Evaluation of growth characters of various genotypes of Tomato (*Solanum lycopersicum* L.) under different environment conditions

ABSTRACT

The present investigation entitled **"Evaluation of growth characters of various genotypes of Tomato (*Solanum lycopersicum* L.) under different environmental conditions"** involving fifty genotypes including three check varieties of tomato under low tunnel, paddy straw and open field conditions was carried out in Randomized Block Design (RBD) with three replications during two Rabi season 2020-2021 and 2021-2022 at Faculty of Agriculture, Vegetable farm, Guru Kashi University, Talwandi Sabo, Bathinda. The analysis of variance depicted significantly high amount of variability among different genotypes for all the parameters. The maximum data for plant height was recorded in the genotype S-115 (220.54cm) under low tunnel conditions.Maximum number of primary branches were recorded in S-115 (18.66). Days to first flowering was revealed in S-115 (33.21 days), days to first fruit set was observed in S-115 (72.56). Maximum value for days to first fruit harvest and last fruit harvest was observed in S-115 (102.56 days) and (177.24 days) respectively. The mean performances of genotypes depicted wide variations over various environments for all the parameters under research.

Keywords: Tomato genotypes, growth parameters, Environments, Mean performance

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is known as the world's most significant and widely grown vegetable crop and it has been the subject of genetic study for more than a century (Gowda, 2013). Tomato require warm and dry climatic conditions but get acclamatize to varied climatic conditionns varying from temperate to tropical conditions (MoARD, 2009). However, it is adapted to a wide range of climatic conditions from temperate to hot and humid tropics. The plants can withstand a wide range of temperatures and they grow well under temperature range of 20–27°C, whereas the plant tissues get damaged below 10 °C and above 38 °C (Naika *et al*., 2005). Extreme low and high temperature conditions eventually leads to poor fruit setting. Tomatoes prefer aerated soil because the roots are very sensitive to

water-logging conditions. The optimum pH of soil is 6.0-7.0 (Hanson *et al*., 2001). Tomato crop must be cultivated below 2000 m.a.s.l. (Peralta and Spooner, 2007). According to reports, the tomato crop frequently experiences extremely high temperature in certain parts of the world which is extremely sensitive to tomato reproduction. Extreme increase in temperature can lead to abortion of male gametophyte as well as causes reduced fruit set (Acharya, 2019). By 2100, according to research there would be increase in the atmospheric temperature which would dramatically impact the productivity of crop. (Reddy and Kakani, 2007; Stainforth et al., 2005). Hence, extensive study of reproductive behavior of tomato crop under the extreme environmental conditions needs to be done (Karapanos*et al*., 2010). In order to meet the demands of the ever-growing population, it is important to bridge the productivity gap caused by the shrinkage of cultivable land and the unpredictable climatic conditions. It is only possible by the crop improvement programs of location-specific genotypes to develop an exceptional acclimatization ability to cultivate year-round(Cox, 2000). Tomato genotypes must be evaluated as evaluation is paramount for selection of effective varieties(Taylor, 1986).

2. MATERIALS AND METHODS

The research study entitled as "**Evaluation of growth characters of various genotypes of Tomato (*Solanum lycopersicum* L.) under different environmental conditions**" was plotted in the season of Rabi in the year 2020-21 and 2021-22.The trail for tomato research was laid out at the Faculty of Agriculture, Vegetable farm, Guru Kashi University, Talwandi Sabo, Bathinda The research study composed of 50 superior genotypes of Tomato (*Solanum lycopersicum* L.)

Table 1: List of genotypes used in the research:

Sr. No.	**Genotypes**	**Sr. No.**	**Genotypes**
1.	S-3	26.	S-37
2.	S-4	27.	S-38
3.	S-5	28.	S-39
4.	S-6	29.	S-44
5.	S-7	30.	S-46
6.	S-9	31.	S-47
7.	S-10	32.	S-49
8	S-11	33.	S-54
9.	S-12	34.	S-55
10.	S-13	35.	S-58
11.	S-14	36.	Marmade Pool
12.	S-15	37.	S-101

