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Effect of Seed Coating and Burkina Rock Phosphate on the Growth and Yield of Rice

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ABSTRACT

Purpose: *Coordinated soil richness management innovation fits into the position of resource for poor cultivating on an Afisol in the Guinea savannah zone of Ghana. The research was conducted to determine the effect of seed coating and Burkina rock phosphate on the growth and yield of rice at University for Development Studies in Nyankpala near Tamale in the Northern Region of Ghana. The study aimed is to determine the interaction of Burkina rock phosphate and Triple superphosphate on the growth and yield of rice.*

Research Method: *The experiment was a 2x3 factorial laid in randomized complete block design replicated six times. Factor one consisted of two levels such as, coated rice seed and non-coated rice seed whilst factor two consisted of three levels of (P) phosphate; (Burkina rock phosphate, Triple superphosphate and Non-Phosphate (control) were all treatments). The research was design to determine the interaction of coated seed and Burkina rock phosphate on the growth and yield of rice. However, treatment 1, 2, 3, 4, 5, 7 and 8 were the main plot whiles treatment 6, 9 and 10 were the sub-plots. The parameters measured included plant height, gravimetric soil moisture content, tiller count, effective tiller count, chlorophyll content, days to 50% flowering, plant height at harvest, straw biomass and grain yield.*

Findings: *The outcome of the results obtained on treatment 1 shows significant on moisture content when coated seed of rice recorded highest among the treatments (Figure 02). Besides, similar results were obtained on plant height when coated seed of rice was compared with non-coated seed of rice on week after planting which confirmed significantly on 3, 6 (WAP) week after planting on Burkina rock phosphate and Triple superphosphate whiles non-coated seed of rice, Burkina rock phosphate and Triple superphosphate were significant on 6, 9 (WAP) week after planting (Figure 03 and Figure 04). Moreover, the results obtained gave similar outcomes when coated seed plus non-coated seeds of rice on treatment 1 and 4 were compared which shows significant on Burkina rock phosphate and Triple superphosphate on grain yield and straw weight (Figure 10 and Figure 11). However, among the treatment applied on tiller count phosphate (P_2O_5) was significant whiles Burkina rock phosphate and Triple superphosphate were significant on effective tiller count with coated seed plus non-coated seed of rice (Figure 05 and Figure 06). Comparatively under Burkina rock phosphate, coated seed of rice was significant in chlorophyll content whiles coated seed of rice shows significant among treatments on chlorophyll content at harvest (Figure 07 and Figure 08). Overall, results obtained on coated seed plus non-coated seed of rice on days to 50% flowering was significant on Burkina rock phosphate (BRP) and phosphate (P_2O_5) (Figure 09).*

Research Limitation: *Deficiency of Burkina rock phosphate and Triple superphosphate resulted on the growth and yield.*

Originality/ Value: *The experiment should further be repeated for confirmation of results on effect of coated seed and Burkina rock phosphate on the growth and yield of rice in the lowland ecology.*

Keywords: *Burkina Rock Phosphate, Rice, Seed Coating, Triple Superphosphate*

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INTRODUCTION

The genus *Oryza* belongs to the family and sub-family Grammineae and bambusiodeae respectively. Rice cultivation is practiced by farmers worldwide. Rice is a major food grain for a large population of people in the Europe, Africa, tropical and temperate zones, particularly in the Asian countries. The crop is almost exclusively cultivated as a human food. Processing rice for human consumption produces rice bran which can be used as livestock feed-stuff. As a result, Ghana is a net importer of both rice and wheat. The post estimates Ghana's rice imports in 2017/18 at 550,000 million tons, down slightly year-to-year due to growing domestic production (Irwin *et al.,* 2011). Besides, one of the principle constraints of rice production is low soil fertility. However, seed coat is a multifunctional organ that plays a critical role in embryo nutrition during seed development and protection against detrimental agents from environment afterward (Mohamed-Yaseen *et al.,* 1994; Bewley and Black, 1994; Bradford, 2002). In Cambodia, 85% of the absolute rice growing area is rainfed lowland and more than 60% of the soils in these areas are low in extractable soil P (Pheav *et al.,* 2003). However, the residual valve of P from triple superphosphate (TSP) on sub-sequent rice crops on sandy loam soils were considerable, but decreased rapidly, whereas that of phosphate rock (PR) was relatively low but persisted for a longer time. Similar finding were reported earlier by (Robertson *et al.,* 1996) on lateritic soils. Moreover, adequate supply of phosphorus early in the life of a plant is important in the development of its reproductive parts. Large quantities of phosphorus are found in seed and it is considered essential with increased in root growth (Ojo and Olufolaji., 1991). According to Koloma *et al.,* (2015), rock phosphate is essential in root growth and is obtainable from neighbouring countries of Burkina Faso, Togo, Mali, Niger and Senegal. The coated seed exerts its germination-restrictive action most of the time by being impermeable to water and oxygen or by its mechanical resistance to radicle protrusion. These properties have been positively correlated with seed coat colour due to phenolic compound in diverse species (Debeaujon *et al.,* 2000). Therefore, the objectives of this study were to: (1) Determine the effect of seed coating on the growth and yield of rice. (2) Assess the effect of Burkina rock phosphate source of P on the performance of the rice. (3) evaluate the effects of seed coating and Burkina rock phosphate on the growth and yield of rice.

