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Evaluation of bacterial wilt resistant genotypes of tomato for yield and other traits under different growing seasons and transplanting dates

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Abstract

Five bacterial wilt resistant genotypes of tomato viz., BT-18, BL 342-1, BL 333-1, EC-191536 and Hawaii-7998 were evaluated for fruit yield and other traits at CSKHPKV under different growing seasons and transplanting dates. The growing seasons, transplanting dates, genotypes and their interactions were found to exhibit significant effects for majority of the characters studied. The early transplanting of Hawaii 7998 in summer season recorded highest marketable fruit yield (2.52 kg/ plant), total number of fruits/ plant (136.40) and marketable fruits per plant (96.27). However, significantly highest average fruit weight (105.32 g) was recorded in BL 342-1 under late transplanting of rainy season. In general, significantly higher average fruit weight and marketable yield per plant were recorded in rainy season as compared to summer season. Early transplanting recorded significantly higher marketable yield per plant, total number of fruits per plant and marketable fruits per plant as compared to late transplanting.

Introduction

Tomato is an important cash crop of mid-hills of Himachal Pradesh. The region is known for producing off-season quality tomatoes fetching very high economic returns to the farmers during June to September. However, presently its cultivation is being seriously threatened by bacterial wilt (*Pseudomonas solanacearum*). Being bacterial and soil borne disease, various control measures except resistance breeding are not efficient, effective and economic. Keeping in view the above consideration, few bacterial wilt resistant genotypes having desirable horticultural traits have been identified at CSK HPKV, Palampur. However, these genotypes need to be evaluated for their suitability to be grown under different growing seasons and transplanting dates as the performance of these genotypes may vary with changing growing conditions because of g x e interaction. Hence the present study was undertaken to evaluate five bacterial wilt resistant genotypes viz., BT 18, BL 333-1, BL 342-1, EC 191536 and Hawaii 7998 under different growing seasons and transplanting dates for fruit yield and other horticultural traits in order to arrive at a conclusion which will indicate the suitable variety and optimum time of transplanting of each variety under study.

Material and Methods

The present investigations were carried out at the Experimental farm of the department of Vegetable Science and Floriculture, CSK, HPKV, Palampur representing mid-hills of H.P. The place is characterized by severe winters, mild summers with high rainfall (2500 mm per annum), majority of which is received in June and July. Relative humidity too was higher during these months. The investigation was carried out with five bacterial wilt resistant genotypes of tomato viz. BT-18, BL 342-1, BL 333-1, EC-191536 and Hawaii-7988, two growing seasons (summer and rainy) and transplanting dates (mid March and mid April in summer season and early July and early Aug in rainy season) during 1999-2000. The experiment was conducted in randomized complete block design (RBD) with three replications. The plot size was 3.6m x 2.25m with plant spacing of 75x 60 cm accommodating 3 rows of 6 plants each. All the recommended production and protection practices were followed. Observations were recorded on number of days to 50 % flowering, average fruit weight (g), total number of fruits per plant, marketable fruits per plat and marketable yield per plant (kg) and analyzed statistically as per the method given by Gomez and Gomez (1984).

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Results and Discussion

The results indicated significant differences among main effects due to seasons, transplanting dates and genotypes for all the parameters studied except average fruit weight (transplanting dates) and marketable fruits per plant (seasons). The various interaction effects due to seasons, transplanting dates and genotypes were also found to be significant for all the characters studied. In general, the crop grown during summer season took significantly lesser days to 50% flowering (Table 1), recorded lower average fruit weight (Table.2), marketable yield per plant (Table 3) but more number of fruits per plant (Table 4) as compared to rainy season crop. This is primarily on account of warm and sunny weather with optimum temperature for tomato growth and fruit set. In summer season crop, although due to favourable temperature, fruit setting was higher as compared to rainy crop but due to heavy incidence of fruit rots and fruit borer the per cent recovery of marketable fruits was lower. Hence non-significant difference between seasons was observed for marketable fruits per plant (Table 5). Lower average fruit weight and marketable yield in summer crop may be attributed to variation in total number of fruits per plant. In summer season higher fruit set was observed as compared to rainy season. Hence during rainy season more food material was accumulated in less number of fruits thereby resulting in increased average fruit weight. These results are in conformity to those of Drost and Price (1991), Meher *et al.* (1994) and Phookan and Shadeque (1996).

