Journal of Agricultural Sciences (Belgrade) https://doi.org/10.2298/JAS2003225D
Vol. 65, No. 3, 2020 UDC: 635.655:632.51(669)
Pages 225-237 Original scientific paper

THE EFFECT OF THE PERIOD OF WEED INTERFERENCE ON THE GROWTH AND YIELD OF SOYBEAN (*GLYCINE MAX* L. MERRILL)

Olumide S. Daramola[1*], Olusegun R. Adeyemi[1], Joseph A. Adigun[1], Christopher O. Adejuyigbe[2] and Patience M. Olorunmaiye[1]

[1]Department of Plant Physiology and Crop Production,
Federal University of Agriculture Abeokuta, Nigeria
[2]Department of Soil Science, Federal University of Agriculture Abeokuta, Nigeria

Abstract: Field trials were conducted to evaluate the effect of different periods of weed interference on weed infestation, growth and yield of soybean in 2016–2017 cropping seasons. In both years, soybean grain yields ranged from 888–1148 kg ha $^{-1}$ in plots where weeds were allowed to grow until harvest to 2103–2389 kg ha $^{-1}$ in plots where weeds were controlled until harvest, indicating a 52–58% yield loss with uncontrolled weed growth. Weed interference until 3 weeks after sowing (WAS) had no detrimental effect on soybean growth and yield provided the weeds were subsequently removed. However, further delay in weed removal until 6 WAS or longer depressed soybean growth and resulted in irrevocable yield reduction, with the number of pods per plant being the most affected yield component. For optimum growth and yield, it was only necessary to keep the crop weed-free between 3 and 6 WAS.

Key words: weed removal, weed competition, hoeweeding, critical period, soybean yield.

Introduction

Soybean (*Glycine max* L.) is an important economic legume crop, largely cultivated by smallholder farmers in Sub-Saharan Africa (SSA) (Joubert and Jooste, 2013). It plays an important role in the provision of food and nutrition security for millions of people in developing countries and improves the livelihood of farmers through income generation (Abate et al., 2012). Compared with other crops, soybean is a feasible alternative to addressing malnutrition in SSA because of its high protein (>40%) and oil (20%) content as well as its excellent profile of highly digestible amino acids (Joubert and Jooste, 2013). In addition, soybean has the ability to fix nitrogen (44–103 kg ha^{-1} per years) in poor agricultural soils for its

[*]Corresponding author: e-mail: olumidedara01@gmail.com

own use and the benefit of intercropped cereals and subsequent crops in rotation, which makes it the choice crop for soil fertility improvement (Ronner et al., 2016).

Nigeria is the largest consumer and the second largest producer of soybean in SSA. However, Nigeria currently produces only 25% (680,000 tons) of its annual soybean requirement (2.2 million tons) with an average yield of 960 kg ha $^{-1}$ leaving a supply gap of 1.5 million tones (Khojely et al., 2018). Among different factors attributed to the poor yield and productivity of soybean in Nigeria and other parts of SSA, weed infestation appears to be the most deleterious (Imoloame, 2014; Daramola et al., 2020). According to estimates, weeds alone cause an average yield reduction of 37% while other pests and diseases account for 22% of yield losses (Oerke and Dehne, 2004). Depending on the level of weed infestation and infesting weed species, between 77% and 90% of potential soybean yield is lost due to weed infestation in different zones in Nigeria (Imoloame, 2014).

Hoe weeding is the predominant weed management method of smallholder farmers in SSA. However, labour shortage and its high cost are a constraint (Daramola et al., 2019). Consequently, the crops are subjected to heavy weed infestation, or the weeds removed well after the crops have suffered irrevocable yield losses (Chikoye et al., 2007). Herbicide use, on the other hand, is expensive and does not provide season-long weed control (Adigun et al., 2020). In addition, smallholder farmers lack the technical know-how for correct herbicide application. Although the use of herbicides for weed control is effective and efficient, phytotoxicity and environmental problems that might be induced when herbicides are wrongly applied have made the use of post-emergence herbicides less desirable for smallholder farmers in SSA (Labrada, 2003).

All crops have a stage during their life cycle when they are particularly sensitive to weed competition (Knezevic et al., 2003). This period has been regarded as the critical period of weed competition (CPWC). Weed interference before and after the critical period of weed competition does not result in unacceptable yield loss (Knezevic et al., 2002). Appropriate timing of weed control during the critical period of weed competition, therefore, will help farmers to make efficient use of available resources. Although the effects of weed competition on crop growth and yield are well documented, appropriate timing and the number of weeding treatments required to achieve minimum weed competition and maximum yield of soybean are still poorly understood. Hence, the objective of this study was to evaluate the effects of different periods of weed interference on the growth and yield of soybean to determine the appropriate timing of weed management.

