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Study of growth parameters and germination of tomato seedlings in soil-less media under protected environment

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Abstract

Tomato (*Solanum lycopersicum* L.) from family Solanaceae is a popularly cultivated vegetable in the world, and is famous for its nutritive and medicinal values. There are some shortcomings in the traditional nursery production techniques such as poor germination, poor quality seedlings and sometimes farmers face problems to raise tomato seedlings in due time in adverse environmental conditions. This nursery production technique has the potential to grow healthy seedlings in short time and even during adverse climatic conditions.

Hence, proposed study was undertaken at the Vegetable Research Farm, Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur under growth chamber during spring-summer season to evaluate germination percent and growth parameters of tomato in soilless media using pro-trays and to isolate the prospective hybrid (s) for protected cultivation too. The experimental material comprised of twelve diverse hybrids of tomato along with one bacterial wilt resistant check. Experiment was laid out in Completely Randomized Design (CRD) with five replications. The analysis of variance showed satisfactory genetic variation among the hybrids for all the traits studied, which showed the presence of adequate variability. Based on the mean performance of all the tested hybrids, the hybrid combination CLN2126 × CLN1314G found significantly thick stem diameter than the check Palam Tomato Hybrid-1 and was found statistically at par with the check for rest of the traits viz., days to 50% germination, total germination percent, number of true leaves, seedling height, root length and total number of healthy seedlings. From the present investigation it was cleared that the hybrid combination CLN2126 × CLN1314G was promising for high germination and other growth parameters in soil-less media.

Keywords: germination percent, growth parameters, protected environment and pro-tray

Introduction

Tomato (*Solanum lycopersicum* L.) is a summer vegetable crop having chromosome number $2x = 24$, comes under Solanaceae family. It is originated in Andean region, Ecuador, Bolivia, Columbia and Peru [11]. In ancient times tomato was thought to be poisonous and only grown as an ornamental garden plant but now a days it became major commercial vegetable crop globally after potato [14]. Tomato fruit is rich source of minerals (0.6 g) and vitamins, mainly vitamin A (321 IU), vitamin C (31.0 mg) with fibre (0.7 g), sulphur (24 mg), protein (1.98 g), moisture (93.1 g), calcium (20 mg) and chlorine (38 mg) basis on per 100 g fresh fruit weight. The juice and pulp has antiseptic property against intestinal infection as well as blood purifier [5].

Tomato is a high-value vegetable crop that is widely consumed fresh or processed and grown in almost every country of the world. The increase in the area of production and value has increased the economic significance of the crop worldwide. The most essential feature for better yield and production of tomato fruits is vigorous and healthy seedlings. Emergence of the seed is a vital stage due to the rest of the plant life is directly dependent upon the speed of its germination [15]. In current days most of the commercial farmers are going to intensive vegetable cultivation using high yielding F_1 hybrids to enhance productivity. As hybrid seeds are costly, converting each individual seed into a healthy seedling becoming important. In traditional nurseries some of the major problems are observed which can lead to higher pest and disease incidence such as damping off, poor germination, lower yield, etc. and seedlings grown in plastic bags with the mixture of sand, soil and compost are infected from soil-borne diseases or transplant shock when plants are moved into the open field [3].

For the production of pest free healthy vegetable seedlings, the pro-tray nursery is gaining importance. The pro-tray nursery is an approaching technique to grow quality vegetable seedlings, where seedlings are grown in desirable conditions and such seedling have healthy

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appearance, better germination, well developed root system and are protected from diseases and insect/pest. The seedlings get ready within 25-30 days and farmers can get early produce of potential vegetable crops with handsome profit in the market. The advantages of pro-tray nursery includes production of insect/pest free healthy seedlings, better seed germination, enhanced root development which improved main field establishment and crop stand, having self-sufficient area for each seed, minimize seedlings mortality and damping off disease, provides uniformity, early maturity of seedlings, easy handling which helps in cheaper transportation. Since, expensive hybrid seeds this seedling production method helps to minimize cost by reducing the seed wastage [2]. As compared with conventional nursery bed, seedlings that are grown using pro-trays germinate vigorous. The plugs of pro-trays are filled with a cohesive medium, and are finally transplanted into other growing systems. Single plant is grown per cell and seeds are sown by hand into plug one by one [8].

