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Evaluation of improved lines of tomato for yield performance and disease resistance under open field conditions

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ABSTRACT

Field experiments were conducted in 2007 and 2008 at AVRDC – The World Vegetable Center's-Regional Center for South Asia in Hyderabad, India to evaluate 30 improved lines of tomato for yield performance and field tolerance/resistance against *Tomato leaf curl virus* and *Peanut bud necrosis virus*. In 2007, yield ranged from 27.92 to 83.74 t/ha, while in 2008 it ranged from 62 to 80 t/ha. Lines DR2-1 (BL1173), DR-4 (BL1176), and NC 3220 X 57-27-3 were found to be high yielding and stable throughout the two-year period. Significant negative correlation was reported between disease severity index (*Tomato leaf curl virus* and *Peanut bud necrosis virus*) and yield. Low *Peanut bud necrosis virus* disease severity was recorded in lines DR2-1 (BL1173) (20 and 0.0%) and NC 3220 × 57-27-3 (23.3 and 0.0%) of and lower ToLCV disease severity in DR-4 (BL1176) (6.7 and 0.0%) and NC 3220 × 20-21-5 (22.2 and 0.0%) against.

Key words: Tomato improved lines, field evaluation, yield performance, disease resistance.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most widely grown solanaceous vegetable crops throughout the world and is an integral part of the daily human diet in many countries. Tomato and tomato-based products are considered as healthy foods for several reasons. They have very low in fat and calories, as well as being a good source of fibre. In addition, tomatoes are rich in carotenoids such as lycopene and β-carotene, vitamin C and other antioxidants and including total phenols (Suarez *et al.,* 18) and provide micronutrients to supplement staple-based diets. In India, tomato is grown for fresh market and processing; the crop is cultivated on an area of 0.57 million ha with a production of 10.2 mt. India ranks fourth in global production, but stands at 96 place in world tomato productivity (17.89 t/ha) (FAO, 4). Pests and diseases lead to low productivity. *Tomato yellow leaf curl virus* (TYLCV; genus Begomovirus, family Geminiviridae) that affects tomatoes in greenhouses and open fields causes important yield losses in tomato up to 100% in many countries around the world (Czosnek and Laterrot, 3; Pico *et al.*, 14). This disease is induced by a number of begomoviruses, the type member being TyLCV, transmitted by the whitefly *Bemisia tabaci* (Gennadius), whose severe population outbreaks are usually associated with high incidence of the disease (Czosnek, 2). In India the begomovirus causing leaf curl diseases is different from others and called as *Tomato Leaf Curl Virus* (ToLCV).

Similarly, *Tospovirus* are listed among the ten most serious plant viruses causing annual loss values around 1,000 million dollars (Goldbach and Peters, 5). Tospoviruses are transmitted from plant to plant by nine species of thrips in a circulative and propagative manner (Ullman *et al.*, 20). Tomato necrosis disease caused by *Peanut bud necrosis virus* (PBNV) in India is a distinct member of tospoviruses belongs to serogroup IV (Raja and Jain, 15) and is a serious constraint to several crops including tomato production in various locations in the region.

PBNV and ToLCV and are among the most destructive diseases of tomato crop also in India and causing yield losses ranging from 27 to 90% in summer as well as the PBNV diminish the quality of fruits (Sain and Chadha, 16; Hazra *et al.*, 7; Singh and Tripathi, 17; Kumar *et al.*, 9; Sundharaiya *et al.*, 19). Managing these diseases has proven to be extremely difficult, expensive and environmentally unfriendly with limited success when insecticides are used to reduce the whitefly and thrips populations. Continuing efforts in breeding for resistance during the last years are providing new hope for managing these diseases. Looking at the problems, the study was conducted to evaluated improved lines of tomato for yield performance and resistance to ToLCV and PBNV under open field conditions.

MATERIALS AND METHODS

The experiments were conducted during two consecutive years, from September-December 2007 and November-May 2008 at AVRDC - The World

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Vegetable Center's - Regional Center for South Asia in Hyderabad, Andhra Pradesh, India to evaluate the productivity levels of the AVRDC's tomato lines under open-field conditions. Seed of 30 improved tomato lines was procured from AVRDC- the World Vegetable Center's headquarters, Taiwan. The trials were laid out in randomized complete block design (RCBD) with three replications.

