THE EFFECT OF WEED CONTROL TIMING ON THE GROWTH AND YIELD OF UPLAND RICE (*ORYZA SATIVA* L.)

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Abstract: Weed interference is a major threat to rice production, leading to high yield reduction and reduced profitability. Therefore, field experiments were conducted to evaluate the effect of the different timings of weed control on the growth and yield of upland rice in the 2015 and 2016 cropping seasons. The treatments consisted of periods when the crop was allowed to be weed-infested for the first 3, 6 and 9 weeks after sowing (WAS) and periods when the weeds were controlled for the first 3, 6 and 9 WAS. Two treatments of weed infestation and weed control until harvest were also included as the checks in a randomized complete block design with three replications. In both years, rice grain yields ranged from 0.6 to 0.8 t ha^{-1} in plots kept weed-infested until harvest, and from 3.5 to 3.9 t ha^{-1} in plots kept weed-free until harvest, indicating a 79–83% yield loss with uncontrolled weed growth. Weed infestation for the first 3 WAS did not cause a significant reduction in the growth and yield of rice provided the weeds were removed thereafter. However, the delay in weed control until 9 WAS reduced rice growth and resulted in irrevocable yield reduction. It was only necessary to remove the weeds between 3 and 9 WAS for optimum grain yield, as no significant yield increase was observed in weed control after 9 WAS in both years. This study showed that weed control between 3 and 9 WAS would give the optimum growth and yield of upland rice.

Key words: critical period, grain yield, hoe weeding, weed infestation, weed removal.

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Introduction

Rice (*Oryza sativa* L.) is the most important food crop of the developing world and the staple food of more than half of the world's population (Johnson et al., 2013). It is largely grown by smallholder farmers throughout Africa, where it serves as a major source of food and livelihood to farmers (Takeshima and Bakare, 2016; Kolo et al., 2021). Rice is the second most important staple food in Nigeria, accounting for 10.5% of the average caloric intake (FAO, 2019) and 6% of household expenses (Johnson et al., 2013). It is the most rapidly expanding food commodity both in terms of consumption and production, and, therefore, an important crop for food security, poverty alleviation and income generation for smallholder farmers (Johnson and Ajibola, 2016).

Nigeria is the largest consumer and the second-largest producer of rice in Africa (USDA-ERS, 2019). However, Nigeria currently produces only 5.8 million tons, well below its annual rice requirement of 7.9 million tons, making Nigeria the second-largest importer of rice after China with an average of 2.4 million metric tons a year (Durand-Morat et al., 2019; FAO, 2019). Despite its increased importance and demand, the average rice yield in Nigeria (2.0 t ha^{-1}) is only about half of the global average yield (5.4 t ha^{1}) and far below Egypt's 9.5 t ha^{-1}(Durand-Morat et al., 2019). Numerous factors, including biotic, abiotic and poor cultural practices, are responsible for the low productivity of rice in Nigeria (Rodenburg and Johnson, 2009; Adeyemi et al., 2017; Daramola et al., 2020a). Among these, a biotic factor such as weed interference is particularly one of the principal constraints that have consistently contributed to severe yield losses in rice (Adigun et al., 2017). Weeds compete with rice for growth resources such as water, light, and nutrients (Adeyemi et al., 2017). Weed competition in rice has been reported to result in a high yield reduction of up to 90% (Rodenburg and Johnson, 2009; Adigun et al., 2017).

Smallholder farmers control weeds in rice predominantly by manual hand weeding. However, labour shortage and its high cost are a major constraint. Consequently, the crops are subjected to heavy weed infestation, or the weeds are removed well after the crops have suffered irrevocable yield losses (Waddington et al., 2010; Adigun et al., 2017). Although the use of herbicides is efficient, they do not provide season-long weed control when used alone, and a single herbicide application may not control the entire weed spectrum with diverse physiology, morphology, and time of emergence (Labrada, 2003; Khaliq et al., 2014; Daramola, 2020). In addition, smallholder farmers lack the technical know-how for correct herbicide application. 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 (Labrada, 2003).

