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Research Article

STUDIES ON EFFECT OF SEEDING INTERVAL, PLANTING RATIO AND SUPPLEMENTARY POLLINATION ON HYBRID RICE (PRH-10) SEED PRODUCTION

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Abstract: The present experiments were conducted during *Kharif* 2017 & 2018 for rice hybrid seed production of PRH-10 at Sabour condition. The successful development and use of hybrid rice production technology is prerequisite to exploit its benefit across the rice growing agro climatic regions. It was reported that the production technology of hybrid seed is very much influenced by the provenance. The parental line *i.e.*, seed parent Pusa 6A and pollen parent PRR78 significantly differ in growth duration difference based on 50 percent flowering. The parental line sown with ten days seeding interval was found most synchronized in flowering. Application of GA_3 was having significantly and positive effect on enhancing the panicle exertion alone or in combination with flag leaf clipping. For achieving maximum hybrid seed yield per ha planting ratio 2:8 and application of GA_3 in combination with flag leaf clipping and supplementary pollination (rope pulling) is best in sabour (Bihar) condition.

Keywords: *Staggered Sowing, Planting ratio, Supplementary Pollination & Hybrid*

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Introduction

Rice (*Oryza sativa* L.), (2n=24) is one of the major staple food crops in the world which are cultivated in India around 43 mha, out of which 2.6 mha area is covered under hybrid rice. In Bihar, 15 percent of total acreage under rice is covered by hybrid rice [1]. But due to limited research work on synchronization of flowering in parental lines keeping in view of local environmental conditions, seed production of hybrid rice in the state is a challenging task. Hybrid rice have the potential to increase productivity 15-20 percent over inbreed varieties. The successful development and use of hybrid rice production technology is prerequisite to exploit its benefit across the rice growing agro climatic regions. It was reported that the production technology of hybrid seed is very much influenced by the provenance. That why this technology is need to be redefined in environments for better synchronization of seed parent and pollen parent of each hybrid. Keeping in view of above, the present studies was conducted at BAC, Farm, sabour, during *Kharif* 2017-18, to achieve synchronization between parental lines; know the effect of staggered sowing (seeding interval), supplementary pollination with rope pulling along with application of GA_3 and flag leaf clipping; and planting ratio for hybrid seed production of Pusa Rice Hybrid-10 (PRH-10).

Materials and Methods

The seeding interval of parental lines *i.e.* pollen parent PRR 78 and seed parent Pusa 6A, was determined by growth duration difference method (GDD) during *kharif* 2017 and in next *Kharif* season staggered sowing of pollen parent PRR 78 with four different seeding interval (15 day, 10 days, 05 days and 0 days) were transplanted with seed parent Pusa 6A in split plot design in two planting ratio (2:6; 2:8) and five treatments combination (Control, Rope pulling; Rope pulling plus GA_3 (60ppm); Rope pulling plus flag leaf clipping; Rope pulling plus GA_3 (60ppm) along with flag leaf clipping).

Rope pulling

Rice is a self-pollinated crop and hence there is need for supplementary pollination for enhancing out crossing. This was done with the help of rope pulling in all DOS. The male parent was shaken at on half hour interval at peak anthesis time between 9.30 am to 11.30 a.m.

Gibberellic acid (GA_3)

GA_3 powder of high media company (HMC) was bought. Its name was RM9157 with molecular weight of 346.37. Spray of GA_3 was done when 5 % of tillers had started heading and it was done during evening. GA_3 (60 ppm) was applied at the rate of 30 gm per ha. Out of total quantity of GA_3, 40 percent sprayed on first day and remaining 60 percent on next day.

Flag leaf clipping

Flag leaf was clipped when primary tillers are at booting stage. This will enhance uniform pollen movement and wide dispersal of pollen grains to give higher seed set.

Observation

Days to 50 percent flowering

The number of days taken from sowing to 50 percent of the plants in the plot to flower was recorded as days to 50 percent flowering.

Panicle exertion percentage

Panicle exertion percentage is calculated using formula:

Panicle exertion (%) = (Length of exerted panicle/Total length of panicle) × 100.

