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RELATIONSHIP BETWEEN GROWTH AND YIELD CHARACTERS WITH GRAIN YIELD OF RICE UNDER SYSTEM OF RICE INTENSIFICATION (SRI) IN KURU. PLATEAU STATE NIGERIA.

Nasamu Azebeokhai Michael* And Garba Ali. A

Faculty Of Agriculture And Agricultural Technology. Department Of Crop Production. Abubakar Tafawa Balewa University, Bauchi. Nigeria

*Corresponding Author:

Nasamu Azebeokhai Michael

ABSTRACT

A Field experiment was conducted in Kuru Plateau State, Nigeria to study the relationship between growth and yield characters with grain yield of rice. The experiment was carried out during the 2016, 2017 and 2018 wet and dry seasons. Variety FARO 44 was used to first test the effect of seedling age, row spacing and seasons on the performance of the crop. However, results from the first year trial which indicated the highest yielding plots which happened to come from 19 day old seedlings spaced at 25cmx25cm were subsequently used for the correlation studies. Randomized Complete Block Design (RCBD) with three replicates were used. Pearson's correlation coefficient was calculated using SPSS version 21.Data were collected from 160randomly selected plants from each replicates on plant height (cm), number of tillers per plant, panicle length (cm), number of panicles/hill, panicle weight (g), spikelet/panicle and 1000 seed weight (g). The result showed that grain yield was significantly and positively correlated with number of tillers(r =0.355**), number of panicles/hill (r=0.313**), number of spikelet/panicle (r=0.283**) and 1000 seed weight (r=0.350**). The multiple regression model with all 7 predictors (number of tillers, plant height, panicle length, number of panicles/hills, panicle weight, number of spikelet/panicles and 1000 seed weight), with the coefficient of determination $R^2 = 0.386$, $F(7,82) = 7.356$, $P<0.0005$. It was observed that number of tillers, panicle/hill, spikelet/panicle and 1000 seed weight all added significantly ($P\leq0.05$) to grain yield. However, no single character was enough to confer absolute responsibility to contribution of grain yield of rice in the study area.

Key words: seedling age, row spacing, transplanted, FARO 44,

1. INTRODUCTION

Rice (*Oryza sativa*) is a major staple food crop for millions of people in West Africa and the fastest growing commodity in Nigeria food basket Oladimeji and Abdulsalam, (2014). The demand for rice has been increasing in much faster rate in Nigeria than in most other sub-Sahara Africa countries since the mid-1970s, for example, Nigeria per capita rice consumption level has increased significantly from 18kg in the 1980s to 22kg in the 1990s. Although rice production in Nigeria has boomed over the years, there has been a considerable lag between production and demand level with imports making up the shortfall. Therefore as population increases with increase in rural-urban migration leading to rapid urbanization, there is the need to increase the rice grain production to enhance food security and poverty reduction. The target of the Federal Ministry of Agriculture and Rural Development (FMARD), through the agricultural transformation agenda (ATA) was to ensure self- sufficiency in rice production by 2015. Among the steps that were taken to achieve the target of self-sufficiency is the commodity value chain approach which was promoted by FMARD through the ATA program. Some of the steps take in this regard is the use of high yielding varieties and good quality inputs. Greater percentage of rice output in Nigeria is produced by smallholder farmers with land holding of between 1 to 2 hectares with an average yield of 1.8T/ha. Estimates by AfricaRice center (2014), Singh et al (1997) and Imolehin and Wada (2000)put potential and actual areas for rice production at 4.6 to 4.9 million hectares and 1.77 million hectares respectively. Out of the actual land area under rice, an estimated output of 2.3 million tones is realized which translates to a low productivity of about 1.3T/ha, while potential yield could be as high as 6T/ha in rain fed lowland ecology (National Food Reserve Agency 2008). Given this low productivity and several other factors contributing to this yield gap, it become imperative to employ other system(s) such as the System of Rice Intensification (SRI), to increase productivity, replenish the soil and increase the farmers profit without necessarily increasing cost of production. However, it will be necessary to investigate the principal character (s) that would confer the absolute responsibility to grain yield of rice under the system of rice intensification in the study area.

