Original Research Article

Effect of Training System and Fruit Load on Seed Production and Quality of Bell Pepper

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Abstract

Study was conducted on effect of training system and fruit load on seed production and quality of bell pepper using cv. “Solan Bharpur” in the Department of Seed Science and Technology, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during kharif season 2018. The experiment was laid out in Randomized Block Design (Factorial) in the open field and in Completely Randomized Design (Factorial) in laboratory. Three training systems (no training - Tr1, two stem training - Tr2, four stem training - Tr3) and four fruit loads (retaining all fruits - FL1, retaining ten fruits - FL2, retaining twelve fruits - FL3, retaining fourteen fruits - FL4 plant⁻¹) were used with different treatment combinations. The treatment combination Tr2FL2 (two stem training with ten fruits plant⁻¹) proved superior in terms of ripe fruit weight (66.65g), ripe fruit length (6.56 cm), ripe fruit width (5.05 cm), number of seeds fruit⁻¹ (187.77), 1000 seed weight (6.21 g), germination (96.50%), speed of germination (15.95), seed vigour index-I (1448.30), seed vigour index-II (284.77) and electrical conductivity of seeds (0.060 dSm⁻¹). Therefore, Tr2FL2 treatment combination can be recommended for quality seed production of bell pepper under mid hills of Himachal Pradesh.

Keywords
Training system, Fruit load and Electrical conductivity of seed

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Introduction

Bell pepper (Capsicum annuum L. var. grossum Sendt) and chilli (Capsicum annuum L. var. longum) are very important vegetable fruit crops cultivated for their edible botanical fruit. Both of these crops are members of the family Solanaceae. Capsicum annuum L. var. grossum Sendt is a native of Mexico with secondary centre of origin in Guatemala (5). Britishers introduced it in 19th Century in Shimla, Himachal Pradesh and Nilgiri hills of Tamil Nadu (7). In India, capsicum is known by the name Shimla mirch, especially in northern regions. Other names of capsicum are sweet pepper, bell pepper, bull nose or capsicum. Himachal Pradesh is a leading supplier of bell pepper fruits to the plains during summer and rainy seasons, hence good source of fetching a higher price due to off-season cultivation.
Seed is the basic input of agriculture and quality seed has been reported to improve yield by 10-20 per cent. Under Indian conditions, non availability of quality seed is the major constraint leading to low productivity. It is well said in manusmirti that “good seed on good land yields abundance produce”. Green revolution in India was possible only due to quality seeds. The response of other inputs like irrigation, fertilizers depends on the quality of seed.

Two-stem training system in capsicum has been found best for most traits except, number of flowers plant\(^{-1}\) and days to first picking which were best under control i.e. on plants not trained at all (19). According to Ansari, 2012 (2) double stem training system can be recommended for commercial seed production of tomato. In bell pepper, studies by Thakur et al., 2018 (21) revealed maximum fruit weight (175.91 g) and least number of days to first harvest (89.36 days), early flower initiation as well as 50 per cent flowering (52.71 days) under two shoots training level. Planting density of 45x30 cm in combination with two shoot training system can be recommended for commercial seed production of bell pepper (8). Nabi et al., 2009 (14) observed that retaining 1\(^st\) six fruits plant\(^{-1}\) in capsicum increased per cent seed germination, 1000-seed weight and seedling vigour indices (both I and II). Maboko et al., (2012) (11) investigated that effect of plant population, flower and stem pruning of hydroponically grown peppers and concluded that quality can be effectively manipulated by plant population and stem pruning, while flower pruning had insignificant (p<0.05) effect.

