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Influence of Stage of Bud for Emasculation and Number of Pollination on Seed Yield and Quality in Tomato Hybrid Seed Production

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ABSTRACT

The present investigation was carried out at Regional Agricultural Research Station, Bijapur, (Karnataka) during 2007-08. The treatments included were selection of two different stages of bud for emasculation (S_1-less than 50% opened bud stage, S_2- more than 50% opened bud stage) and number of pollinations (one time pollination (morning), two time pollination (morning + evening) and three time pollination (morning + evening + next day morning). It was observed that more than 50% opened bud stage (full matured) recorded significantly higher fruit, seed yield and quality as compared to other treatments and number of pollinations.

Key words : Anther, Bud stage, Emasculation, Fruit set percentage, Pollination

Tomato is a highly self pollinated crop. The phenomenon of heterosis has extensively been exploited for developing hybrids through emasculation and hand pollination. The stage of the bud for emasculation is the primary step and proper size of the bud selected decides to a greater extent the success of hybridization. Usually the buds about to open or due to open on the following day are generally selected. The flower buds where the tips of the corolla have not been separated can be selected for emasculation; flower buds with slightly yellow anther which were expected to open two days later were selected among the first three flower buds of cluster (Yogeesha, 1999 and Dev, 1988).

The flowers of the fertile female plants are emasculated in different phases of their development (Kalloo, 1991). The flowers of the fertile plants are emasculated in the phase "fully developed bud or beginning of opening". The emasculation in an earlier phase of the flower is associated with lower seed yield and in a later phase with the danger of self pollination.(Kalloo ,1983). Five phases of flower can be described on the basis of size of the anthers and pistil. The start of the third phase (from the opening of the flower bud to the expansion of the sepals at angle of 45^0 from the axis of flower) is the best phase for emasculation.

For emasculation the flowers are selected at the opening stage of 45^0 (one day before opening). Two time pollination of same bud in a day at 8.30 am and then at about 4.30 pm. did not show any difference in fruit and seed setting (Mc Guire, 1952).

The success rate of effective pollination is also influenced by temperature and humidity, generally 22^0 C to 28^0 C temperatures and 70 to 85% relative humidity are optimum for good seed set. Hence, there are very limited and conflicting reports on stage of bud and number of pollinations in order to find out the optimum stage of bud for emasculation and number of pollinations in tomato hybrid seed production.

MATERIAL AND METHODS

The experiment was laid out at the Regional Agricultural Research Station, Bijapur, Karnataka State (16^o 49' N latitude and 75^0 43' E longitudes at a 593.6 m above the mean sea level). The mean maximum temperature varied from 25 to 35^0 C and from 22 to 38^0 C whereas the minimum temperature varied from 17 to 27^0 C and from 19 to 26^0 C during the experimentation period of 2007 and 2008, respectively. The experimental site consisted of medium black soil and neutral in reaction.

The experiment consisted of two factors, first factor includes pollination of less than 50% opened bud (S_1) and pollination of more than 50 % opened bud (S_2) and second factor comprising of one time pollination (only in morning) (P_1), two time pollination of the same bud (morning + evening hours) (P_2) and three time pollination of the same bud (morning, evening and next day morning) (P_3). The experiment was conducted in a Randomized Block Design in factorial concept with four replications in each season. The pollination was carried out between 8.00 am to 12.00 noon and afternoon 4.00

pm to 6.00 pm. The tomato hybrid DTH-1 parental seed was obtained from the Department of Horticulture, University of Agricultural Sciences, Dharwad.

The planting was done during the month of October first week in both the years. The male parent was sown staggered to get sufficient pollen throughout the crossing programme. Fifty per cent of the male parent was planted two days before the female planting and the remaining 50 per cent of the male along with female planting was done. The spacing of 60 cm X 60 cm was followed with the net plot size of 3.0 m X 2.4 m (7.2 m^2). All improved seed production practices were followed as per the recommendations for tomato seed production.

Emasculation:

Flower buds selected for emasculation were of two types, i.e., less than 50 % opened bud (half developed bud) and more than 50 % opened bud (fully developed bud). Emasculation was done between 2.00 to 6.00 pm using pointed forceps. Previous day emasculated flowers in five tagged plants in each treatment were pollinated and labeled. The number of pollinated flower buds of five labeled plants were counted and worked out the mean number of crossed flowers per plant.

