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EFFECTS OF RICE HUSK ASH AND POTASSIUM FERTILIZER APPLICATION ON YIELD AND YIELD COMPONENTS OF RICE (*Oryza sativa* L.)

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Abstract:

The pot and Field experiments were conducted at Department of Soil and Water Science (YAU Farm), Yezin Agricultural University to evaluate the effect of rice husk ash (RHA) and potassium fertilizer application on yield and yield components of sin thu kha rice variety. The pot and field experiments were carried out in the dry season (December to May) 2022-23 and wet season (June to November) 2023. The experiment using T_1 - control , T_2 - (92 kg K ha^{-1}), T_3 - potassium (46 kg K ha^{-1})+ rice husk ash (5 t ha^{-1}), T_4 - potassium (46 kg K ha^{-1}) + rice husk ash (10 t ha^{-1}), T_5 - rice husk ash (5 t ha^{-1}), T_6 - rice husk ash (10 t ha^{-1}). The experiment was laid out in randomized complete block design (RCBD) with four replications. The both experiments result observed that highest grain yield was observed combined use in T_4 - potassium (46 kg K ha^{-1}) + rice husk ash (10 t ha^{-1}),due to production of higher number of tillers $hill^{-1}$, number of spikelets $panicle^{-1}$, filled grain %, number of panicles $hill^{-1}$. The minimum plant growth parameters and yield components were found from the treatments T_1 (control). Therefore, the result found that highlighted that potassium fertilizer with rice husk ash should be applied at the rate of 46 kg K ha^{-1} for sin thu kha rice variety.

Key Words-Potassium fertilizer, Rice husk ash, grain yield

I. INTRODUCTION

Rice is the single most important crop in the world, as half of the world population eats rice every day. Rice supplies 20% of the world's dietary energy supply (Bin & Zhang, 2023). Asia produces and consumes more than 90 % of the global rice (Wu et al., 2023). Fertilizer has been the

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key input in augmenting food grain production in Myanmar as well as in the world. Among the major essential nutrients, potassium (K) is a vitally important macronutrient in plant growth and in sustainable rice production (Fageria & Baligar, 1997).Potassium is one of the essential macro nutrients needed for plant growth and development in relatively large quantities, as well as N and P nutrients. In fact, the application of chemical fertilizer is costly and gradually leads to environmental problems (Buri et al., 2004).

Nowadays, combined use of organic and inorganic fertilizers in crop production has been widely recognized as a way of increasing yield and improving productivity of the soil (Mamaril et al., 1999). For rice-based cropping systems, the use of rice straw and rice husk ash (RHA) has been practiced for a long time (Eagle et al., 2001). Using RHA causes to produce more grain and straw in paddy and yield increase too (Talashiker & Chavan, 1995). (Singh et al., 2008) reported that potassium and phosphorous contents of RHA were 0.01 - 2.69% P2O5 and 0.1 - 2.54% K2O. Karkama et al., (2009) showed that the application of RHA improved soil properties by decreasing soil bulk density and increasing pH, available nutrients and rice yield.

In our country, especially in yezin soil, the farmers mostly use nitrogenous fertilizers only and, to some extent, phosphate, but they use very little or no potassium fertilizer. This is due to their insufficient knowledge of balancing fertilizer management of rice production and the effects of potassium on contributing yield and rice yield. The application of organic manure mixed up with chemical fertilizer can prove to be an excellent procedure in maintaining and improving the soil fertility and increasing fertilizer use efficiency. Therefore, the experiment was conducted to evaluate the yield response of lowland rice to rice husk ash and potassium fertilizer in yezin soil, and to reduce the use of potassium fertilizer for lowland rice in the study area by adding rice husk ash in rice production.

II. MATERIALS AND METHODS

The pot and field experiments were carried out from December to May (dry season) and from June to November (wet season), 2022-2023. Both pot and field experiments were conducted at Department of Soil and Water science, Yezin Agricultural University, Nay Pyi Taw. The experiment was laid out in randomized complete block design (RCBD) with four replications. The experiment using T_1 - control , T_2 - (92 kg K ha^{-1}), T_3 - potassium (46 kg K ha^{-1})+ rice husk ash (5 t ha^{-1}), T_4 - potassium (46 kg K ha^{-1}) + rice husk ash (10 t ha^{-1}), T_5 - rice husk ash (5 t ha^{-1}), T_6 - rice husk ash (10 t ha^{-1}).Phosphorus fertilizer was applied at 22 kg P ha^{-1} at basal in all treatments and rice husk ash amendment was applied at basal. Before conducting the experiment, the soil sample was analyzed for some physicochemical properties at the Department of Agricultural Research (DAR).The soil of experimental sites was loamy sand in texture, moderately acidic in reaction and results are shown in Table 1.The crop was subjected to recommended package of agronomic practices to obtain a healthy crop. The chemical compositions of rice husk ash using in this experiment is shown in Table 2. Twenty-one days old seedlings (with 1 plant pot^{-1}) were transplanted to each 29 cm diameter and 26 cm in height plastic pot. The mass of soil in each pot is 10 kg/pot. All pots were filled with water maintain water level 5cm above the soil surface.