13.	S-17	38.	4-6 P_5
14.	S-18	39.	Selection 21 Round P L1
15.	S-19	40.	59 P/2 Round Large
16.	S-20	41.	WI-321
17.	S-21	42.	Israel Selection
18.	S-22	43.	Selection 39
19.	S-24	44.	S-115
20.	S-25	45.	WI-181 Round Deep Red
21.	S-26	46.	B_1
22.	S-30	47.	Deep Red Marmade P_9
23.	S-31	48.	Punjab Ratta
24.	S-32	49.	Punjab Upma
25.	S-36	50.	Punjab Sartaj

Research was analyzed for 3 varied environmental conditions:

1. Under the open field conditions
2. Use of Paddy straw
3. Use of Low tunnels

The experimental design of the experiment was Completely Randomized Block Design that comprised three replications and each replication had the plot size of 50 m^2 and 10 plants in one row were maintained. The statistical analysis was carried out for each observed character under study using MS-Excel and OP STAT Software.

4. RESULTS AND DISCUSSION

Plant height

The recorded plant height data (Table 2) reveal that S-115 recorded the maximum plant height in both 1st year and 2nd year in all the three environments. The highest plant height (220.54 cm) of S-115 was recorded in 2nd year under low tunnel environment compared with check variety Punjab Ratta. It was followed by S-115 (218.33) in 2nd year under Paddy straw conditions, out of three environments S-21 showed maximum height (209.89 cm) in 1st year under low tunnel. This might be due to the fact that plants got favorable conditions and temperature to growth leading to good growth (Gunadi and Sawanti, 1988). Whereas, out of all environments the lowest plant height was recorded in genotype S-46 (141.78) in 1st year under open field conditions. The results are in consonance with the research findings of Kumar *et al*. (2001) who concluded that there is a wide range of variation among characters of plant height and number of fruits per plant. Ganesan (2001), Ganesan(2002) and Kanwar (2011) also delineated increased plant height under the protected tomato conditions due to right temperature, optimum CO2 and optimal

micro climate as compared to open field conditions. Also, optimal temperature inside protected conditions lead to enhanced photosynthate accumulation which aids in increased plant height Pooja and Hakkim, (2017).

Table 2: Mean performance of tomato genotypes for Plant height (cm):

	Plant height					
	Low tunnel (E1)		Paddy(E2)		Open field (E3)	
Genotypes	1st year	2nd year	1st year	2nd year	1st year	2nd year
S-3	147.21	149.88	146.00	147.50	145.00	145.78
S-4	152.03	154.87	151.00	152.83	149.22	149.96
S-5	154.33	156.88	152.03	153.85	146.06	146.87
S-6	147.67	149.42	145.30	146.90	141.99	142.80
S-7	154.13	156.43	153.00	154.58	153.21	154.14
S-9	147.63	149.68	146.00	147.57	145.25	146.17
S-10	164.38	166.36	157.00	158.58	156.21	156.96
S-11	159.33	161.49	158.01	159.68	151.03	151.90
S-12	170.22	172.14	169.21	171.84	157.00	157.79
S-13	147.00	149.78	146.00	147.72	143.27	144.15
S-14	152.67	154.80	151.36	153.04	149.36	150.12
S-15	157.33	159.89	156.03	157.59	154.00	154.79
S-17	159.00	161.15	158.00	159.52	156.36	157.21
S-18	152.33	154.77	151.00	152.51	149.00	150.00
S-19	152.00	154.81	151.00	152.67	146.62	147.39
S-20	158.33	160.99	157.33	158.81	156.63	157.40
S-21	207.70	209.89	196.02	197.52	195.14	195.97
S-22	156.67	156.97	155.00	156.52	156.85	157.71
S-24	155.61	157.28	154.31	155.92	151.77	152.51
S-25	156.00	158.32	155.00	156.60	146.45	147.21
S-26	162.35	164.39	161.23	162.81	160.00	160.79
S-30	166.33	168.78	165.64	167.41	166.21	166.99
S-31	169.33	170.54	168.00	169.22	168.85	169.88
S-32	160.00	162.49	159.00	160.62	154.64	155.37
S-36	157.70	159.79	157.45	158.94	156.34	157.21
S-37	165.67	167.45	164.32	166.01	156.00	155.00
S-38	168.00	169.00	168.20	169.41	165.00	166.32
S-39	167.21	168.02	168.23	169.71	164.21	165.21
S-44	153.00	155.84	152.36	153.90	151.00	151.85
S-46	147.52	149.96	146.42	147.99	141.78	142.52

