EFFECT OF PHOTOPERIOD SENSITIVITY ON YIELD AND OTHER ECONOMIC TRAITS OF NEW STRAINS OF BASMATI RICE (*ORYZA SATIVA L.*)

M. Akhter, M. Ahmad, and M. Ramzan*

Rice Research Institute, Kala Shah Kaku *PARC Rice Programme, Kala Shah Kaku

ABSTRACT

Photoperiod sensitivity is one of the most important character which acts as an indicator to distinguish a basmati variety from non-basmati variety. Twelve rice promising lines i.e., 98801, 98410, 98316, 99417, 97502, 99512, 98410, 99513, 98506, 98408, 5261-1-2 along with Super Basmati as check variety were transplanted on six different dates (16May to 1st August) with an interval of fifteen days to test the basmati behavior of new strains. Super Basmati in all the six dates flowered in the last week of September and first week of October irrespective of its time of transplanting. Super Basmati showed a remarked increase in plant height in first (138 cm) and 2nd date (127cm) due to prolonged vegetative period while it showed a considerable decrease in plant height in last date (101cm) due to reduced vegetative phase. New strains 98316, 99417and 98408 reflected the same behavior and appeared to be true basmati strains. Whereas rest of the strains performed equally good in all the dates and remained unaffected by the different transplanting dates and appeared to be non-basmati strains. Most of the promising lines gave good yield when transplanted from 1st July to 16th July. 99512 and 99513 behaved differently, paddy yield of these genotypes reduced when transplanted late. In conclusion, photoperiod sensitivity is an important character of basmati rice. Super basmati is an improved form of Basmati rice and photosensitivity is its major character. Besides this variety, 98316, 99417 and 98408 are also true basmati strains.

Key words: Photoperiod sensitivity, Basmati rice varieties, Transplanting dates.

INTRODUCTION

Earlier mention of Basmati has been made in the epic Heer and Ranjah composed by the Punjabi poet Varis Shah in 1766. The world "Basmati" derives from two Sansakrit roots ('vas': aroma) and ('may up': present from the beginning). While combining the two roots 'mayup' changes to 'mati' making 'Vasmati'. Generally, people pronounce it as Basmati. (Thokral and Ahuja, 1993). Pakistani Basmati rice varieties are highly photosensitive, tall, week culm, low yielding and late in maturity. Therefore, farmers sow the nursery from 10-20 June. Delayed transplanting of Basmati varieties helps in less vegetative growth.

Quality traits of Basmati rice is known to be highly influenced by temperature particularly at the time of flowering, grain filling and maturity. Aroma formation and retention in grain is enhanced at low temperature during the grain filling stage. Basmati require relatively cooler temperature ($25^{O}C/21^{O}C$-day/night temperature during crop maturity) for best retention of aroma (Mann, 1987). Optimum time of transplanting is important in achieving the maximum yield potential of a variety. Xie *et al* (1996) observed that yield and total biomass of rice decreased as sowing was delayed.

Munda *et al* (1994) obtained higher grain yield of rice (CVS, Khonorulla and PK-1-3) by transplanting on 15th June as compared with Ist July. Roy *et al* (1994) found a rice variety which was more sensitive to photoperiod but good temperature tolerant. Low temperature at flowering owed the reduced grain yield during late planting. Ali *et al* (1993) planted two sets of rice varieties for early and late sowing. They recommended BR-11 for early while BR-22 and BR-23 for late sowing. Gangwar and Sharma (1997) obtained maximum grain yield by transplanting on 1st to 16th July compared to 31st July and 16th August. The most serious yield limiting factor associated with early transplanted crop is sterility. Stake and Yoshida (1978) observed that spikelet sterility is induced by high temperature.

Traditional Basmati varieties could not compete the high yielding dwarf rice varieties. Therefore, breeders started work on the development of semi dwarf rice varieties. At the time of field evaluation special attention is given to those varieties which show photosensitivity. Flowering behavior an indicator of photoperiod sensitivity is an important character of basmati rice. Super basmati is an improved form of Basmati rice and photosensitivity is its major character. In the present study, flowering behavior of new strains is compared with super basmati for distinguishing basmati and non Basmati varieties.

