

Studies on Synchronization of Parental Lines in Hybrid Rice

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ABSTRACT Seeding interval between the parental lines of Pusa Rice Hybrid-3 was studied using the methods of Growth duration (D), Effective accumulated temperature (EAT) and Leaf number difference (LND). A comparison of the coefficient of variation (CV) of the three methods showed that the variability was the least for the leaf number method, followed by the difference in days to flowering and the highest for effective accumulated temperature suggesting more stability of leaf number over the seasons.

Keywords: Synchronization of flowering, growth duration, effective accumulated temperature, leaf number difference

Success and sustenance of hybrid rice technology depend to a greater extent on the efficient and economic seed production technology. Some of the important components of hybrid rice seed production package include synchronization of flowering of parental lines, planting pattern, ideal row ratios, dose and time of GA₃ application, supplementary pollination techniques etc. Synchronization of flowering of the pollen and seed parent is the key factor to obtain high seed yields [1]. Flowering of a variety is influenced by seasonal and weather conditions and therefore, it is essential to determine seeding interval between two parents of a given hybrid for each season and location [2]. Determination of seeding interval of parental lines for synchronized flowering is a component in hybrid rice seed production. Jiming [3] stated that in order to ensure synchronization of flowering of seed and pollen parent, it is essential to get optimum seeding interval between parental lines and cited five approaches to determine the seeding interval namely growth duration, leaf number, leaf growth speed, tillering speed and regression formula method.

Restorer lines, which generally have longer growth duration than their female counterparts, are sown first to produce hybrid seed. However, when the transplanting of the late and early parent is done on the same day the flowering of late parent is further delayed (B.C. Viraktamath, personnel communication). This was verified in a preliminary experiment in *kharif* 1997. As per the information

available from the breeder, the restorer line PRR 72 was sown 15 days ahead of CMS line Pusa 5A and transplanting of 45 days old seedlings of the restorer and 30 days old seedlings of CMS parent was done on the same day. We found during *kharif* 1997 that the CMS parent flowered 7 days ahead of the restorer, thus the actual difference observed between the late parent (PRR 72) and the early parent (Pusa 5A) was 22 days. This led to the present study of determining the optimum seeding interval between Pusa 5 A and its restorer PRR 72, following different methods.

MATERIALS AND METHODS

The CMS parent Pusa 5A and restorer PRR 72 of Pusa Rice Hybrid 3, supplied by the Senior Rice Breeder, Division of Genetics, IARI, were used in the present study to determine the seeding interval for ensuring synchronization of flowering. For this, three approaches were followed, namely difference in days to flowering, effective accumulated temperature (EAT) and leaf number difference (LND) as detailed below:

Difference in days to flowering: Eight sowings of Pusa 5A and PRR 72 at five day intervals were done during the *kharif* 1998 and 1999.

Effective accumulated temperature (EAT): For calculating EAT, 12°C was taken as the lower limit of temperature and 30°C as the optimum temperature [4].

Leaf number difference (LND): Fifteen seedlings each of A and R lines were selected and labeled from the 10th day onwards after sowing. Thirty days old seedlings were transplanted in the main field and data on leaf number was recorded at an interval of three days till the opening of flag leaf, leaf growth rate (LGR) of a line was calculated as :

$$\text{LGR} = \frac{\text{Number of days taken to produce first 7 leaves}}{7}$$

Based on LGR, seeding interval for Pusa 5A and PRR 72 was calculated by using the following formula

$$\text{Seeding interval days} = \frac{\text{Leaf number difference}}{\text{Leaf growth rate of early sown parent}} \times$$

Observations recorded: The leaves on the main culm of seedlings in nursery were marked by waterproof ink, and the leaf number was noted down at 3 days interval. First leaf with blade was taken as leaf number one. Plants were tagged and while transplanting, they were transplanted in the same sequence as in nursery, single plant per hill. The leaf number observations on the main culm were recorded till complete unfolding of flag leaf and the date of initial flowering (panicle emergence) was recorded for each plant.

Days to panicle emergence was recorded when 50 per cent of plants had their panicles emerged from the boot leaf.

RESULTS AND DISCUSSION

Difference in days to flowering, which is also known as growth duration method, is most commonly followed for determining the seeding interval since it is simple and easy to adopt. However, at those places where the temperature fluctuations are very high or the parents involved in hybrid seed production are sensitive, this method is not reliable [5]. Based on the date of panicle emergence of both the parents in *kharif* 1998 and 1999, it was observed that the male parent sown and transplanted 15 days earlier synchronized well with the female parent (Table 1). This showed that the restorer line PRR-72 should be sown and transplanted 15 days earlier to the CMS line Pusa 5A. However, transplanting of R line 15 days ahead

of A line is not practically feasible since the field tends to become compact in a gap of 15 days, which will not be conducive for the establishment and growth of plants of seed parent. Viraktamath [6] suggested that in hybrid rice seed production, following staggered seeding, simultaneous planting of male and female parents is preferred to avoid inconvenience and additional labour cost.

Results on days to flowering of Pusa 5A and PRR 72 are presented in Table 2, which showed that as the sowings were delayed, the number of days to flowering reduced in both the lines. Days to flowering in Pusa 5A, which was 93 days in the first sowing, was reduced to 83.5 days in the eighth sowing. Similarly, in PRR 72, number of days required for flowering was 104 days for the first sowing and 91 days for the eighth sowing. Mean difference in days to flowering in PRR 72 and Pusa 5A was 9 days with PRR 72 requiring longer duration. It was observed that difference in days to flowering of the two parents was also reduced with delayed sowings and the difference was 11 days for the first sowing date and 7.5 days for the last sowing date.