There is a stage during the period of crop growth when crops are the most sensitive to weed competition. This period has been regarded as the critical period of weed competition (Knezevic et al., 2003). Weed interference before or after the critical period of weed competition does not result in significant yield loss (Knezevic et al., 2003). Appropriate timing of weed removal during the critical period of weed competition, therefore, will help growers to efficiently use the available resources. In the Philippines, Chauhan and Johnson (2011) reported that the critical period of weed removal in rice was between 18 and 52 days after sowing. Johnson et al. (2004) have reported that to maintain optimum rice yield, a weed removal period between 29 and 32 days in the wet season and between 4 and 32 days in the dry season is required. However, appropriate timing and the duration of weeding required to achieve minimum weed competition and maximum rice yield in Nigerian conditions are still poorly understood. The results reported from other environments might not be applicable to all situations because of differences in soil, weed populations and prevailing weed species. Hence, the objective of this study was to evaluate the effect of different timings of weed control on the growth and yield of upland rice in the forest-savanna transition zone of Nigeria.

Material and Methods

Field experiments were conducted during the cropping seasons of 2015 and 2016 at the Research Farm, Institute of Food Security Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta at latitude 7° 15ʹ N and longitude 3° 25 ʹE in the tropical forest-savanna transition zone of Nigeria. The rainfall pattern at the experimental site is bimodal, with peaks in July and September. During the crop growing season, total rainfalls were 521.3 and 584.1 mm, the mean temperatures were 24.8 °C and 26.7 °C in 2015 and 2016, respectively. The soil at the experimental sites was classified as sandy loam Oxic Paleudulf with 6.7 and 6.9% organic matter, 0.14 and 0.18 cmol kg^{-1} total nitrogen and pH of 6.7 and 6.9 in 2015 and 2016, respectively in the top 20 cm. The site was cleared manually, and plowing and harrowing were done mechanically at a two-week interval. Rice variety (NERICA 2) was sown manually by drilling at the inter-row spacing of 50 cm. Each subplot was 13.5 m^2 in size.

The treatments consisted of periods when the crop was allowed to be infested with weeds for the first 3, 6 and 9 weeks after sowing (WAS) and periods when the weeds were removed for the first 3, 6 and 9 WAS. Two treatments of weed infestation and weed removal until harvest were also included as the checks in a randomized complete block design with three replications. Weed removal was done manually using a hand hoe following the treatments (Table 1).

Data on weed density (No m^{-2}) and dry biomass (g m^{-2}) were taken from a 50-cm^2 quadrat randomly placed at three spots within each plot. Weeds sampled from the quadrat were counted, oven-dried at 70°C until constant weight, and dry

biomass was recorded. The weed cover score for each treatment was evaluated by a visual rating based on a scale of 1 to 100%, where the value of 1% represents plots with no weed cover while the value of 100% represents plots that were fully covered with weeds (Kercher et al., 2003; Nikoa et al., 2015). Data on rice were collected from 10 tagged plants within the net plot (9 m^2) at 80 days after planting to determine plant height (cm plant^{-1}), number of tillers (number m^{-1}), leaf area and leaf area index (LAI). LAI was calculated following the formula of Watson (1947):

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

(1)

The crop vigour score was evaluated by visual rating on a scale of 1–10, where 0 represented plots with dead or least vigorous crops while 10 represented plots with the most vigorous crop (Nikoa et al., 2015). Rice was harvested manually, and grain yield from each plot was recorded at 14% moisture content and expressed in t ha^{-1}. During harvesting, 10 hills were selected within the net plot for measuring panicle length (cm), panicle weight (g), and number of grains per panicle. Data were expressed as mean ± standard deviation (SD) and subjected to analysis of variance (ANOVA) using a mixed model procedure of SAS JAM12. A replicate effect was considered random, whereas the timing of weed control was considered a fixed effect. Means were compared with Tukey's honest significant difference [HSD] (P≤ 0.05).

