Effect of nitrogen levels and weed management methods on weed abundance and yield of upland rice (*Oryza sativa* L.)

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**Abstract:** Weed infestation and inherent low soil fertility are among the major factors attributed to the low yield of rice in Nigeria. Field trials were therefore conducted to evaluate the effect of nitrogen application levels and weed control methods on growth and yield of upland rice (var. NERICA 2) at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta (07° 15’N, 03° 25’E) during 2015 and 2016 cropping seasons. Three nitrogen (N) levels (0, 60 and 90 kg/ha) were evaluated and they constituted the main plot treatments, while three weed control treatments, viz: pre-emergence application of Orizo Plus® (propanil plus 2, 4-D) at 2.0 kg a.i ha⁻¹, Orizo Plus® at 2.0 kg a.i ha⁻¹ followed by supplementary hoe weeding (SHW) at 6 weeks after sowing (WAS) and three hoe-weeding regimes at 3, 6 and 9 WAS, and a weedy check constituted the sub-plot treatments. All the treatments in different combinations were laid out in a randomized complete block design with a split-plot arrangement with three replicates. Results indicated a significant (p≤0.05) increase in weed density and dry matter with an increase in N application level from 0 to 90 kg ha⁻¹. Similarly, crop vigour and plant height increased significantly (p≤0.05) with increasing N application levels up to 90 kg ha⁻¹. However, 60 and 90 kg N ha⁻¹ were at par in increasing the number of tillers, leaf area index and yield attributes of rice. All the weed control methods resulted in a significant (p≤0.05) reduction in weed density and dry matter with subsequent increase in rice growth and yield than the weedy check. Pre-emergence application of Orizo Plus® followed by SHW at 6 WAS and three hoe-weeding regimes resulted in significantly (p≤0.05) lower weed density and dry matter, and a higher number of tillers, panicle weight and grain yield than a sole application of Orizo Plus®. With Orizo Plus® followed by one SHW or three

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hoe-weeding regimes, increasing N application levels resulted in a significant (p≤0.05) increase in grain yield of rice. However, with Orizo Plus® applied alone, increasing N application levels did not increase rice grain yield. These results suggest that Orizo Plus® at 2.0 kg a.i ha⁻¹ followed by one SHW at 6 WAS integrated with N application at 90 kg ha⁻¹ is adequate to effectively control weeds and increase rice yield in the rainforest-savannah transition zone of Nigeria.

**Key words:** grain yield, hoe-weeding, integrated weed management, Orizo Plus®, weed competition.

**Introduction**

Rice is the world’s most important food crop and a major source of food for half of the world population (Kumar and Ladha, 2011). It provides 27% of dietary energy supply and 20% of dietary protein intake in the developing countries (GRiSP, 2013). Rice cultivation is the principal activity and source of income for about 100 million households in Asia and Africa (Seck et al., 2012; GRiSP, 2013). It is planted to about 154 million hectares annually (11% of the world’s cultivated land) with a production of about 741 million tons (FAO, 2012; Pode, 2016). Nigeria is the largest rice-producing country in Africa producing about 5.8 million tons (Udemezue, 2018). Rice production in Nigeria is already a highly strategic and priority element for food security and poverty alleviation. However, there is lopsidedness in the present level of production and yield of rice in Nigeria as compared to its demand and consumption pattern. Reports have indicated that only an average yield of 1.8 tons per hectare of rice is realized in Nigeria (Cadoni and Angelucci, 2013; Adigun et al., 2017). This is far below the potential yield and global average production of 5.4 t ha⁻¹ (GRiSP, 2013). Production constraints such as inherent low soil fertility and poor weed management are among the major factors attributed to the low yields of rice in Nigeria (Adigun et al., 2017). Tropical soils are generally poor in organic matter and are adversely affected by sub-optimal soil fertility, hence, productivity and sustainability decline over time (Batieno et al., 2006; Oikeh et al., 2014). In addition, the heavy downpour and high relative humidity favour rapid and luxuriant weed growth which results in high yield reduction between 48% and 100% (Waddington et al., 2010; Adeyemi et al., 2017). Weed control methods currently employed to avoid such losses are predominantly hoe-weeding and herbicide application. However, these methods are inadequate and have several drawbacks. Hoe-weeding is tedious, inefficient, time-consuming, associated with high labour demands and often too expensive for the average farmer to afford (Imoloame, 2014; Adigun et al., 2017). Herbicide use, on the other hand, does not provide season-long weed control. Moreover, there are not many herbicides that can control different kinds of weeds with one application (Balasubramanian et al., 2007; Chauhan and Opena, 2013). Rice being a closely
spaced crop also makes mechanical weed control difficult, thus resulting in high yield reduction (Johnson et al., 2018).

