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PHENOLOGY AND DEGREE DAYS OF RICE CULTIVARS UNDER ORGANIC CULTURE

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Abstract

Variations in the phenology and degree days of five fine rice cultivars *viz.,* Rajshahi swarna, Silkumul, Kataribhog, Lal pajam and Sanla under organic and inorganic cultural conditions were studied following a split plot design. The requirement of days to attain various phenological stages was highest in Rajshahi swarna, medium in Silkumul, Kataribhog and Lal pajam and the lowest in Sanla for both the cultural conditions. The growing degree days (GDD) and heat use efficiency (HUE) were slightly higher under inorganic than organic culture because of higher life span of rice cultivars in inorganic culture. The highest GDD and HUE were found in Rajshahi swarna, whereas the lowest in Sanla. Results also showed that the requirement of days and GDD were initially higher up to maximum tillering stage under organic culture but thereafter these requirements were greater under inorganic culture for all the cultivars. The grain yield was somewhat lower in organic compared to inorganic culture. In Rajshahi highest grain yield of swarna was 2.90 and 2.74 t/ha under inorganic and organic culture, respectively.

Introduction

Rice (*Oryza sativa* L.) is the first ranking cereal in terms of area and production, and transplanted local aman rice including fine rice, aromatic rice and other cultivars grown in 1.66 million hectares of land with the total production of 1.34 million metric tons (BBS 2008). Consumer demands for the fine rice varieties are higher due to its good nutritional quality, palatability, taste, cooking quality and fragrance (Kaul *et al*. 1982) and cooked on special occasions. Continuous use of inorganic fertilizer had deleterious effects on soil fertility and productivity with steady decline in rice production (Nambiar *et al.* 1998). Organic fertilizer increases soil microbial activity and improves soil health. A good soil should have at least 2.5% organic matter, but in Bangladesh most of soils it is less than 1% (BARC 2005). Some agencies prepare nutrient enriched organic fertilizers, like Moni Mukta, Agro-sar, Jaibo-sar, Super Greenfield, Chook-Chook 111 from cow-dung, FYM and poultry manure and have been evaluated for wetland rice cultivation. It has been observed that fine aromatic rice gradually loses their aroma, yield and taste due to lack of organic matter content in soil, proper cultural management and changes of environment (Singh and Singh 1997). The present study is aimed at studying the phenology and growing degree days of Bangladeshi fine rice cultivars using organic fertilizer.

Materials and Methods

The experiment was set at the research farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the *aman* season (August to December) of 2008. Five fine rice cultivars, *viz.* Rajshahi swarna, Silkumul, Kataribhog, Lal pajam and Sanla were used and cultivated in a split plot design with three replications. The unit plot size was 6 m^2 (3m × 2m) having a plot to plot and block to block

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distance of 0.75 m and 1.0 m, respectively . There were 30 plots in the experiment. A fertilizer dose of 90-75-60-60-10 kg/ha was applied as N, P_2O_5, K_2O, S and Zn, respectively in the form of urea, TSP, MOP, gypsum and zinc oxide. Organic fertilizer of Northern Agro Services Ltd. (NASL) was used at the dose of 2 t/ha which contain N, P_2O_5, K_2O, S, Ca, Mg, Fe, Zn, Mn and Cu as 4, 1.15, 1.5, 1, 2.5, 0.75 and 0.05%, 150, 170 and 24 ppm, respectively.

Phenological stages include seedling establishment tillering, booting, heading, anthesis, milking, dough and maturity.

The accumulated heat unit system is based on the idea that plants have definite temperature requirements to attain certain phenological stage. The GDD and HUE were calculated following Rajput (1980).

Growing degree days (GDD) = $\sum [(T_{max}+T_{min})/2-T_b]$. Here, ($T_b$ = Base temperature = 10ºC)

Heat use efficiency (HUE) = Grain yield (kg/ha)/GDD

The treatment means were compared using DMRT as outlined by MSTAT program (Gomez and Gomez 1984).