**Materials and Methods**

The experiment was laid down on 1\(^st\) May 2018 at Pandah Experimental Farm of the Department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP) located at an altitude of 1250 m above mean sea level with latitude of 35.50\(^{\circ}\) N and longitude of 77.80\(^{\circ}\) E in the mid-hill zone of Himachal Pradesh (India). Bell pepper cv. Solan Bharpur seedlings were transplanted in a Randomized Block Design (Factorial) comprising of twelve treatment combinations replicated thrice. The seeds harvested were tested for quality parameters in laboratory using Completely Randomized Design (factorial) with the same set of treatment combinations replicated four times. Different combinations of training systems and fruit load (Tr\(_1\)FL\(_1\)-No training and all fruits retained, Tr\(_1\)FL\(_2\)-No training and 10 fruits retained plant\(^{-1}\), Tr\(_1\)FL\(_3\)-No training and 12 fruits retained plant\(^{-1}\), Tr\(_1\)FL\(_4\)-No training and 14 fruits retained plant\(^{-1}\), Tr\(_2\)FL\(_1\)-Two shoot training and all fruits, Tr\(_2\)FL\(_2\)-Two shoot training and 10 fruits retained plant\(^{-1}\), Tr\(_2\)FL\(_3\)-Two shoot training and 12 fruits retained plant\(^{-1}\), Tr\(_2\)FL\(_4\)-Two shoot training and 14 fruits retained plant\(^{-1}\), Tr\(_3\)FL\(_1\)-Four shoot training and all fruits, Tr\(_3\)FL\(_2\)-Four shoot training and 10 fruits retained plant\(^{-1}\), Tr\(_3\)FL\(_3\)-Four shoot training and 12 fruits retained plant\(^{-1}\), Tr\(_3\)FL\(_4\)-Four shoot training and 14 fruits retained plant\(^{-1}\)) were used in the study.

On plot basis, observations recorded were plant height (cm) taken at the end of crop season before start of leaf senescence, ripe fruit weight (g), ripe fruit length (cm), ripe fruit width (cm), harvest durations (days), seed yield plant\(^{-1}\) (g) and number of seeds fruit\(^{-1}\), determined on freshly harvested fruits from the healthy plant. Three replications were used in each case. 1000 seed weight (g), germination percentage, speed of germination, seed vigour index-I, Seed vigour index-II and electrical conductivity (dsm\(^{-1}\)) were determined after drying the seed to moisture content of <8% as per the ISTA guidelines (3). In case of laboratory
experiment, 400 seeds in the form of four replications were used for each treatment. Germination was calculated by using the formula:

\[
\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds used}} \times 100
\]

Speed of germination was calculated as:

\[
\text{Speed of Germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2 - Y_1} + \cdots + \frac{X_n - X_{n-1}}{Y_n - Y_{n-1}}
\]

where, \( X_1, X_2 \) and \( X_n \) are number of seeds germinated on first, second and \( n^{th} \) day, respectively and \( Y_1, Y_2 \) and \( Y_n \) are number of days from sowing to first, second and \( n^{th} \) count, respectively. Speed of germination was measured by using top of the paper method.

Seedling vigour index-I was calculated as per the formula given by Abdul-Baki and Anderson (1973) (1) as:

\[
\text{Seedling vigour index-I} = \text{Germination (\%)} \times \text{Seedling length (cm)}
\]

Seedling vigour index-II was calculated as per the formula given by Abdul-Baki and Anderson (1973) (1) as:

\[
\text{Seedling vigour index-II} = \text{Germination (\%)} \times \text{Seedling dry weight (mg)}
\]

Statistical analysis was done as per experimental design suggested by Panse and Sukhatme, 2000 (17).

