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Original Paper

Assessing the critical period of weed interference in groundnut *Arachis hypogaea* L. in Ogun State, south western Nigeria

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The critical period of weed interference in groundnut was investigated in 2018 and 2019 early cropping seasons at the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The experiment consisted of ten treatments arranged in a randomized complete block design and replicated three times. Treatments includes keeping plots weed free initially for 3, 6, 9, 12, 15 weeks after planting (WAP) and keeping plots weed infested initially for 3, 6, 9, 12, 15 WAP. Data collected on weed cover score, weed dry matter production, crop vigour score, canopy spread, pod yield and numbers were subjected to analysis of variance and treatment means were separated using least significant difference at $P \leq 0.05$. The results showed that total weed dry matter production increased with weed infestation period and decreased with weed free period. Also, there was significant increase in pod yield and count when plots were kept weed free for 6 WAP and more. Our findings showed that, the highest percent weed accumulation, weed removal, pod yield loss and pod yield gain all occured between 3 and 6 WAP. Therefore, the critical period of weed interference in groundnut is between 3 and 6 WAP. Also, there was 83.4% pod yield loss in groundnut when weed was allowed to compete freely with the crop throught crop life cycle.

Keywords: canopy spread, groundnut, pod yield, weed infestation, yield loss

1 Introduction

Groundnut *Arachis hypogaea* L. has achieved status as a cash crop and food due to its significance in both the local and international markets. Groundnut being the fourth most important oilseed crop and second most important source of vegetable oil in the world, its products are suitable for both domestic and industrial use (Guchi, 2015; Kombiok et al., 2012). Groundnut, also known as peanut, is a tropical legume primarily grown for oil production, also for human and animal consumption.

The majority of global peanut production is devoted to oil and food products. Between 1996 and 2000, 49 percent of global production was used for oil, and 41 percent used as food product components (Revoredo and Fletcher, 2002). Peanut is also used in animal feed through the valorization of oil cakes, which are a good source of protein for livestock. Groundnut straw is also used as dried hay in most Sahelian countries and is a major source of cattle feed during the dry season. Peanut, like most grain legumes, has significant nutritional value for human consumption. Several studies have found that peanut has a positive impact on human health, and its nutritional value has been used to create highly nutritious food products used in the treatment of severe child malnutrition (Briend, 2001).

Groundnut has the highest oil content of any food crop and, among food legumes, is only second to soybean in terms of protein content (20–30%) (Khan et al., 2004). As a legume, it plays a significant role in feeding the world's people and animals, particularly in third-world countries, where it meets up to two-thirds of human nutritional

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needs. Furthermore, because they can extract nitrogen from the air, they do not require as many chemical fertilizers. As a result, it will be a better bargain for poor farmers who cannot afford fertilizers and a boon for richer farmers (Khan et al., 2004). Groundnuts are used to make a variety of food products, including boiled nuts, roasted nuts, salted nuts, groundnut milk, groundnut yogurt, groundnut bars, groundnut butter, groundnut cheese, and bakery products (Opeke, 2006).

Despite the use of good management practices, groundnut productivity has been low. Intensive weed competition is one of the major barriers to increasing groundnut productivity among the various constraints limiting productivity. Groundnut, as a slow-growing crop at first, provides an ideal environment for weed growth. Weed computational stresses cause significant yield losses (15–75 percent) depending on the season (Jat et al., 2011) and 15–84 percent (Mavarkar et al., 2015).

El Naim et al. (2010) stated that the critical period of weed control in groundnuts as between 3 and 6 WAP whereas Everman et al. (2007) put it at between approximately 3 and 9 WAP. Results from experiments conducted by Webster et al. (2007) revealed a yield loss of 10% for the initial 4 weeks of Bengal dayflower (*Commelina bengalensis*) interference with groundnut and 100% reduction in pod yield for initial 6 weeks of interference in 2004. According to Paulo et al. (2001), maintaining a weed-free environment resulted in maximum yields of groundnut.

