Original Research Article

Screening of bell pepper (*Capsicum annuum* L.var. *grossum*Sendt.) genotypes forhigher marketability and bacterial wiltresistance under mid-hillconditions of North-Western Himalayas

ABSTRACT

Bacterial wilt, caused by *Ralstonia solanacearum,*is a major soil borne disease of bell pepper in hot and humid growing areas around the world. The existing varieties of bell pepper are highly susceptible and not even a single commercial variety resistant to this disease has been developed yet and commercially available. The chemical control measures and manipulation of agronomical practices have been applied, but these are found ineffective against this disease, hence growing of resistant cultivars is the only way to overcome the yield losses**.** Along with resistance, varieties with early yielding ability and superior morphological characters fetch high prices in the market. Thus, an attempt was made to screen 39 genotypes of bell pepper along with four checks during summer-rainy season, 2018 and 2019. Genotypes DPCBWR-14-39, DPCBWR-14-36, DPCBWR-14-2, DPCBWR-14-35 and DPCBWR-14-29 were identified as top yielders and showed high level of resistance to bacterial wilt. Among these, DPCBWR-14-39 and DPCBWR-14-29 genotypes were earliest in flowering and picking. Besides, most of the resistant and top yieldersgenotypes were also green in fruit colour, pendent in fruit position, blocky in fruit shape, cordate at pedicel and sunken at blossom end. Therefore, from this study, it has beensummarized that these genotypes could be utilized in hybridization programmes or could be directly released as a variety after preliminary and multi-location yield trials for commercial release.

Keywords: Bacterial wilt;Capsicum annuum L. var. grossum Sendt.;earliness;morphological traits; yield

1. INTRODUCTION

Bell pepper (*Capsicum annuum* L. var. *grossum*Sendt.; 2n=24) is the second most important Solanaceous vegetable after tomato. It grows well in tropical, subtropical, and sub-temperate climates all over the world. In India, this vegetable was brought by British people during 19^{th} century and was grown first time in Shimla hills, earning it the nickname "Shimla Mirch" [1]. Besides this, it is also famous among people as sweet pepper or pepper or capsicum. Bell pepper is one of the most potential off-season vegetables of mid hill zone of Himachal Pradesh [2] and is generally grown during summer-rainy season. Being off-season vegetable, crop fetches very high prices in plains and generates cash revenues to the farmers of North-Western hills [3]. However, bell pepper yield potential and overall production are low because of low yielding cultivars and increased frequency of diseases and insect-pests in lower and mid-hill pockets. Among diseases, bacterial wilt is the most common soil borne disease of sweet peppers causes upto 100 per cent yield losses in hot and humid tropics, sub-tropics and sub-temperate areas at 30-35°C [4]. The pathogen involved is '*Ralstonia solanacearum'.* The disease is called as 'Green wilt' in some regions because the infected plant's leaves remain green until the signs of wilt appear [5,6]. In low and mid hill zones of Himachal Pradesh, it is the major limiting factor in profitable cultivation of bell pepper. Initially, this disease has been reported from traditional bell pepper growing areas *viz.,* Solan and Kullu valley but gradually, it is spreading to other districts like Bilaspur, Kangra and Hamirpur. Bacterial wilt is also an important disease in other states like Karnataka, Kerala, Odisha, Bihar, Maharashtra, Sikkim, West Bengal and Andaman and Nicobar islands [7]. The existing cultivars/varieties lack resistance to bacterial wilt due to unavailability of stable resistance source in bell pepper [8]. The chemical control measures and manipulation of agrochemical practices have been applied but none of them found effective to control this disease. Therefore, improved disease resistant varieties must be identified and developed to increase the yield potential of bell pepper. Further, earliness is a very desirable characteristic in all vegetables as the market value of early crop is generally high and produce fetches high prices in market. Early maturing strains hold extensive importance in procuring early markets [8]. The morphological characterization of bell pepper germplasm is the foremost step for beginning any improvement scheme, and it is still utilized in places where the capacity to use molecular markers to carry out in situ analysis is not yet completely developed.On the basis of phenotype or visual appearance, morphological descriptors form the base of characterization of genotypes. These are also equally important to genotypic, biochemical and molecular characterization of collected germplasm. Hence, the present study was undertaken on 43 genotypes including one susceptible, one moderately resistant and two resistant checks to measure the extent of genetic variability for bacterial wilt resistance, earliness and morphological characters in bell pepper.