**Results and Discussion**

**Fruit and seed yield parameters**

The data pertaining to the effect of training systems and fruit load on fruit and seed yield parameters have been presented in Tables1 and 2. Significantly maximum plant height (63.99 cm) recorded in \( \text{Tr}_2 \) (two stem training system) might be due to the reason that removal of branches enhanced the apical dominance with great competition for space and light that forced the plants to grow taller. The lowest plant height (51.15 cm) recorded in \( \text{Tr}_3 \) (four stem training system) was statistically at par with \( \text{Tr}_1 \) (no training). These findings are in line with Udit and Girish, 2014 (22) and Singh and Kaur, 2017 (18) in bell pepper. Effects of fruit load and interaction were found to be non-significant. Highest significant ripe fruit weight (59.04 g) was obtained in \( \text{Tr}_2 \) (two stem training system) and \( \text{Tr}_1 \) (no training) resulted in lowest fruit weight (52.26 g). The reason for maximum fruit weight could be that pruning treatment resulted in increased fruit weight owing to more production of photosynthates due to better interception of solar radiation resulting in adequate supply of metabolites to limited number of fruits. These findings match with the work done by Shukla et al., 2011 (19) in bell pepper. With regard to fruit load, significantly maximum fruit weight (62.47 g) was obtained in \( \text{FL}_2 \) (ten fruits plant\(^{-1}\)) and lowest fruit weight (48.62 g) was obtained in \( \text{FL}_1 \) (retaining of all fruits). These results are in line with the findings of Manjunatha et al., 2007 (12) in bell pepper. In case of interaction effect, significantly maximum ripe fruit weight (66.65 g) was recorded in the treatment \( \text{Tr}_2\text{FL}_2 \) (two stem training with retaining of ten fruits plant\(^{-1}\)) and \( \text{Tr}_1\text{FL}_1 \) (no training and retaining all fruits) produced minimum ripe fruit weight (46.44 g). These results are in agreement with Chen-You, 2000 (6). Training system \( \text{Tr}_2 \) (two stems plant\(^{-1}\)) resulted in significantly maximum fruit length (6.12 cm) whereas minimum (5.32 cm) was recorded in \( \text{Tr}_1 \) (no training). Similar results were observed by Lal, 2013 (8) in bell pepper. For fruit load, maximum significant value (6.05 cm) was noticed in treatment \( \text{FL}_2 \) (ten fruits plant\(^{-1}\)) whereas minimum fruit length (5.45 cm)
recorded in FL4 (14 fruits plant⁻¹) was statistically at par with FL1 (all fruits retained). These observations are in conformity with Bhatt and Srinivasa Rao, 1997 (4) and Manjunanatha et al., 2007 (12) in bell pepper. For interaction effect, maximum fruit length (6.56 cm) was found in treatment combination Tr2FL2 whereas minimum value (5.00 cm) was recorded in Tr1FL1 (no training and retaining and all fruits) but with non-significant differences. The reason for maximum fruit length in Tr2FL2 might be due to higher source to sink ratio as in case of more sink, the accumulation of assimilates was low and it directly affected the length of fruit. Significantly maximum fruit width (4.74 cm) was observed in Tr2 (two stem) and minimum (4.15cm) obtained in Tr1 (no training) was statistically at par with Tr3 (four stem training). Shukla et al., 2011 (19) and Lal, 2013 (8) in capsicum also recorded similar observations. Maximum fruit width (4.61 cm) was attained in FL2 (retaining of ten fruits plant⁻¹) (Manjunanatha et al., 2007) (12) whereas minimum (4.18 cm) was recorded in FL4 (retaining of 14 fruits plant⁻¹) with non-significant differences with FL1 (all fruits plant⁻¹) and FL3 (retaining of twelve fruits plant⁻¹).

Table 1 Effect of training system and fruit load on seed on different fruit parameters

| Particulars | Characters | Plant Height (cm) | Ripe fruit weight (g) | Ripe fruit length (cm) | Ripe fruit width (cm) |
|-------------|------------|------------------|-----------------------|------------------------|----------------------|
| Main Effect (Training systems) | Tr1 | 52.97 | 52.26 | 5.32 | 4.15 |
| | Tr2 | 63.99 | 59.04 | 6.12 | 4.74 |
| | Tr3 | 51.15 | 54.74 | 5.63 | 4.22 |
| | CD at 5% | 8.71 | 0.96 | 0.21 | 0.17 |
| Main Effect (Fruit load) | FL1 | 55.91 | 48.62 | 5.51 | 4.32 |
| | FL2 | 58.28 | 62.47 | 6.05 | 4.61 |
| | FL3 | 56.07 | 57.31 | 5.76 | 4.37 |
| | FL4 | 53.91 | 52.98 | 5.45 | 4.18 |
| | CD at 5% | NS | 1.10 | 0.24 | 0.19 |
| Interaction (Training system x Fruit load) | Tr1FL1 | 52.90 | 46.44 | 5.00 | 3.77 |
| | Tr1FL2 | 51.66 | 57.23 | 5.61 | 4.57 |
| | Tr1FL3 | 48.05 | 53.80 | 5.45 | 4.25 |
| | Tr1FL4 | 59.29 | 51.57 | 5.24 | 4.02 |
| | Tr2FL1 | 66.99 | 50.89 | 5.97 | 4.81 |
| | Tr2FL2 | 67.53 | 66.65 | 6.56 | 5.05 |
| | Tr2FL3 | 60.89 | 62.62 | 6.22 | 4.75 |
| | Tr2FL4 | 60.59 | 56.02 | 5.77 | 4.36 |
| | Tr3FL1 | 47.84 | 48.55 | 5.58 | 4.40 |
| | Tr3FL2 | 55.65 | 63.53 | 5.99 | 4.22 |
| | Tr3FL3 | 59.27 | 55.51 | 5.60 | 4.11 |
| | Tr3FL4 | 41.85 | 51.36 | 5.36 | 4.16 |
| | CD at 5% | NS | 1.91 | NS | 0.34 |
Table 2 Effect of training system and fruit load on harvest duration and seed yield parameters