The precise critical period of crop weed competition during the growing season of groundnut must be determined in order to avoid exorbitant weed management costs, as this will guide on the exact time to weed. Weed control must be done on time (Adhikary et al., 2016) not only to prevent yield loss caused by weeds, but also to improve resource use efficiency and, as a result, groundnut productivity. The study hypothesized that the longer the length of weed infestation, the lower the yield of groundnut. Therefore, the objective of the study is to determine the critical period of weed interference in groundnut in south west of Nigeria.

2 Material and methods

The field trials were conducted in the early cropping season of 2018 and 2019 at the Federal University of Agriculture, Abeokuta, Nigeria to determine the critical period of weed interference in groundnut. Abeokuta is located in the forest savannah transition zone of South Western Nigeria and characterized by bimodal pattern of rainfall. The site received a total rainfall of 708.0 and 589.4 mm throughout the period of growth in 2018 and 2019, respectively (Table 1). The mean monthly temperature ranged from minimum of 25.3 °C and 26.2 °C to a maximum of 27.3 °C and 34.0 °C in 2018 and 2019, respectively (Table 1). The soils of the fields in both years had a sandy loam texture, pH of 6.24 and 6.50 (Table 2). Prior to planting, the experimental site was plowed and harrowed at a two-week interval and beds were made manually using hand hoe. Plot size was 3.0×3.0 m^2 in both years.

In both years, groundnut seeds were sown in May, plant spacing at 0.6×0.3 m to give a total plant density

Table 1 Sum of precipitations average day temperature and relative humidity of the experimental site, vegetation periods of 2018 and 2019

Month	2018			2019		
	sum of precipitations (mm)	average day temperature (°C)	relative humidity (%)	sum of precipitations (mm)	average day temperature (°C)	relative humidity (%)
May	152.2	27.3	71.5	150.4	27.7	80.0
June	172.9	26.6	76.3	264.5	27.1	83.1
July	221.1	25.3	80.3	108.7	26.2	87.4
August	161.8	25.8	77.2	65.8	34.0	83.4

Table 2 Physico-chemical properties of soil at the experimental sites

Soil properties	2018	2019
pH (in water)	6.24	6.50
Particle size analysis		
Sand (g/kg)	910.3	892.1
Silt (g/kg)	59.0	63.9
Clay (g/kg)	30.7	44.0
Textural class	sandy-loam	sandy-loam

of 55555 plants/ha. The experiment consisted of ten treatments arranged in a randomized complete block design and replicated three times. The ten treatments includes keeping plots weed free initially for 3, 6, 9, 12, 15 weeks after planting (WAP) and keeping plots weed infested initially for 3, 6, 9, 12, 15 WAP. Weeds were removed by hand hoeing at the required time according to the treatments. In the weed free treatments, weeds were removed at weekly intervals throughout the growing season.

Weeds were sampled from two quadrats of 0.5 × 0.5 m size placed in the middle central rows before any weeding was done. The weeds were sampled by cutting them at the ground level in the quadrats. Weed dry matter production was done by oven drying weeds collected from the quadrats at 70 °C until constant weight was attained. Weed cover score, a visual rating was also taken using the scale of 10 to 100 (where 10 means no weed coverage; 20–30 means slight weed coverage; 40–60 means moderate weed coverage; 70–90 means severe weed coverage and 100 means complete weed coverage) Osunleti et al. (2021). Groundnut crop vigour score, also a visual rating was determined using scale of 1 to 10, where 1 means complete crop death and 10 means vigorously growing crop. The components of crop vigour score include: height of the crop, greenness of leaves, canopy spread. Groundnut was harvested manually at four months after planting. Data collected were subjected to analysis of variance (ANOVA) using Genstat 12th edition to determine the level of significance of the treatments. Least significant difference (LSD) was used to separate significant means at a 5% level of probability.

3 Results and discussion

In both years at 6 and 9 WAP, keeping plots weed free for various periods and those kept weed infested for 3 WAP resulted in higher canopy spread than those kept weed infested for 6 WAP and more (Table 3). The higher canopy spread on the weed free plots and those weed infested initially for only 3 WAP was as a result to less weed-crop interaction which reduces weed-crop competition and thereby making environmental resources needed for good crop growth available for the crop only. This implies that less weed-crop competition is needed for good crop growth. This corroborates the findings of Korav et al. (2020) who reported restriction in foliage coverage of groundnut as the canopy development of weeds increased.

