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GROWTH AND YIELD PERFORMANCE OF AROMATIC FINE RICE AS INFLUENCED BY VARIETIES AND FERTILIZER MANAGEMENTS

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Abstract. *This Research was conducted to investigate the effect of fertilizer management on growth and yield performance of aromatic fine rice varieties. The experiment consisted of two factors were aromatic fine rice and fertilizer management. There were four varieties namely Kalizira, Kataribhog, Tulshimala and BRRI Dhan34 with four fertilizer treatments recommended dose of fertilizers (T1), cowdung @ 10 tha^{-1} (T2), 50% of recommended dose of fertilizers + 50% cowdung(T3), 75% of recommended dose of fertilizers + 50% cowdung (T4). The result showed that BRRI Dhan 34 significantly superior for effective tillers number/ hill (18.46), panicles length (26.67cm), grains number/ panicle (146.30), harvest index (40.73 %), grain protein content (6.23%), grain yield (2.79 tha^{-1}), straw yield (4.06 tha^{-1}), and biological yield (6.85 tha^{-1}). Among fertilizer management, the highest effective tillers number/hill (16.20), grains number/ panicle (142.45, panicles length (26.66 cm),1000 grain weight (13.75), grain protein content (10.2%), biological yield (6.30), were obtained from T3 treatment. Based on interaction effect showed that the highest effective tillers number/hill (18.36), grains number/ panicle (155.33), panicles length (26.73 cm), grain protein content (10.80%), biological yield (7.85) was found with BRRI Dhan 34 combined with T3 treatment. However, grain yield increased with the increase in nitrogen levels. Together tillers number/hill, grains number/panicle, grain protein content, harvest index, grain yield was the main responsible yield contributing characters to improve the yield quality of aromatic fine rice.*
Keywords: aromatic fine rice; cowdung; fertilizer management; yield performance

1. Introduction

Rice (*Oryza sativa* L.) is an essential cereal crop nourishing more than half of the world's populations supplying 50 to 80% off regular caloric consumption (Amirjani, 2011). About 75.01% of the total cropped area of Bangladesh is used for rice production where annual production of 34.71 million tons from 11.28 million hectares of land (BBS, 2015). Different rice genotypes have different characters. Some have special appeal for their aroma and scent. The major identified aromatic varieties in Bangladesh are Kalizira, Chinigura, Kataribhog, BR5, Bashful, BRRI Dhan 34, BRRI Dhan 37, BRRI Dhan 38 (Bashmoti type), Khaskani, Badshabhog, Dudshagar, Tulshimala, Khirshabhog, Horibhog, Parbatjira, Khasha, Modhumadab, Tilkapur, Chinikanai, Khirkon, and Shakhorkora. Though productivity of aromatic fine rice is very low but its demand for internal consumption and for export is increasing day by day (Haque *et al*., 2012). Basmati

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(aromatic) rice has extremely high demand and it occupies a unique place in the world rice market (Singh *et al.*, 2018). Dinajpur region is a native area of some indigenous aromatic rice varieties. About 30% of rice land in Dinajpur is covered by aromatic rice varieties during the 'Aman' season (Alam *et al.*, 2002). Aromatic fine rice has high market value, due to price and taste like polau, khir, firny, payesh and exporting can bring a considerable amount of foreign exchange for the country (Paul *et al.,* 2016).

The use of organic inputs such as crop residues, manures and compost have great potential to improve soil productivity and crop yield through the improvement of the physical, chemical, and microbiological properties of the soil as well as nutrient supply (Stone & Elioff, 1998). According to Tanimu (2013), cowdung manure contains the three major plant nutrients, nitrogen, phosphorus, and potassium (NPK), as well as many essential nutrients such as Ca, Mg, S, Zn, B, Cu, Mn, etc. However higher yields depend on the rational and effective application of chemical fertilizers (Plucknett & Smith, 1986). But many researchers have reported a significant response of rice production depends on (organic + inorganic fertilizers) in different soils in Bangladesh (Uddin *et al*., 2018). So, the use of a judicious combination of organic and inorganic fertilizers is very important for rice production in a tropical country (Esfahani *et al.,* 2019).

