

Effects of Methods and Time of Pollination on Tomato (*Lycopersicon esculentum*) Fruit Set and Seed Quality

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ABSTRACT An investigation was carried out to study the effects of method and time of pollination on fruit set, seed yield, 100-seed weight and germination in tomato (*Lycopersicon esculentum*) cv. Pusa Divya, developed through functional male sterility, under open field and polyhouse conditions. The repeated (twice) pollination of the same stigma resulted in significantly higher fruit set and seed yield than those pollinated once (without emasculation). Pollinations at 9.00 AM and 5.00 PM were better for higher fruit set and seed yield.

Key words: Crossing period, pollination time, stigma receptivity, hand emasculation

Tomato (*Lycopersicon esculentum* Mill.) is an important vegetable crop which occupies an area of 4.55 mha with a production of 125.02 mt. In India, it occupies an area of 0.54 mha with a total production of 7.60 mt and an average yield of 14.074 t/ha, which is very low. The use of F₁ hybrids in tomato is one of the means to meet the ever increasing demand for tomato and it offers several advantages, namely earliness, higher productivity, improved quality and resistance to biotic and abiotic stresses. It also provides a quick and convenient way of combining desirable characters.

Hybrid seed production in tomato is being done through hand emasculation and pollination owing to bigger flower size. But tomato hybrid seed production is expensive and labour intensive, which makes tomato hybrid seed costly. Hand emasculation alone accounts for 40 per cent of total cost for producing hybrid seed in tomato. Moreover, chances are there that seed produced through pollination, following hand emasculation is not 100 per cent pure (genetically). Hence, there has been much interest over the years to

develop an alternative to hand emasculation, for reducing cost and increasing seed yield.

The stigma receptivity, pollen viability, fruit set and seed yield are greatly affected by temperature. Several workers reported reduced fruit set and weight due to low pollen production and pollen viability under low temperature [1, 3, 4]. The pollination in hybrid tomato seed production is usually done in the morning (up to 11.00 A.M.) in Southern and Western parts of India. Temperature, RH, wind velocity and presence of moisture on stigma influences fruit set. To identify the optimum pollination conditions in North India, the present investigation was carried out.

MATERIALS AND METHODS

The seeds of female (long styled *Pusa Saij*) and male (*Roma*) parental lines of tomato hybrid *Pusa Divya* developed by Verma *et al.* [6] was obtained from IARI Regional Station, Katrain, Kullu Valley, Himachal Pradesh. The field experiment was conducted at Centre for Protected Cultivation Technology, IARI, New Delhi, during *rabi* 2005-

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06 and 2006-07, respectively. The treatment consisted of three methods of pollination, *viz.* pollination once without emasculation (T_1), repeated pollination (twice) without emasculation (T_2) and hand pollination, following emasculation during anthesis (T_3), combined with five pollination times, *viz.* 7.00 AM, 9.00 AM, 11.00 AM, 2.00 PM and 5.00 PM (three replicates each). The experiment was laid out in factorial randomized block design. The observations on fruit set percentage, average fruit weight, seed yield/fruit, 100-seed weight and germination percentage were recorded in both open field and polyhouse conditions.

To investigate the effects of different time of pollination on fruit set and seed quality, pollination was done at different times during the day under both open field and polyhouse conditions. Three replicates of 100 flowers each was used for each treatment. Temperature, RH, wind velocity and moisture content on stigma were recorded during pollination. To establish the advantage of repeated pollination, pollinated flowers were once again pollinated next day without emasculation.

RESULTS AND DISCUSSION

Effects of pollination methods on fruit and seed set, and quality

The data on repeated (twice) pollination in field experiment showed significantly higher mean fruit set and seed yield per fruit (78% and 102 mg, respectively) than those in hand emasculation and pollination (43% and 66 mg, respectively) during both the seasons (Table 1).

Similarly in polyhouse, significantly higher fruit set and seed yield/fruit (100% and 220 mg, respectively) were obtained with the repeated pollination (twice) than those with hand emasculation and pollination (77% and 148 mg, respectively) Table 2. The higher fruit set with repeated pollination will be due to fertilization of more number of ovules in an ovary since the stigma was receptive until the next day. Fruit set and seed yield were significantly reduced with hand emasculation and pollination compared to pollination without emasculation (genetic purity

is maintained by bagging the flowers) under both the conditions and seasons. This may be due to mechanical injury to stigma during emasculation, which will reduce the number of ovules fertilized. In North India, repeated pollination will help in increasing seed yield within limited period.

