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Research Article

Comparative studies on different methods for perfect synchronization of parental lines of Sahyadri 3 rice hybrid for commercial hybrid rice seed production

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Abstract
Perfect synchronization between the parental lines of Sahyadri rice hybrid *viz.,* IR 58025A (A-line), IR 58025B (B-line) and KJTR-3 (R-line) were determined by using three methods *viz.,* Growth duration difference, (GDD) Leaf number difference (LND) and Effective accumulated temperature (EAT). The seeding interval between A x B line was 2.66 days and between A x R was 11.89 days. The B line flowered 2.66 days before A line and R line flowered 11.89 days after A line. The Effective Accumulated temperatures (EAT) for attaining 50% flowering of A, B, & R line were 2265.91ºC, 2189.61 ºC and 2596.29 ºC respectively. The difference of EAT between A and B lines was 76.30 ºC and between A and R lines was 330.38ºC. Parental lines *viz.,* A, B, and R lines flowered after 13.60, 12.60 and 16.70 leaves respectively. The leaf number difference between A and B lines was 1.0 leaf and between A & R line 3.2 leaves. The perfect synchronization of flowering between A and B lines can be achieved by sowing A line 3 days before second date of seeding of B line, sowing of B line after emergence of 1.0 leaf of A line and when A line reaches its EAT to 76.30 ºC. Similarly, the synchronization of flowering between A and R line can be achieved by sowing A line 12 days after second date of seeding of R line, after emergence of 3.2 leaves of R line and when R line reaches its EAT to 330.38ºC. This phenology model can be exploited for perfect synchronization of flowering in commercial seed production of A x B line and A x R line of Sahyadri rice hybrid.

Keywords
Hybrid rice, synchronization, Growth Duration Difference (GDD), Leaf number difference (LND), Effective accumulated temperature (EAT), parental lines.

INTRODUCTION

Efficient and economic commercial hybrid rice seed production is one of the primary requirements for the success and sustenance of hybrid rice technology. Even if the hybrid is highly heterotic, unless it is producible it has no commercial value. Besides other factors, adoption of hybrid rice depends on the availability of adequate quantity of high quality seeds at affordable cost. Higher seed cost is one of the constraints in popularization of hybrids, which is directly influenced by the seed yields. Seed yields depend on several factors such as row ratios, outcrossing ability, level of management, synchronization, GA3 application, supplementary pollination etc. Among these factors, the proper synchronization in flowering between parental lines is most crucial as its failure may lead to severe reduction or no seed yields in extreme cases. Hence it is necessary that both male and female parents should come to flowering at the same time though they differ in their growth duration. Synchronization may be achieved by staggered sowing of parental lines. In spite of staggered sowing, it is necessary to predict the flowering of parental lines if there are any problems in synchronization and take corrective measures. Problems in obtaining synchronization are encountered, especially in the initial stages. Careful recording of flowering data

and minor mid term corrections over the seasons will help to overcome this problem. In China, the hybrid rice seed productivity initially was only 0.31 t/ha, which subsequently increased to 0.90 t/ha in 1982 and 1.5 t/ha in 1985 and maximum seed yield of 4.5 t/ha achieved after refinement of hybrid rice technology (Singh and Virmani, 1990).

Regional Agricultural Research Station, Karjat released Sahyadri 3 rice hybrid, during 2006 for commercial cultivation in Maharashtra State. In order to obtain perfect synchronization between parental lines (A x B & A x R) of Sahyadri-3 rice hybrid, this study was undertaken to determine seeding interval between parental lines by using different methods.

MATERIALS AND METHODS

A field experiment consisting of three parental lines *viz*., IR 58025A, IR 58025B and KJTR-3 (R) of Sahyadri 3 rice hybrid was conducted in randomized block design (RBD) during *Kharif*-2016, *Kharif*-2017 and *Kharif*-2018 at Agricultural Research Station, Shirgaon, Ratnagiri. The parental lines were transplanted in 20 x 15 cm spacing and the observations were recorded on 20 individual plants in each replication. All the parental lines of Sahyadri 3 rice hybrid were studied at the 50 % flowering stage using three methods a) Growth duration difference (GDD) - Days required to 50 % flowering from the date of sowing were recorded in each parental line of the hybrid. b) Effective accumulated temperature: - (EAT) = Σ (T – H – L), where EAT = Effective accumulated temperature in ºC from seeding to 50% flowering, T = mean daily temperature, i.e. Average of daily maximum and minimum temperatures. H = temperature higher than 30^0c, L = temperature of lower limit less than 12^0C and c) Leaf number difference (LND) - In three division method of counting leaves, the value for the growing leaves were assigned with the reference to the fully opened previous leaf, counting was started from the 1st fully opened leaf after every 5 days. The ratings for the 3-division method were 0.2 for the leaf just emerged, 0.5 for half opened and 0.8 for fully opened leaves (Sharma, 1995).

Table 1. Growth duration difference (GDD), Leaf Number Difference (LND) and Effective Accumulated Temperatures (EAT) for 50% flowering in parental lines of Sahyadri rice hybrid

Parental lines	Days to 50% flowering				
	Kharif-2016	*Kharif*-2017	*Kharif*-2018	Mean	CV (%)
a) Growth duration difference (GDD)					
IR 58025A (A-line)	87.33	88.33	86.67	87.44	1.69
IR 58025B (B-line)	84.0	84.67	85.67	84.78	0.92
KJTR-3	98.67	99.33	100.0	99.33	1.53
b) Leaf Number Difference (LND)					
IR 58025A (A-line)	13.60	13.30	13.90	13.60	1.85
IR 58025B (B-line)	12.72	12.48	12.62	12.60	2.99
KJTR-3	16.70	16.65	16.75	16.70	2.61
c) Effective Accumulated Temperatures (EAT)					
	Kharif-2016	*Kharif*-2017	*Kharif*-2018	Mean	Difference in EAT between parental lines
IR 58025A (A-line)	2272.09ºC	2251.20ºC	2274.45ºC	2265.91ºC	--
IR 58025B (B-line)	2195.32ºC	2182.6ºC	2190.9ºC	2189.61ºC	--
KJTR-3	2605.31ºC	2593.58ºC	2589.99ºC	2596.29ºC	--
EAT Difference between A-line and B-line	--	--	--	--	76.30˚C
EAT Difference between A-line and R-line	--	--	--	--	330.38˚C

