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# Effect of methods and time of pollination on seed yield and quality parameters in cherry tomato grown under different protected conditions

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## ABSTRACT

**A research experiment was conducted in three types of protected conditions to study the effect of different methods of pollination and time of pollination on berry setting, berry size and other seed yield and quality parameters of cherry tomato variety Pusa Selection-1 during the autumn-winter season of 2011-12 and 2012-13. Among the structures semi-controlled environmental polyhouse recorded significantly highest fruit set of mature berries (40.99%) followed by naturally ventilated polyhouse (40.51%) and insect-proof nethouse (39.25%). Among the methods of pollination, air-blowing recorded more fruit set (41.76%), berry weight (6.070 g), berry width (2.36 cm), berry length (2.22 cm), number of seeds (68.05), 100-seed weight (0.1291 g), seed yield per berry (0.0872 g) and germination (80.71%). The pollination at 11.00 am had given better result under all three conditions. The seed contributing traits were lower under insect proof nethouse (P3) indicating its limitations for cherry tomato seed production.**

**Key words:** Cherry tomato, pollination methods, protected structures, seed production.

## INTRODUCTION

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*), a wild relative of slice tomato, is one of the emerging tropical vegetable crop under protected cultivation. Although it is self-pollinated but the percentage of berry set under polyhouse conditions is very poor and lead to the production of limited berries with less number of seeds, hence resulting poor seed yield. This is theto less or no movement of air in the polyhouse affect the transfer of pollen to stigma, especially under low light intensity and short day conditions. Pollination in tomato flowers does not occur in glasshouses in winter unless they are disturbed either by wind or by artificial means. Moreover, pollen tends to be sticky and to aggregate in winter, whereas in summer such condition does not occur (Picken, 10). The fruit set is low at 10 and 12.8°C, while optimum temperature requirement is 25°C and 30°C during day and 22°C during the night (Gomejo Lopez and Gomez, 3). However, 2-4°C increase in optimal temperature adversely affected gamete development and inhibited the ability of pollinated flowers develop into seeded fruits and thus reduced crop yield (Firon *et al*., 4). Pollen production and pollen viability are very sensitive to minimal increase in temperature above the optimum (Sato *et al*., 12). The reduction of fruit set under moderately high temperature stress is mostly due to a reduction in pollen release and viability but not in pollen production (Sato *et al*., 12). The imported bumble bees are high in cost, however, is not advantageous to their early and widespread adoption (Giordano *et al*., 5). The application of hormone may offer an attractive alternative to the electrical 'bee' in view of labour cost but more reliable and effective treatment need to be found. Considering the pivotal role of pollination for good fruit set, seed set and limited availability of information particular in cherry tomato seed production under protected conditions. Thus the present investigation with three artificial methods of pollination and three different time of pollination under three different protected structures were planned to find out the suitable structure, method as well as time of pollination for cherry tomato seed production.

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## MATERIALS AND METHODS

The present study was conducted at Centre for Protected Cultivation Technology, IARI, New Delhi during autumn winter of 2011-12 and 2012-13 with newly developed cherry tomato cv. Pusa Selection-1. The seedlings were raised in multi-celled plastic plug trays (20 $cm^3$) using soilless media consisting of cocopeat, vermiculite and perlite in the ratio of 3:1:1 (on volume basis). Fertigation in nursery was done once in a day and the concentrations of NPK as well as micro-nutrients were kept from 20 to 80 ppm based upon the stage of the nursery. Seedlings were transplanted at the two-true leaf stage in three different environmental conditions, *viz*., P1 (semi-climate controlled polyhouse), P2 (naturally ventilated polyhouse) and P3 (insect proof nethouse) after hardening them under direct sunlight. Plants were fertigated at 100% of nutrient concentration through a drip system with integrated droppers for every 30 $cm^3$. An identical management practise (stacking, irrigation and plant protection measures) were followed under three environments. The pollination was done following three methods of pollination, *viz*., pollination by stick (M1); with the help of a stick a three gentle knocks were employed on the truss. Pollination by using vibrator (M2); Vibrator was used for affecting pollination by keeping it on the truss for few seconds each, without touching the individual blossom. Pollination by using air blower (M3); air blower (Black and Decker, KTX5000) was employed for pollination by blowing air for five seconds, at three different timings, *viz*., 9-00 am (T1), 10-00 am (T2) and 11-00 am (T3). The pollination was employed next day as per above mentioned treatments. The trusses were selected one day before the artificial pollination with flowers, which will open next day by removing all the immature and undeveloped buds from truss. Completely randomised block design with factorial arrangement of 3 × 3 × 3 (27 treatments applied at the time of pollination) was used to for experiment