In response to this, therefore, the development of integrated weed management (IWM) is pivotal to combat weed menaces in rice production. IWM involves the reduction of weed interference through a multi-disciplinary action, while acceptable crop yields and environment, social and economic health are maintained (Tohari et al., 2017). The number of hoe-weeding regimes and the amount of herbicides used could be reduced if they were integrated with agronomic practices that enhance crop competitiveness with weeds (Chauhan and Johnson, 2010). Supply and availability of nutrients are of immense significance among these agronomic practices because they influence weed dynamics and weed-crop interference (Camara et al., 2003; Mahajan and Timsina, 2011). Of all nutrients, plant response to nitrogen (N) fertilizer is the most widely observed (Camara et al., 2003). N fertilizer has been reported to play an important role in the competitive balance between weeds and rice (Mahajan and Timsina, 2011). However, some weeds are more effective in utilizing the available excess nutrients than the crops (Blackshaw et al., 2005). Under weedy conditions, fertilizer application has been reported to stimulate weed growth so greatly that the crop growth is suppressed (Mahajan and Timsina, 2011). However, if fertilizers are applied at the proper rate and time, they could enhance crop growth to smother infesting weed species. There is a paucity of information on the interaction of N application levels and weed control methods in the upland rice system in Nigeria, and the influence of N fertilizer on weed interference in the crop has not been yet fully understood (Zoschke and Quadranti, 2002). We hypothesized that efficient weed management and optimum yield of upland rice can be achieved through the integration of appropriate N rate and weed control methods. An early application of N could enhance the growth and competitiveness of rice against weeds. Early weed control provided by herbicide application could further give rice an advantage over weeds. The objective of this study was therefore to evaluate the effects of N levels and weed control methods on weed-crop competition, growth and yield of upland rice in the forest-savanna transition zone of Southwestern Nigeria.

**Materials and Methods**

Field trials were conducted at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta, Nigeria (07 15’N; 03 25’E) in the forest-savanna transition zone of South-western Nigeria during 2015 and 2016 cropping seasons. In both trials, the land was first plowed and disc harrowed, then it was pulverized and leveled manually before marking into various plots. Gross and net plot sizes were (4.5 x 3.0) m² and (3.0 X 3.0) m², respectively. Three nitrogen application levels (0, 60 and 90 kg ha⁻¹) constituted the main plot treatments while
the subplot treatments were three weed control methods: pre-emergence application of propanil plus 2, 4-D (Orizo Plus®, Proficol Calle, Baranquilla, Colombia) at 2.0 kg a.i ha⁻¹ Orizo Plus® at 2.0 kg a.i ha⁻¹ followed by supplementary hoe-weeding (SHW) at 6 weeks after sowing (WAS) and three hoe-weeding regimes at 3, 6 and 9 WAS, and a weedy check. All treatments in different combinations were set up in a randomized complete block design with a split-plot arrangement and three replicates. Rice seed (Var. NERICA 2) was sown manually by the drilling method at the inter-row spacing of 75 cm in both years. Nitrogen was applied as urea in two equal doses at 3 and 6 WAS by banding between the crop rows. Herbicide treatments were applied pre-emergence, one day after sowing with a knapsack sprayer (CP 15) with a spraying volume of 250 L ha⁻¹ using a deflector nozzle at a pressure of 2.1 kg cm⁻². Hoe-weeding was done using a West African hoe in both years.

