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Effect of day of emasculation, time of pollination and crossing ratio on seed quality of brinjal hybrid (*Solanum melongena* L.)

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Abstract
The present study entitled "Effect of day of emasculation, time of pollination and crossing ratio on seed quality of brinjal hybrid" was conducted in laboratory using the fresh seed harvested from the field experiment using Completely Randomized Design (Factorial) repeated thrice in laboratory of Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh during 2019. The study consisted of 18 treatment combinations involving two emasculation days *viz.*, E_1: Same day of emasculation, and E_2: Previous day of emasculation; three pollination times *viz.*, T_1: Pollination between 8:00 am to 9:00 am, T_2: Pollination between 9:00 am and 10:00 am, and T_3: Pollination between 10:00 to 11:00 am; and three crossing ratios *viz.*, P_1: Two female buds pollinated per male flower, P_2: Four female buds pollinated per male flower, and P_3: Six female buds pollinated per male flower. The previous day of emasculation (E_2) produced significantly the higher seed germination (88.48%), seedling vigour index I (493.29) and seedling vigour index II (1058.64). Likewise, pollination during 9.00 am to 10.00 am (T_2) recorded significantly more seed germination (86.56%), seedling vigour index I (476.38) and seedling vigour index II (1023.76), while crossing of four female flowers with one male flower (4:1 crossing ratio) (P_2) recorded significantly higher seed germination (85.67%), seedling vigour index I (468.05) and seedling vigour index II (1013.37). The higher seed germination (94.33%), seedling vigour index I (556.47) and seedling vigour index II (1160.04) were recorded in $E_2T_2P_2$ (four female buds pollinated per male flower in previous day of emasculation during 9.00 to 10.00 am).

Keywords: Brinjal, crossing ratio, day of emasculation, time of pollination, seed quality

Introduction
In India, brinjal hybrids are becoming more popular with farmers and consumers owing to their earliness, high yielding potentiality, and superior colour, shape and taste of fruits. In India, the first attempt to hybridize eggplant have been made by Rao (1934) [12], however, in the cross between two wide varieties, a high degree of partial sterility due to abortive pollen was observed. However, commercial exploitation of heterosis in brinjal has resulted in increase of fruit yield per plant (Reddy and Patel, 2014) [13] and also enhanced adaptation to variable agro climate and better resistance to biotic stresses. The most commonly used method for hybrid seed production of brinjal is seed to seed. Most productive and desirable hybrid seed can be obtained from the female parent when there is a perfect coincidence of stigma receptivity with pollen viability of male parent. In brinjal, both anthesis and anther dehiscence are influenced by day light, temperature, humidity and cultivar difference. The amount of F_1 hybrid seed is also decided by the quantity of the male pollens depositing on the receptive stigma of the female parent. In case, if more pollen is deposited on the stigma, there may be more chances of poor seed setting due to competition between germinating pollens. Similar is the case with deposition of inadequate viable pollens. Therefore, time of pollination and ratio between female: male flower crossing is to be optimized to get increased seed set and yield in hybrid brinjal. However, research work pertaining to day of emasculation, tome of pollination and crossing ratio between male and female flowers on seed quality after harvesting is very scantly and in conclusive. Hence, the present study was conducted by using the fresh hybrid seed harvested from field experiment conducted in the field for the same aspects and studied its effects on seed quality of brinjal hybrid, GKBH 4.

Materials and Methods
The laboratory study was made by using the fresh seed harvested from the field experiment in the Department of Seed Science and Technology, College of Agriculture, Junagadh

Agricultural University, Junagadh during 2019. The study consisted of 18 treatment combinations involving two emasculation days *viz*., E_1: Same day of emasculation, and E_2: Previous day of emasculation; three pollination times *viz.*, T_1: Pollination between 8:00 am to 9:00 am, T_2: Pollination between 9:00 am and 10:00 am, and T_3: Pollination between 10:00 to 11:00 am; and three crossing ratios *viz.*, P_1: Two female buds pollinated per male flower, P_2: Four female buds pollinated per male flower, and P_3: Six female buds pollinated per male flower. The experiment was conducted using Completely Randomized Design (Factorial) repeated thrice as per the method suggested by Cochran and Cox (1957) [4] using *cv.* Gujarat Junagadh Brinjal Hybrid 4 (GJBH 4). The observations were recorded on random sample of seeds harvested in field from each treatment combinations were brought to the laboratory for analyzing seed quality parameters *viz*., germination percentage, root length (cm), shoot length (cm), seedling length (cm), seedling fresh weight (mg), seedling dry weight (mg), seedling vigour index I (length) and seedling vigour index II (mass). Seedling vigour index in terms of length and mass were determined as per formulae given by Abdul-Baki and Anderson (1973) [1].