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

Treatments	Details
WI3	Weed-infested until 3 WAS
WI6	Weed-infested until 6 WAS
WI9	Weed-infested until 9 WAS
WIH	Weed-infested until harvest
WF3	Weed-free until 3 WAS
WF6	Weed-free until 6 WAS
WF9	Weed-free until9 WAS
WFH	Weed-free until harvest

Results and Discussion

Weed species composition

Sixteen weed species were recorded during the period of crop growth in 2015 and 2016. The weed species comprised eight types of broadleaf weeds, six types of grasses, and two types of sedges (Table 1). The prevalence of both annual and perennial broadleaf weeds and grasses in this study may be as a result of the high disturbance environment that favors them (Menallad et al., 2001; Daramola et al.,

2021). However, there were differences in the level of weed infestation between the two years. The level of infestation of some weed species such as *Euphorbia heterophylla, Cyperus rotundus, Panicum maximum, Talinum triangulare* and *Digitaria horizontalis* was moderate in 2015 but increased to a higher level in 2016 (Table 2). Variation in the level of weed infestation between the two years may be attributed to rainfall differences. The rainfall was generally more abundant and evenly distributed in 2016 than in 2015. It has been reported that rainfall affects weed species distribution and their competitiveness within a crop community (Shaidul et al., 2011).

Table 2. Weed species and the level of infestation during the experiment in 2015 and 2016.

Weed species	Plant family	Life cycle	Level of infestation	
			2015	2016
Amaranthus spinosus Linn.	Amaranthaceae	Annual broadleaf	MI[a]	MI
Boerhavia diffusa Linn.	Nyctaginaceae	Perennial broadleaf	MI	HI
Commelina benghalensis Burn.	Commelinaceae	Perennial broadleaf	MI	HI
Euphorbia heterophylla Linn.	Euphorbiaceae	Annual broadleaf	MI	HI
Gomphrena celosioides Mart.	Amaranthaceae	Annual broadleaf	MI	HI
Tridax procumbens Linn.	Asteraceae	Annual broadleaf	MI	HI
Chromolaena odorata (L.) R.M. King and Robinson	Asteraceae	Perennial broadleaf	MI	HI
Talinum triangulare(Jacq.) Willd.	Portulacaceae	Perennial broadleaf	MI	MI
Digitaria horizontalis Willd.	Poaceae	Annual grass	MI	MI
Panicum maximum Jacq.	Poaceae	Perennial grass	MI	HI
Paspalum scrobiculatum (Linn.)	Poaceae	Perennial grass	MI	MI
Axonopus compressus (Sw.) P. Beauv	Poaceae	Perennial grass	MI	MI
Eleusine indica Gaertn.	Poaceae	Annual grass	MI	MI
Cynodon dactylon (L.)Gaertn	Poaceae	Perennial grass	MI	MI
Cyperus rotundus	Cyperaceae	Perennial sedge	MI	HI
Cyperus esculentus	Cyperaceae	Perennial sedge	MI	MI

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

The effect of weed control timing on weed cover score, weed density, and weed biomass

Weed control timing had a significant effect on weed cover score, weed density, and weed biomass in 2015 and 2016 (Table 2). In both years, weed cover score, weed density, and weed biomass increased significantly with an increasing period of weed infestation and *vice versa* with an increasing weed-free period from 3 to 9 WAS (Table 3). Thereafter, there was no significant increase in weed cover, weed density, and weed biomass with an increasing period of weed infestation until harvest (WIH). This was probably due to the lower growth rate of weeds during the

final stage of their life cycle and the increased shading by rice which might have limited light penetration for weed germination (Khaliq et al., 2014). This result supports the findings of Satorre and Slaffer (1999), and Daramola et al. (2019a, b), who reported that weed growth and aggressiveness decreased during the final stage of their life cycle. Weed cover score, weed density and weed biomass were similar between plots where weeds were allowed to grow until 3 WAS (WI3) and where weeds were controlled until 9 WAS (WC9). However, allowing weeds to infest the crops until 6 or 9 WAS significantly increased weed cover by 19–160%, weed density by 68–378%, and weed biomass by 46–353%, compared to plots where weeds were controlled until 9 WAS (WC9) in both years (Table 3). In both years, weed control until 9 WAS (WC9) reduced weed density by 69–70% and biomass by 63–67% compared to weed control for 3 weeks only (WC3), while the reduction was 56–57% for weed density and 42–53% for weed biomass when weeds were controlled until 6 WAS. This trend suggests that rapid weed growth was observed between 3 and 9 WAS in both years. This result corroborates an earlier report on the same ecology, which showed that rapid weed growth occurred between 3 and 9 WAS in a study conducted on soybean (Daramola et al., 2019b).