Data on weed density and weed dry matter were collected at 12 WAS in both years using a 50 cm × 50 cm quadrat placed randomly at three spots in each plot. Weeds sampled from the quadrat were counted and oven-dried at 70°C for 72 hours, after which they were weighed and expressed in g m⁻². Observation on rice growth and yield attributes such as crop vigour score and plant height per plot (cm), leaf area index (LAI), number of tillers (number/m²) at 9 WAS, panicle length (cm), panicle weight (g/plant), number of grains per panicle and grain yield (t ha⁻¹) at harvest were recorded. Crop vigour score was accessed by a visual estimate based on the scale 0–10, where 0 represents a completely dead plant and 10 represents the most vigorous plant (Tunku et al., 2007; Adigun et al., 2017). LAI was calculated following the formula of Watson (1947, as follows:

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

(1)

The grain yield of rice was obtained after harvesting the plants in each plot. The resulting grain weight in kg plot⁻¹ at 12.5% moisture content was expressed in t/ha. Data collected were subjected to analysis of variance (ANOVA) using the GENSTAT discovery package. Treatment means were separated using the least significant difference (LSD at p ≤ 0.05).

Results and Discussion

Effect of nitrogen levels and weed management methods on weed type, weed density and weed dry matter. The major weed species at the experimental sites in 2015 and 2016 were *Tridax procumbens*, *Euphorbia heterophylla*, *Commelina benghalensis*, *Gomphrena celosioides*, *Digitaria horizontalis*, *Eleusine indica*, *Rottboellia cochinchinensis* and *Cyperus rotundus* (Table 1).
Nitrogen levels had a significant effect (p≤0.05) on grasses, broadleaves and total weed density, and weed dry matter (Table 2). There was a significant (p≤0.05) increase in grasses, broadleaves and total weed density, and weed dry matter with increasing N application levels from 0 to 60 and 60 to 90 kg ha⁻¹. However, the density of sedges was not affected by N application levels (Table 2). This result is in agreement with that of Mahajan and Timsina (2011), who reported that weed response to nitrogen application varies with different species. A similar density of sedges at 0, 60 and 90 N kg ha⁻¹ may be attributed to the fact that sedges have higher efficiency in the use of N compared to grasses and broadleaf weeds (Li, 1993). The higher efficiency in N use by sedges could have resulted in increased density of these groups of weed species even at low or no N application. In this study, total weed density increased by 50.4% and weed dry matter by 10.7% with the application of 60 kg ha⁻¹ compared to plots where N was not applied. Furthermore, an increase in N application levels from 60 to 90 kg ha⁻¹ resulted in 10.6 and 8% increases in total weed density and weed dry matter, respectively in both years.

Weed control methods had a significant (p≤0.05) effect on weed density and dry matter in both years of experimentation (Tables 2). All the weed control methods reduced grasses, broadleaves, sedges and total weed density, and weed dry...

Table 1. Weed species composition of the experimental plots.

| Weed species                          | Plant family  | Photosynthetic pathway |
|---------------------------------------|---------------|------------------------|
| *Axonopus compressus* (Sw.) P. Beauv | Poaceae       | C4                     |
| *Cynodon dactylon* (L) Gaertn         | Poaceae       | C4                     |
| *Digitaria horizontalis* (Willd.)    | Poaceae       | C4                     |
| *Eleusine indica* (Gaertn)            | Poaceae       | C4                     |
| *Panicum maximum* (Jacq)              | Poaceae       | C4                     |
| *Paspalum scrobiculatum* (Linn.)      | Poaceae       | C4                     |
| *Rottboellia cochinchinensis* (Lour.) | Poaceae       | C4                     |
| *Amaranthus spinosus* Linn.           | Amaranthaceae | C4                     |
| *Boerhavia diffusa* (Linn.)           | Nyctaginaceae | C4                     |
| *Centrosema pubescens* (Linn.)        | Fabaceae      | C3                     |
| *Chromolaena odorata* (L.) R.M. King and Robinson | Asteraceae | C3                     |
| *Commelina benghalensis* (Burn.)      | Commelinaceae | C3                     |
| *Euphorbia heterophylla* (Linn.)      | Euphorbiaceae | C4                     |
| *Gomphrena celosioides* (Mart.)       | Amaranthaceae | C3                     |
| *Tridax procumbens* (Linn.)           | Asteraceae    | C3                     |
| *Cyperus esculentus* (Linn.)          | Cyperaceae    | C4                     |
| *Cyperus rotundus* (Linn.)            | Cyperaceae    | C4                     |