The indigenous aromatic rice varieties, however, poor yielders having a poor response to fertilizer application (Mohioddin *et al.,* 2014). As the use of organic manures plays an important role to enhance the fertilizer use efficiency, reduce the cost of nutrient supply, increase production. Researchers observed aromatic rice gradually losing their aroma and qualities due to lack of soil organic matter and the use of imbalance chemical fertilizers. Therefore, the objectives of the research article were to compare the growth and yield performance of aromatic fine rice varieties with different fertilizer managements and to identify the most responsible yield contributing traits for higher production of aromatic fine rice yield.

2. Methods

The experiment was conducted at the Agronomy Research Field of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during (July to December 2017). Experimental site was characterized under the sub-tropical weather and climate by three distinct seasons with medium high land containing soil pH 5.6, organic carbon 0.45%, temperatures differed from July to December (33°C to 25°C), humidity (72% to 82%), and rainfall (296.2 mm-10 mm). This location contained latitude, longitude, and elevation from sea level (25.13° N, 88.23°E, 37.5 m). Two factors were included in the experiment namely, Factor-A (Four varieties namely), Kalizira, Kataribhog, Tulshimala, and BRRI Dhan34. Factor-B (4 fertilizer doses): Recommended fertilizer doses (T1), Cowdung @ 10 t/ha (T2), 50% recommended fertilizers doses + 50% cowdung (T3) and 75% of recommended fertilizers doses + 50% cowdung

(T4). The experiment was laid out in a Randomized Complete Block Design with three replications where the size of each unit plot was 2.5m x 2.0 m. Before sowing in the nursery, seeds were soaked in water for 24 hrs. After that kept into gunny bags in dark condition. When seeds sprouted, sown in wet seedbed on 4th July 2017. At 36 days old, 3 seedlings/ hill were transplanted on 9th August 2017 according to the experimental design. Fertilizers like TSP(P_2O_5) and MoP (K_2O) were applied at final land preparation. The nitrogen (urea) was applied as an experimental specification. One-third urea was applied during final land preparation, and rest urea in two equal installments at 33 and 66 DAT, respectively. Agronomic actions e.g., weed and insect control were done manually. Insect pests were controlled by the application of 20 ml per 1 L Cypermethrin 10% w/v EC and 50 ml per 1 L Benfuracarb 20% w/v EC with water.

2.1. Data collection

Data on individual plant parameters was recorded from selected hills/plots. Grain yield, straw yield, biological yield, and harvest index were recorded from the whole plot at harvesting time and qualitative traits were recorded from selected grain. Collected parameters were plant height (cm), tillers number/ hill, effective tillers/ hill, panicles length(cm), grains number/panicle, 1000-grain weight, grain protein content (%), grain yield (t/ ha), straw yield (t/ ha), biological yield (t/ ha) and harvest index (%).

2.2. Statistical Analysis

Data were analysed statistically as per the design used following the analysis of variance (ANOVA) technique and the mean differences were adjusted with DMRT at a 5% level of significance using the statistical computer package program, (MSTAT-C) following Russel (1986).

3. Results and Discussions

3.1. Plant height on varieties and fertilizer treatments

Tables 1 and 2 showed that varieties and fertilizer treatments were significantly influenced by plant height. It was observed that Tulshimala produced the tallest plant 161.44cm and the smallest 144.55cm by BRRI Dhan34. It was evident that plant height differed significantly from varieties due to genetic variation, nutrient uptake, photosynthesis rate, etc. This result agreed with (Jiang, *et al*., 2003). The tallest plant 155.96 cm was observed at T1 while the shortest 149.32 cm was observed at T2 fertilizer management treatments.

3.2. Effective tillers number/ hill on genotypes and fertilizer treatments

Tables 1 and 2 showed that effective tillers number/ hill was significantly influenced by genotypes and fertilizer managements. Highest (18.46) was found from BRRI Dhan34 which was followed by Tulshimala (16.36) and Kalizira (16.16). Whereas, lowest (14.06) from Kataribhog

varieties. Chandel *et al*. (2010) and Sarkar *et al.* (2014) reported that tillers number/ hill differed significantly for different varieties due to genetic and varietal variation that might be influenced by heredity. The highest tillers number/ hill was obtained 16.20 at T3 treatment. Adequacy of nitrogen application probably favored the cellular activities during yield and development which lead to increase tillers number/hill. In the present experiment with nitrogen at higher level produced identically higher effective tillers.

