EFFECTS OF DEFOLIATION ON THE SEED YIELD PARAMETERS OF FOUR GROUNDNUT (Arachis hypogaea L.) VARIETIES

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ABSTRACT

Defoliation in groundnut (Arachis hypogaea L.) could be due to many biotic factors such as leaf eating insects, diseases and harvesting by man, just as the response elicited could also vary. Four groundnut varieties (SAMNUT 21, SAMNUT 22, SMANUT 23 and SAMNUT 24) were investigated to determine the effects of defoliation treatment on their yield parameters. The seeds of these varieties were obtained from Legume and Oilseeds Section, Institute for Agricultural Research, Ahmadu Bello University, Zaria. 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 flower count was evaluated between 6-10 WAP whereas other yield parameters were at harvest. The results revealed that, the control, 25 and 50 % defoliation treatments had the highest flower count, while 100 % defoliation level was the lowest in most cases. Total pods, number of mature pods per plant, haulms weight, pod dry weight and seed weight decreased with increase in defoliation but the number of immature pods per plant increased with increase in defoliation level. The 25 and 50 % defoliation levels were found to increase pod yield and haulms weight but the 100 % defoliation level produced the lowest yield values in most cases. The results also showed higher yield values in varieties SAMNUT 22 and SAMNUT 21 than the other varieties. Although, SAMNUT 23 produced the lowest pod and seed weight compared to other varieties, it exhibited good tolerance to defoliation treatments. Thus the order of tolerance to defoliation observed was: SAMNUT 23 > SAMNUT 24 > SAMNUT 21 > SAMNUT 22. In conclusion, this study showed that, the 25 and 50 % defoliation increased yield parameters in most varieties, while 75 and 100 % defoliation levels tended to reduce yield parameters.

Key words: Defoliation, Groundnut varieties, Haulms, SAMNUT, Seed, Yield parameters

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INTRODUCTION

Groundnut (Arachis hypogaea L.) is one of the most important subsistence...
legumes along with cowpea (*Vigna unguiculata* L. Walp) in Nigeria, mainly used as food and source of oil [1, 2]. Groundnut seeds are eaten raw, boiled or roasted and are used for making margarine, candy, salted groundnut and confectionery products [3, 4, 2]. Virtually all part of groundnut are useful. According to [5] over 330 products can be commercially produced from groundnut.

However, the observed decline in groundnut production had been attributed partly to drought, pest and diseases [6, 7]. Foliar diseases of groundnut are among the most important yield-limiting factors in groundnut production, due to loss of photosynthetic leaf area. Early and late leaf spots and rust together may cause up to 70 % yield losses [8]. Adult beetles and larvae feed on the pods and leaves of the plants causing numerous small holes [9]. Leaf injuries delay plant development, photosynthetic activities and reduced yield [9]. Defoliation causes a decrease in seed production either due to decrease in flower production [10, 11, 12] or increased abortion of fruits and seeds [13, 14, 15, 16]. However, the degree of yield reduction varies with the percentage of leaf area destroyed, the variety and crop growth stage when defoliation occurred [17].

The effect of manipulation of source (leaf) size in plants have been studied and reported to be either advantageous or disadvantageous in Soybean, Okra, Cowpea, and Sunflower [18, 19, 20, 21, 22]. Mild defoliation during reproductive phase did not adversely affect seed yield in Mungbean (*Vigna radiata*) [23, 24] and in soybean [18]. However, an experiment with perennial orchid (*Dactylorhiza maculata*) showed that, the non-defoliated and partially defoliated plants produced relatively heavier capsules than the completely defoliated plants [25]. One-third leaf removal from basal portion of the canopy in cowpea increased grain yield over control and severe defoliation decreased seed yield [20, 26]. 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 defoliation [20, 26, 27].

Apart from foliar damage due to pest and diseases, the use of young groundnut leaves in soup preparations and matured leaves as fodder in some parts of West Africa [8, 28] makes it necessary to investigate the impact of defoliation on groundnut yield. Also, there is scarcity of information on the impact of defoliation on groundnut yield.

Due to high economic value of groundnut and the desire to maximize these benefits especially by the poor resource farmers, there is the need to determine the effect of defoliation levels on the yield of some of the available groundnut varieties in the Northern Guinea Savannah zone of Nigeria.

**MATERIALS AND METHODS**

The research was carried out in the Botanical garden, Department of Biological Sciences, Ahmadu Bello University, Samaru, (latitude 11° 11’N, longitude 07° 038'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 mixed thoroughly in the proportion of 1:1, sterilized by heat and was used to fill the polythene bags, used as pots for the experiment. Seeds of four groundnut varieties (SAMNUT 21, SAMNUT 22, SAMNUT 23 and SAMNUT 24) were collected from Legume and Oilseeds Section, Institute for Agricultural Research, Ahmadu Bello University, 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 undamaged seeds were sown per polythene bag (which served as pots) and thinned to two plants in each polythene bag at two weeks after planting (WAP). The potted soils were watered to field capacity at two days interval until harvest. The groundnut varieties were subjected to five different levels (0 (control), 25, 50, 75 and 100 %) of defoliation at 5 WAP. The treatments were replicated thrice and each replicate was represented with 8 pots. The pots were laid out in a completely randomized design. Single superphosphate (P\textsubscript{2}O\textsubscript{5}) fertilizer was applied at planting at the rate of 22 kg P\textsubscript{2}O\textsubscript{5}/ha.

