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ESTIMATION OF SOME GENETIC PARAMETERS FOR RATOONING ABILITY IN F_2 POPULATIONS OF RICE (*ORYZA SATIVA* L.)

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ABSTRACT

Genetic variability, broad-sense heritability, genetic advance under selection for ratooning ability and its association with some main-crop traits were studied in eight F_2 populations. The maximum genetic variability was observed in the cross IR 19799-17-3-1-1A × IR 13420-6-3-3-1. The estimates of heritability and genetic advance were moderate only in three crosses. Low heritability and genetic advance in most crosses indicated that early generation selection would not be effective in improving this trait. Ratooning ability did not show a consistent trend of association with main-crop plant height, tillers and panicles/plant.

Key words: Ratooning ability, rice.

Rice ratoon cropping (management of the stubble crop) has been suggested to be one of the possible ways of rice crop intensification [1, 2]. The use of high ratooning cultivars is foremost for the success of a ratoon crop. Therefore, efforts should be made to breed varieties with good ratooning ability. A large genotypic difference in ratooning ability has been reported (cf. [3]). Being a varietal character, it is possible to improve the ratooning ability of rice cultivars/breeding lines. The existence of variability is a prerequisite for the improvement of any genetic character by breeding methods. Since F_2 populations form the base materials for selection, it is pertinent to investigate the nature and extent of variability and other genetic parameters in this population to predict the efficiency of early generation selection. Also, segregating populations provide a better material for correlation studies due to less influence of independent segregation. Thus, it would be useful to study correlations in F_2 generation. The present investigation attempts to obtain information on genetic variability, heritability and genetic advance for ratooning ability and its association with some main-crop traits in eight F_2 populations of *indica* rice.

MATERIALS AND METHODS

The parental and F_2 populations of eight crosses were grown in a randomized complete block design with three replications at the International Rice Research

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Institute, Los Baños, Laguna, Philippines, during 1983 wet season. The plots were fertilized with 60 : 30 : 30 N : P : K/ha at the time of final land preparation. Nineteen-day-old seedlings were transplanted (one seedling/hill). The plant spacings were maintained at 25 and 20 cm between and within rows, respectively. There were 36 hills/row, 4 rows/parent, and 8 rows/F_2 population/replication. Thirty kg N/ha was topdressed 30 days after transplanting and standard agronomic practices were followed to raise the main crop. Ten plants for each parent and 35 plants for each F_2 population per replication were taken at random in the main crop to record plant height, tiller and panicle number per plant. The plants were ratooned by cutting the stalks 15 cm above the ground four weeks after flowering and the number of ratoon tillers/plant recorded 28 days later. Ratooning ability was expressed as ratio of ratoon tillers to the main-crop tillers. The mean values were used for analysis of variance. The genetic parameters phenotypic, genotypic coefficients of variability (PCV, GCV), and heritability were computed by the standard methods. The expected genetic advance (GA) at 5% selection intensity for ratooning ability was estimated as per [4]. Simple correlation coefficients of ratooning ability with main-crop plant height, tillers and panicles/plant in each population were calculated following Snedecor and Cochran [5].

RESULTS AND DISCUSSION

Significant differences for ratooning ability among experimental populations were revealed by the analysis of variance. The highest mean ratooning ability (1.59 ± 0.21) was exhibited by IR 19799-17-3-1-1, whereas IR 48 has the lowest mean ratooning ability of 0.36 ± 0.08 (Table 1). Among the F_2 populations, cross IR 19657-34-2-2-3-3A × IR 10781-143-2-3 had the highest (1.0 ± 0.05) ratooning ability,

Table 1. Average ratooning ability of different experimental populations

Cross	Ratooning ability of different populations		
	P_1	P_2	F_2
IR 19657-34-2-2-3-3A × IR 36	0.81 ± 0.19	0.54 ± 0.07	0.93 ± 0.04
IR 19657-34-2-2-3-3A × IR 48	0.81 ± 0.19	0.36 ± 0.08	0.96 ± 0.04
IR 19657-34-2-2-3-3A × IR 9729-67-3	0.81 ± 0.19	0.77 ± 0.09	0.69 ± 0.04
IR 19657-34-2-2-3-3A × IR 10781-143-2-3	0.81 ± 0.19	0.63 ± 0.08	1.00 ± 0.05
IR 19657-34-2-2-3-3A × IR 19661-364-1-2-3	0.81 ± 0.19	0.54 ± 0.06	0.75 ± 0.04
IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1	0.81 ± 0.19	1.24 ± 0.02	0.93 ± 0.04
IR 19657-34-2-2-3-3A × IR 13146-45-2-3	0.81 ± 0.19	0.86 ± 0.13	0.66 ± 0.05
IR 19799-17-3-1-1A × IR 13420-6-3-3-1	1.59 ± 0.21	1.00 ± 0.11	0.75 ± 0.08

while the lowest (0.66 ± 0.05) was recorded in cross IR 19657-34-2-2-3-3A × IR 13146-45-2-3. In general, the F_2 frequency distribution was skewed and also showed distinct peaks, indicating the involvement of major gene(s) in the inheritance of this trait. However, the crosses IR 19657-34-2-2-3-3A × IR 36 and IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1 showed normal distribution in F_2, suggesting polygenic control of ratooning ability. Transgressive segregation towards both high and low ratooning parents was observed in all the crosses, which indicated the influence of modifiers in the expression of ratooning ability.