Seedlings were raised in nursery and then twenty-one days old seedlings were transplanted with two plants hill^{-1} at the spacing of 20 cm x 15 cm. Double bounds were constructed 1 m apart between each plot and 1.5 m apart between the blocks to prevent flowing water from one plot to another. Total numbers of the experimental plots were 24 plots and each plot size were 5 m x 4 m (double bund). The plants were harvested at crop maturity around 135 days after sowing (DAS) in both experiments.

The grain yield was determined from a central 1 m^2 harvested area in each plot and was adjusted to 14% moisture content. The recorded five hills were selected to assess the yield component parameters such as number of panicles hill^{-1}, number of spikelets panicle^{-1}, filled grain % and 1000 grain weight. As a regular practice, the experimental pot and plot were irrigated whenever necessary. For cultural practices, irrigation, weed control, and pest and disease management practices were done when it was necessary.

Table 1. Physicochemical properties of the experimental soils before planting

Parameters	**Analytical result**	**Description**
Soil Texture	Loamy sand	-
Soil pH	5.4	moderately acid
Total K (%)	0.122	low
Available N (mg kg^{-1})	80	medium
Available P (mg kg^{-1})	2.4	low
Available K (mg kg^{-1})	39	low
Organic matter (%)	1.43%	low
Electrical Conductivity (dSm^{-1})	0.04	non-saline

Table 2. Chemical compositions of rice husk ash using in this experiment

Parameters	Amount
Carbon (% by mass)	8.90
Available K (mg kg^{-1})	2.11
Available P (mg kg^{-1})	1.17
Si (% by mass)	60.05
pH	8.40
CEC (cmol$_c$ kg^{-1})	6.70

III. STATISTICAL ANALYSIS

The results were statistically analyzed by using statistix software (8th version). All treatment were carried out three replications with Completely Randomized Design (CRD). Mean comparison were carried out Least Significant Difference (LSD) at 5% level.

IV. RESULTS AND DISCUSSION

Plant height (cm)

Plant height in all treatments increased progressively from 14 DAT to 84 DAT under both seasons in Figure 1(a and b). It was observed that only control treatment (T_1) gave the minimum plant height at all growth stages, while combined use of rice husk ash amendment and potassium fertilizer application (T_4) possessed a significant difference in plant height among the other treatments similarly. Yi Yi Cho (2010) stated that plant height increased with increasing potassium levels. Daftadar and Savant (1995) reported that plants treated with RHA are healthier than untreated ones,and can increase plant growth parameters than without RHA treated plants which supported the present experimental result. Daftadar and Savant (1995) reported that plants treated with rice hull ash are healthier than untreated ones, and their use can increase plant height. Increasing potassium rate significantly encouraged cell division and elongation resulted in tallest plant (Zayed et al., 2007).The results agreed favorably well with the findings of Moghadam and Heidarzadeh (2014) who observed that the effect of rice husk on the height of rice plant was significant. Plant height increased with the application of RHA in this experiment. Anggria et al. (2016) found that plants height increases by using silica containing materials. The results showed that the effects of different rates of potassium fertilizer were significant on plant height. Youssef et al. (2001) reported that application of 100% organic manure alone or combination resulted in taller plants than other treatments.

