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# Studies on stigma receptivity and fruit load for hybrid seed production in tomato (*Solanum lycopersicum* L.) under protected environment

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## Abstract

**An experiment was conducted in factorial randomized block design with three replications during spring-summer season 2013 at Experimental Farm, Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur to standardize the best time of stigma receptivity and optimum fruit load in tomato (*Solanum lycopersicum* L.). The data indicated that for hybrid seed production of tomato under polyhouse conditions, the pollination carried out between 9.00 to 10.00 am and retaining fruit load of 20 fruits per plant, exhibited higher fruit set (65.1%), average fruit weight (64.2g), 1000-seed weight (4.20g), average seed weight per fruit (0.17g), fruit yield per plant (1496.7g), seed yield per plant (4.54g) and seed quality parameters such as germination (91.7%) and seedling vigour index (1943) as compared to the pollinations done before and after this time and retaining fruit load of 25 or 30 fruits per plant.**

**Key words:** Tomato, emasculation, pollination time, stigma receptivity, seed quality.

Tomato (*Solanum lycopersicum* L.) is a solanaceous self pollinated vegetable crop spread throughout the world occupying an area of 4.8 million ha with a production of 125.02 million tonnes. In India, tomato is cultivated in all agro climatic zones in about 8,80,000 hectares area with a production of 1,8227,000 tonnes. It is one of the most important off-season vegetable crops of mid and low hills of Himachal Pradesh and is grown in an area of about 10,000 ha with an annual production of 4,14,000 tonnes (NHB 2012-2013). It is also grown as a summer-rainy crop mostly in open fields in the 'Humid Sub-Temperate' areas of Himachal Pradesh. The hybrid seed production in tomato is economical since manual emasculation and pollinations are easier, seed requirement per unit area are lesser and a good number of seeds are produced per fruit. In countries like India, environmental conditions are favourable to cultivate the tomato throughout the year and the availability of relatively semi-skilled labour, hybrid seed production in tomato offers a good scope for export.

## Materials and Methods

Parental lines of bacterial wilt resistant hybrid "Palam Tomato Hybrid -1" were obtained from CSKHPKV, Palampur. The experiment was laid out in randomized block design. There were nine treatment combinations consisting of three pollination times *viz.*, 8.00 am to 9.00 am, 9.00 am to 10.00 am and 10.00 am to 11.00 am and retaining three types of fruit loads viz., 20, 25 and 30 fruits per plant with in replications. The healthy seedlings were raised in plug trays having soilless media. Five weeks old seedlings were transplanted in modified naturally ventilated polyhouse. Crop was maintained by following the package for protected cultivation of tomato crop. Pollination work was carried out daily as per treatments. Statistical analysis was done as per the method given by Gomez and Gomez (1984). Data were recorded on five plants which were randomly selected in each treatment. Seed germination was tested as per the 'International Seed Testing Association" procedure (Anonymous. 1999). Seeding vigour index was calculated as per Abdul-

Baki and Andreson (1973) formula, seedling vigor index = seed germination × [root length + shoot length (cm)]. The other quality parameters like fruit set (%) fruit yield per plant (g), average fruit weight (g), seed yield per plant (g), average seed weight per fruit (g) and 1000- seed weight (g) were also recorded.

**Results and Discussion**

Fruit set, seed yield per plant, average seed weight per plant and 1000-seed weight were highest (59.6%, 4.15g, 0.12g and 3.82g, respectively) when pollination was done between 9.00am-10.00am as compared to pollination done at 8.00am -9.00am and 10.00am – 11.00am (Table 1). Similarly, average fruit weight, fruit yield per plant and seed germination percentage were highest (55.6g, 1392.2 and 89.4%, respectively) when pollination was done between 8.00am- 9.00am as compared to other two pollination times (Table1).This implies that the stigma receptivity was highest between 9-10am followed by 8-9 am under protected environment as judged from fruit set percentage, seed yield per plant, average seed weight per plant and 1000-seed weight. Among the fruit load treatments, C1 (20 fruits per plant) resulted in the highest fruit set (48.6%), average fruit weight (48.4g), average seed weight per plant (0.11g), 1000-seed weight (2.88g) and seed germination (70.6%) which were significantly higher than C2 (25 fruits per plant) and C3 (30 fruits per plant). Similarly, seed yield per plant (3.25g) and seedling vigour index (1077.1) was highest in C2 treatment.