Materials and Methods

The experiment was conducted at the Research Farm of the Institute of Food Security, Environmental Resources and Agricultural Research located at latitude 7°

15′ N and longitude 3° 25 ′E in the forest-savanna transition zone of Nigeria during the 2016–2017 cropping seasons. The site received a total rainfall of 669.6 and 544.6 mm in 2016 and 2017, respectively. The soil at the experimental sites was sandy with 89.8% and 87.9% sand, 5.4% and 5.3% silt and 4.8% and 4.6% clay in 2016 and 2017, respectively. The soils had a pH of 7.7 and 7.5; organic matter of 2.5% and 2.1% and nitrogen of 0.17% and 0.15% in 2016 and 2017, respectively. Prior to planting, the experimental site was ploughed and harrowed at a two-week interval while levelling was done manually using a hand hoe. Soybean seeds were sown manually at inter-row and intra-row spacings of 50 cm and 5 cm, respectively. The soybean variety (var. TGX 1448-2E) used in this study is a semi-determinate, late maturing (115–120 days) and high yielding (1.7–2.3 ton ha^{-1}) with good nodulation (Tefera, 2011). The gross and net plot sizes in both years were 4.5 m × 3.0 m and 3.0 m × 3.0 m, respectively. The experimental site was previously fallow land for 1 year after cropping with groundnut (*Arachis hypogea* L.) for the previous years.

The experiments in both years consisted of two sets of treatments in a randomised complete block design. One set consisted of plots initially kept weed-free for 3, 6 and 9 WAS and subsequently kept weed-infested until harvest. The other set of treatments consisted of plots initially kept weed-infested until 3, 6 and 9 weeks after sowing (WAS) and subsequently kept weed-free until harvest. Two treatments of weed-infested and weed-free plots throughout the crop life cycle were also included as the checks (Table 1). Weed density (m^{-2}), weed dry weight ($g\ m^{-2}$), crop vigour score, canopy height (cm), number of leaves and branches per plant, leaf area index, number of pods and seeds per plant, pod and seed weight per plant (g), 100-seed weight (g) and seed yield (kg) were the parameters used to evaluate the performance of the treatments in both years. Crop vigour score was taken by visual observation based on the scale 0–10, where 0 represented plots with crops completely killed and 10 represented plots with the most vigorous growing and healthy crop (Adigun et al., 2018). Soybean dry weight was determined from five plants by destructive sampling within the net plot. The plants were uprooted and then oven-dried at 70°C until a constant weight was obtained. The crop growth rate was calculated as proposed by Hunt (1978), as indicated below:

$$crop\ growth\ rate = \frac{W2 - W1}{T2 - T1} \quad (1)$$

Where W1 and W2 are values of dry weight at times T1 (6 weeks after sowing) and T2 (12 weeks after sowing), respectively. Leaf area index (LAI) was calculated following the formula of Watson (1947), as follows:

$$LAI = \frac{Leaf\ area\ per\ plant\ (cm^2)}{Ground\ area\ per\ plant\ (cm^2)} \quad (2)$$

Table 1. The details of the duration of weed interference treatments.

Treatments	Details
WR3	Weed removal until 3 weeks after sowing
WR6	Weed removal until 6 weeks after sowing
WR9	Weed removal until 9 weeks after sowing
WRH	Weed removal until harvest
WI3	Weed interference until 3 weeks after sowing
WI6	Weed interference until 6 weeks after sowing
WI9	Weed interference until 9 weeks after sowing
WIH	Weed interference until harvest

Weeds were removed by a hand hoe at the required time and weekly intervals thereafter. Weed cover score for each treatment was evaluated by visual observation before weed removal based on a rating scale of 1 to 10, where 1 represents a complete weed-free situation while 10 represents a complete weed cover (Adigun et al., 2017). In the weed-free treatment, weeds were removed at weekly interval throughout the growing season. Weeds were sampled from two quadrats of 0.5m × 0.5m size before any weeding was done and cumulative weed dry weight produced was recorded at harvest. Weeds were sampled by cutting them at the ground level. Weed density was taken by physically counting the number of weeds in the quadrats, and these were dried in an oven at 70°C for 72h. Soybean seeds were harvested manually per plot when 95% of plants had 80% mature pods. Seed yield from the net plot was converted to kg ha^{-1} at 12% moisture content.