The different transplanting dates markedly influenced all the characters studied except average fruit weight. Early transplanting significantly increased total number of fruits and marketable fruit yield per plant during both the seasons. This may be due to the prevalence of favourable conditions for more fruit set, less incidence of fruit rot diseases and longer duration of early transplanted crop. By early transplanting, flowering was significantly advanced in summer season and delayed in rainy season. It could be due to early and late establishment of seedlings in summer and rainy season, respectively. These results are in consonance with those of Kadam *et al.* (1993), Jamwal *et al.* (1995) and Sharma and Tiwari (1996). The genotypes were found to exhibit significant differences for all the characters studied. The genotype BL 333-1 took minimum number of days to 50% flowering (36.17) followed by BT 18 (36.75), however EC 191536 (46.25) took maximum number of days. The delayed flowering in EC 1915136 was primarily due to its indeterminate growth habit. These results are in the conformity to the findings of Arora *et al.* (1981), Gulshan *et al.* (1991) and Bhardwaj *et al.* (1995). The highest average fruit weight was recorded in the genotype BL 342-1 (95.24g) followed by EC 191536 (63.71g), while the lowest in Hawaii 7998 (28.66g). This may be due to lesser total number of fruits per plant in case of BL 342-1 and EC 191536 as compared to other genotypes. Genotype Hawaii 7998 produced significantly more number of fruits and higher marketable yield in comparison to other genotypes and was followed by BT18. Higher yield in these cultivars may be attributed to more number of fruits per plant. The indeterminate genotype EC 191536 could not express its full yield potential due to the synchronicity of peak fruiting period with heavy rains in summer crop and frost in late rainy season crop. Varietal variation for these characters has also been observed by many workers (Shukla *et al.* 1990, Nandi, 1993 and Bhardwaj *et al.* 1995).

The interaction effects due to season x transplanting dates, season x genotypes, transplanting dates x genotypes and season x transplanting dates x genotypes were found to be significant for all the presented characters. Earliest 50% flowering was observed in early summer crop (32.93) followed by late transplanting of the same season (36.40). This may be due to the favorable weather conditions during early transplanting of summer season. Although the average fruit weight was higher in rainy season as compared to summer season in both the transplanting dates but delay in transplanting decreased average fruit weight in summer season and increased in rainy season significantly. The maximum total number of fruits were obtained in early transplanting of summer season (67.97) followed by late transplanting of the same season (44.77). Early and late transplanting dates in rainy season had higher marketable yield per plant as compared to the corresponding dates in summer season. However, during summer season there was drastic reduction in yield due to delay in transplanting as compared to rainy season. This is because of heavy incidence of diseases, relatively unfavorable conditions for fruit set and early senescence of late summer crop.

The interaction effects due to seasons x genotypes revealed that genotype BL 333 in summer season and BT 18 in rainy season were earliest to

Table 1. Effect of seasons, transplanting dates and interaction on different genotypes in respect of days to 50 % flowering

Genotypes (V)	Seasons (S) / Transplanting dates (D)						Mean over seasons		Mean over seasons & transplanting date
	Summer (S_1)			Rainy (S_2)					
	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	
BT 18	33.00	38.00	35.50	37.33	38.67	38.00	35.17	38.33	36.75
BL 342-1	34.33	39.00	36.67	60.00	43.00	51.50	47.17	41.00	44.08
BL 333-1	28.00	33.00	30.50	44.00	39.67	41.83	36.00	36.33	36.17
EC 191536	36.00	39.00	37.50	63.33	46.67	55.00	49.67	42.83	46.25
Hawaii 7998	33.33	33.00	33.17	44.00	44.00	44.00	38.67	38.50	38.55
Mean over genotypes	32.93	36.40	34.67	49.73	42.40	46.07	41.33	39.40	