RESULTS AND DISCUSSION

The parental lines of IR 58025B recorded minimum days to 50 % flowering (84.78 days) followed by IR 58025A (87.44 days) and KJTR-3 (99.30 days) (**Table 1**). The difference between A and B line was 2.66 days and the difference between A and R line of Sahyadri 3 rice hybrid was 11.89 days to 50 % flowering. The synchronization in flowering between A and B line would be possible through the earlier sowing of A line i. e. 3 days before B line. Similarly R line should be sown 12 days before A line for better synchronization in flowering between A and R lines. The IR 58025A line should be sown at once only. While, IR 58025B and KJTR-3 (R) lines should be sown staggered thrice at an interval of 5 days for sufficient pollen load throughout the flowering period of A line (7 – 8 days). Range of stigma receptivity was assured to be a maximum period of 7 days until no pollen is received by the stigmatic surface (Sharma, 1995). The flowering period for a single panicle of R line was 4 days while the flowering period for single plant of A line was

8 days (Anonymous, 1999-2000). The line A should be seeded 3 days before the second date of seeding of B line and 12 days after the second date of seeding of R line respectively. The 50% flowering duration of A, B and R lines were reported 97, 93 and 103 days, respectively at Coimbatore and A line observed to flower in 87 days during *Kharif* 2000 at Hyderabad, Chinsurah and Karnal (Anonymous, 1998-99). The line IR 58025A reported to flower in 90 days during *Rabi*-1998-99 at Maruteru (Anonymous, 1998-99). The above observations were in line with the present findings.The effective accumulated temperature (EAT) for 50% flowering was more in R line (2596.29^{0}C) followed by A line (2265.91^{0}C) and B line (2189.61^{0}C) **Table 1**. The difference of EAT between A and B line was 76.30^{0}C while, A and R line showed 330.38^{0}C difference of EAT for 50% flowering. The above result reveals that A line should be seeded first and B line should be seeded later when the A line reaches 76.30^{0}C EAT. Similarly, the R line should be seeded first and A line should be seeded later when R line reaches 330.38^{0}C EAT for better synchronization between these lines. Effective Accumulated Temperature of IR 58025A and IR 29723R recorded 1400^{0}C and 1580^{0}C respectively at Hyderabad (Viraktamath, 1995).

Table 2. Adjustment of seeding Interval for synchronization for 50 % flowering of IR 58025A x B lines and A x R lines by corresponding leaf number charts of Sahyadri 3 rice hybrid

Sahyadri rice hybrid parental CMS lines seed production (AxB) of			Sahyadri rice hybrid seed production (AxR)		
Days after sowing	**IR 58025A**	**IR 58025B**	**Days after sowing**	**IR 58025A**	**KJTR-3**
0	0	-	0		0
3	0	0	5		1.7
5	1.7	0	10		2.5
10	2.4	1.6	15		3.0
15	2.7	2.5	18	0	3.2
20	4.3	3.2	20	-	4.6
25	5.6	4.0	25	2.7	5.7
30	6.0	4.7	30	4.3	6.3
35	6.4	5.4	35	5.6	6.7
40	7.1	6.0	40	6.0	7.7
45	7.5	6.6	45	6.4	8.2
50	8.1	7.2	50	7.1	8.6
55	8.5	7.4	55	7.5	9.4
60	9.6	7.5	60	8.1	10.3
65	10.1	8.7	65	8.7	10.7
70	10.7	9.5	70	9.6	11.3
75	11.5	10.0	75	10.1	11.6
80	12.3	10.7	80	10.7	12.7
85	13.4	11.5	85	11.5	13.5
87.44	13.6	12.6	90	12.3	14.4
--	--	--	95	13.4	15.5
--	--	--	99	13.6	16.7
Total	**13.6**	**12.6**	**--**	**13.6**	**16.7**
Seeding Interval (LND)*	**1.0***	**--**	**--**	**--**	**3.2***

(LND)* - Leaf number difference

The R, A and B lines flowered after emergence of 16.70 leaves 13.60 leaves and 12.60 leaves, respectively. The leaf number difference between A and B lines was 1.0 leaf for 50 % flowering. The leaf number difference between A and R lines was 3.2 leaves. Therefore, B line should be sown after emergence of 1.0 leaf of A line for synchronization between A and B lines while, A line should be seeded after emergence of 3.2 leaves of R line for better synchronization between A and R lines (**Table 2**). The leaf number of IR 58025A observed was 15.3 leaves for 50 % flowering at Hyderabad (Anonymous, 2003).

The perfect synchronization of flowering between A line and B line of Sahyadri 3 rice hybrid can be achieved by sowing A line 3 days before second date of sowing B line, and sowing of B line after emergence of 1.0 leaf of A line and when A line reaches its EAT 76.30^{0}C. Similarly, the synchronization between A and R lines of Sahyadri 3 rice

hybrid can be achieved by sowing A line 12 days after second date of sowing of R line, after emergence of 3.2 leaves of R line and when R line reaches EAT 330.38^{0}C. This model of phenology may be exploited for perfect synchronization between parental lines in commercial seed production of Sahyadri 3 rice hybrid.

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