ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 3 (2): 90-93, 2004
ISSN 1680-8207
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Effect of Planting Dates on Phenological Events of Transplanted Aman Rice

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Abstract. Due to late planting the panicle initiation, heading and maturity of all the cultivars were slowed with decreasing air temperature and solar radiation. Nizersail and BR11 did not complete flower beyond October 01 and September 01 planting, respectively while BR11 completed flowering in all the planting dates. An average temperature 23.92, 26.17 and 21.31°C for 10 days after start of heading was required for Nizersail, BR11 and BR22, respectively. Eighty three to 94% tillers of Nizersail produced fully exserted panicles upto October 01 planting while for BR11 it was 21-92% upto September 15 planting but in BR22 it was about 86-97% in all planting dates. Full panicle exsertion of Nizersail sharply increased with increasing temperature sum for 10 days from start of heading, later slightly decreased but it was sharply increased in BR11. The BR22 was less sensitive to temperature. The percent panicle exsertion was highly correlated with temperature sum for 1-10 days after start of heading for Nizersail (r = 0.87**) and BR22 (r = 0.96**). In BR11, it was highly correlated with temperature sum for 1-10, 11-20, 21-30 and 11-30, days from start of heading and the corresponding values were (r = 0.97**), (r = 0.95**), (r = 0.81*), (r = 0.90**), respectively.

Key words: Planting dates, T.aman rice, phenological events, air-temperature

INTRODUCTION

In Bangladesh, the rice varieties grown in Transplanted aman (T. aman) i.e. in wet season are mostly photoperiod sensitive. When these varieties were transplanted in the late season during September-October their sensitivity of flowering in the months of October-December mostly depends on the planting dates. Though these varieties are photosensitive but their phenological events also depend on the particular air temperature. BRRI[1] and Yoshida[2] reported that rice plants require a particular temperature for its phenological affair such as panicle initiation, flowering, panicle exsertions from flag leaf sheath and maturity and these are very much influenced by the planting dates during T. aman season. Deviation from the optimum planting time may cause incomplete and irregular panicle exsertion, increase spikelet sterility[3]. The optimum planting time of T.aman rice is in August[4]. But sometimes transplanting is delayed due to various physical and socio-economic factors[5,6]. This late planting exposes the reproductive phase as well as phenological events of crop in an unfavorable temperature regime thereby causing high spikelets sterility and poor growth of the plant[1]. Informations regarding phenological events of these varieties to temperature are not adequate. Therefore, this study was under taken to find out the effect of planting dates on phenological development and to determine the degree of sensitivity of cultivars to air temperature.

MATERIALS AND METHODS

The field experiment was conducted at the Bangladesh Rice Research Institute (BRRI) Gazipur farm where three rice cultivars (Nizersail, BR11 and BR22) were planted on seven different dates (August 01 and 15, September 01, 15 and 22, October 01 and 07). The experiment was laid out in a split plot design as planting dates were in main plots and cultivars in subplot. The treatments were replicated in three times. The unit plot size was 3×3m. Three to four 35 days old seedlings were transplanted at 25×20cm spacing. Fertilizers as N, P_2O_5, K_2O and S were applied @ 60-40-40-10 kg ha^{-1} from urea, triple super phosphate, muriate of potash and gypsum, respectively. All fertilizers and one third of urea were applied at basal. Rest of urea was applied in two equal splits as top-dressed at 15 days after transplanting (DAT) and 7-days before panicle initiation (PI) followed by their incorporation with soil two days after application. All other cultural practices were done as and when needed for proper crop management. The following data were recorded.

Date of Panicle Initiation (PI): From the boarder line of each plot 3-4 tillers were randomly collected and opened

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by a needle and panicle primordia was observed through a magnifying glass at 2-days intervals beginning stem elongation stage.

Date of heading: This was the date when 50% tillers in a hill produced completely exserted panicles.

Flowering duration: It was the duration between start of heading and when about 50% of the plants had completely emerged panicles.

Panicle exsertion: At maturity the number of panicle with 100, 75, 50, 25 and 0% of their length exposed from flag leaf sheath were counted from nine hills per variety (0.45 m^2 area) and expressed as present of total tillers per group.

Weather data: It was taken from the BRRI Plant Physiology Division.

Statistical analysis: The relationship between fully panicle exsertion and temperature was studied using the best fitted regression models and correlation analysis[7]. Effect of temperature sum on complete panicle emergence was determined by the model, y=a+bx for BR22, and by $y=a+bx+cx^2$ for Nizersail and BR11; where, y is the percent tillers with emerged panicles, x is the temperature sum for 10 days since start of heading and a, b, c are constants.

