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Influence of rice hull ash and levels of p and k on growth performance of rice grown in sandy loam soils of Chikkamangaluru district of Karnataka

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Abstract
A field experiment was conducted at Agricultural and Horticultural Research Station, Bhavikere, Chikkamangaluru, Karnataka State from 2018-2019 to know the influence of rice hull ash and levels of p and k on growth performance of rice grown in sandy loam soils. The treatments comprised of the recommended dose of RHA (2 t ha^{-1}), FYM (7.5 t ha^{-1}) and varied levels of P and K with rice as test crop and tried in RCBD with eleven treatments and three replications. Results of the field experiment showed significant increase in growth attributes (plant height, tillers per plant and dry matter accumulation), with treatment receiving application of recommended dose of RHA, FYM and NPK.

Keywords: Rice hull ash (RHA)

Introduction
The combined use of organic and inorganic fertilizers in crop production has been widely recognized as a way of increasing yield and improving the productivity of the soil. Agricultural activities produce billions of tons of waste materials. The main types of agricultural wastes are crop residues and farm animal wastes. It has been suggested that organic wastes can help to bridge the gap between demand and supply of chemical fertilizers to a great extent by supplying plant nutrients.

In paddy processing industries, about 25 million tonnes of rice husk is produced annually and not being used appropriately (Singh *et al*., 2013) [5]. The husk is usually deposited as heap and later burnt to ashes. The ash often used as manure in traditional crop production and as well as protection purpose elsewhere. It has reasonable quantities of cations Ca, Mg, K, Na and other essential elements including P and K, the recycling of which is especially important. The reaction products formed in soil could be entirely different with chemical fertilizers than with organic wastes like rice hull ash, because of their influence on chemical reactions in soil. The rice hull ash is available in large quantities in rice growing areas and can be an alternative. The role of phosphorus (P) in rice husk ash is to play key roles in plat metabolism, structure and energy transformation and further helps in root development, straw strength, hastening of flowers, crop maturity and seed formation. The role of potassium (K) in husk ash is to strengthen the plant, manage the respiratory system, assist the transpiration of enzyme work and maintain the osmotic potential.

Materials and Methods
The experiments were conducted at Agricultural and Horticultural Research station Bhavikere which comes under University of Agricultural and Horticultural Sciences (UAHS), Shivamogga and located at north west of Tarikere taluk of Chikkamagalur district, Karnataka State. The research station comes under Southern Transition Agro-climatic Zone (Zone-VII) of Karnataka. It is situated at 13°42ˈ N latitude and 75°51ˈ E longitude and an altitude of 695 meters above mean sea level. The average rainfall of the zone is 1193.8 mm. Prior to the initiation of experiment, composite soil sample from experimental area were collected from 0 to 15 cm depth and analysed for physical and chemical properties using standard procedures.