Table 3. The effect of weed control timing on weed cover score, weed density, and weed biomass in 2015 and 2016.

	Weed cover score		Weed density (m^{-2})		Weed dry weight (kg ha^{-2})	
	2015	2016	2015	2016	2015	2016
WI3	53.3 ± 5.7d	33.3 ± 5.6d	21.3 ± 7.5e	23.3 ± 10.2e	15.3 ± 6.6e	19.3 ± 5.0e
WI6	63.4 ± 5.8c	53.3 ± 5.8c	37.0 ± 6.2d	48.0 ± 7.8d	22.6 ± 14.1d	25.0 ± 10.1d
WI9	86.7 ± 5.9a	86.7 ± 5.7a	94.3 ± 11.1a	129.0 ± 26.6a	68.3 ± 10.5a	77.0 ± 6.0a
WIH	87.6 ± 5.7a	88.7 ± 5.8a	92.3 ± 11.1a	129.7 ± 27.6a	69.0 ± 8.8a	76.7 ± 5.9a
WF3	75.3 ± 5.6b	73.3 ± 5.7b	70.3 ± 6.8b	91.0 ± 7.2b	44.7 ± 4.5b	55.0 ± 3.6b
WF6	66.7 ± 5.7c	56.7 ± 5.7c	49.7 ± 5.4c	64.0 ± 5.2c	32.0 ± 3.6c	34.0 ± 2.6c
WF9	53.3 ± 5.8d	33.3 ± 5.6d	22.3 ± 7.5e	27.0 ± 7.8e	15.0 ± 8.5e	20.0 ± 6.2e
SED (df. 6)	6.7	8.6	13.3	14.5	6.5	4.3

WI3 – weed-infested until 3 WAS, WI6 – weed-infested until 6 WAS, WI9 – weed-infested until 9 WAS, WIH – weed-infested until harvest, WF3 – weed-free until 3 WAS, WF6 – weed-free until 6 WAS, WF9 – weed-free until 9 WAS. Means (±SD) in the table followed by the same alphabets are not significantly different (p ≤ 0.05; Tukey's HSD test).

The effect of weed control timing on the growth, yield components and yield of rice

Weed control timing had a significant effect on the growth and yield of rice in 2015 and 2016 (Table 3). Crop vigour score, plan height, number of tillers, leaf area index, number of grains per panicle, panicle weight, panicle length and grain

yield of rice were similar between plots where weeds were allowed to grow until 3 WAS (WI3), and where weeds were controlled until 9 WAS (WC9) or harvest (WCH) in both years (Tables 4 and 5). These results showed that weed infestation for only 3 WAS was not detrimental to rice growth and yield provided the weeds were subsequently removed. This was probably because the weeds were not yet established, and hence could not compete appreciably with the crop at this time. Only grass weed seedlings and few annual broadleaf weeds were present at this initial stage of crop growth, and these were small and physiologically immature to offer significant competition to the crop seedlings. This result is contrary to the report of Toure et al. (2013) that weed infestation from 14 days after sowing was detrimental to rice grain yield in a study conducted in Mali where the main infesting weed species were *Dactyloctenium aegyptium*, *Digitaria loniflora* and *Acanthospermum hispidum*. The crop response to periods of weed interference between the two locations could be due to contrasting rice varieties, weed flora, soil moisture regimes and prevailing climatic conditions. However, the result of this study corroborates earlier investigation in the same ecology, which showed that weed infestation for the first three weeks did not cause a significant reduction in the crop growth and yield of rice (Adeyemi et al., 2017) and soybean (Daramola et al., 2020b, c).