Pollen collection:

Fully opened flowers were plucked and filled in a polythene bag during early hours of the day. Anther cones were separated and spread on a cloth and exposed to sun for three hours. Dried anthers were kept in a steel cup, covered with muslin cloth and put one more steel cup in an inverted position and were agitated rigorously. The pollens were separated out from the anthers and filtered through muslin cloth in empty cups separated pollens from the anthers in this way were transferred to plastic container with the help of a camel brush. The plastic cup was kept in a cool place over night under ambient condition. Such stored pollens were used for pollination of the emasculated flower buds.

Pollination:

The pollen stored under ambient condition was collected in plastic pollen ring specially designed to carry out hand pollination. The stigma of the emasculated flower buds was dipped in the pollen ring to effect pollination. Two calyxes of the pollinated flower buds were given half cut after pollination for crossed fruits identification. From the experiment, the data on number of flowers pollinated, number of crossed fruits, fruit set percentage, fruit weight, crossed fruit yield, seed recovery percentage, seed weight per fruit, number of seeds per fruit, seed yield per plant were recorded. Germination test was conducted in four replications of hundred seeds each by adopting 'between paper method' as described by ISTA (Anon, 1999). The final germination count was taken on 14th day of germination test for normal seedlings and expressed in percentage. Field emergence one hundred seeds selected at random from each of the treatment in four replications were used for the field emergence studies. The seeds were sown in red soils of a well prepared, raised seed bed and water was added at regular interval to maintain adequate moisture in the bed. Emergence count and the emergence percentage were calculated taking into account the number of seedlings emerged three cm above the soil surface. The vigour index of seedling was calculated by adopting the method suggested by Abdul – Baki and Anderson (1973) and expressed in number by using following formula. Seedling Vigour Index =Germination (%) x (Shoot + Root length (cm). The data obtained in this investigation are analyzed as per the procedure given by Panse and Sukhatme (1967) and Gomez and Gomez (1984). Levels of significance used in 'F' and't' test was P = 0.05. Critical difference (CD) values were calculated only when the 'F' tests was found significant. The percentage values of germination and field emergence were converted into arc sine transformation then used them for statistical analysis (Snedecor and Cochran, 1967 and Fisher and Yates, 1963).Two year's pooled data was subjected for statistical analysis and are presented in Tables 1 to 3.

RESULTS AND DISCUSSION

Fruit set percentage:

The pooled analysis indicated that the pollination of more than 50% opened bud (S_2) recorded significantly higher fruit set percentage (52.92) compared to the pollination of less than 50% (S_1) opened bud (27.12). Three time (P_3) pollination (morning +evening+ next day morning) of same emasculated bud significantly increased fruit set (43%) over one time (P_1) pollination (38.07%) and two time (P_2) pollination (39.00). This may be due to retention of higher number of crossed fruits per plant. Similar results were reported by Mc Guire (1952).Interaction effect of stage of bud and number of pollination were found to be non significant. However, these two factors acted independently rather than combined (Table 1). This may be due to the stigma receptivity was less in after noon

Table 1. Effect of stage of bud and number of pollinations on number of flowers crossed, number of crossed fruits, fruit set and crossed fruit yield per plant in tomato hybrid (DTH-1) seed production

