10a
	Mean	1.10	4.46	8.03
	SE ±	0.11	0.68	0.85
SAMNUT 24	0	1.00a	5.27a	8.60a
	25	0.73b	2.47b	5.93a
	50	0.83ab	4.53a	6.27a
	75	0.67b	5.00a	6.70a
	100	0.73b	2.33b	3.30b
	Mean	0.79	3.92	6.16
	SE ±	0.07	0.63	0.81
	Interaction (VxD):	S	S	S

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different ($P \geq 0.05$), using DMRT. S= Significant, NS= Not Significant, WAP= Weeks After Planting

Root Nodules

Defoliation generally reduced root nodules in all the four varieties at 10 WAP, although most treatments produced comparable root nodule count. The highest root nodules number at 10 WAP, was produced by the control treatment in varieties SAMNUT 21 (137.33) and SAMNUT 24 (145.00) but in varieties SAMNUT 22 (160.67) and SAMNUT 23 (128.33) by 25 % defoliation treatment. On the other hand, the lowest number of nodules in varieties SAMNUT 22, SAMNUT 23 and SAMNUT 24 (100.67, 75.67, 62.33 respectively) was due to 100 % defoliation treatment (Table 3).

Shoot Relative Growth Rate (RGR)

Defoliation reduced shoot RGR with the resultant RGR being generally comparable among most treatments. At both 4-7 and 7-10 WAP, the control treatment in SAMNUT 21 (13.34, 19.25 g/g/wk respectively) and SAMNUT 24 (13.43, 18.63 g/g/wk respectively) and 25 % defoliation treatment in SAMNUT 23 produced the highest shoot relative growth rate (15.51 g/g/wk) at 4-7 WAP . At 4-7 WAP, the highest shoot relative growth rate in groundnut varieties SAMNUT 21 and SAMNUT 24 due to the control treatment was only comparable with that due to 50 % defoliation treatment. On the other hand, at 4-7 WAP, the lowest shoot relative growth rate was due to 100 % defoliation treatment in all the four groundnut varieties (Table 4).

Root Relative Growth Rate (RGR)

Generally, defoliation reduced root RGR to generally comparable values among most treatments. At 4-7 WAP, the highest root RGR was due to 50 % defoliation treatment in groundnut varieties SAMNUT 21 and SAMNUT 24 (Table 4). The lowest root RGR was due to 75 % defoliation treatment in groundnut varieties SAMNUT 21 and SAMNUT 23 but due to 100 % defoliation treatment in varieties SAMNUT 22 and SAMNUT 24 (Table 4).

At 7-10 WAP, the highest root RGR was due to the control in groundnut varieties SAMNUT 21 and SAMNUT 24 while it was due to 25 % defoliation treatment in groundnut varieties SAMNUT 22 and SAMNUT 23 (Table 4).

Table 3: Effect of Defoliation on Root Dry Matter and Root Nodule Count of four Groundnut Varieties.

		Root dry matter (g)			Root nodule No./plant
	Plant Age (WAP) ⟹	4	7	10	10
Variety (V)	Defoliation (D) level (%)				
SAMNUT 21	0	0.23ab	1.00a	2.03a	137.33a
	25	0.13b	0.80a	1.70a	103.67ab
	50	0.13b	0.70a	1.37a	91.67ab
	75	0.33a	0.60a	1.03a	74.33b
	100	0.10b	0.63a	1.43a	78.00b
	Mean	0.19	0.75	1.51	97.00
	SE ±	0.05	0.15	0.34	15.48
SAMNUT 22	0	0.10a	0.97a	1.47ab	108.00b
	25	0.13a	0.87a	1.87a	160.67a
	50	0.10a	0.90a	1.40ab	136.00ab
	75	0.10a	0.80a	1.17bc	103.33b
	100	0.10a	0.60a	0.80c	100.67b
	Mean	0.11	0.83	1.34	121.73
	SE ±	0.02	0.17	0.17	12.28
SAMNUT 23	0	0.10a	0.57a	0.67a	116.33ab
	25	0.17a	0.63a	1.07a	128.33a
	50	0.13a	0.60a	0.87a	111.67abc
	75	0.10a	0.37a	0.50a	83.33bc
	100	0.10a	0.47a	0.53a	75.67c
	Mean	0.12	0.53	0.73	103.07
	SE ±	0.02	0.10	0.22	11.74
SAMNUT 24	0	0.10a	0.87a	1.10a	145.00a
	25	0.10a	0.33b	0.83ab	135.00ab
	50	0.13a	0.90a	0.70abc	88.33bc
	75	0.10a	0.40b	0.60bc	87.67bc
	100	0.10a	0.30b	0.33c	62.33c
	Mean	0.11	0.56	0.71	103.67
	SE ±	0.02	0.15	0.14	15.90
	Interaction (VxD):	S	NS	NS	NS

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different ($P \geq 0.05$), using DMRT. S= Significant, NS= Not Significant, WAP= Weeks After Planting

Table 4: Effect of Defoliation on Shoot and Root Relative Growth Rates of four Groundnut Varieties