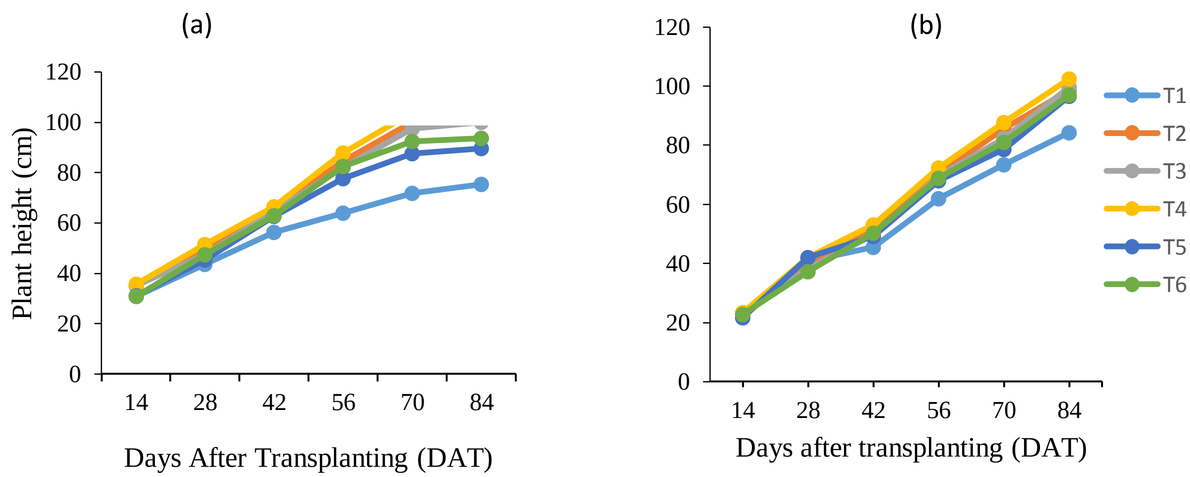

Figure 1. Mean value of plant height (cm) as affected by potassium fertilizer and rice husk ash during (a) dry season and (b) wet season

Number of tillers hill^{-1}

The number of tillers hill^{-1} counted at different growth stages from 14 DAT to 84 DAT are illustrated in Figure 2 (a and b). In the dry season, the tiller number ranged from 9.4 to 13.0 and the maximum value was observed in T_4 (13.0) followed by T_2, T_3, T_6 and T_5 respectively, and the minimum value in control. In the wet season, number of tillers ranged from 7.6 to 11.9. The highest number of tillers was produced by T_4 and the lowest number by control treatment T_1. Number of tillers hill^{-1} was significantly different by the application of rice husk ash. The highest number of tillers hill^{-1} (13.0) was obtained from with (46 kg K ha^{-1}+ RHA 10 t ha^{-1}). Seyedeh et al. (2012) reported that rice husk ash contains over 60% silica and application of RHA significantly increased the number of reproductive tillers. These findings were similar to that of Reyhaneh et al. (2012) who found that the number of tillers increased significantly (P<0.01) by the application of potassium over control. Thakur et al. (1993) stated that application of potassium increased the number of tillers. The effect of rice husk ash was significant at 5% level of significance. This result is supported by Agusalim (2010) who mentioned that highest number of tillers hill^{-1} can be obtained by using rice husk ash. The number of tillers hill^{-1} was significantly different (P<0.05) among the different rates of potassium fertilizer treatments. Application of potassium significantly increased tiller number/hill (Sarker et al., 1995 and Haque 1997). In this experiment, the number of tillers increased with the increasing rice husk ash doses. This result is in conformity with those of Sarkar et al. (2001) and Kalita et al. (2002) who reported that application of potassium significantly increases number of tillers hill^{-1} in rice. Bhuiya and Akand (1982) also reported the number of tillers at maximum stage was 16-21 days due to the application of organic material and chemical fertilizer combination. The combined effect of potassium fertilizer and RHA was significant different on number of tillers hill^{-1}. Ahmed and Rahman (1991) reported that the combined application of organic matter and chemical fertilizers increased the tiller number of rice.

