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Effect of time of pollination and fruit retention on seed yield & quality of Parental Lines of cv Arka Vikram hybrid ridge gourd under Chhattisgarh plain conditions

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Abstract
The present investigation was conducted at Raipur KVK Farms IGKV Raipur during the *rabi* season of (2021-22). The experiment was planned with the view to find out efficient time of pollination and fruit retention on seed yield and quality Parental Lines of cv Arka Vikram hybrid ridge gourd. The experiment was laid out in randomized block design with six treatments, repeated four times. Treatment T_3 (Pollination done 12 hours after anthesis + retained 6 fruits) reported significantly higher seed yield per plant (g), fruit yield per vine, fruit length and highest number of seeds per plant, higher percentage of seed germination, maximum seedling length and higher value of seed vigor index. The efficient time for pollinating the stigma for hybrid seed production of ridge gourd was found 12 hours after anthesis. For pre-harvest traits, number of days recorded for earliest flowering for both staminate and pistillate flower ranged from 38.9-45.8 days and 37.8- 42.8 days after transplanting. Treatment T_3(Pollination done 12 hours after anthesis + retained 6 fruits) and T_4 (Pollination done 12 hours after anthesis + retained 10 fruits) recorded early setting of fruits and highest fruit set percentage as compared to other treatments. The pollination done 12 hour after anthesis + retained 6 fruits recorded good quality hybrid seed of ridge gourd.

Keywords: Ridge gourd, pollination, efficient time of pollination, fruits retained, seed yield, seed quality

1. Introduction
RIDGE GOURD (*Luffa acutangula* L.) is a cross pollinated crop with diploid chromosome number (2n=26) and is native to India (Muthaiah *et al*., 2017) [14]. Ridge Gourd belongs to cucurbitaceae family, cucurbit is a large group of vegetable comprises of 118 genera and 825 species and share about 5.6 per cent of total vegetable produced throughout India (Rathore *et al.*, 2017). The cultivated area of Ridge gourd in India is approximately 24,800 acres and the total production is 3,16,925 tonnes with an average yield of 39 tonnes per hectare (Anon., 2019) [1]. Among the Asian countries, Thailand exports ridge gourd to Western Europe more than any other Asian country. In Chhattisgarh the area under ridge Gourd cultivation is 2949 ha with the production of 25978 MT and the productivity is of 8.8 MT/ha as per data collected by the Directorate of Horticulture and Farm Forestry (Department of Agriculture, Government of Chhattisgarh 2018-19).

Ridge gourds are high in dietary fibre, water content, vitamin A, vitamin C, iron, magnesium, and vitamin B6, among other nutrients. They have a minimal calorie, saturated fat, and cholesterol content by nature. They're also high in antioxidants and alkaloid chemicals, which help the body regulate metabolism and expel toxins. Because of its high moisture content, mineral (P, Zn), Vitamins & Carotenoids content, and low calorific value, it is classified as "diet food vegetable." It's a blood purifier with anti-inflammatory, anti-diabetic, anti-cancer, and antioxidant qualities, and it's utilized for skin care and optimal excretory system function.

Local varieties of Ridge gourd are prone to insect pests and diseases, have a low response to greater doses of fertiliser, and have extremely limited adaptability to a wide range of agro-climatic conditions, resulting low yield per unit area. To meet the growing need of our country's growing population, we must enhance vegetable production and productivity per unit space and per unit time. In these circumstances, vegetable hybrids can play an important role because hybrids in the cucurbitaceous vegetable family have many advantages open pollinated

varieties, including higher yields, tolerance to biotic and abiotic stressors, and a longer shelf life. Adaptability to a wider range of agro-climatic conditions, for example. As a result, Hybrids are now also preferred by farmers over open pollinated types. Ridge gourd, being largely monoecious, is a cross-pollinated crop that allows for optimal application of hybrid vigor.

Seed performance is influenced by two inherent factors: pollination time and seed growth. The quality of seed is determined by the number of fruits on the mother plant and the time of pollination for the development of fruit. Seeds continue to develop and mature until they are retrieved from fleshy fruits (Ahmed *et al*. 1987). After gaining desiccation tolerance and maximum dry weight, the quality of seeds in fleshy fruited species improves even further (Demir and Ellis 1996). Fruit development and seed maturation can happen at different times, so seeds gathered at different times may be at different stages of development (Liu *et al*. 1997).