The total eleven treatments were T_1: Rec. FYM, T_2: Rec. NPK only, T_3: Rec. RHA @ 2t ha^{-1}, T_4: Rec. NPK + Rec. FYM, T_5: Rec. RHA + Rec. NPK + Rec. FYM, T_6: Rec. NK + 75% Rec. P + Rec. FYM, T_7: Rec. RHA + Rec. NK + 75% Rec. P + Rec. FYM, T_8: Rec. NP + 75% Rec. K + Rec. FYM, ,T_9: Rec. RHA + Rec. NP + 75% Rec. K + Rec. FYM, T_{10}: Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM and T_{11}: Rec. RHA + Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM. The results of the analysis soil properties are given in Table 1. Initial characterization of soil for the experimental site found to be sandy loam having normal bulk density of 1.3 Mg m^{-3}. Soil is having acidic in reaction (6.14). The soil is low in available nitrogen (201.60 kg ha^{-1}), high in phosphorus (83.47 kg ha^{-1}) and medium in available potassium (257.51 kg ha^{-1}) status. The exchangeable Ca and Mg were found to be 2.90 and 1.22 cmol (p$^+$) kg^{-1}, respectively, whereas available sulphur content is 19.34 mg kg^{-1}. The micronutrient status of soil is high with respect to Fe (35.98 mg kg^{-1}), Mn (22.24 mg kg^{-1}), Zn (1.81mg kg^{-1}) and Cu (2.91 mg kg^{-1}). Total organic carbon, total inorganic carbon and total carbon were 7.51, 0.28 and 7.79 g kg^{-1}, respectively. Data related to P fractions in the initial soil samples as Saloid-P, Aluminium bound P, Iron bound P, Reductant soluble P, Occluded P, Calcium bound P, Organic P and Total P recorded 11.79, 66.91, 77.50, 68.33, 16.20, 17.08, 219.44 and 477.25 mg kg^{-1}, respectively. The K fractions, *viz*., Water soluble K, Exchangeable K, Non exchangeable K, Lattice K and Total K were recorded 18.32, 37.11, 181.82, 1761.41 and 1998.66 mg kg^{-1}, respectively for initial soil of the experimental site. After preparing the land, recommended quantity of RHA was applied 2 weeks before planting and seedlings were transplanted with a spacing of 20 cm ×10 cm. The recommended dose of fertilizers along with FYM were applied as per the recommendation. The nitrogen was applied in 3 splits, *i.e*., 50 per cent at transplanting, 25 per cent each at 30 and 60 days after transplanting (DAT) and doses for P, K were applied at five days after transplanting. Before application, the land was drained and fertilizers were uniformly broadcasted over the field followed by irrigation after 24 hours of fertilizers application. Crop was raised as per package of practices.

Table 1: Initial soil properties of the experimental site

Physicochemical properties	Value	Available nutrient status	Value
Sand (%)	67.18	Available N (kg ha^{-1})	201.60
Silt (%)	14.29	Available P_2O_5 (kg ha^{-1})	83.47
Clay (%)	18.53	Available K_2O (kg ha^{-1})	257.51
Textural class	Sandy loam	Available S (mg kg^{-1})	19.34
Bulk density (Mg m^{-3})	1.3	Exchangeable Ca [cmol (p$^+$) kg^{-1}]	2.90
CEC [cmol (p$^+$) kg^{-1}]	14.56	Exchangeable Mg [cmol (p$^+$) kg^{-1}]	1.22
pH	6.14	DTPA extractable Fe (mg kg^{-1})	35.98
EC (dS m^{-1} at 25^{o}C)	0.35	DTPA extractable Mn(mg kg^{-1})	22.24
		DTPA extractable Zn (mg kg^{-1})	1.81
		DTPA extractable Cu (mg kg^{-1})	2.91

Result & Discussion

Plant Height: Data obtained on plant height as influenced by Rice Husk Ash and different levels of P and K application in paddy at different growth stages are given in Table 2. Plant height of paddy was influenced significantly at different growth stages due to different treatments. Highest plant height (34.88 cm) at 30 DAT was recorded in the treatment T_5 (Rec. RHA + Rec. NPK + Rec. FYM) and which found on par with treatment T_{11} (Rec. RHA + Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM), T_9 (Rec. RHA + Rec. NP + 75% Rec. K + Rec. FYM) and T_7 (Rec. RHA + Rec. NK + 75% Rec. P + Rec. FYM) (34.33, 34.22 and 33.44 cm, respectively). Lowest plant height (27.44 cm) was recorded with T_2 followed by T_3, T_1, T_{10}, T_6, T_8 and T_4 (27.55, 28.11, 29.11, 29.44, 29.88 and 32.11cm, respectively). RHA and P and K levels along with FYM significantly influenced the plant height at 60 DAT. Treatment T_5 (Rec. RHA + Rec. NPK + Rec. FYM) recorded highest plant height (59.89 cm) and found on par with the application of Rec. RHA + Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM (T_{11}) (59.44 cm) and T_9 (Rec. RHA + Rec. NP + 75% Rec. K + Rec. FYM) (59.22 cm) which were significantly superior over rest of the treatments. The lowest plant height (52.22 cm) was recorded with treatment T_3 followed by T_1, T_{10}, T_6, T_8, T_4 and T_7 (53.22, 53.67 53.89, 54.56, 54.89, 57.00 and 58.11 cm, respectively). Maximum plant height was recorded in T_5 (Rec. RHA + Rec. NPK + Rec. FYM) treatment at 90 DAT and harvest (80.89 and 82.44 cm, respectively) which was on par with almost all treatments except T_3 (Rec. RHA @ 2t ha^{-1}) (63.89 and 65.56 cm, respectively), T_1 (Rec. FYM) (69.11 and 71.44 cm, respectively) and T_2 (Rec. NPK only) (74.67 and 76.33 cm, respectively).