The observations were recorded for the seed yield attributing traits, *viz*., number of flowers, number of berry set per truss, number of berries developed to maturity, berry weight (g), number of seeds per berry, and 100-seed weight (g). The germination (%) was recorded following the standard guidelines of ISTA (7). The experimental data of individual year and pooled were subjected to analysis of variance (ANOVA) by using SAS 9.2 software.

## RESULTS AND DISCUSSION

The results presented (Table 1) indicated significant differences ($P \leq 0.01$) for structure, different methods of pollination, time of pollination and their interactions. Under P1 higher number of berry set per truss were recorded (73.10), followed by P3 (64.06) and P2 (63.65). The air blowing method (M3) recorded highest number of berry (72.91) followed by M2 (65.97) and M1 (61.93). At 11.00 am T3 showed higher number of fruit set (69.96), with minimum in T1 (63.31) and results are in agreement with Peet *et al.* (9). The initial berry set was higher in P1 (64.92%), followed by P2 (61.73%) and P3 (60.08%), with air-blowing method of pollination at 11.00 am. The variable mature berry set per truss (Table 1) showed the similar trend by recording more number of mature berries under P1 (28.64 and 40.56%), followed by P2 (25.60 and 39.15%) as compared to P3 (24.220 and 38.13%). The increase in the mature fruit set under P1 could be due to the enrichment of carbon dioxide, which markedly improves yield principally by increasing fruit set and the final sizes of fruit. The highest value of mature berry set (%) was recorded for P1 (40.03) at 11:00 am under air blower method of pollination. This finding was in accordance with Sanjeev Kumar *et al.* (11) who studied the effect of crossing ratio and pollination time in tomato for yield attributes. The interaction P1M3T3 showed significantly higher effect in this variable. In addition, all the factors (polyhouse, method of pollination and time of pollination) showed significant interaction ($P \leq 0.01$), since the small difference between the day and night temperatures effect the growth and development of plants grown under different environments. The short photoperiods during winter with less irradiance were limiting the production of carbohydrates and deficit affect the vegetative growth. The low mature fruit set under nethouse condition, may also be due to competition with the neighbouring berries, and was aptly reported by Hurd *et al.* (6) that sometimes all of the fruits on a truss show a delay in swelling under conditions of severe competition with other trusses of fruit. The interaction among P × M, P × T, M × T, P × M × T were significance for number of mature berry set percentage per truss. Among the interaction of the combination P1M3 (43.62%), P2M2 (41.50%) and P1M3T3 (43.97%) have been recorded for higher mature berry set per truss in cherry tomato.

The berry attributes, *viz*., berry weight, length and fruit width were significantly affected by protected conditions ($P \leq 0.01$). The variables showed a direct relationship with the protected conditions. Average fruit weight is directly contributed to total yield (Amit *et al*., 1). Highest value for average berry weight was recorded for P1 (6.15 g) compared to P2 (6.08 g) followed P3 (5.6 g) condition (Table 2). The increase in weight of berry was subsequently increased the length and width. The M3 recorded higher berry weight (6.07 g), followed by M2 (5.90 g). The air-blow method of pollination was recorded higher value (6.17 g) under P1 condition for berry weight followed by P2 and P3 for the same method (6.11 and 5.94 g respectively). More berry weight (6.15 g) per truss was noted at 11.00 am under P1 condition, followed by P2 (6.14 g) and P3 (5.66 g) as compared to 9:00 and 10:00 am pollination. The fruit size and number of fruits increased with artificial method of pollination under greenhouse conditions in tomato. The highest berry weight at 11.00 am might be due to the increased effectiveness of air-blower method at mid day as a consequent of higher temperature and irradiance at this time and the relative humidity of the polyhouse is around 70%, which is very congenial for transfer of pollen from anthers to stigma. The interaction among P × M, P × T, M × T, P × M × T were significance for berry weight per truss. Among the interaction combinations P1M3T3 (6.20 g) noted higher berry weight per truss in cherry tomato.