S-47	152.63	154.96	151.23	152.87	146.68	147.44
S-49	153.61	155.79	152.14	153.87	151.78	152.53
S-54	155.00	157.32	154.00	155.57	149.23	150.01
S-55	159.33	161.88	158.21	159.93	156.68	157.44
S-58	158.67	160.18	157.52	159.34	155.00	155.78
Marmade Pool	162.00	164.22	161.65	163.52	156.41	156.99
S-101	157.23	159.80	156.32	157.75	152.00	152.82
4-6 P_5	157.72	159.86	156.26	157.78	155.21	155.97
Selection 21 Round P L1	166.00	168.25	164.23	165.81	156.41	157.00
59 P/2 Round Large	167.00	169.09	166.43	168.02	155.00	156.21
WI-321	159.00	161.78	158.00	159.57	151.03	151.92
Israel Selection	161.68	163.25	160.67	162.01	155.00	155.80
Selection 39	162.45	164.77	161.67	162.95	155.21	156.32
S-115	217.63	220.54	216.67	218.33	212.00	212.85
WI-181 Round Deep Red	157.37	159.70	156.67	158.54	152.00	152.82
B_1	161.00	163.18	160.00	161.67	155.00	155.79
Deep Red Marmade P_9	155.67	157.77	153.96	155.63	152.00	152.86
Punjab Ratta	200.00	202.99	195.03	196.70	190.26	191.04
Punjab Upma	155.43	157.29	154.13	155.67	146.00	146.85
Punjab Sartaj	152.33	154.39	151.00	152.63	149.00	149.88
C.D.	7.25	8.02	5.63	6.84	8.01	7.48
SE(m)	2.00	2.48	2.00	1.89	2.87	2.24
SE(d)	2.83	2.12	2.83	1.96	2.99	2.17
C.V.	5.02	4.21	3.65	4.25	5.65	5.21

No. of primary branches

The different environments had significant influence on number of primary branches in various tomato genotypes. The maximum number of branches was observed in S-115 under all the three environments but the highest value of 18.66 branches was noted under low tunnel environment in 2nd year followed by S-21 (17.83). The highest number of primary branches can be observed under protected conditions because the plants obtained the right amount of soil temperature and atmospheric conditions to grow. The results are in agreement with the research findings of Patil and Basod, 1972. The lowest number of primary branches was nearly 7 i.e., 7.4, 7.5, 7.6 which were

recorded in S-4, S-5, S-18, S-19, S-9 under open field conditions in 2nd year trial.

Table 3: Mean performance of tomato genotypes for No. of primary branches:

	No. of primary branches					
	Low tunnel (E1)		Paddy(E2)		Open field (E3)	
Genotypes	1st year	2nd year	1st year	2nd year	1st year	2nd year
S-3	10.333	11	9.333	10.218	8.2	8.655
S-4	9.667	10.667	8.667	9.242	7.6	7.878
S-5	9.667	11.333	8.667	9.2	7.7	7.878
S-6	11	12.333	10	11.1	9	9.433
S-7	10.667	11.52	9.667	10.479	8.48	8.878
S-9	9.333	10.813	8.333	9.491	7.5	7.655
S-10	12.333	12.563	11.333	12.298	10.1	10.322
S-11	10.667	11.903	9.667	10.509	8.49	9.211
S-12	14	16	13	14.093	11	11.1
S-13	9.333	11.187	8.333	9.398	7.9	7.655
S-14	10.333	11.75	9.333	10.361	8.2	8.655
S-15	10.667	11.813	9.667	10.525	8.8	9.045
S-17	10	12.063	9.667	10.482	8.52	9.078
S-18	9	10.847	8.333	9.278	7.5	7.655
S-19	9.333	11.063	8.333	9.447	7.4	7.655
S-20	11	12.897	10	11.18	9	9.393
S-21	16.667	17.837	15.667	15.8	14.667	14.878
S-22	11	12.3	10	11.243	11	11.1
S-24	10.333	12.037	9.333	10.564	9	9.393
S-25	10.333	11.82	9.333	10.423	8.333	8.649
S-26	10.333	11.883	9.333	10.52	8	8.433
S-30	11.667	12.15	10.667	11.597	9	9.1
S-31	11.667	12.843	10.667	12.102	9.667	9.878
S-32	11	12.203	10	11.187	9	9.257
S-36	10.667	12.07	9.667	10.422	8.21	8.573
S-37	11.667	12.23	10.667	11.577	9	9.317
S-38	11	13.173	14.667	14.22	9	9.347
S-39	14	15.887	13	14.127	12	9.403
S-44	10	12.1	9	9.847	8	8.317
S-46	9.667	10.667	8.667	9.26	7.667	8.028
S-47	10.333	12.03	9.333	10.467	8.21	8.377
S-49	11.333	12.667	10.333	11.343	9.333	9.322
S-54	10.667	11.887	9.667	10.35	8.667	9.045