RESULTS AND DISCUSSION

Phenological events

Panicle Initiation stage: Panicle Initiation (PI) of BR11 took place earlier than Nizersail and BR22 in early planting (Fig. 1). In late planting (September), PI of BR22 occurred earlier than BR11 and Nizersail. The development of PI stage among the three varieties differed only by one day. However, in September 15 to October 07 planting, the PI of BR11 appeared 7-12 days later than Nizersail and BR22. In Nizersail and BR22 the PI stage occurred within 32-37 days after transplanting (DAT) while in BR11, it was within 41-47 DAT in September 15 to October 07 planting. Similar results were reported by BRRI[8]. Due to late PI, the BR11 was affected by lower temperature and solar radiation during stem elongation stage, heading and grain filling stages than Nizersail and BR22. Nizersail and BR22 completed PI by November 08 when it was transplanted within August 01 to October 07 whereas BR11 took it until November 16 indicated that the variety BR11 was relatively cold susceptible than Nizersail and BR22.

Heading: Nizersail completed its heading (about 50% tillers in a hill) between October 31 to December 09 when

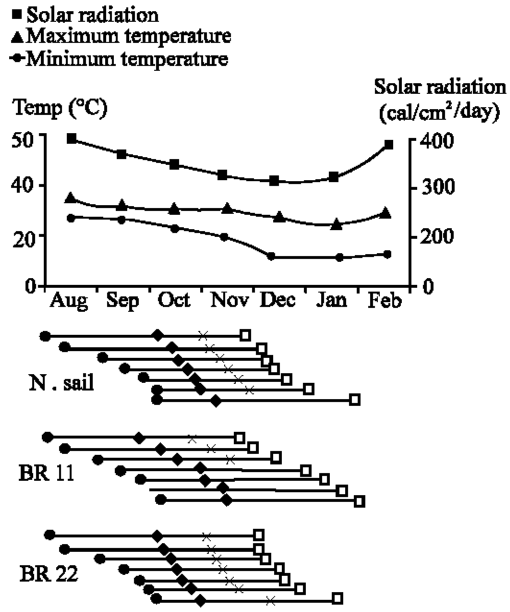

Fig. 1: Monthly mean air temperature, solar radiation and phenological events of three rice varieties at different planting date, BRRI farm, Joydebpur date of planting (●), PI (♦), heading (×) and maturity (□) are shown in the horizontal bar

transplanted within August 01 to October 01 but heading was not completed when transplanted on October 07 might be due to low temperature at the reproductive phase (Fig. 1). These results are agreed with the findings of De Datta[9] and Yoshida [10]. They observed that low temperature during panicle development stage aggravate heading that may cause incomplete and irregular flowering which affects the grain filling processes.

BR11 completed heading between October 24 and November 18 when transplanted on August 01 through September 01. But this variety did not complete heading beyond September 01 planting due to low temperature at reproductive phase. Vergara and Chang[11] reported that panicle could not emerge from the flag leaf sheath if temperature goes below 25°C during booting stage depending on the varietal characteristics.

BR22 completed heading by November 02 to December 20 when transplanted planted between August 01 and October 07 indicating that this variety is, to some extent, cold tolerant than BR11 and Nizersail. Similar result was reported by BRRI[8].

Maturity: Nizersail matured within November 26 to January 28 and BR11 within 21 November 21 to January 28 in all the plantings. BR22 matured within 01 December to 19 January for all the plantings. BR22 matured earlier than Nizersail and BR11 perhaps due to better cold tolerance[8]. Maturity delayed with decreasing temperature

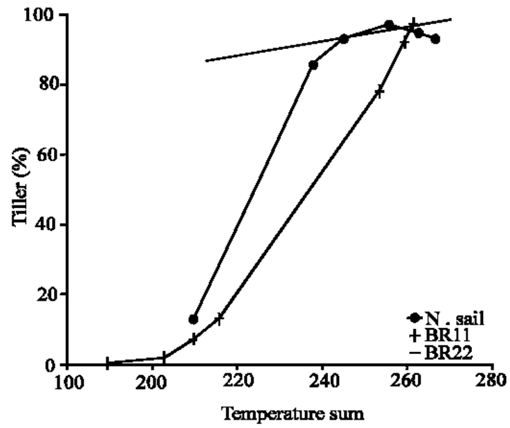

Fig. 2: Percent tillers with completely emerged panicles as affected by temperature sum for 10 days since start of heading

and solar radiation as well as delayed planting in all varieties.

Flowering duration: The speed of flowering was not the same for all varieties. Flowering duration of Nizersail, BR11 and BR22 was increased by 2-14, 3 and 3-20 days, respectively with delayed planting (Table 1). Generally 10-14 days were required for completion of heading as reported by Yoshida[10].

