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Breeding strategy for aromatic rice in Egypt

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Abstract

Recently, selection for aromatic rice quality has placed some unique demands on the rice breeding program in Egypt. This aromatic rice is the most preferred and earn high premium prices in both international and domestic markets. Therefore, great attention was laid in the rice breeding program in Egypt to select and bread a new rice variety passes high yielding ability and aroma. A strategic plan was established to cover this new objective and consisted of two main trials. The first aimed to screen and select one of the international aromatic varieties suitable to the Egyptian conditions, while the second aimed to study the inheritance of arom in rice to provide the breeding program with the knowledge of the genetic behavior of this traits.

Jasmine 85 proved to be the best aromatic rice variety among the tested varieties from the agronomic characters, yield and grain quality characters points of view. Accordingly, it was selected to be released under the name of "Egyptian Yasmin".

Furthermore, the results showed that there were at least two gene pairs involved in the inheritance of aroma trait and non-aroma was completely dominant.

Keywords

- Rice, Breeding, Rice grain quality, Aromatic rice
- Egypt.

Introduction

Rice is a vital food material for more than half of the world population. In Egypt, its importance as a food crop increases along with the increase in population. Among cereals, rice is even more nutritious than wheat. Grain quality next to grain yield is the foremost objective of any successful breeding program. Grain quality to a large extent determines market price and acceptance by consumers. Recently the Egyptian policy is aimed to gain more rice markets for exportation. Therefore, the improvement of the grain quality of the local rice varieties is needed in order to meet the demand of the foreign as well as the local markets. From another point of view, and because of the change in the national economic policy and due to the increase in the tourist motion during the recent years the demand on the aromatic rice was increased. It also fetches higher price than the normal varieties in national and international markets. Therefore, rice breeding program in Egypt lays great emphasis on the development of high yielding varieties with excellent grain quality and aroma. In 1993, a strategic plan was started to test select one of the rice varieties which emanate aroma among cultivated rices of the world to be adapted and released as local selection. Secondly, a breeding program for aromatic rice was established to breed local rice variety possessing yield potential and aroma beside the other important characters such as earliness, short stature, blast resistance...etc.

Breeding methods

The rice breeding program for aromatic rice varieties consisted of two main categories :

- Screening and adoption of some exotic aromatic rice varieties and,
- Inheritance of aroma in rice.

Screening and adoption of some exotic aromatic rice varieties

This trial aimed to test and screen the performance of some developed and famous aromatic rice varieties selected in 1993 season from the International Rice Genetic Evaluation Nursery (INGER) introduced from the International Rice Research Institute (IRRI), to select one of these varieties to be adapted and grown under the Egyptian conditions.

During 1994, 1995 and 1996 rice growing seasons, four selected aromatic varieties namely; Pusa Basmati, Jasmine 85, Goolarah and Brimful, together with three common local varieties i.e. Giza 177, Giza 178 and Giza 181 were tested in a RCBD experiment with three replications. Thirty days old seedlings were individually transplanted in 10 rows/replicate with 5 m lengthened with distance between rows and between hills being 20 x 20 cm. all other recommended agronomic practices were followed throughout the three growing season. The data were recorded on an individual plant basis however grain yield was estimated for the five internal rows per plot. Grain quality characters were examined in the Grain Quality Lab., of the Rice Research & Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt according to Ghosh et al (1971), Little et al (1958) Webb et al (1973) Juliano et al (1971) Cagampang et al (1973) and Khush et al (1979). On the other hand, test of aroma was made according to the method described by Sood and Siddiq (1979). Data collected were statistically analyzed following Gomez and Gomez (1979).

Inheritance of aroma in rice

This study was conducted to understand the nature of inheritance of aroma for use in the breeding program to develop local aromatic rice. A crossing program was affected in 1994 season using two aromatic varieties i.e Pusa Basmati and Jasmine 85 and two local varieties namely; Giza 177 (short grain, japonica) and Giza 181 (long grain, indica) as non-aromatic ones. The studies were made on four crosses, viz., Giza 177 x Pusa

Basmati, Giza 177 x Jasmine 85, Giza 181 x Pusa Basmati and Giza 181 x Jasminee 85. During the winter of 1994, half of the hybrid seeds were sent to IRRI to be grown there and to produce F2 seeds. In 1995 season, the crossing program was done again, moreover the remaining half of the hybrid seeds and the F2 seeds came from IRRI were planted to produce the advancing generations .In 1996 season, the parents, F1, F2 and F3 plants were individually transplanted at a spacing of 20 x 20 between rows and between hills.