Results and Discussion

Germination percentage

Significant variation was noted for germination percentage among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 1). The pollination done on previous day of emasculation (E_2) produced significantly the higher germination percentage (88.48%). It might be due to that, at that time, stigma was capable of receiving pollen and ovules were fully ripe and resulted in higher fruit weight, fruit length and more number of seeds per fruit with higher test weight and germination percentage. Similar results are earlier reported by Patta *et al.* (2015) [10] in tomato and Priya *et al*. (2009) [11] in chilli. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher germination percentage (86.56%) and it was at par with pollination between 10:00 to 11:00 am (T_3) (85.56%). Significantly the lower germination percentage (76.00%) was recorded in pollination during 8.00 to 9.00 am (T_1). Optimum environmental condition, pollen viability and stigma receptivity have caused good fertilization and seed formation, that's resulted into higher seed weight per fruit, test weight and germination. The results are in agreements with reports of Patil *et al.* (2008) [8], Korat *et al*. (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Yogeesha *et al.* (1999) [16], Jolli (2004) [6] and Kumar *et al.* (2008) [8] in tomato; Basavaraj (2006) [3], Singh *et al.* (2010) [14] and Abhishekkatagi *et al.* (2013) [2] in okra; and Priya *et al*. (2009) [11] in chilli. Significantly the higher germination percentage (85.67%) produced when four female flower buds pollinated per male flower (P_2) and it was at par with two female flower buds pollinated per male flower (P_1) (84.78%). Significantly the lowest germination percentage (77.67%) was noted when six female flower buds pollinated per male flower (P_3). An increase in germination percentage in the crossing ratio of 2:1 or 4:1 (two or four female flower buds pollinated per male flower) might be due to sufficient availability of pollen and optimum environmental condition lead to complete fertilization and formation of seed of all the ovules present in the ovary results into higher seed weight per fruit, test weight and germination. These findings are similar to the findings of Patil *et al.* (2008) [9] and Korat *et al.* (2018) [7] in brinjal, Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3] and Gowda *et al.* (2017) [5] in okra.

Interaction effect of day of emasculation and time of pollination, time of pollination and female to male flower crossing ratio and day of emasculation and female to male flower crossing ratio on germination percentage was found non-significant (Table 1). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher germination percentage (92.22%) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (91.11%). The maximum germination percentage (89.00%) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (88.83%), while the minimum germination percentage (71.00%) was noted with (T_1P_3). These findings are in accordance with the results of Patil *et al.* (2008) [8] and Korat *et al.* (2018) [7] in brinjal and Kumar *et al.* (2008) [8] in tomato. Comparatively the higher germination percentage (91.33%) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (90.55%). Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on germination percentage was found non-significant (Table 1). On comparison, the highest germination percentage (94.33%) was recorded in $E_2T_2P_2$ (four female buds pollinated per male flower in previous day of emasculation during 9.00 to 10.00 am) followed by $E_2T_3P_2$ (94.33%) and $E_2T_2P_1$ (93.67%), while the lowest germination percentage (65.67%) was observed in $E_1T_1P_3$ (six female buds pollinated per male flower in same day of emasculation during 8.00 to 9.00 am).

Root length (cm)

The results presented in Table 1 revealed that day of emasculation, time of pollination and female to male flower crossing ratio on root length was found significant. The pollination done on previous day of emasculation (E_2) produced significantly the higher root length (3.44 cm). The maximum root length was observed with the emasculation done at previous day of pollination might be due to that, at that time, stigma was capable of receiving pollen and ovules were fully ripe and resulted in higher fruit weight, fruit length and more number of seeds per fruit with higher test weight, germination percentage and root length. Similar results are earlier reported by Priya *et al*. (2009) [11] in chilli. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher root length (3.43 cm) and it was at par with pollination between 10:00 to 11:00 am (T_3) (3.37 cm). Significantly the lower root length (3.11 cm) was recorded in pollination during 8.00 to 9.00 am (T_1). Optimum environmental condition, pollen viability and stigma receptivity have caused good fertilization and seed formation, that's resulted into higher fertilization and seed formation and ultimately the higher seed weight per fruit, test weight, germination and root length. The results are in agreements with reports of Patil *et al.* (2008) [8], Korat *et al*. (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Jolli (2004) [6] and Kumar *et al.* (2008) [8] in tomato; Basavaraj (2006) [3], Singh *et al.* (2010) [14] and Abhishekkatagi *et al.* (2013) [2] in okra; and Priya *et al*. (2009) [11] in chilli. Significantly the higher root length (3.40 cm) produced when four female flower buds pollinated per male flower (P_2) and it was at par with two