Table-1 *Mean growth duration difference (GDD) of Seed Parent and Pollen Parent for three different date of sowing in nursery during Kharif 2017*

Sowing Date	Days to 50 % Flowering			GDD of R & A line
	A Line	R Line	Mean	
25-Jun-17	81	91	86	10
30-Jun-17	81.66	90	85.83	8.34
05-Jul-17	80.67	90.33	85.5	9.66
Mean	81.11	90.44		
CD (P=0.05)				
Line 1.16; Planting Date NS; Line x Planting Date NS				

Table-2 *Effect of treatments and staggered sowing on days to 50% flowering of seed parent and pollen parent*

Treatments	Days to 50% flowering									
	Seed Parent (Pusa 6A)					Pollen Parent (PRR 78)				
	S1	S2	S3	S4	Mean	S1	S2	S3	S4	Mean
T_1: Control	83.17	82.5	82.17	80.17	82	90.83	90.33	91.67	90	90.71
T_2: Rope pulling	82.33	81.5	83.17	82.67	82.42	90.5	89.33	90.5	89.67	90
T_3: Rope pulling +GA_3	79	80.83	79.5	80	79.83	90.33	89.17	87.5	88.83	88.96
T_4: Rope pulling +Flag leaf clipping	82.5	81.83	80	81.33	81.42	90.17	90.67	88.5	89.33	89.67
T_5: Rope pulling+GA_3+Flag leaf clipping	80.17	79.33	79.33	80.83	79.92	89.67	89.83	86.83	89.33	88.92
Mean	81.43	81.2	80.83	81		90.3	89.87	89	89.43	
CD (P=0.05)										
T	1.08					0.71				
S	NS					0.63				
T x S	NS					1.41				

Table-3 *Effect of treatments and staggered sowing on panicle exertion of seed parent*

Treatments	Panicle Exertion (%)				
	S_1	S_2	S_3	S_4	Mean
T_1: Control	78.88	79.05	79.52	79.03	79.12
T_2: Rope pulling	79.28	78.95	80.83	80.35	79.85
T_3: Rope pulling +GA_3	92.63	93.45	92.9	92.9	92.97
T_4: Rope pulling +Flag leaf clipping	82.48	82.48	82.48	83.75	82.8
T_5: Rope pulling+GA_3+Flag leaf clipping	93.97	93.13	93.1	93.58	93.45
Mean	85.45	85.41	85.77	85.92	
CD (P=0.05)					
T	1.33				
S	NS				
T x S	NS				

Seed setting (%)

For determining the percent seed set/row, six panicles were selected randomly from each row of each plot. The filled spikelet was separated from the unfilled spikelet and was counted.

The seed set percent was calculated by using the following formula and expressed as seed set in percentage.

Seed setting (%) = (No of filled spikelet/Total number of spikelet) × 100.

Seed yield (kg/ha)

Seed harvested from seed parent (A line) was taken and yield was calculated as kg seed per ha.

Results and Discussion

The study conducted during *Kharif* 2017 for determining seeding interval, we found mean value for growth duration difference (GDD) based on days to 50% flowering for seed parent (Pusa 6A) and pollen parents (PRR 78) were 81.11 and 90.44 respectively. The mean difference between 50% flowering of pollen parent and seed parent was 9.33 days. It indicates that pollen parent takes approx 10 days more time to flowering than seed parent. Similar differences were also reported by Varma *et al*. (2018) [2], while working with other rice hybrid [Table-1].

During *Kharif* 2018 we have transplanted seed parent Pusa 6 A with 21 day old seedling along with various combination of male parent PRR 78 *i.e*. 36 day old seedling (15 days interval of sowing with female line), 31 days old seedling (10 days interval of sowing with female line), 26 days old seedling (05 days interval of sowing with female line) and 21 old seedling (0 days interval of sowing with female line) and found the mean growth duration difference on basis on days to 50 percent flowering was 8.54. Significant effect of staggering of pollen parent was observed on its days to 50% flowering. It was observed that when staggered sowing and transplanting of pollen parent of various seedling aged *i.e*. 36 day old seedling, 31 days old seedling, 26 days old seedling and 21 days old seedling; in crossing block with 21 days old seedling of seed parent, the range of difference in days to 50 percent flowering were 8.67, 8.17, 8.44 and 8.53 days, similar observations were reported by Madhukeshwara *et al*. (2019) [3]. The CMS lines/seed parent based on WA cytoplasm generally have imperfect panicle exertion, in which certain portion of the panicle are covered within leaf sheath. It results into no pollination and fertilization of enclosed spikelet. The seed parent Pusa 6A having WA cytoplasm facing the same problem of poor panicle exertion as reported by Thangapandian *et al*. (2018) [4]. There were several reports on application of GA_3 and flag leaf clipping for enhancing panicle exertion as reported by Rahman *et al*. (2013) [5]. Data presented in [Table-3] revealed the significant and positive effect of GA_3 application and flag leaf clipping on panicle exertion in seed parent. The panicle exertion was significantly highest in T5 (93.45 %) followed by T3 (92.97 %) and T4 (82.80 %) than control T1 (79.12 %). Suralta and Robles (2003) [6] showed that GA_3 application at 150 g/ha in two split doses at the beginning of 5-10 percent panicle initiation of the female parent population, results in increased percentage of panicle exertion from the flag leaf sheath by a maximum of around 80 percent. Seed setting percentage is one of the most yield attributing characters. In present experiment, we have found that seed seeting percent was significantly highest in T5 (18.96 %) followed by T3 (13.13 %), T4 (12.75 %), T2 (9.25 %) than control (4.21 %). There was also significant effect of staggered sowing reported. The highest seed seeting percent (15.20 %) was observed in 10 day seeding interval between pollen parent PRR 78 and seed parent Pusa 6A. Similar trend were observed on effect of treatment and staggered sowing hybrid seed per ha. The highest hybrid seed yield was reported in T5 (1113.49 kg/ha) followed by T3 (774.64 kg/ha), T3 (752.23 kg/ha), T2 (554.04 kg/ha) than control (226.74 kg/ha).

