Correlation Study on Growth and Yield Components of Rice (*Oryza sativa* L.) Varieties Grown under Integrated Weed Management in Sudan Savanna of Nigeria

ABSTRACT

Weeds are the most prominent of all rice biotic stresses across all the ecologies in terms of yield reduction and increased cost of production. Weed control is therefore one of the most important and suggestive practices for potential rice production. Based on the above, field trials were carried out during 2017/2018 dry season at the Teaching and Research Fadama farm of the Kebbi State University of Science and Technology located at Jega (Latitude 12^0 21ˈN; Longitude 4^0 36ˈE) and that of Usmanu Danfodiyo University Sokoto located at Kwalkwalawa (Latitude 13^0 01ˈN, Longitude 5^0 09ˈE) to study the correlation between yield and selected parameters of some rice varieties grown in an integrated weed management (IWM) system. Both locations lie within the Sudan Savanna ecological zone of Nigeria. The experiment was done between December, 2017 and August, 2018. The treatments consisted of six (6) weed management options (Solarization/Orizo-plus (3WAT)/Hoe-weeding (6WAT), Round-up/Orizo-plus(at 3WAT)/Hoe-weeding (6WAT), Solarization/Hoe-weeding (3WAT)/Hoe-weeding (6WAT), Round-up/Hoe-weeding (3WAT)/Hoe-weeding(6WAT), Weedy-check and Weed-free) and three (3) rice varieties (Jamila, Faro 44 and Faro 57). The factorial combinations of the treatments were laid out in a randomized complete block design (RCBD) with split-plot arrangement, replicated three times. Weed management options formed the main plots while rice varieties were assigned to the sub-plots. Based on the results of this study, it could be concluded that high weed density in rice field causes poor rice growth and reduces grain yield (r=-0.757). Also, increase in number of leaves, number of tillers, leaf area index, percent productive tillers, length of panicle, weight of panicle and 1000-grain weight resulted to increased grain yield. Therefore, factors that encourage the performance of those parameters can be explored for high rice grain yield.

Key-words: Correlation; Integrated weed management; rice varieties; Sudan savanna

1. INTRODUCTION

Rice belongs to the genus *Oryza* and the tribe *Oryzeae* of the family *Gramineae* also known as *Poaceae*. The genus *Oryza* contains 25 recognized species, of which 23 are wild species and two (*O. sativa* and *O. glaberrima*) are cultivated [1]. *O. sativa* is the most widely grown of the two cultivated species. It is grown worldwide including Asian, North and South American, European Union, Middle Eastern and African countries.

Rice constitutes major staple foods in many parts of the world. They supply one or more of carbohydrates, proteins and fats) and also minerals vital for survival and health [2]. Rice supplies 2,808 calories/person/day which represent 21% of the total calories needed and it is a source of income to more than 100 million household around the world [3]. Rice stands out as the major food crop for about a half of human race. Globally, rice ranks third after wheat and maize in terms of production [2]. 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 a wide number of ecosystems [3].

[4] defined weeds as unwanted plants, which succeed in the struggle for existence in competition with crops. Weeds compete with crops for the limited environmental resources such as light, water, nutrients and even space. Weeds also serve as alternate hosts to pests and pathogens

which usually affect crops in the field and during storage [5]. Previous studies have shown that weed occurrence is a constant component of the ecosystem in comparison to the epidemic nature of other pests which makes farmers unaware of the significant losses they incur from weed infestation [6]. The percentage losses due to unchecked weed growth on different cereals are appreciable in crops like wheat, maize, sorghum, rice, rye, oats etc. [7]. [8] and [9] reported a positive correlation between weed density and weed competition. A negative and highly significant correlation between weed dry weight and crop yield was also reported by [10] in Irish potatoes and [9] in garlic.

[11] said that variety is one of the most important factors to be considered for getting increased rice production. Using high yielding crop varieties competitive against weeds in combination with other methods of weed control is one of the most economical approaches to attain optimal crop yield [12]. The activities of West Africa Rice Development Association (WARDA) now called Africa Rice Center (AfricaRice) with the National Agricultural Research Institutions (NARIs), leading to the formation of Task Forces in different areas of rice research from breeding to natural resources management has led to the release of FAROs 38 to FARO 57 rice varieties [13].

In view of the above discussion, the present study was undertaken to study the correlation between yield and selected parameters of some rice varieties grown in an integrated weed management (IWM) system.

2. MATERIALS AND METHODS

2.1 Experimental Site

The trials were carried out during 2017/2018 dry season at the Teaching and Research Fadama farm of the Kebbi State University of Science and Technology located at Jega (Latitude 12^0 21'N; Longitude 4^0 36'E) and that of Usmanu Danfodiyo University Sokoto located at Kwalkwalawa (Latitude 13^0 01'N, Longitude 5^0 09'E). Both locations lie within the Sudan Savanna ecological zone of Nigeria.