female flower buds pollinated per male flower (P_1) (3.34 cm). Significantly the lowest root length (3.18 cm) was noted when six female flower buds pollinated per male flower (P_3). An increase in root length in the crossing ratio of 2:1 or 4:1 (two or four female flower buds pollinated per male flower) might be due to sufficient availability of pollen and optimum environmental condition lead to complete fertilization and formation of seed of all the ovules present in the ovary results into higher seed weight per fruit, test weight, germination percentage and root length. These findings are similar to the findings of Patil *et al.* (2008) [8] and Korat *et al.* (2018) [7] in brinjal, Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3] and Gowda *et al.* (2017) [5] in okra.

Interaction effect of day of emasculation and time of pollination, time of pollination and female to male flower crossing ratio, day of emasculation and female to male flower crossing ratio on root length was found non-significant (Table 1). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher root length (3.56 cm) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (3.50 cm). The lower root length (2.95 cm) was recorded in pollination during 8.00 to 9.00 am on same day of emasculation (E_1T_1). The maximum root length (3.51 cm) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (3.48 cm), while the minimum root length (2.98 cm) was noted with six female flower buds pollinated per male flower at 8.00 to 9.00 am (T_1P_3). These findings are in accordance with the results of Patil *et al.* (2008) [9] and Korat *et al.* (2018) [7] in brinjal and Kumar *et al.* (2008) [8] in tomato. Comparatively the higher root length (3.53 cm) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (3.45 cm), while the lowest root length (3.02 cm) was recorded in six female flower buds pollinated per male flower on same day of emasculation (E_1P_3). Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on root length was found non-significant (Table 1). On comparison, the highest root length (3.63 cm) was recorded in $E_2T_2P_2$ (four female buds pollinated per male flower in previous day of emasculation during 9.00 to 10.00 am) followed by $E_2T_3P_2$ (3.62 cm) and $E_2T_2P_1$ (3.59 cm), while the lowest root length (2.81 cm) was observed in $E_1T_1P_3$ (six female buds pollinated per male flower in same day of emasculation during 8.00 to 9.00 am).

Shoot length (cm)

Significant variation was noted for shoot length among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 1). The pollination done on previous day of emasculation (E_2) produced significantly the higher shoot length (3.51 cm). Similar results are earlier reported by Priya *et al.* (2009) [11] in chilli. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher shoot length (3.44 cm) and it was at par with pollination between 10:00 to 11:00 am (T_3) (3.38 cm). Significantly the lower shoot length (3.13 cm) was recorded in pollination during 8.00 to 9.00 am (T_1). The results are in agreements with reports of Patil *et al.* (2008) [8], Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Jolli (2004) [6] and Kumar *et al.* (2008) [8] in tomato; Basavaraj (2006) [3], Singh *et al.* (2010) [14] and Abhishekkatagi *et al.* (2013) [2] in okra; and Priya *et al.* (2009) [11] in chilli. Significantly the higher shoot length (3.39 cm) produced when four female flower buds pollinated per male flower (P_2) and it was at par with two female flower buds pollinated per male flower (P_1) (3.36 cm). Significantly the lowest shoot length (3.19 cm) was noted when six female flower buds pollinated per male flower (P_3). These findings are similar to the findings of Patil *et al.* (2008) [9] and Korat *et al.* (2018) [7] in brinjal, Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3] and Gowda *et al.* (2017) [5] in okra.

Interaction effect of day of emasculation and time of pollination, time of pollination and female to male flower crossing ratio, day of emasculation and female to male flower crossing ratio on shoot length was found non-significant (Table 1). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher shoot length (3.62 cm) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (3.57 cm). The maximum shoot length (3.51 cm) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (3.46 cm), while the minimum shoot length (2.99 cm) was noted with six female flower buds pollinated per male flower at 8.00 to 9.00 am (T_1P_3). These findings are in accordance with the results of Patil *et al.* (2008) [8] and Korat *et al.* (2018) [7] in brinjal and Kumar *et al.* (2008) [8] in tomato. Comparatively the higher shoot length (3.58 cm) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (3.52 cm), Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on shoot length was found non-significant (Table 1). On comparison, the highest shoot length (3.67 cm) was recorded in $E_2T_2P_2$ (four female buds pollinated per male flower in previous day of emasculation during 9.00 to 10.00 am) followed by $E_2T_3P_2$ (3.66 cm) and $E_2T_2P_1$ (3.64 cm), while the lowest shoot length (2.78 cm) was observed in $E_1T_1P_3$