2. MATERIAL AND METHODS

In the year 2003, lines resistant to bacterial wilt were brought from World Vegetable Center (WVC), Taiwan to CSKHPKV, Palampur. They were screened *in vivo* and *in vitro* for six seasons and after that two accessions *viz.,* EC-464107 and EC-464115 resistant to bacterial wilt were selected. To introgress resistance gene into indigenous cultivars, these resistant accessions were then crossed to Kandaghat Selection and Sweet Happy-1 followed by backcross breeding [9]. The best lines were picked up in 2013 from F_2 and $BC_5F_2$and subjected to repeated selfing. In 2018 and 2019, we evaluated 39 (F_7 and F_8 progenies) genotypes tolerant to bacterial wilt disease along with four checks *viz.,* California Wonder (susceptible check), Kandaghat Selection (moderately resistant check), and EC-464107 and EC-464115 (resistant checks) as shown in figure 1 at research farm of Department of Vegetable Science and Floriculture, CSK HPKV, Palampur (HP) for bacterial wilt resistance, earliness and morphological characterization under natural sick field conditions in three replications using Randomized Complete Block Design (RCBD) at 60 × 45 cm spacing. California Wonder was planted at each tenth row for ensuring homogeneity in disease inoculum. For bacterial wilt incidence, observations were recorded at regular intervals on every plant of all replications. For confirmation of bacterial wilt, ooze test was performed on all the infected plants after 90 days of transplanting and plant survival (%) rate was calculated from the recorded data. On the basis of incidence, the genotypes were classified into four different categories *viz.,* susceptible (>60%), susceptible (>60 %), moderately resistant (20-40%) and resistant (< 20%) [10]. Formula of plant survival (%) is as under:

$$\text{Plant survival (\%)} = \frac{\text{Number of healthy plants 90 days after transplanting}}{\text{Number of established plants}} \times 100$$

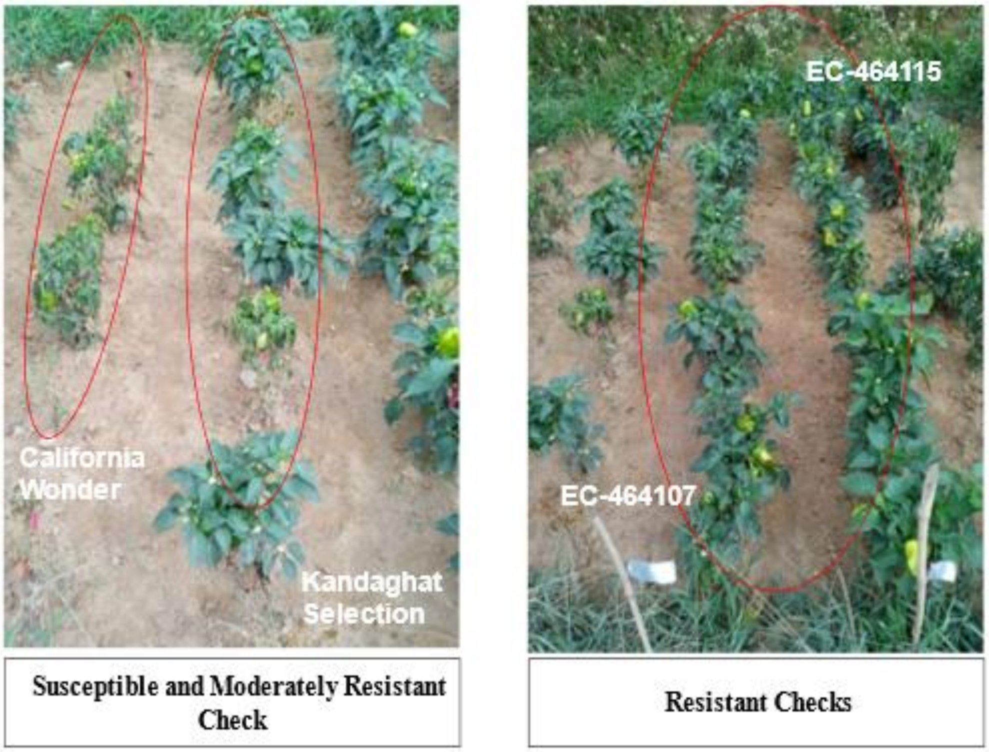

Fig. 1: Disease reaction of checks used in the study

Along with resistance, observations were also recorded on days to 50 per cent flowering, days to first harvesting, marketable fruit yield per plant and morphological traits *viz.,* overall fruit shape (Fig. 2), fruit shape at pedicel and blossom end (Fig.3&4), and fruit position (Fig.5) on randomly preferred five plants in each replication at horticultural maturity. Morphological traits were reported in accordance with the descriptor [11]. On the basis of colour, the fruits were divided into two groups (green group; GG and yellow green group; YGG) and compared to Royal Horticultural Society (RHS) colour chart. Each descriptor's frequency distribution was determined once the genotypes were characterized.