MATERIALS AND METHODS

This study was carried out at Rice Research Institute, Kala Shah Kaku during 2004. Twelve rice strains i.e., 98801, 98410, 98316, 99417, 97502, 99512, 98410, 99513, 98506, 98408, 5261-1-2 and Super Basmati were transplanted on 6 different dates i.e. 16/5,

1/6, 16/6, 1/7, 16/7 and 1/8. The experiment was laid out in Randomized complete Block Design with three replications and plot size was 2 x 9 meter. Row to row and plant to plant distance was 22.5 cm. The physiochemical properties of experimental site are given in Table 1.

Table 1. Physical and chemical properties of the soil used for the study

Parameter	0-6 Inch Depth	6-12 Inch Depth
E.C. mS/cm	1.2	0.8
Soil pH	7.7	7.8
Organic Matter %	0.97	0.56
Nitrogen %	0.048	0.028
Available Phosphorous	9.4	8.6
Available Potash	100	80
Saturation % age	42	37
Texture	Clay Loam	Clay Loam

At the time of sowing 18 Kg N/ha, 34 Kg P/ha and 25 Kg K/ha were applied in the form of urea, diammonium phosphate and potassium sulfate, respectively. Remaining 2/3 urea was applied in two splits at 25 and 45 days after transplanting (DAT). Recommended herbicide was applied 3 days after transplanting to control weeds. Other agronomic and cultural practices were kept standard and uniform for all repeats. The data regarding days to 50 % flowering, plant height, sterility %age, 1000 grain weight and paddy yield were recorded. The data were statistically analyzed using Fisher's Analysis of Variance technique and treatment means were compared by LSD at 0.05 probability level (Steel and Torrie, 1997).

RESULTS AND DISCUSSION

Days Taken to 50% Flowering: A perusal of data (Table 2) revealed that there were significant differences among the varieties for days taken to 50% flowering. Super Basmati took maximum days (127) for this character followed by 98408 (126). The strain 98408 was a perfect match of Super Basmati in flowering behavior or photoperiod sensitivity. Whereas, 98316 and 99417 also showed photoperiod sensitivity in the same pattern as was expressed by Super Basmati. 99512 and 99513 are seemed to be partial photoperiod sensitive varieties. All other strains remained unaffected or least affected by different transplanting dates, hence are non-photo sensitive or non-Basmati strains. These results are in accordance with findings of Roy *et al* (1994) and Ahmad *et al* (2006). They also found that different rice varieties behave differently towards photoperiod sensitivity.

Table 2. Mean values for days taken to 50% flowering of different rice strain in different transplanting dates

Variety	Transplanting dates					
	D1 (16/5)	D2 (1/6)	D3 (16/6)	D4 (1/7)	D5 (16/7)	D6 (1/8)
98801	78	74	68	69	67	64
98316	118	109	95	85	75	64
97502	83	72	68	67	61	59
98410	84	72	67	66	58	58
98506	87	81	79	72	62	57
5261-1-2	80	71	67	66	59	57
98410	77	75	66	67	60	59
99417	123	113	96	82	66	54
99512	104	100	90	85	77	72
99513	104	97	90	85	76	74
98408	126	117	103	90	75	65
Super Bas	127	114	97	86	76	66
LSD 5%	3.257	2.854	2.584	2.510	2.636	2.698

Flowering behavior and plant height: All the varieties in D1 (Table-2) showed maximum height while minimum height was recorded in D6. The varieties which showed Basmati flowering behavior were considerably tall in early dates while significantly short in the late dates. This increase in plant height was due to prolonged vegetative period whereas, decrease in plant height was the result of reduced vegetative phase. The strain, 98410 remained unaffected by different transplanting dates and proved to be non- photosensitive and non Basmati strain.

Table 3. Mean values for plant height (cm) of different rice strain in different transplanting dates

Variety	Transplanting dates					
	D1 (16/5)	D2 (1/6)	D3 (16/6)	D4 (1/7)	D5 (16/7)	D6 (1/8)
98801	144.8	137.5	135.3	116.1	115.3	105.1
98316	148.0	132.3	133.7	123.1	123.0	101.0
97502	141.6	136.3	142.5	139.8	121.9	117.3
98410	142.1	138.4	136.4	135.0	129.3	115.1
98506	161.1	158.0	151.8	144.6	130.7	112.4
5261-1-2	167.5	160.7	161.8	174.3	148.1	139.3
98410	138.1	137.9	132.8	139.7	126.9	111.6
99417	185.7	182.0	177.8	168.0	166.1	152.3
99512	164.9	160.7	156.6	146.4	138.3	97.8
99513	164.7	163.7	149.8	143.9	133.7	98.3
98408	147.9	141.9	132.9 f	129.4	121.2	98.4
Super Bas	138.1	127.0	121.9	120.0	113.7	101.4
LSD 5%	17.47	17.45	17.50	17.36	17.26	17.17

Akram *et al* (2007) also observed that varieties transplanted on 1st July produced the tallest plants as compared to the transplanting in later stages i.e. 31st July.

