

Incidence of leaf curl disease on *Capsicum* germplasm under field conditions*

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Among the five cultivated species of the genus *Capsicum*, *C. annuum* is most commonly cultivated for its pungent and non-pungent fruits (Kumar *et al.* 2006a). During 2007–08, India produced 1.33 million tonnes of chilli from an area of 0.808 million ha with an average productivity (dry fruits) of 1.5 tonnes/ha (Rao and Joseph 2008). A serious constraint on chilli production in India is damage caused by leaf curl disease (Kumar *et al.* 2006b). This disease is caused by white fly transmitted begomovirus called pepper/chilli leaf curl virus (Chi/Pep-LCV). Crop protection from the virus through host plant resistance is a preferred option, especially for the resource-poor farmers. The results of *Capsicum* germplasm screening against leaf curl disease have been presented and discussed in the light of its utilization in chilli improvement and production.

A total of 321 genotypes representing *C. annuum* (311), *C. frutescens* (4), *C. chinense* (1), *C. baccatum* (4) and 1 inter-specific derivative were screened against disease incidence during three consecutive seasons (2005–06, 2006–07, 2007–08) under open field conditions at the Indian Institute of Vegetable Research, Varanasi. Seeds were sown in nursery beds in July–August of every year and 30-days old seedlings were transplanted on raised beds. Standard cultural practices without pesticide application were followed to protect whitefly population. The disease incidence was recorded at 60, 120 and 180 days after transplanting on 20

plants of each genotype with symptom severity on a 0-5 scale (Chakraborty *et al.* 2003). On the basis of distinguishable features of different cultivated species (Kumar *et al.* 2006a), genotypes were assigned to correct taxonomic status.

The frequency of genotypes with specific reaction type varied during three seasons (Fig 1), as some of the highly resistant genotypes scored during first season turned out to be highly susceptible during second or third season and *vice-versa*. This may be due to chance escape of genotype from the viruliferous whitefly. During 2007–08, there were maximum incidences of disease because this season had maximum susceptible and minimum resistant genotypes (Fig 1). On the basis of mean coefficient of infection value of three seasons, all genotypes were assigned to symptom-less (7), highly resistant (27), resistant (14), moderately resistant (53), moderately susceptible (125), susceptible (76) and highly susceptible (19) categories (Table 1). Three genotypes, namely 'Pusa Jwala', 'Pant C 1' and 'Punjab Lal' were reported to be leaf curl resistant genotypes. However, in this study, 'Pusa Jwala' and 'Pant C 1' were susceptible and 'Punjab Lal' was free from disease (Table 1). But 'Punjab Lal' became highly susceptible when challenged artificially (Kumar *et al.* 2009). Most likely symptomless reaction of 'Punjab Lal' seems to be due to non-preference of whitefly and this makes it an interesting genotype that can be used to study the possible mechanism of whitefly non-preference. Considering the present and future scenario on crop and land use in India, cultivation of a mixture of improved genotypes in proximity to each others, it would be wise to evaluate and promote field resistant / white fly non-preferred genotype, like 'Punjab Lal' and others with desirable fruit types and better general adaptability. Many genotypes studied herein are recommended varieties for cultivation in specific climatic zones of India. Hence, list of genotypes with specific disease reaction (Table 1) can provide assistance to select appropriate genotypes by the researchers planning to develop integrated pest management (IPM) package. This work on field screening has also narrowed down the numbers of genotypes to a fewer and manageable symptomless (7) and highly

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Table 1 Assignment of *Capsicum* genotypes to specific reaction based on mean coefficient of infection (CI) value of three seasons screening under field conditions