The best growing media should have proper aeration, water holding capacity and adequate nutrition supply; different manures provide good nutrition to plants when applied in combination with soil less substrates [7]. Simply soilless cultivation can be defined as the any method of growing plants without use of soil as rooting medium [6]. The most commonly used substrates in soilless culture are sphagnum peat, vermiculite, barkchips, rice hulls, bagasse, sedge peat, sawdust and straw [9].

There were major drawbacks in conventional transplanting viz., poor quality seedlings, low productivity, high seed cost, poor plant establishments as well as sometimes farmers face problems to grow tomato seedlings in time due to unfavorable environmental conditions. This practice has the potential to grow healthy seedlings in unfavorable climatic condition and finally facilitates the production of tomato with good quality seedlings. Hence, present investigation was undertaken to estimate the effect of soilless media using pro-trays on tomato seed germination and production of healthy seedlings.

Materials and methods

Description of Experimental site

The present investigation was carried out at the Vegetable Research Farm, Department of Vegetable Science and Floriculture, C.S.K. Himachal Pradesh Krishi Vishvavidyalaya, Palampur, under growth chamber during spring-summer season, 2019. It was an ideal growth chamber with various important features like double door, side and top ventilation, drip and fogging facility and internal shading with 50 per cent green agro-shade net. The experimental farm is located at 32°6'N latitude and 76°3' E longitude at an elevation of 1290.80 m above mean sea level with East-West orientation which represents the mid hill zone of Himachal Pradesh, India. All seeds used in the experiment were grown in pro-tray.

The seeds of twelve hybrids were used for the study and details of these hybrids are presented in Table 1.

Table 1: List of tomato (*Solanum lycopersicum* L.) hybrids and their sources

Sr. No.	Hybrids	Source
1	15-2 × 12-1	CSKHPKV, Palampur
2	7-2 × Palam Pride	CSKHPKV, Palampur
3	CLN2126 × Palam Pride	CSKHPKV, Palampur
4	CLN1314G × Palam Pride	CSKHPKV, Palampur
5	7-2 × 16-B	CSKHPKV, Palampur
6	CLN2126 × CLN1314G	CSKHPKV, Palampur
7	15-2 × CLN1314G	CSKHPKV, Palampur
8	16-B × Palam Pride	CSKHPKV, Palampur
9	12-1 × 6-B	CSKHPKV, Palampur
10	12-1 × CLN1314G	CSKHPKV, Palampur
11	12-1 × BWR-5	CSKHPKV, Palampur
12	Palam Tomato Hybrid -1 (check)	CSKHPKV, Palampur

Nursery sowing, irrigation including fertigation

The seeds of all the genotypes were sown in pro-tray using soil-less media having a mixture of coco peat: perlite: vermiculite in the ratio of 3:1:1 respectively in pro-trays having the sheet's 98 cells measure 1.5" deep and 27cc in volume undergrowth chamber to facilitate the emergence of healthy and disease free seedlings of tomato. It was an ideal growth chamber with various important features like double door, side and top ventilation, drip and fogging facility and internal shading with 50 per cent green agro shade net. The media was filled 75% of each cell in each tray. The tomato seeds were soaked in water over night in non-metallic bowl in order to boost germination and single seed was sown in each cell of the pro-tray and further the sown seed was covered with vermiculite only. All these trays were kept under growth chamber till transplanting. Watering to the pro trays was done daily using rose cans and after 4-5 days, the seed emerged, application of water was restricted gradually depending on moisture level in trays and as per the plants requirement. After 15 days the fertigation was given twice a week by applying water soluble fertilizer (19:19:19) @ 1.0 g/lit of

water as per recommendation for protected cultivation.