Data were subjected to analysis of variance using the GenStat (VSN International Ltd, Hempstead UK) discovery package to determine the level of significance of the treatments. The treatment means were separated using the least significant difference (LSD) at $p \leq 0.05$ probability level.

Results and Discussion

The effect of the duration of weed interference on weed growth in soybean

The experimental sites in 2016 and 2017 were infested with weeds such as *Tridax procumbens*, *Euphorbia heterophylla*, *Commelina benghalensis, Gomphrena celosioides*, *Digitaria horizontalis, Panicum maximum*, *Cynodon dactylon*, *Eleusine indica*, *Rottboellia cochinchinensis*, *Cyperus rotundus*, etc. However, some of the weed species such as *Euphorbia heterophylla*, *Commelina benghalensis*, *Gomphrena celosioides*, *Digitaria horizontalis* and *Panicum maximum* with a moderate infestation (30–59%) in 2016 were found with a high infestation (60–90%) in 2017 (Table 2). This was possible because of more evenly distributed rainfall experienced in 2017 than in 2016 (Figure 1). In 2016, more than

57% of the season rainfall occurred between September and October when the crops were already well established and able to smother emerging weed species.

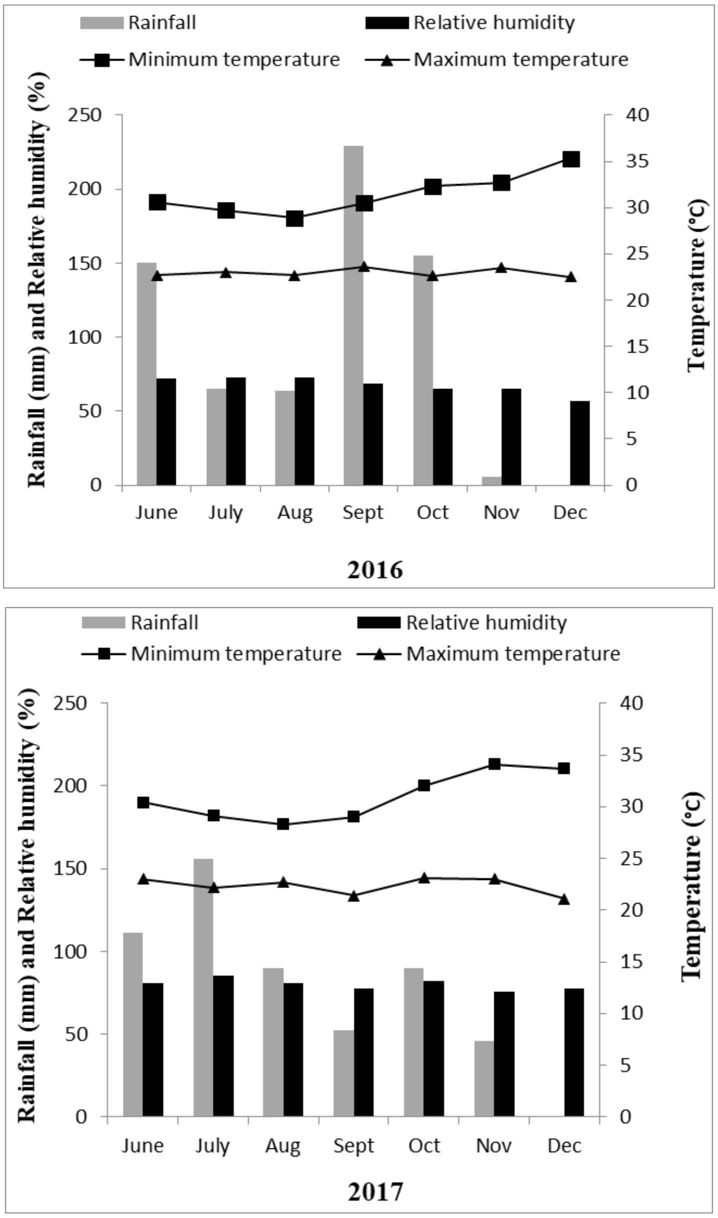

Figure 1. Weather data during the period of crop growth in 2016 and 2017.

Table 2. Weed species and the level of infestation during the experiment in 2016 and 2017.