S-55	11.333	12.183	10.333	11.443	9.23	9.553
S-58	10	11.733	9	10.263	8	8.333
Marmade Pool	11.667	12.943	10.667	11.312	9.667	9.878
S-101	12.333	13.007	11.333	12.527	10.23	10.587
4-6 P_5	11.667	12.847	10.667	11.407	9.667	10.058
Selection 21 Round P L1	16.667	16.887	11	11.89	10	10.333
59 P/2 Round Large	17	17	16.333	17.401	10	10.367
WI-321	10.53	11.89	9.333	10.371	8.45	8.9
Israel Selection	11.333	12.667	10.333	11.308	9.333	9.655
Selection 39	11	12.187	10	10.707	9	9.367
S-115	17	18.667	16	17.183	15	15.1
WI-181 Round Deep Red	11.333	12.683	10.333	11.364	9.2	9.233
B_1	10.333	11.833	9.333	10.703	8.36	8.693
Deep Red Marmade P_9	11.333	12.843	10.333	11.313	9.333	9.322
Punjab Ratta Check	15	16.667	14	15.02	12	12.433
Punjab Upma	10	11.74	9	10.083	8	8.43
Punjab Sartaj	11.667	12.667	10.667	11.42	9.667	10.058
C.D.	2.052	3.68	3.41	2.54	2.052	1.06
SE(m)	0.73	0.301	0.58	0.15	0.73	0.73
SE(d)	1.032	0.426	0.64	0.213	1.032	1.2
C.V.	4.87	4.101	4.84	4.02	4.56	4.21

Days to first flowering

The earliest flowering was observed in S-115 (33.21 days) in the first year under low tunnel conditions followed by Punjab Ratta (34 days) and S-21(35.65 days) respectively in the 1st year under low tunnel conditions. The reason behind this was estimated to be the congenial conditions under protected covering which was appropriate temperature, relative humidity, sunlight that has paramount role in good quality characters of a plant. These results are identical with the findings of Ramesh *et al*, 2022. The last first flowering was recorded in Paddy straw in 2nd year for variety S-58 which was 61.15 days. The interaction between a plant and a protective covering showed insignificant difference for the character of flowering.

Table 4: Mean performance of tomato genotypes for days to first flowering:

	Days to first flowering					
	Low tunnel (E1)		Paddy(E2)		Open field (E3)	
Genotypes	1st year	2nd year	1st year	2nd year	1st year	2nd year
S-3	41	42.667	42.32	53	44.67	44.1467
S-4	45	46.377	46.32	50.437	48.67	48.5567
S-5	45.32	46.857	46.64	50.64	48.99	48.77
S-6	47	48.21	48.32	52.413	50.67	50.2933
S-7	40	41.767	41.32	45.403	43.67	43.11
S-9	46.32	47.773	47.64	51.703	49.99	49.3167
S-10	43.58	44.86	44.9	48.84	47.25	46.4967
S-11	49.65	50.883	50.97	54.98	53.32	52.65
S-12	39.25	40.923	40.57	41.25	40.03	42.7067
S-13	47.55	49.27	48.87	52.98	51.22	49.44
S-14	51.36	52.993	52.68	56.693	55.03	54.3767
S-15	50.11	51.85	51.43	55.56	53.78	53.2433
S-17	52.96	54.007	54.28	58.353	56.63	55.81
S-18	52.03	54.24	53.35	57.547	55.7	55.19
S-19	47.48	48.92	48.8	52.763	51.15	50.8767
S-20	48.69	49.45	50.01	53.84	52.36	51.4867
S-21	35.65	37.67	36.97	40.87	39.32	38.8733
S-22	45	46.763	46.32	50.343	48.67	47.7367
S-24	45.68	47.277	47	50.873	49.35	48.5033
S-25	47.44	48.99	48.76	52.663	51.11	50.3433
S-26	48.32	49.983	49.64	53.213	51.99	51.2833
S-30	46.98	48.07	48.3	48.397	50.65	49.76
S-31	48.77	49.377	50.09	50.777	52.44	51.54
S-32	49	50.197	50.32	51.083	52.67	52.0967
S-36	52.36	54.063	53.68	55.743	56.03	55.1667
S-37	52.99	54.233	54.31	57.91	56.66	56.2167
S-38	53	54.707	54.32	56.66	56.67	55.9267
S-39	46.32	48.083	47.64	52.177	49.99	49.2133
S-44	47.11	49.357	48.43	51.893	50.78	50.01
S-46	53.47	55.007	54.79	57.543	57.14	56.34
S-47	51.56	52.963	52.88	55.087	55.23	54.5933
S-49	45.26	46.867	46.58	56	48.93	48.73
S-54	44.14	45.927	45.46	56	47.81	47.1567
S-55	52.62	53.917	53.94	59.14	56.29	55.3033
S-58	55.36	56.933	56.68	61.147	59.03	58.2133
Marmade Pool	44	45.997	45.32	50.097	47.67	46.9733