Furrow watering was done as per the crop irrigation requirement. Standard production practices including weeding, use of imidacloprid (acitamiprid®) in the nursery stage, a basal dose of 50 kg/ha each of P_2O_5 and K_2O was applied and 100 kg/ha of nitrogen was applied in three split doses, 30^{th}, 45^{th} and 60^{th} day after transplantation. Plant to plan and row to row distance of 60 cm × 45 cm were maintained. Practices for tomato cultivation were followed as per the recommendations for Andhra Pradesh (Anon, 1). Thirty improved tomato lines were selected for field evaluation in 2007. Seed was planted on September 14, 2007 in plastic plug trays using sand, soil, and compost mixture in a ratio of (1:1:3). Seedlings were grown under 60-mesh nylon netting. On October 4, seedlings were transplanted on 4 m long and 30 cm high raised ridges. Fourteen plants were maintained in each replication. Among the 30 lines evaluated in 2007, 13 high yielding genotypes apparently tolerant to ToLCV and PBNV were selected for further evaluation in 2008. Nurseries of selected lines were raised on November 15, 2008 and seedlings were transplanted on December 23 on 4 m long and 30 cm high raised ridges with three replications.

Observations were recorded on yield characteristics, plant type, fruit shape, size, fruit color, and total fruit yield. In addition to the yield characteristics the tow most important viral diseases (ToLCV and PBNV) incidence and disease severity were recorded during the cropping seasons. Although, the winter season is not very conducive to ToLCV and PBNV incidence in Hyderabad but, incidence of these diseases occurs coinciding with the rain/ showers occurrence during early November and in mid February onwards. Symptoms of the ToLCV disease consisted of a more or less prominent upward curling of leaflet margins, reduction of leaflet area and yellowing of young leaves, together with stunting and flower abortion (Moriones and Castillo, 10). The symptomatic plants were confirmed with ELISA testing. The ToLCV a begomoviruse is small, circular, single-stranded DNA plant virus. However, symptoms of PBNV consisted bronzing, wilting and necrosis of leave and stem, chlorotic/yellow ring spots on fruits. The samples were also collected from the plants expressed symptoms resembling to ToLCV and PBNV. The samples were tested by enzyme-linked immunosorbent assay (ELISA) with the specific antibodies for confirmation of the disease and disease scoring. Plants were observed for virus incidence and severity twice during the crop season, once approximately seven weeks after transplanting (50 DAT) and again just prior to first/last harvesting (75 DAT) (at first and fourth harvesting). The observations were highlighted as ToLCV1 and PBNV1 as the first observation and as ToLCV2 and PBNV2 as the final stage observation.

PBNV symptom severity rating was evaluated on a scale of 0 (symptomless) to 4 (symptoms as severe as the susceptible control, including leaf yellowing, curling and severe stunting of the plant) (Muniyappa *et al.*, 11). Then rating scores were calculated into disease severity index (DSI) values using the formula (Yang *et al.*, 22): % DSI = Σ (rating scale x number of plants) x 100 / total number of plants x highest rating. In case of PBNV severity was evaluated on a scale of 0-4 where 1 = no symptom, 1 = mild symptoms, 2 = moderate symptoms, 3 = severe symptoms, 4 = very severe symptoms. Although, almost all plants those were sowing moderate symptom in the beginning turned in to severe symptoms resulted in death of the plants within 6-10 days.

The average final score was considered for the result of ToLCV and PBNV. The recorded data was analyzed as suggested by Panse (13) for analysis of variance (ANOVA). Mean for yield disease severity was compared. Simple product moment correlation was analyzed to see the relativity among the factors on yield. Simple liner, multiple or split regression (X *vs* Y plot) were fitted depending on the form and the relationship and the data availability and to see the relationship between yield and ToLCV/PBNV.

RESULTS AND DISCUSSION

Highly significant difference was reported for yield**, PBNV** and ToLCV** disease severity index. Out of 30 accessions, 14 were determinate, 12 semi-determinate and 4 were indeterminate types (Table 2). Three types of fruit shape, oval, round and oval round, were observed among the 30 lines tested. The fruit size ranged from small to large, and fruit color from orange red to dark-red. The average fruit weight ranged from 48.5 to 207.6 g. Yield ranged from 27.9 to 83.7 t/ha in 2007 and 62 to 80 t/ha in 2008 (Table 3). The highest yield was recorded in DR2-1 (BL1173) (83.7 t/ha), followed by NC 3220 × 57-27-3 (78.3 t/ ha), which is at par with the highest yielder, NC 3220 × 57-1-2, NC 3220 × 57-22-1, DR-4 (BL1176), and DR-2 (BL1174) in 2007. In 2008 the highest yielder was DR-4 (BL1176) (80.3 t/ha). It was at par with lines NC 3220 × 57-27-3, NC 3220 × 57-22-1, DR2-1(BL1173), and NC 3220 × 11-9-7. Based on two year

Table 2. Yield performance of tomato lines.

