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Ajay Kumar
Seed Technology Section, ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh, India

RDS Yadav
Professor and Head, Department of Genetics and Plant Breeding, ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh, India

Pankaj Kumar
Assistant Professor, J.J.T.U., Jhunjhunu, Rajasthan, India

Corresponding Author:
Ajay Kumar
Seed Technology Section, ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh, India

Standardization of seeding schedule of parental lines of hybrid rice for perfect synchronization

Ajay Kumar, RDS Yadav and Pankaj Kumar

Abstract
A field experiment was carried out at Instructional Farm of Acharya Narendra Dev University of Agriculture and Technology Kumarganj, Ayodhya, U.P, India during kharif 2015 and 2017 to study the flowering behaviour and leaf growth pattern with a view to develop a technique for attaining perfect synchronization between the parental lines *i.e.* IR58025-A (CMS line), IR58025-B (maintainer line) and NDR 3026-3-1R (restorer line) of a promising hybrid rice NDRH2. Based on the results, it is concluded that, the synchronization of flowering between IR58025-A and IR58025-B could be obtained if second seeding of maintainer line is done on 5 days after seeding of CMS line under A×B system. Whereas, three staggered seeding is done in restorer line as; the second seedling of restorer line was done on 4th day and third seeding on 7th day from its first seeding under A×R system which is earlier to 9, 12 and 15 days seeding of CMS line were appropriate for attaining perfect synchronization between three line approach system (A,B and R) in hybrid rice seed production technology.

Keywords: Parental lines, flowering behaviour, synchronization, hybrid rice

Introduction
Synchronization of flowering between the parental lines of hybrid considers greater importance. Seed set on female parent depends on the amount of pollen supplied from the male parent during flowering period. Failure to obtain proper synchronization is the most commonly experienced problem in hybrid seed production, resulting in very poor or no seed set results at all. The knowledge on flowering behaviour of the parental lines which varies with locations and seasons is very much essential to know the exact difference in days to flowering between the parents. If the flowering gap is more, the problem of non-synchronization could be overcome by staggered sowing of male parent based on the information on days to flowering at each location and season (N.K. Biradarpatil *et al*., 2006) [3]. Some, time in spite of adjusting the sowing date, the parents do not flower at a time because of the differential response of the parents to the change in environmental conditions. Therefore, it is essential to adjust the flowering of parental lines after observing the difference at primordial development stage. If the difference in flowering is marginal, it can be manipulated to some extent by the application of gibberellic acid, urea, phosphorus etc. (Halaswamy *et al*., 1997) [1]. Since, the parents of each hybrid behave differently for flowering at different locations, there is need to take up studies to findout effectiveness of different techniques to achieve synchronization in flowering. With this back ground, the present investigation was carried out for staggered sowing of parental lines to know the flowering behaviour of parents and to find out the perfect synchronization for enhancing the seed set and seed yield in NDRH2.

Materials and Methods
The present investigation was carried out at Instructional Farm of Acharya Narendra Deva University of Agriculture & Technology Narendra Nagar (Kumarganj), Ayodhya during *Kharif* season 2015-2017. Geographically this place is situated at latitude 26.54^{0}N and longitude 81.83^{0}E and an altitude of 113 meter above the sea level. The Experimental materials consisted the parental lines of rice hybrid NDRH 2; wild abortive CMS line (IR58025A) along with its maintainer (IR58025B) in CMS multiplication and same CMS line with a restorer (NDR 3026-3-1). The nature of CMS line is wild abortive (WA) type, developed at IRRI, Manila, Philippine, which is used as female parent and the duration of its maturity is 110-115 days. Maintainer line (IR58025B) is an isogenic line of IR58025A but matured comparatively earlier to its A line. A promising fertility restorer *viz.* NDR3026-3-1, developed at ANDUA&T Kumarganj, Ayodhya having medium duration (120-125 days).