Flowering behavior and sterility %age: There is a general observation that the genotype sensitive to day length and temperature regime shows higher sterility rate as compared to others. It is clear from Table 4 that sterility percentage of photoperiod sensitive genotypes was higher in early transplanting than late transplanting. Super Basmati showed highest sterility %age in D1, D2 and D3. It was followed by 99417 and 97502. This data suggested that photo period sensitivity had no affect on seed setting and certain other factors such as thermo-sensitivity had played a role in causing in high sterility %age. This result is in agreement with Guilani *et al* (2002) who reported that fertility %age of cultivar depended on temperature at growth stages before and at anthesis. Among environmental factors, affecting plant growth, temperature was relatively more important than others particularly photo period.

Table: 4. Mean values for sterility %age of different rice strain in different transplanting dates

Variety	Transplanting dates					
	D1 (16/5)	D2 (1/6)	D3 (16/6)	D4 (1/7)	D5 (16/7)	D6 (1/8)
98801	38.26	32.60	21.64	25.22	20.52	21.73
98316	23.88	29.72	25.43	12.72	10.18	16.88
97502	50.20	31.50	38.01	26.62	29.70	14.0
98410	28.79	18.85	23.33	20.79	23.25	14.09
98506	27.86	15.03	18.96	16.47	23.24	9.65
5261-1-2	41.91	26.19	34.02	24.28	29.34	14.78
98410	13.75	16.99	16.84	18.67	10.89	24.32
99417	45.46	42.39	19.12	21.55	13.29	14.7
99512	8.33	13.92	8.31	15.32	11.17	17.23
99513	5.63	7.50	7.45	15.74	8.93	21.28
98408	16.45	23.47	15.25	24.75	11.41	16.72
Super Bas	80.06	79.41	24.21	13.14	12.91	17.12
LSD 5%	6.248	6.210	6.181	6.156	6.048	6.119

Flowering behavior and 1000 grain weight: All the strains (Table-5) showed minimum 1000 grain weight in D1, D2 and D6 and apparently flowering had no affect on 1000 grain weight. This result is supported by Guilani et. al (2002) and Khedikar *et al* (2003) who reported that the variation among the cultivar was not only due to genetic contents but also due to the influence of environment.

Table: 5. Mean values for 1000 grain weight of different rice strain in different transplanting dates

Variety	Transplanting dates					
	D1 (16/5)	D2 (1/6)	D3 (16/6)	D4 (1/7)	D5 (16/7)	D6 (1/8)
98801	17.36	21.95	22.43	22.52	21.97	19.88
98316	18.85	19.19	20.59	20.45	21.79	19.24
97502	21.25	21.43	23.64	22.49	21.27	19.49
98410	21.32	21.55	22.84	23.97	23.75	21.01
98506	20.12	20.90	22.67	22.40	23.24	22.00
5261-1-2	21.05	21.35	21.87	23.00	22.08	21.15
98410	20.81	21.32	21.36	22.33	21.71	20.76
99417	22.68	24.01	24.16	24.45	24.02	23.73
99512	22.08	22.23	22.25	24.09	22.31	22.15
99513	23.07	21.5	21.39	21.94	23.37	21.44
98408	19.45	20.16	20.45	24.46	20.53	19.46
Super Bas	20.57	20.56	21.12	22.05	22.23	21.77
LSD 5%	2.230	2.275	2.243	2.250	2.213	2.193

Flowering behavior and Paddy yield: There were significant differences for paddy yield among varieties. The yield data in Table-6 indicated that 99512 and 99513 were high yielding varieties in all the dates except D6. The variety 98408 which showed a perfect match with Super Basmati in flowering behavior gave better yield than Super Basmati in all the dates. Most of the varieties gave good yield when transplanted from 1st July to 16th July 99512 and 99513 behaved differently, paddy yield of these genotypes reduced when transplanted late.