Weed species	Plant family	Level of infestation	
		2016	2017
Broad leaves			
Amaranthus spinosus (Linn.)	Amaranthaceae	MI[a]	MI
Boerhavia diffusa (Linn.)	Nyctaginaceae	MI	HI
Commelina benghalensis (Burn.)	Commelinaceae	MI	HI
Euphorbia heterophylla (Linn.)	Euphorbiaceae	HI	HI
Gomphrena celosioides (Mart.)	Amaranthaceae	MI	HI
Spigelia anthelmia (Linn.)	Loganiaceae	HI	HI
Tridax procumbens (Linn.)	Asteraceae	MI	HI
*Chromolaena odorata (*L.) R.M. King and Robinson	Asteraceae	MI	HI
Talinum triangulare (Jacq.) Willd.	Portulacaceae	MI	MI
Grasses			
Digitaria horizontalis (Willd.)	Poaceae	MI	MI
Panicum maximum (Jacq.)	Poaceae	MI	MI
Axonopus compressus (Sw.) P. Beauv	Poaceae	MI	MI
Eleusine indica (Gaertn.)	Poaceae	MI	MI
Rottboellia cochinchinensis (Lour.) Clayton	Poaceae	LI	LI
Cynodon dactylon (L) Gaertn	Poaceae	MI	MI
Paspalum scrobiculatum (Linn.)	Poaceae	MI	MI
Sedges			
Cyperus rotundus (Linn.)	Cyperaceae	MI	MI
Cyperus esculentus (Linn.)	Cyperaceae	MI	MI

[a] LI = Low infestation 1–29%; MI = Moderate infestation 30–59%; HI = High infestation 60–90%.

However, in 2017, higher rainfall was recorded in July during the early period of crop growth, which encouraged high weed infestation from the start of the season, when the crops were less competitive against weeds. It has been reported that rainfall affects weed species distribution and their competitiveness within a weed community (Vitorino et al., 2017).

In both years, the duration of weed interference significantly affected weed cover score, weed density and weed dry matter (Table 3). Weed cover score increased significantly with increasing duration of weed interference and decreased significantly with increasing duration of weed removal from 3 WAS until harvest in both years (Table 3). Weed density and dry matter were similar between plots where weeds were allowed to infest the crops until 3 WAS only (WI3) and where weeds were removed until 6 (WR6) and 9 (WR9) WAS in both years. However, allowing weeds to infest the crops until 6 WAS (WI6) or longer significantly increased weed density by 66–86% and weed dry matter by 74–144% compared with plots where weeds were controlled until 6 WAS (WR6) in both years. Weed density and dry matter were also similar between plots where weeds were allowed to infest the crops until 6 (WR6) and 9 (WR9) WAS. Similarly, weed density and dry matter were similar between plots where weeds were removed until 3 WAS (WR3) only and those where weeds were allowed to grow until 6 WAS (WI6), 9 (WI9) and until the harvest (WIH). This trend suggests that rapid weed growth and critical weed-crop interference in soybean were between 3 and 6 WAS. This result is similar to the observation of Osipitan et al. (2013) in cowpea.

Table 3.The effect of the duration of weed interference on weed cover score, weed density and weed dry weight in 2016 and 2017.

	Weed cover score		Weed density (no m^{-2})		Weed dry weight (kg ha^{-2})	
	2016	2017	2016	2017	2016	2017
WR3	8.2	8.7	45.6	64.3	3024	3697
WR6	5.2	6.5	30.3	32.3	1400	2213
WR9	4.2	5.5	25.8	30.7	1413	2127
WI3	3.1	4.4	26.7	29.0	1863	2677
WI6	3.3	4.5	50.5	56.9	3033	3847
WI9	8.1	6.4	55.7	57.1	3117	3897
WIH	8.9	8.5	56.5	58.6	3410	3813
Lsd ($p<0.05$)	0.33	0.82	7.9	8.2	468.5	480.4

WR3 – Weed removal until 3 weeks, WR6 – Weed removal until 6 weeks, WR6 – Weed removal until 9 weeks, WI3 – Weed interference until 3 weeks, WI6 – Weed interference until 6 weeks, WI9 – Weed interference until 9 weeks, WIH – Weed interference until harvest, Lsd – Least significant difference.