| Particulars     | Harvest duration (days) | Seed yield plant\(^1\) (g) | Number of seeds fruit\(^1\) |
|-----------------|-------------------------|-----------------------------|-----------------------------|
| **Main Effect (Training systems)** | | | |
| Tr\(_1\)       | 81.92                   | 8.78                        | 159.62                      |
| Tr\(_2\)       | 78.25                   | 8.67                        | 172.22                      |
| Tr\(_3\)       | 78.42                   | 8.24                        | 164.38                      |
| CD at 5%       | 2.73                    | 0.45                        | 3.33                        |
| **Main Effect (Fruit load)** | | | |
| FL\(_1\)       | 82.44                   | 9.16                        | 158.81                      |
| FL\(_2\)       | 76.89                   | 8.43                        | 174.51                      |
| FL\(_3\)       | 79.22                   | 8.27                        | 166.52                      |
| FL\(_4\)       | 79.56                   | 8.40                        | 161.79                      |
| CD at 5%       | 3.15                    | 0.52                        | 3.84                        |
| **Interaction (Training system x Fruit load)** | | | |
| Tr\(_1\)FL\(_1\) | 85.00                   | 10.34                       | 154.03                      |
| Tr\(_1\)FL\(_2\) | 78.66                   | 8.26                        | 165.43                      |
| Tr\(_1\)FL\(_3\) | 81.32                   | 8.21                        | 161.20                      |
| Tr\(_1\)FL\(_4\) | 82.68                   | 8.34                        | 157.80                      |
| Tr\(_2\)FL\(_1\) | 80.30                   | 8.40                        | 161.80                      |
| Tr\(_2\)FL\(_2\) | 75.67                   | 9.16                        | 187.77                      |
| Tr\(_2\)FL\(_3\) | 77.69                   | 8.52                        | 171.80                      |
| Tr\(_2\)FL\(_4\) | 79.32                   | 8.58                        | 167.53                      |
| Tr\(_3\)FL\(_1\) | 82.00                   | 8.73                        | 160.60                      |
| Tr\(_3\)FL\(_2\) | 76.31                   | 7.88                        | 170.33                      |
| Tr\(_3\)FL\(_3\) | 78.64                   | 8.07                        | 166.58                      |
| Tr\(_3\)FL\(_4\) | 76.67                   | 8.27                        | 160.03                      |
| CD at 5%       | NS                      | 0.90                        | 6.66                        |
Table 3: Effect of training system and fruit load on different seed parameters