Effects of time of pollination on fruit and seed sets

In open field, day temperature (on the day of pollination) varied from 10.5° to 35°C. Significantly higher fruit set was recorded for 9.00 AM (72%) and at 5.00 PM pollinations (71%), the prevailing temperature at the time of pollination was 20°-23°C. Similarly, significantly higher seed yield/fruit (88-89 mg) was recorded in 9.00 AM and 5.00 PM pollinations (Table 3). There was a significant reduction in fruit set (35%) and seed yield/fruit (65 mg) for 7.00 AM pollination. In the early morning, the stigma appeared to be too wet preventing pollen to adhere to the surface, resulted in failure of effective pollination. The low temperature of 10.5°C in early morning (7.00 AM) was also responsible for lower fruit set and seed yield, as reported by other workers in tomato [4].

The fruit set and seed yield were also lower in 11.00 AM and 2.00 PM pollinations due to higher temperature (33°C and 35°C, respectively). Increase in temperature around 11.00 AM (> 33°C) and RH (32%) resulted in drying up of stigmatic surface as well as desiccation of pollen grains, leading to failure of pollens to germinate. At 5.00 PM a congenial atmosphere in open field again makes it convenient for pollination work.

There was no significant difference between the treatments in average fruit weight and 100-seed weight. Whereas, seed yield/fruit was significantly reduced for 7.00 AM pollination. The prevailing temperature during pollination in the polyhouse varied from 11.8° to 38°C (Table 4). Significantly low fruit set (87%) and seed yield (110 mg) at 7.00 AM pollination was due to very low temperature (11.8°C) and presence of excess moisture on stigma. The fruit set was above 90 per cent, during the rest of the time of

Table 1. Effects of pollination methods on fruit set, seed yield and quality under field condition

Treatment	Fruit set (%)		Average fruit weight (g)		Seed yield/fruit (mg)		100-seed weight (mg)		Germination (%)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Pollination once without emasculation (T ₁)	62.0 (38.36)	58.0 (35.47)	31.5	33.4	71.33	82.0	302.0	294.0	94.0 (70.09)	90.0 (64.09)
Repeated pollination without emasculation (T ₂)	75.0 (48.67)	78.0 (51.32)	35.8	36.8	88.00	102.0	300.0	290.0	93.0 (68.47)	91.0 (65.44)
Hand emasculation and pollination (T ₃)	51.0 (30.69)	43.0 (25.69)	28.2	29.8	62.00	70.0	297.0	292.0	95.0 (71.86)	90.0 (64.09)
Mean	62.67 (39.24)	59.67 (37.49)	31.83	33.33	73.78	84.67	299.67	292.00	94.0 (70.14)	90.33 (64.54)
CD (p=0.05)	4.30	3.37	4.24	4.24	9.20	5.65	5.65	5.65	2.40	1.88

Figures in parentheses are arc sine values

Table 2. Effects of pollination methods on fruit set, seed yield and quality under polyhouse

Treatment	Fruit set (%)		Average fruit weight (g)		Seed yield/fruit (mg)		100-seed weight (mg)		Germination (%)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Pollination once without emasculation (T ₁)	89.0 (63.17)	87.0 (60.59)	45.2	35.8	204.0	165.0	332.0	300.0	99.0 (83.47)	99.0 (83.47)
Repeated (twice) pollination without emasculation (T ₂)	100.0 (90.00)	100.0 (90.00)	49.5	40.3	220.0	195.0	335.0	306.0	99.0 (83.47)	99.0 (83.47)
Hand emasculation and pollination (T ₃)	78.0 (51.36)	77.0 (50.40)	40.8	31.2	182.0	148.0	337.0	302.0	98.0 (78.78)	98.0 (78.78)
Mean	89.00 (68.18)	88.00 (67.00)	45.17	35.77	202.00	169.33	334.67	302.67	98.67 (81.91)	98.67 (81.91)
CD (p=0.05)	5.14	3.62	5.65	4.23	8.48	7.07	5.65	5.65	7.23	7.23

Figures in parentheses are arc sine values

Table 3. Effects of pollination time on fruit set, seed yield and seed quality in tomato hybrid seed production under field condition