Variety (V)	Defoliation (D) level (%)	Plant Age (WAP) Shoot Relative Growth Rate (g/g/wk)		Root Relative Growth Rate (g/g/wk)	
		4-7	7-10	4-7	7-10
SAMNUT 21	0	13.34a	19.25a	2.51ab	4.63a
	25	9.40b	13.78a	2.05ab	3.90a
	50	11.82ab	14.02a	3.70a	3.09a
	75	8.92b	15.57a	1.33b	2.27a
	100	5.98c	18.01a	1.63ab	3.32a
	Mean	9.89	16.13	2.24	3.44
	SE ±	0.52	1.87	0.40	0.54
SAMNUT 22	0	12.66a	16.03ab	2.54a	3.11ab
	25	11.42ab	19.47a	2.24a	4.30a
	50	14.16a	15.14ab	2.36a	2.99ab
	75	11.82ab	16.48ab	2.08a	2.45b
	100	7.16b	9.07b	1.54a	1.64b
	Mean	11.45	15.24	2.15	2.90
	SE ±	0.86	1.67	0.27	0.30
SAMNUT 23	0	13.51ab	19.40a	1.45a	1.30a
	25	15.51a	20.95a	1.57a	2.32a
	50	11.18ab	18.86a	1.52a	1.82a
	75	7.98b	7.86b	0.66a	1.03a
	100	7.50b	21.98a	1.18a	1.03a
	Mean	11.13	17.81	1.28	1.50
	SE ±	1.04	1.50	0.17	0.31
SAMNUT 24	0	13.43a	18.63a	2.26a	2.21a
	25	6.05b	13.91a	0.82b	1.85ab
	50	11.58a	12.95a	2.33a	1.15ab
	75	12.99a	13.71a	0.99ab	1.27ab
	100	5.68b	6.86b	0.72b	0.64b
	Mean	9.95	13.21	1.43	1.42
	SE ±	0.97	1.11	0.23	0.23
	Interaction (VxD):	S	S	Ns	Ns

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different ($P \geq 0.05$), using DMRT. S= Significant, NS= Not Significant, WAP= Weeks After Planting

DISCUSSION

Defoliation had varied effect on vegetative growth parameters (plant height, shoot dry matter, root dry matter and root nodules) of all the four groundnut varieties. The increase in the

plant height in the groundnut varieties at 75 % defoliation especially at 10 WAP could be due to the fact that, new leaves formed after defoliation were at the stem apex (not at the region where former leaves were removed) and that the defoliated plants possibly expended the available resources for this increase in height. This is in agreement with the result obtained in peanut by [20] who stated that, defoliation increased plant growth in peanut. However, this is contrary to the report of [21] which indicated that defoliation significantly reduced plant height, number of branches and crop growth rate of cowpea, when carried out at the vegetative and flowering stages and the decrease increased with increase in the intensity of defoliation.

The increase in the root and shoot dry weight at 25 and 50 % defoliations in varieties SAMNUT 23 and SAMNUT 22 could be attributed to compensatory growth after defoliation. This is in line with the reports of [22] and [23] on soybean. The report of [23] stated that, plants could compensate for lost leaves through production of new leaves if photosynthate is still adequate in the defoliated plants. They reported fast recovery of leaves [22] by plants at low defoliation levels but leaf area development was slow at complete defoliation.

The reduction in root and shoot dry matter per plant due to defoliation at higher levels was probably due to the removal of the photosynthetic apparatus which prevented the plants from accumulating dry matter. This is similar to earlier reports of [9, 10,] on soybean, and [22] on cowpea. They all reported decline in dry matter production in defoliated plants which depend on the magnitude of the defoliation.

The increase in root nodules in varieties SAMNUT 22 and SAMNUT 23 at 25 % defoliation is in line with the increase observed earlier in the vegetative growth at 25 and 50 % defoliation in the other aspect of this study. However, [24] stated that, defoliation reduced weight per nodules but the number of nodules increased per plant in both *Desmodium uncinatum* and *Phaseolus atropurpureus*. The reduction in roots nodules per plant at high defoliation level in all the four groundnut varieties could be linked to reduction in initiation of new nodules as an aftermath of the reduction of total assimilate that was translocated to the roots of plants. This result is in agreement with that of [15] who reported that, defoliation reduced nodules formation and nitrogen fixation in 'Vaginia' and a 'Spanish' type peanut. These invariably reduced growth.

The effect of defoliation on relative growth rate varies among varieties and this could be as a result of differences in developmental pattern and maturity between the varieties used in this study. For instance, the increase in shoot and root RGR under 25 % defoliation at age 4-7 and 7-10 WAP in groundnut variety SAMNUT 23 could indicate tolerance to low defoliation level. The decline in the relative growth rate in varieties SAMNUT 21 and SAMNUT 24 might be due to their sensitivities to defoliation. Similar result was reported by [25] on wheat cultivars. The variation (among varieties) in effects of defoliation on relative growth rate could be due to varietal differences in response to defoliation. Similar findings was published by [5] on two varieties of soybean and [26] on maize on four cowpea varieties.

CONCLUSION

The impact of defoliation on vegetative growth parameters of groundnut varieties varied among varieties and

with the level of defoliation. The variety SAMNUT 23 appeared to be most tolerant to defoliation among the varieties. Defoliation at 25 and 50 % defoliation levels increased vegetative growth parameters but 75 % and above defoliation levels reduced vegetative growth parameters in groundnut varieties. Therefore, defoliation by pest and diseases below 50 % may not necessitate pesticides application and farmers growing the crop for forage may defoliate their plants up to 25 % to increase forage yield but severe defoliation should be avoided in groundnut to ensure maximum yield.

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