The experimental F_2 populations investigated had substantial variability for ratooning ability as evident from high PCV and GCV (Table 2). Nevertheless, appreciable differences in the magnitudes of PCV and GCV indicated that environmental factors significantly contributed to the variation in ratooning ability in these crosses. The highest genetic variability was observed in the F_2 population of cross IR 19799-17-3-1-1A × IR 13420-6-3-3-1 and lowest in IR 19657-34-2-2-3-3A × IR 48. The remaining crosses had moderate variability (Table 2). The existence of moderate to high genetic variability suggested that ratooning ability of these crosses could be improved through selection.

Table 2. Estimates of PCV, GCV, heritability, and GA for ratooning ability in F_2 populations

Cross	PCV (%)	GCV (%)	Heritability	GA	GA as% of mean
IR 19657-34-2-2-3-3A × IR 36	32.7	26.8	0.31	0.286	30.7
IR 19657-34-2-2-3-3A × IR 48	47.0	21.2	0.20	0.189	19.7
IR 19657-34-2-2-3-3A × IR 9729-67-3	44.7	31.6	0.25	0.225	32.7
IR 19657-34-2-2-3-3A × IR 10781-143-2-3	49.7	33.8	0.46	0.471	47.1
IR 19657-34-2-2-3-3A × IR 19661-364-1-2-3	58.9	39.3	0.45	0.407	54.3
IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1	45.4	32.5	0.33	0.358	38.5
IR 19657-34-2-2-3-3A × IR 13146-45-2-3	61.9	42.7	0.30	0.317	48.0
IR 19799-17-3-1-1A × IR 13420-6-3-3-1	81.1	60.2	0.55	0.692	92.2

The heritability estimates for ratooning ability were generally low in all crosses, except IR 19657-34-2-2-3-3A × IR 10781-143-2-3; IR 19657-34-2-2-3-3A × IR 19661-364-1-2-3, and IR 19799-17-3-1-1A × IR 13420-6-3-3-1, where the values were moderate (Table 2). The highest GA (92.2%) and heritability estimates (0.55) observed in cross IR 19799-17-3-1-1A × IR 13420-6-3-3-1 revealed predominance of additive gene effects in the inheritance of ratooning ability and offers ample scope for improvement of this trait through selection. In the crosses IR 19657-34-2-2-3-3A × IR 10781-143-2-3 and IR 19657-34-2-2-3-3A × IR 19661-364-1-2-3, such estimates were moderate and selection can also be practised in these populations.

Low heritability and genetic advance in F_2 of crosses IR 19657-34-2-2-3-3A × IR 9729-67-3 and IR 19657-34-2-2-3-3A × IR 13146-45-2-3 could be due to less diversity among the parents for this character (Table 1). The low to moderate GA coupled with low heritability in crosses IR 19657-34-2-2-3-3A × IR 36; IR 19657-34-2-2-3-3A × IR 48 and IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1 indicated that the inheritance of ratooning ability may be under polygenic control and also influenced by environment. The normal F_2 distribution of crosses IR 19657-34-2-2-3-3A × IR 36 and IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1 also supports this conclusion. The results are in agreement with the findings of [2]. In such crosses, selection should be postponed to the advance generations.

Correlations. Close association between the main-crop characters and ratooning ability would be desirable and will also facilitate early selection for this trait.

Main-crop plant height was positively and significantly correlated with ratooning ability only in two crosses: IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1 (r = 0.38**) and IR 19657-34-2-2-3-3A × IR 9729-67-3 (r = 0.37**). In other crosses there was no definite association between these two characters. This variable pattern of association may be due to differential response of populations to environment. Another possible explanation could be overshadowing of dwarf plants by the tall segregants which reduced the ratooning potential of dwarf plants, as reduction in light intensity in the main crop has been reported to lower the ratooning ability [6]. The F_2 samples of these two crosses had predominance of tall plants.

Ratooning ability, in general, showed negative correlation with tillers/plant. But such association was only significant in three crosses: IR 19657-34-2-2-3-3A × IR 10781-143-2-3 (r = −0.37**), IR 19657-34-2-2-3-3A × IR 9729-67-3 (r = −0.22*), and IR 19799-17-3-1-1A × IR 13420-6-3-3-1 (r = −0.42**).

The correlation coefficients between ratooning ability and panicles/plant were negative but significant only in crosses IR 19657-34-2-2-3-3A × IR 10781-143-2-3 (r = −0.23**) and IR 19657-34-2-2-3-3A × IR 19735-5-2-3-2-1 (r = −0.41**). Besides the panicles, the late vegetative tillers at harvest may also act as sink rather than source, and this depletes the carbohydrates of the stubbles and thus reduces the ratooning ability, since the ratoon tiller production is believed to be dependent on the carbohydrate reserve left in the roots and stubbles after the harvest of main crop [2, 7]. The negative and significant association of ratooning ability with number of tillers and panicles may lend credence to this reasoning.

The results of the present investigation indicated that in majority of crosses ratooning ability could be improved without affecting the main-crop components. However, in crosses where negative association of ratooning ability with tiller and panicle number was recorded, biparental mating could be adopted, and selection practised in the later generations. The negative effect of tillers/plant on ratooning ability can also be minimised by restricting main-crop tillering by adjusting plant spacing and/or using more seedlings per hill which also increases ratooning ability [8]. Further, while selecting lines for good ratooning ability care must be taken not to forsake the main-crop yield. The optimum level of both main-crop yield and ratooning ability should be worked out.

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