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Evaluation of Somaclonal Variants for Yield and some Quality Parameters

F M Abbasi [a], S Touqeer Abbas[b] and M A Sagar [a]*

[a]*Coordinated Rice Programme, NARC, Islamabad*

[b]*Rice Biotechnology, NARC, Islamabad*

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A field experiment was conducted to examine the variability of eight somaclones for agronomic and quality parameters. A significant reduction in plant height and days to flowering was noted. There was increase in kernel length and head rice recovery. TF4 was selected having stiff stem, early in flowering, semi dwarf with high fertility,better grain quality and greater yield potential than the parent variety. TF8, TF9 and SN12 yielded at par with the parentt variety i. e. Basmati 370. Profuse but unproductive tillers did not contribute to the yield. Linear relationship existed between increased L/B ratio and better grain quality. The grains of all the somaclones were fine type, slender in shape and long in size. The highest quality Index was exhibited by TF9 followed by TF11 and TF10 respectively.

Key words: Rice, Somaclonal variant, Agronomy, Quality characteristics.

Introduction

Rice *(Oryza sativa* L.*)* is an important cereal crop of Pakistan for domestic consumption and export abroad. Current Basmati varieties possess excellent cooking and eating qualities. However, grain yield of these varieties are very low. Development of new high-yielding rice varieties will boost the rice production. Non-conventional methods like tissue culture, cell fusion and gene transfer are useful tools to accelerate the plant breeding process.

This is well documented that tissue and cell culture techniques are useful innovative breeding methods in the genetic modification and improvement of plants (Brar *et al* 1984 a, & b). These techniques are new breeding tools for the improvement of rice productivity. Tissue culture is being used for varietal improvement in many other countries. The success of this breeding technology depends upon the selection efficiency of the cultured cells for desired characteristics. Selection efficiency of rice crop can be enhanced by increasing genetic variability for agronomic and quality traits. In its cycle, tissue culture itself generates genetic variability (Larkin and Scowcroft 98).

The objectives of the work reported here were to evaluate the field performance of a group of somaclonal lines for morphological characters and quality parameters. Quality of rice is determined by milling recovery, grain appearance, cooking and eating qualities and nutritional value. Cooking quality is determined by high swelling capacity, non stickiness of kernels, retention of shape of kernel and fluffiness after cooking (Srivastava *et al* 1978). Improvement of rice quality means to develop the desired characters for the particular group of consumers. It requires major adjustment in varietal selection, grading, milling and price support programme (Efferson 1985).

*Author for correspondence

Materials and Methods

Eight true breeding somaclonal variants of Basmati 370 viz. TF4, TF8, TF9, TF10, TF11, TF12, SN85, SN1-80 were generated through callus culture process. The calli were initiated using whole seed on MS medium supplemented with 2mg per liter 2, 4-D, maintained for six months and plants were regenerated on the same medium supplemented with 2mg per liter. This was followed by field selection up to three generations at NARC Tissue Culture Laboratory and NARC Rice Fields. Keeping all this in mind present study was conducted to select new Basmati rice lines. These lines along with two commercial cultivars i.e Basmati 370 and Basmati 385 were evaluated for their agronomic performance and grain quality characteristics. The trial was laid out in Randomized Complete Block Design (RCBD) with three replications and two blocks at NARC Islamabad in Kharif 1990. Size of the plot in each replication was 3x5m. Twenty days-old seedlings were transplanted at 20x20 cm spacing and fertilized with 80-40-0 NPK, kg h^{-1}. Data were recorded on days to 50% flowering, plant height, productive

tillers hill^{-1}, grain yield milled and head rice recovery and physical rice grain measurements viz. kernel length, breadth, thickness, L/B ratio, quality index (Q.1), size, shape and type. The crop was harvested when 85% grain turned straw colour at 18-20 % moisture level. Twenty kernels from each somaclone and variety were measured and classified as reported by Khush *et al* 1979 to estimate the kernel size and shape.

Results and Discussion

Data on average days to flowering, plant height, productive tillers hill^{-1}, 1000-grain weight, fertility percentage and paddy yield of the somaclonal variants planted at NARC are presented in Table 1. Variations were observed in the somaclones from the true breeding variety (Basmati 370) for agronomic and quality characteristics. It is noteworthy that all these lines were generated through calli of Basmati 370 seeds. It means that culture in its cycle produces mutation, hence somaclonal variation can be achieved. This is quite in agreement with the findings of Larkin and Scowcroft 1981. The mutation may be caused by 2, 4-D supplied in the callus medium. The 2,4-D is highly carcinogenic and causes mutation even at very low doses (Abbas 1991). Even very minute quantities of 2,4-D inherited by the seed from parent plant can cause mutation (Chakamikov *et al* 1975, Mumma and Hamilton 1976). Therefore, it cannot be established with conformity at what stage a specific mutation is caused in the lines under study.