S-101	52.41	53.927	53.73	57.757	56.08	55.3133
4-6 P_5	44.32	45.987	45.64	50.107	47.99	47.3933
Selection 21 Round P L1	45.21	46.863	46.53	50.807	48.88	48.1767
59 P/2 Round Large	43.69	44.993	45.01	49.06	47.36	46.3567
WI-321	52.95	54.103	54.27	56.317	56.62	55.7033
Israel Selection	53.21	54.807	54.53	58.403	56.88	56.03
Selection 39	53.66	55.56	54.98	59.29	57.33	56.3767
S-115	33.21	35.36	34.53	38.953	36.88	37.03
WI-181 Round Deep Red	53.47	54.823	54.79	58.953	57.14	56.2767
B_1	52.1	53.82	53.42	57.58	55.77	55.3733
Deep Red Marmade P_9	53.22	54.827	54.54	58.143	56.89	56.52
Punjab Ratta Check	34	35.877	35.32	39.423	37.67	36.6267
Punjab Upma	52.36	53.907	53.68	57.127	56.03	55.5833
Punjab Sartaj	55.21	56.963	56.53	58.567	58.88	58.5567
C.D.	N/A	0.601	2.458	1.56	2.1	3.41
SE(m)	0.908	0.214	0.875	0.555	0.029	0.85
SE(d)	1.283	0.302	1.237	0.785	0.041	0.64
C.V.	5.014	4.21	5.077	3.24	4.71	3.54

First fruit set

This trait was highly influenced by varying environmental conditions and variety. The earliest fruit set (Table 5) was noted in S-14 (70 days) in the 2nd year under paddystraw condition followed by S-19 (72.04 days) in the 2nd year under paddy straw. Similarly, Incalcaterra*et al*. (2004) revealed that early flowering plants were grown under protected covering and the plants grown on the bare soil conditions showed late flowering. The research results were in conformity with Melek and Atilla (2009) whose study concluded that the earliest flowering and fruit formation were earliest observed under protection in comparison to control. For the current study soil temperature may be regarded as the contributing factor. These results are also supported by Arin and Sozer (2001). The last first fruit set was recorded in S-38 (98.86 days), S-37 (98.85) in 1st year under open field conditions.

Table 5: Mean performance of tomato genotypes for days to first fruit set:

	Days to first set

	Low tunnel (E1)		Paddy(E2)		Open field (E3)	
Genotypes	**1st year**	**2nd year**	**1st year**	**2nd year**	**1st year**	**2nd year**
S-3	78.22	72.5	79.21	76.54	75.63	77.03
S-4	76.25	76.107	76.26	78.25	79.63	79
S-5	75.32	75.773	76.58	77.22	79.95	79
S-6	77	78.52	78.26	80	81.63	80.21
S-7	78.23	78.96	79.21	79	79.63	79.44
S-9	76.32	77.107	77.58	78.23	80.95	78.64
S-10	76.11	77.02	77.69	78.02	78.21	79.66
S-11	85.65	86.99	80.91	82.42	90.28	81.98
S-12	75.96	76.083	76.56	77.03	77.21	78.35
S-13	83.55	84.917	78.81	79.33	88.18	76.55
S-14	87.36	88.187	82.62	70	91.99	83.74
S-15	86.11	87.137	81.37	71.65	90.74	82.84
S-17	88.96	89.987	84.22	72.41	93.59	84.84
S-18	88.03	89.193	83.29	73.25	92.66	84.84
S-19	83.48	85.013	78.74	72.04	88.11	81
S-20	84.69	86.27	79.95	75	89.32	80.41
S-21	75.25	75.36	77.05	76.04	76.28	75.36
S-22	76	76.177	76.26	79.66	79.84	76.54
S-24	76.04	77.17	76.94	78.2	80.52	77.48
S-25	77.65	79.053	78.7	80.33	82.28	79.48
S-26	78.53	80.12	79.58	81.28	83.16	80.54
S-30	77.19	78.337	78.24	79.66	81.82	78.65
S-31	90	91.283	80.03	82.54	94.63	80.41
S-32	90.23	91.263	80.26	82.63	94.86	81.62
S-36	93.59	95.01	83.62	85.36	98.22	84.11
S-37	94.22	95.193	84.25	86.33	98.85	86
S-38	94.23	95.13	84.26	87.45	98.86	85.11
S-39	87.55	88.957	77.58	82.33	92.18	78.33
S-44	83.54	84.903	78.37	80.47	88.17	79.14
S-46	89.9	91.08	84.73	86.42	94.53	85.41
S-47	87.99	88.993	82.82	84.33	92.62	83.99
S-49	81.69	83.147	76.52	78.15	86.32	79
S-54	80.57	82.013	75.4	77.19	85.2	76.52
S-55	89.05	90.14	83.88	84.26	93.68	84
S-58	91.79	92.947	86.62	88.22	96.42	87.25
Marmalade Pool	85.32	86.35	75.26	77.46	89.95	76.25

S-101	93.73	95.033	83.67	85.29	98.36	84.45
4-6 P_5	85.64	87.56	75.58	77.11	90.27	76.87
Selection 21 Round P L1	86.53	88	76.47	78.25	91.16	77.44
59 P/2 Round Large	85.01	86.18	74.95	77.42	89.64	75.02
WI-321	94.27	95.347	84.21	86.32	98.9	84.54
Israel Selection	93.43	94.393	84.47	86.41	98.06	85
Selection 39	93.88	95.117	84.92	86.58	98.51	85.14
S-115	72.56	73.56	74.23	74.39	75.01	74.26
WI-181 Round Deep Red	93.69	94.517	84.73	86.37	98.32	85.22
B_1	92.32	93.91	83.36	85.17	96.95	85.25
Deep Red Marmade P_9	93.44	94.27	84.48	86.41	98.07	86.45
Punjab Ratta Check	73.12	75.073	75.32	76.58	78.85	79.41
Punjab Upma	92.58	94.027	83.62	81.21	97.21	85.36
Punjab Sartaj	95.43	96.353	86.47	87.26	100.06	88.58
C.D.	N/A	0.621	0.042	0.808	0.602	0.504
SE(m)	1.325	0.221	0.015	0.287	0.214	0.312
SE(d)	1.874	0.313	0.021	0.406	0.303	0.403
C.V.	4.212	0.447	0.049	0.9	1.027	1.062

Days to first fruit harvest

Out of all the three environments the very first fruit set was observed in variety S-115 at 102.56 days under low tunnel conditions in the 1st year. It was followed by S-15 which showed first fruit setting at 102.65 days in the 2nd year under paddy conditions. The impacting factor behind early harvest under low tunnel conditions can be attributed to hastened reproductive phase i.e. early fruit setting, early maturity due to high mean soil temperature as compared to bare soil. The results are in parallel with the results of Lamont (1999) who confirmed that mulches ameliorate the soil hydrothermal regime and therefore it leads to enhanced vegetative phase, advanced flowering and advanced harvest. These findings are also supported by Ham *et al*. (1991) that at least 9 day early flowering was noted for plants that were under some protected covering

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Table 6: Mean performance of tomato genotypes for days to first fruit harvest:

	Days to first fruit harvest					
	Low tunnel (E1)		Paddy(E2)		Open field (E3)	
Genotypes	1st year	2nd year	1st year	2nd year	1st year	2nd year
S-3	108.22	102.71	110.26	107.54	106.28	108.51
S-4	106.25	106.317	107.31	109.25	110.28	110.48
S-5	105.96	106.02	107.63	108.22	110.6	110.48
S-6	107	108.73	109.31	111	112.28	111.69
S-7	108.23	109.17	110.26	110	110.28	110.92
S-9	106.32	107.317	108.63	109.23	111.6	110.12
S-10	106.11	107.23	108.74	109.02	108.86	111.14
S-11	115.65	117.2	111.96	113.42	120.93	113.46
S-12	105.96	106.293	107.61	108.03	107.86	109.83
S-13	113.55	115.127	109.86	110.33	118.83	108.03
S-14	117.36	118.397	113.67	101	122.64	115.22
S-15	116.11	117.347	112.42	102.65	121.39	114.32
S-17	118.96	120.197	115.27	103.41	124.24	116.32
S-18	118.03	119.403	114.34	104.25	123.31	116.32
S-19	113.48	115.223	109.79	103.04	118.76	112.48
S-20	114.69	116.48	111	106	119.97	111.89
S-21	105.25	105.57	108.1	107.04	106.93	106.84
S-22	106	106.387	107.31	110.66	110.49	108.02
S-24	106.04	107.38	107.99	109.2	111.17	108.96
S-25	107.65	109.263	109.75	111.33	112.93	110.96
S-26	108.53	110.33	110.63	112.28	113.81	112.02
S-30	107.19	108.547	109.29	110.66	112.47	110.13
S-31	120	121.493	111.08	113.54	125.28	111.89
S-32	120.23	121.473	111.31	113.63	125.51	113.1
S-36	123.59	125.22	114.67	116.36	128.87	115.59
S-37	124.22	125.403	115.3	117.33	129.5	117.48
S-38	124.23	125.34	115.31	118.45	129.51	116.59
S-39	117.55	119.167	108.63	113.33	122.83	109.81
S-44	113.54	115.113	109.42	111.47	118.82	110.62
S-46	119.9	121.29	115.78	117.42	125.18	116.89
S-47	117.99	119.203	113.87	115.33	123.27	115.47
S-49	111.69	113.357	107.57	109.15	116.97	110.48
S-54	110.57	112.223	106.45	108.19	115.85	108
S-55	119.05	120.35	114.93	115.26	124.33	115.48
S-58	121.79	123.157	117.67	119.22	127.07	118.73

Marmade Pool	115.32	116.56	106.31	108.46	120.6	107.73
S-101	123.73	125.243	114.72	116.29	129.01	115.93
4-6 P_5	115.64	117.77	106.63	108.11	120.92	108.35
Selection 21 Round P L1	116.53	118.21	107.52	109.25	121.81	108.92
59 P/2 Round Large	115.01	116.39	106	108.42	120.29	106.5
WI-321	124.27	125.557	115.26	117.32	129.55	116.02
Israel Selection	123.43	124.603	115.52	117.41	128.71	116.48
Selection 39	123.88	125.327	115.97	117.58	129.16	116.62
S-115	102.56	103.77	105.28	105.39	105.66	105.74
WI-181 Round Deep Red	123.69	124.727	115.78	117.37	128.97	116.7
B_1	122.32	124.12	114.41	116.17	127.6	116.73
Deep Red Marmade P_9	123.44	124.48	115.53	117.41	128.72	117.93
Punjab Ratta Check	103.12	105.283	106.37	107.58	109.5	110.89
Punjab Upma	122.58	124.237	114.67	112.21	127.86	116.84
Punjab Sartaj	125.43	126.563	117.52	118.26	130.71	120.06
C.D.	4.594	5.23	4.63	12.379	5.23	5.67
SE(m)	1.634	1.54	1.71	4.404	2.54	1.62
SE(d)	2.311	2.58	2.43	6.228	4.65	2.84
C.V.	2.463	3.02	2.65	7.716	3.66	3.41

Days to last fruit harvest (no.)

The last fruit harvest was seen to be recorded at 177.24 days for variety S-115 for 2nd year under the environmental conditions of paddy straw. It has been noticed that mulching the soil provided early growth season boost, enhanced growth and longer fruit duration may be due to more reflected sunlight and lesser rate of evapo-transpiration as well as good soil moisture content is maintained by mulches. These findings are in confirmation with Maida, Bisen and Diwan (2019).