The number of seeds/berry registered significant differences ($P \leq 0.01$) between all the three factors polyhouse, pollination methods and time of pollination

**Table 1.** Effect of growing structures, methods of pollination & time and their interaction on berry set and its traits in cherry tomato.

| | No. of berries set per truss | | | Berry set (%) | | | No. of mature berry per truss | | | Mature berry set (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled |
| Structure (P) | | | | | | | | | | | | |
| P1 | 71.34 | 68.92 | 70.13 | 64.19 | 65.65 | 64.92 | 29.53 | 27.38 | 28.46 | 41.44 | 39.68 | 40.56 |
| P2 | 67.80 | 62.92 | 65.36 | 62.53 | 60.93 | 61.73 | 27.08 | 24.11 | 25.60 | 39.96 | 38.34 | 39.15 |
| P3 | 65.83 | 61.14 | 63.48 | 61.05 | 59.11 | 60.08 | 25.76 | 22.68 | 24.22 | 39.16 | 37.11 | 38.13 |
| CD (P = 0.05) | 0.30 | 0.43 | 0.37 | 0.42 | 0.59 | 0.51 | 0.18 | 0.37 | 0.27 | 0.31 | 0.62 | 0.46 |
| Method of pollination (M) | | | | | | | | | | | | |
| M1 | 66.50 | 64.12 | 65.31 | 62.61 | 59.91 | 61.26 | 26.42 | 24.26 | 25.34 | 39.46 | 37.65 | 38.55 |
| M2 | 69.21 | 63.19 | 66.20 | 61.29 | 61.26 | 61.28 | 27.41 | 24.01 | 25.71 | 39.91 | 38.10 | 39.00 |
| M3 | 69.26 | 65.67 | 67.46 | 63.87 | 64.51 | 64.19 | 28.54 | 25.90 | 27.22 | 41.20 | 39.38 | 40.29 |
| CD (P = 0.05) | 0.30 | 0.43 | 0.37 | 0.42 | 0.59 | 0.51 | 0.18 | 0.37 | 0.27 | 0.31 | 0.62 | 0.46 |
| Time of pollination (T) | | | | | | | | | | | | |
| T1 | 67.38 | 59.44 | 63.41 | 61.92 | 57.20 | 59.56 | 25.70 | 21.94 | 23.82 | 39.64 | 37.02 | 38.33 |
| T2 | 66.28 | 65.65 | 65.96 | 60.76 | 63.36 | 62.06 | 27.52 | 25.52 | 26.52 | 40.16 | 38.81 | 39.48 |
| T3 | 71.31 | 67.89 | 69.60 | 65.10 | 65.13 | 65.11 | 29.16 | 26.72 | 27.94 | 40.77 | 39.30 | 40.03 |
| CD (P = 0.05) | 0.30 | 0.43 | 0.37 | 0.42 | 0.59 | 0.51 | 0.18 | 0.37 | 0.27 | 0.31 | N.S. | 0.31 |