Reduction in plant height may improve their resistance to lodging and reduce the substantial yield losses associated with this trait (Timothy 1984). In the present study a significant reduction in plant height of the somaclonal variants was observed. None of the variants lodged under the field conditions; all of them resisted lodging and were relatively more responsive to nitrogen fertilizer. This confirms the findings of Timothy 1984. Significant difference in productive tillers hill^{-1} among the somaclonal variants and Basmati 370 was noticed. Maximum tillering was manifested by TF9 followed by TF10 and Basmati 385, respectively. Furthermore, all the somaclones had short erect leaves with study culms making them more resistant to lodging than Basmati 370 which has long broad drooping leaves and tall weak stem. The plant vigour and yield of the somaclone (TF4) was better than the parent as well as the check in the field conditions.

It is evident from the present study that the production of somaclonal variants is the most innovative technique which reduces plant height, flowering duration and increases yield potential. In our study one somaclonal line (TF4), out of the eight somaclones tested, yielded higher than the parent (Basmati 370). This indicates that tissue culture derived line tested at NARC was superior to the parent in terms of yield. Three lines (SN12, TF8 and TF9) yielded at par with the parent.

It is evident from the Table 1, that the significant increase in the number of filled grains contributed primarily to the high yields of the most outstanding line TF4. Yield is the direct function of the spikelets number per square meter, 1000-grain weight and fertility (Reuben and Katuli 1989). Although this line exhibited a lower 1000-grain and fewer number of tillers than the check variety (Bas.385), its significantly higher filled grain compensated for this negative factor to give a signifi-

Table 1
Agronomic performance of somaclonal variants

Variant	Flowering (d)	Plant height (cm)	Tillers hill^{-1} (no.)	1,000 grains weight (g)	Fertility (%)	Yield (t/ha)
TF4	114 de	120 f	12 e	17.33cd	89.0 a	5.0 a
SN85	127 b	140 c	14 cd	16.00 de	65.0 de	3.0 be
SNI-80	129 ab	147 b	14 cd	14.33 e	65.0 de	2.5 cd
TF11	115 de	116 g	15 bc	13.67 e	63.3 de	2.1 d
SN12	116 cd	113 h	13 de	19.00 abc	70.0 c	3.5 b
TF8	113 e	123 e	13 de	17.67 bcd	65.0 de	3.5 b
TF9	116 cd	127 d	20 a	17.33 cd	66.3 CD	3.2 b
TF 10	118 c	123 e	16 b	16.00 de	61.7 e	3.1 be
Bas.385	114 de	122 e	15 bc	21.00 a	80.0 b	5.2 a
Bas.370	130 a	150 a	9 f	20.00 ab	70.0 c	3.5 b
LSD (5%)	2.142	2.187	1.265	2.38	3.514	0.5868
CV (%)	1.05	0.99	5.23	8.08	2.95	9.90

Table 2
Grain quality characteristics of TF4 and Basmati 370

Genotype	Head rice (%)	Kernel			Quality Index	Kernel		
		Length (mm)	Breadth (mm)	Thickness (mm)	L:BxT	Size	Shape	Type
TF4	55.4	6.9	1.73	1.55	2.6	Long	Slender	Fine
Bas.370	55.6	6.7	1.70	1.60	2.5	Long	Slender	Fine

*Results are average of three determinations.

cantly higher yield. TF11, TF9 and TF10 tillered profusely but were unproductive. TF4 had comparatively less number of tillers but were productive and contributed to high yield potential.

Physical characteristics of grain quality of somaclones are presented in Table 2. All these somaclones possessed fine grain quality. The grains of all the somaclones are fine type, slender in shape and long in size. The L/B ratio of TF9, TF10, TF11 and TF4 are in descending order followed by all the other somaclonal lines and commercial cultivars under study. The line TF4 can be selected for varietal adaptability trials under different agro-climatic conditions of Pakistan keeping in view of its agronomic performance and quality parameters. The breeding lines alongwith the cultivars under study significantly differ from one another in quality index. The highest quality index was observed in case of TF9 followed by TF11 and TF10. There is no significant difference in quality index of commercial cultivars i.e Basmati 370 and Basmti 385 when compared with TF4. A linear relationship exists between increased L/B ratio and better grain quality. Our results are in agreement with (Bari *et al* 1989). TF9, TF10 and TF11 with L/B ratio 4.21 and 4.13,respectively were finer than the parent Basmati 370 with L/B ratio 3.84. SN85, SNI-80 and SN12 had significantly lower L/B ratio and were inferior in fineness to the parent. All the somaclones had significantly greater kernel length than the check (Bas. 370). TF8 and TF10 had maximum kernel length (7.23mm) respectively. Basmati 385 had minimum kernel length (6.9mm) followed by Basmati 370 (6.93mm). The correlation between grain characteristics and quality index is presented in Table 3. There is positive non- significant correlation in case of kernel length. It is non-significant but negative in case of kernel thickness and negative but non-significant in case of kernel breadth. There is linear and significant correlation between L/B ratio and quality index. It is in agreement with the findings of Bari *et al* 1981 who stated that a linear relationship existed between L/B ratio and quality index. It is concluded from the present study that tissue culture technique can be used successfully to improve morphological as well as quality parameters.

Table 3
Correlation coefficient between grain characteristics and quality index

Character	Correlation coefficients between Quality index and other characters
Kernel length	0.128ns
Kernel breadth	-0.786*
Kernel thickness	-0.600ns
L/B ratio	0.815*

* = Significant at 5% level of significance, ns = Non-significant.

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