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Effect of varieties and organic manure on growth and yield of Black Rice (*Oryza sativa* L.)

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Abstract
The experiment was conducted during *Kharif* season 2021, at Crop Research Farm, Department of Agricultural Sciences, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.). The soil of the experimental plot was sandy loam in texture, nearly natural in soil reaction (pH 7.6), low in organic content (0.51), low in available N (230 kg/ha), medium in available P (17.80 Kg/ha) and medium in available K (245.10 kg/ha). The objective was to study Effect of varieties and organic manure on growth and yield of Black Rice (*Oryza sativa* L.) under Randomized block design comprising of 3 replications and 9 treatments (Conventional Transplanting of Rice). The Treatment consistant of 3 organic manures (FYM, Poultry manure and Vermicompost) and 3 different varieties (Chakhao Poreiton), (Chakhao Amubi) and (SKM 111). The experimental results revealed that with black rice cultivars along with Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM (T_3) recorded highest numbers of tillers/hill (10.20), Plant Dry weight (32.32g), Crop Growth Rate (12.46 g/m/day), Relative Growth Rate (0.014g/g/day), number of panicle/hill (10.00), numbers of grains per panicles (206.70), numbers of filled grains per panicles (83.20), grain yield (4.36 t/ha), straw yield (10.15 t/ha) were recorded highest among other treatments. Chakhao Poireiton + 50% N through Poultry manure + 50% N through Vermicompost was recorded in highest test weight (24.57 g). It is clearly concluded that from the research T_3: Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM significantly produce more yield and recommended for eastern U.P condition.

Keywords: FYM, vermcompost, poultry manure, Chakhao Poreiton, Chakhao Amubi, SKM111

Introduction
Rice (*Oryza sativa*) is the major food crop in the world about 40% of the world's population consumes rice as the staple food. Rice provides entirely 60% of food intake in Southeast Asia and about 35% in East Asia and South Asia. The highest level of per capita rice consumption (130-180 kg per year, 55-80% of total caloric source) takes place in Bangladesh, Cambodia, Indonesia, Laos, Myanmar (Burma), Thailand, and Vietnam (Kenneth and Kriemhild, 2000). Rice is an excellent food and an excellent source of carbohydrates and energy. Among number of rice varients, Black rice is very important and rich in nutrients. Black rice is also known as purple rice, forbidden rice, paradise rice, royal rice, king's rice and prized rice. This rice contains several varieties with a long history of cultivation in Southeast Asian countries such as China, India and Thailand (Kang *et al*., 2012) [8]. China alone accounts for 62% of the global production of black rice and has developed more than 54 modern black rice varieties with high yield characteristics and many resistances. China cultivates most of the black rice, followed by Sri Lanka, Indonesia, India and Philippines etc. Thailand occupies the ninth position for black rice cultivation (Ichikawa *et al*., 2001; Sompong *et al*., 2011) [6, 13]. Black rice also comes in a number of short grain, long grain and glutinous varieties. Rice varieties with coloured pericarp (other than white and red) are usually known as 'Black rice'. Black rice has a dark purplish-black colour with a nutty, slightly sweet flavour. Black rice is black due to the presence of the black colour pigment called anthocyanin which contain high amounts of certain antioxidants (Takashi *et al*., 2001) [14]. Black rice also has higher levels of protein, vitamins and minerals than common white rice (Suzuki *et al.*, 2012) [12]. Compared to white rice, black rice is relatively rich in mineral content such as Fe, Zn, Mn and P and has a high variability in mineral content that depends on varieties and soil types of the planting area (Qiu *et al*., 1993; Liu *et al*., 1995; Zhang, 2000) [11, 9, 17]. The supplementation of black scented rice in the diet will have a big impact on human health (Asem *et al*., 2015) [2].