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Weed control methods had a significant (p≤0.05) effect on weed density and dry matter in both years of experimentation (Tables 2). All the weed control methods reduced grasses, broadleaves, sedges and total weed density, and weed dry...
matter significantly (p≤0.05) compared to the weedy check (Table 2). All the weed control methods were significantly (p≤0.05) at par in reducing the density of grasses and sedges in both years. However, application of Orizo Plus® at 2.0 kg a.i ha⁻¹ followed by hoe-weeding and three hoe-weeding regimes significantly (p≤0.05) reduced broadleaves and total weed density as well as weed dry matter better than the sole application of Orizo Plus® in both years (Table 2).

Table 2. Effect of nitrogen levels and weed management methods on weed density and dry matter.

| Nitrogen level (kg ha⁻¹) | Weed density (no m⁻²) | Weed dry matter (g m⁻²) |
|-------------------------|------------------------|-------------------------|
|                         | Grasses 2015 | 2016 | Broadleaves 2015 | 2016 | Sedges 2015 | 2016 | Total 2015 | 2016 | 2015 | 2016 |
| 0                       | 49.0 | 55.0 | 41.1 | 45.1 | 30.4 | 22.4 | 115.6 | 110.0 | 106.7 | 96.7 |
| 60                      | 73.6 | 79.6 | 54.6 | 58.6 | 32.7 | 24.7 | 172.8 | 167.0 | 117.7 | 107.7 |
| 90                      | 85.9 | 91.9 | 64.6 | 68.6 | 37.4 | 29.4 | 191.3 | 185.0 | 126.2 | 116.2 |
| Lsd                     | 2.5 | 8.5 | 4.3 | 8.3 | ns | ns | 14.5 | 8.5 | 10.5 | 0.5 |

Weed control methods

|                         | Grasses 2015 | 2016 | Broadleaves 2015 | 2016 | Sedges 2015 | 2016 | Total 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
|-------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Orizo Plus®             | 30.4 | 36.4 | 17.7 | 21.7 | 20.8 | 12.8 | 72.9 | 66.9 | 88.2 | 78.2 |
| Orizo Plus® + SHW       | 23.6 | 29.6 | 13.3 | 17.3 | 17.0 | 9.0 | 57.9 | 51.9 | 65.4 | 55.4 |
| 3 hoe-weeding regimes   | 19.9 | 25.9 | 18.6 | 22.6 | 11.8 | 3.8 | 54.3 | 48.3 | 66.3 | 56.3 |
| Weedy check             | 203.3 | 209.3 | 162.3 | 166.3 | 85.0 | 77 | 454.6 | 449 | 247.9 | 237.9 |
| Lsd                     | 4.5 | 10.5 | 7.8 | 11.8 | 12.5 | 4.5 | 20.5 | 14.5 | 13.2 | 3.2 |

SHW – supplementary hoe-weeding; Lsd – Least significant difference; ns – Not significant.

Better weed control obtained with the pre-emergence application of Orizo Plus® followed by supplementary hoe-weeding can be attributed to the initial weed control of the herbicide, as well as the effectiveness of the supplementary hoe-weeding in controlling subsequent weeds that emerged, thereby sustaining efficient weed control until harvest similar to three hoe-weeding regimes. This clearly underscores the usefulness of integrated weed management as a substitute for the single weed control method or multiple hoe-weeding, particularly where labour is limited and expensive and land under cultivation is large. This result is in conformity with those of Imoloame (2014) and Adigun et al. (2017), who reported superior weed control efficiency of herbicide application plus supplementary hoe-weeding to sole herbicide application. Although the sole application of Orizo Plus® reduced the detrimental effect of weed infestation to a great extent compared with the weedy plot, it did not provide season-long weed control. As the herbicide was taken up mainly through the root and coleoptile, the weeds were killed before, at or shortly after emergence. The excellent germicidal activity of Orizo Plus® effectively controlled the first flush of the weeds but did not control the later
flushes of the weeds. Previous studies also reported late-season weed infestation after pre-emergence herbicide application (Jonas et al., 2016; Adigun et al., 2017).