Beginning at 6 WAP, the flowers were counted from each plant at a week interval to determine the effect of defoliation on flowering. Plants were harvested at maturity by selecting the plants in one pot from each treatment replicates. The plants and pods were removed and washed in water. The total number of pods (both mature and immature) from six selected plants were counted, noting the mature and immature pods. Pods were air dried to constant weight. The weight of all the pods harvested from the plants from each replicate was determined using Mettler balance and the pod weight /plant calculated. After shelling the pods from each treatment replicate, the seeds from the plants were weighed using a top- loading Mettler balance and the mean value per plant was obtained by dividing the value by the number of plants harvested. The 100-seed weight and haulm weight were also obtained for each treatment. Shelling percentage was computed using the formula:

\[
\text{Shelling \%} = \frac{\text{Weight of kernels}}{\text{weight of pods}} \times 100
\]

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

RESULTS

Total flower

The lowest flower counts were observed among most of the varieties at 75 and 100 % defoliation levels on most sampling dates. The results showed that, groundnut varieties SAMNUT 21 and SAMNUT 22 had the highest total flower count (11.00) at 0 % defoliation, which was only significantly higher than the least due to 100 % defoliation in SAMNUT 21 (Table 1). The 50 % defoliation resulted in the highest total flower count (66.07) in variety SAMNUT 23 which was comparable with that due to other treatments. Similarly, in groundnut variety SAMNUT 24, the highest total flower count due to 50 % defoliation was only comparable with that due to 25 % defoliation. On the other hand, the lowest total flower count due to 100 % defoliation was similar to that due to the control and 75 % defoliation (Table 1).

Mature Pods

The highest number of mature pods at harvest was due to the 25 % defoliation in varieties SAMNUT 21 and SAMNUT 24, but due to the control in SAMNUT 22 (Table 2). The lowest number of mature pods was due to 100 % defoliation in varieties SAMNUT 21, SAMNUT 22 and SAMNUT 23 (Table 2). The number of mature pods decreased with defoliation level in all the groundnut varieties.
However, the decrease was only significant in varieties SAMNUT 21 and SAMNUT 22.

**Immature Pods**

At harvest, 50 and 100% defoliation resulted in the highest number of immature pods in groundnut varieties SAMNUT 23 and SAMNUT 24. On the other hand, the lowest number of immature pods due to 25% defoliation was obtained in varieties SAMNUT 22, SAMNUT 23 and SAMNUT 24 (Table 2). Generally, defoliation treatments had no significant effect on the number of immature pods in groundnut varieties except in variety SAMNUT 22. In SAMNUT 22, all the defoliation treatments produced significantly lower immature pods/plant compared with the highest obtained from the control.

**Total Number of Pod per Plant**

Total number of pods per plant decreased with increase in defoliation level, being lowest at 100% defoliation. The decrease was significant (P=0.05) only in varieties SAMNUT 21 and SAMNUT 22. The highest total number of pods per plant was due to 25% defoliation in varieties SAMNUT 21 and SAMNUT 24 but due to 50% defoliation in SAMNUT 23 and the control in SAMNUT 22. The lowest number of total pods per plant was due to 100% defoliation in varieties SAMNUT 21, SAMNUT 22 and SAMNUT 23 (Table 2).

**Haulms weight per plant:**

At harvest, the highest haulms weight in varieties SAMNUT 23 and SAMNUT 24 was due to 50% defoliation treatment. On the other hand, the lowest haulm weight in varieties SAMNUT 21 and SAMNUT 22 due to 100% defoliation was significantly lower than that of other treatments (Table 2).

**Total Pods Dry Weight:**

Defoliation treatments decreased pods dry weight in all the four varieties but the decrease was only significant (P=0.05) in variety SAMNUT 22. The highest pod dry weight in varieties SAMNUT 23 and SAMNUT 24 was due to 50% defoliation but in SAMNUT 21 it was due to 25% defoliation. However, the lowest pods weight was due 100% defoliation in varieties SAMNUT 21 and SAMNUT 22 (Table 3).

**Seeds Weight**

All the defoliation treatments reduced the total seeds weight per plant in SAMNUT 22, however, in SAMNUT 21 and SAMNUT 24 defoliation at 25 and 50% resulted in higher seed weight than the other treatments. Defoliation had significant effect on the seed weight produced in varieties SAMNUT 22 and SAMNUT 24. The lowest seed weight in varieties SAMNUT 21 and SAMNUT 22 was due to 100% defoliation (Table 3).