Healthy and uniform seeds of each line were presoaked in water over night and thereafter kept in shadow covered with wetted gunny bags to get seeds sprouted and broadcasted uniformly in well prepared wet nursery beds during *kharif* 2015. 21 days old seedlings were transplanted in ten rows at 5 meter row length in 30×15 cm spacing and noted flowering behaviour of each line. Based on the differences for days to 50 per cent flowering between the parental lines, the seeding intervals were obtained for A×B and A×R systems and seedings were done accordingly for *kharif* 2017. For recording the leaf number, 10 seedlings exhibiting almost uniform features just after emergence from plumule were marked by permanent marker in nursery and counted total number of leaves till the emergence of flag leaf at three days interval. On the basis of differences for leaf number between the parental lines, seeding intervals were done for *kharif* 2017 alongwith a complete set of experiment comprising these parental lines for recording the same observations as conducted in previous year. Synchronization behaviour between parental lines (A×B & A×R) planted on the basis of leaf growth rate were critically observed. in variably, seeding were prepared during first week of June every year and 21-25 days old seedings were transplanted by accommodating single seedling per hill in a planting ratio of 2:10 for A×B system and 2:12 for A×R system, in 2.65m×2.00m plot size for maintenance of CMS line (A×B) and 2.95m×2.00m for hybrid seed production (A×R) with the spacing (row and plant), row to row-male×male:30cm, male×female:20cm, female×female:15cm and plant to plant:10cm adopted perpendicular to wind direction in a randomized block design with three replications for both years. Fertilizers (NPK/ha) at the rate of 120: 60: 40 and 25 Kg/ha $ZnSO_4$ were applied at proper stages of crops. Foliar spray is applied at panicle initiation stage GA_3 60, 90 and 120 g/ha, DAP 1%, 2% and 3%, Boric acid 0.1%, 0.2%and 0.3% alone and in combinations over female lines of A×B and A×R systems. An isolation distance kept for 400m from the adjoining rice experimental plots and nearby grown rice fields to avoid genetic contaminations and physical admixture of seed. Other agronomical practices such as weeding, rouging, plant protection measures and supplementary pollination were followed time to time to raise an ideal crop.

Results and Discussion

Synchronization of flowering in hybrid seed production means that both the male and female parents come to flower at the same time, even though they differ in their growth duration. It is quite common that the parental lines of hybrids generally differ in their growth duration. It is rare to find the parental lines having the same growth duration. It is observed that in some cases, the extent of heterosis is quite higher when the parents differ significantly in their growth duration. In China, the difference in growth duration of some parental lines is more that 35 days. But for successful seed production, it is desirable that the difference in growth duration of parental lines is not more than 15 days. Besides, the synchronization in flowering date, synchronized anthesis is also equally important to ensure higher seed yields.

For better synchronization, we generally accord that the male and female parents should come to flowering at the same time. But in field, it is desirable if the female parent flowers a day or two days earlier than the male parent. This is because the stigma remains receptive 2-3 days after flowering so that it can receive pollens from the male parent even later. On the other hand, if male parent flower early, it sheds pollen and by the time the female parent comes to flower, most of the pollen are become either unviable or shed. Male parent coming to flowering much earlier than female parent is not an acceptable signal which should be avoided. Failure to obtain good synchronization may result in very low or no seed yield at all as the seed set on female parent, to a great extent depend upon the pollen supplied from the male parent. Hence, it is aptly said "half the success is achieved if one is able to get perfect synchronization in flowering between parental lines".

Synchronization in flowering can easily be obtained by sowing and planting on the same day if parents have the same growth duration. But in other cases, if the parents are sown on the same day, they do not synchronize. When the parents differ in their growth duration, synchronization can be obtained by sowing the parental seed on different dates so as to come ensure that their flowering coincides perfectly. This is called staggered or differential sowing or seeding and it is the primary strategy to obtain synchronization in flowering.

When the parents are sown on the same day, they take different days for flowering. This difference in growth duration is called as seeding interval. It is necessary to precisely determine the seeding intervals between the parental lines before embarking on large-scale seed production. Seeding intervals can be determined by the three methods as growth duration differences, leaf number difference and effective accumulated temperature. The growth duration difference method is simple and most popular method for determining seeding interval used by the breeder as he has to deal in the several cross combinations. It is widely followed by the commercial seed growers. In this method, the seeding interval is calculated between the two parental lines in respect of number of days taken by them from date of sowing to date of flowering (initial or 50 per cent flowering). After determining the seeding interval, as a general rule, in the initial years, R-line is seeded two or three times at an interval of 3-4 days to ensure the supply of pollens from male parent to female parent for a longer period during flowering, while the A-line is selected only once at a seeding calculated from the second date of R-line sowing.