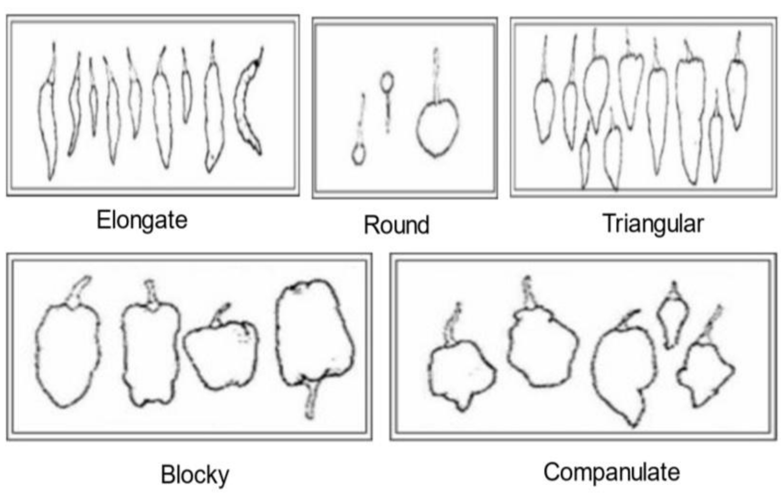

Fig. 2: Fruit shape

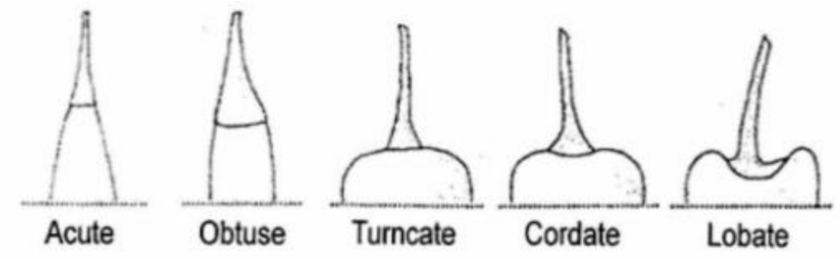

Fig.3: Fruit shape at pedicel end

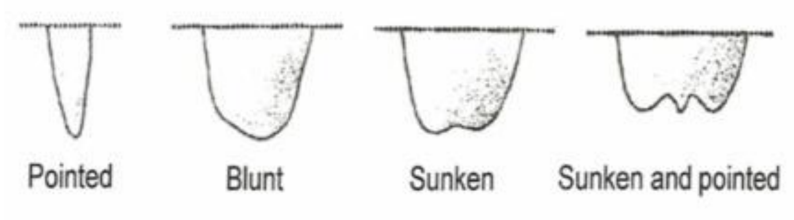

Fig.4: Fruit shape at blossom end

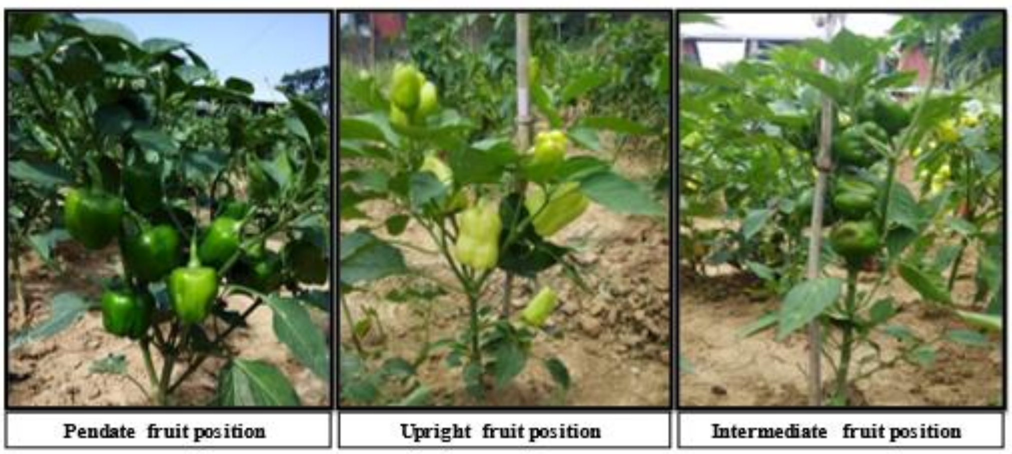

Fig. 5:Fruit position

3. RESULTS

Experimental results unveiled the presence of sufficient genetic variability for all attributes among genotypes. A high resistance level was reported in genotypes along with resistant checks. The genotypes DPCBWR-14-6-1 and DPCBWR-14-7 have the maximum plant survival (99.17 % and 99.13 %, respectively) and found statistically *at par* with L-22 (97.67 %), DPCBWR-14-31 (97.67 %) and DPCBWR-14-16 (97.67 %) (Table1). All the resistant checks *viz.,* EC464107 and EC414115 gave 100 per cent plant survival and susceptible check *viz*., California Wonder gave quite low plant survival (7.50 %). In the genotypes studied, the minimum plant survival was recorded in DPCBWR-14-14 (37.25 %). The range for this trait varied from 7.50 to 99.38 %.

Out of 39 genotypes evaluated, genotype DPCBWR-14-39 (35.05 days) recorded minimum number of days to 50 per cent flowering and was found to be statistically *at par* with genotype DPCBWR-14-32 (35.55 days) followed by DPCBWR-14-29 (37.22 days) and then DPCBWR-14-7 (38.22 days). These genotypes were also significantly superior to the check. The range for this trait varied from 35.05 to 48.55 days. Data pertaining to days to first harvesting showed that genotype DPCBWR-14-29 was the earliest (51.55 days) and was statistically *at par* with DPCBWR-14-39 (52.55 days). As many as 15 genotypes were significantly superior to susceptible check including EC-464107, EC-464115 and Kandaghat Selection. The character ranged between 51.55 to 69.55 days. In every crop improvement programme, higher fruit yield is the fundamental objective. Perusal of result in Table 1 revealed that DPCBWR-14-39 (546.94 g) produced highest marketable fruit yield per plant escorted by genotype DPCBWR-14-36 (515.80 g) and then DPCBWR-14-2 (454.43 g). DPCBWR-14-36 was statistically *at par* with DPCBWR-14-39. Whereas, CaliforniaWonder was the lowest yielder (95.82 g). The range for this trait varied from 95.82 to 546.94 g per plant. From commercial point of view, in Table 1, marketable fruit yield per plant of different genotypes is also presented in q/ha.

