

# Yield and yield attributes of lowland rice as affected by weed control methods in Sudan savanna zone of Kebbi State Nigeria

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**ABSTRACT:** Field experiment was conducted during 2019 rainy season at the Experimental/Seed Multiplication Farm of National Cereals Research Institute (NCRI), Rice Research sub-station, Gwadangaji, Birnin Kebbi, Kebbi State (latitude 12° 11'; longitude 12° 4'). The treatments consist of factorial combination of two level of *Topstar spectrum* 600 and 400 ml ha<sup>-1</sup>, two level of *Cranstan spectrum* 1250 and 800 ml ha<sup>-1</sup>; (pre-emergence and post-emergence herbicide), hoe weeding and a weedy check. The treatments were laid out in Randomized Complete Block Design (RCBD) and were replicated three times. Data were taken and subjected to analysis of variance (ANOVA) and means were separated using Duncan's Multiple Range Test (DMRT). Result obtained revealed that, *Topstar* at the rate of 600 ml ha<sup>-1</sup> produced significantly higher number of productive tillers, panicle length, 1000 grain weight and grain yield. *Topstar* show highest weed control than all other treatments. Weed cover score and weed dry weight significantly responded to weed control treatments. The result also shows that weedy check consistently recorded the highest value for weed cover and weed dry weight which was followed by plot treated with *Cranstan* at 800 ml ha<sup>-1</sup>. *Topstar* at 600 ml ha<sup>-1</sup> is found to be the best pre-emergence spectrum in weed management in rice field.

**Keywords:** *Cranstan spectrum*, rice, *topstar spectrum*, weedy check, weed cover.

## INTRODUCTION

Rice belongs to grass family, *Gramineae* with genus *Oryza* and species *sativa* (Asian rice) or *glaberrima* (African rice). As a cereal, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia (Anonymous, 2009). It is the Agricultural commodity with the third-highest worldwide production of 741.5 million tons after sugarcane (1.9 billion tones) and maize (1.0 billion tones) (FAOSTAT, 2017). Rice stands out as the major food crop for about a half of human race. The consumption of rice is growing faster than that of any other staple in Africa and the world at large, simply because it has become a convenient food for the growing world population. It is cultivated on almost 11% of the earth's cultivated land area and on a wide number of ecosystems (Abiwon et al., 2016). Rice is a weak competitor against weeds and the majority of African farmers have few

options and resources available for effective weed control (Rodenburg and Johnson, 2009). Weeds are the most frequent and widespread biotic constraints to productivity throughout the rice environments of Africa (Balasubramanian et al., 2007). In sub-Saharan Africa (SSA), weeds are estimated to account for rice yield losses of at least 2.2 million tons (Mt) per year (Rodenburg and Johnson, 2009). Combined with costs of weed control, the financial losses easily surpass half the cost of current regional rice imports. If not controlled, weeds cause yield losses in the range of 28 to 74% in transplanted lowland rice, 28 to 89% in direct seeded lowland rice and 48 to 100% in upland rice (Rodenburg and Johnson, 2009). Weed control is carried out manually using hand hoe in the Nigerian Savanna. Manual hoe weeding is tedious and associated with serious drudgery. It is also costly and

sometimes the labour is scarce or not available at the time of need. Considering the limitations of cultural methods of weed control, chemical weed control is an important alternative. *Topstar* and *Cranstan* have been demonstrated to give pre- and post-emergence control of several stubborn weeds in rice fields. They provide good control of annual and perennial grasses as well as many broadleaf weeds.

The study was aimed to evaluate and compare the efficacy of *Topstar* and *Cranstan* on management of weeds in lowland rice with the objective to determine the efficacy of *Topstar* on the growth and yield of lowland rice, efficacy of *Cranstan* (post-emergence) on the growth and yield of lowland and to find out the best herbicide and rates for high rice production

## MATERIALS AND METHODS

The experiment was conducted at the rice research sub-station of National Cereals Research Institute Farm (NCRI), located at Gwadangaji (latitude 12° 11'N; longitude 12° 4'E) in Kebbi State during the 2019 wet season. The location lies within the Sudan Savanna ecological zone of Nigeria and hence exhibits the characteristic erratic and scanty rainfall that lasts for about five (5) months (May - September) and long dry period usually characterized by cool dry air during harmattan from November to February and hot dry air during hot season from March to May. The climate of the area is semi-arid with average rainfall of 550 to 650 mm per annum (NNN, 2012). Soil samples were randomly collected before land preparation using soil auger from a depth of 0 to 30 cm across the experimental sites prior to planting, bulked and composite soil was taken and analyzed for physical and chemical properties using standard procedure as described by Black (1965).

