

Studies on Grain Shedding in Rice (*Oryza Sativa* L.)*

by

K. K. VIDYADHARAN¹ and B. W. X. PONNAIYA²

Synopsis : The results gathered from a study of inheritance of shedding involving three strains of paddy viz., ADT. 16, Co. 13 and PTB. 10 are presented in this paper. The non-shedding trait was observed to be dominant over shedding in F_1 and in the F_2 a greater frequency of non-shedding segregates was noted.

Introduction : Shattering or shedding of grain is an economically important character in rice. In this crop, if a variety sheds easily, much of the grain is lost even before ripening and if it has highly persistent grains, then also it is not desired as the grains will cling on to the ears thus making threshing difficult. The non-shedding types of the cultivated rice are not absolutely non-shedding but have a low percentage of shedding. Similarly, the 'shedding types' of cultivated rice also do not shed the grains completely, but have a number of shedding grains compared to non-shedding types.

Three studies on shedding of grain in rice were made and have been presented in this paper. Although Hanumantha Rao (1935) designed a fairly efficient device for estimating shedding, he had not fixed the optimum size of the sample required for the efficient study of this character. A study was, therefore, conducted to fix the optimum size of the sample for assessing the shedding character in rice. The second study was the screening of economic types available at the Paddy Breeding Station, Coimbatore to assess their intrinsic worth on the shedding aspect and also to find out whether duration of the crop has any relationship with shedding. The genetic behaviour of this character in the strains evolved was also pursued to a limited extent.

Materials and Methods : 1. *Description of material :* Rice strain ADT. 16 is a pure line selection of the variety "Konakuruwai" of Tanjore (Madras State) and is preferred for its fine quality of rice. It gives 25 per cent higher yield over ryots' bulk and yields on an average 3700 lbs. of paddy per acre. Though a high yielding short duration strain, it is observed to be a shedding variety not popular among the ryots.

METHOD : Plants were selected at random in a pure line bulk of the strain and were marked. Flowering date of these plants were noted and on the 35th day after flowering, the heads were harvested and the shedding estimated for individual heads using the apparatus designed by Hanumantha Rao (1935).

1. Faculty of Plant Breeding and Genetics, Coimbatore - 3.

2. Professor of Plant Breeding and Genetics and Dean, Agricultural College and Research Institute, Coimbatore.

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Different sample sizes ranging from five heads to 100 were tried and the standard error of mean and co-efficient of variability worked out for each sample. The optimum sample size was then fixed, based on the co-efficient of variability (Panse and Sukhatme, 1957).

2. *Screening of types for correlation study*: MATERIAL: Sixty different types, twenty each from short (below 120 days duration), medium (120 to 150 days) and long duration (above 150 days) varieties were selected from the existing collection of types of the Paddy Breeding Station, Coimbatore. Care was taken to include as many important economic strains as possible from those released by the department.

METHODS: The sixty types were grown as bulk in plots of 80' x 4' and about one hundred plants selected at random. The individual heads were harvested from these plants at 35 days without causing any shedding. Thirty heads were selected and used for shedding estimation using the same apparatus, the correlation values were then worked out separately for short, medium and long duration types.

3. *Genetical aspect of shedding*: MATERIAL: The following two sets of crosses were studied upto F_2 generation - Co. 13 x ADT. 16 and PTB. 10 x ADT. 16.

The parents were selected from the existing collection of strains in the Paddy Breeding Station, Coimbatore based on their shedding behaviour.

Description of materials: 1. *Co. 13 (Arupathamkodai)*: This is from a pureline variety "Arupathamkodai" of Madurai district and yields 10 per cent over the local. It gives an average yield of 2,170 lb. per acre and has a duration of 110 days.

2. *PTB. 10 (Thekkancheera)*: It is an isolated variety from "Thekkancheera" of Malabar. It is a popular short duration variety (100 days) in Kerala.

3. *ADT. 16 (Konakuruwai)*: Description furnished already

F_1 Generation: Fifteen seeds from the cross PTB. 10 x ADT. 16 and 22 seeds from cross Co. 13 x ADT. 16 were sown individually in earthen pots on 5th June, 1959. Enough seeds from the three parents were also sown on the same date. One month old seedlings were transplanted in singles at 6" apart in the line and 1' between lines. The F_1 seedlings were transplanted along with the respective parents on either side for easy comparison. Uniform treatments were given to both parents and the F_1 population during the period of growth. In each F_1 plant five heads were marked for the study. In cross No. 1 (Co. 13 x ADT. 16) eleven F_1 plants and in cross No. 2 (PTB. 10 x ADT. 16) eight F_1 plants were available for the detailed study. Five heads were harvested 35 days after flowering and the mean shedding estimated for individual hybrids. The data were subjected to statistical analysis. In the case of parents, 30 heads from 30 plants were tested for estimating the shedding behaviour of each parent. Based on the analysis, four F_1 cultures from the cross Co. 13 x ADT. 16 were carried forward to the F_2 generation.