The number of tillers per hill: The data collected on the number of tillers per hill as influenced by RHA and different levels of P and K application in paddy at different growth stages are given in Table 2. The maximum number of tillers per hill of paddy recorded significantly in treatment receiving recommended dose of fertilizer along with recommended RHA and FYM (T_5) at all growth stages (12.67, 16.78, 21.78 and 21.78 at 30, 60, 90 DAT and at harvest, respectively). At 30 DAT number of tillers per hill with T_5 treatment was on par with treatment T_{11} (12.45), T_9 (12.33) and T_7 (12.11) while it was found significantly superior over rest of the treatments. The treatments T_{11}, T_9, T_7, T_4, T_8, T_6 and T_{10} found to be on par with T_5 at 60 DAT, 90 DAT and at harvest whereas significantly superior over rest of the treatments. The lowest number of tillers per hill was observed in T_3 treatment, followed by T_1 and T_2. The significant increase in plant height and number of tillers was observed in the treatments (T_5, T_{11}, T_9, and T_7) where RHA had applied in combination with FYM and fertilizers in different levels. The increase in plant height and number of tillers could be attributed to the influence of RHA, which has enhanced the soil physical properties and increased nutrient availability and their subsequent uptake by the plant. Increase in yield attributing characters is possibly due to the RHA's property to retain the plant nutrient due to high CEC and high porosity. Combination of RHA along with FYM might have regulated the nutrient supply in tune with the crop requirement in addition to encouraging soil microbial activity which

enhanced root development, a higher number of grains per panicle and ultimately highest grain and straw yield. Similar findings were recorded by Saranya *et al*. (2018) [4], Mishra *et al.* (2017) [2] and Masulili *et al*. (2010) [1].

Dry matter accumulation: The data on periodical dry matter accumulation per plant of paddy as affected by Rice Husk Ash and levels of P and K at different growth stages of paddy is presented in Table 3. The paddy crop supplied with the recommended dose of fertilizer along with recommended RHA and FYM (T_5) recorded significantly higher dry matter accumulation per plant at all growth stages (5.34, 15.15, 21.79 and 29.03 g hill^{-1} at 30, 60, 90 DAT and at harvest respectively), but was found at par with T_{11} at 30 DAT whereas T_{11}, T_9, T_7, T_4, T_8, T_6 at 60 and 90 DAT and T_{11}, T_9, T_7, T_4 at harvest. The lowest dry matter accumulation per plant of paddy was observed under treatment T3 (3.83, 10.03 and 15.79 g hill^{-1}) at 30, 60 and 90 DAT, respectively. However, T_1 recorded lowest dry matter accumulation (22.55 g hill^{-1}) at harvest stage. The significantly lower amount of dry matter per hill was recorded in T_9, T_7, T_4, T_8, T_6, T_{10}, T_2 and T_1 treatments at 30 DAT, treatments T_{10}, T_2 and T_1 at 60 and 90 DAT and T_6, T_8, T_{10}, T_2 and T_3 at harvest stage. The result presented in Table 2 indicates that significant increase in dry matter accumulation per hill at different growth stages of paddy was observed due to treatments which received RHA, compared to non-RHA treatments. It might be due to efficient photosynthesis influenced by combine application of RHA, FYM and varied levels of fertilizers through providing better nutrient supply and in turn induced better vegetative growth. The result is in consistence with the studies of Saranya *et al*. (2018) [4], Mishra *et al.* (2017) [2] and Munda *et al.* (2016) [3]. It can be seen from the data in accordance with growth and yield parameters of paddy *viz*. panicle per hill, total grains per panicle, grain and straw yield significantly influenced with the application of RHA and levels of P and K. Addition of RHA along with FYM and varied levels of P and K recorded significant values. Combination of RHA along with FYM might have regulated the nutrient supply in tune with the crop requirement in addition to encouraging soil microbial activity which enhanced root development, a higher number of grains per panicle and ultimately highest grain and straw yield.