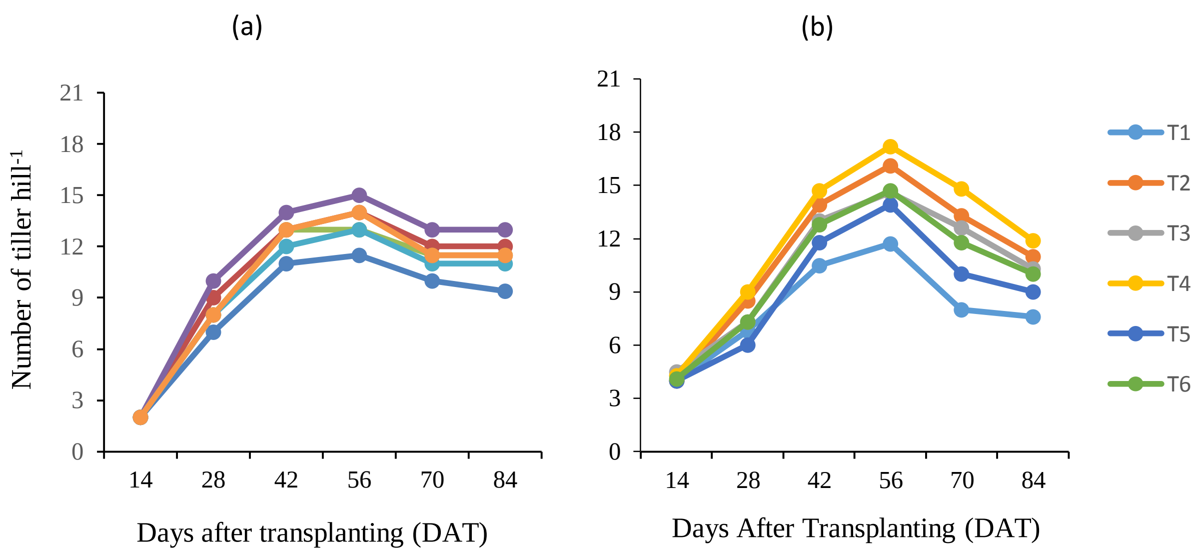

Figure 2. Mean value of number of tillers hill^{-1} as affected by potassium fertilizer and rice husk ash during (a) dry season and (b) wet season

Yield and Yield Component Characters

Number of panicles hill^{-1}

The number of panicles hill^{-1} observed highly significant variation (P<0.01) among the potassium fertilizer treatments. The combined use of different rates of potassium fertilizer and rice husk ash was significantly different on number of panicles hill^{-1}. The highest number of panicle hill^{-}

^{1} was found in T_4 (46 kg K ha^{-1}+ RHA 10 t ha^{-1}) and the lowest number was observed in T_1 (control). Bagheri et al. (2011) who mentioned that panicle number was increased with increasing potassium rate. This finding was analogous with the result of Zayed et al. (2007). There is significant interaction between potassium fertilizer application and rice husk ash treatments.

Number of spikelets panicle^{-1}

Number of spikelets panicle^{-1} was significant different among rice husk ash and potassium fertilizer application is shown in Table (3 and 4). Uddin et al. (2007) reported that potassium helped in proper filling of seeds which resulted higher number of plump seeds and thus increased the number of grains panicle^{-1}. In both experiments, the highest number of spikelets panicle^{-1} was produced by T_4 (46 kg K ha^{-1}+ RHA 10 t ha^{-1}) (127.9) in dry season, (138.6) in wet season. The reason why T_4 showed the maximum was related combined use rice husk ash amendment and potassium fertilizer.

Panicle length (cm)

Application of organic manures and chemical fertilizers observed an increasing effect on panicle length was described in Table (3 and 4). The increasing effect was more where rice husk ash applied. All the treatments increased the panicle length as compared to T_1 (control) treatment. The maximum panicle length was obtained in T_4 (46 kg K ha^{-1}+ RHA 10 t ha^{-1}) which was statistically similar to those observed in T_2,T_3,T_6 and T_5 and minimum panicle length was found in T_1(control).Ahmed and Rahman (1991) reported that the combined application of organic matter and chemical fertilizers increased panicle production. (Chang and Wong, 1962) also stated that application of K increased the length of panicles. In case of other field experiment, it was observed that application of K increased the length of panicles (Mahatim et al., 1979; Thakur et al., 1993 and Haque, 1997).

1000 grain weight (g)

The highest 1000 grain weight were obtained in the treatments T_4 (46 kg K ha^{-1}+ RHA 10 t ha^{-1}) which was no statically different from all other treatment and lowest 1000 grain weight were observed in the treatments T_1(control). Bansal et al. (1993) who mentioned that potassium fertilizer application can increase grain yield performance, number of filled grains and 1000 grain weight. There was combined effect between different rates of potassium fertilizer application and rice husk ash over control treatment. One of the main factors influencing rice yield is thousand grain weight because it is mostly governed by the genetic makeup of the variety.

Filled grain (%)

The average impact of potassium fertilizer application rates and rice husk ash on the percentage of filled grain was displayed in Table (3 and 4). Percent filled grain was significant difference in rice husk ash treatments. Among the rice husk ash treatments, the highest filled grain % was observed inT_4 (46 kg K ha^{-1}+ RHA 10 t ha^{-1}). The highest filled grain percent was obtained from T_4 in both pot and field experiments. Talashilkar and Chavan (1995) stated that using rice husk ash cause to produce more grain and straw in paddy and the yield increase too. Minimum percent filled grain was obtained from T_1 (control). Esfehani et al. (2005) showed that potassium fertilizer has positive effect on filled grains in rice while its deficiency caused pollen sterility and decreased the number of filled grains panicle^{-1}. Similar results found by Krishnappa et al. (2006) and reported that applied K increased the number of filled grains panicle^{-1}.