In both years at 6 WAP, keeping plots weed free for 6 WAP and more resulted in higher crop vigour than those left weed infested for 12 WAT and more (Table 3). Also at 9 WAP in both years, keeping plots weed free for 9 WAP resulted in higher crop vigour than weed infestation for 9 WAP and more (Table 3). The higher crop vigour on the plots weed free for 9 WAP and more compared to when weeds were allowed to compete freely with crops for 9 WAP and more was as a result of longer weed free periods on the plots kept weed free for 9 WAP and more. The longer weed free periods enhance crop vigour and give the crop the enable environment to make good use of the environmental resources and help in proper assimilate partitioning in the presence of no weeds. Also the higher canopy spread on the weed free plots contributed greatly to the higher crop vigour on the weed free plots. This result agrees with earlier report of Korav et al. (2020) who reported better growth of groundnut when the crop

Table 3 Effect period of weed interference on canopy spread and crop vigour score

	Canopy spread (cm)				Crop vigour score			
	6 WAP		9 WAP		6 WAP		9 WAP	
Treatment	2018	2019	2018	2019	2018	2019	2018	2019
Weed infested for 3 WAP	30.5	28.6	35.2	32.9	4.3	3.3	7.7	5.7
Weed infested for 6 WAP	18.1	19.1	21.1	22.2	3.3	3.3	6.7	5.3
Weed infested for 9 WAP	17.7	19.7	20.5	22.8	3.3	2.0	3.6	2.7
Weed infested for 12 WAP	19.5	19.7	22.6	22.8	2.3	2.3	4.0	3.7
Weed infested for 15 WAP	17.4	17.9	20.2	20.7	2.3	2.0	3.6	2,7
Weed free for 3 WAP	30.5	26.9	35.3	31.3	2.3	2.7	4.7	4.0
Weed free for 6 WAP	31.0	29.7	35.7	34.3	4.7	4.0	6.0	6.0
Weed free for 9 WAP	32.5	34.1	37.7	39.3	3.3	4.3	7.0	7.7
Weed free for 12 WAP	33.4	32.9	38.7	38.0	4.7	3.7	7.7	6.3
Weed free for 15 WAP	30.8	32.8	35.6	37.9	5.0	4.7	8.3	6.3
LSD*	8.254	7.917	9.41	9.005	1.487	0.940	2.132	1.820

*P = 0.05

is allowed to grow in the midst of less weed canopy. They further reported that weed disturbed the mineral supply, has allelopathic effect on the crop and thereby reducing the growth and development of groundnut.

In both years, keeping plots weed free for 12 WAP and those weed infested for 3 WAP resulted in higher yield and yield components compared to those left weed infested for 9 WAP and more (Table 4). Weed free situation for 6 WAP resulted in similar yield and yield component to those weed free for 12 WAP and more in both years. Plots kept weed free for 6 WAP and more produced higher groundnut pod yield compared to those left weed infested for 9 WAP and more (Table 4). This implies that groundnut need weed free situation for the first 6 weeks for optimum yield. Generally, groundnut pod yield increased with increase in weed free period and reduced with increase in weed infestation period. This confrim the findings of Korav et al. (2018) who reported decrease in plant dry matter production with increase in period of weed infestation as a result of higher weed dry matter production. The higher pod yield on plots kept weed free for 6 WAP and more compared to those left weed infested for 9 WAP and more could be attributed to availability of adequate environmental resources that support reproductive process in plants as a results of weed free situation. Conversely, inadequate resources to support reproductive process in plants as a result of weed competition for nutrient, water, space and light was probably responsible for the lower yield on the plot weed infested for 9 WAP and more. Obviously, keeping plots weed free for 6 WAP and more had resulted in higher canopy spread and crop vigour score which increase the photosynthesis activities in groundnut and thereby increasing the food manufacturing in the crop. Consequently, there is adequate assimilate partitioning of the food manufactured to the root zone where we have the economic yield which is the pod. Furthermore, the lowest pod yield and numbers on the plots weed infested for 15 WAP is as a result of uninterrupted weed-crop competition which deny the crop of adequate environmental resources for healthy crop growth. The results agrees with the findings of Bhalerao et al. (2011) who reported maximum value of pod yield and numbers on the weed free plots. Similarly, Olayinka and Etejere (2015) reported lowest yield and yield components on plots weed infested throughout. Singh et al. (2016) in their results showed, that the yield attributes and grain yield declined with the increased duration of crop-weed interference period.