S. No.	Genotype	Average yield (t/ha)		Pooled mean
		2007	2008	
1.	CLN2768A	47.81	–	47.81
2.	CLN2777A	29.18	–	29.18
3.	CLN2777B	27.92	–	27.92
4.	CLN2777C	39.09	–	39.09
5.	CLN2777E	36.65	–	36.65
6.	CLN2777F	33.55	–	33.55
7.	CLN2777G	41.15	–	41.15
8.	BL1373-8-3-10	34.00	–	34.00
9.	CLN2460E	53.56	–	53.56
10.	CLN2498D	67.36	–	67.36
11.	CLN2413R	53.65	62.00[c]	57.82
12.	CLN2418A	33.30	–	33.30
13.	CL5915-93D4-1-0-3	60.34	–	60.34
14.	CLN2001A	47.87	–	47.87
15.	CLN1621L	46.61	68.00[bc]	64.30
16.	DR2-1 (BL1173)	83.74	76.00[ab]	79.87
17.	DR-2 (BL1174)	74.02	68.00[bc]	69.01
18.	DR-3 (BL1175)	49.74	61.00[c]	55.37
19.	DR-4 (BL1176)	74.47	80.33[a]	77.40
20.	NC03220 × -11-9-7	73.13	75.33[ab]	74.23
21.	NC03220 × -20-6-4	52.07	–	52.07
22	NC03220 × -20-21-5	48.29	73.67[a]	60.98
23.	NC03220 × -20-17-24	64.33	–	64.33
24.	NC03220 × -57-1-2	74.60	72.33[abc]	73.46
25.	NC03220 × -57-22-1	74.92	76.00[ab]	75.46
26.	NC03220 × -57-23-16	68.26	73.67[ab]	70.96
27.	NC03220 × -57-24-3	70.65	–	70.65
28.	NC03220 × -57-27-3	78.32	76.34[ab]	77.33
29.	NC03220 × -57-29-6	65.73	–	65.73
30.	NC03220 × -57-30-1	46.60	64.33[bc]	55.46
Mean		56.87	71.59	61.32
Variance		615.51	304.25	564.37
Standard deviation		24.81	17.44	23.76
Standard error of mean (SEm)		2.61	2.79	2.09
0.950 Confidence Interval for mean		51.74 to 61.99	66.11 to 77.06	57.22 to 65.42

data, entries DR2-1 (BL1173), DR-4 (BL1176), NC 3220 × 57-27-3, NC 3220 x 57-22-1, and NC 3220 × 11-9-7 were found to be high yielding. Similarly, Kaur and Kanwar (8) reported highest fruit yield (94.6 t/ha) at Ludhiana from tomato variety Punjab Chhuhara planted on 20 November.

PBNV incidence was high from September to December 2007, but low from December to May 2008 (Table 3). The range of PBNV infection varied between 6.7 to 40% in 2007 and 0 to 22.6% in 2008. In Hyderabad, PBNV incidence is reported to be low from December to May, while high incidence during May to September with the highest (up to 100%) in September (Sain and Chadha, 16). In this study, the lowest PBNV disease severity index (<15%) was recorded in lines CLN 2460E, NC03220 × -57-23-16, NC03220x-11-9-7, and NC03220 × -57-24-3 during 2007 (Table 3). These values were at par with each other. Overall, lower incidence of PBNV was recorded in indeterminate lines compared with determinate and semi-determinate types. Moreover, CLN2413R, CLN1621L, DR2-1 (BL1173), DR-3 (BL1175), DR-4 (BL1176) were found free from PBNV incidence in 2008 (Table 3).

Table 3. ToLCV and PBNV diseases severity index in tomato lines.