| Particulars | Characters | 1000 seed weight (g) | Germination % | Speed of germination |
|-------------|------------|----------------------|---------------|----------------------|
| **Main Effect (Training systems)** | | | | |
| Tr\(_1\) | | 5.58 | 84.18 (9.23) | 9.40 |
| Tr\(_2\) | | 5.90 | 91.25 (9.60) | 12.31 |
| Tr\(_3\) | | 5.70 | 88.18 (9.43) | 10.42 |
| CD at 5% | | 0.06 | 0.04 | 0.47 |
| **Main Effect (Fruit load)** | | | | |
| FL\(_1\) | | 5.61 | 82.16 (9.12) | 9.13 |
| FL\(_2\) | | 5.86 | 92.16 (9.65) | 12.74 |
| FL\(_3\) | | 5.77 | 90.33 (9.55) | 10.81 |
| FL\(_4\) | | 5.68 | 86.78 (9.37) | 10.18 |
| CD at 5% | | 0.07 | 0.05 | 0.55 |
| **Interaction (Training system x Fruit load)** | | | | |
| Tr\(_1\)FL\(_1\) | | 5.53 | 81.75 (9.09) | 7.72 |
| Tr\(_1\)FL\(_2\) | | 5.63 | 88.00 (9.43) | 10.75 |
| Tr\(_1\)FL\(_3\) | | 5.62 | 85.00 (9.27) | 10.03 |
| Tr\(_1\)FL\(_4\) | | 5.54 | 82.00 (9.11) | 9.16 |
| Tr\(_2\)FL\(_1\) | | 5.63 | 82.75 (9.15) | 9.88 |
| Tr\(_2\)FL\(_2\) | | 6.21 | 96.50 (9.88) | 15.95 |
| Tr\(_2\)FL\(_3\) | | 6.00 | 94.00 (9.75) | 12.38 |
| Tr\(_2\)FL\(_4\) | | 5.78 | 91.75 (9.63) | 11.03 |
| Tr\(_3\)FL\(_1\) | | 5.66 | 82.00 (9.11) | 9.80 |
| Tr\(_3\)FL\(_2\) | | 5.73 | 92.00 (9.64) | 11.52 |
| Tr\(_3\)FL\(_3\) | | 5.68 | 92.00 (9.64) | 10.01 |
| Tr\(_3\)FL\(_4\) | | 5.70 | 86.75 (9.36) | 10.36 |
| CD at 5% | | 0.12 | 0.05 | 0.95 |
### Table 4: Effect of training system and fruit load on different seed parameters

| Particulars | SV-I  | SV-II | Electrical conductivity (dSm⁻¹) |
|-------------|-------|-------|----------------------------------|
| **Main Effect (Training systems)** |       |       |                                  |
| Tr₁         | 747.39| 202.48| 0.123                            |
| Tr₂         | 1066.05| 243.90| 0.090                            |
| Tr₃         | 926.45| 221.54| 0.106                            |
| CD at 5%    | 53.54 | 3.43  | 0.008                            |
| **Main Effect (Fruit load)** |       |       |                                  |
| FL₁         | 757.05| 187.93| 0.117                            |
| FL₂         | 1112.29| 257.09| 0.082                            |
| FL₃         | 928.27| 233.86| 0.112                            |
| FL₄         | 855.57| 211.67| 0.114                            |
| CD at 5%    | 61.82 | 4.54  | 0.009                            |
| **Interaction (Training system x Fruit load)** |       |       |                                  |
| Tr₁FL₁      | 664.56| 173.13| 0.120                            |
| Tr₁FL₂      | 823.42| 231.98| 0.121                            |
| Tr₁FL₃      | 774.20| 208.40| 0.127                            |
| Tr₁FL₄      | 727.37| 196.39| 0.126                            |
| Tr₂FL₁      | 846.95| 199.14| 0.103                            |
| Tr₂FL₂      | 1448.30| 284.77| 0.060                            |
| Tr₂FL₃      | 1021.56| 253.79| 0.100                            |
| Tr₂FL₄      | 947.38| 237.90| 0.097                            |
| Tr₃FL₁      | 759.64| 191.52| 0.127                            |
| Tr₃FL₂      | 1065.14| 254.51| 0.067                            |
| Tr₃FL₃      | 989.06| 239.39| 0.110                            |
| Tr₃FL₄      | 891.97| 200.72| 0.120                            |
| CD at 5%    | 107.09| 7.86  | 0.015                            |