Determination for the presence or absence of an aroma was made according to the method described by Sood and Siddiq (1979). At tillering stage of rice, 2 g of two or three leaves are excised from individual plants, cut into 5 mm long pieces and kept in petri dishes mixed with 10 ml of 1.7% potassium hydroxide (KOH) solution. The petri dishes were kept under room temperature for about 10 minutes. They were then opened one by one and the sample were classified into two categories in presence or absence of aroma. Chai square test was applied in order to test the differences between the observed and the expected ratios for F2 plants and the means of F3 families according to Snedecor and Cochrans's (1971) formula.

Results and discussion

Screening and adoption of some exotic aromatic rice varieties

Table (1a) presents the mean performance of aromatic rice varieties compared with the three local varieties, Giza 177, Giza 178 and Giza 181 for some vegetative characters as well as grain yield. It is clear that the two local varieties Giza 177 and Giza 178 were earlier than the other varieties, while the two aromatic varieties Brimful and Gooralah were very late.

Regarding plant height, the results of the three years of study showed that Jasmine 85 and Giza 177 were the shortest among all screened varieties. In meantime, the longest panicles were determined for the two rice varieties Giza 181 and Jasmine 85, respectively.

Furthermore the results in Table (1a) showed that the highest number of tillers/plant and number of panicles/plant were detected for the two rice varieties Giza 181 and Jasmine 85, while the lowest numbers of these two characters were found in the rice varieties, Giza 177, Gooralah and Brimful, respectively.

Grain yield was also estimated in the three successive seasons. It is obvious to observe that the highest grain yield was resulted from the local varieties being 8.7, 8.5 and 6.1 tons/ha for Giza 181, Giza 178 and Giza 177 varieties, respectively. However, the yield of the tested aromatic varieties was low and ranged between 4.3 tons/ha for Jasmine 85 and 2.6 tons/ha for Gooralah variety.

Further, the mean performance of some grain quality characters for the tested varieties in the three seasons of study were presented in Table (1b). regarding to grain length, Giza 177 and Giza 178 only were having short grains, while long to extra long grains were found for the other examined varieties. Bold grain shape was measured only for Giza 177 variety, however, medium grain shape was found in case of Giza 181 and Jasmine 85 rice varieties. The grain shape of the other varieties were slender.

Table (1a): Mean performance of the aromatic varieties and the local varieties in 1994, 1995 and 1996 seasons (Vegetative character and yield)

Varieties	Heading days	Pl. height	Panicle length	No. till./plant	No. panicles/plant	Yield T/ha
Pusa Basmati	107	126.6	24.3	22.2	20.1	3.1
Jasmine 85	110	119.3	26.0	25.1	24.3	4.3
Brimful	116	159.2	22.1	20.2	18.2	2.6
Gooralah	117	143.2	22.1	19.4	15.1	2.4
Giza 177	91	125.6	22.3	12.3	10.3	6.1
Giza 178	102	136.2	24.4	21.6	20.4	8.5
Giza 181	110	140.2	28.2	25.3	26.1	8.9

Table (1b): Mean performance of the aromatic varieties and the local varieties in 1994, 1995 and 1996 seasons (Grain quality characters)

Varieties	Grain length	Grain shape	Milling %	Amylose %	Aroma	Panel test
Pusa Basmati	Extra long	Slender	53.1	26.3	Good	Good
Jasmine 85	Long	medium	62.3	18.2	very Good	Very good
Brimful	Extra long	Slender	45.4	25.3	Good	Fair
Gooralah	Extra long	Slender	48.2	24.2	Good	Fair
Giza 177	Short	Bold	73.2	17.3	Non	Very good
Giza 178	Short	Slender	70.5	18.1	Non	Good
Giza 181	Long	Medium	65.2	22.5	Non	very good

The highest milling percentage was found for the two local varieties Giza 177 (73.24) and Giza 178 (70.5%) followed by Giza 181 (65.2 %) and Jasmine 85 (62.3%). Low milling percentage ranged between 53.1% (for Pusa Basmati) and 45.4% (for Brimful). Amylose content as an important character for cooking and eating quality was also determined for all varieties under study. The rice varieties, Giza 177, Giza 178 and Jasmine 85 were having low amylose content. Their respect values were 17.3%, 18.1% and 18.2%. Medium to high amylose content were found for the other varieties and varied from 22.5% (for Giza 181) and 26.3 (for Pusa Basmati).