S. No.	Genotype	ToLCV severity index (%)				PBNV severity index (%)			
		2007		2008		2007		2008	
		50 DAT	75 DAT	50 DAT	75 DAT	50 DAT	75 DAT	50 DAT	75 DAT
1.	CLN2768A	0.0	3.3	–	–	16.9	23.3	–	–
2.	CLN2777A	0.0	6.0	–	–	32.6	40.0	–	–
3.	CLN2777B	0.8	10.0	–	–	27.8	36.7	–	–
4.	CLN2777C	0.4	8.4	–	–	26.8	33.3	–	–
5.	CLN2777E	0.1	6.4	–	–	23.5	37.2	–	–
6.	CLN2777F	0.4	8.3	–	–	14.9	26.1	–	–
7.	CLN2777G	1.4	14.3	–	–	17.9	30.0	–	–
8.	BL1373-8-3-10	2.1	22.2	–	–	23.0	33.3	–	–
9.	CLN2460E	0.4	9.9	–	–	16.1	22.2	–	–
10.	CLN2498D	2.2	20.0	–	–	1.7	6.7	–	–
11.	CLN2413R	0.2	5.7	8.6	17.0	14.3	24.4	0.0	0.0
12.	CLN2418A	0.5	10.2	–	–	23.7	33.3	–	–
13.	CL5915-93D4-1-0-3	0.4	8.3	–	–	24.9	35.0	–	–
14.	CLN2001A	0.9	17.0	–	–	11.4	21.7	–	–
15.	CLN1621L	0.3	9.6	13.6	21.6	24.1	31.1	0.0	0.0
16.	DR2-1 (BL1173)	1.4	21.3	9.6	18.0	14.0	20.0	0.0	0.0
17.	DR-2 (BL1174)	1.3	18.6	6.9	14.9	11.9	19.4	2.4	7.2
18.	DR-3 (BL1175)	0.6	9.0	5.2	12.8	17.5	25.0	14.3	22.2
19.	DR-4 (BL1176)	0.1	6.7	0.0	0.0	28.9	35.0	14.9	22.6
20.	NC03220 × -11-9-7	0.0	4.2	5.8	13.9	5.1	8.3	5.5	11.1
21.	NC03220 × -20-6-4	3.8	22.2	–	–	11.8	20.6	–	–
22.	NC03220 × -20-21-5	2.8	20.0	0.0	0.0	13.8	24.4	11.9	16.6
23.	NC03220 × -20-17-24	2.1	18.7	–	–	9.2	19.4	–	–
24.	NC03220 × -57-1-2	1.0	11.1	6.4	12.1	12.0	22.2	0.0	0.0
25.	NC03220 × -57-22-1	1.3	13.3	4.9	10.5	9.8	16.7	0.0	0.0
26.	NC03220 × -57-23-16	1.0	11.1	3.5	8.8	5.7	8.3	0.0	0.0
27.	NC03220 × -57-24-3	1.3	12.7	–	–	10.8	13.3	–	–
28.	NC03220 × -57-27-3	0.9	9.0	9.9	15.1	18.1	23.3	0.0	0.0
29.	NC03220 × -57-29-6	0.8	10.0	–	–	18.4	25.0	–	–
30.	NC03220 × -57-30-1	0.4	5.3	5.5	11.0	26.2	33.3	0.7	2.8
Mean		0.97	11.77	0.51	6.84	17.43	25.63	2.76	5.01
Variance		2.46	148.32	0.61	24.55	287.93	447.91	19.53	43.67
Standard deviation		1.57	12.18	0.78	4.96	16.97	21.16	4.42	6.61
Standard error of mean (SEm)		0.16	1.28	0.12	0.79	1.79	2.23	0.71	1.06
0.950 Confidence interval for mean		0.65 to 1.29	9.25 to 14.28	0.27 to 0.76	5.28 to 8.39	13.92 to 20.93	21.26 to 30.00	1.37 to 4.14	2.939 to 7.08

ToLCV disease severity index was high in 2007 as compared to 2008, ranging from 3.3 to 22.2%, compared with 2008 where it ranged from 0 to 21.6% with the disease severity in lines CLN2768A, NC03220 × -11-9-7, NC03220 × -57-30-1, CLN2413R and CLN2777E (≤8% severity index) in 2007 (Table 3). Overall 14 entries showed less than 10% disease severity index during 2007. The maximum loss due to ToLCV was reported from January to February in northern India (Singh and Tripathi, 18). In contrast to these findings, Murugan (13) has reported maximum loss due toToLCV ranging from 45 to 60% in tomato from August to December in Coimbatore. Similarly, Vijaya *et al.* (22) have reported 6.9% incidence of ToLCV in *rabi* (winter) season in Hyderabad, and Sain and Chadha (16) reported 80% incidence in May in Secunderabad, Andhra Pradesh. Up to 27.5% incidence in December at Hisar (Hazeri *et al*., 6) and 80 to 98% incidence in Jammu with lowest yield in September transplanted crop (Kumar *et al*., 9) have been reported. Hazra and Nath (7) reported that disease incidence was highest in August followed by February, and October. Our findings are in agreement with Murugan (12), and Sain and Chadha (16), showing that the maximum loss due to ToLCV occurs during August to December, with a mean of 41.2% in Hyderabad.