Table 7: Mean performance of tomato genotypes for days to last fruit harvest:

	Days to last fruit harvest					
	Low tunnel (E1)		Paddy(E2)		Open field (E3)	
Genotypes	1st year	2nd year	1st year	2nd year	1st year	2nd year
S-3	163	164	162.007	168.019	163.07	165.737
S-4	165	166.173	165.333	170.424	166.077	168.744
S-5	165.667	162.353	166.01	171.48	166.15	168.817
S-6	165	164.947	163.387	169.076	165.01	167.677
S-7	165	166.22	162	167.35	163.07	165.737
S-9	164.333	165	166.673	172.181	167.117	169.784
S-10	167.667	162.28	165.667	171.626	168.157	170.824
S-11	166	165.23	172	173.223	166	175.877
S-12	166	167.07	170.52	173.997	173.21	172.2
S-13	164	165.263	166	171.24	166.107	168.774
S-14	167.333	167.99	171	176.183	161.2	174.82
S-15	164	165.117	65	70.993	166.07	168.737
S-17	166	167.007	166.333	172.018	166.737	169.404
S-18	164	165.153	162.667	168.202	163.787	166.454
S-19	162.667	162.917	161.667	166.316	162.88	165.547
S-20	163.667	164	164.773	170.368	154.88	157.547
S-21	166.02	168.037	170	175.26	172.153	174.52
S-22	164.667	165.083	165.683	171.698	167.113	169.78
S-24	166	167.177	170.7	175.717	169.897	172.564
S-25	165	166.193	167.02	172.91	168.227	170.894
S-26	165.333	165.83	165.347	171.469	165.25	167.917
S-30	167	167.853	167.34	171.84	166.797	169.464
S-31	165.667	166.173	166.34	172.563	166.07	168.737
S-32	162.667	163.463	164.333	169.368	163.13	165.797
S-36	165.333	166.243	167.007	172.216	169.213	171.88
S-37	163	164.24	167.673	173.191	167.09	169.757
S-38	165.667	166.177	167.333	173.111	165.877	168.544
S-39	165.333	166.287	167.333	119.558	165.977	168.644
S-44	168	165.18	164	175.281	171.143	173.81
S-46	165.333	166.183	166	171.27	168.027	170.694
S-47	165.333	166.18	170.333	175.151	169.103	171.77
S-49	165.667	166.173	165	170.17	165.403	168.07
S-54	165.333	166.07	173	174.393	171.053	173.72

S-55	165.333	166.15	168	173.29	166.187	168.854
S-58	165.667	166.28	166	171.067	168.127	170.794
Marmade Pool	162.667	163.397	166	171.83	168.107	170.774
S-101	164	165.15	164	169.817	165.007	167.674
4-6 P_5	166.333	163.547	168.667	174.019	168.113	170.78
Selection 21 Round P L1	167.667	168.223	172.007	173	171.78	174.447
59 P/2 Round Large	168	166.277	174	174	168	175.817
WI-321	164.333	165.107	167	172.24	167.093	169.76
Israel Selection	164.667	165.147	165.347	170.149	165.32	167.987
Selection 39	166.333	167.15	172.337	173	171.21	173.877
S-115	167.85	169.083	175.36	177.24	175.3	173.25
WI-181 Round Deep Red	163.667	164.193	163.333	168.274	163.153	165.82
B_1	164.667	165.29	169.333	174.248	169.213	171.88
Deep Red Marmade P_9	165.667	166.15	166.017	171.246	166.107	168.774
Punjab Ratta Check	168	169.19	174.62	176.298	175.78	172
Punjab Upma	164.667	165.617	166.007	172.012	166.22	168.887
Punjab Sartaj	166	167.037	167.013	172.738	167.117	169.784
C.D.	N/A	0.427	1.239	5.49	4.074	3.965
SE(m)	1.361	0.152	0.441	2.04	1.45	1.32
SE(d)	1.925	0.215	0.623	3.54	2.05	1.85
C.V.	1.427	0.159	0.462	2.05	1.502	1.35

4. CONCLUSION

It was concluded that for most of the characters maximum and ideal data was observed under low tunnel environment followed by paddy straw, which wasthenfollowed by open field conditions. Protected conditions provided favourable growing conditions leading to profuse growth.The maximum data for plant height was recorded

in the genotype S-115 (220.54cm).Maximum number of primary branches were recorded in S-115 (18.667). Days to first flowering was revealed in S-115 (33.21 days, days to first fruit set was observed in S-115 (72.56). Maximum value for days to first fruit harvest and last fruit harvest was observed also in S-115 (102.56) and (177.24) respectively.

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