Table 1. Varietal effect on the yield and yield contributing characters of aromatic rice

Variety	Plant height (cm)	Tiller numbers/hill (no)	Panicles length (cm)	Grains/ panicle (no)	1000-grain weight (g)	Grain protein content (%)	Straw yield	Biological yield (tha^{-1})
V1	145.12c	16.16b	24.56c	133.67c	12.44c	6.12b	3.07c	5.10c
V2	155.24b	14.06c	25.65b	133.56c	14.05a	6.08b	3.50b	5.73b
V3	161.44a	16.36b	24.45c	136.45b	12.60c	6.23b	3.06c	4.98c
V4	144.55c	18.46a	26.67a	146.30a	13.37b	7.17a	4.06a	6.85a
Level of Significance	**	**	**	**	**	**	**	**
LSD	3.167	0.633	0.519	1.15	0.445	1.12	0.334	0.379
CV (%)	2.53	5.06	2.63	0.95	4.10	0.93	0.98	8.43

Here V1 means variety, figure bearing same, or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test, * = Significant at 5% level of significance, ** = Significant at 1% level of significance

3.3. Panicle length (cm) on varieties and fertilizer doses

Panicle length was significantly influenced due to varieties and fertilizer doses. The results indicated that the longest 26.67cm by BRRI Dhan34 and the shortest 24.45 cm produced by Tulshimala (Table 1). Panicles length with varieties differed significantly among each other due to their differences in genetic variation reported by (Chandel *et al.* 2010; Islam *et al*., 2013). Panicle length was significantly influenced by fertilizer management. Results showed that the longest 26.66 cm was produced at T3 while the shortest 23.66 cm was obtained from T2 fertilizer management treatment (Table 2).

3.4. Grains number/panicle on varieties and fertilizer doses

Results showed that grains number/panicle was significantly influenced by varieties. BRRI Dhan34 produced statistically the highest 146.30 no. and lowest 133.56no. was found in Kataribhog (Table 1). Reza *et al.* (2016) reported that grains number/panicle influenced significantly due to varieties. Grains number/ panicle varied significantly due to differences in nitrogen levels. Grains number/ panicle increased using T4 treatment *i.e.,* increasing fertilizer management. Table 2 showed the statistically highest grains number/panicle 142.45no was recorded from T3 while lowest from T2 treatment. An adequate supply of nitrogen contributed to grain formation that probably increased grains number/ panicle.

3.5. 1000 grain weight (g) on varieties and fertilizer doses

Table 1 showed that the highest 1000 grain weight 14.05 gm was obtained from Kataribhog and the lowest 12.60 gm was from Tulshimala. It was evident that variation in 1000 grain weight might be due to differences in the size of the grains that are partly controlled by the genetic make-up of the studied varieties. Islam *et al.* (2016) reported that 1000 grain weight is stable, important yield determining the character and influenced by the environment that differed significantly among the cultivars due to genetic make-up which supported the present experimental result. A similar result was reported by (Djaman *et al.,* 2016). Table 2 showed that the influence of different treatments of organic, inorganic, and their combinations on 1000 grain weight (g) was significant. The highest 1000 grain weight 13.75 gm was obtained from T3 and lowest 12.94 gm from T4 treatments.

Table 2. Effect of fertilizer management on the yield and yield contributing traits of aromatic fine rice.