The effect of the duration of weed interference on the growth and yield of soybean

Duration of weed interference had a significant effect on all the growth and yield parameters of soybean in 2016 and 2017 (Tables 4 and 5). Canopy height, number of leaves and branches, crop vigour, leaf area index, dry weight, crop growth rate, number of pods and seeds per plant, 100-seed weight, pod and seed weight per plant and grain yield of soybean were similar between plots where weeds were allowed to grow until 3 WAS only (WI3) and where weeds were controlled until harvest (WRI) in both years (Tables 4 and 5). This showed that weed infestation for only 3 WAS had no detrimental effect on soybean growth and yield probably because weeds were not yet well established and hence reduced competitiveness at this time. Only grass weed seedlings and few annual broad-leaved weeds were present at this initial stage of crop growth. Such weeds, with an only rudimentary root system and few leaves, could not compete vigorously with the crop. This result is contrary to the report of Periera et al. (2015) that weed infestation from 7 days after emergence was detrimental to soybean grain yield in a study conducted in Brazil, where the main infesting weed species were *Digitaria* *horizontalis* and *Ipomea grandifolia*. Such difference in the effect of weed interference on soybean grain yield in the present study may be due to differences in soybean cultivars, locations, soil types, infesting weed species, soil moisture regimes and prevailing agro-climatic conditions. Our results, however, corroborate the previous findings of Osipitan et al. (2013) and Adigun et al. (2017) who reported that weed infestation for the first 3 WAS did not have any adverse effects on crop yield in a study conducted in the forest-savanna transition agro-ecological zone of Nigeria.

Table 4.The effect of the duration of weed interference on soybean growth in 2016 and 2017.

	Crop vigour score		Canopy height (cm)		Number of branches		Number of leaves		Leaf area index		Dry weight (g/plant)		Crop growth rate	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2016
Duration of weed interference														
WR3	4.6	3.6	86.6	84.0	6.4	6.3	16.0	14.6	2.01	2.03	27.4	27.0	0.34	0.33
WR6	7.7	7.8	97.2	94.5	8.3	7.6	33.0	31.6	3.18	3.08	40.1	39.4	0.54	0.52
WR9	7.8	7.5	99.6	96.0	8.4	7.9	33.0	31.6	3.15	3.05	41.5	41.8	0.53	0.52
WRH	8.1	7.6	100.2	98.5	8.3	7.6	33.3	32.0	3.15	3.03	40.2	39.7	0.55	0.54
WI3	6.3	5.6	98.3	96.6	8.3	7.7	29.0	27.6	2.91	2.43	40.5	40.1	0.56	0.54
WI6	5.5	5.0	86.4	84.7	7.0	6.6	20.3	19.0	2.12	2.13	28.7	23.1	0.34	0.33
WI9	4.7	4.2	81.8	79.2	6.6	6.3	14.0	12.6	2.10	2.04	26.8	25.2	0.33	0.33
WIH	4.4	3.8	83.3	80.6	6.7	6.1	13.0	11.7	2.04	2.06	27.2	25.0	0.32	0.34
Lsd ($p<0.05$)	0.32	0.43	5.82	5.74	0.43	0.37	4.3	4.6	0.17	0.18	2.2	2.6	0.06	0.06

WR3 – Weed removal until 3 weeks, WR6 – Weed removal until 6 weeks, WR6 – Weed removal until 9 weeks, WRH – Weed removal until harvest, WI3 – Weed interference until 3 weeks, WI6 – Weed interference until 6 weeks, WI9 – Weed interference until 9 weeks, WIH – Weed interference until harvest, Lsd – Least significant difference.

In this study, allowing weeds to grow until 6 WAS (WI6) or longer resulted in a significant reduction in all the growth and yield parameters of soybean compared to plots where weeds were controlled until the harvest (WRH) (Tables 4 and 5). The number of leaves of soybean was reduced by 38–40% with increasing duration of weed interference until 6 WAS (WI6) and by 57–63% with increasing duration of weed interference until 9 WAS (WI9) compared to the weed-free treatment. Similarly, crop vigour was reduced by 31–34% with increasing duration of weed interference until 6 WAS (WI6) and by 42–45% with increasing duration of weed interference until 9 WAS (WI9) compared to the weed-free treatment in both years. Weed interference until 6 WAS (WI6) reduced the number of branches by 13–20%, leaf area index by 32–35%, dry weight of soybean by 29–40% and the crop growth rate by 37–42% compared to the weed-free treatment in both years. Allowing the weeds to remain in the plots until 6 WAS (WI6) or longer reduced the number of pods by 52–60%, number of seeds by 25–29%, 100-seed weight by 13–16%, pod weight by 43–50%, seed weight by 28–39% and grain yield of soybean by 49–56%. Rapid weed growth occurred between 3 and 6 weeks after sowing. Hence, the reduction in growth and yield observed may be attributed to increased weed competition for growth resources. The previous findings of Khaliq et al. (2012) have shown that there is limited use of resources (moisture, light and nutrients) for crop growth and yield as a result of increased weed competition. Our result also corroborates the report of Mohammadi and Amiri (2011) that increasing the period of weed interference resulted in a drastic yield reduction. In this study, the number of pods per plant was the yield component most affected by weed interference, while the number of seeds per pod was not affected by season-long weed interference. This result is similar to that of Van Acker et al. (1993). It is possible that the reduction in the number of branches due to weed interference resulted in the reduced number of soybean pods per plant, whereas the number of seeds per pod was maintained.