F₂ Generation: The seeds from each of the four *F₁* cultures were separately raised in the nursery. The *F₂* was grown in randomised and replicated blocks, each *F₁* culture constituting a replication. The plot size for each replication was 30' x 20'. The seedlings in all the replications were transplanted in singles at 6" apart in lines and 1' between lines. All the blocks were transplanted on 3-12-1959 giving uniform spacing. On flowering, individual heads were marked, taking one head from each plant. Uniform period of maturity was allowed to all heads, and 35 days after flowering the heads were harvested and shedding determined using the same apparatus.

Experimental Results: *Experiment 1. Optimum size of sample:* On statistical analysis of the various sample sizes, it was observed that there was a steady fall in the value of coefficient of variability as the size of sample increased. It is also seen that the coefficient of variability in respect of sample sizes 30 and 40 do not differ appreciably.

Experiment 2. Screening of types for correlation study: The correlation values for three different duration groups individually as well as all the three groups put together were worked out. They were not found to be significant.

Genetical aspect of shedding: In the two sets of crosses studied, namely, Co. 13 x ADT. 16, and PTB. 10 x ADT. 16, the parents Co. 13, and PTB. 10 were used as the ovule parent and ADT. 16 as the common male parent in both the crosses. The details regarding shedding values of the parents and *F_{1s}* are furnished in Table 1. The data presented in Table 1 revealed that in cross No. 1, the ovule

TABLE 1
Shedding values of parents and hybrids

Cross No.	Ovule parent	Mean shedding percentage	Pollen parent	Mean shedding percentage	Mean shedding value of parents	Mean shedding values of <i>F₁</i>
1.	Co. 13	11.33 ± 1.21	ADT. 16	22.63 ± 1.92	16.98	12.3 ± 1.51
2.	PTB.10	9.52 ± 1.8	ADT. 16	22.63 ± 1.92	16.07	11.8 ± 1.80

parent Co. 13 had a mean shedding value of 11.33 ± 1.21 while the pollen parent ADT. 16 had a mean value of 22.63 ± 1.92 of shedding. The hybrid showed a mean percentage of 12.3 ± 1.51 of shedding which was less than the parental mean and much closer to the non-shedding parent, namely Co. 13. Similarly in cross No. 2, the ovule parent PTB. 10 and pollen parent ADT. 16 showed mean shedding values of 9.52 ± 1.03 and 22.63 ± 1.92 respectively. The hybrids with a mean percentage of 11.8 ± 1.8 of shedding were tending towards the non-shedding parent, namely, PTB. 10. The data showed that there was significant difference among the *F₁* plants in cross Co. 13 x ADT. 16.

The study of the *F₂* population was confined to the progenies from one of the *F_{1s}* from cross Co. 13 x ADT. 16. The *F₂* data showed that most of the progenies behaved like the non-shedding parent. Out of 437 plants studied in the *F₂*, 399 plants showed less shedding than the general mean of the two parents. The frequency distribution of the *F₂* segregates is presented in Table II.

TABLE 2
Frequency distribution of F_2 segregates in cross Co. 13 x ADT 16

Percentage of shedding - ranging from 0.1 to 33.0											Total
0.1-3	3.1-6	6.1-9	9.1-12	12.1-15	15.1-18	18.1-21	21.1-24	24.1-27	27.1-30	30.1-33	
26	107	121	79	49	32	11	6	1	4	1	437

Discussion : 1. *Optimum size of sample for shedding analysis:* Among the standard strains, ADT. 16 was preferred as the basic material for the study because of its short duration and high shedding nature. In the method employed for the study flowering dates for individual panicles were noted so as to obtain a uniform maturity period in the case of the heads earmarked for the study. Ramiah and Hanumantha Rao (1936) had fixed 40 days for maturity of the panicles after flowering, before the heads were harvested for estimation of grain shedding. A constant maturity period of 35 days was fixed in this study as the types and crosses under study tended to be shorter in duration and hence began exhibiting the shedding nature even earlier. From the data gathered, it was observed that the coefficient of variability values did not alter much for the two samples, viz., 30 and 35. Hence the sample size was fixed at 30 (Panse and Sukhatme, 1957).