2. MATERIALS AND METHODS

A Field experiment was conducted during the dry and wet seasons of 2016, 2017 and 2018 at the research farm of potato program, National Root Crops Research Institute (NRCRI), Kuru Plateau state, Nigeria, located at latitude 08° 44´N and longitude 09º 44´E. The experimental material variety used was FARO44 sourced from the National Agricultural Seed Council (NASC). It is a lowland variety otherwise known as Sippi 692033.It was developed by the West Africa Rice Development Association (WARDA) in collaboration with International Institute of Tropical Agriculture (IITA) and National Cereals Research Institute (NCRI). It is an interspecific hybrid between the local African rice and Taiwan rice. The variety is a medium maturing type, taking 110-120 days to mature, high yielding between 4 to 8t/ha, tolerant to blight and has long grains Dontsop *et al*., 2011.The treatments consisted of four seedling ages of 15,17,19 and 35-days after the seeds were sown in the nursery which corresponds to (10,12,14 and 30 days after emergence from the nursery) since the seeds in the nursery took 5 days to emerge above the ground. In addition, direct seeded plots considered as control, three inter and intra row spacings (15cm x 15cm, 20cm x 20cm and 25cm x 25cm) were used. These treatments were tested in two different cropping seasons (wet and dry) within a year for three years. The four-transplanted ages and control and the 3-row spacings gave fifteen treatment combinations which where factorially combined and laid out in Randomized Complete Block Design (RCBD) with three replications. System of Rice Intensification (SRI) methodology was applied and all necessary measures were taken to ensure an optimum yield such as recommended weed control, bonding and leveling the field. Data were collected in all 3 replicates on plant height (cm), number of tillers per plant, panicle length (cm), number of panicles/hill, panicle weight(g), spikelet/panicle, 1000 seed weight (g) and grain yield (kg/ha).Results from the first year trial were analyzed using Statistical Package for Social Sciences (SPSS) version 22 and Microsoft Excel 2010 in order to identify the plots with the highest yield that could be used for the correlation analysis. The result showed that the highest yielding plots were 19-day-old seedlings spaced at 25cmx25cm this was subsequently used for the correlation studies.

3. RESULTS AND DISCUSSIONS

Simple correlation coefficient of both growth and yield characters with grain yield of rice in 2016, 2017 and 2018 in Kuru, Plateau State are presented in Table 1.The result in all the three years showed significantly ($P \leq 0.05$) positive correlation, except on plant height which showed negative correlation with grain yield (r = - 0.162). Other agronomic characters studied had positive relationship with grain yield, and these include number of tillers (r = 0.355**), panicle length (r = 0.161), number of panicles/hills (r = 0.313**), panicle weight (r = 0.053), number of spikelet/panicle (0.283**) and 1000 seed weight (r = 0.350**). A multiple regression analysis was conducted to examine the extent of the relationship between yield and other growth and yield characters. Table 2 summarizes the results of combined/mean data values from 2016, 2017 and 2018 seasons. The multiple regression model with all 7 predictors (Number of tillers, plant height, panicle length, number of panicles/hills panicle weight, number of spikelet/panicles and 1000 seed weight), with the coefficient of determination R^2 = 0.386, $F(7,82)$ =7.356, $P<0.0005$. It was observed that number of tillers, panicle/hill, spikelet/panicle and 1000 seed weight all added significantly ($P \leq 0.05$) to grain yield.

The positive and significant coefficient between grain yield with other growth and yield components, explained the true relationship between grain yield and the studied characters. The result indicates that except for panicle length and weight that showed positive but non-significant correlation and plant height that showed negative and non-significant correlation, all the characters studied showed significant and positive relationship with grain yield. Characters like number of tillers, number of panicles/hill, number of spikelet/panicle and 1000 seed weight were significant and positively correlated with grain yield. These relationships means that increase in any one of the aforementioned yield components causes an increase in grain yield, even though with different effects.

The significant correlation between number of tillers (r = 0.355**) and grain yield depicts that tillering is an important factor for higher grain yield, since any increase in number of tillers is expected to result in an proportionate increase in grain yield. Tillering ability in rice is an important agronomic trait for grain production especially when the crop is transplanted early and spaced optimally as recommended by the system of rice intensification. Less transplanting shock is experienced when the rice plant is transplanted early for example at 19 days after being sown in the nursery with a spacing of 25x25cm compared to transplanting of 35 days old seedlings at same spacing. Ibrahim *et al*., 1990 earlier found out that production of tillers is the most reliable character in selecting genotypes of rice for higher yields. Tillering plays an important role in determining rice grain yield, since it is closely related to number of panicles/hill, where too few tillers are likely to result in fewer numbers of panicles. On the other hand, excess tillers result in higher tiller mortality, small panicles, poor grain filling and consequent reduction in grain yield. Peng *et al*., 1994 corroborated this finding. The FARO 44 variety used in the present study has the capacity to produce up to 100 functional tillers, therefore the mean number of tillers (70.661) produced in this investigation was not in excess of the crop's potential. The result of this research is in line with the earlier studies carried out by Gravois *et al*., 1992 and Garba *et al*., 2016 who reported the importance of number of tillers in determining rice yield. Similarly, studies carried out by Samonte *et al.,* 1998 and Oad *et al*., 2002 corroborated the present result.