Treatment combination Tr₂FL₂ gave significantly maximum fruit width (5.05 cm) being in conformity with Mitra et al., 2014 (13), however, Tr₁FL₁ recorded minimum (3.77) which was statistically at par with Tr₁FL₄ (4.02 cm) and Tr₃FL₃ (4.11 cm). Treatment Tr₁ (no training) resulted in significantly better harvest duration (81.92 days). This is in conformity with Onis et al., 2001 (15). In case of fruit load, FL₁ (all fruits retained plant⁻¹) recorded maximum harvest duration (82.44 days) being statistically at par with FL₄ (fourteen fruits retained) while minimum harvest duration (76.89 days) recorded in FL₂ (ten fruits plant⁻¹ retained) was statistically at par with FL₃ (twelve fruits plant⁻¹) and FL₄. This might be due to less fruits plant⁻¹ and more carbohydrates stored in two stem training system. The interaction effect for harvest duration was found to be non-significant. Training system Tr₁ (no training) recorded maximum significant seed yield plant⁻¹ (8.78 g) which was statistically at par with Tr₂ (8.67 g) and minimum seed yield.
plant\(^{-1}\) (8.24 g) obtained in Tr\(_3\) (four stem training system) was statistically at par with Tr\(_2\). This might be due to fact that Tr\(_1\) had more number of branches which produced more number of fruits plant\(^{-1}\) resulting in higher seed yield. Retaining all fruits on a plant (FL\(_4\)) resulted in significantly maximum seed yield plant\(^{-1}\) (9.16 g) whereas minimum (8.27 g) recorded in FL\(_3\) (twelve fruits plant\(^{-1}\)) was statistically at par with FL\(_2\) (8.43 g) and FL\(_4\) (8.40 g). Treatment combination Tr\(_2\)FL\(_1\) showed significantly maximum seed yield plant\(^{-1}\) (10.34 g) and minimum (7.88 g) observed in Tr\(_3\)FL\(_2\) was statistically at par with Tr\(_2\)FL\(_1\), Tr\(_3\)FL\(_3\), Tr\(_1\)FL\(_2\), Tr\(_2\)FL\(_3\), Tr\(_3\)FL\(_1\), Tr\(_1\)FL\(_4\), Tr\(_2\)FL\(_4\) and Tr\(_3\)FL\(_4\). Significantly maximum number of seeds fruit\(^{-1}\) (172.22) observed in Tr\(_2\) is in line with Osman and George, 1984 (16) and the minimum (159.62) was noticed in case of Tr\(_1\) (no training). Significantly highest seed number (174.51) was found in FL\(_2\) (ten fruits retained plant\(^{-1}\)) being in conformity with Manjunantha et al., 2007 (12) in bell pepper. Minimum seed number (158.81) was observed in FL\(_1\) (all fruits retained), being statistically at par with FL\(_4\) (161.79).

In case of interaction, significantly maximum number of seeds fruit\(^{-1}\) in Tr\(_2\)FL\(_2\) (187.77) might be due to large size of fruit with reduced sink load. Tr\(_1\)FL\(_1\) resulted in minimum number of seeds fruit\(^{-1}\) (154.03), which was statistically at par with Tr\(_1\)FL\(_4\) (157.80), Tr\(_3\)FL\(_1\) (160.60) and Tr\(_2\)FL\(_4\) (160.03).