Only a few farmers were willing to cultivate black rice, because of the longer age of the crop and the use of local seed production were less preferred. The Chakhao Poireiton is cultivated by most farmers (43%) due to its high productivity and modesty. Black rice plants attain 136–166 cm height which was comparatively higher than other traditional non-black rice varieties cultivated in the study area and flowering is initiated between 108-116 DAT. Chakhao Amubi was the tallest black rice. Konthoujam and Chhetry. (2007) showed that three local cultivars *viz*., Chakhao amubi, Ching Chakhao and Huikap were moderately resistant to the disease. The highest number of panicles, number of grains, and the tiller was recorded for the Chakhao poireiton.

The kernel length of Chakhao amubi and Chakhao poireiton are considerd as long and medium (Borah, N. *et al.* 2018) [4]. Chakhao poireiton and chakhao amubi, were shown to have high anthocynin and phenolics content and strong antioxidant activity. Chakhao poireiton was classified as waxy, as their amylose content was less than (2%). Chakhao amubi was with very low amylose content (3.16%). Konthoujam and Chhetry (2007) showed that three local cultivars *viz*., Chakhao amuba, Ching Chakhao and Huikap were moderately resistant to the disease. SKM111 is a sugar free variety of black rice having medium plant height (130-135 cm). Farmyard manure (FYM) is being used as a major source of organic manure in farm crops as it supplies all the essential plant nutrients and enhances the activities of microbes in the soil (Sutaliya and Singh, 2005). Farmyard manure not only acts as a source of N and other nutrients, but also increases the efficiency of applied N. Enriched Farmyard manure (EFYM) is also considered as an important source of macro and micronutrients to increase crop yield. Significant increase in grain yield of rice with the conjunctive use of farm yard manure. The organic N nutrition with organic manures proved superior due to its visible favorable effect on soil health with respect to nutrient status and microbial count and this indicates the utilization of this low-cost but long-term beneficial practice under high-intensity cropping for sustainable crop production. Nitrogen is the nutrient which limits the most rice production worldwide. Bejbaruah *et al*. (2013) studied on the impact of vermicompost and cow manure on the improvement of grain protein. Kumar *et al*. (2006) recorded that combined use of farm yard manure and poultry manures improvement in organic carbon and available nitrogen content of soil. Sangeetha *et al*. (2010) revealed that the application of enriched poultry manure compost on equal N basis (2.3 t ha^{-1}) recorded higher growth parameters, yield attributes and grain yield. It was 46.75 kg ha^{-1} in 2007 and 49.53 kg ha^{-1} in 2008, which was comparable with composted poultry manure. In view of these investigations the experiment was under taken to find out suitable varieties and organic manures on the application for maximizing the yield, quantity and quality of Black rice under eastern Uttar Pradesh conditions.

Materials and Methods

The experiment was carried out during *Kharif* season of 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) which is located at 25^0 24' 42" N latitude, 81^0 50 '56" E longitude and altitude of 98 m above mean sea level. The climate is characterized by alternate warm rainy seasons with an average temperature of 38 °C from late June to early September. The experiment was conducted in Randomized Block Design 3 replicates consisted of 9 treatment combinations and were placed with different treatments randomly allocated in each replicate. The treatment combinations were T1 (50% N through Vermicompost + 50% N through FYM), T2 (50% N through Poultry manure + 50% N through Vermicompost), T3 (50% N through Poultry manure + 50% N through FYM), T4 (50% N through Vermicompost + 50% N through FYM), T5 (50% N through Poultry manure + 50% N through Vermicompost), T6 (50% N through Poultry manure + 50% N through FYM), T7 (50% N through Vermicompost + 50% N through FYM), T8 (50% N through Poultry manure + 50% N through Vermicompost), T9 (50% N through Poultry manure + 50% N through FYM). Soil samples from 5 locations of the experimental field were collected randomly from 0 to 15 cm depth just before the layout of the experiment. A representative homogenous composite sample was drawn by mixing all these soil samples together, which was analyzed to determine the physico-chemical properties of the soil are sand (63%), silt (22.6%), clay (14.40%). The available nitrogen, phosphorus, potassium are 230 kg ha^{-1}, 17.80 kg ha^{-1}, 245.10 kg ha^{-1} respectively. The organic carbon was 0.51%, pH 7.6 and EC 0.88 (dSm^{-1}).