Fruit colour is an important visual character because it adds aesthetic value to the produce and attracts consumers. In Indian market, green to dark green fruits are generally preferred as consumers are not much aware about coloured bell peppers. From this study, we have recorded green (GG) and yellow green (YGG) colour intensities in tested genotypes (Table 2). 27 genotypes *viz.,* DPCBWR-14-1, DPCBWR-14-2, DPCBWR-14-4, DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-11, DPCBWR-14-11 (BS), DPCBWR-14-13, DPCBWR-14-14, DPCBWR-14-15, DPCBWR-14-17, DPCBWR-14-22, DPCBWR-14-23, DPCBWR-14-24, DPCBWR-14-24-1, DPCBWR-14-25, DPCBWR-14-28, DPCBWR-14-29, DPCBWR-14-30, DPCBWR-14-31, DPCBWR-14-32, DPCBWR-14-35, DPCBWR-14-38, DPCBWR-14-39, DPCBWR-14-40, L-22, L-4 along with checks (Kandaghat Selection and California Wonder) had shown green colour intensity, whereas all other genotypes produced yellow green fruits (Fig. 6). Further, the shape of the fruit is extremely important quality trait in peppers which is considered as key attribute to classify the different fruit types. Generally, blocky fruits are preferred by the consumers. All the genotypes were blocky in fruit shape (Table 2). Cordate and truncate fruit shapes at pedicel end are generally preferred, whereas lobate fruit shape is not desirable because water get accumulated at pedicel end which leads to fruit rot. Cordate fruit shape was noticed in most of the genotypes, whereas DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-6, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-11, DPCBWR-14-11 (BS), DPCBWR-14-17, DPCBWR-14-20, DPCBWR-14-24, DPCBWR-14-24-1, DPCBWR-14-28, DPCBWR-14-31, DPCBWR-14-40, and California Wonder had lobate fruit shape at pedicel end. Majority of genotypes were sunken at blossom end, while DPCBWR-14-5, DPCBWR-14-14, DPCBWR-14-23, DPCBWR-14-24, DPCBWR-14-39 and EC-464115 were sunken and pointed at blossom end. DPCBWR-14-4 was the only genotype categorized with blunt blossom end. Pendent fruit position was noticed in most of the genotypes, whereas DPCBWR-14-6, DPCBWR-14-6-1, DPCBWR-14-10, DPCBWR-14-11, DPCBWR-14-24-1, DPCBWR-14-39 and DPCBWR-14-40 had intermediate fruit position, and DPCBWR-14-7-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-22, DPCBWR-14-24, DPCBWR-14-35, DPCBWR-14-36, EC-464107 and EC-464115 were upright in fruit position (Table 2).