When 25 fruits per plant were retained, fruit yield per plant was highest (Table1). The results of present study with regards to appropriate time of pollination and fruit load are in close agreement to those of Kumar *et al.* (2008) in tomato who have reported 10.00 am as the best time of pollinating emasculated tomato flower buds for getting the highest fruit set, seed yield per plant, average seed weight per plant and 1000-seed weight, Kivadasannavar *et al.* (2009) 9am -12 noon in chillies as the best time for pollinating emasculated flower buds for getting highest seed yield per plant under open field conditions at Dharwad (Karnataka) and Abhishekatagi *et al.* (2013) in okra who have reported 9am-12noon, the best time for pollination with respect to 1000-seed weight. The variation may be attributed to the environments under which these two studies have been carried out. Among the interaction effect (P×C) between pollination time (P) and fruit load (C) fruit set (%), average fruit weight, seed yield per plant and seed germination (%) was recorded highest in P2C1 treatment combination (65.1%,64.2g, 4.54g and 91.7% respectively) and this was significantly superior to other treatment combination. Whereas fruit yield per plant was recorded significantly highest in treatment combination P1C3 and seedling vigour index was recorded highest in P2C2 treatment combination (Table1).

This indicates that the stigma receptivity in tomato is the highest between 9-10am and by retaining 20 crossed fruits per plant. Higher average fruit weight by retaining relatively less number of crossed fruits can be attributed to the fruit that the plant energy is available to lesser number of fruits. Kumar *et al.* (2008) have reported 10.00 am in tomato whereas Kivadasannavar *et al.* (2009) 9.00 am-12 noon in chillies as the best time for pollinating emasculated flower buds for getting the highest seed yield per plant under open field conditions at Dharwad (Karnataka).

Seed germination is recorded highest in all the three combination i.e. P2C1 (91.7%), P1C2 (91.0%) and P1C1 (90.7%) and were at par with each other. The result of the present study are in close agreement with Kivadasannavar *et al.* (2009) in chilli, Kumar *et al.* (2008) in tomato and Abhishekkatagi *et al.* (2013) in okra as the effect of pollination time on seed germination percentage. In case of fruit yield per plant, the interaction effect revealed that the treatment combination P1C3 (pollination carried out between 8.00-9.00am and 30 fruits per plant were retained) and P2C3 (pollination was done between 10-11 am and 30 fruits per plant were retained) gave the highest fruit yield (1496.7g and 1493.3g respectively) and both were at par but significantly superior to all other interactions. This implies that the pollination time between 8-10am by retaining 30 fruits per plant will results in significantly higher fruits yield per plant.

In case of seed yield per plant (4.54g) and was at par with P1C2 (4.20g) and P2C2 (4.10g) but was significantly higher as compared to other treatment combinations. This implies that pollination between 8-10 am and fruit load of 20-25 fruits per

plant will result in the highest seed yield per plant (Table1). Kumar *et al.* (2009) 9.00am -12.00noon in chillies as the best time for pollinating emasculated flower buds for getting the highest seed yield per plant under open field conditions at Dharwad (Karnataka).

Data on the seedling vigour index as influenced by different pollination times and by retaining fruit load per plant are presented in the Table 1. The effect of different pollination time treatments on seedling vigour index were non significant. On the other hand, the fruit load of 25 fruits per plant (C2) resulted in the highest seedling vigour index value which was at par with the crossed fruit load treatment (C1). Among P×C interaction, the treatment combination P2C2 expressed the highest seedling vigour index (14.78.7) which was at par with P1C2, P1C1, P1C3, and P2C1. This implies that the pollination between 8-10 am and crossed fruit load of 20-25 fruits per plant will lead to the production of seed with maximum seedling vigour index. The results of the present study are in close agreement