Figure 1 shows percentage pod yield as affected by periods of weed interference in both years. There was decrease in pod yield with increase in weed infestation period, while there was increase in percentage pod yield with increase in weed free period. The highest pod yield gain of 58.6% was obtained between 3 and 6 WAP of weed free situation, while the highest pod yield loss 47.3% was also between 3 and 6 WAP of weed infestation. The highest yield gain and loss occurred between 3 and 6 WAP in both years, which makes the period, the critical period of weed interference in which crop is most sensitive to weed infestation with high yield loss. This implies that for acceptable yield in groundnut, this period must be kept weed free. Everman et al. (2008) had earlier reported that 4.3 to 9 WAP and 2.6 to 8 WAP to be the critical period of weed interference in groundnut under mixed grass and mixed broadleaf weed interference,

Table 4 Effect period of weed interference on yield and yield components of groundnut

	Yield and yield components					
	dry haulm (kg/ha)		number of pods		pod yield (kg/ha)	
Treatment	2018	2019	2018	2019	2018	2019
Weed infested for 3 WAP	855.1	515.5	2227867	1146463	1289	1126.6
Weed infested for 6 WAP	487.9	407.9	1501883	491080	722	423.1
Weed infested for 9 WAP	281.7	215.4	785352	270931	544	144.2
Weed infested for 12 WAP	194.4	203.2	287973	209366	236	146.4
Weed infested for 15 WAP	251.5	243.8	454223	334680	292	153.9
Weed free for 3 WAP	338.6	299.0	339387	286913	398	264.9
Weed free for 6 WAP	560.0	638.4	1623760	1444043	1064	1173
Weed free for 9 WAP	519.0	748.5	1440737	1216503	1242	980
Weed free for 12 WAP	756.6	759.3	1967990	1941756	1452	1235
Weed free for 15 WAP	824.8	820.3	1435597	1625825	1410	1263
LSD*	348.1	300.9	725777.4	867665.9	593.9	616.4