4. DISCUSSION

Above mentioned information reveals the existence of considerable scope for identifying excellent genotypes in the parent material as significant differences were existed for all the traits. Many of the characters investigated in bell pepper had previously been demonstrated to have sufficient genetic diversity by Ahmed *et al.*, Afroza *et al.* and Sharma *et al.*[12,13, 2]. Except for DPCBWR-14-14, all genotypes were determined to be resistant or moderately resistant to bacterial wilt disease. Sood and Kumar and Devi *et al.*[14, 9] found similar results for disease resistance using different material. Early flowering and early harvesting decide whether a variety will come early in the market or not and as a result help farmers to fetch high price for their produce in markets. On the basis of mean performance, genotypes DPCBWR-14-39, DPCBWR-14-32, DPCBWR-14-29 and DPCBWR-14-7 were earliest in 50 per cent flowering and genotypes *viz*., DPCBWR-14-29 and DPCBWR-14-39 in days to first harvesting.Sood *et al.* and Afroza *et al.*[15, 13] found comparable results for these traits. DPCBWR-14-39, DPCBWR-14-36, DPCBWR-14-2, DPCBWR-14-35, and DPCBWR-14-29 (Table 1) were the top highest yielders, and these genotypes were also among top for other contributing characters *viz*., days to 50 per cent flowering, days to first harvesting and plant survival (Table 1). Similar findings with different breeding material were also observed by Ahmed *et al.*[12].

Table 1.Mean values of bell pepper genotypes for different traits over pooled environment