MATERIALS AND METHODS

Experimental Site

The field experiment was carried out during the 2012 and 2013 farming season (June – September) in the Tolon kumbungu district of the northern region at the Faculty of Agriculture (FOA), University for Development Studies (Figure 01). The experimental site had previously been cropped with rice characterized by natural vegetation and dominated by grasses with few shrubs and trees. It falls on the latitude 9° 25' 14' N and longitude 0° 58' 42' W, with an altitude of 183 m above sea level. The zone is located in the Guinea Savannah ecological zone and experiences mono-modal rain fall pattern beginning in May and end in October, annual rainfall between 900mm and 1000mm. Temperatures are high throughout the year with the highest of 36^0c in March and April. Lower temperatures are experienced between November and February (Issahaku *et al.,* 2016). The soil type of the experimental site was conducted on an Alfisol under USDA system of classification. The soil is sandy-loan with brown coloration, moderately drained, free from concretion, very slow with hard pan underneath the top few centimetres, developed from voltarian sand stone, classified as Nyankpala series-Plinthic Aerisol Mikkelsen *et al.,* (1997).

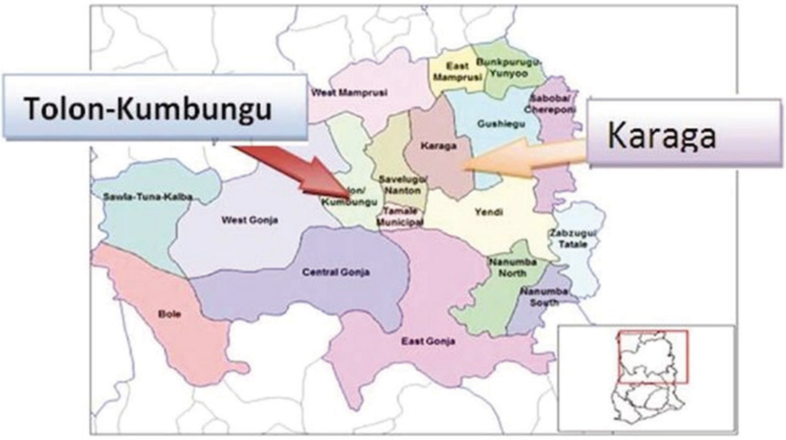

Figure 01: Show a map of experiment site in Tolon-Kumbungu.

Experimental Design and Treatments

The trial was a 2x3 factorial experiment consisting of two treatments with five levels. Treatment one consisted of two levels such as, coated rice seed and non-coated rice seed whilst treatment two consisted of three levels of (P) phosphate; Burkina rock phosphate, Triple superphosphate and Non-Phosphate applied on lowland at the basis of 135kg P_2O_5/ha, 135kg P_2O_5/ha and 0 kgP_2O_5/ha. Coated seed + Burkina Rock Phosphate (treatment 1), coated seed + Triple-super phosphate (treatment 2), coated seed + Non-phosphate (treatment 3), Non-coated seed + Burkina Rock Phosphate (treatment 4), Non-coated seed + Triple super phosphate (treatment 5), Non-coated seed + Non-phosphate (treatment 6 control). The experiment was laid in a randomized complete block design (RCBD) with five replications. The plots dimensions were 5m x 5m with an experimental plot size of 25m^2. A 1m alley space was between within a replication and 2m between replications respectively.