Grain yield

Grain yield varied significantly due to different treatments. The grain yield ranged was presented in Table (3 and 4). The maximum grain yield was obtained by the treatment T_4 (46 kg K ha^{-1}+ RHA 10 t ha^{-1}) and the minimum grain yield was found from T_1 (control) treatment in both experiments. These finding was similar to that of Talashilkar and Chavan (1995), Prakash et al. (2007), Sitio et al. (2007), Mohammad Reza et al. (2014) who stated that using rice husk ash cause to be producing more grain and straw in paddy and the yield increase too. Using RHA can give higher yield response in this experiment. The significant increase in grain yields with the application of RHA seems to be attributed to the increased availability of nutrients and favorable effects of ash on soil physical conditions and microbial processes (Demeyer et al. 2001). This result was consistent with the findings of (Matte and Kene 1995) who stated that application of rice husk ash and other industrial wastes had a positive effect on grain and straw yield of rice. The finding was in accordance with the results of Prakash et al. (2007) who observed that significant increase in the grain and straw yields of rice with the application of RHA.

Table 3. Yield and yield components of Sin Thu Kha rice variety as affected by rice husk ash and potassium fertilization during the dry season,2022-2023.

Treatments	Panicle length(cm)	Number of panicle hill^{-1}	Number of spikelet panicle^{-1}	Filled grain %	1000 grain weight(g)	Grain yield (g plant^{-1})
T_1	18.9 d	9.5 c	93.5 e	70.4 e	18.9	23.5 e
T_2	21.3 b	11.2 b	126.1 ab	78.9 b	21.3	42.5 ab
T_3	20.7 bc	11.5 b	120.4 bc	76.2 c	20.1	41.7 b
T_4	22.3 a	12.8 a	127.9 a	81.7 a	21.7	45.9 a
T_5	19.9 cd	10.8 b	103.7 d	72.6 d	20.2	32.0 d
T_6	20.8 bc	11.3 b	110.2 c	75.1 c	19.2	36.2 c
$LSD_{0.05}$	1.46	0.78	7.95	1.64	2.17	3.98
Pr>F	*	**	**	**	ns	**
CV%	6.91	4.62	3.13	3.44	7.12	7.14

Means followed by different letters in the same column are not significantly different by LSD test at 5% level.

* significant difference at 5% level, **significant difference at 1% level, ^{ns} non-significant difference

Table 4. Mean effect of yield and yield components of rice as affected by rice husk ash and potassium fertilization in wet season, 2023

Treatments	Panicle length(cm)	Number of panicle hill^{-1}	Number of spikelet panicle^{-1}	Filled grain %	1000 grain weight(g)	Grain yield (t ha^{-1})
T_1	18.23 d	8.8 f	107.7 d	68.6 e	19.1	3.7 c
T_2	22.7 a	10.8 b	138.3 a	76.4 b	20.4	5.5 ab
T_3	21.6 b	10.3 c	135.2 ab	74.9 bc	19.4	4.9 b
T_4	22.9 a	11.7 a	138.6 a	81.4 a	20.5	5.8 a
T_5	19.9 c	9.4 e	128.9 c	71.9 d	19.2	4.4 bc
T_6	20.8 bc	9.9 d	133.9 b	73.2 cd	19.5	4.6 bc
$LSD_{0.05}$	0.99	0.33	3.7	2.44	1.92	1.14
Pr>F	**	**	**	**	ns	*
CV%	3.12	2.17	1.88	2.18	6.05	15.68

Means followed by different letters in the same column are not significantly different by LSD test at 5% level. * significant difference at 5% level, **significant difference at 1% level, ^{ns} non-significant difference

V. CONCLUSION

The present study emphasized rice husk ash and K fertilizer applications had significant effect grain yield, number of spikelets per panicle, filled grain percent, panicle length and, number of panicle per hill but 1000 grain weight were not significantly different. Rice ash husk incorporation gave the higher growth parameters than that of without rice ash husk. According to the study, combined use of potassium fertilizer and rice husk ash showed beneficial effect on the yield contributing characters that ultimately gave higher yield. The present study pointed out that rice husk ash contains nutrient materials and able to use as a fertilizer. Farmers should use a combination of organic fertilizer and reduced inorganic fertilizers to increase rice yield and protect an improve soil health. It is undesirable to use too much or too little fertilizer in a production system. Balanced and proper amount application of fertilizers is an effective approach to increase the growth and productivity of rice and ensure environmental sustainability.

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