However, the present investigation attempts to understand the association that exists between grain yield and growth and yield characters in a near temperate climate like Kuru, where temperatures during the early growth of the crop in the dry season could go as low as 15^{oc}.

The significant and positive correlation between number of panicles/hill and grain yield (r = 0.313**) in this study indicates the influence of the number of panicles in determining the final yield of rice. Number of panicles per hill has been known to affect yield capacity, as number of grains per unit area and potential size of grains determine yield capacity of the rice plant. This relationship is in line with an earlier study by Feil, 1992 and Samonte *et al.,*1998 that showed similar results. Number of spikelet/panicle is one of the most important components of yield, number of spikelet/panicle was positively and significantly correlated (r = 0.283**) with grain yield. The more the number of spikelets the higher the grain yield. Sharma and Chouby, 1985 and Prasad *et al.,*1988 also reported a significant correlation between grain yield per plant and number of spikelet. Spikelet per unit of land may be increased through cultural practices or by genetic manipulation, Matsushima, 1970 collaborated this finding. On the whole, the significant relationship between spikelet/panicle observed in this study however, contradicts an earlier report by Gravois and Helms, 1992, that number of spikelet/panicle exhibited very weak direct effect (r = 0.080) on grain yield. These discrepancies might be explained by another report by Yoshida, 1981that the components of the rice yield consisted of number of spikelets, percentage of filled spikelets and grain weight and that among these, number of spikelets was the most important component limiting rice yield, while grain weight rarely affected the crop yield. However, more investigation is needed to critically examine this phenomenon.

Association between seed weight and grain yield was positive and significantly correlated with each other (r = 0.355**). This positive correlation indicates the reliability of the 1000 seed weight as an index for yield determination in cereals, this was also observed by Eckebil *et al.*, 1977. Even though grain weight is a varietal trait and of secondary importance in determining rice yield, it is determined by the source capacity (photosynthetic leaves) to supply assimilates during the ripening period and also by sink capacity (developing grain) to accumulate the imported resources.

The non-significant correlation between panicle length (r = 0.161), panicle weight (0.053)and grain yield observed in this study showed that both characters had contributing effect to final grain yield, while the negative correlation between plant height (r=-.0162) and grain yield showed that plant height had no effect on grain yield. This result is corroborated by an earlier study Aris *et al.,* 2009 which concluded that number of productive tillers per hill, number of filled grains per panicle and spikelet fertility had positive correlation with grain yield of rice while on the other hand, plant height had negative correlation meaning that it did not contribute to the final grain yield.

Multiple regression analysis (Table 2) carried out, revealed that the major characters, which accounted for the highest grain yield are number of panicles per hill and number of spikelets/panicle. This result is in agreement with the findings of Sokoto *et al.,* 2012 working on wheat, who reported that most agro-physiological crop parameters had significant influence with grain yield in both dry and wet seasons hence, important in yield determination. The other characters may be less important in growing rice using the System of Rice Intensification (SRI) in Kuru, however no single character is enough to confer absolute responsibility to contribution of grain yield. Garba *et al.,* 2016 while working on sorghum advanced similar views.

CONCLUSIONS AND RECOMENDATIONS

According to the Pearson r conducted, grain yield correlates positively with number of tillers, number of panicles per hill, number of spikelet per panicle and 1000 seed weight. The result showed that transplanting 19-day-old seedlings at a row spacing of 25cmx25cm under the system of rice intensification could be a veritable method to increase productivity of rice in kuru and therefore could be recommended to the farmers

Table 1: Simple correlation coefficient between growth and yield characters of rice grown in Kuru Plateau State, Nigeria (3 years pooled)

Characters	Correlation(r)*	Mean	Std. Deviation
Yield	-	4.593	.973
Number of tillers	0.355**	70.661	4.722
Plant height	-0.162	66.302	11.403
Panicle length	0.161	21.586	0.891
Number of panicles/hills	0.313**	34.289	2.635
Panicle weight	0.053	28.177	3.220
Number of spikelet/panicle	0.283**	160.167	47.190
1000 Seed weight	0.350**	23.574	2.408

*Correlation coefficient (r) derived from 160 data value

**= Significant at 5% level of probability

Table 2: Multiple regression coefficient of grain yield in regards to growth and yield characters of rice grown in Kuru, Plateau State (3 years pooled)

Variables	Coefficient	SE	t- value	p- value
Number of tillers	0.171	0.021	8.142	.004*
Plant height	-0.424	0.013	-32.615	0.006*
Panicle length	0.151	0.110	13.727	.137ns
Panicle/hill	0.225	0.036	6.250	0.024*
Panicle weight	-0.086	0.046	-1.869	0.78ns
Spikelet/panicle	0.055	0.003	18.333	.000*
1000 seed weight	0.194	0.037	5.243	0.036*

Ns = Non- significant. *= Significant at 5% level of probability

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