Table 5.The effect of the duration of weed interference on yield and yield components of soybean in 2016 and 2017.

	Number of pods/plant		Number of seeds/plant		Numberof seeds/pod		Pod weight		100-seed weight		Seed weight		Seed yield	
							Kg ha^{-1}							
Treatments	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Weed interference														
WR3	63.8	61.0	216.0	170.5	2.7	2.7	19.4	17.2	8.8	8.6	16.3	14.8	1103	1079
WR6	123.5	104.4	277.1	201.6	2.8	2.4	29.2	29.0	10.4	10.0	25.2	21.2	2322	2038
WR9	120.6	101.7	267.2	196.9	2.8	2.3	27.7	24.0	10.4	9.8	24.5	20.5	2358	2056
WRH	122.5	102.2	260.4	191.1	2.8	2.3	28.9	26.6	10.3	9.8	24.3	20.4	2389	2103
WI3	119.9	102.0	255.0	190.9	2.6	2.3	29.5	27.7	10.1	9.9	23.8	19.8	2312	1901
WI6	53.8	51.1	182.3	149.2	2.7	2.4	16.9	16.0	8.8	8.7	16.2	15.3	1299	1019
WI9	53.5	50.1	144.2	142.1	2.6	2.3	16.5	16.5	8.7	8.5	15.6	14.2	1187	979
WIH	49.3	48.6	142.4	143.2	2.8	2.4	14.8	16.4	8.5	8.6	15.3	14.3	1148	888
Lsd ($p<0.05$)	4.7	3.0	15.1	12.1	3.6ns	1.9ns	2.2	1.6	0.4	0.2	1.8	1.8	153.2	134.8

WR3 – Weed removal until 3 weeks, WR6 – Weed removal until 6 weeks, WR6 – Weed removal until 9 weeks, WRH – Weed removal until harvest, WI3 – Weed interference until 3 weeks, WI6 – Weed interference until 6 weeks, WI9 – Weed interference until 9 weeks, WIH – Weed interference until harvest, Lsd – Least significant difference.

In this study, weed removal for only 3 WAS did not increase all the growth and yield parameters of soybean significantly compared with crops weed-infested until the harvest (WIH) in both years (Tables 4 and 5). However, weed removal until 6 WAS (WR6) or longer resulted in a significant increase in soybean growth and yield compared to weed interference until 6 WAS (WI6) or beyond (Tables 4 and 5). Allowing weeds to remain in the crops until 6 WAS (WI6) and subsequently removing the weeds did not obviate growth and yield depression of the crop compared to crops weed-infested until the harvest. Weed density and dry matter in plots where weeds were allowed to remain in the crop until 6 WAS did not differ significantly from those where weeds were allowed to remain in the plots until 9 WAS or throughout the crop life cycle. Hence, their subsequent removal was therefore not expected to alleviate crop growth. On the other hand, weed removal until the harvest (WRH) did not improve all the growth and yield parameters of soybean significantly compared to weed removal for only 6 or 9 WAS in both years. This was probably a result of soybean canopy closure which could have limited light penetration to weeds emerging below the leaves thereby reducing late-season weed competition and giving the crop a competitive advantage over weeds coming later in the seasons (Steckel and Sprague, 2004). These results are similar to the previous findings of Imoloame (2014), who reported that if weeds were controlled within the first 5 weeks after sowing, the canopy of soybean can suppress late-emerging weeds.

Our study has shown that soybean can tolerate weed infestation until 3 WAS and beyond 6 WAS without causing any significant reduction in soybean growth and yield compared to crops kept weed-free until the harvest. Hence, weed removal between 3 and 6 weeks after sowing was sufficient to maintain maximum grain yield. This period coincided with the period of maximum weed growth and the most significant difference in leaf area index and dry matter production between weed-infested and weed-free soybean. This suggests that the leaf area index and dry matter production are indicators of the detrimental effect of weed interference on soybean grain yield.