*$P = 0.05$

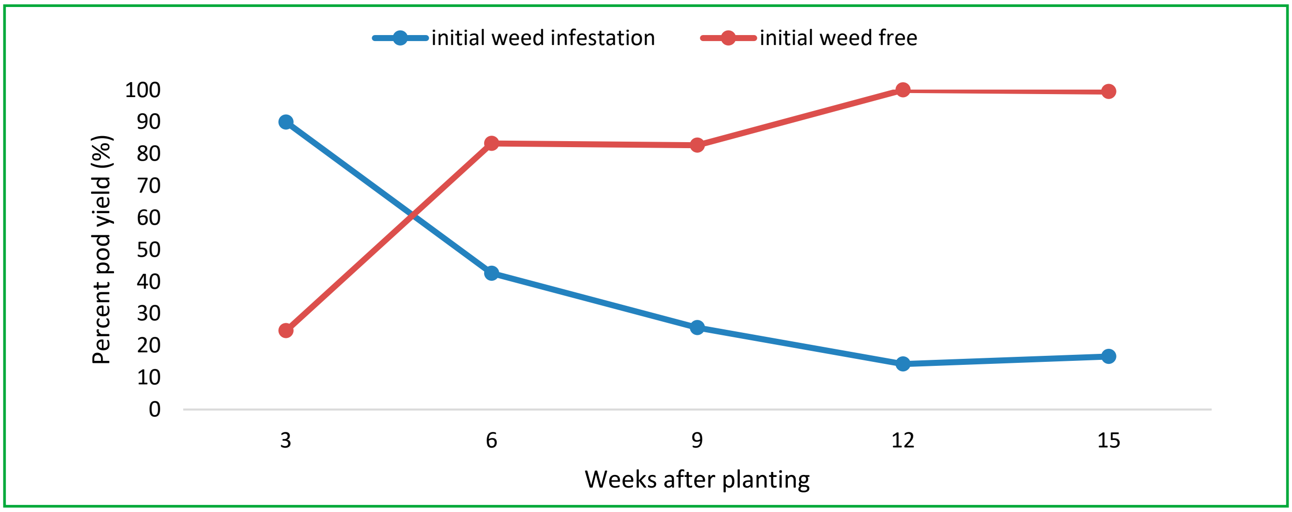

Figure 1 Effect of period of weed infestation and removal on percent pod yield in both years

respectively. Also, uncontrolled weed infestation resulted in 83.4% yield loss. This results corroborates with that of many researchers among which are Jat et al., 2011 and Mavarkar et al., 2015 who reported yield losses to the tune of 84% due to uncontrolled weed competition in groundnut.

At 6 WAP in both years, plots kept weed free for 6 WAP and more produced lower weed cover than those left weed infested for 6 WAP and more. Also at 9 WAP, keeping plots weed free for 9 WAP and more, and those weed infested initially for 3 and 6 WAP resulted in lower weed cover than those left weed infested for 9 WAP and more (Table 5). In both years, keeping groundnut weed free for 12 WAP and more resulted in lower weed dry matter production for grass, broadleaf and their totals than weed infestation for 6 WAP and more (Table 6). Also, plots kept weed free for 6 and 9 WAP, and those left weed infested initially for 3 WAP produced lower weed dry matter than those left weed infested for 9 WAP and more (Table 6).

In both years, weed cover score and cumulative weed dry matter production for grass, broadleaf and total was higher on plots left weed infested for 9 WAP and more compared to when plots were kept weed free for the periods. The higher value of weeds recorded on plots weed infested was as a results of undisturbed weed infestation on the plots. The weeds had advantage to grow faster since groundnut is slow growing initially. Consequently, the weeds grow taller and in abundance than the crops in the plots that were left weed infested initially. Conversely, the lower weed cover score and weed dry matter production on the weed free plots compared to the weed infested plots was as a result of

Table 5 Effect period of weed interference on weed cover score

	Weed cover score			
	6 WAP		9WAP	
Treatment	2018	2019	2018	2019
Weed infested for 3 WAP	10.0	10.0	10.0	10.0
Weed infested for 6 WAP	48.3	55.0	10.0	10.0
Weed infested for 9 WAP	48.3	50.0	76.7	70.0
Weed infested for 12 WAP	53.3	61.7	80.0	85.0
Weed infested for 15 WAP	46.7	43.3	76.7	75.0
Weed free for 3 WAP	31.7	36.7	50.0	63.3
Weed free for 6 WAP	10.0	10.0	26.7	26.7
Weed free for 9 WAP	10.0	10.0	10.0	10.0
Weed free for 12 WAP	10.0	10.0	10.0	10.0
Weed free for 15 WAP	10.0	10.0	10.0	10.0
LSD*	18.25	17.19	18.26	13.97

* $P = 0.05$

Table 6 Effect period of weed interference on weed dry matter production

	Weed dry matter production (kg/ha)					
	grasses		broadleaf species		total	
Treatment	2018	2019	2018	2019	2018	2019
Weed infested for 3 WAP	547	260	282	232	829	493
Weed infested for 6 WAP	2562	2184	624	875	3186	3059
Weed infested for 9 WAP	2903	3388	1036	1542	3939	4931
Weed infested for 12 WAP	3303	3105	1680	2103	4983	5208
Weed infested for 15 WAP	3701	4601	1858	1532	5559	6133
Weed free for 3 WAP	2766	2999	1388	1526	4154	4525
Weed free for 6 WAP	1369	1269	784	1290	2153	2559
Weed free for 9 WAP	257	236	284	303	542	539
Weed free for 12 WAP	167	315	214	217	381	533
Weed free for 15 WAP	225	243	178	170	402	414
LSD*	1196.4	2418.2	740.7	586.0	1420.6	2463.8