Factors	Seasons	Tr. dt.(D)	S x D	Genotypes (V)	S x V	D x V	S x D x V
SE (d) ±	0.18	0.18	0.25	0.28	0.39	0.39	0.56
CD (P=0.05)	0.36	0.36	0.51	0.57	0.80	0.80	1.13

Table 2. Effect of seasons, transplanting dates and interaction on different genotypes in respect of average fruit weight (g)

Genotypes (V)	Seasons (S) / Transplanting dates (D)						Mean over seasons		Mean over seasons & transplanting date
	Summer (S_1)			Rainy (S_2)					
	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	
BT 18	37.82	42.92	40.37	43.51	47.82	45.67	40.67	45.37	43.02
BL 342-1	92.46	83.24	87.85	99.94	105.32	102.63	96.20	94.28	95.24
BL 333-1	41.77	34.81	38.29	38.23	36.89	37.56	40.00	35.85	37.93
EC 191536	60.65	58.61	59.63	63.72	71.88	67.80	62.19	65.24	63.71
Hawaii 7998	26.17	26.15	26.16	30.18	32.13	31.16	28.17	29.14	28.66
Mean over genotypes	51.77	49.14	50.46	55.12	58.81	56.96	53.45	53.98	
Factor	Seasons	Tr. dt.(D)	S x D	Genotypes (V)	S x V	D x V	S x D x V		
SE (d) ±	0.42	0.42	0.60	0.67	0.94	0.94	1.33		
CD (P=0.05)	0.86	NS	1.21	1.35	1.91	1.91	2.70		

Table 3. Effect of seasons, transplanting dates and interaction on different genotypes in respect of marketable yield/ plant (kg)

Genotypes (V)	Seasons (S) / Transplanting dates (D)						Mean over seasons		Mean over seasons & transplanting date
	Summer (S_1)			Rainy (S_2)					
	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	
BT 18	1.20	1.17	1.18	1.91	1.56	1.73	1.55	1.36	1.46
BL 342-1	0.90	0.64	0.77	1.92	1.81	1.86	1.41	1.22	1.32
BL 333-1	0.82	0.57	0.70	1.05	0.81	0.93	0.93	0.69	0.81
EC 191536	1.40	0.52	0.96	0.82	0.93	0.87	1.11	0.72	0.92
Hawaii 7998	2.52	1.31	1.92	1.85	1.39	1.62	2.18	1.35	1.77
Mean over genotypes	1.37	0.84	1.11	1.51	1.30	1.40	1.44	1.07	
Factors	Seasons	Tr. dt. (D)	S x D	Genotypes (V)	S x V	D x V	S x D x V		
SE (d) ±	0.02	0.02	0.024	0.025	0.035	0.035	0.05		
CD (P=0.05)	0.03	0.03	0.05	0.05	0.07	0.07	0.10		

Table 4. Effect of seasons, transplanting dates and interaction on different genotypes in respect of total number of fruits per plant

Genotypes (V)	Seasons (S) / Transplanting dates (D)						Mean over seasons		Mean over seasons & transplanting date
	Summer (S_1)			Rainy (S_2)					
	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	
BT 18	85.47	53.20	69.33	50.53	36.67	43.60	68.00	44.93	56.47
BL 342-1	35.93	24.40	30.17	23.13	21.53	22.33	29.53	22.97	26.25
BL 333-1	42.40	51.87	47.13	31.47	25.67	28.57	36.93	38.77	37.85
EC 191536	39.73	19.60	29.67	15.60	15.40	15.50	27.67	17.50	22.58
Hawaii 7998	136.40	74.80	105.60	67.73	48.00	57.87	102.07	61.40	81.73
Mean over genotypes	67.97	44.77	56.38	37.69	29.45	33.57	52.84	37.11	

Factor	Seasons (S)	Tr. dt. (D)	S x D	Genotypes (V)	S x V	D x V	S x D x V
SE (d) ±	0.24	0.24	0.34	0.38	0.53	0.53	0.76
CD (P=0.05)	0.48	0.48	0.69	0.77	1.08	1.08	1.53