Land Preparation and Planting

The experimental field was harrowed a few days after it has been ploughed and levelled to create a favourable condition for planting and emergence of seedlings. The field was then laid with bunds made around each experimental plot to avoid erosion and prevent incident of losing soil fertility. Prior to planting of the rice, seeds were coated with Burkina rock phosphate (BRP), Triple superphosphate (TSP) to enhance decomposition and mineralization. Sowing was done with four seed per holes base on the plant density of rice plants which was set-upped at recommendation rate of 20 x 20cm in each plots. The rice was grown for four month in each plots.

Data Collection and analysis

Data collected from the experiment conducted included plant height, gravimetric soil moisture content, tiller count, effective tiller count, chlorophyll content, days to 50% flowering, plant height at harvest, grain yield kg/ha and straw biomass kg/ha. The height of five randomly selected plants were tagged and measured at 3, 6, 9 and 12 weeks after planting (WAP). The number of productive tillers count per plot was recorded by the use of 1m^2 quadrant at 50 days after planting (DAP). The quadrant were thrown twice in each plot randomly and effective tiller count was also counted at 15 weeks after planting (WAP) to compare the differences. Chlorophyll content was done using patented Apogee model MC-100 chlorophyll to measure leafs of 5 plant per plot. Besides, weeds on the experimental field was controlled at every 3 weeks interval by hand hoeing till harvest, to prevent/reduce weeds and insect infestation. Data were collected on the number of days to 50% rice flowering in each experimental plot. It was done by counting the number of days at which half or more of the total rice in each experimental plot flowered. The grain and straw yields of rice were harvested from each net plot and weighed. Grain weight was adjusted for grain moisture content (14%) at dryness. Data collected were subjected to the two-way Analysis of Variance (ANOVA) model using Genstat statistical package. Means were separated using Least Significant Difference (LSD) at 5%. Correlation and simple regression relationships were calculated.

RESULTS

Gravimetric Soil Moisture Content from each replication were taken at a depth of 5cm at the beginning of the experiment and final soil samples taken after harvesting. All collected soil samples were oven dried at a temperature of 105^0C for 24 hours to a constant dry weight to determine gravimetric moisture content using the relation:

%GMC = (W-D)/D X100…………eqn. (1)
Where;
GMC = Gravimetric Moisture Content (%),
W = Wet soil weight,
D = Dry soil weight.

There was a significant difference among the interactions on both coated seeds and non-coated seeds of rice. Among the coated seed of rice on moisture content Phosphate and Triple Superphosphate recorded the highest (Figure 02). Moreover, Plant height was done with five randomly selected plants tagged and measured at 3, 6, 9 and 12 weeks after planting (WAP). The interaction between phosphatic fertilizers and coated seeds of rice was not significant (p>0.05) at third, sixth and ninth week except for plant height at twelve week and at harvest. However, there was no significant difference (p>0.05) between phosphatic fertilizers and non-coated seed of rice except for twelve week after planting and plant height at harvest (Figure 03 and Figure 04). Tiller Count was recorded by the use of $1m^2$ quadrant at 50 days after planting (DAP) whilst effective tiller was counted at 15 weeks after planting (WAP) and the differences were compared. The application of phosphorus in the form of Burkina Rock Phosphate, phosphate and Triple Superphosphate enhanced tillering at all growth stages. However, significant difference (p < 0.05) was recorded between interaction of the phosphatic fertilizers and the coated seeds rice while there was no significant difference in the interaction between the phosphatic fertilizers and non-coated seeds of rice (Figure 05). Effective tiller count was significant difference (p< 0.05) observed among interaction means of phosphatic fertilizers and non-coated seeds of rice. However, interaction between phosphatic fertilizers and coated seeds of rice was not significant (p>0.05). Among the coated seeds and non-coated seeds of rice, phosphate recorded the highest effective tiller count (Figure 06). Besides, chlorophyll content was insignificant difference (p< 0.05) in both phosphatic fertilizers and non-coated seeds of rice in first chlorophyll content and chlorophyll content at harvest. However, among the coated seeds of rice and phosphatic fertilizers, there was a significant difference at the early stage but insignificant difference in first chlorophyll content at harvest respectively (Figure 07 and Figure 08). Days to 50% Flowering was done by counting the number of days at which half or more of the total rice in each experimental plot flowered. There was no significant difference (p>0.05) between the interactions of phosphatic fertilizers with both coated and non-coated seed of rice. However, phosphate recorded the highest mean value among the coated seeds of rice while BRP recorded the highest mean among the non-coated seeds of rice (Figure 09). Grain and Straw Yield of rice was harvested from each net plot, weighed and adjusted for grain moisture content (14%) at dryness. Phosphatic fertilizers influence the grain yield of coated and non-coated seeds of rice progressively. However, there was a significant difference (p< 0.05) among the interaction means of phosphatic fertilizers and non-coated seeds of rice while there was an insignificant difference between the interaction of phosphatic fertilizers and coated seeds of rice. Straw weight was significantly (p< 0.05) influence among the interaction between the phosphatic fertilizers and non-coated seeds of rice. However, interaction between the phosphatic fertilizers and coated seeds of rice was not significantly affected. Phosphate recorded the highest straw weight in both coated and non-coated seeds of rice respectively (Figure 10 and Figure 11).