Seedling length (cm)

Significant variation was noted for seedling length among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 1). The pollination done on previous day of emasculation (E_2) produced significantly the higher seedling length (6.95 cm). Similar results are earlier reported by Priya *et al.* (2009) [11] in chilli. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher seedling length (6.86 cm) and it was at par with pollination between 10:00 to 11:00 am (T_3) (6.76 cm). The results are in agreements with reports of Patil *et al.* (2008) [8], Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Jolli (2004) [6] and Kumar *et al.* (2008) [8] in tomato; Basavaraj (2006) [3], Singh *et al.* (2010) [14] and Abhishekkatagi *et al.* (2013) [2] in okra; and Priya *et al.* (2009) [11] in chilli. Significantly the higher seedling length (6.79 cm) produced when four female flower buds pollinated per male flower (P_2) and it was at par with two female flower buds pollinated per male flower (P_1) (6.69 cm). Significantly the lowest seedling length (6.37 cm) was noted when six female flower buds pollinated per male flower (P_3). These findings are similar to the findings of Patil *et al.* (2008) [8] and Korat *et al.* (2018) [7] in brinjal, Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3] and Gowda *et al.* (2017) [5] in okra.

Table 1: Effect of day of emasculation, pollination time, female to male flower crossing ratio and their interaction effect on seed germination (%), root length (cm), shoot length (cm) and seedling length (cm) in brinjal

Treatments	Seed germination (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)
Day of emasculation (E)				
E_1	76.92 (61.50*)	3.17	3.12	6.29
E_2	88.48 (70.76)	3.44	3.51	6.95
S. Em±	0.30	0.02	0.02	0.03
CD at 5%	0.85	0.07	0.05	0.09
Time of pollination (T)				
T_1	76.00 (60.93)	3.11	3.13	6.24
T_2	86.56 (69.11)	3.43	3.44	6.86
T_3	85.56 (68.36)	3.37	3.38	6.76
S. Em±	0.36	0.02	0.02	0.04
CD at 5%	1.04	0.06	0.06	0.11
Female to male flower crossing ratio (P)				
P_1	84.78 (67.73)	3.34	3.36	6.69
P_2	85.67 (68.51)	3.40	3.39	6.79
P_3	77.67 (62.16)	3.18	3.19	6.37
S. Em±	0.36	0.02	0.02	0.04
CD at 5%	1.04	0.06	0.06	0.11
Day of emasculation (E) x Time of pollination (T)				
E_1T_1	69.88 (56.74)	2.95	2.92	5.88
E_1T_2	80.88 (64.18)	3.30	3.25	6.55
E_1T_3	80.00 (63.58)	3.24	3.19	6.43
E_2T_1	82.11 (65.12)	3.26	3.32	6.59
E_2T_2	92.22 (74.03)	3.56	3.62	7.17
E_2T_3	91.11 (73.12)	3.50	3.57	7.08
S. Em±	0.51	0.03	0.03	0.06
CD at 5%	NS	NS	NS	NS
Time of pollination (T) x Female to male flower crossing ratio (P)				
T_1P_1	77.83 (62.18)	3.14	3.17	6.32
T_1P_2	79.16 (63.12)	3.20	3.21	6.41
T_1P_3	71.00 (57.50)	2.98	2.99	5.97
T_2P_1	88.33 (70.60)	3.46	3.46	6.91
T_2P_2	89.00 (71.20)	3.51	3.51	7.02
T_2P_3	82.33 (65.51)	3.31	3.33	6.65
T_3P_1	88.16 (70.42)	3.40	3.43	6.84
T_3P_2	88.83 (71.20)	3.48	3.46	6.95
T_3P_3	79.66 (63.45)	3.24	3.24	6.48
S. Em±	0.63	0.04	0.03	0.07
CD at 5%	NS	NS	NS	NS

Contd....

Table 1: Contd....