Table 4 The effect of weed control timing on rice growth parameters in 2015 and 2016.

	Crop vigour score		Plant height (cm)		Number of tillers m^{-2}		Leaf area index	
	2015	2016	2015	2016	2015	2016	2015	2016
WI3	8.7 ± 0.5a	9.3 ± 0.6a	117.4 ± 8.5a	122.0 ± 6.5a	43.5 ± 2.5a	46.1 ± 3.6a	0.36 ± 0.07a	0.30 ± 0.06a
WI6	4.7 ± 1.5d	4.3 ± 0.6d	83.6 ± 16.5c	70.5 ± 11.0c	18.4 ± 5.5c	19.4 ± 2.6c	0.23 ± 0.08c	0.21 ± 0.06c
WI9	3.3 ± 1.1e	2.3 ± 0.7e	53.2 ± 2.5d	51.3 ± 7.1d	21.1 ± 5.0c	17.7 ± 5.0c	0.12 ± 0.01d	0.12 ± 0.01d
WIH	3.0 ± 0.6e	2.3 ± 0.5e	51.3 ± 2.0d	42.7 ± 7.1d	21.3 ± 7.7c	17.5 ± 3.4c	0.12 ± 0.01d	0.11 ± 0.01d
WF3	6.0 ± 0.6c	5.7 ± 0.5c	96.6 ± 16.5b	79.4 ± 20.9b	31.1 ± 3.4b	27.6 ± 7.6b	0.24 ± 0.04c	0.22 ± 0.06c
WF6	8.0 ± 0.7b	7.0 ± 0.6b	94.6 ± 11.0b	82.4 ± 13.3b	43.3 ± 4.9a	43.9 ± 3.3a	0.30 ± 0.04b	0.26 ± 0.07b
WF9	9.3 ± 0.6a	9.7 ± 0.7a	118.7 ± 9.5a	124.3 ± 5.6a	42.7 ± 1.1a	44.6 ± 2.5a	0.30 ± 0.07a	0.30 ± 0.06a
WFH	9.3 ± 1.7a	9.6 ± 0.6a	116.1 ± 8.5a	120.6 ± 7.7a	45.3 ± 1.7a	46.2 ± 1.7a	0.35 ± 0.06a	0.31 ± 0.06a
S.E.D (df. 7)	0.9	0.4	7.5	8.2	3.0	3.3	0.04	0.03

WI3 – weed-infested until 3 WAS, WI6 – weed-infested until 6 WAS, WI9 – weed-infested until 9 WAS, WIH – weed-infested until harvest, WF3 – weed-free until 3 WAS, WF6 – weed-free until 6 WAS, WF9 – weed-free until 9 WAS, WFH – weed-free until harvest. Means in the table followed by the same alphabets are not significantly different (p ≤ 0.05; Tukey's HSD test).

In both years, delaying weed control from 3 to 9 WAS (WI3, WI6 and WI9) resulted in a significant reduction in all the growth and yield parameters compared to crops kept weed-free until harvest (WCH). The number of tillers was reduced by

59% in 2015 and by 58% in 2016 when weeds were allowed to grow until 6 WAS (WI6) compared to crops kept weed-free until harvest (WCH). A further delay in weed control from 6 WAS (WI6) to harvest (WCH), however, did not result in a significant reduction in the number of tillers in both years (Table 4). The corresponding yield loss for a 3-week delay in weed control between WI6 and WI9 was 13% in 2015 and 19% in 2016 (Table 5). Higher yield reduction observed with increasing the period of weed infestation in 2016 than in 2015 in this study is a reflection of the competitive advantage of C4 weeds such as *Euphorbia heterophylla, Cyperus rotundus, Panicum maximum, Talinum triagulare* and *Digitaria horizontalis*, which were more abundant in 2016 than in 2015. These weed species probably took advantage of the higher amount of rainfall recorded in 2016 compared to 2015. Procopio et al. (2004) have earlier reported that C4 weeds exhibit enhanced metabolism, which confers them a higher efficiency in water use and net photosynthesis than rice which is a C3 plant.