Treatments	No. of flowers Crossed/plant			No. of crossed fruits /plant			Fruit set (%)			Crossed fruit yield /plant (g)		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Stage of bud (S)												
S_1	75.11	77.92	76.52	20.06	21.39	20.73	26.77	27.47	27.12	1556.66	1542.75	1549.71
S_2	76.84	76.83	76.84	40.61	40.68	40.65	52.32	53.52	52.92	2540.39	2576.19	2558.29
S.Em±	1.41	2.58	2.15	0.76	0.59	0.61	1.37	1.16	1.21	72.20	52.92	61.08
CD at 5%	NS	NS	NS	2.29	1.78	1.83	4.14	3.49	3.67	217.55	159.46	183.87
Number of pollinations (P)												
P_1	77.86	76.75	77.31	29.18	29.32	29.26	37.09	39.04	38.07	1877.60	1922.42	1899.80
P_2	74.33	77.88	76.10	28.92	30.45	29.69	38.73	39.27	39.00	1917.57	1900.50	1989.04
P_3	75.74	77.50	76.62	32.89	33.32	33.11	42.81	43.17	43.00	2350.86	2355.49	2533.16
S.Em±	1.15	2.11	1.98	6.62	0.48	0.50	1.12	0.95	1.05	58.95	43.21	49.21
CD at 5%	NS	NS	NS	1.87	1.55	1.52	3.38	2.83	3.15	177.63	130.20	146.15
Interaction (S x P)												
$S_1 P_1$	79.63	77.00	78.32	19.19	19.54	19.37	24.03	25.43	24.73	1402.00	1413.41	1407.71
$S_1 P_2$	73.12	78.50	75.81	19.72	21.54	200.63	26.97	27.45	27.21	1407.54	1370.25	1388.90
$S_1 P_3$	72.57	78.25	75.41	21.27	23.08	22.18	29.31	29.55	29.43	1860.47	1844.60	1852.42
$S_2 P_1$	76.09	76.50	76.30	39.18	39.10	39.14	50.16	52.66	51.41	2352.32	2431.43	2391.88
$S_2 P_2$	75.53	77.25	76.39	38.13	39.36	38.75	50.48	51.09	50.79	2427.59	2430.76	2429.18
$S_2 P_3$	78.90	76.75	77.83	44.51	43.57	44.04	56.31	56.80	56.56	2841.25	2866.38	2853.82
S.Em±	1.99	3.65	2.83	1.07	0.84	1.13	1.94	1.64	1.05	102.10	74.84	84.53
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS: Non Significant
S_1: Less than 50 percent opened bud stage
S_2: More than 50 percent opened bud stage

P_1: One time pollination (Morning)
P_2: Two time pollination (Morning + Evening)
P_3: Three time pollinations (Morning + Evening + Next day morning)

Table 2. Effect of stage of bud and number of pollinations on fruit weight, number of seeds per fruit, seed recovery and seed yield per plant of tomato hybrid (DTH-1) seed production.

Treatments	Fruit weight (g)			Number of seeds /fruit			Seed recovery (%)			Seed yield (g) /plant		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Stage of bud (S)												
S_1	70.96	70.91	70.94	58.80	59.03	58.92	3.50	3.49	3.50	6.86	5.52	6.19
S_2	99.58	101.27	100.43	103.46	103.41	103.44	4.45	4.53	4.49	8.44	7.05	7.75
S.Em±	1.89	2.30	2.18	1.68	1.68	1.67	0.16	0.15	0.15	0.15	0.18	0.17
CD at 5%	NS	NS	6.57	5.07	5.08	5.07	NS	NS	NS	NS	NS	NS
Number of pollinations (P)												
P_1	84.34	84.66	84.50	78.30	78.58	78.44	3.87	3.90	3.89	7.68	6.14	6.50
P_2	84.45	84.63	84.54	78.43	78.34	78.39	3.90	3.87	3.87	7.50	6.16	6.84
P_3	87.02	88.99	88.02	86.68	86.73	86.72	4.15	4.26	4.21	7.92	6.54	7.23
$S.Em_{\pm}$	1.55	1.88	1.80	1.57	1.38	1.37	0.13	0.12	0.12	0.12	0.14	0.15
CD at 5%	4.65	5.65	5.46	4.14	4.14	4.15	0.39	0.36	0.34	0.37	0.43	0.44
Interaction (S x P)												
$S_1 P_1$	69.18	69.22	69.20	57.85	58.40	58.13	3.36	3.37	3.37	6.68	5.37	6.03
$S_1 P_2$	70.01	70.08	70.05	57.81	57.64	57.73	3.41	3.32	3.37	6.68	5.39	6.04
$S_1 P_3$	73.69	73.44	73.57	60.76	61.04	60.90	3.72	3.72	3.75	7.21	5.79	6.50
$S_2 P_1$	99.50	100.10	99.80	98.75	98.75	98.75	4.39	4.43	4.41	8.39	6.92	7.66
$S_2 P_2$	48.88	99.18	99.03	99.04	99.04	99.04	4.39	4.41	4.40	8.31	6.95	7.63
$S_2 P_3$	100.36	104.55	102.46	112.59	112.43	112.51	4.58	4.74	4.66	8.62	7.29	7.96
$S.Em_{\pm}$	2.68	3.25	2.98	2.38	2.38	2.37	0.22	0.21	0.12	0.21	0.25	0.23
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS: Non Significant
S_1: Less than 50 percent opened bud stage
S_2: More than 50 percent opened bud stage