Time of pollination	Temperature (°C)	Relative humidity (%)	Fruit set (%)	Average fruit weight (g)	Seed yield/fruit (mg)	100-seed weight (mg)	Germination (%)
7 AM	10.5	60	35 (20.50)	31	65	280	88 (60.47)
9 AM	20.0	48	72 (46.12)	30	88	270	87 (60.47)
11 AM	33.0	32	45 (26.76)	32	80	275	88 (61.66)
2 PM	35.0	25	47 (28.05)	30	80	272	86 (59.33)
5 PM	23.0	38	71 (45.30)	29	89	274	87 (60.47)
Mean			54.0 (33.35)	30.40	80.40	274.20	87.2 (60.48)
CD (p=0.05)			3.68	3.86	3.85	6.43	1.50

Figures in parentheses are arc sine values

Table 4. Effects of pollination time on fruit set, seed yield and seed quality in tomato hybrid seed production under poly house

Time of pollination	Temperature (°C)	Relative humidity (%)	Fruit set (%)	Average fruit weight (g)	Seed yield/fruit (mg)	100-seed weight (mg)	Germination (%)
7 AM	11.8	98	87 (60.59)	41.0	110.0	345.0	98 (78.78)
9 AM	23.0	67	92 (67.20)	41.8	145.0	345.0	99 (80.77)
11 AM	34.0	40	96 (74.69)	38.8	137.0	340.0	99 (81.89)
2 PM	38.0	32	100 (87.30)	40.2	138.0	338.0	98 (78.78)
5 PM	25.0	47	96 (74.69)	38.0	145.0	339.0	98 (78.78)
Mean			94.20 (72.89)	39.96	135.0	341.40	98.4 (79.80)
CD (p=0.05)			6.95	5.16	6.43	7.72	3.18

Figures in parentheses are arc sine values

pollination. A significantly higher seed yield/fruit was recorded for 9.00 AM and 5.00 PM pollinations (145 mg), whereas least seed yield/fruit was recorded for 7.00 AM pollination.

Generally pollination is practised during morning time in hybrid seed production of tomato. However, present results showed that pollination could be done in the evening time, if the temperature is not too high. Pollination at 9.00 AM and 5.00 PM is better for higher fruit set and seed yield. However, under polyhouse conditions, pollination could be done throughout the day, starting from 8.00 AM, as the fruit set was above 90 per cent and there was not much variation among the treatments except 7.00 AM. Jolli *et al.* [2] recorded significantly higher fruit set (53.5%) and seed recovery (4.75%) per plant with 11.00 AM pollination followed by 10.00 AM and 12.00 noon pollinations. Sanjeev Kumar *et al.* (2008) also recorded higher fruit yield, fruit set, seed yield, 100-seed weight and germination with higher seed vigour, if pollination was done at 10.00-11.00 AM under Dharwad condition of India.

REFERENCES

1. CHARLES, W.B. & R.E. HARRIS (1972). Tomato fruit set at high and low temperature. *Can. J. Plant Sci.* **52**: 497-506.
2. JOLLI, R.B., B.S. VYAKARANAHAL, V.K. DESHPANDE & P.R. DHARMATTI (2006). Standardization of hybrid seed production techniques in tomato. XII National Seed Seminar, 24-26 February 2006, ANGRAU Hyderabad, *Abstr.*
3. MAISONNEUVE, B. & J. PHILOUZE (1982). Action des basses températures nocturnes sur une collection varietale de tomate (*Lycopersicon esculentum* Mill.). I. Etude de la quantite et de la qualite du pollen. *Agronomie* **2**: 453-458.
4. RYLSKI, I. (1979). Fruit set and development of seeded and seedless tomato fruits under diverse regimes of temperature and pollination. *J. Amer. Soc. Hort. Sci.* **104**: 835-838.
5. KUMAR, SANJEEV, B.S. VYAKARANAHAL, Y.B. PALLED, P.R. DHARMATTI & M.S. PATTIL (2008). Studies on crossing ratio and pollination time in tomato hybrid seed production (*Lycopersicon esculentum* Mill.). *Karnataka J. Agric. Sci.* **21**(1): 30-34.
6. VERMA, T.S., S. JOSHI, R.K. SHARMA & D.C. PACHAURI (2001). Pusa Divya: A new tomato hybrid. *Indian Hort.* **46**(3): 10-24.