Fruit retention on the mother plant has a significant impact on seed production and quality. High seed setting with poor seed quality occurred from keeping more fruits on the mother plant, and vice versa. In the ridge gourd crop, the effects of fruit retention on mother plants and seed position in fruit on seed traits and performance have not been fully examined and very little study has been conducted to find out the optimum time of pollination of Ridge gourd + fruit retention on production of quality hybrid seed in Chhattisgarh as well as other parts of country.

2. Material and Methods

The experiment was conducted at farms of Raipur Krishi Vigyan Kendra, Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG), during *Rabi* season 2021-2022. Geographically the farm falls under the tropical zone of Chhattisgarh, and it is located at 21.25N latitude and 81.62E longitude at an elevation of 289 meters above mean sea level. The soil was clay loam with good drainage and adequate water holding capacity. The soil was a clay loam with appropriate water holding capacity and good drainage. Parents (Female Line IIHR-6-1-1) X (Male Line IIHR -53-1-3) in ration 4:1 were raised in Randomized Block Design (RBD), with six treatments (T_1 - (P_1F_1) Pollination just after anthesis + six crossed fruits to be retained. T_2 - (P_1F_2) Pollination just after anthesis + ten crossed fruits to be retained. T_3 - (P_2F_1) Pollination 12 hours after anthesis + six crossed fruits to be retained. T_4 - (P_2F_2) Pollination 12 hours after anthesis + ten crossed fruits to be retained. T_5 - (P_3F_1) Pollination 16 hours after anthesis + six crossed fruits to be retained. T_6 - (P_3F_2) Pollination 16 hours after anthesis + ten crossed fruits to be retained), here P is Time of Pollination and F is Fruit retention. The treatment was replicated four times. Five plants from each plot of each replication were randomly selected and marked for data recording. The mean of the data collected from five selected plants was calculated and subjected to statistical analysis. The characters studied for various seed yield and quality related traits *viz*., days taken to first male and female flower appearance, no of male and female flowers per vine, days taken to fruit set, per cent fruit set, days taken from fruit setting to maturity, number of fruits per vine, fruit length (cm), fruit girth (cm), fruit weight (g), fruit yield per vine (kg), number of seeds per crossed fruit, 1000 seed weight (g), seed yield per plant (g), per cent seed germination, seedling length (cm) and seed vigor index. Data from various parameters gathered throughout the experiment period were analysed statistically using Panse and Sukhatme's (1967) [16] method of analysis of variance.

3. Results and Discussion

3.1 Pre harvest characters

3.1.1 Days taken to first Male and Female flower appearance

First male flower appearance was in the range of 36.5 days after transplanting to 45.8 days under various treatment and differences was non-significant. Similarly, In case of female lines, Under various treatments, the first female bloom appeared between 37.8 and 42.4 days after transplantation, and differences was also non-significant. Similar results have also been reported by Akand (1993) [4] & Latif (1993) [12].

3.1.2 Number of female flowers per vine in female parental lines

Number of female flowers per vine in female parental lines increased with the advancement of crop age i.e from 45, 60, 75 to 90 days. It was also noticed that, number of female flowers recorded under different treatments were statistically non significant during all the steps of observation. In 45 days maximum number of female flower per vine i.e. (2.5) was recorded in T_1 followed by in T_6 (2.3) and in T_4 (2.2). The lowest number of female flower per vine was recorded in T_3 (1.9) followed by in T_2 (2.1) and T_5 (2.1). In 60 days there was no significant differences observed in number of female per vine where T_3 recorded highest number of female flowers per vine (7.1) and T_6 was observed lowest number of female flowers per vine (6.2). During 75 days maximum number of female flowers per vine was recorded in T_4 (11.2) and minimum number of female flowers per vine was in T_1 (8.4). It was found that in 90 days maximum number of female flowers per vine (18.0) was noticed in T_2 followed by T_5 in (17.7) and T_1 in (17.1). The minimum number of female flowers per vine was noticed in T_6 in (14.7) followed by T_3 in (16.2). This is an agreement with the findings of Murthy (2020) [13].