Rice cultivar 'Chakhao Poreiton, *Chakhao Amubi, SKM11'* which is an open pollinated cultivar from Manipur was taken as test variety in this investigation. One hundred seeds were tested before nursery sowing or direct seeds were sown to find out the germination potential of rice seeds. Germination testing was performed using filter paper and Petri dish in laboratory conditions total germination percentage 92% the seed volume was adjusted accordingly. The experimental field was sorted with the help of a tractor-drawn plough followed by manually flooding and puddling operations in the experimental blocks after two painful and planking. Seeds were sown in the nursery after the recommended package and practices 20 days old rice seedlings were transplanted manually at a spacing of 20 cm x 15 cm in the experimental field on 16 July 2021. Gaps caused by mortality were filled by re-transplanting after 6 days of transplanting.

The FYM used contained 0.5-0.2-0.5 N-P-K in terms of percentage which was obtained from the Warner School of Food and Dairy Technology, SHUATS. The Vermicompost contained 3.0-1.0-1.5 N-P-K in terms of percentage and the Poultry manure used contained 3.03-2.63-1.4 N-P-K in term of percentage which was obtained from the Warner School of Food and Dairy Technology, SHUATS. Uttar Pradesh. The recommended dose of fertilizers for open pollinated varieties in *Kharif* season was 75.40.40 kg/ha of N-P-K kg/ha. At the time of transplanting, full dose of N through FYM, N through Vermicompost and N through Poultry manure were applied. Weeding was done thrice during the critical crop weed competition period.The field was maintained in moist condition and for this, irrigation was given to retain 2-3 inches of standing water during the entire growing period except for harvesting. Comments were recorded from 5 tagged hills in running meter from each plot by leaving the 3 border rows at 20, 40, 60, 80 and 100 DAT (Days after Transplanting). Data was recorded from these tagged hills.

Results and Discussion

Growth parameters

Plant height (cm): Plant height was significantly affected by various treatment combinations and increased with the

advancement of crop growth up to 100 DAT. Significant and highest plant height was observed in T_4 (Chakhao Amubi + 50% N through Vermicompost + 50% N through FYM) and it is statistically at par with T_6 (Chakhao Amubi + 50% N through Poultry manure + 50% N through FYM) in all the plant growth, development and reproductive stages in which different organic manures were applied in combination. However treatments receiving SKM111 variety (T_8) and only (T_7 and T_9) show poor performance as compared to the ones receiving varieties (T_4, T_5, T_6). Lodging of plants was observed in treatments which received high tallest variety (T_4, T_5, T_6). However, the plants that lodged early recovered within 7-10 days. Significant and higher performance of Chakhao Amubi along with Vermicompost with FYM might be due to reduced loss of nutrients and its increased availability to crop by fixation of NH^{4+} ion with humus present in FYM (Bellaki *et al*., 1998) [3]. The interaction between with the variety (Chakhao Ambui), Vermicompost and FYM is responsible for increased Plant height variety Chakhao Ambui has a characterstic feature of higher plant height as compared to the other varieties. As Vermicompost is a rich source of organic carbon which enchances plant growth due to improved soil health. FYM is also an organic manure in field crops as it supplies all essential plant nutrients and increases activities of microbes in soil which in turn helpful for increasing plant height. Similar findings were obtained by Tharmaraj *et al*. (2011), and Yadav *et al.* (2014) [16].

Number of tillers/hill: The number of tillers/hill gradually increases up to 60 DAT and then reduces from 80 DAT. The maximum number of tillers/hill was observed at 60 DAT with treatment T_3 (Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM) which is statistically at par with T_2 (Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost). Use of Chakhao Poreiton variety and organic sources of nutrient (T_1,T_2,T_3) registered appreciably more number of tillers /hill in comparison to other Chakhao Amubi variety and organic nutrient source (T_4,T_5 and T_6) and SKM111 variety and organic nutrient source (T_7, T_8, T_9) during the experimentation. Maximum tillering observed in treatment where application of Poultry manure and FYM in combination would be attributed to the more availability of nitrogen which played a vital role in plant growth and the more solubility of which promoted root development and tillering. The reduction in number of tillers after 60 DAT is resulted due to ageing and senescence which causes death of secondary and tertiary tillers which is a genetic constitution addition Poultry manure and FYM to the Variety Chakhao Poireiton may induced tiller production due to the increased organic carbon content at maximum tillering stage. Similar findings were obtained from Arif *et al.* (2014).