Results and Discussion

Phenology of five fine rice cultivars under the cultural conditions of inorganic and organic culture is presented in Table 1. Results indicated that phenology was significantly influenced by the interaction effect of cultural conditions and cultivars. The numbers of days for attaining different phenological stages differed from cultivar to cultivar. In case of organic culture, all the cultivars showed higher requirement of days for attaining seedling establishment, initial and maximum tillering stages compared to inorganic culture. But from booting to harvesting stage, this requirement of days decreased as compared to inorganic culture. It was found that both inorganic and organic culture, the requirement of days to complete various phenological stages like seedling establishment, initial and maximum tillering, booting, heading, anthesis, milking, dough, maturity and harvesting were highest in Rajshahi swarna, medium in Silkumul, Kataribhog and Lal pajam and lowest in Sanla. The results also indicated that the life duration of all the cultivars were significantly shorter in organic than inorganic culture. Similar results were found in fine aromatic strains that the phenological stage (flowering) of IR-8 × Jajai-77 required minimum (73-77) days, followed by D. Basmati × Lateefy and Jajai-77 (80 days and 105 days, respectively) due to varietals differences (Oad *et al.* 2006) and also found that the cultivar Chinigura required highest number of days before booting (83.20), heading (86) and flowering (88.80) as compared to Begunbitchi and Kalijira (Kabir *et al.* 2004).

The combined effect of cultural conditions and cultivars on heat unit at growing degree days (GDD) was significant at all the phenological stages of rice cultivars (Table 2). The lowest heat unit (GDD) requirement was observed in seedling establishment stage, whereas in the successive phenological stages like initial tillering, maximum tillering, booting, heading, anthesis, milking, dough, maturity and harvesting the heat unit (GDD) increased. All the cultivars showed significantly higher heat unit (GDD) from seedling establishment to maximum tillering stage in organic culture than inorganic culture. But from booting stage to harvesting stage the GDD was increased in inorganic culture. Under both growing conditions Rajshahi swarna required the highest heat unit (GDD) at all the phenological stages which was followed by Silkumul, Kataribhog and Lal pajam, whereas Sanla required lowest heat unit (GDD) at its different phenological stages. The GDD requirement for maturity was highest in Lal Swarna (2385 degrees C/day), followed by IR-36 (1975 degrees C/day) and Kshitish (1913 degrees C/day) (Khan *et al.* 2006).

Table 1. Phenology at days after transplanting of five fine rice cultivars as affected by cultural conditions at different stages.

Cultivars	Cultural conditions	Seedling establishment	Initial tillering	Maximum tillering	Booting	Heading	Anthesis	Milking	Dough	Maturity	Harvesting
Rajshahi swarna	Inorganic	13 bc	17 bc	60 ab	68 a	75 a	78 a	83 a	85 a	102 a	116 a
	Organic	15 a	19 a	61 a	66 abc	74 ab	76 b	81 ab	85 a	100 b	113 b
Silkumul	Inorganic	12 cd	16 cd	58 cd	67 ab	73 abc	76 b	81 ab	85 a	100 b	114 b
	Organic	14 ab	18 ab	60 ab	65 abcd	72 bc	75 bc	80 bc	84 ab	98 bcd	112 b
Kataribhog	Inorganic	13 bc	17 bc	57 de	66 abc	71 cd	74 cd	79 bcd	84 ab	99 bc	113 b
	Organic	15 a	19 a	59 bc	64 bcd	69 de	73 de	78 cd	82 bc	97 cde	109 cd
Lal pajam	Inorganic	13 bc	17 bc	58 cd	64 bcd	69 de	72 ef	78 cd	82 bc	98 bcd	110 c
	Organic	14 ab	17 bc	58 cd	63 cd	68 e	71 fg	77 de	81 cd	96 de	108 d
Sanla	Inorganic	11 d	15 d	56 e	64 bcd	68 e	71 fg	75 ef	79 de	96 de	108 d
	Organic	13 bc	16 cd	57 de	62 d	67 e	70 g	74 f	78 e	95 e	107 d
CV (%)	-	6.18	5.55	1.65	2.71	1.65	1.38	1.61	1.64	1.10	1.99

Mean followed by same letter(s) within a phenological stage did not differ significantly at 5% level by DMRT.