Day of emasculation (E) x Female to male flower crossing ratio (P)				
E_1P_1	79.00 (62.94)	3.21	3.18	6.40
E_1P_2	80.00 (63.60)	3.26	3.21	6.47
E_1P_3	71.77 (57.96)	3.02	2.97	5.99
E_2P_1	90.55 (75.52)	3.45	3.52	6.99
E_2P_2	91.33 (73.41)	3.53	3.58	7.12
E_2P_3	83.55 (66.34)	3.33	3.41	6.74
S. Em±	0.51	0.03	0.03	0.06
CD at 5%	NS	NS	NS	NS
Day of emasculation (E) x Time of pollination (T) x Female to male flower crossing ratio (P)				
$E_1T_1P_1$	71.00 (57.43)	3.01	3.00	6.01
$E_1T_1P_2$	73.00 (58.70)	3.05	2.99	6.04
$E_1T_1P_3$	65.67 (54.10)	2.81	2.78	5.59
$E_1T_2P_1$	83.00 (65.70)	3.33	3.28	6.61
$E_1T_2P_2$	83.67 (66.17)	3.40	3.34	6.74
$E_1T_2P_3$	76.00 (60.67)	3.17	3.13	6.30
$E_1T_3P_1$	83.00 (65.70)	3.30	3.28	6.59
$E_1T_3P_2$	83.33 (65.93)	3.34	3.28	6.62
$E_1T_3P_3$	73.67 (59.13)	3.09	3.01	6.09
$E_2T_1P_1$	84.67 (66.93)	3.29	3.35	6.63
$E_2T_1P_2$	85.33 (67.53)	3.35	3.42	6.77
$E_2T_1P_3$	76.33 (60.90)	3.16	3.21	6.37
$E_2T_2P_1$	93.67 (75.50)	3.59	3.64	7.23

$E_2T_2P_2$	94.33 (76.23)	3.63	3.67	7.30
$E_2T_2P_3$	88.67 (70.37)	3.46	3.55	7.00
$E_2T_3P_1$	93.33 (75.13)	3.50	3.59	7.10
$E_2T_3P_2$	94.33 (76.47)	3.62	3.66	7.28
$E_2T_3P_3$	85.67 (67.77)	3.39	3.47	6.86
Mean	82.70 (66.13)	3.30	3.31	6.62
S. Em±	0.89	0.06	0.05	0.10
CD at 5%	NS	NS	NS	NS
CV%	2.32	3.14	2.57	2.54

Interaction effect of day of emasculation and time of pollination, time of pollination and female to male flower crossing ratio, day of emasculation and female to male flower crossing ratio on seedling length was found non-significant (Table 1). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher seedling length (7.17 cm) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (7.08 cm). The maximum seedling length (7.02 cm) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (6.95 cm). Comparatively the higher seedling length (7.12 cm) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (6.99 cm). Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on seedling length was found non-significant (Table 1). On comparison, the highest seedling length (7.30 cm) was recorded in $E_2T_2P_2$ followed by $E_2T_3P_2$ (7.28 cm) and $E_2T_2P_1$ (7.23 cm), while the lowest seedling length (5.59 cm) was observed in $E_1T_1P_3$.

Seedling fresh weight (mg)

Significant variation was recorded for seedling fresh weight among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 2). The pollination done on previous day of emasculation (E_2) produced significantly the higher seedling fresh weight (322.17 mg). The maximum seedling fresh weight was observed with the emasculation done at previous day of pollination might be due to higher germination percentage and seedling length. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher seedling fresh weight (305.75 mg) and it was at par with pollination between 10:00 to 11:00 am (T_3) (304.19 mg). Significantly the lower seedling fresh weight (286.64 mg) was recorded in pollination during 8.00 to 9.00 am (T_1). The results are in agreements with reports of Patil *et al.* (2008) [8], Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal. Significantly the higher seedling fresh weight (306.12 mg) produced when four female flower buds pollinated per male flower (P_2), while significantly the lowest seedling fresh weight (289.65 mg) was noted when six female flower buds pollinated per male flower (P_3). These findings are similar to the findings of Korat *et al.* (2018) [7] in brinjal.

Table 2: Effect of day of emasculation, pollination time, female to male flower crossing ratio and their interaction effect on seedling fresh weight (mg), seedling dry weight (mg), seedling vigour index I and seedling vigour index II in brinjal