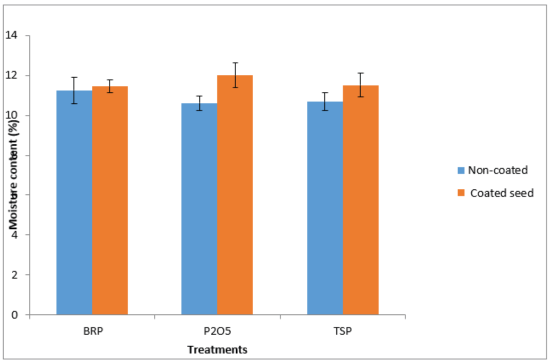

Figure 02: **Shows the mean sandy-loan moisture content for the various treatments. Bars represent SEMs.**

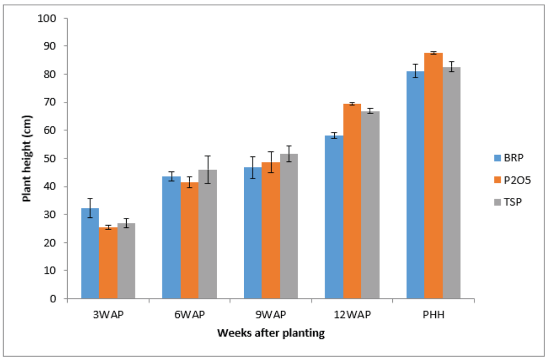

Figure 03: **Effects of Phosphatic fertilizers on plant height with coated seeds of rice. Bars represent SEMs.**

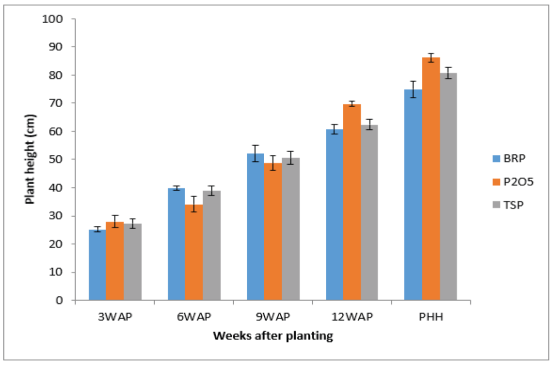

Figure 04: **Effects of phosphatic fertilizers on plant height with non-coated seeds of rice. Bars represent SEMs.**

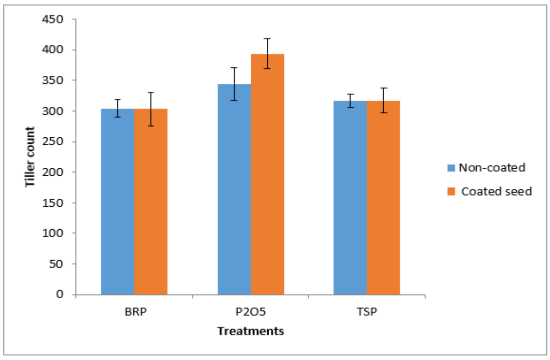

Figure 05: **Effects of Phosphatic fertilizers on tillers with coated seeds and non-coated seeds of rice. Bars represent SEMs.**