2.2 Treatments and Experimental Design

The treatments consisted of six (6) weed management options (Solarization/Orizo-plus(3 weeks after transplanting [WAT])/Hoe-weeding(6WAT), Round-up/Orizo-plus(3WAT)/Hoe-weeding(6WAT), Solarization/Hoe-weeding(3WAT)/Hoe-weeding(6WAT), Round-up/Hoe-weeding(3WAT)/Hoe-weeding(6WAT), Weedy-check and Weed-free) and three (3) rice varieties (Jamila, Faro 44 and Faro 57). The factorial combinations of the treatments were laid out in a randomized complete block design (RCBD) with split-plot arrangement and were replicated three times. Weed management options formed the main plots while rice varieties were assigned to the sub-plots. The dimensions of the individual plots were 4x3m ($12m^2$). Main-plots were spaced at 0.7m apart; blocks at 1.5m apart and water channels were well constructed for effective irrigation. The inter and intra-row spacing was 20×20cm with two seedlings per stand and 20 rows of 15 stands in each plot. The net plot area ($2m^2$) contained the ten (10) middle rows for growth and yield assessment; while the boarder rows were used for destructive sampling.

2.3 Cultural Practices

The fields were cleared, ploughed, harrowed and leveled. Three nursery beds, one each for FARO 44, FARO 57 and Jamila variety of 5x2m ($10m^2$) were made. The beds were fertilized with nitrogen-phosphorus-potassium (NPK) 15:15:15 at $50gm^{-2}$. Rice seeds were sown by drilling at an inter-row spacing of 30cm. Irrigation was made in every two days interval to supply adequate water. Rice seedlings were transplanted four (4) weeks after sowing when the seedlings were at 4-5 leaf stage at a spacing of 20x20cm. Transplanting at Jega location took place on 13th March, 2018 while Sokoto location was on 22nd March, 2018. The plant population was 250,000 plants per hectare. Gap filling was done after one (1) week of transplanting to maintain the plant population in the experimental field. Basal application of NPK 15:15:15 fertilizer was done at the rate of 45 kg ha^{-1} of N, K_2O and P_2O_5 before transplanting. Urea was applied in split form at 4 weeks after transplanting (WAT) (46 kg ha^{-1}N) and 8WAT (44 kg ha^{-1}N). Surface irrigation method was used to fill up the basin, every three (3) days interval from transplanting and was later increased to two (2) days interval when evapotranspiration increased. The weed control was done as per treatment. Each variety was harvested when 80-85% of the panicle turned yellow and grains in the lower part of the panicles were hard and not easily broken when squeezed between the teeth.

2.4 Data Collection

Four (4) plants were randomly selected and tagged from each net plot. Plant height, number of leaves, number of tillers and leaf area index were assessed from the tagged plants at 6, 8 and 10 weeks after transplanting. The total number of weeds from $1m^2$ quadrat (weed density) of each plot was collected from the net plot at 3, 6, 9WAT and at harvest. Collected weeds were air-dried and later oven-dried at 75°C to a constant weight. Electronic weighing balance was used to measure the dry weight and expressed as g per m^2. The number of days from planting to 50% heading was recorded for each plot. Productive tillers (those with panicles) per square meter were counted within each net plot using a $1m^2$ quadrat before harvesting the crop and the values obtained were used to express the percent of the productive tillers. Length and weight of panicle were taken from four (4) randomly selected stands of each net plot with the aid of a meter rule and electronic weighing scale before harvesting and mean values were recorded. A total of 250 grains were counted from each net plot and weighed with the help of an electronic weighing balance. The result was multiplied by four (4) to obtain 1000 grain weight of each net plot. Grain yield of each net plot was taken after harvesting.

2.5 Statistical Analysis

The data generated were subjected to analysis of variance using general linear model (GLM) of the Statistical Analysis System package as described by [14]. The treatments were separated using the Duncan's Multiple Range Test [15]. Correlation coefficient analyses were carried out to study the relationship among the parameters measured.

3. RESULTS AND DISCUSSION

3.1 Correlation Analysis

The mean correlation of both locations for yield and other growth and yield components is presented in Table 1.