Treatments	Seedling fresh weight (mg)	Seedling dry weight (mg)	Seedling vigour index I	Seedling vigour index II
Day of emasculation (E)				
E_1	275.54	14.36	388.33	884.03
E_2	322.17	14.95	493.29	1058.64
S. Em±	1.57	0.05	3.56	7.52
CD at 5%	4.51	0.15	10.21	21.56
Time of pollination (T)				
T_1	286.64	14.47	381.95	883.08
T_2	305.75	14.79	476.38	1023.76
T_3	304.19	14.71	464.11	1007.18
S. Em±	1.92	0.07	4.36	9.21
CD at 5%	5.52	0.19	12.51	26.41
Female to male flower crossing ratio (P)				
P_1	300.81	14.68	455.84	996.43
P_2	306.12	14.76	468.05	1013.37
P_3	289.65	14.52	398.55	904.23
S. Em±	1.92	0.07	4.36	9.21
CD at 5%	5.52	0.19	12.51	26.41
Day of emasculation (E) x Time of pollination (T)				
E_1T_1	266.43	14.11	334.07	800.98
E_1T_2	279.26	14.51	421.11	932.03
E_1T_3	280.94	14.44	409.81	919.09
E_2T_1	306.86	14.81	429.81	965.16
E_2T_2	332.23	15.05	531.64	1115.49
E_2T_3	327.43	14.96	518.41	1095.27
S. Em±	2.72	0.09	6.17	13.02
CD at 5%	NS	NS	NS	NS
Time of pollination (T) x Female to male flower crossing ratio (P)				

T_1P_1	289.44	14.48	394.57	902.54
T_1P_2	291.99	14.51	406.19	917.63
T_1P_3	278.51	14.39	345.06	829.06
T_2P_1	306.03	14.81	489.98	1047.62
T_2P_2	314.73	14.92	501.39	1064.47
T_2P_3	296.48	14.61	437.75	959.19
T_3P_1	306.96	14.73	482.95	1039.11
T_3P_2	311.65	14.83	496.55	1058.00
T_3P_3	293.96	14.55	412.82	924.43
S. Em±	3.33	0.11	7.55	15.95
CD at 5%	NS	NS	NS	NS

Contd.....

Table 2: Contd.....

Day of emasculation (E) x Female to male flower crossing ratio (P)				
E_1P_1	279.58	14.38	404.06	906.44
E_1P_2	283.74	14.43	412.51	918.54
E_1P_3	263.30	14.26	348.42	827.13
E_2P_1	322.03	14.97	507.61	1086.41
E_2P_2	328.50	15.08	523.58	1108.19
E_2P_3	315.99	14.78	448.08	981.32
S. Em±	2.72	0.09	6.17	13.02
CD at 5%	NS	NS	NS	NS
Day of emasculation (E) x Time of pollination (T) x Female to male flower crossing ratio (P)				
$E_1T_1P_1$	272.77	14.15	345.15	812.89
$E_1T_1P_2$	270.43	14.12	354.79	828.70
$E_1T_1P_3$	256.08	14.07	302.28	761.38
$E_1T_2P_1$	281.56	14.51	434.43	953.84
$E_1T_2P_2$	291.05	14.64	446.31	968.90
$E_1T_2P_3$	265.16	14.39	382.59	873.36
$E_1T_3P_1$	284.42	14.50	432.60	952.58
$E_1T_3P_2$	289.75	14.53	436.43	958.02
$E_1T_3P_3$	268.66	14.32	360.40	846.67
$E_2T_1P_1$	306.10	14.82	443.99	992.20
$E_2T_1P_2$	313.55	14.90	457.60	1006.56
$E_2T_1P_3$	300.94	14.72	387.86	896.74
$E_2T_2P_1$	330.51	15.11	545.54	1141.41
$E_2T_2P_2$	338.41	15.22	556.47	1160.04
$E_2T_2P_3$	327.80	14.84	492.92	1045.03
$E_2T_3P_1$	329.50	14.98	533.31	1125.63
$E_2T_3P_2$	333.55	15.13	556.68	1157.98
$E_2T_3P_3$	319.25	14.79	465.24	1002.19
Mean	298.86	14.65	440.81	971.34
S. Em±	4.71	0.16	10.68	22.56
CD at 5%	NS	NS	NS	NS
CV%	2.73	1.91	4.20	4.02

Interaction effect of day of emasculation and time of pollination, day of emasculation and female to male flower crossing ratio, on seedling fresh weight was found non-significant (Table 2). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher seedling fresh weight (332.23 mg) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (327.43 mg). The lower seedling fresh weight (266.43 mg) was recorded in pollination during 8.00 to 9.00 am on same day of emasculation (E_1T_1). The interaction effect of time of pollination and female to male flower crossing ratio was non-significant on seedling fresh weight (Table 2). The maximum seedling fresh weight (314.73 mg) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (311.65 mg), while the minimum seedling fresh weight (278.51 mg) was noted in T_1P_3. Comparatively the higher seedling fresh weight (328.50 mg) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (322.03 mg), while the lowest seedling fresh weight (263.30 mg) was recorded in E_1P_3. Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on seedling fresh weight was found non-significant (Table 2). On comparison, the highest seedling fresh weight (338.41 mg) was recorded in $E_2T_2P_2$ followed by $E_2T_3P_2$ (333.55 mg) and $E_2T_2P_1$ (330.51 mg), while the lowest seedling fresh weight (256.08 mg) was observed in $E_1T_1P_3$.