Genotypes	Source	PS (%)	BWI (%)	RC	DFF	DFP	MFYPP (g)	MFY (q/ha)
		2018-19	2018-19	2018-19	2018-19	2018-19	2018-19	2018-19
DPCBWR-14-1	CSKHPKV, Palampur	93.50	6.50	Resistant	42.55	58.55	325.55	94.40
DPCBWR-14-2	-do-	87.25	12.75	Resistant	39.88	54.55	454.43	131.78
DPCBWR-14-3	-do-	91.42	8.58	Resistant	41.88	64.55	347.91	100.89
DPCBWR-14-4	-do-	85.17	14.83	Resistant	40.55	54.55	227.98	66.11
DPCBWR-14-5	-do-	85.17	14.83	Resistant	41.55	64.72	251.86	73.03
DPCBWR-14-5-1	-do-	95.58	4.42	Resistant	44.88	59.72	245.93	71.31
DPCBWR-14-6	-do-	93.50	6.50	Resistant	41.55	54.55	412.11	119.51
DPCBWR-14-6-1	-do-	99.17	0.84	Resistant	38.55	62.55	232.05	67.29
DPCBWR-14-7	-do-	99.13	0.88	Resistant	38.22	56.96	365.88	106.10
DPCBWR-14-7-1	-do-	91.42	8.08	Resistant	40.55	56.96	237.82	68.96
DPCBWR-14-8-1	-do-	93.50	6.50	Resistant	41.55	56.96	367.75	106.64
DPCBWR-14-9	-do-	87.25	12.75	Resistant	45.88	56.96	255.18	74.00
DPCBWR-14-10	-do-	76.83	23.17	Moderately Resistant	44.88	56.96	317.24	91.99
DPCBWR-14-11	-do-	85.17	14.83	Resistant	43.55	56.96	336.87	97.69
DPCBWR-14-11(BS)	-do-	76.83	23.17	Moderately Resistant	45.55	56.96	278.82	80.85
DPCBWR-14-12	-do-	97.08	4.42	Resistant	43.55	61.55	296.80	86.07
DPCBWR-14-13	-do-	80.05	19.95	Resistant	41.55	55.55	402.52	116.73
DPCBWR-14-14	-do-	37.25	62.75	Moderately Susceptible	43.88	56.96	355.83	103.19
DPCBWR-14-15	-do-	93.50	6.50	Resistant	42.88	56.96	376.83	109.28
DPCBWR-14-16	-do-	97.67	2.33	Resistant	48.55	56.96	319.88	92.76
DPCBWR-14-17	-do-	87.25	12.75	Resistant	42.22	54.55	307.17	89.07
DPCBWR-14-20	-do-	87.25	12.75	Resistant	48.22	54.55	301.07	87.31
DPCBWR-14-22	-do-	95.58	4.42	Resistant	46.88	69.55	305.33	88.54
DPCBWR-14-23	-do-	76.83	23.17	Moderately Resistant	43.22	56.96	364.01	105.56
DPCBWR-14-24	-do-	93.50	6.50	Resistant	41.55	54.55	316.11	91.67
DPCBWR-14-24-1	-do-	95.58	4.42	Resistant	44.88	54.55	398.87	115.67
DPCBWR-14-25	-do-	62.25	37.75	Moderately Resistant	42.55	56.96	359.93	104.37
DPCBWR-14-28	-do-	95.58	4.42	Resistant	43.22	56.96	310.86	90.14
DPCBWR-14-29	-do-	93.50	6.50	Resistant	37.22	51.55	426.99	123.82
DPCBWR-14-30	-do-	89.33	10.67	Resistant	46.22	54.55	391.08	113.41
DPCBWR-14-31	-do-	97.67	2.33	Resistant	43.88	54.55	399.79	115.93
DPCBWR-14-32	-do-	95.58	4.42	Resistant	35.55	64.55	395.80	114.78
DPCBWR-14-35	-do-	85.17	14.83	Resistant	42.88	66.96	429.84	124.65
DPCBWR-14-36	-do-	87.25	12.75	Resistant	43.55	56.96	515.80	149.58

DPCBWR-14-38	-do-	65.34	34.66	Moderately Resistant	42.55	60.72	268.43	77.84
DPCBWR-14-39	-do-	93.50	6.50	Resistant	35.05	52.55	546.94	158.61
DPCBWR-14-40	-do-	93.50	6.50	Resistant	41.88	54.55	386.17	111.98
L-22	-do-	97.67	2.33	Resistant	47.55	60.72	385.18	111.70
L-4	-do-	95.58	4.42	Resistant	42.55	61.96	259.00	75.11
EC-464107	WVC, Taiwan	100.00	0.00	Resistant	42.55	54.55	344.00	99.76
EC-464115	WVC, Taiwan	100.00	0.00	Resistant	43.88	54.55	298.22	86.48
Kandaghat Selection	RRS, Kandaghat, UHF, Solan	93.50	6.50	Resistant	45.22	54.55	343.02	99.47
California Wonder	IARI, Res Stn, Katrain	7.50	92.50	Susceptible	41.88	56.96	95.82	27.78
SE(m)±		1.12			1.18	0.56	11.08	
SE(d)±		1.58			1.67	0.79	15.67	
C.V. (%)		2.22			4.79	1.68	5.67	
C.D. ($P \leq 0.05$)		3.14			3.33	1.57	31.21	
Range		7.50-99.38			35.05-48.55	51.55-69.55	95.82-546.94	

*PS = Plant survival; BWI = Bacterial wilt incidence; RC = Reaction category; DFF = Days to 50 per cent flowering; DFP = Days to first harvesting, MFYPP = Marketable fruit yield per plant; MFY = Marketable fruit yield