Effect of nitrogen levels and weed management methods on yield and yield attributes of upland rice in 2015 and 2016 cropping seasons

Crop vigour score and plant height of rice increased significantly (p≤0.05) with increasing N application rates from 0 to 90 kg ha\(^{-1}\) in 2015 and 2016 (Table 3). The improvement in rice vegetative growth with increasing N application levels observed in this study may be attributed to the effect of applied N for chlorophyll formation which allows plants to convert solar energy to sugars used for growth (Brady and Weil, 2002).

Table 3. Effect of nitrogen levels and weed management methods on rice growth parameters.

| Nitrogen level (kg ha\(^{-1}\)) | Crop vigour score | Plant height (cm) | Number of tillers (no m\(^{-2}\)) | Leaf area index |
|-------------------------------|-------------------|-------------------|-----------------------------------|----------------|
|                               | 2015  | 2016  | 2015  | 2016  | 2015  | 2016  | 2015  | 2016  |
| 0                             | 3.3   | 5.3   | 71.0  | 74.0  | 51.3  | 49.3  | 1.6   | 1.3   |
| 60                            | 5.1   | 7.1   | 79.0  | 82.0  | 60.0  | 58.0  | 1.9   | 1.6   |
| 90                            | 6.7   | 8.7   | 94.0  | 97.0  | 66.0  | 64.0  | 1.9   | 1.6   |
| Lsd                           | 0.5   | 0.9   | 2.5   | 5.5   | 8.4   | 6.4   | 0.4   | 0.1   |

Weed control methods

|                                   | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
|-----------------------------------|------|------|------|------|------|------|------|------|
| Orizo Plus\(^{\text{®}}\)         | 7.2  | 9.2  | 91.6 | 94.6 | 54.6 | 52.6 | 1.8  | 1.5  |
| Orizo Plus\(^{\text{®}}\) + SHW   | 6.6  | 8.6  | 93.0 | 96.0 | 70.0 | 68.0 | 2.0  | 1.7  |
| 3 hoe-weeding regimes            | 7.1  | 9.1  | 94.3 | 97.3 | 70.0 | 68.0 | 2.2  | 1.9  |
| weedy check                      | 1.3  | 1.2  | 50.0 | 53.0 | 42.0 | 40.0 | 1.2  | 0.9  |
| Lsd                              | 1    | 1    | 5.5  | 8.5  | 10.3 | 8.3  | 0.5  | 0.2  |

Lsd – Least significant difference; ns – Not significant.

Thus, plants were taller and more vigorous as a result of the production of more photosynthates needed for more vegetative growth. Similarly, number of tillers, leaf area index, panicle length, panicle weight, number of grains per panicle and grain yield of rice increased with increasing N application rates from 0 to 60 kg ha\(^{-1}\). A further increase in N application levels from 60 to 90 kg ha\(^{-1}\), however, did not result in a significant (p≤0.05) increase in these parameters (Tables 3 and 4). This result showed that N-use efficiency increased with increasing N application up to 60 kg N ha\(^{-1}\) with a subsequent increase in yield of rice, whereas increasing N application up to 90 kg ha\(^{-1}\) led to luxuriant vegetative growth similar to the observation of Aminifard et al. (2012). In this study, it was observed that weed density and dry matter increased consistently with increasing N application...
up to 90 kg ha\(^{-1}\), thus resulting in increased weed competition which must have limited yield increase. Hence, the crop did not respond further to increasing N application from 60 to 90 kg ha\(^{-1}\). This showed that the increase in N application favoured weed growth at the expense of the crop. Weeds have been reported to exhibit high growth rates, water and N-use efficiency which confers them higher competitiveness with crops (Ampong-Nyarko and De Datta, 1993; Harbur and Owen, 2004).

Pre-emergence application of Orizo Plus\(^{®}\) followed by supplementary hoe-weeding at 6 WAS and three hoe-weeding treatments resulted in similar crop vigour score, plant height, number of tillers, leaf area index, panicle length, panicle weight, number of panicles and grain yield, all of which were significantly (p≤0.05) higher than those recorded with the sole application of Orizo Plus\(^{®}\) (Table 4). A similar result was reported by Adigun et al. (2017) who reported that pre-emergence application of butachlor followed by hoe-weeding resulted in superior growth and yield of rice compared to hoe-weeding and the sole application of butachlor.