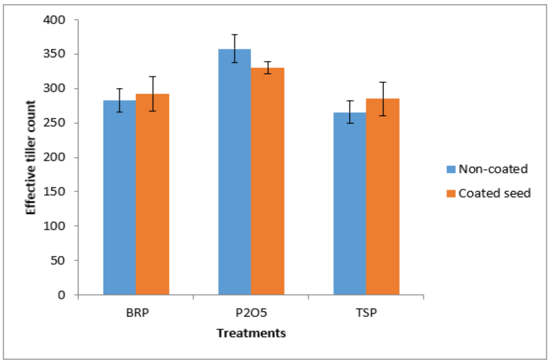

Figure 06: **Effects of phosphatic fertilizers on effective tillers with coated seeds and non-coated seeds of rice. Bars represent SEMs.**

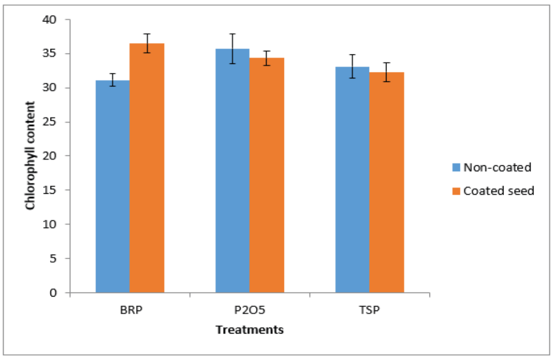

Figure 07: **Effects of phosphatic fertilizers on chlorophyll content with coated seeds and non-coated seeds of rice. Bars represent SEMs.**

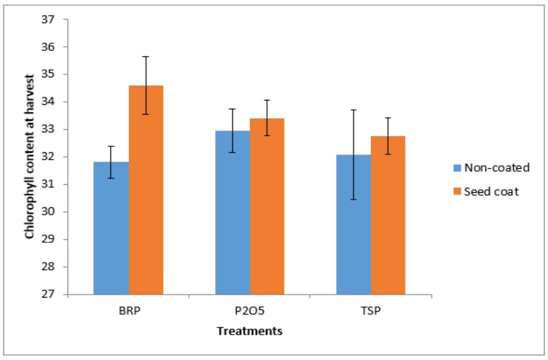

Figure 08: Effects of phosphatic fertilizers on chlorophyll content at harvest with coated seed and non-coated seeds of rice. Bars represent SEMs.

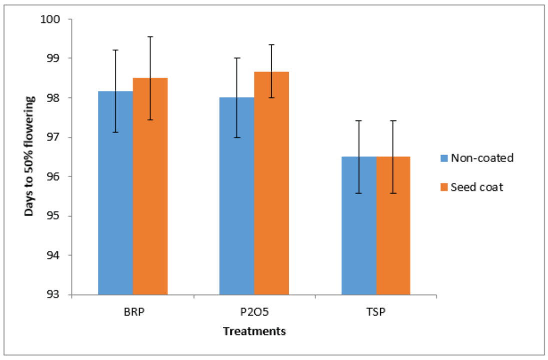

Figure 09: Effects of phosphatic fertilizers on flowering with coated seed and non-coated seeds of rice. Bars represent SEMs.

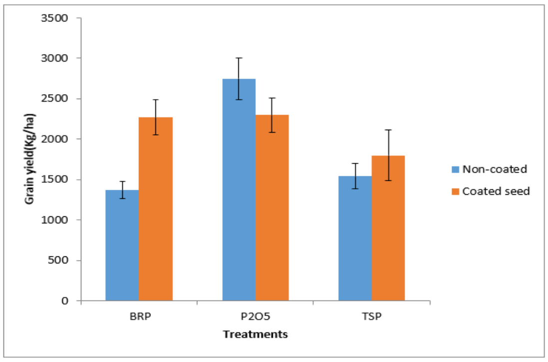

Figure 10: Effects of phosphatic fertilizers on grain yield with coated and non-coated seeds of rice. Bars represent SEMs.