Regarding the presence or absence of aroma, it was very clear that all the local varieties under study were non-aromatic. On the other hand, very good aroma were observed for the introduced variety Jasmine 85, however the presence of aroma was good for the other aromatic varieties. The panel test indicated that very good taste was detected for the three rice varieties Giza 177, Giza 181 and Jasmine 85, while, good to fair taste was reported for the other examined variety.

According to the aforementioned results, it could be concluded that, among the introduced aromatic varieties, Jasmine 85 proved to be the earliest, high yielder variety and regarding to the grain quality characters, it was having the best grain shape, and milling %, low amylose content and very good aroma. Besides, the panel test showed that it was having very good taste. As a final result Jasmine 85 was selected to be released as a new aromatic variety to be grown under the Egyptian conditions with the local name "Egyptian Yasmin".

Inheritance of aroma in rice

The results of the presence of aroma in F1 generation for the four studied crosses showed that all plants were non-aromatic indicating that non-aromatic was dominant (Table 2). This result was in agreement with Sood and Siddiq (1979), Reddy and Sathyanaraynaiah (1980), Berner and Hoff (1986) and Tszuki and Shimokawa (1990). However, Dhulapparnaavar and Mensinkai (1969) reported that an aroma was dominant.

Table (2): F2 and F3 segregations for the observed plants for aroma for the studied crosses

Crosses		Classes		Segregating ratio	P
		Non-Aromatic	Aromatic		
Giza 177 X Pusa Basmati	F_2	163	37	13 : 3	0.75 - 0.90
	F_3	125	35	13 : 3	0.25 - 0.50
Giza 177 X Jasmine 85	F_2	129	31	13 : 3	0.50 - 0.75
	F_3	161	39	13 : 3	0.25 - 0.50
Giza 181 X Pusa Basmati	F_2	189	11	15 : 1	0.75 - 0.90
	F_3	76	16	15 : 1	0.98 - 0.99
Giza 181 X Jasmine 85	F_2	183	17	15 : 1	0.50 - 0.75
	F_3	148	12	15 : 1	0.25 - 0.50

The data resulted from F2 plants and F3 families for the studied crosses are presented in Table 2. It was clear that the plant of the two crosses of the aromatic varieties Pusa Basmati and Jasminee 85 with the japonica, short grain variety Giza 177 in F2 generation were segregated with the ratio of 13:3 (non-aroma: aroma). Meanwhile, the crosses with the indica ,long grain variety showed a segregating ratio of 15:1 (non-aroma: aroma). Similarly, the segregations of the means of F3 families, were found to be in good agreement with those obtained from the F2 generation in both cases. Accordingly it could be concluded that there were at

least two gene pairs involved in the inheritance of aroma. These two gene pairs were completely dominant with inhibiting gene action an the first case and duplicate gene action in the second case. Different results were early reported by many investigators. Sood and Siddiq (1979) and Berner and Hoff (1986) reported that aroma was monogenic recessive to non-aromatic. However, a digenic segregation of 9 non-aroma: 7 aroma (Tripathi and Rao, 1979), 15:1 (Dhulapparnavar and, 1969), 13:3 (Tsuzuki and Shimokawa, 1990) and trigenic ratio of 37 non-aroma:27 aroma (Nagarju et al, 1975; Reddy and Sathyanaraynaiah, 1980) are also reported. Moreover, Dhulappanavar (1976) showed four complementary genes indicating ratio of 175 non-aroma: 81 aroma.

Finally, Tsuzuki and Shimokawa (1990) suggested that there is no consensus as yet on the nature of inheritance in aromatic characters. The lack of agreement among investigators appears to be related to the differences in the aromatic varieties used and also the methods on evaluating aroma.

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