Table 4. Effect of nitrogen levels and weed management methods on yield and yield attributes of rice.

| Nitrogen level (kg ha\(^{-1}\)) | Panicle length (cm plant\(^{-1}\)) | Panicle weight (g plant\(^{-1}\)) | Number of grains | Grain yield (t ha\(^{-1}\)) |
|--------------------------------|-----------------------------------|---------------------------------|------------------|--------------------------|
| 2015                          | 2016                              | 2015                            | 2016             | 2015                     | 2016                     | 2015                     | 2016                     |
| 0                              | 21.3                              | 18.9                            | 45.6             | 47.9                     | 140.8                    | 145.8                    | 1.5                       | 1.8                       |
| 60                             | 24.2                              | 21.8                            | 53.7             | 56                       | 157.8                    | 162.8                    | 3.0                       | 3.3                       |
| 90                             | 22.4                              | 20.0                            | 58.2             | 60.5                     | 186.6                    | 191.6                    | 3.3                       | 3.6                       |
| Lsd                            | 0.9                               | 1.5                             | 4.5              | 6.8                      | 15.7                     | 20.7                     | 0.5                       | 0.8                       |

| Weed control methods           |                                  |                                 |                  |                          |                          |                          |
| Orizo Plus\(^{®}\)             |                                  |                                 |                  |                          |                          |                          |
| Orizo Plus\(^{®}\) + SHW       | 26.0                              | 23.6                            | 64.8             | 67.1                     | 206.7                    | 211.7                    | 4.0                       | 4.3                       |
| 3 hoe-weeding regimes          | 27.9                              | 25.5                            | 65.9             | 68.2                     | 200.7                    | 205.7                    | 4.0                       | 4.3                       |
| Weedy check                    | 17.1                              | 14.7                            | 24.7             | 27.0                     | 80.6                     | 85.6                     | 0.5                       | 0.8                       |
| Lsd                            | 1.5                               | 1.7                             | 5.3              | 7.6                      | 20.6                     | 25.6                     | 0.5                       | 0.6                       |
| Interaction                    | ns                                | ns                              | ns               | ns                       | ns                       | ns                       | 0.9                       | 1.2                       |

SHW – supplementary hoe-weeding; Lsd – Least significant difference; ns – Not significant.

In this study, the rice crop capitalized on the changes in weed competition across the weed control methods with crop growth, yield and yield attributes showing an opposite response to weed density and dry matter. A significant (p≤0.05) increase in grain yield with a reduction in weed density and dry matter may be attributed to the adequate supply and use of growth resources occasioned by reduced weed infestation that led to increased assimilation during the crop growth period and its subsequent partitioning at maturity (Matloob et al., 2015).
The interactive effect of nitrogen application levels and weed management methods on weed infestation and rice grain yield

With increasing N application levels from 60 to 90 kg ha\(^{-1}\), weed density and dry matter were similar in plots treated with Orizo Plus\(^{®}\) plus supplementary hoe-weeding and plots hoe-weeded thrice at 3, 6 and 9 WAS, while rice grain yield increased significantly (p≤0.05) with increasing N application in these plots (Figure 1).

![Figure 1](image)

Figure 1. Nitrogen level × weed control method interaction on (a) weed density, (b) weed dry matter and (c) grain yield in upland rice (Data average for 2015 and 2016).
However, in weedy plots and plots treated with Orizo Plus® alone, weed density and dry matter increased with increasing N application levels from 60 to 90 kg ha⁻¹, while rice grain yield had no response to increasing N application rates. This response may be attributed to high weed infestation in weedy plots and poor weed control with the sole application of Orizo Plus® which made the increased N application favour weeds at the detriment of the crops. On the other hand, with Orizo Plus® followed by supplementary hoe-weeding or three hoe-weeding treatments, good weed control was achieved, hence, the N application favour the crop. This result suggests that, in the presence of weeds, increased N application levels increased weed infestation rather than crop yield. This result has corroborated the earlier findings of Blackshaw et al. (2003), who indicated that many weed species are more responsive to increased N application levels than crops.