Plant dry weight hill^{-1}: The maximum plant dry weight/hill was observed in treatment T_3 (Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM) in which organic were applied and is statistically at par with T_2 (Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost) in the entire growing season but with T_1 at 40 DAT and 80 DAT. Treatment receiving SKM111 (T_8) and only organic source of nutrients (T_7 and T_9) show poor performance as compared to the ones receiving organic source of nutrients (T_4, T_5, T_6). Application of Organic manures like Poultry manure and FYM at recommended proportions which supplies higher concentrations of nutrients may increases the plant growth which in turn led to higher dry matter accumulation. Similar findings were obtained from Vindra Singh *et al.* (2001).

Table 1: Effect of organic manure on growth parameter of black rice varieties at 100 DAT.

S. No	Treatment	Plant height (cm)	Number of tillers/hill	Plant dry weight (g)
T1	Chakhao poireiton + 50% N through Vermicompost + 50% N through FYM	138.78	8.67	31.80
T2	Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost	137.52	9.13	31.95
T3	Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM	138.60	10.20	32.32
T4	Chakhao Amubi + 50% N through Vermicompost + 50% N through FYM	143.06	7.80	30.12
T5	Chakhao Amubi + 50% N through Poultry manure + 50% N through Vermicompost	140.15	8.20	30.97
T6	Chakhao Amubi + 50% N through Poultry manure + 50% N through FYM	141.98	7.27	29.73
T7	SKM111 + 50% N through Vermicompost + 50% N through FYM	136.12	5.40	28.60
T8	SMK111 + 50% N through Poultry manure + 50% N through Vermicompost	133.38	6.00	28.99
T9	SKM111 + 50% N through Poultry manure + 50% N through FYM	134.73	6.53	29.27
F test		S	S	S
S.Em (±)		0.65	0.29	0.23
CD (P= 5%)		1.39	0.61	0.50

Yield Attributes

Number of tillers/ hill, number of grains/ panicle, number of filled grains/panicle-, test weight (g). The yield attributes of black rice was significantly influenced by rate of N through organic manure and varieties (Table 2). At Harvest, maximum number of panicle/ hill with treatment the application of T_3 Chakhao Poireiton + 50% Poultry manure + 50% FYM) was recorded maximum number of panicle/hill (10.00) which was significantly superior over all other treatments except with the application of treatment T_2 (Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost) which was statistically at par with the treatment with application of Chakhao Poireiton + 50% Poultry manure + 50% FYM. Maximum number of grains/ panicle with treatment the application of T3 Chakhao Poireiton + 50% Poultry manure + 50% FYM) was recorded maximum number of grains panicle/hill (206.73) which was significantly superior over all other treatments except with the treatment application of Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost was noticed statistically at par. The treatment with application of Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM was recorded significantly maximum no. of filled grains/panicle (83.20) and found to be superior over all other treatments except with application of Chakhao poireiton +

50% N through Poultry manure + 50% N through Vermicompost was statistically at par. The treatment with application of Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM was recorded significantly maximum test weight (24.58) than all other treatments except with application of Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost (24.43) was noticed statistically at par. Hence, in the current experiment we are supplying required content of N through poultry manure and FYM. Similar findings were obtained from **Hussain *et al.* (2012**), **Devi *et al.* (2019)** and **Yumnam *et al.* (2021)**

Table 2: Effect of organic manure on yield attributes of black rice varieties.