Table-4 *Effect of treatments and staggered sowing on yield of hybrid seed production*

Treatments	Seed Setting (%)					Hybrid Seed Yield (kg per ha)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
T_1: Control	4.333	6.333	4.5	1.667	4.208	234.447	337.7	250.648	84.167	226.74
T_2: Rope pulling	10	12.833	10.167	4	9.25	591.837	755.26	600.295	228.803	544.049
T_3: Rope pulling +GA_3	13.333	17.167	14.5	7.5	13.125	790.022	1,006.98	861.455	440.107	774.641
T_4: Rope pulling +Flag leaf clipping	15.667	15.833	13	6.5	12.75	925.188	940.733	761.668	381.357	752.237
T_5: Rope pulling+GA_3+Flag leaf clipping	21.5	23.833	21.333	9.167	18.958	1,263.86	1,397.61	1,254.50	538.025	1,113.50
Mean	12.967	15.2	12.7	5.767		761.071	887.656	745.713	334.492	
CD (P=0.05)										
T	0.483					28.001				
S	0.454					24.476				
T x S	0.966					56.002				

Table-4 *Effect of treatments on planting ratio on hybrid seed setting percent and yield*

Treatment	Seed Setting (%)			Hybrid Seed Yield (Kg per ha)		
	P_1	P_2	Mean	P_1	P_2	Mean
T_1: Control	4.417	4	4.208	250.453	203.028	226.74
T_2: Rope pulling	9.333	9.167	9.25	525.24	562.858	544.049
T_3: Rope pulling +GA_3	13.417	12.833	13.125	750.938	798.344	774.641
T_4: Rope pulling +Flag leaf clipping	13.25	12.25	12.75	742.688	761.786	752.237
T_5: Rope pulling+GA_3+Flag leaf clipping	19.583	18.333	18.958	1,092.62	1,134.38	1,113.50
Mean	12	11.317		672.387	692.079	
CD (P=0.05)						
T	0.483			28.001		
P	0.306			17.709		
T x P	NS			39.6		

The 10 days seeding interval between seed parent Pusa 6A and pollen parent PRR 78 gives significantly highest yield (887.65 kg/ha). Planting ratio between pollen parent and seed parent has a profound effect on hybrid seed setting and yield. In order to obtain maximum seed yield planting ratio of seed and pollen parent should be optimum. The seed setting percent was significantly higher in P1 (12.00 %) than P2 (11.31%). However, highest seed yield per ha was reported in P2 (692.07 kg/ha) than P1 (672.38 kg/ha). The effect of treatment and planting ratio was also found significant for hybrid seed yield per ha. The highest seed yield was recorded in planting ratio P2 when treatment T5 (1134.37 kg/ha) was applied followed by P1 (1092.61) with same treatment [Table-4]. Similar trend was also reported by Guzman (2001).

Conclusion

It is concluded from the above studies that for successful production of hybrid rice PRH 10 in Sabour (Bihar) conditions, sowing of pollen parent (PRR 78) should be done 9 to 10 days earlier than seed parent (Pusa 6A). The effect of application GA_3 and flag leaf clipping followed by supplementary pollination with rope pulling significantly increases the seed setting percentage. The effect of GA_3 application was significantly higher than flag leaf clipping. Seed setting percent were significantly higher in planting ratio 2:6, while increasing the planting ratio, percentage seed setting decreases. However, total seed yield per ha were recorded highest in planting ratio 2:8.

Application of research: We can achieve maximum hybrid seed yield is by adopting planting ratio of 2:8 and GA_3 application in combination with flag leaf clipping and supplementary pollination (rope pulling), which was found best in sabour (Bihar) condition.

Research Category: Seed Science and Technology

Abbreviations: S: Staggered Sowing; T: Treatment (Supplementary Pollination); S1: 15 days seeding interval between Pollen parent & Seed Parent; S2: 10 days seeding interval between Pollen parent & Seed Parent; S3: 5 days seeding interval between Pollen parent & Seed Parent S4: 0 days seeding interval between Pollen parent & Seed Parent.

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Cultivar / Variety / Breed name: Rice (*Oryza sativa* L.)

Conflict of Interest: None declared

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