3.1.3 Number of male flowers per vine in female parental lines

The number of male flowers per vine in male parental lines increased as the crop age increased, i.e. 60, 75, 90, and 120 days. But statistically it was non significant, In 60 days maximum number of male flower per vine (29.0) recorded in T_2 followed by T_1 in (28.3) and T_3 in (27.5). The lowest number of male flower per vine was recorded in T_4 (24.5) followed by T_6 in (25.9) and T_5 in (26). In 75 days also there was no significant difference in number of male flower treatment per vine however T_2 recorded highest number of male flowers per vine (79.7) and T_4 observed with lowest number of male flowers per vine (64.3). During 75 days maximum number of male flowers per vine was recorded in T_2 (103.5) and minimum number of male flowers per vine was in T_4 (87.4). It was found that in 120 days maximum number of male flowers per vine (111.3) was noticed in T_5 followed by in T_2 (110.4) and T_6 in (108.6). The minimum number of male flowers per vine was noticed in T_4 (103.6) followed by in T_1 (104.8). Similar findings have been reported by Murthy (2020) [13].

3.1.4 Per cent Fruit Set

It is quite clear from the above table that the various treatment taken for study reported significant difference over percent fruit set. Pollination after 12 hours + retained 6 fruit (T_3) and Pollination after 12 hours + retained 10 fruit (T_4) observed significantly highest percentage of fruit set i.e. 84.8 and 80.9 percent respectively, followed by T_5 and T_6 *i.e.* 76.1 and 75.9 percentage respectively, over pollination just after anthesis + retained 6 fruit (T_1) and pollination just after anthesis + retained 10 fruits (T_2) which was reported lowest percentage of fruit set i.e. 70.3 and 68.4 percent respectively. Similar results have also been reported by Murthy (2020) [13].

3.1.5 Days taken from fruit setting to maturity

There were significant differences among different treatment with respect to days taken from fruit setting to maturity. The mean value from the table revealed that pollination just after anthesis + retained 6 fruits took significantly more days from fruit setting to maturity as compared to pollination after 12 and 16 hours of anthesis + retained 6 and 10 fruits. Pollination of ridgegourd after 12 and 16 hours of anthesis + retained6 and 10 fruits (T_3 T_5 $T_4$and T_6) reported significantly lowest days from fruit setting to maturity as compared to pollination just after anthesis + retained 6 and 10 fruits retained i.e. T_1 and T_2. This is an agreement with the findings of Islam (2005) [6] and Kumar (2008) [11]. Our finding are in close confirmatory with the findings of Kannan (2015) [7].

3.1.6 Number of fruits per vine

The outcome of study presented in the table revealed that the effect of different time of pollination + Number of fruits retained significantly influenced the Number of fruits per vine. It was found that Pollination after 12 hours + retained 10 fruits (T_4) and Pollination after 12 hours + retained 6 fruits (T_3) recorded significantly highest fruits per vine (6.7 and 6.0 respectively) followed by T_6 and T_5 (5.5 and 5.4 respectively) over Pollination just after anthesis + retained 6 fruits (T_1) and Pollination just after anthesis + retained 10 fruit (T_2), which produced 3.8 and 4.5 fruits per vine respectively. This is agreement with the findings of Murthy (2020) [13].

3.2 Post harvest observation

3.2.1 Fruit length (cm)

Significant differences were observed among different treatment with respect to fruit length of ridge gourd. Fruit length decreased significantly in the treatment where pollination was done just after anthesis + retained 6 and 10 fruits per plant (T_1 and T_2) i.e. Increasing time of pollination after anthesis was observed increased fruit length. The mean value from the table revealed that length of fruit was significantly highest in T_4 (57.28) and T_3 (53.87)which was pollinated 12 hours after anthesis with retention of 10 and 6 fruits followed by T_6 (52.40) and T_5 (51.40). However, significantly minimum length of fruit was observed in T_1 (41.13) and T_2 (41.77). Our findings are in close confirmatory with the findings of Kumar (2008) [11].

3.2.2 Fruit girth (cm)

The mean value from the table revealed that different pollination time + number of fruit retention exerted significant influence on fruit girth, The maximum fruit girth (14.63 cm) was recorded when pollination was carried out at 12 hours after anthesis + retained 6 fruits (T_3) followed by (T_4) (13.15 cm) T_5 (12.65) and T_6 (11.19), The minimum fruit girth (8.93 cm) was observed in T_2 i.e. pollination just after anthesis + retained 10 fruits followed by T_1 (10.10 cm). Similar results have also been reported by Kumar (2008) [11] and Hanh (2008) [5].

3.2.3 Average fruit weight (g)

It is quite clear from the table 4.3.3 that there was significant differences among different treatment with respect to Average fruit weight (g). Pollination done just after anthesis + retention of 10 and 6 fruits recorded significantly lowest Average fruit weight (207.25 g and 233.45 g respectively) as compared to the treatment where pollination was done after 12 hour of anthesis + retention of 6 fruits T_3 (325.33 g) followed by T_4 (301.88 g), T_5 (272.13 g) and T_6 (259.28 g). Our findings are in close confirmatory with the findings of Karthick (2017) [9].