Table 5. Effect of seasons, transplanting dates and interaction on different genotypes in respect of marketable fruits per plant

Genotypes (V)	Seasons (S) / Transplanting dates (D)						Mean over seasons		Mean over seasons & transplanting date
	Summer (S_1)			Rainy (S_2)					
	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	Mean	Early (D_1)	Late (D_2)	
BT 18	31.73	27.20	29.47	43.87	32.13	38.00	37.80	29.67	33.73
BL 342-1	9.77	7.77	8.75	19.20	17.13	18.17	14.48	12.43	13.46
BL 333-1	19.73	16.27	18.00	27.33	22.07	24.70	23.53	19.10	21.35
EC 191536	23.20	8.80	16.00	12.87	12.87	12.87	18.03	10.83	14.43
Hawaii 7998	96.27	50.20	73.23	61.20	43.20	52.20	78.73	46.70	62.72
Mean over genotypes	36.14	22.04	29.09	32.89	25.48	29.19	34.52	23.76	

Factor	Seasons (S)	Tr. dt. (D)	S x D	Genotypes (V)	S x V	D x V	S x D x V
SE (d) ±	0.35	0.35	0.50	0.55	0.78	0.78	1.11
CD (P=0.05)	NS	0.71	1.01	1.12	1.59	1.59	2.25

flower as compared to other combinations. However, BT 18 in early transplanting and BL 333-1 in late transplanting took significantly lesser number of days to 50% flowering as a result of genotype x transplanting date interaction. Flowering was delayed in BT 18 and hastened in BL 342-1 and EC 191536 as a result of delay in transplanting but exhibited non-significant effects on the performance of BL 333-1 and Hawaii in this respect. The comparative performance of the different genotypes remained at par in both the seasons in respect of average fruit weight due to large proportion of genotypic variation. All the genotypes except BL 333-1 recorded significantly higher average fruit weight during rainy season in comparison to summer season. Similarly, genotypes BT 18 and EC 191536 in late transplanting and BL 342-1 and BL 333-1 in early transplanting recorded significantly higher average fruit weight as compared to early and late transplantings of the respective genotypes. All the genotypes produced significantly higher total number of fruits/ plant in summer season as compared to rainy season. A drastic increase in total number of fruits was observed in genotypes Hawaii 7998 and EC 191536 during summer season as compared to rainy season. This increase in number of fruits may be attributed to indeterminate nature of these genotypes coupled with longer duration of the summer crop. All the genotypes except BL 333-1 produced significantly more total number of fruits as a result of early transplanting however, BL-333-1 showed the opposite trend. Genotypes BT 18, BL 342-1 and BL 333-1 in rainy season and EC 191536 and Hawaii 7998 in summer season produced significantly higher marketable yield as compared to summer and rainy season respectively. A significantly higher marketable fruit yield was recorded as a result of early transplanting in all the genotypes.

Seasons x transplanting dates x genotypes interaction effects revealed that earliest 50 % flowering was recorded in BL 333-1 when transplanted early in summer season followed by late summer transplanting of the same genotype. Significantly highest marketable yield (2.52 kg/ plant) and total number of fruits per plant (136.40) were recorded in Hawaii 7998 when transplanted early in summer season. The genotype BT 18 recorded a highest fruit yield of 1.91kg/ plant in early transplanting of rainy season in comparison to other transplantings. The highest average fruit weight was recorded in BL 342-1 (105.32 g) when transplanted late in rainy season. Earlier researchers viz., Meher *et al.* (1994) and Phookan and Shadeque (1996) observed similar interaction effects due to seasons, transplanting dates and genotypes for different traits in tomato.

In the present experiment, genotypes BT 18, BL 342-1 and BL 333-1 in rainy season and EC 191536 and Hawaii 7998 in summer season produced significantly higher marketable yield, which reflects their suitability to be grown in the corresponding season. Early transplanting had a favourable effect on all the genotypes irrespective of growing seasons. Out of the five genotypes tested, Hawaii 7998 gave the highest average fruit yield of 1.77 kg/ plant followed by BT 18 (1.46 kg/ plant).

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