Fertilizer	Plant height (cm)	Effective tiller number/ hill (no)	Panicles length (cm)	Grains/ panicle (no)	1000-grain weight (g)	Grain protein content (%)	Straw yield (tha^{-1})	Biological yield (tha^{-1})
F1/T1	155.96a	14.59c	25.55b	142.05a	13.42a	9.92b	3.67a	6.27a
F2/T2	149.32b	14.57c	23.66c	135.88c	13.23a	9.67b	3.18b	4.75b
F3/T3	149.56b	16.20a	26.66a	142.45a	13.75a	10.2a	3.66a	6.30a
F4/T4	151.43b	15.45b	25.42b	140.60b	12.94b	10.0a	3.16b	4.90b
Level of Significance	**	**	**	**	**	**	**	**
LSD	3.167	0.644	0.528	1.2	0.445	0.566	0.612	0.388
CV (%)	2.45	5.35	2.67	0.97	4.25	2.77	3.67	8.32

Here F means fertilizer, figure bearing same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test, * = Significant at 5% level of significance, ** = Significant at 1% level of significance

3.6. Grain Protein Content (%) on varieties and fertilizer managements

Grain protein content was significantly varied due to varieties (Table 1). The highest 7.17% was obtained from BRRI Dhan34 and the lowest 6.08% was found from Kataribhog. This result was liked by Aziz *et al.* (2017) who recorded variable protein percentage among varieties. Table 2 showed that the influence of different treatments of organic, inorganic, and their combinations on grain protein content was significant. The highest grain protein content obtained 10.2 % T3 and lowest 9.67% from T2 fertilizer management treatments.

Table 3. Interaction effect of varieties and fertilizer managements on the growth and yield contributing traits of aromatic fine rice.

Interaction (Variety × Fertilizer)	Plant height (cm)	Effective tillers/ hill (no)	Panicles/ length (cm)	Grains/ panicle (no)	1000-grain weight (g)	Grain protein content (%)	Straw yield (tha^{-1})	Biological yield (tha^{-1})
V1F1	155.42d	16.21c	22.55c	131.34g	10.86d	8.20c	3.35f	5.74b
V1F2	141.89f	15.45d	21.41c	135.77f	11.35c	8.45c	2.62k	4.35c
V1F3	142.10f	15.76d	24.02b	137.77e	11.53c	8.33c	3.33f	5.76b
V1F4	148.93e	17.06b	19.38d	133.77g	10.43d	8.67c	2.85j	4.45c
V2F1	158.35c	14.94f	24.09b	132.77g	14.35a	8.23c	3.64e	6.24b
V2F2	153.87d	15.84d	22.18c	137.11e	14.05a	8.50c	3.26f	5.12b
V2F3	155.62d	16.42c	24.55b	136.26e	14.35a	8.68c	3.75d	6.58b
V2F4	155.03d	17.25b	20.35d	135.43f	13.74b	8.88c	2.92i	4.65c
V3F1	165.71a	16.42c	22.55c	136.10e	11.16c	9.23b	3.10h	5.20b
V3F2	159.75c	15.54d	21.65c	141.00d	10.55d	9.02b	2.95i	4.61c
V3F3	161.42b	16.78b	24.55a	137.66e	11.25c	8.80	3.20g	5.40b
V3F4	161.44b	17.07b	21.10c	137.66e	10.45f	9.34b	2.95i	4.46c
V4F1	150.14e	16.84c	25.56a	139.00d	13.35b	8.80c	4.55a	7.85a
V4F2	149.21e	16.60c	23.23b	153.00b	12.82b	10.00a	3.88c	5.48b
V4F3	146.61e	18.36a	26.73a	155.33a	12.37b	10.80a	4.45b	7.85a
V4F4	138.16g	18.04a	23.10b	149.77c	13.75ab	10.20a	3.85c	6.15b
Level of Significance	*	**	ns	**	**	**	**	**
LSD	6.333	1.268	1.058	2.20	0.789	2.12	2.10	0.765
CV (%)	2.53	5.08	2.62	0.98	4.14	0.99	0.92	8.35

Here, V= Variety and F= Fertilizer; figure bearing, same or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test, * = Significant at 5% Level of significance, ** = Significant at 1% level of significance, ns= Non- significant.