**Table1. Effect of pollination time and fruit load on various seed quality parameters**

| | Fruit set (%) | Average fruit weight (g) | Fruit yield per plant (g) | Seed yield per plant (g) | Average seed weight per plant (g) | 1000-seed weight (g) | Seed germination (%) | Seedling vigour index |
|---|---|---|---|---|---|---|---|---|
| **Pollination time** | | | | | | | | |
| P1 | 57.8$^{b}$ | 55.6$^{a}$ | 1392.2$^{a}$ | 3.53$^{b}$ | 0.10$^{a}$ | 3.29$^{b}$ | 89.4$^{a}$ | 1294.2 |
| P2 | 59.6$^{a}$ | 55.0$^{a}$ | 1331.1$^{b}$ | 4.15$^{a}$ | 0.12$^{a}$ | 3.82$^{a}$ | 83.6$^{b}$ | 1092.1 |
| P3 | 19.2$^{c}$ | 18.4$^{b}$ | 464.4$^{c}$ | 1.18$^{c}$ | 0.03$^{b}$ | 1.0$^{c}$ | 29.0$^{c}$ | 409.6 |
| SEm(±) | 0.31 | 0.24 | 5.77 | 0.13 | 0.01 | 0.12 | 0.64 | 67.22 |
| CD (P=0.05) | 0.9 | 0.7 | 17.3 | 0.40 | 0.02 | 0.37 | 1.9 | NS |
| **Fruit load (C)** | | | | | | | | |
| C1 | 48.6$^{a}$ | 48.4$^{a}$ | 976.7$^{b}$ | 2.95$^{a}$ | 0.11$^{a}$ | 2.88$^{a}$ | 70.6$^{a}$ | 938.5$^{a}$ |
| C2 | 44.5$^{b}$ | 41.9$^{b}$ | 1047.8$^{a}$ | 3.25$^{a}$ | 0.10$^{a}$ | 2.53$^{a}$ | 69.4$^{a}$ | 1077.1$^{a}$ |
| C3 | 43.5$^{c}$ | 38.8$^{c}$ | 1163.3$^{a}$ | 2.67$^{b}$ | 0.06$^{b}$ | 2.70$^{a}$ | 62.0$^{b}$ | 780.3$^{b}$ |
| SEm(±) | 0.31 | 0.24 | 5.77 | 0.13 | 0.01 | 0.12 | 0.64 | 67.22 |
| CD (P=0.05) | 0.9 | 0.7 | 17.3 | 0.4 | 0.02 | 0.37 | 1.9 | 201.5 |
| **P×C Interaction** | | | | | | | | |
| P1C1 | 60.6$^{b}$ | 61.0$^{b}$ | 1283.3 | 3.25 | 0.11 | 3.43 | 90.7$^{c}$ | 1277.3$^{c}$ |
| P1C2 | 56.9 | 55.9$^{c}$ | 1396.7$^{c}$ | 4.20$^{b}$ | 0.13 | 3.09 | 91.0$^{b}$ | 1335.1$^{b}$ |
| P1C3 | 55.8 | 49.9 | 1496.7$^{a}$ | 3.16 | 0.07 | 3.36 | 86.7 | 1270.3 |
| P2C1 | 65.1$^{a}$ | 64.2$^{a}$ | 1220.0 | 4.54$^{a}$ | 0.17 | 4.20 | 91.7$^{a}$ | 1146.6 |
| P2C2 | 57.3$^{c}$ | 51.2 | 1280.0 | 4.10$^{c}$ | 0.12 | 3.55 | 88.3 | 1478.7$^{a}$ |
| P2C3 | 56.3 | 49.8 | 1493.3$^{b}$ | 3.81 | 0.08 | 3.72 | 70.7 | 651.1 |
| P3C1 | 20.1 | 20.0 | 426.7 | 1.07 | 0.04 | 1.01 | 29.3 | 391.6 |
| P3C2 | 19.2 | 18.7 | 466.7 | 1.45 | 0.04 | 1.95 | 29.0 | 417.6 |
| P3C3 | 18.3 | 16.7 | 500.0 | 1.03 | 0.02 | 1.03 | 28.7 | 419.5 |
| SEm(±) | 0.53 | 0.24 | 9.99 | 0.23 | 0.01 | 0.21 | 1.12 | 116.43 |
| CD (P=0.05) | 1.60 | 1.2 | 30.0 | 0.70 | NS | NS | 3.3 | 349.1 |

NS – Non Significant
P1 - Pollination done between 8.00 – 9.00 am
P2 - Pollination done between 9.00 – 10.00 am
P3 - Pollination done between 9.00 – 10.00 am
C1 – 20 fruits per plant
C2 – 25 fruits per plant
C3 – 30 fruits per plant

with those of Kivadasannavar *et al.* (2009) in chilli, Kumar *et al.* (2008) in tomato and Abhishekkatagi *et al.* (2013) in okra who have reported 9am -12 noon, 10 am and 9 am-12 noon, respectively as the best time for pollination with respect to seedling vigour index.

Therefore, from the study it can be inferred that the pollination done between 9.00-10.00 am was optimum for hybrid seed production of tomato in order to obtain good fruit set and seed yields with better quality.

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