Table 2. Growing degree days at different phenological stages of five fine rice cultivars as affected by cultural conditions.

Cultivars	Cultural conditions	Seedling establishment	Initial tillering	Maximum tillering	Booting	Heading	Anthesis	Milking	Dough	Maturity	Harvesting
Rajshahi swarna	Inorganic	252.1 bc	323.9 bc	1139 ab	1278 a	1389 a	1484 a	1510 a	1569 a	1755 a	1918 a
	Organic	287.9 a	362.4 a	1157 a	1244 abc	1377 ab	1427 bc	1478 ab	1554 ab	1732 ab	1882 b
Silkumul	Inorganic	233.1 cd	305.6 cd	1103 cd	1262 ab	1364 ab	1454 ab	1478 ab	1541 ab	1732 ab	1894 b
	Organic	270.5 ab	343.1 ab	1139 ab	1227 abcd	1346 bc	1429 bc	1462 bc	1526 bc	1707 cd	1871 b
Kataribhog	Inorganic	252.1 bc	323.9 bc	1084 de	1244 abc	1331 c	1418 bc	1446 bcd	1526 bc	1720 bc	1882 b
	Organic	287.9 a	362.5 a	1121 bc	1210 bcd	1296 d	1372 def	1431 cd	1494 cd	1695 de	1834 cd
Lal pajam	Inorganic	252.4 bc	323.8 bc	1103 cd	1209 bcd	1296 d	1409 cd	1431 cd	1494 d	1707 cd	1846 c
	Organic	270.3 ab	323.8 bc	1103 cd	1192 cd	1279 de	1399 cde	1416 de	1478 d	1683 de	1822 cd
Sanla	Inorganic	213.6 d	287.9 d	1067 e	1210 bcd	1279 de	1366 ef	1389 ef	1446 e	1683 de	1822 d
	Organic	252.1 bc	305.6 cd	1085 de	1174 d	1262 e	1349 f	1377 f	1431 e	1671 e	1810 d
CV (%)	-	5.75	5.42	1.55	2.48	1.35	1.54	1.32	1.13	1.76	1.70

Mean followed by same letter(s) within a phenological stage did not differ significantly at 5% level by DMRT.

The interaction effect of cultural conditions and cultivars significantly influenced the heat use efficiency in most of the cases (Table 3). Results showed that all the cultivars used heat more efficiently at inorganic as compared to organic culture. Under inorganic culture, Rajshahi swarna and Silkumul showed significantly higher HUE followed by Kataribhog, whereas Sanla and Lal pajam recorded lowest HUE. In case of organic culture, Rajshahi swarna had the highest HUE and Sanla showed the lowest heat use efficiency. The reduction in HUE the Rajshahi swarna and Lal pajam were lower and the highest reduction was found in Sanla followed by Kataribhog and Silkumul.

Table 3. Heat use efficiency of five fine rice cultivars as affected by cultural conditions.

Cultivars	Heat use efficiency		Reduction at organic culture (%)
	Inorganic culture	Organic culture	
Rajshahi swarna	1.51 a	1.45 bc	3.97
Silkumul	1.50 ab	1.30 d	13.33
Kataribhog	1.44 c	1.20 e	16.68
Lal pajam	1.32 d	1.25 e	5.30
Sanla	1.21 e	0.96 f	20.66
CV (%)	1.18		-

Mean followed by same letter(s) did not differ significantly at 5% level by DMRT.

Based on phenology, growing degree days, heat use efficiency and yield the farmer should be cultivated the cultivar Rajshahi swarna by using organic fertilizer.

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