| Interactions (pooled) | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1M1 | 65.88 | 69.68 | 70.73 | 68.76 | 61.66 | 65.08 | 65.63 | 64.12 | 26.78 | 27.94 | 28.18 | 27.63 | 38.15 | 38.55 | 40.12 | 38.94 |
| P1M2 | 70.78 | 71.80 | 74.03 | 72.20 | 63.20 | 65.47 | 66.38 | 65.02 | 28.35 | 28.85 | 29.96 | 29.05 | 41.04 | 39.83 | 40.42 | 40.43 |
| P1M3 | 71.21 | 81.24 | 82.60 | 78.35 | 67.27 | 77.25 | 77.31 | 73.84 | 28.74 | 33.36 | 35.51 | 32.54 | 43.00 | 43.88 | 43.97 | 43.62 |
| P2M1 | 54.64 | 55.86 | 59.88 | 56.79 | 53.13 | 53.74 | 57.53 | 54.80 | 25.74 | 23.93 | 24.54 | 24.73 | 39.12 | 40.09 | 40.21 | 39.81 |
| P2M2 | 63.96 | 64.51 | 65.73 | 64.73 | 61.19 | 61.12 | 61.81 | 61.37 | 26.33 | 24.38 | 24.85 | 25.18 | 39.85 | 40.67 | 40.12 | 40.21 |
| P2M3 | 62.65 | 69.36 | 76.23 | 69.41 | 59.58 | 66.66 | 72.39 | 66.21 | 30.78 | 25.68 | 27.61 | 28.02 | 43.02 | 40.39 | 41.08 | 41.50 |
| P3M1 | 58.95 | 60.66 | 61.10 | 60.24 | 54.15 | 56.83 | 56.93 | 55.97 | 22.66 | 23.74 | 23.55 | 23.32 | 38.55 | 38.83 | 38.86 | 38.75 |
| P3M2 | 57.13 | 61.98 | 63.81 | 60.97 | 54.75 | 59.69 | 61.15 | 58.53 | 21.81 | 25.58 | 23.65 | 23.68 | 38.24 | 38.20 | 40.10 | 38.84 |
| P3M3 | 64.61 | 72.71 | 75.58 | 70.97 | 62.56 | 69.66 | 71.17 | 67.80 | 25.80 | 30.01 | 29.56 | 28.46 | 40.01 | 40.71 | 39.76 | 40.16 |
| CD (P = 0.05) | | | | | | | | | | | | | | | | |
| P*M | | 0.601 | | | | 0.825 | | | | 0.305 | | | | 0.627 | | |
| P*T | | 0.601 | | | | 0.825 | | | | 0.305 | | | | NS | | |
| M*T | | 0.601 | | | | 0.825 | | | | 0.305 | | | | NS | | |
| P*M*T | | 1.041 | | | | 1.429 | | | | 0.528 | | | | 1.087 | | |

P1 = Semi-climate controlled polyhouse
P2 = Naturally ventilated polyhouse
P3 = Insect-proof nethouse

M1 = Knocking of truss with stick
M2 = Vibration
M3 = Air-blow method

T1 = 09.00 am
T2 = 10.00 am
T3 = 11.00 am

**Table 2.** Effect of growing structures, methods of pollination & time and other interaction with berry attributes and number of seeds per berry in cherry tomato.