In the present investigation, the increased flowering duration was due to lower temperature and solar radiation which prisoner heading[9]. However, BR11 produced less than 50% flower beyond September 01 planting and that of Nizersail beyond October 01 planting. BR22 flowered in all the plantings indicating that it was more resistant to low temperature stress than BR11 and Nizersail with respect to flowering[8].

The results indicated that minimum temperature as low as 18°C caused longer flowering duration and further decrease in temperature inhibited flowering of Nizersail. Whereas, flowering in BR22 did not stop at this temperature. BR11 did not flower (50% tiller of a hill) below 20°C night temperature after start of heading due to susceptibility to low temperature. Similar result was also reported by BRRI[8]. Thus it was found that an average temperature 23.92°C for 10 days after start of heading was required for complete flowering (50% tillers produced complete exserted panicle) of Nizersail and 26.17°C for BR11 and 21.31°C for BR22. Yoshida[10] found that temperature dropped by 1°C from 24°C causes 13-days delay heading in case of IR25. Vergara and Chang[11] found that below 25°C panicle could not emerge completely from flag leaf sheath.

Table 1: Number of days required to get completely emerged panicles in 50% plants of three rice cultivars since start of heading as influenced by time of planting

Planting dates		Nizersail	BR11	BR22
Aug.	01	7	6	5
	15	9	6	5
Sep.	01	10	9	8
	15	12	<50% heading	8
	22	12	,,	8
Oct.	01	21	,,	11
	07	<50% heading	,,	25

Table 2: Percent of plants showing the extent of emergence of their panicle length at final heading as influenced by planting dates

Planting dates		Extent of emergence (%) 100	75	50	25	0
Nizersail						
Aug.	01	83	0	0	0	17
	15	88	0	0	0	12
Sept.	01	94	0	0	0	6
	15	96	0	0	0	4
	22	93	0.5	0.5	1	5
Oct.	01	94	0	0	0	6
	07	12	35	12	5	36
BR 11						
Aug.	01	89	0	0	0	11
	15	91	2	1	0	6
Sept.	01	92	0	0	0	8
	15	21	54	18	1	6
	22	0	70	20	1	9
Oct.	01	0	51	23	6	20
	07	0	38	25	8	29
BR 22						
Aug.	01	92	0	0	0	8
	15	96	0	0	0	4
Sept.	01	97	0	0	0	3
	15	94	0	0	0	6
	22	95	1	1	0	3
Oct	.01	88	2	1	1	8
	07	86	2	1	1	10

Panicle exsertion from the leaf sheath: Panicle exsertion of different varieties varied depending of time of planting are presented in (Table 2).

Nizersail: Eighty three to 94% tiller of Nizersail produced fully exserted panicle upto October 01 planting. Only a small fraction of the tillers did not bear any panicle when planted on September 22 and October 01.

BR11: Upto September 15 planting, 21-92% tiller had fully exserted panicles. Partial exsertion (50-75%) was observed in 18-54% tiller beyond 15 September planting. However, majority tillers either exserted panicle partially or there was not panicle exsertion at all might be due to low temperature. BRRI[1] also reported that due to later planting panicle could not come out from leaf sheath for low temperature.

Table 3: Coefficient of correlation between temperature sum and panicle exsertion of three rice cultivars as influenced by planting dates

Cultivars	Duration for temp. summation[1]	Panicle exsertion (%)
Nizersail	1-10	0.874**
	11-20	0.433NS
	21-30	0.387NS
	11-30	0.421NS
BR11	1-10	0.971**
	11-20	0.950**
	21-30	0.810*
	11-30	0.902**
BR22	1-10	0.963**
	11-20	0.557NS
	21-30	0.413NS
	11-30	0.511NS

[1]Days after start of heading, **=significant at 1% level,
**=significant at 5% level, NS = non significant

BR22: Exsertion of panicle was not hampered by planting dates indicating that this variety was resistant to cold. Similar result was reported by BRRI[1]. However, a small fraction of the plants had partial exsertion of panicles beyond September 22 plantings.

The percent of tillers produced fully exserted panicles of Nizersail increased sharply with the increasing temperature sum (total temperature for 10 days since start of heading) and then slightly decreased (Fig. 2). Full panicle exsertion of BR11 was sharply increased with increasing temperature sum and BR22 showed less sensitivity.

Full panicle exsertion of Nizersail and BR22 was highly correlated with temperature sum for 10 days since start of heading (Table 3) but not after this period. Panicle exsertion of BR11 was highly correlated with the temperature sum for 1-10, 11-20, 21-30 and 11-30 days from the start of heading. Basis on these results it may be concluded that BR11 is very much sensitive to cold followed by Nizersail and BR22.

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