Table 2: Influence of RHA and levels of P and K on plant growth parameters at different growth stages of rice

Treatments	Plant height (cm)				Tillers plant^{-1}			
	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest
T_1: Rec. FYM	28.11	53.22	69.11	71.44	8.89	13.33	16.67	16.67
T_2: Rec. NPK only	27.44	53.67	74.67	76.33	9.22	13.89	17.22	17.22
T_3: Rec. RHA @ 2t ha-1	27.56	52.22	63.89	65.56	8.44	11.67	16.67	16.89
T_4: Rec. NPK + Rec. FYM	32.11	57.00	78.67	80.33	11.67	15.78	20.78	21.00
T_5: Rec. RHA + Rec. NPK + Rec. FYM	34.89	59.89	80.89	82.44	12.67	16.78	21.78	21.78
T_6: Rec. NK + 75% Rec. P + Rec. FYM	29.44	54.56	77.67	79.33	10.22	15.00	20.11	20.22
T_7: Rec. RHA + Rec. NK + 75% Rec. P + Rec. FYM	33.44	58.11	79.22	80.89	12.11	16.00	21.00	21.22
T_8: Rec. NP + 75% Rec. K + Rec. FYM	29.89	54.89	78.11	79.78	11.00	15.44	20.22	20.22
T_9: Rec. RHA + Rec. NP + 75% Rec. K + Rec. FYM	34.22	59.22	79.78	81.22	12.33	16.33	21.56	21.78
T_{10}: Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM	29.11	53.89	77.33	79.11	9.89	14.11	19.11	19.22
T_{11}: Rec. RHA + Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM	34.33	59.44	80.22	81.67	12.44	16.67	21.67	21.78
S.Em±	0.51	0.52	1.87	1.68	0.32	0.90	0.97	0.97
C.D at 5%	1.50	1.53	5.53	4.97	0.94	2.67	2.86	2.85

DAT: Days after transplanting, RHA: Rice hull ash

Table 3: Influence of RHA and levels of P and K on dry matter accumulation per hill at different growth stages of rice

Treatments	Dry matter accumulation (gram hill^{-1})			
	30 DAT	60 DAT	90 DAT	Harvest
T_1: Rec. FYM	3.91	12.06	15.86	22.55
T_2: Rec. NPK only	3.96	12.22	16.24	23.11
T_3: Rec. RHA @ 2t ha-1	3.83	10.03	15.79	22.87
T_4: Rec. NPK + Rec. FYM	4.67	14.12	20.16	26.85
T_5: Rec. RHA + Rec. NPK + Rec. FYM	5.34	15.15	21.79	29.03
T_6: Rec. NK + 75% Rec. P + Rec. FYM	4.27	13.40	18.97	25.94
T_7: Rec. RHA + Rec. NK + 75% Rec. P + Rec. FYM	4.76	14.24	20.18	27.22
T_8: Rec. NP + 75% Rec. K + Rec. FYM	4.51	13.48	19.25	25.79
T_9: Rec. RHA + Rec. NP + 75% Rec. K + Rec. FYM	4.93	14.51	20.71	27.81
T_{10}: Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM	4.06	12.42	18.05	25.30
T_{11}: Rec. RHA + Rec. N + 75% Rec. P + 75% Rec. K + Rec. FYM	5.11	14.81	20.94	28.49
S.Em±	0.09	0.86	0.97	0.94
C.D at 5%	0.26	2.55	2.88	2.77

DAT: Days after transplanting, RHA: Rice hull ash

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