Table: 6. Paddy yield (t/ha) of different rice strain in different transplanting dates

Variety	Transplanting dates					
	D1 (16/5)	D2 (1/6)	D3 (16/6)	D4 (1/7)	D5 (16/7)	D6 (1/8)
98801	1.94	2.55	2.09	2.59	2.86	2.45
98316	1.19	2.26	2.36	3.42	3.18	3.00
97502	2.37	2.95	3.06	3.76	3.26	3.07
98410	2.96	2.87	3.21	4.18	3.22	2.58
98506	2.39	2.74	2.95	3.30	2.30	2.69
5261-1-2	2.10	2.86	3.14	3.34	3.04	3.26
98410	3.89	4.01	3.95	3.59	3.44	2.64
99417	1.05	1.19	2.33	2.49	3.03	3.16
99512	5.74	5.27	5.24	4.31	4.21	2.52
99513	6.08	4.56	4.93	4.60	4.26	2.19
98408	3.95	3.36	4.00	4.00	4.27	3.53
Super Bas	0.70	1.88	2.49	3.53	3.02	3.08
LSD5%	0.0765	0.0750	0.0755	0.075	0.075	0.0743

Similarly paddy yield of 98410 was least effected by different transplanting dates. These results suggested that flowering behavior or photoperiod sensitivity is an independent factor and has no correlation with yield, 1000 grain weight and sterility %age. These results are in accordance with the findings of Guilani *et al* (2002).

CONCLUSIONS: Photoperiod sensitivity is an important character of basmati rice. Super basmati is an improved form of Basmati rice and photosensitivity is its major character. Besides this variety, 98316, 99417 and 98408 are also true basmati lines.

REFERENCES

Ahmad, M. M. Ashraf, M.E, Safdar, L. Ali and M. S. Akhtar (2006). Role of transplanting times on yield and quality of Basmati rice. In proceedings of International symposium on Sustainable Crop Improvement and Integrated Management. Sept. 14-16, 2006 in Faculty of Agri. Univ. of Agri., Faisalabad PP 208-215.

Akram, H. M., A. Ali., M. A. Nadeem and M. S. Iqbal (2007). Yield and yield components of rice varieties as affected by transplanting dates. J. Agri. Res.45(2):105-111.

Ali, M. G., M. A. Mannan, K. P., Halder and S. B. Siddque (1995). Effect of planting dates on the growth and yield of modern transplanted rice. Annals of Bangladesh Agri.3(2): 103-108 (1993). [Rice Absts. 18 (2): 949,.

Gangwar, K. S. and S. K. Sharma (1997). Influence of planting dated on producitivity of traditional scented rice varieties. IRRN.22(1):42.

Guilani, A., G. Fathi, S. A. Siadat (2002). Effect of planting dates on yield and yield components of seven high quality rice cultivar in Khuzestan. Journal of Science and technology of Agriculture Natural resources, 6:1, 163-176.

Khedikar, V. P., A. A. Bharose, D. Sharma, Y. P. Khedikar. (2003). Studies on genetic parameter in scented rice genotypes. J. Soils and Crops 13:2, 338-342.

Mann, R.F. (1987). Basmati rice: Wonder of Pakistan's agriculture. IRRC Newslt. XXXVI:23-28.

Munda, G. C., P. B. Chaudhry and C. S. Patel (1994**)**. Variety, date of transplanting and space on high altitude rice. Indian J. Hill Farming 7(1) 96-98. [Rice Absts. 19(3): 1723.

Roy, S. K. B., S. Biswas and D. T. Mackill (1994). Photoperiod sensitivity and low temperature tolerance in traditional low land rices. India Agriculturist. 38:65-68.

Stake, T. and S. Yoshida. (1978). High temperature induced sterility in indica rice at flowering. Japan J. Crop Sci. 47(1):6-17.

Steel. R. G. D., J. H. Torrie, and D. A. Dickey (1997). Principles and Procedures of Statistics: A Biometric Approach (3rd Ed.) McGraw-Hill Book Co., New York. USA.

Thakral, R. and S.C. Ahuja, (1993). Potential and prospects export of Basmati rice'. In: New Frontiers in Rice Research (K. Murlidharan and E.A. Siddiq, eds.) Directorate of Rice Research, Hyderabad. Pp. 382-387.

Xie, G. H., B. L. Su, L. Shi and A. Y. Tian (1996). Study on growth and dry matter production of rice. J. China Agric. Univ., 1(1): 89-94.