2. *Screening types for correlation study:* As the study was intended to determine the correlation between duration and shedding, varieties with different durations and varying degrees of shedding were selected. The material had high variation in shedding ranging from 3.1 per cent to 23.2 per cent. Similarly the duration also had a range from 90 to 205 days. The correlation values determined for each duration group, in respect of 20 types studied were found to be not significant indicating the absence of any association between duration and shedding. The correlation value for all the 60 types was also not significant. The findings, therefore, suggested that there was no significant correlation between shedding and duration, although there was a tendency for the longer duration types to have higher shedding percentages.

3. *Genetical aspect of shedding:* In the two sets of crosses studied, namely, Co. 13 x ADT. 1 and PTB. 10 x ADT. 16 the parents Co. 13 and PTB. 10 were preferred because of the short duration and comparatively low shedding nature and ADT. 16, due to its high shedding percentage. The shedding type was used as the pollen parent in order to avoid any probable loss of crossed seeds due to shedding which might otherwise occur if the shedding type is used as the ovule parent. The necessity for such a procedure has been indicated in the work of Kadam (1936) and Ramiah and Hanumantha Rao (1936) on similar aspect of shedding in rice.

The F_1 plants of the cross, Co. 13 x ADT. 16 showed a mean shedding percentage of 12.3 ± 1.51 and was lower than the general mean of the two parents (16.98 per cent). The same behaviour was also observed in the other set of cross, namely, P'TB. 10 x ADT. 16 where the mean shedding percentage of the hybrid

was 11.8 ± 1.80 . The details of the comparison of the hybrids with the parental means in the two crosses are presented in Table I. In both the crosses the hybrids, though they showed a mean shedding percentage lower than the general mean of the two parents, were tending towards the non-shedding parent. The findings from the two sets of crosses, therefore, indicated that there was a bias towards dominance of non-shedding, in the F_1 generation. This is further confirmed by the observations made in the F_2 analysis.

The greater variability and preponderance of non-shedding segregates in the F_2 and the bias towards the non-shedding character in the F_1 suggested that the factors contributing to the non-shedding character in the two crosses studied were controlled by a few major genes whose effects got modified in the positive direction by minor ones. The distinct tendency for a greater frequency of plants to be of the non-shedding type may be due to the interaction of the modifiers which will influence the shedding class. Ramiah and Hanumantha Rao (1936) observed an intermediate behaviour in F_1 with no indication of simple inheritance in the F_2 and the distribution of F_2 population suggested that more than one factor was involved. Porter (1949) studying the character in wheat, observed a similar behaviour with partial dominance of resistance to shattering, the means of F_1 and F_2 being more close to the resistant parent. The high percentage of resistant segregates was suggested to be due to the interaction of two major factor pair differences with one or more modifying factors.

It is also seen from the present studies that plants exceeding either parents in shedding and non-shedding occur in the F_2 . The interaction of modifiers brought in from the two parents can account for such transgressive variation. Only a thorough analysis of the succeeding generations can give confirmatory evidence.

Kadam (1936) in a cross between wild and cultivated types obtained a 15 : 1 ratio with dominance of shedding in F_1 . This may be due to the wild parent used in the cross, the genomic make up of which is likely to be different from that of the cultivated types. Kato (1927) obtained simple dominance of non-shedding character in rice varieties studied by him. Jones (1933) however, observed the F_1 to be intermediate in behaviour. Sakai and Niles (1957) observed that the number of effective factors responsible for grain shedding were six and two in the two different cross combination of rice studied by them.

There appears to be some divergence in the findings of different workers on the inheritance of this character in rice, which can be accounted for, by the distinct variability in the materials used. However, it is observed that the character is influenced by more than one factor with different degrees of effect. The present study reveals such an interaction of factors with major and modifying effects.

Summary: Correlation values between shedding and duration, determined for the medium and long duration groups of paddy were found to be not significant although the latter exhibited a higher degree of shedding.

The nature of inheritance of grain shedding was studied in two sets of crosses involving shedding and non-shedding parents. Non-shedding appeared to be incompletely dominant. The preponderance of non-shedding segregates in the F_2 population suggest that the factors associated with the non-shedding are probably controlled by a few major genes and whose effects are modified by minor ones.

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SUGARCANE CROP YIELD COMPETITION, 1962—'63

We are glad to publish that Sri A. T. Subramaniam, S/o Sri Thangavel Mudaliar, Kurinjipadi, South Arcot District has been adjudged as the State Prize Winner in the Sugarcane Yield competitions held in Madras State during 1962—'63. He has produced an acre Yield of 116 Tons and 257 Kgs. Our hearty congratulations to him.