**Seed quality parameters**

The data pertaining to the effect of training system and fruit load on different seed quality parameters have been presented in Tables 3 and 4. Training system Tr\(_2\) (two stem training system) recorded significantly highest 1000 seed weight (5.90 g) whereas training Tr\(_1\) (no training) resulted in the lowest 1000 seed weight (5.58 g). These studies are in agreement with and Lal et al., 2016 (9) in capsicum. For fruit load, significantly maximum 1000 seed weight (5.86 g) was observed in FL\(_2\) (ten fruits plant\(^{-1}\) retained) and minimum 1000 seed weight (5.61 g) recorded in FL\(_1\) (retaining all fruits plant\(^{-1}\)) was statistically at par with FL\(_4\) (5.68). This might be due to the fact that removal of flowers from bell pepper increased the concentrations of stored carbohydrates in stems making them available to developing seeds. Significantly maximum 1000 seed weight (6.21 g) was noticed in Tr\(_2\)FL\(_2\) whereas minimum 1000 seed weight (5.53 g) obtained in Tr\(_1\)FL\(_1\) was statistically at par with Tr\(_2\)FL\(_2\), Tr\(_1\)FL\(_3\), Tr\(_1\)FL\(_4\) and Tr\(_2\)FL\(_4\). Tr\(_2\) (two stem training system) resulted significantly higher germination (91.25 %) being in line with Ansari, 2012 (2) in tomato and Lal, 2013 (8) in bell pepper, however, Tr\(_1\) (no training) lead to minimum germination (84.18 %). This might be due to more partitioning of carbohydrates to different stems. FL\(_2\) (ten fruits plant\(^{-1}\)) recorded maximum seed germination (92.16 %) and FL\(_1\) (all fruits) had minimum seed germination (82.16 %) (14). Significantly higher germination (96.50 %) noticed in Tr\(_2\)FL\(_2\) might be due to less branches and fruits that lead to more photosynthates availability to developing fruits and seeds which can be correlated to higher seed germination. Minimum germination (81.75 %) observed in Tr\(_1\)FL\(_1\) was statistically at par with Tr\(_1\)FL\(_4\), Tr\(_2\)FL\(_1\) and Tr\(_3\)FL\(_4\). Training system Tr\(_2\) (two stem) recorded significantly maximum speed of germination (12.31) while minimum speed of germination (9.40) was obtained in Tr\(_1\) (no training). This is because of its correlation with high germination in two stem training system. As far as fruit load is concerned, FL\(_2\) (ten fruits plant\(^{-1}\)) showed significantly maximum speed of germination (12.74) (20) and FL\(_1\) (all fruits retained plant\(^{-1}\)) had minimum speed of germination (9.13).
Among the interactions, treatment combination $\text{Tr}_2\text{FL}_2$ produced significantly maximum speed of germination (15.95), however, $\text{Tr}_1\text{FL}_4$ resulted in minimum speed of germination (7.72). Significantly maximum seed vigour index-I (1066.05) was obtained in $\text{Tr}_2$ (two stem) whereas minimum (747.39) was observed in $\text{Tr}_1$ (no training). Maximum SVI-I in $\text{Tr}_2$ could be due to the fact that two stems plant$^{-1}$ had less number of fruits and there was less competition among the fruits for photosynthates, thereby resulting in bigger sized fruits with bolder seeds (8). In case of fruit load, maximum SVI-I (1112.9) was recorded in $\text{FL}_2$ (ten fruits plant$^{-1}$) whereas the minimum SVI-I (757.05) was obtained in $\text{FL}_1$ (all fruits retained). Amongst interactions, $\text{Tr}_2\text{FL}_2$ resulted in significantly maximum SVI-I (1448.30) while minimum SVI-I (664.56) observed in $\text{Tr}_1\text{FL}_1$ had statistical similarity with $\text{Tr}_1\text{FL}_4$ and $\text{Tr}_3\text{FL}_1$. Seed vigour index-II was significantly maximum (243.90) in $\text{Tr}_2$ (two stem training system) and minimum (202.48) in $\text{Tr}_1$ (no training).

For fruit load, significantly maximum SVI-II (257.09) was found in $\text{FL}_2$ (ten fruits plant$^{-1}$) and minimum (187.93) was observed in $\text{FL}_1$ (all fruits plant$^{-1}$). Interaction $\text{Tr}_2\text{FL}_2$ recorded significantly maximum SVI-II (284.77) and minimum (173.13) was obtained in $\text{Tr}_1\text{FL}_1$. Two stem training system ($\text{Tr}_2$) registered significantly minimum EC (0.090 dSm$^{-1}$) whereas in case of $\text{Tr}_1$ (no training at all), it was maximum EC (0.123 dSm$^{-1}$). This might be due to effective partitioning of photosynthates in case of no training. On the other hand, fruit load $\text{FL}_2$ (ten fruits) recorded significantly minimum EC (0.082 dSm$^{-1}$) which has conformity with Vasudevan et al., 2008 (23) in methi and Lakshmi et al., 2015 (10) in fenugreek. Fruit load $\text{FL}_1$ (all fruits) had maximum EC (0.117 dSm$^{-1}$) being statistically at par with $\text{FL}_4$ and $\text{FL}_3$. Interaction $\text{Tr}_2\text{FL}_2$ had minimum EC (0.060 dSm$^{-1}$) of seed being statistically at par with $\text{Tr}_2\text{FL}_2$. This might be due to effective translocation of photosynthates from source to sink which is evident from high seed weight, high germination (%), high dry weight and more seed vigour index. The maximum EC (0.127 dS m$^{-1}$) observed in case of $\text{Tr}_1\text{FL}_3$ (no training and twelve fruits plant$^{-1}$) and $\text{Tr}_2\text{FL}_1$ was statistically at par with, $\text{Tr}_1\text{FL}_4$, $\text{Tr}_1\text{FL}_2$, $\text{Tr}_1\text{FL}_1$ and $\text{Tr}_3\text{FL}_4$.

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