Conclusion

The results of this study have shown that soybean can tolerate weed infestation until 3 WAS and beyond 6 WAS without causing any significant reduction in growth and yield compared to crops kept weed-free until harvest. Hence, weed removal between 3 and 6 weeks after sowing was sufficient to maintain maximum grain yield. This period coincided with the period of maximum weed growth and the most significant difference in leaf area index and dry matter production between weed-infested and weed-free soybean. This suggests that the leaf area index and dry matter production are indicators of the detrimental effect of weed interference on soybean grain yield. The establishment of maximum leaf area index and good branching ability could enhance soybean competitiveness against weeds. However, weed removal between 3 and 6 weeks after sowing is crucial for optimum grain yield.

References

Abate, T., Alene, A., & Bergvinson, B. (2012). *Tropical Grain Legumes in Africa and South Asia: Knowledge and Opportunities*. Nairobi, Kenya: ICRISAT.

Adigun, J.A., Daramola, O.S., Adeyemi, O.R., Olorunmaiye, P.M., Osipitan, O.A., & Idiodemise, O. (2017). Effects of Row-Spacing and Period of Weed Interference on Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp). *Nigerian Journal of Ecology, 16* (2), 88-100.

Adigun, J.A., Daramola, O.S., Adeyemi, O.R., Olorunmaiye, P.M., & Osipitan, O.A. (2018). Nitrogen and weed management in transplanted tomato in the Nigerian forest-savanna transition zone. *Annals of Agrarian Science, 16,* 281-285.

Adigun, J.A., Adeyemi, O.R., Daramola, O.S., & Olorunmaiye, P.M. (2020). Response of cowpea to inter-row spacing and weed competition. *Agricultura Tropica et Subtropica, 53* (2), 73-79.

Chikoye, D., Ellis-Jones, J., Riches, C., & Kanyomeka, L. (2007). Weed management in Africa: experiences, challenges and opportunities. XVI International Plant Protection Congress. (pp. 652-653). Glassgow, Scotland, UK

Daramola, O.S., Adeyemi, O.R., Adigun, J.A., & Adejuyigbe, C.O. (2019). Economics of row spacing and integrated weed management in soybean. *Journal of Agricultural Sciences (Belgrade), 64* (3), 265-278.

Daramola, O.S., Adeyemi, O.R., Adigun, J.A., & Adejuyigbe, C.O. (2020). Weed interference and control as affected by row spacing in the transition zone of south west Nigeria. *Journal of Crop Improvement, 34* (1), 103-121.

Hunt, R. (1978). *Plant Growth Analysis*. Edward Arnold, London.

Imoloame, E.O. (2014). The effects of different weed control methods on weed infestation, growth and yield of soybeans (*Glycine max* (L) Merrill) in the southern guinea savanna of Nigeria. *Agro search, 14* (2), 129-143.

Joubert, J.C.N., & Jooste, A.A. (2013). Comparative analysis of different regions of South Africa Soybean industry.*Proceedings of the World Soybean Research Conference IX,* (pp. 1-11). Urban, South Africa.

Khaliq, A.A., Matloob, S., Mahmood, R.N., Abbas, M.B., & Khan, K. (2012). Seeding density and herbicide tank mixture furnishes better weed control and improve the growth, yield and quality of direct seeded fine rice. *International Journal of Agricultural Biology, 14,* 499-508.

Khojely, D.M., Ibrahim, S.E., Sepey, E., & Han, T. (2018). History, current status, and prospect of soybean production and research in sub-Saharan Africa. *The crop Journal*, *6*, 226-235

Knezevic, S.Z., Evans, S.P., Blankenship, E.E., Van Acker, R.C., & Lindquist, J.L. (2002). Critical period for weed control: the concept and data analysis. *Weed Science, 50,* 773-786.

Knezevic, S.Z., Evans, S.P., & Mainz, M. (2003). Row spacing influences the critical timing for weed removal in soybean (*Glycine max*) *Weed Technology, 17* (4), 666-673.

Labrada, R. (2003). The need for improved weed management in rice. In: Van Tran, Dat, Duffy, R. (Eds.), Sustainable Rice Production for Food Security 2003. *Proceedings of the 20th Session of the International Rice Commission Bangkok, Thailand.* (pp. 1-11). FAO, Rome, Italy.

Mohammadi, G.R., & Amiri, F. (2011). Critical period of weed control in soybean (*Glycine max*) as influenced by starter fertilizer. *Australian Journal of Crop Science, 5* (11), 1350-1355

Nikoa, R.M., Owen, D.K., & Swanton, C.J. (2015). Weed Abundance, Distribution, Diversity, and Community Analyses. *Weed Science*, *63*, 64-90.