It was observed that most of the parameters considered had significant correlation with grain yield except days to 50% heading (r=0.061). Negative and significant association was obtained between grain yield and weed dry matter (r=-0.757). Plant height at 10WAT had negative and significant correlation with weed dry matter at harvest (r=-0.367), but negative and non-significant relationship with number of leaves at 10WAT (r=-0.180) and number of tillers at 10WAT (r=-0.126). Plant height had positive and no significant relationship with leaf area index (r=0.045) and days to 50% heading (r=0.158) while other parameters had positive and significant correlation with plant height at 10WAT. Number of leaves at 10WAT showed no significant relationship with length of panicle (r=0.214) and days to 50% heading (r=-0.228) but had negative correlation with weed dry matter at harvest (r=-0.401) while other parameters had positive and significant correlation with number of leaves. Number of tillers at 10WAT showed no significant relationship with length of panicle (r=0.226) but had negative correlation with days to 50% heading (r=-0.278) and weed dry matter at harvest (r=-0.527) while other parameters had positive and significant correlation with number of tillers. Leaf area index at 10WAT negatively correlated with weed dry matter at harvest (r=-0.469), but showed negative and no significant correlation with days to 50% heading (r=-0.163), while other parameters showed positive and significant correlation. Days to 50% heading were not significant correlated with all the parameters considered. Percent of the productive tillers had positive and highly significant correlation with length of panicle (r=0.484), weight of panicle (r=0.748) and 1000-grain weight (r=0.703), but negative significant correlation with weed dry matter at harvest (r=-0.858). Length of panicle was highly significantly correlated with weight of panicle (r=0.544), 1000-grain weight (r=0.541) but had negative significant correlation with weed dry matter at harvest (r=-0.414). Weight of panicle had positive and highly significant association with 1000-grain weight (r=0.857) but negative and significant correlation with weed dry matter at harvest (r=-0.689). 1000-grain weight was highly significant and negatively correlated with weed dry matter at harvest (r=-0.591).

3.2 DISCUSSION

The relationship between weed dry matter and most of the growth and yield characters investigated was highly significant and negative at both locations and the combined. This implies that as weed dry matter increased, rice growth and yield decreases due to competition for growth factors between the rice plant and weeds. This observation is in conformity with the work of [10] in Irish potatoes, [16] in wheat, [17] in cowpea and [18] in triticale.

Positive and highly significant correlation was observed between grain yield and growth characters such as number of leaves, number of tillers and leaf area index. This indicates the importance of good vegetative development necessary for high yield and implies that yield could be highly dependent on these factors. This agrees with the findings of [19] and [16] in wheat. However, there was no significant correlation between grain yield and plant height at Jega location, while Sokoto location gave a highly significant correlation between plant height and grain yield.

When the association between grain yield and the yield component such as percent of the productive tillers, length of panicle, weight of panicle and 1000-grain weight was examined for both locations, significant correlation was noted. This result is a clear indication of inter-dependency within and between the characters. This agrees with the findings of [19] and [16] in wheat.

Table 1. Correlation matrix among yield, growth parameter, yield components and weed dry matter of rice for the combined locations during 2017/2018 dry season.

	1	2	3	4	5	6	7	8	9	10	11
Grain yield ha^{-1}	1.000										
Plant height (10WAT)	0.355**	1.000									
Number of leaves (10 WAT)	0.562**	-0.180ns	1.000								
Number of tillers (10 WAT)	0.607**	-0.126ns	0.951**	1.000							
Leaf area index (10 WAT)	0.646**	0.045ns	0.930**	0.899**	1.000						
Days to 50% heading	0.061ns	0.158ns	-0.228ns	-0.278*	-0.163ns	1.000					
Percent productive tillers	0.992**	0.281*	0.607**	0.663**	0.660**	-0.168ns	1.000				
Length of panicle	0.534**	0.362**	0.214ns	0.226ns	0.278*	0.146ns	0.484**	1.000			
Weight of panicle	0.907**	0.446**	0.393**	0.450**	0.508**	0.226ns	0.748**	0.544**	1.000		
1000-grain weight	0.851**	0.408**	0.329**	0.379**	0.448**	0.151ns	0.703**	0.541**	0.857**	1.000	
Weed dry matter (Harvesting)	-0.757**	-0.367**	-0.401**	-0.527**	-0.469**	0.223ns	-0.858**	-0.414**	-0.689**	-0.591**	1.000

1. Grain yield ha^{-1}, 2. Plant height (10 weeks after transplanting [WAT]), 3.Number of leaves (10 WAT), 4. Number of tillers (10 WAT), 5. Leaf area index (10 WAT), 6. Days to 50% heading, 7. Percent productive tillers, 8. Length of panicle, 9. Weight of panicle, 10. 1000-grain weight, 11. Weed dry matter (Harvesting), ns = not significant, * = significant at 5%, ** = significant at 1%

4. CONCLUSION

The result of the study indicated that high weed density in rice field causes poor rice growth and reduces grain yield. Also, increase in number of leaves, number of tillers, leaf area index, percent productive tillers, length of panicle, weight of panicle and 1000-grain weight resulted to increased grain yield. Therefore, factors that encourage the performance of those parameters can be explored for high rice grain yield.

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