3.7. Grain yield (t/ ha) on varieties and fertilizer doses

Results showed that grain yield had significant variation on varieties (Figure 1). The highest 2.79 tha^{-1} was achieved from BRRI Dhan34 and the lowest 1.92 tha^{-1} from Tulshimala. The highest yield in BRRI Dhan34 may be due to higher effective tillers number/hill, panicles length, grains/ panicle, and grain protein content. These findings were very much like (Kabir *et al.*, 2004). Scented rice responded significantly to different fertilizer management practices. Dry matter production during the crop growth period and its translocation to panicles are the major determinants of grain yield of rice. Further, grain yield of a genotype depends largely on the total dry matter accumulation and its distribution after anthesis, as the major portion of the dry matter produced during the post anthesis period is translocated to the panicles. Grain yield increased with the application of T3 fertilizer management treatment.

Results in Figure 2 showed that the highest grain yield (2.64 tha^{-1}) from T3 hence lowest (1.57 tha^{-1}) from T2 and T4 treatments. A significant improvement in grain yields due to the combined application of organic and inorganic fertilizer management (Manzoor *et al.*, 2006). The efficiency of inorganic fertilizers might be increased when it was applied along with organic manures and brought a beneficial effect on rice grain yield due to an increase in effective tillers/ ha as reported by Srinivas *et al.* (2010).