The experimental area was harrowed to a fine tilth. The land was then marked into plots of 4 m x 4.5 m (18 m<sup>2</sup>). Border spaces of 0.5 m and 1.5 m were left between plots and replicates, respectively. Treatment consisted of *Topstar* (*oxadiargyl*) pre-emergence herbicide at the rate 600 and 400 ml ha<sup>-1</sup>; *Cranstan Spectrum* (fluroxypyr-meptyl and cyhalofop-butyl) post-emergence herbicide at 1250 and 800 ml ha<sup>-1</sup>; hoe weeding at 3 and 6 WAS; and weedy check as control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replicates. The gross plot size consisted of 6 rows each measured 4 m long and 4.5 m wide (4m x 4.5 m = 18 m<sup>2</sup>). While the two inner ridges 4 m x 1.5 m (6 m<sup>2</sup>) constituted the net plot. The nursery beds of Faro 44 variety of 6 m x 3 m (18 m<sup>2</sup>) were made. The beds were fertilized with NPK 15:15:15 at 50 gm<sup>-2</sup>. Rice seeds were sown by drilling at an inter-row spacing of 30 cm. Seedlings were transplanted 3 weeks after planting when they were at 4 to 5 leaf stage. Gap filling was done within 7 to 10 days after transplanting (DAT) of rice seedlings to maintain the plant population. The first fertilizer dose was applied at the rate

of 400 kg NPK 15:15:15 per hectare as basal at 1 WAT. The second dose was applied at 4 WA, while Urea-46 was applied at 8 WAT. The pre-emergence herbicide (*Topstar*) was applied immediately after planting in the nursery while post-emergence herbicide (*Cranstan*) was applied at 3 weeks after sowing (WAS) on treatment basis. Hoe weeding was carried out at 3 and 6 WAT for the hoe weeded treatment only. Pests and diseases were controlled with appropriate recommended *Phyto* sanitary measures. Harvesting was done when 80 to 85% of the panicles turned yellow and grains in the lower part of the panicle are hard and not easily broken when squeezed between teeth. At that time the moisture content is assumed to be 18 to 25%. The crop from the net plot area was harvested manually with the aid of sickle. Harvested plants were air-dried for 5 days. The grains were threshed and winnowed manually. Data were collected on the following weed and yield parameters weed cover score weed dry weight, panicle weight, 1000 grain weight and grain yield.

## Statistical analyses

Data collected were subjected to analysis of variance (ANOVA). Means that are significantly different were separated using least significant difference (LSD). The relationships between the parameters were determined using correlation analysis.

## RESULTS

Details of physico-chemical properties of soils at the experimental site is shown on Table 1. The results showed that the textural class of the soil was sandy loam, pH in water was slightly acidic (5.44), total nitrogen was moderate (0.16 g kg<sup>-1</sup>), available phosphorous was moderate (17.31 mg kg<sup>-1</sup>), organic carbon was also moderate (1.28) g kg<sup>-1</sup> and the exchangeable cations were, moderate Calcium (3.99 cmol kg<sup>-1</sup>), high Magnesium (1.50 cmol kg<sup>-1</sup>), medium Potassium (0.22 cmol kg<sup>-1</sup>), high Sodium (0.56 cmol kg<sup>-1</sup>) and low Cation Exchange Capacity (1.30 cmol kg<sup>-1</sup>).

Weed cover score significantly responded to weed control treatment at 8 and 12 WAT, the weedy check consistently recorded the highest value for weed cover which was followed by plots treated with *Cranstan* at 800 ml ha<sup>-1</sup>. The remaining weed control measures recorded least value for weed cover score (Table 2). There was significant effect of weed control treatments on weed dry weight at all sampling periods. The highest weed dry weight was recorded in the weedy checks likewise all other weed control treatments recorded similar and least weed dry weight.

Hoe weeding at 4 and 8 WAT recorded highest panicle length which in turn were at par with plots treated with herbicides at all rates but significantly higher than the weedy check (Table 3). Plots treated with *Topstar* at 600

**Table 1.** Analyzed at the soil science laboratory, Kebbi State University of Science and Technology, Aliero.

Soil characteristics	Results
<b>Particle size distribution (g kg<sup>-1</sup>)</b>	
Sand	540
Silt	360
Clay	100
Textural class	Sandy loam
<b>Chemical composition</b>	
pH in water (1:2.5)	5.44
pH in 0.01M CaCl <sub>2</sub> (1:2.5)	5.94
Organic carbon (g kg <sup>-1</sup> )	1.28
Total nitrogen (g kg <sup>-1</sup> )	0.16
Available phosphorus (mg kg <sup>-1</sup> )	17.31
<b>Exchangeable bases (cmol kg<sup>-1</sup>)</b>	
Calcium (Ca)	3.99
Magnesium (Mg)	1.50
Potassium (K)	0.22
Sodium (Na)	0.56
Cation Exchange Capacity (C.E.C)	1.30

**Table 2.** Effect of weed control treatment on weed cover score and weed dry weight (gm<sup>2</sup>) of rice at Birnin Kebbi during 2019 wet season.