Reaction (CI value)	Genotypes (total number)
Symptomless (0)	'BS 35', 'CV 2', 'EC 497636', 'GKC 29', 'IC 3640632', 'IC 383072', 'Punjab Lal' (7)
Highly resistant (0.1-5.0)	'AMK 7', 'BC 30', 'Bhut Jolokia', 'BS 40', 'Bullet B 2', 'CM 334', 'CO 5778', 'COO 265 1', 'COO 304', 'COO 309', 'CSB 15', 'CV 1', 'DC 16', 'EC 119457 B', 'EC 345629', 'Kalayanpur Chanchal', 'KM Collection', 'Lankamura Collection', 'Local Collection', 'NBC 2', 'NDS 463', 'NMCA 40008', 'NuMex Centennial', 'PBC 601', 'PKM 51', 'TC 6941', 'Taiwan 2' (27)
Resistant (5.1-10.0)	'00072259', '9852-54', 'AS Collection', 'CO 5677', 'CO 5686 1', 'CSB 13', 'EC 119457A', 'EC 341094', 'KDCS 810', 'PDC 24', 'Perennial 2A', 'EC 519634', 'NuMex Primavera', 'PBC 534(B)' (14)
Moderately resistant (10.1-20.0)	'AKC 89/38', 'ARCH 50-1', 'BS 20 (yellow)', 'BS 38', 'BS 39', 'Capsicum Chilli', 'CH 202', 'CMB 10', 'CMB 12', 'CMB 19', 'CO 5482', 'CSB 8', 'CSB 9', 'DC 2', 'DC 28', 'DC 6', 'DC 7', 'DC 8', 'Early Plant', 'EC 119474', 'EC 341025', 'EC 341075', 'EC 43758', 'EC 497637', 'EC 497639', 'EC 519612', 'EC 519625', 'CO 5671', 'EC 519633', 'IC 113368', 'IC 119327', 'IIHR 10', 'IN 16', 'ISC 9', 'J/ZM/BLM 07', 'Japani Longi', 'Jayanti', 'LCA 403', 'Local Jayapur DN', 'Local Collection 2', 'NBC 1', 'Pant C 3', 'PBC 328', 'PBC 357', 'PBC 367 PT 1', 'PBC 374', 'PBC 522', 'PBC 602', 'PBC 873', 'PDG 50B', 'Phule Sai 30', 'Rosani', 'S Collection 5' (53)
Moderately susceptible (20.1-40.0)	'0037-7554', '0107-7011', '0337-7065', '92-1203', '97-7116', '9793-4', '9852-173', '9852-173 (06)', '9950-5197', 'AC-Assam 10', 'AMK 10', 'AMK 11', 'AMK 12', 'Azamgarh Local', 'Basti Round', 'BC 2 2', 'BC 28', 'BS 5', 'BS 70', 'BS 79', 'BS 80', 'Chilli S 49', 'CO 229', 'CO 3453', 'CO 5484', 'CO 5635', 'CO 5676', 'Collection 3', 'COO 222', 'COO 229', 'COO 712', 'COO 713', 'CSB 1', 'CSB 10', 'CSB 2', 'Byadagi Dabbi', 'DC 24', 'DC 25', 'DC 3', 'DC 4', 'DC 5', 'Divya Jyoti', 'EC 341049', 'EC 345625', 'EC 391094', 'EC 454597', 'EC 492576', 'EC 517097', 'EC 519630', 'EC 519631', 'EC 519635', 'EC 519636', 'EC 519694', 'EC 566320', 'G 4', 'G 5', 'IC 109368', 'IC 113361', 'IC 113367', 'IC 119310', 'IC 119361', 'IC 119455', 'IC 119457', 'IC 119457A', 'IC 119474', 'IC 1402', 'IC 381090', 'IC 382260', 'IC 397471', 'IC 413714', 'IIHR 11', 'IIHR 14', 'IIHR 15', 'IIHR 17', 'IIHR 20', 'IIHR 22', 'IIHR 25', 'IIHR 26', 'IIHR 3', 'IIHR 5', 'IIHR 7', 'IIHR 8', 'IIHR 9', 'ISC 1', 'ISC 3', 'JCA 21', 'JCA 9', 'KA 2', 'LCA 333', 'LCA 404', 'LCA 433', 'LGL', 'MCA 24', 'MCA 32', 'MS 4', 'NDS 390', 'NIC 268216', 'P 1649', 'PBC 142', 'PBC 1439', 'PBC 161', 'PBC 212', 'PBC 222', 'PBC 228', 'PBC 30', 'PBC 473', 'PBC 542', 'PBC 56-95-2-1-1-2', 'PBC 574', 'PBC 904', 'PDC 49', 'PDCAC 54', 'PDG 1', 'PDG 2', 'PDG 50', 'PDG 66', 'SM 20', 'SNDS 53', 'S Collection 1', 'S Collection 6', 'TC 6842', 'TC 6903', 'Taiwan 1', 'Utkal Ava', 'VNS 4'(125)
Susceptible (40.1-70.0)	'97-7125-2B', '9852-18', 'AC-Assam 9', 'AMK 6', 'Arka Lohit', 'BC 4', 'BS 13', 'BSBS 4937', 'CMB 13', 'CO 5675', 'CO 5692', 'CO 223', 'COO 280', 'CSB 3', 'CSB 4', 'EC 454591', 'EC 497635', 'EC 518968', 'EC 519633', 'EC 570008', 'IC 112474', 'IC 392212', 'IIHR 16', 'IIHR 29', 'IIHR 30', 'Indira Chilli', 'Jayapur Long', 'JCA 283', 'JCA 352', 'KA 2', 'Byadagi Kaddi', 'LCA 206', 'LCA 235', 'LCA 301', 'LCA 334', 'LCA 353', 'LCA 357', 'LCA 402', 'LCA 408', 'LCA 412', 'LCA 422', 'LCA 424', 'LCA 439', 'LCA 440', 'LCA 442', 'Local Collection 3', 'MBS 426', 'MCA 35', 'MI 2(SL)', 'MS 3', 'NDS 39', 'NuMex Twilight', 'OP 0042 68', 'P 18', 'Pant C 1', 'PBC 1474', 'PBC 367', 'PBC 535', 'PBC 543', 'PBC 776', 'Phule Sai 537', 'PKM 1', 'Pusa Jwala', 'SM 1', 'SM 12', 'SM 14', 'LCA 335', 'LCA 224', 'LCA 96', 'Super', 'S Collection 2', 'S Collection 4', 'TL 2K 1 28', 'Utkal Rosani', 'VR 338', 'Waiialua' (76)
Highly susceptible (70.1-100)	'EC 458206', 'IC 383079', 'IC 397564', 'IC 413701', 'IC 413702', 'IC 413713', 'KCS 2013', 'LCA 405', 'LCA 407', 'LCA 414', 'LCA 427', 'LCA 434', 'LCA 436', 'LCA 437', 'LCA 438', 'MCA 30', 'MCA 34', 'PBC 574', 'Sandhya' (19)