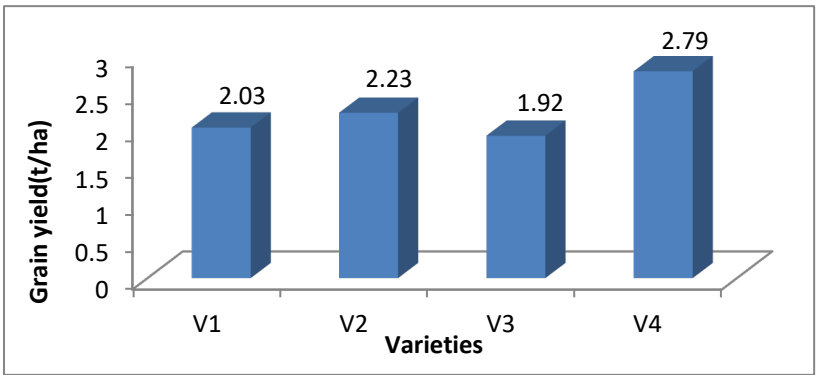

Figure 1. Varietal effect on the grain yield of aromatic fine rice

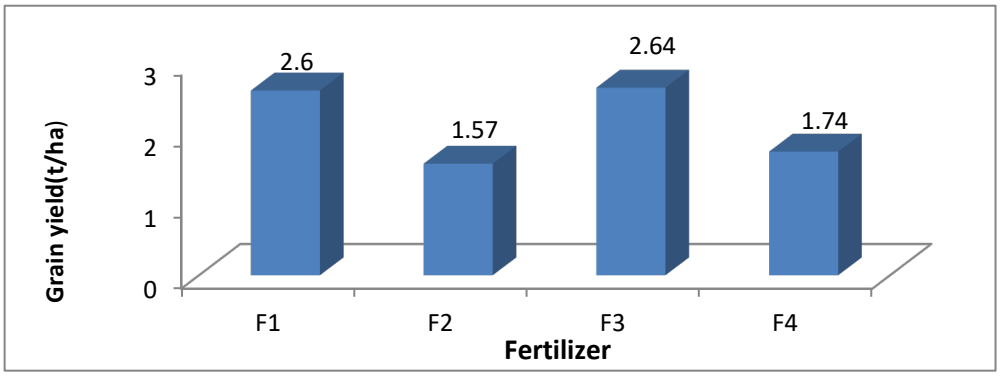

Figure 2. Effect of fertilizer on the grain yield of aromatic fine rice

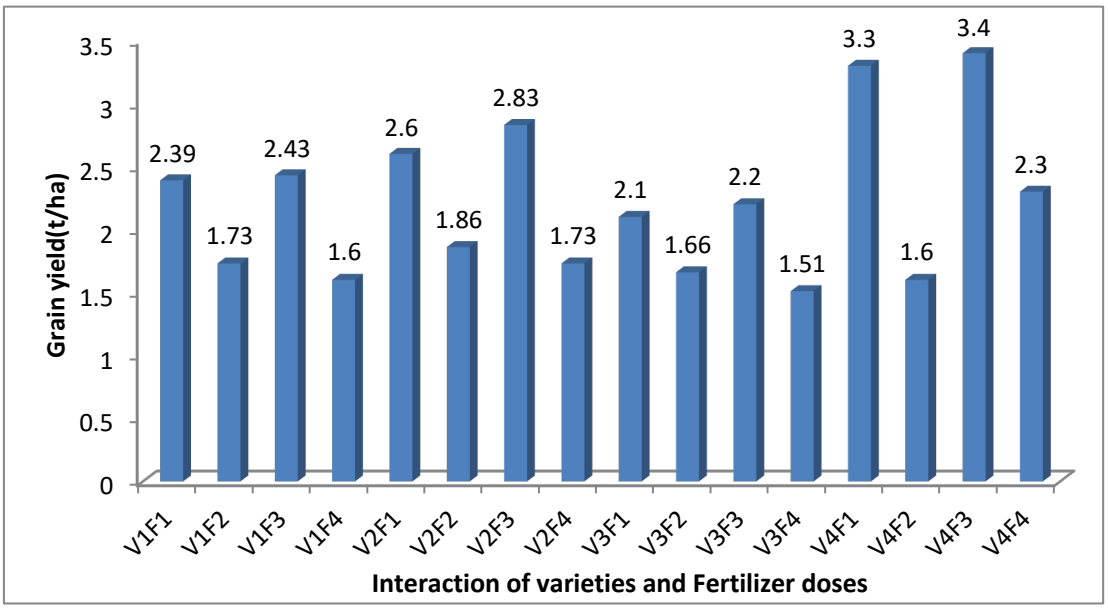

Figure 3. Interaction effect of varieties and fertilizer managements on the grain yield of aromatic fine rice

3.8. Straw yield (t/ ha) on varieties and fertilizer doses

Table 1 showed that the highest straw yield 4.06 tha^{-1} was produced by BRRI Dhan34 and lowest 3.06 tha^{-1} by Tulshimala. The effect of the nitrogen level was found to be highly significant in respect of straw yield (Table 2). The highest 3.67 tha^{-1} was produced at T1 treatment. Nitrogen influenced vegetative growth in terms of plant height and tillers number/ hill which resulted in increased straw yield. Among, the treatments higher straw yield at T1 and the lowest recorded at T4 treatment. Combination result (Table 3) showed that v4F1 gave highest result. This agreed with the findings of (Das *et al*., 2009; Bahadur *et al*., 2013; Mannan *et al.,* 2013; Meena *et al*., 2016).

3.9. Biological yield (tha^{-1}) on varieties and fertilizer doses

The varietal effect on biological yield was significant. Table 1 showed the highest 6.85 tha^{-1} from BRRI Dhan34 and the lowest 4.98 tha^{-1} was recorded from Tulshimala. This result was supported by (Islam *et al*., 2014; Singh *et al*., 2017). The effect of bio fertilizer and nitrogen was found significant in terms of biological yield (Table 2). The highest 6.30 tha^{-1} was found from T3 and the lowest 4.75 tha^{-1} was recorded from T2 treatment. Nitrogen level positively influenced grain yield and straw yield which increased biological yield.

3.10. Harvest index (%) on varieties and fertilizer doses

The harvest index was significantly influenced by varieties. From Table 1 and Figure 4, it was evident that the highest 40.73% from BRRI Dhan34 and the lowest 38.55 % was recorded from Tulshimala. The highest 42.9% was found from F3 and the lowest 33.05% was recorded from F2 treatment (Figure 5). Gill and Aulakh (2018) reported that genotype had a great influence on the harvest index.