Weed control	Weed cover score			Weed dry weight (g m <sup>-2</sup> )		
	4WAT	8WAT	12WAT	4WAT	8WAT	12WAT
<i>Topstar</i> (ml ha <sup>-1</sup> )						
400	1.67	2.33b	2.33b	7.27b	15.07b	28.47b
600	1.33	1.00c	1.67c	3.07c	8.93d	14.60c
<i>Cranstan</i> (ml ha <sup>-1</sup> )						
800	2.00	2.95b	2.67b	6.23b	17.07b	32.37b
1250	2.67	2.00c	2.67b	6.70b	12.73c	22.67b
Hoe weeding	1.00	2.00c	1.67c	3.07c	13.87c	17.23b
Weedy check	3.45	4.00a	5.67a	15.87a	20.07a	67.60a
LSD <sub>0.05</sub>	0.87	1.04	1.00	2.56	3.07	8.15

Means followed by the same letter (s) within a column in each treatment are not significantly different at 5% using LSD \* = Significant at 5%, NS = not significant. ml ha<sup>-1</sup> = milligram per hectare, WAT = weeks after Transplanting.

ml/ha produced a greater number of grains per panicle that was comparable to plots weeded twice at 3 and 6 WAT and the weedy check plots recorded the least value for number of grains per panicle. Higher value for 1000 grain weight was recorded in the *Topstar* treated (600 ml ha<sup>-1</sup>) than the other weed control treatments and the weedy check had the least. Likewise, a similar trend was observed in the grain yield per hectare.

## DISCUSSION

*Topstar* at higher rate of 600 ml ha<sup>-1</sup> effectively control

weeds by inhibiting cell division and elongation of weed seed beyond the critical period of rice growth. This minimized competition for growth resources between the crops and the weeds particularly during the critical period of weed interference, leading to greater efficiency in utilizing growth and yield resources by the crop. This also led to vigorous crop growth and development of larger vegetative parts and consequently achieving a high light interception for increased dry matter production and yield. This result is in line with findings of Ajala et al. (2018) who reported significant decrease in weed infestation when treated with herbicide on rice. However, weedy check had

**Table 3.** Effect of Weed control treatment on panicle length, number of grain per panicle, 1000 grain weight and grain yield of Rice at Birnin Kebbi during 2019 wet season.

Weed control	Panicle length (cm)	Grain number per panicle	1000-grain weight (g)	Yield (t ha <sup>-1</sup> )
<i>Topstar</i> (ml ha <sup>-1</sup> )				
400	21.27a	74.33b	18.97c	2.59c
600	25.27a	123.00a	28.33a	3.49a
<i>Cranstan</i> (ml ha <sup>-1</sup> )				
800	23.21a	82.67b	19.33c	2.42c
1250	25.59a	107.00b	24.67b	3.07b
Hoe weeding 4 & 8 WAT	26.40a	120.00a	26.33b	3.05b
Weedy check	12.77b	47.67c	11.67d	0.23d
LSD <sub>0.05</sub>	3.20	17.34	2.65	0.45

Means followed by the same letter (s) within a column in each treatment are not significantly different at 5% using LSD  
 \*= Significant at 5%, NS= not significant. ml ha<sup>-1</sup> = milligram per hectare, WAT= weeks after Transplanting.

significantly higher weed cover and weed dry weight than the 2-hoe weeded control and application of *Topstar* and *Cranstan* at all rates, this could be attributed to intense competition for scarce resources between weeds and crop plants. This result is in accordance with the finding of Na-Allah et al. (2017) who reported that weedy check treatments had significantly higher weed cover score and weed dry weight than application of herbicide and hoe weeding on cowpea.

The positive response of most of the yield component and grain yield such as panicle length, panicle weight, 100-grain weight and grain yield to weed control treatments could also be attributed to effective weed control management and the ability for weed control measure applied which control weeds beyond the level that can have a harmful effect on the performance of rice crop. This result is in line with the findings of Ajala et al. (2018) who reported increased in yield and yield attributes of rice due to application of herbicide to weed in rice field.

## Conclusions

Based on the findings of this research it could be concluded that application *Topstar* at 600 ml ha<sup>-1</sup> gave the best result in weed management and highest value in growth and yield components.

## Recommendation

*Topstar* at 600 ml ha<sup>-1</sup> is recommended for rice production in the study area.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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