| | Mature berry weight (g) | | | Berry width (cm) | | | Berry length (cm) | | | No. of seeds per berry | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled |
| Structure (P) | | | | | | | | | | | | |
| P1 | 6.27 | 6.03 | 6.15 | 2.44 | 2.30 | 2.37 | 2.34 | 2.26 | 2.30 | 70.65 | 69.24 | 67.87 |
| P2 | 6.16 | 6.00 | 6.08 | 2.47 | 2.13 | 2.30 | 2.27 | 2.18 | 2.23 | 64.54 | 61.20 | 63.94 |
| P3 | 5.72 | 5.50 | 5.61 | 2.17 | 2.12 | 2.09 | 1.88 | 1.81 | 1.85 | 64.52 | 60.60 | 63.75 |
| CD (P = 0.05) | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.30 | 0.31 | 0.260 |
| Method of pollination (M) | | | | | | | | | | | | |
| M1 | 5.93 | 5.79 | 5.86 | 2.33 | 2.05 | 2.18 | 2.07 | 1.99 | 2.03 | 64.66 | 63.22 | 63.21 |
| M2 | 6.02 | 5.79 | 5.90 | 2.32 | 2.14 | 2.22 | 2.16 | 2.08 | 2.12 | 65.23 | 63.03 | 64.29 |
| M3 | 6.19 | 5.96 | 6.07 | 2.43 | 2.36 | 2.36 | 2.27 | 2.18 | 2.22 | 69.82 | 64.79 | 68.05 |
| CD (P = 0.05) | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.30 | 0.31 | 0.260 |
| Time of pollination (T) | | | | | | | | | | | | |
| T1 | 5.95 | 5.81 | 5.88 | 2.31 | 2.14 | 2.22 | 2.11 | 2.02 | 2.07 | 65.24 | 63.02 | 63.33 |
| T2 | 6.10 | 5.85 | 5.97 | 2.37 | 2.19 | 2.26 | 2.19 | 2.10 | 2.14 | 66.29 | 63.98 | 64.62 |
| T3 | 6.10 | 5.87 | 5.99 | 2.39 | 2.23 | 2.28 | 2.21 | 2.12 | 2.17 | 68.18 | 64.04 | 67.61 |
| CD (P = 0.05) | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 | 0.02 | 0.02 | 0.02 | 0.303 | 0.307 | 0.260 |

| Interactions (pooled) | Mature berry weight (g) | | | | Berry width (cm) | | | | Berry length (cm) | | | | No. of seeds per berry | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean |
| P1M1 | 6.11 | 6.14 | 6.14 | 6.13 | 2.32 | 2.25 | 2.41 | 2.33 | 2.22 | 2.25 | 2.26 | 2.24 | 65.49 | 64.00 | 68.93 | 66.14 |
| P1M2 | 6.14 | 6.14 | 6.15 | 6.14 | 2.29 | 2.39 | 2.32 | 2.33 | 2.30 | 2.33 | 2.34 | 2.32 | 67.13 | 69.79 | 66.74 | 67.88 |
| P1M3 | 6.14 | 6.18 | 6.20 | 6.17 | 2.45 | 2.45 | 2.46 | 2.45 | 2.31 | 2.34 | 2.36 | 2.33 | 68.94 | 67.58 | 72.24 | 69.58 |
| P2M1 | 5.82 | 6.18 | 6.13 | 6.04 | 2.23 | 2.24 | 2.26 | 2.24 | 2.22 | 2.16 | 2.22 | 2.20 | 60.91 | 61.80 | 62.14 | 61.62 |
| P2M2 | 6.08 | 6.05 | 6.14 | 6.09 | 2.19 | 2.27 | 2.28 | 2.24 | 2.15 | 2.34 | 2.23 | 2.24 | 58.44 | 60.93 | 66.56 | 61.98 |
| P2M3 | 6.10 | 6.09 | 6.15 | 6.11 | 2.40 | 2.42 | 2.42 | 2.41 | 2.24 | 2.20 | 2.28 | 2.24 | 63.10 | 70.15 | 71.40 | 68.22 |
| P3M1 | 5.53 | 5.39 | 5.34 | 5.42 | 2.00 | 1.96 | 2.00 | 1.98 | 1.64 | 1.70 | 1.64 | 1.66 | 62.40 | 61.19 | 62.08 | 61.89 |
| P3M2 | 5.49 | 5.48 | 5.48 | 5.48 | 2.05 | 2.08 | 2.09 | 2.07 | 1.90 | 1.64 | 1.84 | 1.79 | 60.16 | 62.10 | 66.73 | 63.00 |
| P3M3 | 5.52 | 6.14 | 6.16 | 5.94 | 2.06 | 2.27 | 2.30 | 2.21 | 1.62 | 2.34 | 2.34 | 2.10 | 63.36 | 64.01 | 71.69 | 66.35 |
| CD (P = 0.05) | | | | | | | | | | | | | | | | |
| P*M | | 0.03 | | | | NS | | | | 0.04 | | | | 0.305 | | |
| P*T | | 0.03 | | | | 0.05 | | | | 0.04 | | | | 0.305 | | |
| M*T | | 0.03 | | | | NS | | | | 0.04 | | | | 0.305 | | |
| P*M*T | | 0.04 | | | | 0.09 | | | | 0.06 | | | | 0.528 | | |