3.2.4 Fruit yield per vine (Kg)

The outcome of analysis presented in table 4.3.3 indicated that the various treatment taken for study reported significant difference over fruit yield per vine. Pollination after 12 hours + retained 10 fruit (T_4) and Pollination after 16 hours + retained 10 fruits (T_6) observed significantly highest Fruit yield per vine i.e. 3.43 kg and 2.93 kg, respectively followed by T_3 (2.71 kg) and T_5 (2.42 kg) as compared to treatment where Pollination was done just after anthesis + retained 10 fruit (T_2) and Pollination was done just after anthesis + retained 6 fruit (T_1) i.e. 2.20 kg and 1.33 kg fruit yield per vine respectively. This is an agreement with the findings of Karthick (2017) [9].

3.2.5 Number of seeds per crossed fruit

The mean value from the table revealed that different pollination time exerted their significant influence on Number of seeds per crossed fruit. The maximum Number of seeds per crossed fruit (79.26) was recorded when pollination was done in 12 hours after anthesis + retained 10 fruits (T_4) followed by T_3 (76.18), T_6 (76.11) and T_5 (68.79) over other treatments. The significantly Lowest Number of seeds per crossed fruit (40.98) was observed in (T_1) pollination just after anthesis + retained 6 fruits, followed by T_2 (44.24). Similar results were also obtained by Kannan (2015) [7].

3.2.6 1000 seed weight (g)

It is obvious from the table that there were significant differences in different treatments on 1000 seed weight. Pollination 12 hours after anthesis + retaining 6 fruits (T_3) produced significantly maximum 1000 seed weight i.e. 117.6 g followed by Pollination 12 hours after anthesis + retaining 10 fruits i.e. 109.7 g 1000 seed weight, (112.5 g) in T_5 and (98.4 g) in T_6 over T_1 and T_2. The significantly lowest number of 1000 seed weight was recorded in the treatment where pollination was done just after anthesis + retention of 10 fruits (84.2 g) followed by treatment where in pollination was done just after anthesis + retention of 6 fruits (91 g).

3.2.7 Seed yield per plant (g)

Pollination after 12 hours + retained 10 fruit (T_4) produced significantly maximum seed yield per plant (185.98 g) followed by Pollination after 16 hours + retained 10 fruit (T_6) (172.98 g), T_3 and T_5 (162.43 g and 152.58 g) over T_1 and T_2. The significantly lowest amount of seed yield per plant was

produced in the treatment T_1 where in Pollination was done just after anthesis + retained 6 fruit (117.33 g) and T_2 where in Pollination was done just after anthesis + retaining 10 fruit (128.23 g). Our results fall in line with the report of Kalyanrao (2012) in Bottlegourd.

3.3 Quality parameter

3.3.1 Per cent seed germination

It is quite clear from the table that the effect of different time of pollination + number of fruits retained significantly influenced the Percentage of seed germination. Pollination after 12 hours + retained 6 fruit (T_3) and Pollination after 12 hours + retained 10 fruit (T_4) resulted maximum percentage of seed germination i.e. 93.25 and 89.75 respectively followed by T_5 (84.50) and T_6 (81) over Pollination done just after anthesis + retained 6 fruit (T_1) recorded 80.5 percent of seed germination, followed by T_2 (75.00 Percent). Similar results also reported by Abinaya (2020) [3].

3.3.2 Seed vigor index

The outcome of analysis presented in table 4.4.1 indicated that seed vigor index was significantly influenced by different time of pollination and number of crossed fruits retained. Significantly maximum seed vigor index was found in treatment where crop was Pollinated 12 hours after anthesis and retained 6 fruits T_3 (2769.01) followed by Pollination 12 hours after anthesis and retained 10 fruits T_4 (2532.05), Pollination 16 hours after anthesis and retained 6 fruits i.e. T_5 (2376.30) and Pollination 16 hours after anthesis and retained 10 fruits i.e. T_6 (2144.90). Significantly Lowest seed vigor index 1831.18 was observed in T_2 where Pollination was done just after anthesis and retained 10 fruits followed by T_1 1971.35.