Days to 50% germination and total germination percent

Days to 50% germination was recorded after germination of at-least half of total seeds sown of each treatment. The total germination per cent of seedlings was recorded in 10 days after seed sowing by counting all the germinated seeds and the total germination per cent of seedlings was calculated using the formula given below [1].

$$\text{Germination (\%)} = \frac{\text{Seeds germinated}}{\text{Total No. of seeds}} \times 100$$

Growth Parameters

The growth parameters like; number of true leaves, seedling root length (cm), seedling height (cm), stem diameter (cm) and total number of healthy seedlings were recorded. The data were recorded from randomly selected 49 seedlings of each treatment and then the mean value is worked out. The seedlings were removed by hand from the pro-tray cells, the root length and shoot height of the seedlings was measured

with the help of plastic ruler. The stem diameter of seedling was measured with using a digital Vernier caliper. The measurements were taken for 30 days old seedlings.

Layout of the experiment

The experiment was conducted in a completely randomized design (CRD) with replication five times. Data was subjected to Analysis of Variance (ANOVA) using statistical software OPSTAT [13].

Results and discussions

1. Analysis of variance for the experimental design

The values of mean sum of squares of analysis of variance (ANOVA) revealed highly significant differences among the tested tomato hybrids and hybrid combinations for all the traits studied *viz.*, days to 50% germination, total germination percent, number of true leaves, seedling height (cm), stem diameter (cm), root length (cm) and total number of healthy seedlings (%). The significant variation among the hybrids are presented in table 2, showed the presence of adequate variability which can be exploited through selection.

Table 2: Analysis of variance for germination and growth traits in tomato hybrids

Traits	Mean sum of Squares		
	Source	Treatments	Error
	Df	11	48
Day to 50% germination		1.158*	0.025
Total germination percent		194.207*	14.572
Number of true leaves		0.138*	0.018
Seedling height		1.406*	0.131
Stem diameter (mm)		0.098*	0.002
Root length (mm)		1.067*	0.033
Total number of healthy seedling		182.172*	13.738

*Significant at P=0.05

Mean performance of genotypes

Days to 50 % germination revealed that the overall mean value ranged from 4.00 to 5.00 days with overall mean 4.66 days. The hybrid combinations *viz.*, CLN2126 × Palam Pride and CLN2126 × CLN1314G along with check Palam Tomato Hybrid-1 (4.00) took less days for days to 50 % germination. As early germination is the outmost desirable trait in tomato genotypes for the early production of the crop. Total germination percent showed that the overall mean value was ranged from 74.26 % to 93.98 % with overall mean 82.16 %. The hybrid combination CLN2126 × CLN1314G (93.98 %) was found statistically at par with the check Palam Tomato Hybrid-1. Total germination percent is one of the most

important traits which shows the good seed vigor of superior genotype. Similar result was also obtained by [12] in different tomato hybrids under protected environment. Number of true leaves plays important role in proper growth and development of plants. The purpose of true leaves is to provide stored food to the seedling, through photosynthesis. The range of mean value of this trait was 3.00 to 4.00 with overall mean 3.36 true leaves. Same number of true leaves were recorded in hybrid combinations *viz.*, CLN2126 × Palam Pride, CLN2126 × CLN1314G and 12-1 × CLN1314G (4.00) were statistically at par with the check Palam Tomato Hybrid-1 (4.00). Seedling height is also one of the crucial trait during transplanting time for the proper crop establishment in the field. The range of this parameter was 7.04 to 8.56 cm with the overall mean 7.64 cm. The result of this trait revealed that hybrid combinations CLN2126 × CLN1314G (cm) and 12-1 × CLN1314G (cm) were found at par with the check Palam Tomato Hybrid-1 (8.20 cm).