Table 5. The effect of weed control timing on yield and yield attributes of rice in 2015 and 2016.

	Number of grains per panicle		Panicle weight (g)		Panicle length (cm)		Grain yield t ha^{-1}	
	2015	2016	2015	2016	2015	2016	2015	2016
WI3	206.7 ± 14.4a	225.6 ± 17.3a	58.3 ± 13.5a	53.3 ± 19.5a	23.9 ± 1.3a	25.7 ± 1.2a	3.9 ± 0.2a	3.4 ± 0.7a
WI6	167.4 ± 29.0b	149.7 ± 36.8c	32.0 ± 6.2c	38.0 ± 6.5c	20.5 ± 2.6b	21.7 ± 1.8b	2.0 ± 0.2d	1.5 ± 0.1d
WI9	69.0 ± 12.5d	59.9 ± 16.3d	19.3 ± 5.5d	18.0 ± 3.4d	15.6 ± 5.3c	12.5 ± 1.0c	0.9 ± 0.4e	0.7 ± 0.2e
WIH	66.0 ± 12.6d	59.7 ± 14.7d	17.0 ± 2.6d	16.3 ± 2.0d	15.7 ± 3.1c	12.5 ± 0.8c	0.8 ± 0.3e	0.6 ± 0.2e
WF3	143.7 ± 8.1c	145.9 ± 11.4c	35.6 ± 1.5c	30.7 ± 5.1c	21.1 ± 2.1b	21.1 ± 1.3b	2.5 ± 0.9c	2.3 ± 0.5c
WF6	164.0 ± 8.8b	164.0 ± 9.6b	49.7 ± 11.9b	45.3 ± 16.6b	24.1 ± 1.6a	25.8 ± 1.6a	3.4 ± 0.9b	2.8 ± 0.6b
WF9	219.6 ± 19.2a	219.6 ± 21.8a	59.7 ± 12.9a	55.3 ± 18.5a	23.9 ± 1.8a	25.6 ± 1.7a	3.8 ± 0.8a	3.4 ± 0.7a
WFH	227.9 ± 20.7a	225.9 ± 20.0a	57.6 ± 12.5a	55.0 ± 20.2a	24.1 ± 1.9a	26.7 ± 0.9a	3.9 ± 0.4a	3.5 ± 0.6a
S.E.D (df. 7)	8.2	10.5	6.8	8.3	2.5	2.3	0.4	0.3

WI3 – weed-infested until 3 WAS, WI6 – weed-infested until 6 WAS, WI9 – weed-infested until 9 WAS, WIH – weed-infested until harvest, WF3 – weed-free until 3 WAS, WF6 – weed-free until 6 WAS, WF9 – weed-free until 9 WAS, WFH – weed-free until harvest. Means in the table followed by the same alphabets are not significantly different (p ≤ 0.05; Tukey's HSD test).

Allowing weed infestation between 3 and 9 WAS (WI3 and WI9) and subsequently controlling the weeds did not alleviate growth and yield depression of the crop compared to the crop weed-infested until harvest (WCH). The period between 3 and 9 WAS was the period of the most rapid increase in weed density and biomass. Hence, the significant reduction in growth and yield observed may be due to increased weed competition for growth resources. The previous findings of Khaliq (2012) have shown that there is limited use of resources (moisture, light and

nutrients) for crop growth and productivity due to an increase in weed competition. Other reports on the Nigeria forest-savanna also revealed a significant yield reduction in crop growth of soybean (Daramola et al., 2019a) and cowpea (Adigun et al., 2018) due to weed infestation between 3 and 9 weeks. The result of this study showed that a further delay in the weed control from 9 WAS (WI9) to harvest (WIH) did not result in a significant reduction in all the growth and yield parameters in both years (Tables 3–5). This was possibly because weed density and biomass did not increase significantly during this period. Moreover, the weeds were less aggressive due to their lower growth rate during this period. Hence, their presence was not detrimental to rice growth and yield. This result supports the findings of Khaliq et al. (2014), who have reported that rice is less vulnerable to weed competition during its late phase of growth.