P_1: One time pollination (Morning)
P_2: Two time pollination (Morning + Evening)
P_3: Three time pollinations (Morning + Evening + Next day morning)

Table 3. Effect of stage of bud and number of pollinations on seed germination, field emergence and vigour index of tomato hybrid (DTH-1)

Treatments	Germination (%)			Field emergence (%)			Vigour index		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Stage of bud (S) method									
S_1	71.28 (89.75)	71.73(96.55)	71.51 (89.95)	65.22 (82.45)	66.14 (83.65)	65.68 (83.00)	1393	1559	1476
S_2	77.72 (95.45)	79.28(93.75)	78.50 (96.00)	71.77 (90.25)	72.00 (90.45)	71.89 (90.35)	1591	1752	1671
S.Em±	0.35	0.91	0.63	0.36	0.89	0.59	18.83	20.52	20.01
CD at 5%	NS	NS	NS	NS	NS	NS	NS	61.82	60.63
Number of pollinations (p)									
P_1	74.13 (92.55)	74.80 (93.15)	74.48 (92.85)	68.25 (86.25)	69.62 (87.85)	68.94 (86.88)	1477	1625	1551
P_2	74.12 (92.55)	74.78 (93.15)	74.56 (92.45)	68.26 (86.25)	65.54 (86.65)	68.4 (86.45)	1471	1619	1555
P_3	75.24 (93.55)	76.92 (94.84)	76.09 (94.25)	68.97 (87.25)	69.06 (87.25)	69.2 (87.15)	1527	1723	1625
S.Em±	0.29	0.74	0.48	0.29	0.73	0.59	15.37	16.75	15.88
CD at 5%	0.86	2.34	1.45	0.89	2.20	1.89	46.63	50.48	47.16
Interaction (S x P)									
$S_1 P_1$	71.12 (89.55)	71.49 (89.95)	71.31 (89.75)	65.03 (82.15)	67.42 (85.25)	66.23 (83.75)	1384	1537	1460
$S_1 P_2$	71.10 (89.55)	71.52 (89.95)	71.31 (89.75)	65.05 (82.20)	65.37 (82.65)	65.21 (82.45)	1377	1538	1457
$S_1 P_3$	71.62 (90.00)	72.17 (90.65)	71.90 (90.35)	65.57 (82.90)	65.63 (82.95)	65.60 (82.95)	1419	1602	1510
$S_2 P_1$	77.15 (95.00)	78.12 (95.12)	77.64 (95.45)	71.47 (89.90)	71.82 (90.25)	71.65 (90.00)	1570	1713	1642
$S_2 P_2$	77.15 (95.00)	78.04 (95.75)	77.60 (95.35)	71.47 (89.90)	71.71 (90.15)	71.59 (90.00)	1566	1700	1633
$S_2 P_3$	78.87 (96.25)	81.68 (97.95)	80.28 (97.15)	72.37 (90.85)	72.49 (89.95)	72.43 (90.85)	1635	1845	1740
S.Em±	0.49	1.29	0.94	0.51	1.26	0.79	26.63	29.02	28.54
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	85.62

NS: Non Significant
S_1: Less than 50 percent opened bud stage
S_2: More than 50 percent opened bud stage

P_1: One time pollination (Morning)
P_2: Two time pollination (Morning + Evening)
P_3: Three time pollinations (Morning + Evening + Next day morning)

pollination (P_2) and some of the immature ovules were matured in the next day morning pollination (P_3). Similar results were also reported by Dev (1998), who opined that all the ovules would not mature in one day (after emasculation), and some of immatured ovules would get maturity on the next day also.