The mean value of stem diameter ranged from 0.72 to 1.14 cm with the overall mean 0.92 cm. The mean performance of this trait revealed that the hybrid combinations CLN2126 × CLN1314G (1.14 cm) and 12-1 × CLN1314G (1.06 cm) found significantly thicker stem diameter than the check Palam Tomato hybrid -1 (1.00cm) whereas, 16-B × Palam Pride (1.04 cm) and CLN2126 × Palam Pride (1.00 cm) were found statistically at par with the check. Based on the mean performance of the trait the hybrid combinations; CLN2126 × CLN1314G and 12-1 × CLN1314G were superior than the check. Thicker stem diameter is one of the most important parameters of healthy seedling, as stem diameter serves as a proxy for the amount of resources supplied per unit cross section to developing leaves and the flow of photosynthates from mature leaves to rest of the plant body [4]. The mean performance of this trait (root length) revealed that mean value ranged from 2.90 to 3.44 cm with the overall mean 3.03 cm. The hybrid combination CLN2126 × CLN1314G (3.44 cm) was found statistically at par with the check Palam Tomato Hybrid-1 (3.30 cm). Root length is also one of the most desirable traits in tomato seedling because the size, morphology of root system may control the relative size and growth rate of the shoot [10]. Total number of healthy seedling is outmost character in tomato crop for the better plant establishment and higher production. The mean performance of this parameter show the mean value ranged from 72.49 to 91.68 % with the overall mean 80.12 %. The hybrid combination CLN2126 × CLN1314G (91.68 %) was found at par with the check Palam Tomato Hybrid-1 (89.55 %).

Table 3: Per-se performance of tomato hybrids in relation to germination and growth traits

Genotypes	Day to 50% germination	Total germination percent	Number of true Leaves	Seedling height (cm)	Stem diameter (cm)	Root length (cm)	Total number of healthy seedling (%)
15-2 × 12-1	4.80	78.84	3.00	7.10	0.96	2.96	76.16
7-2 × Palam Pride	5.00	79.36	3.00	7.14	0.72	2.94	77.76
CLN2126 × Palam Pride	4.00	85.14	4.00	8.04	1.00	3.10	83.63
CLN1314G × Palam Pride	5.00	75.94	3.00	7.22	0.80	2.94	74.30
7-2 × 16-B	5.00	82.16	3.00	7.24	0.94	2.98	80.33
CLN2126 × CLN1314G	4.00	93.98	4.00	8.56	1.14	3.44	91.68
15-2 × CLN1314G	5.00	78.58	3.00	7.60	0.94	2.92	76.91
16-B × Palam Pride	5.00	74.26	3.40	8.00	1.04	3.02	72.49
12-1 × 6-B	5.00	82.4	3.00	7.04	0.70	2.90	80.57
12-1 × CLN1314G	5.00	77.12	4.00	8.20	1.06	3.00	74.58
12-1 × BWR-5	4.20	85.66	3.00	7.34	0.80	2.96	83.49
Palam Tomato Hybrid -1 (check)	4.00	92.56	4.00	8.20	1.00	3.30	89.55

Range	4.00-5.00	74.26-93.98	3.00-4.00	7.10- 8.56	0.72- 1.14	2.90- 3.44	72.49- 91.68
Overall mean	4.66	82.16	3.36	7.64	0.92	3.03	80.12
SE(m)±	0.08	1.70	0.06	0.16	0.02	0.06	1.65
CD (5%)	0.23	4.86	0.17	0.46	0.05	0.17	4.72
CV (%)	3.92	4.64	4.41	4.73	4.93	4.41	4.62

Conclusion

The values of mean sum of squares of analysis of variance (ANOVA) revealed highly significant differences among the tested tomato hybrids for all the traits studied which showed the presence of adequate variability in the genotypes. Based on the per-se performance hybrid combination CLN2126 × CLN1314G found significantly superior as compared to other hybrid for thicker seedlings stem diameter compared to check Palam Tomato Hybrid-1 and was also statistically at par with the check for rest of the traits viz., days to 50 % germination, total germination percent, number of true leaves, seedling height, root length and total number of healthy seedling. From this study it can be concluded that the hybrid combination CLN2126 × CLN1314G is promising for high germination and growth parameters using soil-less media with cocopeat: perlite: vermiculite @ 3:1:1.

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