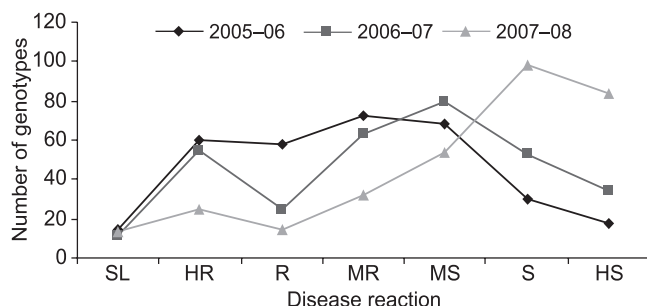
resistant lines (27) for the further testing under controlled conditions. Different categories of resistant lines (Table 1) can also be rapidly diagnosed with the different set of degenerative primers available to detect begomovirus (Kumar *et al.* 2006b).

Considering distinguishable features of cultivated species

(Kumar *et al.* 2006a), 'GKC 29' and 'IC 364063-2' had morphology of both *C. annuum* (white corolla) and *C. frutescens* (purple filaments), therefore, they are derivatives of a natural cross between *C. annuum* and *C. frutescens*. Likewise 'BS 35' and 'Lankamura Collection' were also assigned to correct taxonomic status (Table 2). Three

Table 2 Assignment of genotypes to correct taxonomic status of inter-specific derivatives

Genotypes	Earlier status	Morphology recorded	Assigned to derivative of:
'BS 35'	<i>C. annuum</i>	Greenish corolla, purple filament with partial annular constriction	<i>C. chinense</i> and <i>C. frutescens</i>
'EC 497636'	<i>C. annuum</i>	White corolla with purple filament	<i>C. annuum</i> and <i>C. frutescens</i>
'GKC 29'	<i>C. frutescens</i>	Greenish white corolla with purple filament	<i>C. annuum</i> and <i>C. frutescens</i>
'IC 364063-2'	<i>C. annuum</i>	White corolla with purple filament	<i>C. annuum</i> and <i>C. frutescens</i>
'Lankamura Collection'	<i>C. baccatum</i>	Greenish corolla, yellow spots on corolla lobes and purple filaments	<i>C. frutescens</i> and <i>C. baccatum</i>

Fig 1 Reaction of *Capsicum* germplasm to PepLCV under field conditions

genotypes, viz 'GKC 29', 'BS 35' and 'Lankamura Collection' were collected from north-eastern India. Interestingly yet in an other report *C. frutescens* genotype ('Bhut Jolokia') collected from same region has been assigned to inter-specific derivative of *C. chinense* and *C. frutescens* (Bosland and Baral 2007). This observations on existence of inter-specific derivatives in the north-eastern India recognizes that the region is secondary centre of diversity for the genus *Capsicum*.

SUMMARY

Three hundred and twentyone genotypes of pepper (*Capsicum* spp) were screened against pepper leaf curl disease during three consecutive seasons (2005-06, 2006-07, and 2007-08) under field conditions. Based on mean coefficient of infection, all genotypes were assigned to

symptomless (7), highly resistant (27), resistant (14), moderately resistant (53), moderately susceptible (125), susceptible (76) and highly susceptible (19) categories. The information generated on specific reaction of each genotype will be useful to select appropriate genotype for developing integrated pest management package. Five genotypes were also assigned to derivatives of natural inter-specific cross between domesticated *Capsicum* spp.

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