S. No	Treatment	No. of Panicles/hill	Number of Grains/panicle	Number of filled Grains/panicle	Test weight (g)
T1	Chakhao poireiton + 50% N through Vermicompost + 50% N through FYM	8.47	197.07	79.93	23.95
T2	Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost	8.93	199.20	80.67	24.43
T3	Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM	10.00	206.73	83.20	24.58
T4	Chakhao Amubi + 50% N through Vermicompost + 50% N through FYM	7.60	192.13	75.60	23.83
T5	Chakhao Amubi + 50% N through Poultry manure + 50% N through Vermicompost	8.00	194.67	77.40	23.77
T6	Chakhao Amubi + 50% N through Poultry manure + 50% N through FYM	7.07	188.73	73.73	23.81
T7	SKM111 + 50% N through Vermicompost + 50% N through FYM	5.20	180.20	69.67	23.70
T8	SMK111 + 50% N through Poultry manure + 50% N through Vermicompost	5.73	183.93	71.53	23.72
T9	SKM111 + 50% N through Poultry manure + 50% N through FYM	6.27	185.93	72.73	23.74
F test		S	S	S	S
S.Em (±)		0.19	1.11	0.64	0.13
CD (P= 5%)		0.57	3.33	1.92	0.39

Yield

The grain yield of black rice was significantly influenced by rate of N application through organic sources and varieties (Table 3). The treatment with application of Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM (T_3) was recorded significantly maximum grain yield (4.26) which was superior over all other treatments except application of Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost (T_2) noticed statistically at par with application of Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM (T_3). Treatment with application of Chakhao Amubi + 50% Vermicompost + 50% FYM (T_3) was recorded maximum straw yield (10.06 t/ha) which was significantly superior over all other treatments except treatment with application of Chakhao Amubi + 50% Poultry manure + 50% FYM (T_6) found statistically at par with the treatment with application of Chakhao Amubi + 50% Vermicompost + 50% FYM (T_7). The highest harvest index was observed with application of SMK111 + 50% Poultry manure + 50% Vermicompost (36.86) and minimum in treatment with application of Chakhao Amubi + 50% Vermicompost + 50% FYM (27.06). Similar results were observed by Hussain *et al.* (2012), (Borah *et al.* 2018) [4].

Table 3: Effect of organic manure on yield attributes of black rice varieties.

S. No	Treatment	Grain Yield (kg/ ha)	Straw Yield (kg/ha)	Harvest index (%)
T1	Chakhao poireiton + 50% N through Vermicompost + 50% N through FYM	4.03	8.05	33.36
T2	Chakhao poireiton + 50% N through Poultry manure + 50% N through Vermicompost	4.05	7.73	34.37
T3	Chakhao Poireiton + 50% N through Poultry manure + 50% N through FYM	4.26	7.93	34.99
T4	Chakhao Amubi + 50% N through Vermicompost + 50% N through FYM	3.90	10.16	27.06
T5	Chakhao Amubi + 50% N through Poultry manure + 50% N through Vermicompost	3.96	8.28	32.33
T6	Chakhao Amubi + 50% N through Poultry manure + 50% N through FYM	3.89	9.04	30.08
T7	SKM111 + 50% N through Vermicompost + 50% N through FYM	3.60	7.50	32.43
T8	SMK111 + 50% N through Poultry manure + 50% N through Vermicompost	3.66	6.27	36.86
T9	SKM111 + 50% N through Poultry manure + 50% N through FYM	3.73	6.60	31.05
F test		S	S	S
S.Em (±)		0.03	0.09	0.20
CD (P= 5%)		0.11	0.27	0.62

Conclusion

Black rice is very important source of nutrient for human being and mostly rice edible in India providing organically black rice maintain quality of food and also improve soil status. It was concluded the variety Chakhao Poireiton along with 50 % N through Poultry manure + 50 % N through FYM (T_3) was resulted in better growth parameter, yield attributes and ultimately it gave maximum grain yield (4.26 t/ha) compare to other treatments. Hence the variety Chakhao poireiton + 50 % N through Poultry manure + 50 % N through FYM was recommended for eastern UP condition.

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