Accordingly, in the present investigation, the staggered seeding of NDR 3026-3-1 were determined. The second seeding of NDR 3026-3-1 was done on 4th day and third seeding on 7th day from its first seeding under A×R system. Besides, in the case of A×B system, the second seeding of IR 58025 B was done on 5th day from seeding of IR 58025 A line. Almost similar trend for obtaining good synchronization flowering between male and female parents of various hybrid combinations had also been reported earlier by several researchers (Viraktamath *et al*., 1998; Virmani, 1993; Xu and Li, 1998; Yadav 2008 *et al.;* Yadav *et al*., 1988; 2002; Vitor *et al*., 2014; Halaswamy *et al*., 1997 and Lingaraju *et al*., 1996) [4, 5, 7, 8, 6. 1, 2].

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Table 1: Flowering behaviour and floral traits of parental lines of hybrid rice NDRH2.

S.no.	Parameter	Parental line								
		CMS line (IR 58025 A)			Maintainer line (IR 58025 B)			Restorer (NDR 3026-3-1)		
		2015	2017	Mean	2015	2017	Mean	2015	2017	Mean
1.	Leaf numbers	18.68	19.34	19.01	18.05	18.32	18.19	22.82	23.36	23.09
2.	Plant height (cm)	86.59	87.29	86.94	90.21	91.65	90.93	112.53	113.74	113.14
3.	Days to 50%heading	84.63	83.30	83.97	83.76	82.85	83.31	98.12	99.36	98.74
4.	Panicle exsertion (%)	88.84	89.36	89.10	100.00	100.00	100.00	100.00	100.00	100.00
5.	Panicle length(cm)	21.23	21.50	21.37	19.12	20.25	19.69	23.27	23.86	23.57
6.	Seed set (%)	28.42	29.01	28.72	100.00	100.00	100.00	100.00	100.00	100.00

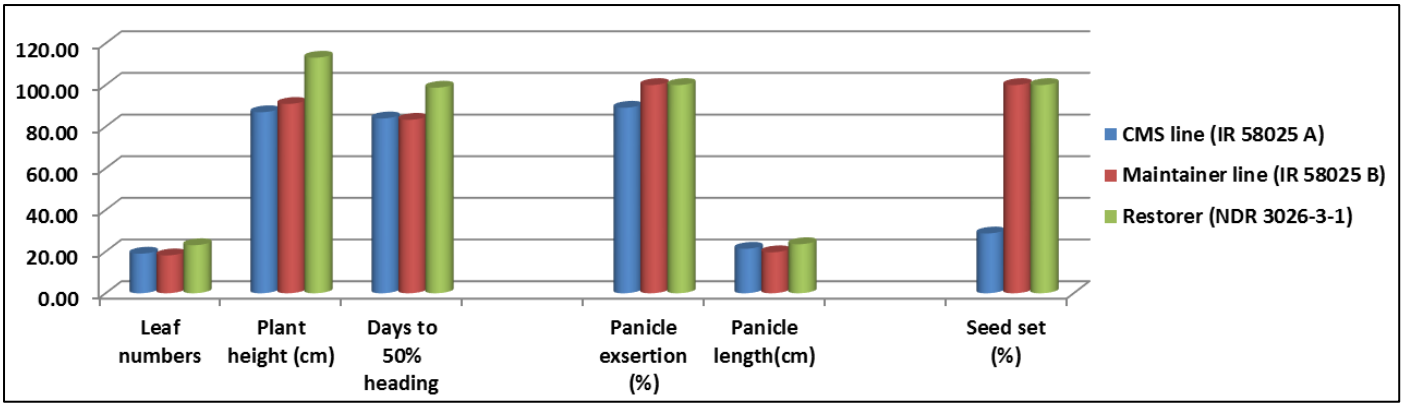

Fig 1: CMS line maintainer and restorer

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