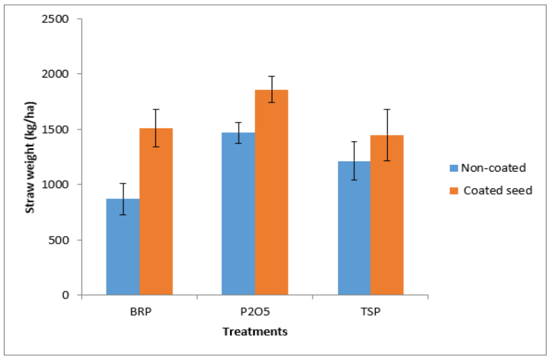

Figure 11: Effects of phosphatic fertilizers on straw weight with coated seed and non-coated seeds of rice. Bars represent SEMs.

DISCUSSION

The changes in gravimetric soil moisture content observed significant difference among the interactions on both coated seeds and non-coated seeds of rice on P_2O_5 and TSP (Figure 02). However, changes on soil moisture content had effect on rice at 12WAP and plant height at harvest and the tallest plants were recorded in a plot that received coated seeds. This could be due to the highly soluble nature of Phosphorus (P_2O_5) and Triple superphosphate (TSP) over Burkina Rock Phosphate (BRP) which makes P_2O_5 and Triple superphosphate (TSP) a readily available source of P to enhance growth at the early stage of rice. This is in line with (Biswas *et al.*, 2016; Hossaen *et al.*, 1970) that the combined application of fertilizers with manure increased plant height compared to single application of recommended dose of fertilizers. This revealed that all treatments received coated seed produced significantly taller plants compared to non-coated seeds at all stages of measurement (Figure 03 and Figure 04). However, among the coated seed of rice, Burkina Rock Phosphate (BRP) recorded the tallest plant on the 3 week after planting (WAP) and Triple superphosphate (TSP) recorded on the 6, 9 week after planting whiles Phosphorus (P_2O_5) recorded tallest plant on the 12 weeks after planting and at harvest (Figure 03). Meanwhile among the non-coated seed of rice, Phosphorus (P_2O_5) recorded tallest plant on the 3, 12 and plant after harvest whiles Burkina Rock Phosphate (BRP) recorded the tallest plant on the 6, 9 week after planting (Figure 04). The application of phosphatic fertilizer in the form of Burkina Rock Phosphate (BRP), Phosphorus (P_2O_5) and Triple superphosphate (TSP) on various plots enhances tillers at all growth stages. These indicated that lack of P in the soil reduces the growth formation. According to Graciano, *et al.,* (2006) when P is deficient in the soil its leads to retarded plant growth, tillering and reduce quality of produce. Based on the results on tiller count and effective tiller count, Phosphorus (P_2O_5) shows significant difference among interaction on treatment (Figure 05). Moreover, the result lead to the role of phosphorus in root development which enhances the absorption of nutrients. Similar results were observed by Tollens *et al.,* (2013), who reported that high phosphorus levels were needed to maximize tillering in rice. The highest grain yield was due to the combined effect of the seed coating and P sources. Besides maximum grain yield was recorded in the application of coated seeds to plot that received Burkina Rock Phosphate (BRP) and Triple superphosphate (TSP) whiles non-coated seeds also recorded the highest grain yield to the plot that received Phosphorus (P_2O_5). This concedes with Serme *et al.,* (2018) who reported that, integrated fertility management increase grain yield. Olufolaji and Ojo (2010) also reported that, large quantities of phosphorus are essential in seed formation.

CONCLUSION

The results of this study revealed that the interaction between phosphatic fertilizers and coated seeds of rice enhances plant height, tiller count, effective tiller count and days to 50% flowering (Figure 03, Figure 04, Figure and 05). However, the highest plant height was obtained at twelve weeks and at harvest between interaction of the phosphatic fertilizers and the coated seeds rice to plot that direct application of Burkina rock phosphate (BRP) and triple superphosphate (TSP). This implies that direct application of Burkina rock phosphate (BRP) and triple superphosphate (TSP) was effective on rice yield under lowland rice cultivation system. Therefore, future studies confirming the accuracy of coated seed simulations need to be conducted in order to develop better tools for accurate estimation of Burkina rock phosphate (BRP) and triple superphosphate (TSP) direct application's effect on rice cultivation in Guinea savannah zone.

RECOMMENDATIONS

Based on the results, this trial recommended that for optimum grain yield, Burkina rock phosphate (BRP) and triple superphosphate (TSP) application would be appropriate to lowland rice farmers in Guinea savannah zone. The trial should further be experimented for confirmation of results on effect of coated seed and phosphatic fertilizer on the growth and yield of rice on lowland.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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