At locations where fluctuations in temperatures are very frequent the difference in days to flowering is not very effective in determining the seeding interval. Under these circumstances, the effective accumulated temperature (EAT) method can be of more use. Every genotype requires a specific quantum of temperature to reach the flowering stage, which is considered to be relatively stable irrespective of time of seeding [4]. EAT was calculated for different dates of sowing. The results are presented in Table 2. The EAT required for flowering reduced in both the parents when the sowing was delayed. In Pusa 5A, EAT reduced from 1626.3°C in first sowing to 1431.5°C in eighth sowing. Similarly, in PRR 72, EAT required for flowering of first set was 1818.5°C and 1541.5°C in eighth sowing respectively. The average EAT for Pusa 5A was 1545.2°C and for PRR 72 it was 1693.8°C. Thus, the restorer line PRR 72 required 148.6°C more EAT than Pusa 5A. Therefore, PRR 72 should be sown first and when EAT reaches 148.6°C, then Pusa 5A should be sown.

Unlike days to flowering and EAT, the leaf number of a given variety is reported to be more stable over the seasons/years [7]. In the present experiment, it was observed that the leaf number remained stable over the two years of the experiment in both the parents. Leaf number difference of Pusa 5A and PRR 72 has been presented in Table 3. Leaf

Table 1. Dates of sowing and panicle emergence in Pusa 5A and PRR 72

Variety	Kharif 1998		Kharif 1999	
	DOS	DOPE	DOS	DOPE
PRR 72	3-6-98	15-9-98	14-6-99	24-9-99
	8-6-98	19-9-98	19-6-99	27-9-99
	13-6-98	23-9-98	24-6-99	1-10-99
	18-6-98	24-9-98	29-6-99	4-10-99
	23-6-98	29-9-98	4-7-99	8-10-99
	28-6-98	1-10-98	9-7-99	11-10-99
	3-7-98	4-10-98	14-7-99	14-10-99
	8-7-98	7-10-98	19-7-99	16-10-99
Variety	DOS	DOPE	DOS	DOPE
Pusa 5A	3-6-98	3-9-98	14-6-99	14-9-99
	8-6-98	7-9-98	19-6-99	19-9-99
	13-6-98	10-9-98	24-6-99	23-9-99
	18-6-98	16-9-98	29-6-99	26-9-99
	23-6-98	19-9-98	4-7-99	30-9-99
	28-6-98	22-9-98	9-7-99	2-10-99
	3-7-98	26-9-98	14-7-99	6-10-99
	8-7-98	29-9-98	19-7-99	9-10-99

DOS = Date of Sowing

DOPE = Date of Panicle Emergence

Table 2. Days to flowering and EAT for Pusa 5A and PRR 72 for different sowing dates

Sowing Sets	Days to flowering						EAT (°C)					
	Pusa 5A			PRR 72			Pusa 5A			PRR 72		
	Kharif 98	Kharif 99	Mean	Kharif 98	Kharif 99	Mean	Kharif 98	Kharif 99	Mean	Kharif 98	Kharif 99	Mean
1	93	93	93.0	105	103	104.0	1633.6	1619.1	1626.3	1841.2	1795.9	1818.5
2	92	93	92.5	104	101	102.5	1615.6	1617.8	1616.7	1820.1	1757.9	1789.0
3	90	92	91.0	103	100	101.5	1583.3	1598.4	1590.8	1800.5	1735.4	1767.9
4	91	90	90.5	99	98	98.5	1590.6	1559.9	1575.2	1724.8	1690.2	1707.5
5	89	89	89.0	99	97	98.0	1556.5	1541.0	1548.7	1720.7	1660.6	1690.6
6	87	86	86.5	96	95	95.5	1517.0	1482.5	1499.7	1666.1	1615.2	1640.6
7	86	85	85.5	94	93	93.5	1493.7	1451.9	1427.8	1625.5	1565.7	1595.6
8	84	83	83.5	92	90	91.0	1455.9	1407.1	1431.5	1580.9	1502.2	1541.5
Mean	89.0	88.8	88.9	99.0	97.1	98.0	1555.7	1534.7	1545.2	1722.4	1665.3	1693.8
CV			3.57			8.66			8.55			10.72

Table 3. Mean leaf number in Pusa 5A and PRR 72

Variety	Kharif 98	Kharif 99	Mean
PRR 72	18.06	18.00	18.03
Pusa 5A	16.26	16.00	16.13
Difference	1.8	2.0	1.9

number at flowering Pusa 5A was 16.26 in kharif 1998 and 16.00 in kharif 1999. The average leaf number difference between PRR 72 and Pusa 5A was 1.9. To calculate the number of days equivalent to leaf number difference between Pusa 5A and PRR 72, leaf growth speed method was used. Based on leaf growth rate, the seeding interval (SI) was determined by using the formula: Accordingly, seeding interval was found to be 8 days i.e., sowing of PRR 72 should be taken up 8 days before the sowing of Pusa 5 A.

Comparison of the coefficient of variation (CV) (table 2) of the three methods showed that the CV was least for the leaf number method, followed by difference in days to flowering and highest in effective accumulated temperature, suggesting more stability of leaf number over the seasons. Viraktamath [8] suggested that leaf number method is more reliable and other methods can be used to obtain finer adjustments so as to obtain proper synchronization between parental lines which is very crucial for successful hybrid rice seed production. The present experiment showed that though the leaf number remained same over the two different years, the growth duration and effective accumulated temperature varied with different sowing dates within the same year. The above information also indicated that staggered sowings of the male parent should be taken three times to extend the duration of pollen availability to the female parent.

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