Seedling dry weight (mg)

Significant variation was recorded for seedling dry weight among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 2). The pollination done on previous day of emasculation (E_2) produced significantly the higher seedling dry weight (14.95 mg). These results are in agreement with reports of Priya *et*

al. (2009) [11] in chilli and Patta *et al.* (2015) [10] in tomato. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher seedling dry weight (14.79 mg) and it was at par with pollination between 10:00 to 11:00 am (T_3) (14.71 mg). Significantly the lower seedling dry weight (14.47 mg) was recorded in pollination during 8.00 to 9.00 am (T_1). The results are in agreements with reports of Patil *et al.* (2008) [9]; Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3], Singh *et al.* (2010) [14] and Abhishekkatagi *et al.* (2013) [2] in okra. Significantly the higher seedling dry weight (14.76 mg) produced when four female flower buds pollinated per male flower (P_2) and it was at par with two female flower buds pollinated per male flower (P_1) (14.68 mg). Significantly the lowest seedling dry weight (14.52 mg) was noted when six female flower buds pollinated per male flower (P_3). An increase in seedling dry weight in the crossing ratio of 2: 1 or 4:1 might be due to sufficient availability of pollen and optimum environmental condition lead to complete fertilization and formation of seed of all the ovules present in the ovary results into higher test weight, germination and seedling length and in turn higher seedling dry weight. The results are in agreements with reports of Patil *et al.* (2008) [9]; Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3], Singh *et al.* (2010) [14], Abhishekkatagi *et al.* (2013) [2] and Gowda *et al*. (2017) [5] in okra.

Interaction effect of day of emasculation and time of pollination, of time of pollination and female to male flower crossing ratio, day of emasculation and female to male flower crossing ratio on seedling dry weight was found non-significant (Table 2). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher seedling dry weight (15.05 mg) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (14.96 mg). The results obtained in the present study are in accordance with the findings of Patil *et al.* (2008) [8] and Korat *et al.* (2018) [7] in brinjal; and Kumar *et al.* (2008) [8] in tomato. The maximum seedling dry weight (14.92 mg) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (14.83 mg), while the minimum seedling dry weight (14.39 mg) was noted with six female flower buds pollinated per male flower at 8.00 to 9.00 am (T_1P_3). Comparatively the higher seedling dry weight (15.08 mg) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (14.97 mg). Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on seedling dry weight was found non-significant (Table 2). On comparison, the highest seedling dry weight (15.22 mg) was recorded in $E_2T_2P_2$ followed by $E_2T_3P_2$ (15.13 mg) and $E_2T_2P_1$ (15.11 mg), while the lowest seedling dry weight (14.07 mg) was observed in $E_1T_1P_3$.

Seedling vigour index I

Significant variation was recorded for seedling vigour index I among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 2). The pollination done on previous day of emasculation (E_2) produced significantly the higher seedling vigour index I (493.29). The maximum seedling vigour index I was observed with the emasculation done at previous day of pollination due to higher germination percentage. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher seedling vigour index I (476.38) and it was at par with pollination between 10:00 to 11:00 am (T_3) (464.11). Optimum environmental condition, pollen viability and stigma receptivity have caused good fertilization and seed formation, that's resulted into higher fertilization and seed formation and in turn higher germination and seedling vigour index I. The results are in agreements with reports of Patil *et al.* (2008) [8]; Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Jolli (2004) [6] and Kumar *et al.* (2008) [8] in tomato; Basavaraj (2006) [3], Singh *et al.* (2010) [14] and Abhishekkatagi *et al.* (2013) [2] in okra; and Priya *et al*. (2009) [11] in chilli. Significantly the higher seedling vigour index I (468.05) produced when four female flower buds pollinated per male flower (P_2), while significantly the lowest seedling vigour index I (398.55) was noted when six female flower buds pollinated per male flower (P_3). The results are in agreements with reports of Patil *et al.* (2008) [9] and Korat *et al.* (2018) [7] in brinjal; Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3] and Gowda *et al.* (2017) [5] in okra.