* $P = 0.05$

constant weed removal from the plots which did not give the weed opportunity to thrive on the plot. The constant weed removal on the weed free plots resulted in lower values of weeds and higher values for groundnut growth parameters, and consequently, higher pod yield. The results corroborates that of Korav et al. (2018) who reported higher weeds biomass accumulation with increasing length of weed interference period.

Figure 2 show weed growth as affected by period of weed infestation and removal in both years. On the plots weed infested initially, weed dry matter increased with period up to 15 WAT in both years. However, on the plots kept weed-free initially, weed dry matter decreased with increase in weed free period. The figure also show that the highest cumulative weed weight gains of 42.1% occurred between 3 to 6 WAP in both years (Figure 2). The highest weed accumulation between 3 and 6 WAP further explains the reason for the highest yield loss between the periods.

4 Conclusions

The study showed that groundnut pod yield decreased with increase in weed infestation period and increased with increase in weed free period. Conversely, weed dry matter production increased with increase in period of weed infestation and decreased with increase in weed free period. The critical period of weed interference in groundnut is between 3 and 6 WAP as the period witness the highest percent weed accumulation, weed removal, pod yield loss and pod yield gain. Therefore, for optimum

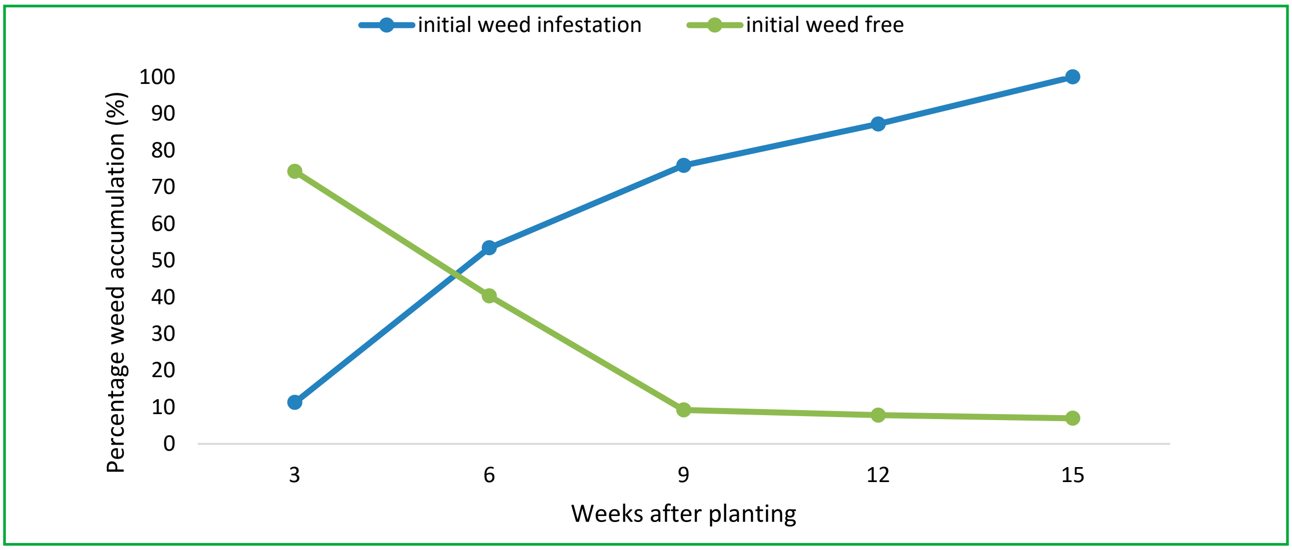

Figure 2 Effect of period of weed infestation and removal on weed accumulation in both years

pod yield production, groundnut should be kept weed free for the first six weeks of production.

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