Fig.6: Variability among genotypes of bell pepper for fruit colour

Attractive green to dark green fruit colour, blocky fruit shape and upright/intermediate fruit position are the preferable horticultural attributes from purchaser's point of view. Appealing fruit colour, desirable fruit shape and position are the most important quality factors. Green and blocky fruits are preferred by consumers, and these observations frequently provide preconceived ideas about other quality attributes. Excluding DPCBWR-14-3, DPCBWR-14-6, DPCBWR-14-6-1, DPCBWR-14-7, DPCBWR-14-7-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-12, DPCBWR-14-13, DPCBWR-14-16, DPCBWR-14-20, DPCBWR-14-36, EC-464107 and EC-464115, all other genotypes had green fruit colour at immature fruit stage (Fig.5 and Table 2). All genotypes were blocky in fruit shape. The genotypes DPCBWR-14-7-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-22, DPCBWR-14-24, DPCBWR-14-35, DPCBWR-14-36, EC-464107 and EC-464115 showed upright fruit position while rest of them had pendent and intermediate fruit position.All the genotypes showed cordate fruit shape at pedicel end while rest of the genotypes had lobate fruit shape (DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-6, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-11,DPCBWR-14-11 (BS), DPCBWR-14-17, DPCBWR-14-20, DPCBWR-14-24, DPCBWR-14-24-1, DPCBWR-14-28, DPCBWR-14-31, DPCBWR-14-40 and California Wonder). For fetching crop during rainy season, upright fruit position is generally preferred, whereas lobate fruit shape with pendent fruit position is not desirable as stagnation of rainwater at pedicel area generally enhances rotting. Genotypes DPCBWR-14-5, DPCBWR-14-14, DPCBWR-14-23, DPCBWR-14-24, DPCBWR-14-39 and EC-464115 showed sunken and pointed blossom end fruit shape while rest of them had sunken fruit shape except DPCBWR-14-4 (blunt fruit shape at blossom end) (Table 2). Variability for visual characters in bell pepper also reported by Sood and Kumar, Sattar *et al.*, Sharma *et al.* and Ferdousi *et al.* [16-19].

Table 2. Frequency distribution of 43 genotypes of bell pepper based on morphological traits

Sr. No.	Traits	Category (Minimal Descriptors)	Total Genotypes	Genotypes
1.	Fruit colour (RHSCC)	GG(137A)	8	DPCBWR-14-2, DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-17, DPCBWR-14-23, DPCBWR-14-31, DPCBWR-14-32, DPCBWR-14-39
		GG(137B)	11	DPCBWR-14-11, DPCBWR-14-11 (BS), DPCBWR-14-14, DPCBWR-14-15, DPCBWR-14-22, DPCBWR-14-24, DPCBWR-14-24-1, DPCBWR-14-25, DPCBWR-14-40, Kandaghat Selection, California Wonder
		GG(137C)	3	DPCBWR-14-4, DPCBWR-14-35, DPCBWR-14-38
		GG(137D)	1	DPCBWR-14-1
		GG(143A)	6	L-22, L-4, DPCBWR-14-13, DPCBWR-14-28, DPCBWR-14-29, DPCBWR-14-30
		YGG(144A)	8	DPCBWR-14-3, DPCBWR-14-6-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-12, DPCBWR-14-16, DPCBWR-14-20
		YGG(144B)	3	DPCBWR-14-6, DPCBWR-14-7, DPCBWR-14-7-1
		YGG(146A)	1	DPCBWR-14-36
		YGG (150C)	1	EC-464115
		YGG (151A)	1	EC-464107
2.	Fruit shape	Blocky	43	DPCBWR-14-1, DPCBWR-14-2, DPCBWR-14-3, DPCBWR-14-4, DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-6, DPCBWR-14-6-1, DPCBWR-14-7, DPCBWR-14-7-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-11, DPCBWR-14-11 (BS), DPCBWR-14-12, DPCBWR-14-13, DPCBWR-14-14, DPCBWR-14-15, DPCBWR-14-16, DPCBWR-14-17, DPCBWR-14-20, DPCBWR-14-22, DPCBWR-14-23, DPCBWR-14-24, DPCBWR-14-24-1, DPCBWR-14-25, DPCBWR-14-28, DPCBWR-14-29, DPCBWR-14-30, DPCBWR-14-31, DPCBWR-14-32, DPCBWR-14-35, DPCBWR-14-36, DPCBWR-14-38, DPCBWR-14-39, DPCBWR-14-40, L-22 , L-4, EC-464107, EC-464115, Kandaghat Selection, California Wonder
3.	Fruit shape at pedicel end	4	27	DPCBWR-14-1, DPCBWR-14-2, DPCBWR-14-3, DPCBWR-14-4, DPCBWR-14-6-1, DPCBWR-14-7, DPCBWR-14-7-1, DPCBWR-14-12, DPCBWR-14-13, DPCBWR-14-14, DPCBWR-14-15, DPCBWR-14-16,DPCBWR-14-22, DPCBWR-14-23, DPCBWR-14-25, DPCBWR-14-29, DPCBWR-14-30, DPCBWR-14-32, DPCBWR-14-35, DPCBWR-14-36, DPCBWR-14-38, DPCBWR-14-39, L-22, L-4, EC-464107, EC-464115, Kandaghat Selection
		5	16	DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-6, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-11, DPCBWR-14-11 (BS), DPCBWR-14-17, DPCBWR-14-20, DPCBWR-14-24, DPCBWR-14-24-1, DPCBWR-14-28, DPCBWR-14-31, DPCBWR-14-40, California Wonder
4.		2	1	DPCBWR-14-4