Crossed fruit yield per plant

The crossed fruit yield per plant showed that the pollination of more than 50% opened bud (S_2) recorded significantly higher fruit yield of 2558.29g per plant than the less than 50% (S_1) opened bud. This may be due to more number of matured ovules found in the more than 50% opened bud. In less than 50% opened bud of immature ovules, the fertilization rate is less due to buds were not developed fully (Table 1) which is in concordance with the report of Pollack and Larson, (1956).

Three times pollination (P3) recorded significantly higher fruit yield of 2553.16 g /plant compared to two time and one time pollination (1899.80 g). This may be due to the increase in the yield components such as fruit weight, number of crossed fruits retained and fruit set percentage. This is in agreement with the reports of Mc Guire (1952) in tomato.

The treatment combination of more than 50% opened bud stage and three time pollinations gave the highest fruit yield of 2853.82 g / plant over all other combinations. The lowest fruit yield was recorded with the treatment combination of less than 50% opened bud stage with one time pollination (Table 1). This is due to number of ovules matured was more at the time of pollination (Valdes1995).

Three time pollination showed higher seed recovery (4.21) per cent (Table 2) as compared to two (3.87) and one time (3.89) pollination. The percentage of seed setting was more. This is in agreement with the reports of Yogeesha et al, (1999) in tomato hybrid seed production. The interaction effects were non significant, however, more than 50% opened bud stage with three time pollination recorded higher seed (4.60) recovery percent while the lowest (3.75) was recorded in less than 50% opened bud with three time pollination. It was also reported by Siddhu et al, (1988)

Seed yield per plant

More than 50% opened bud stage recorded significantly higher seed yield of 7.75g per plant over less than 50% opened bud stage (6.19g/plant). Three time pollination gave significantly higher seed yield of 7.23g per plant over one time (6.50g) and two time (6.84g) pollination (Table 2). The significant increase in the seed yield per plant in more than 50% opened bud stage may be due to significant increase in seed weight per fruit, number of seeds per fruit and seed recovery percent per plant.

These results were in agreement with the reports of Dev et al, (1994) and Kalloo, (1995) in tomato hybrid seed production. Interaction effect of more than 50% opened bud stage with three times pollination gave higher seed yield of 7.96 g / plant over all other combinations. The lowest seed yield of 6.03g per plant was recorded in less than 50% opened bud stage with one time pollination. This is in agreement with the observations of Dev (1988).

Seed quality

More than 50% opened bud stage (S_2) recorded significantly higher germination (96.00%), field emergence (90.35%) vigour index (1671) as compared to less than 50% opened bud stage. This may be due to the more number of matured ovules (more than 50% opened bud stage) compared to less than 50% opened bud stage, which produced higher seed quality parameters (Table 3). Such higher quality seeds were harvested when more than 50% opened bud was emasculated for hybrid seed production as it was reported by Yogeesha (1999) and Valdes (1995) and Kalloo (1988, 1991) in tomato.

Three time pollination of same bud recorded significantly higher germination (94.25%), field emergence (87.15%) and seedling vigour index (1625) over one and two time pollinations. This may be due to some of immatured ovules may mature by next day morning (morning + evening + next day morning) and higher seed weight and bold seeds that were harvested in three time pollinations compared to one and two time pollination (Dev, 1997). Interaction between stage of bud and number of pollinations were found to be non significant for most of the characters. However, numerically higher values were recorded in the combination of more than 50% opened bud stage with three time pollination over rest of the combinations.

From the above discussion it is revealed that the more than 50% opened bud stage for emasculation recorded higher fruit set, fruit yield, seed yield per plant and seed quality compared to other treatment combinations. It can be concluded that more than 50% opened bud stage with three times pollination gave higher seed yield and its components and seed quality parameters. The data were subjected to statistical analysis. The analysis of variance and interpretation of data were done as per procedure given by Panse and Sukhatme (1967)

and Gomez and Gomez (1984). Levels of significance used in 'F' and't' test was P = 0.05. Critical difference (CD) values were calculated only when the 'F' tests was found significant. The percentage values of germination and field emergence were converted into arc sine transformation then used them for statistical analysis (Snedecor and Cochran, 1967 and Fisher and Yates, 1963).

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