Interaction effect of day of emasculation and time of pollination, time of pollination and female to male flower crossing ratio on seedling vigour index I was found non-significant (Table 2). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher seedling vigour index I (531.64) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (518.41). The maximum seedling vigour index I (501.39) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (496.55), while the minimum seedling vigour index I (345.06) was noted with six female flower buds pollinated per male flower at 8.00 to 9.00 am (T_1P_3). Comparatively the higher seedling vigour index I (523.58) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (507.61). Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on seedling vigour index I was found non-significant (Table 2). On comparison, the highest seedling vigour index I (556.68) was recorded in $E_2T_3P_2$ followed by $E_2T_2P_2$ (556.47 mg) and $E_2T_2P_1$ (545.54), while the lowest seedling vigour index I (302.28) was observed in $E_1T_1P_3$.

Seedling vigour index II

Significant variation was recorded for seedling vigour index II among different day of emasculation, time of pollination and female to male flower crossing ratio (Table 2). The pollination done on previous day of emasculation (E_2) produced significantly the higher seedling vigour index II (1058.64). Similar results were earlier reported by Priya *et al.* (2009) [11] in chilli and Patta *et al.* (2015) [10] in tomato. The pollination between 9:00 to 10:00 am (T_2) produced significantly the higher seedling vigour index II (1023.76) and it was at par with pollination between 10:00 to 11:00 am (T_3) (1007.18). The results are in agreements with reports of Patil *et al.* (2008) [8]; Korat *et al.* (2018) [7] and Veeresha *et al.* (2018) [15] in brinjal; Jolli (2004) [6] and Kumar *et al.* (2008) [8] in tomato; Basavaraj (2006) [3], Singh *et al.* (2010) [14] and

Abhishekkatagi *et al.* (2013) [2] in okra; and Priya *et al*. (2009) [11] in chilli. Significantly the higher seedling vigour index II (1013.37) produced when four female flower buds pollinated per male flower (P_2) and it was at par with two female flower buds pollinated per male flower (P_1) (996.43). The results are in agreements with reports of Patil *et al.* (2008) [8] and Korat *et al.* (2018) [7] in brinjal; Kumar *et al.* (2008) [8] in tomato; and Basavaraj (2006) [3] and Gowda *et al.* (2017) [5] in okra.

Interaction effect of day of emasculation and time of pollination, time of pollination and female to male flower crossing ratio, day of emasculation and female to male flower crossing ratio on seedling vigour index II was found non-significant (Table 2). The pollination during 9.00 to 10.00 am on previous day of emasculation (E_2T_2) produced the higher seedling vigour index II (1115.49) followed by pollination during 10.00 to 11.00 am on previous day of emasculation (E_2T_3) (1095.27). The maximum seedling vigour index II (1064.47) recorded with four female flower buds pollinated per male flower at 9.00 to 10.00 am (T_2P_2) followed by 10.00 to 11.00 am pollination with four female flower buds pollinated per male flower (T_3P_2) (1058.00). Comparatively the higher seedling vigour index II (1108.19) was noted in four female flower buds pollinated per male flower on previous day of emasculation (E_2P_2) followed by two female flower buds pollinated per male flower on previous day of emasculation (E_2P_1) (1086.41). Interaction effect of day of emasculation, time of pollination and female to male flower crossing ratio on seedling vigour index II was found non-significant (Table 2). On comparison, the highest seedling vigour index II (1160.04) was recorded in $E_2T_2P_2$ followed by $E_2T_3P_2$ (1157.98) and $E_2T_2P_1$ (1141.41), while the lowest seedling vigour index II (761.38) was observed in $E_1T_1P_3$.

Conclusion

Day of emasculation, time of pollination and female to male flower crossing ratio played an important role on quality of brinjal hybrid seeds after the harvest of seeds. Irrespective of day of emasculation and female to male flower crossing ratio, the pollination during 9:00 am and 10:00 am (P_2) noted significantly the higher values for different seed quality parameters. Similarly, irrespective of time of pollination and female to male flower crossing ratio, emasculation done on previous day of pollination produced significantly the higher seed quality parameters. In the same way, irrespective of day of emasculation and time of pollination, pollination of four female flower buds per male flower (4:1) produced significantly the higher values for seed quality parameters. Among the different combinations of day of emasculation, time of pollination and female to male flower crossing ratio, pollination of two or four female flower buds per male flower (2:1 or 4:1) during 9.00 am to 10.00 am emasculated on previous day of pollination ($E_2T_2P_1$ and $E_2T_2P_2$) were found to be the best combination, as it produced the seed with high germination and vigour.

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