In both years, crop vigour score, plant height, number of tillers, leaf area index, number of grains per panicle, panicle weight, panicle length and grain yield of rice increased significantly where plots were kept weed-free until 9 WAS (WC9) compared to 3 WAS and 6 WAS only (WC3 and WC6). However, these growth and yield parameters did not differ significantly between plots where weeds were controlled until 9 WAS (WC9) and where weeds were controlled until harvest (WCH) in both years. Weed control until 9 WAS (WC9) increased rice grain yield by 52% compared to weed removal until 3 WAS (WC3) and by 15–25% compared to weed removal until 6 WAS (WC6) in both years. No significant yield increase was observed in weed control after 9 WAS in both years. Weed density and biomass did not increase significantly beyond 9 WAS in weed-infested plots, and the weeds at this period probably reduced competition with the crop due to the shading effect of rice canopy. Hence, their subsequent control was not expected to improve crop growth and yield. This result has corroborated the report of Ekeleme (2009) that there is little or no benefit of subsequent weed control after 9 weeks of crop growth provided the crops were initially kept weed-free.

Conclusion

The results of this study have shown that rice can tolerate weed infestation initially for the first 3 weeks and that the minimum period that it should be kept weed-free was 9 WAS without causing any significant reduction in growth and yield compared to crops kept weed-free until harvest. Hence, weed removal between 3 and 9 weeks after sowing was sufficient to maintain maximum grain yield. This period coincided with the period of maximum weed growth and the most significant reduction in crop vigour, plant height, number of tillers and leaf area index due to weed interference. Therefore, weed removal between 3 and 9 WAS is recommended for effective weed control, optimum growth and higher yield of upland rice.

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UTICAJ VREMENA SUZBIJANJA KOROVA NA RAST I PRINOS PLANINSKOG PIRINČA (*ORYZA SATIVA* L.)

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R e z i m e

Zastupljenost korova predstavlja glavnu pretnju za proizvodnju pirinča, što dovodi do visokog smanjenja prinosa i smanjene profitabilnosti. Zbog toga su sprovedeni terenski eksperimenti kako bi se procenio efekat različitog vremena suzbijanja korova na rast i prinos planinskog pirinča tokom 2015. i 2016. vegetativne sezone. Tretmani su se sastojali od perioda kada je bilo dozvoljeno da usev da bude zakorovljen tokom prve 3, 6 i 9 nedelja nakon setve, i perioda kada je korov suzbijan prve 3, 6 i 9 nedelja nakon setve. Dva tretmana zakorovljavanja i suzbijanja korova do žetve bila su takođe uključena kao kontrole u potpuno slučajnom blok dizajnu sa tri ponavljanja. Tokom obe godine, prinosi zrna pirinča kretali su se od 0,6 do 0,8 t ha^{-1} na parcelama koje su bile zakorovljene do žetve, kao i od 3,5 do 3,9 t ha^{-1} na parcelama bez korova do žetve, što ukazuje na gubitak prinosa od 79% do 83% pri nekontrolisanom rastu korova. Zakorovljenost tokom prve 3 nedelje nakon setve nije prouzrokovala značajno smanjenje rasta i prinosa pirinča pod uslovom da je korov nakon toga uklonjen. Međutim, kašnjenje u suzbijanju korova do 9 nedelja nakon setvene smanjilo je rast pirinča i dovelo do nepovratnog smanjenja prinosa. Bilo je samo neophodno da se ukloni korov između 3 i 9 nedelja nakon setve, kako bi se postigao optimalni prinos zrna, jer nije primećen značajan porast prinosa pri suzbijanju korova nakon 9 nedelja posle setve tokom obe godine. Ova studija je pokazala da bi suzbijanje korova između 3 i 9 nedelja dovelo do optimalnog rasta i prinosa planinskog pirinča.

Ključne reči: kritični period, prinos zrna, okopavanje, zakorovljenost, uklanjanje korova.

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