**Shelling Percentage**

Generally, defoliation had no significant effect on the shelling percentage in the four groundnut varieties. The 100% defoliation had the highest shelling percentage in groundnut varieties SAMNUT 21 and SAMNUT 22 (68.00 and 64.12% respectively). On the other hand, the lowest shelling percentage was due to 75% defoliation in varieties SAMNUT 22, SAMNUT 23 and SAMNUT 24 (Table 3).

**100-Seeds Weight:**

The results showed that, leaf defoliation had no significant effect on 100-seed weight of the four groundnut varieties (Table 3).
Table 1: Effect of Defoliation on Flower Production of four Groundnut Varieties

<table>
<thead>
<tr>
<th>Variety (V)</th>
<th>Defoliation (D) level (%)</th>
<th>Plant Age (WAP) Flower count</th>
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Interaction (VxD): NS NS NS NS NS 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.
Table 2: Effect of Defoliation on the Pods and Haulms yield of four groundnut varieties.

<table>
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<tr>
<th>Variety (V)</th>
<th>Defoliation (D) level (%)</th>
<th>Mature Pods/plant</th>
<th>Immature Pods/Plant</th>
<th>Total pods/plant</th>
<th>Haulms weight/plant</th>
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Interaction (VxD): NS S S S

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
Table 3: Effect of Defoliation on the Total Pods Dry Weight, Seed Weight, Shelling Percentage and 100-seed weight of four Groundnut Varieties.

<table>
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<tr>
<th>Variety (V)</th>
<th>Defoliation (D) level (%)</th>
<th>Pod weight (g)</th>
<th>Seed weight (g)</th>
<th>Shelling Percentage</th>
<th>100-seed weight (g)</th>
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Interaction (VxD): S = Significant, NS = Not Significant, WAP = Weeks After Planting

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different (P ≥ 0.05), using DMRT.

**DISCUSSION**

The general reduction in flower count in all the four groundnut varieties under defoliation treatments could be attributed to lesser leaf area for photosynthesis and consequently low assimilate supply to growing regions in defoliated plants. This can be corroborated with the findings of [12] on Mungbean.
The increase in pod weight, seed weight and haulms weight in varieties SAMNUT 21 SAMNUT 23 and SAMNUT 24 due to 25 and 50 % defoliation levels was probably due to the increases observed earlier in the root and shoot dry weight and flower production under these treatments. This possibly indicates the presence of an effective compensatory mechanism in these varieties. This shows that even if such defoliated leaves were fed to animals, the yield production was still good and therefore such plants can serve dual purpose. The 25 % basal defoliation of Mungbean showed superiority in seed yield compared to other treatments because of higher total dry matter production, greater number of opened flowers and increased pod and seed size [12]. However, at higher defoliation levels (75 and 100 %) a decrease was observed in pod weight, seed weight and haulms weight in these groundnut varieties. One-third removal from basal portion of the canopy in cowpea increased grain yield over the control and severe defoliation decreased seed yield [20].

The reduction in number of mature pods per plant and increase in the number of immature pods per plant due to defoliation in groundnut varieties in this study could be attributed to reduction in flower production possibly due to delay in maturity. Delay in maturity could had been due to the usage of the food reserve in the plants for refoliation instead of being channelled to enhance pod production. This is corroborated by the findings of [29, 17] on peanut. This decrease in pods weight per plant was more pronounced when defoliation was complete (100 %). The reduction in weight of pods per plant could be due to the removal of leaves which reduced available leaf area for photosynthesis and time taken for recovery. It had been observed that, peanut plants that were defoliated at 100 % level took longer time to recover [29]. Defoliation at this level probably reduced greatly the total assimilates supplied to the young pods for development. This result is in agreement with those obtained by [21, 22] who reported that, the leaf is the major source of supplying assimilates to developing organs, young pods and seeds in crops. Defoliation did not only reduced source size but also decreased total sink (flower) production resulting in lower pod and seed yield in Mungbean [12]. Also, defoliation reduced dry weight of stem, pods, grains, and size of individual grain in all the four legumes (cowpea, groundnut, greengram and soybean) studied. The adverse effect being more pronounced when defoliation was complete than when half of the number of leaves were removed.

Variety 22 showed high sensitivity to defoliation and possibly the plants were also short of assimilates even to develop properly most of the pods initiated thus resulting in the highest immature pods count. The effect of defoliation on 100-seeds weight was not significant in each of the varieties. However, [30] reported that, pod number per plant, leaf protein concentration, grain yield and 100-seed weight were significantly reduced by defoliation in cowpea, and that 100-seed weight decreased linearly with increase in defoliation.

**CONCLUSION**

The impact of defoliation on yield parameters varies among the groundnut varieties and with the level of defoliation. Great ability to recover from defoliation effect was observed especially in SAMNUT 23 at 50 and 75 % defoliation levels and SAMNUT 23 at 25 and 50 % defoliation levels. The converse of these was true in the SAMNUT 22. Severe defoliation should however be avoided in groundnut to ensure maximum yield. Further study should be carried out on
the oil and nutrients composition of harvested seeds from defoliated plants.

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REFERENCES