Oerke, E.C., & Dehne, H.W. (2004). Safeguarding production-losses in major crops and the role of crop protection. *Crop Production*, *23*, 275-285.

Osipitan, O.A., Adigun, J.A., Lagoke, S.T.O., & Afolami, S.O. (2013). Effect of inter-row spacing and weed control methods on growth and yield of cowpea (*Vigna unguiculata* L. Walp) in South Western Nigeria. *Nigeria Journal of Plant Protection, 27*, 97-111.

Periera, F.A.R., Bono, J.A.M., Neto, J.F.R., Silveira, D.S., Berselli, C., & Carvalho, T. (2015). Period of competition between weeds and soybean crop in Cerrado. *African Journal of Agricultural Research, 10* (37), 3644-3649.

Ronner, E., Franke, A.C., Vanlauwe, B., Diande, M., Edeh, E., Ukem, B., Bala, A., Van Heerwaarden, J., & Giller, K.E. (2016). Understanding variability in soybean yield and response to P-fertilizer and rhizobium inoculants on farmers' field in northern Nigeria, *Field Crop Research, 186*, 33-145.

Steckel, L.E., & Sprague, C.L. (2004). Late season common water hemp (*Amaranthus rudis*) interference in narrow- and wide-row soybean. *Weed Technology, 18,* 947-952.

Suryanto, P., Sulistyaningsih, E., Putra, E.T.S., Kastono, D., & Taufan, A. (2017). Estimation of critical period for weed control in soybean on agro-forestry system with kayu Putih. *Asian Journal of Crop Science, 9* (3), 91-105.

Tefera, H. (2011). Breeding for promiscuous soybean at IITA, In: A. Sudaric (Ed.), *Soybean-Molecular Aspect of Breeding*, In Tech, Rijeka, Croatia.

Van Acker, R.C., Weise, S.F., & Swanton, C.J. (1993). Influence of interference from mixed weed species on soybean (*Glycine max* (L.) Merr.) growth. *Canadian Journal of plant Science, 73*, 1293-1304.

Vitorino, H.S, Silva, A.C., Gonçalves, C.G., & Martins, G. (2017). Interference of a weed community in the soybean crop in functions of sowing spacing. *Revista Ciência Agronômica*, *48* (4), 605-613.

Watson, D.J. (1947). Comparative physiological studies in the growth of field crops. I. Variation in net assimilation rate and leaf area between species and varieties, and within and between years. *Annals of Botany*, *11*, 41-76.

Received: August 29, 2019
Accepted: July 2, 2020

UTICAJ DUŽINE PRISUSTVA KOROVA NA RAST I PRINOS SOJE (*GLYCINE MAX* L. MERRILL)

Olumide S. Daramola[1*], Olusegun R. Adeyemi[1], Joseph A. Adigun[1], Christopher O. Adejuyigbe[2] i Patience M. Olorunmaiye[1]

[1]Odsek za fiziologiju biljaka i proizvodnju useva,
Federalni poljoprivredni univerzitet Abeokuta, Nigerija
[2]Odsek za nauku o zemljištu, Federalni poljoprivredni univerzitet Abeokuta, Nigerija

R e z i m e

Poljski ogledi su sprovedeni kako bi se ocenio uticaj različite dužine prisustva korova na zakorovljenost, rast i prinos soje u 2016. i 2017. sezoni gajenja. Tokom obe godine, prinosi zrna soje kretali su se od 888–1148 kg ha^{-1} u parcelama gde su korovi bili prisutni do žetve soje, do 2103–2389 kg ha^{-1} u parcelama gde su korovi kontrolisani do žetve, ukazujući na gubitak prinosa od 52% do 58% pri nekontrolisanom rastu korova. Prisustvo korova do 3 nedelje posle setve nije štetno uticalo na rast i prinos soje pod uslovom da su korovi naknadno suzbijeni. Međutim, dalje odlaganje uklanjanja korova do 6 nedelja posle setve ili duže smanjilo je rast soje i vodilo do nepovratnog smanjenja prinosa, sa brojem mahuna po biljci kao najviše pogođenoj komponenti prinosa. Za optimalni rast i prinos, neophodno je da se korovi uklone između 3 i 6 nedelja posle setve.

Ključne reči: uklanjanje korova, kompeticija korova, okopavanje, kritični period, prinos soje.

Primljeno: 29. avgusta 2019.
Odobreno: 2. jula 2020.

*Autor za kontakt: e-mail: olumidedara01@gmail.com