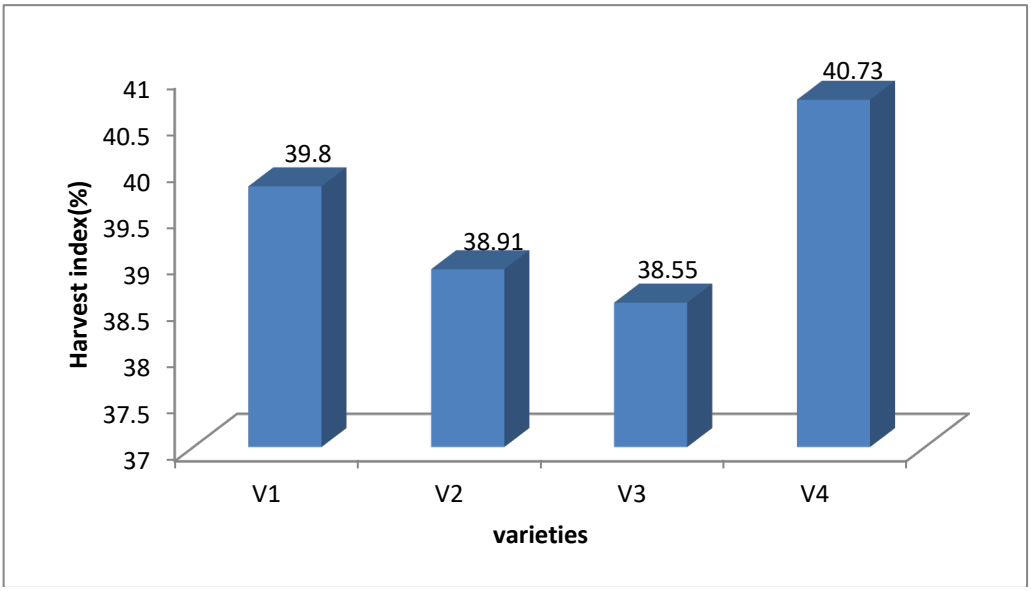

Figure 4. Varietal effect on the harvest index of aromatic fine rice

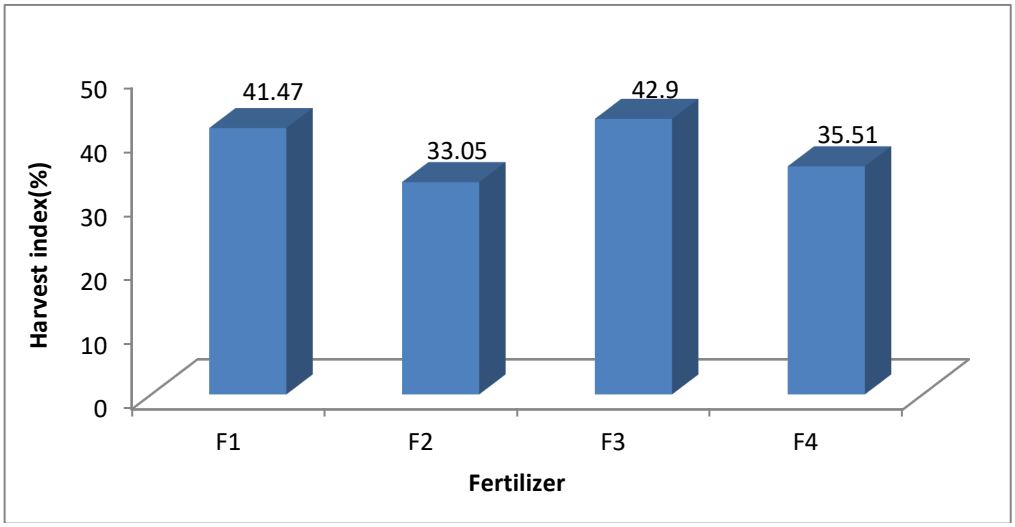

Figure 5. Effect of fertilizer on the harvest index of aromatic rice

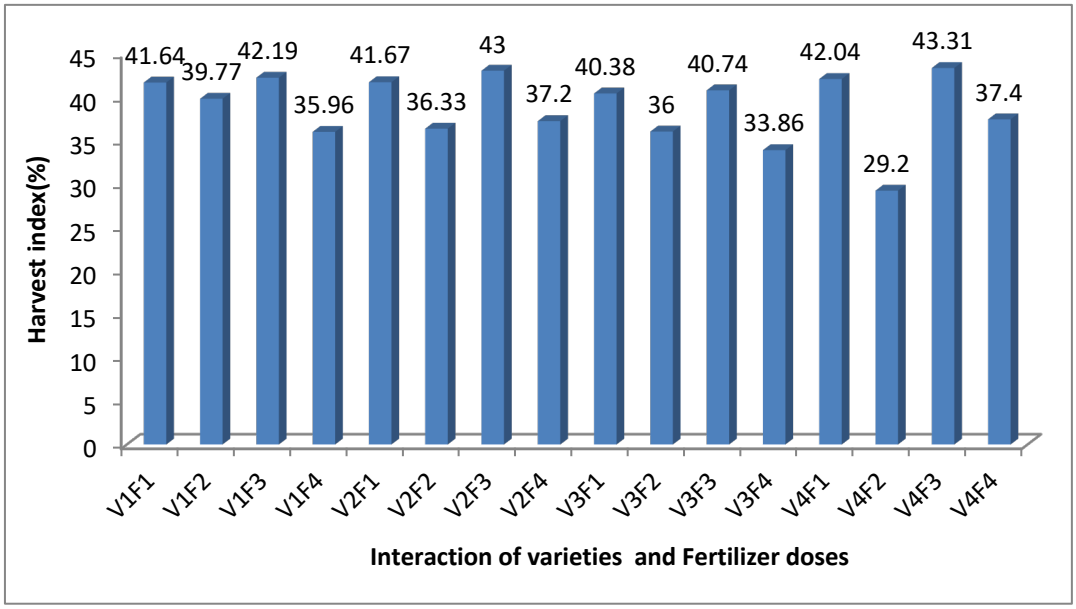

Figure 6. Interaction effect of varieties and fertilizer on the harvest index of aromatic rice

3.11. Interaction effect of varieties and fertilizer managements

Table 3 showed that interaction between varieties and nutrient management was significant on yield and yield components of aromatic fine rice. Highest plant height 165.71cm from V3F1, highest tiller numbers/plant 18.36 from V4F3, longest panicles length 26.73 cm from V4F3, longest grains number/panicle 155.33 from V4F3, maximum 1000 grain weight 14.35gm from V2F3; highest grain protein content 10.80% from V4F3; highest biological yield 7.85 tha^{-1} fromV4F3; highest grain yield 3.4 tha^{-1} observed from V4F3 (Figure 3); highest straw yield 4.55 tha^{-1} from V4F1; the highest harvest index 43.31% from V4F3(Figure 6). Maximum yield and yield contributing traits found from BRRI Dhan34+interaction with 50% of recommended dose of fertilizers + 50% cowdung, and BRRI Dhan 34 +75% of recommended dose of fertilizers + 50% cowdung.

Besides, lowest plant height 141.89 cm from V1F1, lowest tiller numbers/plant 14.94 from V2F1; longest panicles length 19.38 cm from V1F4**;** lowest grains number/panicle 131.34 no. from V1F1, minimum1000 grain weight 10.43 gm from V1F4; lowest