P1 = Semi-climate controlled polyhouse
P2 = Naturally ventilated polyhouse
P3 = Insect-proof nethouse

M1 = Knocking of truss with stick
M2 = Vibration
M3 = Air-blow method

T1 = 09.00 am
T2 = 10.00 am
T3 = 11.00 am

(Table 2). The P1 showed more value (67.87) followed by P2 (63.94) and P3 (63.75). Among the pollination methods, air-blower method showed more number of seeds/ berry (68.05) under P1 condition followed by P2 (64.29) and P3 (63.21). The pollination at 11.00 am recorded highest number of seeds/berry (67.61), followed by T2 (64.62) and T1 (63.33). The higher number of seeds/berry in the air blowing method might be due to better pollination compared to vibration and stick methods. The interaction among P × M, P × T, M × T, P × M × T were recorded significant for number of seeds per truss and among the interaction combinations the P1M3T3 have been recorded for more number of seeds per truss (72.24). The 100-seed weight significantly affected by different environments (*P*≤0.01) and interaction between structures and method of pollination showed significance (Table 3).

**Table 3.** Effect of growing structures, methods & time of pollination and their interaction on 100-seed weight, seed yield (g) and germination (%) in cherry tomato.

| | 100-seed weight (g) | | | Seed yield per berry (g) | | | Germination (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled | 2011-12 | 2012-13 | Pooled |
| Structure (P) | | | | | | | | | |
| P1 | 0.132 | 0.132 | 0.132 | 0.090 | 0.089 | 0.087 | 81.33 | 79.81 | 80.57 |
| P2 | 0.127 | 0.124 | 0.126 | 0.087 | 0.084 | 0.087 | 81.00 | 79.28 | 80.14 |
| P3 | 0.127 | 0.122 | 0.125 | 0.078 | 0.072 | 0.086 | 80.56 | 78.83 | 79.69 |
| CD (P = 0.05) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.46 | 0.46 | 0.41 |
| Method of pollination (M) | | | | | | | | | |
| M1 | 0.126 | 0.126 | 0.125 | 0.083 | 0.082 | 0.086 | 80.67 | 78.92 | 79.79 |
| M2 | 0.130 | 0.126 | 0.128 | 0.084 | 0.082 | 0.087 | 80.67 | 79.14 | 79.90 |
| M3 | 0.131 | 0.127 | 0.129 | 0.088 | 0.081 | 0.087 | 81.56 | 79.86 | 80.71 |
| CD (P = 0.05) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.46 | 0.46 | 0.41 |
| Time of pollination (T) | | | | | | | | | |
| T1 | 0.127 | 0.126 | 0.126 | 0.083 | 0.082 | 0.087 | 80.67 | 78.94 | 79.81 |
| T2 | 0.129 | 0.126 | 0.127 | 0.086 | 0.082 | 0.087 | 80.89 | 79.28 | 80.08 |
| T3 | 0.130 | 0.127 | 0.129 | 0.086 | 0.082 | 0.087 | 81.33 | 79.69 | 80.51 |
| CD (P = 0.05) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | N.S. | N.S. | N.S. |