**Conclusion**

The result of this study demonstrated that rice grain yield was improved with the application of 90 kgNha⁻¹ when weeds were controlled either by pre-emergence application of Orizo Plus® at 2.0 kg a.i ha⁻¹ followed by supplementary hoe-weeding at 6 WAS or three hoe-weeding regimes at 3, 6 and 9 WAS. However, under poor weed control conditions (sole application of Orizo Plus® at 2.0 kg a.i ha⁻¹), increasing N application did not improve rice grain yield but rather increased vegetative growth and weed infestation at the detriment of crop yield. It is therefore concluded that pre-emergence application of Orizo Plus® at 2.0 kg a.i ha⁻¹ followed by supplementary hoe-weeding at 6 WAS integrated with N application at 90 kg ha⁻¹ will provide adequate weed control and optimum yield of rice in the rainforest-savannah transition zone of Nigeria.

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Effect of nitrogen levels and weed management on weed abundance and yield of upland rice

UTICAJ DOZA AZOTA I METODA KONTROLE ZAKOROVLJENOSTI NA BUJNOST KOROVA I PRINOS PLANINSKOG PIRINČA (ORYZA SATIVA L.)

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Rezime

Zakorovljenost udružena sa niskom plodnošću zemljišta su među glavnim faktorima koji se pripisuju niskom prinosu pirinča u Nigeriji. Sprovedeni su poljski ogledi, kako bi se procenio uticaj primene azota i metoda kontrole zakorovljenosti na rast i prinos planinskog pirinča (sorta NERICA 2) na Naučno-istraživačkom imanju Federalnog poljoprivrednog univerziteta, Abeokuta (07° 15’N, 03° 25'E) tokom žetve u 2015. i 2016. godini. Tri doze azota (N) (0, 60 i 90 kg/ha) vrednovane su kao glavni tretmani, dok su tri tretmana kontrole zakorovljenosti: primena preparata Orizo Plus® (propanil plus 2, 4-D) sa dozom od 2,0 kg a.s ha⁻¹ pre nicanja, Orizo Plus® sa dozom od 2,0 kg a.s ha⁻¹ praćen dodatnim okopavanjem 6 nedelja posle setve, kao i sa tri okopavanja 3, 6 i 9 nedelja posle setve i kontrola bez uklanjanja korova, predstavljala tretmane potparcela. Svi tretmani u različitim kombinacijama postavljeni su u potpuno slučajnom blok dizajnu sa rasporedom podeljениh parcela sa tri ponavljanja. Rezultati su pokazali značajan (p≤0,05) porast zakorovljenosti i suve materije sa povećanjem primenjene doze azota od 0 do 90 kg ha⁻¹. Pored toga, životna sposobnost useva i visina biljke su se povećali značajno (p≤0,05) sa povećanjem primenjene doze azota do 90 kg ha⁻¹. Međutim, efekti 60 i 90 kg N ha⁻¹ bili su jednakci pri povećanju broja bokora, indeksa lisne površine i karakteristika prinosa pirinča. Sve metode suzbijanja korova vodile su do značajnog (p≤0,05) smanjenja zakorovljenosti i suve materije sa naknadnim povećanjem rasta i prinosa pirinča u odnosu na kontrolu. Primena preparata Orizo Plus® pre nicanja uz dodatno okopavanje 6 nedelja posle setve kao i sa tri okopavanja rezultirala je značajno (p≤0,05) nižom zakorovljenošću i suvom materijom i većim brojem bokora, težinom metlice i prinosom zrna u odnosu na samostalnu primenu preparata Orizo Plus®. Primenom preparata Orizo Plus® sa jednim i tri okopavanja povećavanje nivoa primene azota dovelo je do značajnog

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(p<0,05) porasta prinosa zrna pirinča. Međutim, samo primenom preparata Orizo Plus®, povećanje doze primjenjenog azota nije povećalo prinosa zrna pirinča. Ovi rezultati sugerišu da Orizo Plus® sa 2,0 kg a.s ha⁻¹ sa jednim okopavanjem 6 nedelja posle setve u sadejstvu sa primenom azota u količini od 90 kg ha⁻¹ je adekvatan za efikasno suzbijanje korova i povećanje prinosa pirinča u zoni prelaska prašume u savanu u Nigeriji.

Ključne reči: prinos zrna, okopavanje, integralna kontrola zakorovljenosti, Orizo Plus®, kompeticija korova.