grain protein content 8.20 % from V1F1; lowest grain yield 1.51 tha^{-1} observed from V3F4; lowest straw yield 2.62 tha^{-1} from V1F2; lowest harvest index 29.20 % from V4F2. Whereas most of the minimum yield contributing traits found from Kalizira + Recommendation fertilizer doses; and Kalizira + Cowdung @ 10 tha^{-1}. All the findings are shown (Table 3).

4. Conclusion

From the present study, it can be concluded that yield contributing characters like effective tillers number/ hill (18.46), longest panicles length (26.67cm), highest grains number/ panicle (146.30 no), grain protein content (6.23%), grain yield (2.79 tha^{-1}), highest straw yield (4.06 tha^{-1}), highest biological yield (6.85 tha^{-1}), highest harvest index (40.73 %) was achieved from aromatic fine rice BRRI Dhan34. Highest effective tiller (16.20 no), highest panicles length (26.66cm), grains number/panicle (142.45 no), 1000 grain weight (13.75), grain protein content (10.2%) and biological yield (6.30 tha^{-1}) obtained from 50% of recommended dose of fertilizers + 50% cowdung treatment combination. At the same time, the highest grain yield (3.4 tha^{-1}) was found between the interaction of BRRI dhan34 with (50% recommended fertilizers doses + 50% cowdung) treatment. Besides, tillers number/hill, grains number/panicle, grain protein content, harvest index, grain yield main yield contributing characters to improve the grain yield of aromatic fine.

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