Sr. No.	Traits	Category (Minimal Descriptors)	Total Genotypes	Genotypes
	Fruit shape at blossom end	3	36	DPCBWR-14-1, DPCBWR-14-2, DPCBWR-14-3, DPCBWR-14-5-1, DPCBWR-14-6, DPCBWR-14-6-1, DPCBWR-14-7, DPCBWR-14-7-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-10, DPCBWR-14-11, DPCBWR-14-11 (BS), DPCBWR-14-12, DPCBWR-14-13, DPCBWR-14-15, DPCBWR-14-16, DPCBWR-14-17, DPCBWR-14-20, DPCBWR-14-22, DPCBWR-14-24-1, DPCBWR-14-25, DPCBWR-14-28, DPCBWR-14-29, DPCBWR-14-30, DPCBWR-14-31, DPCBWR-14-32, DPCBWR-14-35, DPCBWR-14-36, DPCBWR-14-38, DPCBWR-14-40, L-22, L-4, EC-464107, , Kandaghat Selection, California Wonder
		4	6	DPCBWR-14-5, DPCBWR-14-14, DPCBWR-14-23, DPCBWR-14-24, DPCBWR-14-39, [illegible] 464115
5.	Fruit position	3	27	DPCBWR-14-1, DPCBWR-14-2, DPCBWR-14-3, DPCBWR-14-4, DPCBWR-14-5, DPCBWR-14-5-1, DPCBWR-14-7, DPCBWR-14-11 (BS), DPCBWR-14-12, DPCBWR-14-13, DPCBWR-14-14, DPCBWR-14-15, DPCBWR-14-16, DPCBWR-14-17, DPCBWR-14-20, DPCBWR-14-23, DPCBWR-14-25, DPCBWR-14-28, DPCBWR-14-29, DPCBWR-14-30, DPCBWR-14-31, DPCBWR-14-32, DPCBWR-14-38, L-22, L-4, Kandaghat Selection, California Wonder
		5	7	DPCBWR-14-6, DPCBWR-14-6-1, DPCBWR-14-10, DPCBWR-14-11, DPCBWR-14-24-1, DPCBWR-14-39, DPCBWR-14-40
		7	9	DPCBWR-14-7-1, DPCBWR-14-8-1, DPCBWR-14-9, DPCBWR-14-22, DPCBWR-14-24, DPCBWR-14-35, DPCBWR-14-36, EC-464107, EC-464115

*Royal Horticultural Society Colour Charts (RHSCC): GG = green group, YGG = yellow green group

#Minimal descriptors; Fruit shapes at pedicel end: 3- truncate, 4-cordate, 5- lobate, Fruit shapes at blossom end: 2- blunt, 3- sunken, 4-sunken and pointed

Fruit positions: 3- pendent, 5- intermediate, 7-upright

5. CONCLUSION

Thegenotypes of bell pepper had wide variations for bacterial wilt resistance, morphological characters (fruit colour, fruit shape, fruit shape at pedicel and blossom end, and fruit position), earliness (days to 50 per cent flowering and first harvesting) and fruit yield. Except for DPCBWR-14-14, all genotypes were identified to be resistant or moderately resistant to bacterial wilt disease. Among the top five high yielding genotypes, all showed green fruit colour, pendent fruit position, blocky fruit shape, cordate fruit shape at pedicel and sunken fruit shape at blossom end with few exceptions including DPCBWR-14-36 (YGG); DPCBWR-14-39 (intermediate fruit position); DPCBWR14-35 and DPCBWR-14-36 (upright fruit position) and DPCBWR-14-39 (sunken and pointed blossom end fruit shape). The genotypes DPCBWR-14-39 and DPCBWR-14-29 also took fewer days to 50 per cent flowering and days to first harvesting. Hence, for future hybridization programme, they can be used as better parents or released as a variety after multi-location testing because they have a high yielding ability as well as bacterial wilt resistance and advantageous morphological characteristics.

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