3.3.3 Seedling length (cm)

It is obvious from the table that in general seedling length increased with the advancement of seedling age. In 20days significant maximum seedling length (36.90 cm) was recorded in T_3 followed by T_4 (34.35 cm) T_5 (33.70 cm) and T_6 (31.43 cm). The lowest seedling length (26.23 cm) was found in T_2 followed by T_1 (28.83 cm).

Table 1: Mean performance study of No of female & male flowers per vine in ridge gourd.

Treatment	No of female flowers per vine	No of female flowers per vine	No of female flowers per vine	No of female flowers per vine	No of male flowers per vine	No of male flowers per vine	No of male flowers per vine	No of male flowers per vine
	45 Days (Mean)	60 Days (Mean)	75 Days (Mean)	90 Days (Mean)	60 Days (Mean)	75 Days (Mean)	90 Days (Mean)	120 Days (Mean)
T_1 (P_1F_1)	2.5	6.8	8.4	17.1	28.3	71.8	92.1	104.8
T_2 (P_1F_2)	2.1	6.7	8.6	18	29	79.7	103.5	110.4
T_3 (P_2F_1)	1.9	7.1	9.2	16.2	27.5	68.8	91.7	105.6
T_4 (P_2F_2)	2.2	6.9	11.2	17	24.5	64.3	87.4	103.6
T_5 (P_3F_1)	2.1	6.3	8.5	17.7	26	66.1	99.3	111.3
T_6 (P_3F_2)	2.3	6.2	9.2	14.7	25.9	72.2	90.8	108.6
S.Em±	0.2	0.71	1	1.4	2.5	7.2	5.5	4.36
CV %	18.7	21.26	21.6	16.4	18.3	20.5	11.7	8.15
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Mean performance study of pre harvest observation on seed yield and seed quality of ridge gourd.

Treatments	1st female flower appearance	1st male flower appearance	Days taken to Fruit Set	Per cent Fruit Set	Days taken from fruit setting to maturity	No of fruits per vine
T_1 (P_1F_1)	37.8	40.2	3.5	70.3	72.9	3.8
T_2 (P_1F_2)	40.2	37.9	3.4	68.4	69.33	4.5
T_3 (P_2F_1)	38.2	42.9	1.9	84.8	57.23	6
T_4 (P_2F_2)	42.4	36.5	2.17	80.9	61.63	6.7
T_5 (P_3F_1)	39.9	44.7	2.57	76.1	60.68	5.4
T_6 (P_3F_2)	39.7	45.8	2.97	75.9	63.15	5.5
S.Em±	2.14	2.37	0.24	4.27	3.23	0.32
CV (%)	10.77	11.34	17.65	18.73	10.07	12.03
CD at 5%	NS	NS	0.74	12.4	9.74	0.96

Table 3: Mean performance study of post-harvest observation on seed yield and seed quality of ridge gourd.

Treatment	Fruit Length (cm)	Fruit Girth (cm)	Avg. fruit wt (g)	Fruit yield per vine (kg)	Seeds per crossed fruits	1000 seed wt (g)	Seed yield per plant (g)
T_1 (P_1F_1)	41.13	10.1	233.45	1.33	40.98	91	117.33
T_2 (P_1F_2)	41.77	8.93	207.25	2.2	44.24	84.2	128.23
T_3 (P_2F_1)	53.87	14.63	325.33	2.71	76.18	117.6	162.43
T_4 (P_2F_2)	57.28	13.15	301.88	3.43	79.26	109.7	185.98
T_5 (P_3F_1)	51.4	12.65	272.13	2.42	68.79	112.5	152.58
T_6 (P_3F_2)	52.4	11.19	259.28	2.93	76.11	98.4	172.98
S.Em±	2.43	0.74	14.68	0.12	3.28	2.75	15.2
CV (%)	9.8	20.91	18.36	15.72	10.23	8.98	19.83
CD at 5%	7.33	2.14	42.59	0.34	9.89	7.99	45.81

Table 4: Mean performance study of seed quality parameter observation on seed yield and seed quality of ridge gourd.

Treatment	Seed vigor index	Percent seed germination	Seedling Length (cm)
T_1 (P_1F_1)	1971.35	80.5	28.83
T_2 (P_1F_2)	1831.18	75	26.23
T_3 (P_2F_1)	2769.01	93.25	36.9
T_4 (P_2F_2)	2532.05	89.75	34.35
T_5 (P_3F_1)	2376.3	84.5	33.7
T_6 (P_3F_2)	2144.9	81	31.43
S.Em±	102.64	3.87	1.26
CV (%)	15.07	9.21	13.17
CD at 5%	297.84	11.66	3.66

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