| Interactions (pooled) | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1M1 | 0.126 | 0.127 | 0.130 | 0.128 | 0.087 | 0.087 | 0.087 | 0.087 | 80.13 | 79.63 | 80.63 | 80.13 |
| P1M2 | 0.132 | 0.133 | 0.133 | 0.133 | 0.089 | 0.087 | 0.088 | 0.088 | 80.13 | 80.13 | 80.13 | 80.13 |
| P1M3 | 0.132 | 0.135 | 0.136 | 0.134 | 0.087 | 0.088 | 0.088 | 0.087 | 80.13 | 82.13 | 82.13 | 81.46 |
| P2M1 | 0.123 | 0.124 | 0.125 | 0.124 | 0.087 | 0.087 | 0.087 | 0.087 | 79.13 | 80.13 | 80.13 | 79.79 |
| P2M2 | 0.125 | 0.125 | 0.126 | 0.125 | 0.088 | 0.087 | 0.087 | 0.087 | 80.13 | 80.13 | 80.13 | 80.13 |
| P2M3 | 0.126 | 0.126 | 0.130 | 0.127 | 0.086 | 0.088 | 0.087 | 0.087 | 80.13 | 80.25 | 81.13 | 80.50 |
| P3M1 | 0.123 | 0.123 | 0.124 | 0.123 | 0.086 | 0.086 | 0.086 | 0.086 | 79.13 | 79.13 | 80.13 | 79.46 |
| P3M2 | 0.123 | 0.129 | 0.124 | 0.125 | 0.087 | 0.086 | 0.086 | 0.086 | 80.13 | 79.13 | 79.13 | 79.46 |
| P3M3 | 0.124 | 0.124 | 0.129 | 0.126 | 0.086 | 0.087 | 0.088 | 0.087 | 79.25 | 80.13 | 81.13 | 80.17 |
| CD (P = 0.05) | | | | | | | | | | | | |
| P*M | | 0.000 | | | | N.S. | | | | 0.709 | | |
| P*T | | 0.000 | | | | 0.000 | | | | N.S. | | |
| M*T | | 0.000 | | | | 0.000 | | | | 0.709 | | |
| P*M*T | | 0.001 | | | | 0.000 | | | | N.S. | | |

P = Polyhouse
P1 = Semi-climate controlled polyhouse
P2 = Naturally ventilated polyhouse
P3 = Insect-proof nethouse

M = Method of pollination
M1 = Knocking of truss with stick
M2 = Vibration
M3 = Air-blow method

T = Time of pollination
T1 = 09.00 am
T2 = 10.00 am
T3 = 11.00 am

The 100-seed weight was higher under P1 (0.132 g) as compared to P2 (0.126 g) and P3 (0.125 g). The less seed weight under P3 might be due to the lower temperature and low irradiation and is in agreement with Jolli (8). Air-blower method of pollination (M3) recorded more 100-seed weight (0.129 g) in P1, whereas, P2 (0.128 g) and P3 (0.125 g) recorded at par values may due to the better pollen dispersion resulting proper development of fruits and seeds. The pollination at 11.00 am (T3) resulted in higher seed weight (0.129 g) as compared to T2 (0.127 g) and T1 (0.126 g). The interaction among P × M, P × T, M × T, P × M × T were significant. Among the interaction combinations P1M3 (0.134 g), P1T3 (0.133 g) and P1M3T3 (0.136 g) were recorded for higher 100-seed weight. Seed yield per berry showed significant difference for structures ($P \leq 0.01$) and method of pollination. Among the structures P1 noted higher seed yield (0.088 g), followed by P2 (0.087 g) and P3 (0.086). The pollination by air-blow method (M3) and shaking recorded at par for seed yield (0.872 g) with low seed yield/berry in M1. The pollination at 11.00 AM recorded more seed yield per berry (0.0871 g) followed by T1 and T2. The interactions among P × T, M × T, P × M × T were recorded significant difference for seed yield per berry, with best performing combinations of P1M2T3, P1M3T3 and P3M3T3. The germination percent was higher in P1 (80.57), followed by P2 (80.14) and P3 (79.69). The air-blow method of pollination (M3) recorded for high germination percentage (80.71) followed by M2 and M1 (79.90 & 79.79). The higher percentage of P1 and M3 could be due to the better development of seed as evident from higher 100-seed weight. The interaction among P x M had recorded significant for germination percentage and interaction combination P1M1T3 (80.63) have been recorded higher germination percentage than other types of combinations.

Keeping in view of the results obtained it is recommended that cherry seed production under subtropical conditions (north India) should be organized under semi-environment controlled polyhouse and pollination with air-blow method at 11:00 am should be practiced for higher seed yield and quality.

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