No mixed infection of ToLCV and PBNV was recorded in the samples collected during the study by the ELISA testing, as well as there was not any synergistic interaction on disease severity. In case of PBNV infection, which occurred in the early crop stage in November and there was no further disease spread during the month of December to up to mid February. It was concluded that despite the low disease incidence/disease severity following spontaneous field inoculation, it is possible to discard the most susceptible genotypes with field testing.

Table 4 predicts the results of product moment correlation among all 30 lines, seasons, yield, ToLCV, and PBNV severity index at two stages. Very significant and negative correlations between yield and disease severity index; between tomato entries and the PBNV and ToLCV severity index; between season and the disease severity were observed. For 2007/08 experiments there were no differences among treatments.

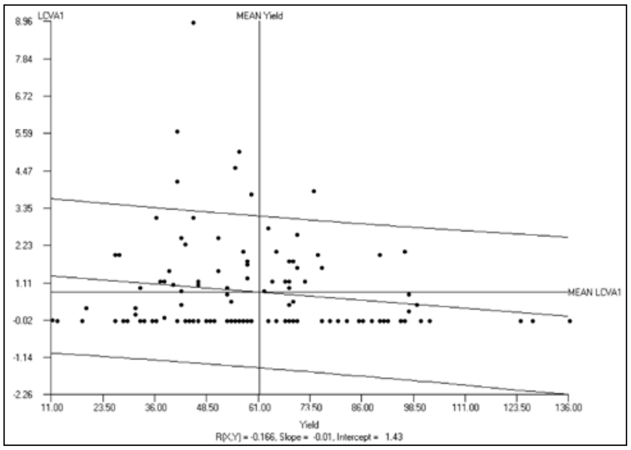
As was expected, negative correlation between yield and ToLCV1 (at first observation) (r^2 = -0.17); yield and PBNV1 (r^2 = -0.40); yield and ToLCV2 (r^2 = -0.23); and yield and PBNV2 (at final observation) (r^2 = -0.41) were observed (Table 4). These findings are in agreement with the earlier findings of Sain and Chadha (16), and Sundharaiya *et al.* (19).

As it was expected, significant negative slope in X *vs* Y plot for yield and both the ToLCV and PBNV disease severity at initial and final observation stages were recorded (Fig. 1), which suggest regression model could be used to predict the yield performance of tomato lines. Higher slope (-0.27 to -0.36) was found positive and significantly different than zero for fruit yield and PBNV disease severity index. The regression line intercept at 29.47 and 41.19 on PBNV severity index scale. While, there was low but negative slope for initial ToLCV severity (-0.01) and fruit yield but it was increased at the final stage (-0.1). Hence, for every value of ToLCV and PBNV severity in prediction of average fruit yield would be negative. The regression line intercepts at 1.43 and 16.57 for ToLCV severity and fruit yield at first and final disease severity recoding stage, respectively.

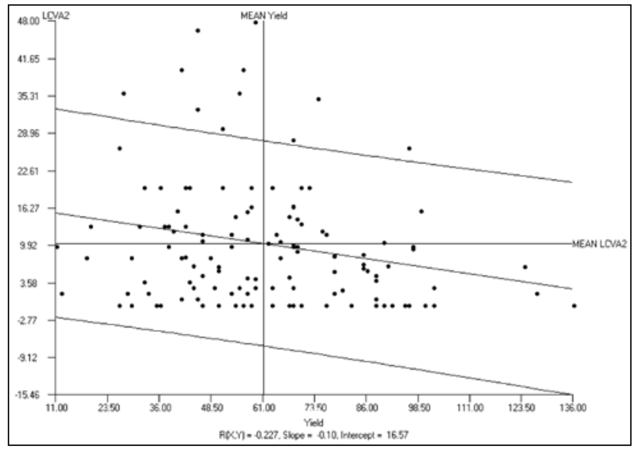
Significant negative slope in X *vs* Y plot for season and both the ToLCV and PBNV disease severity were observed (Fig. 2). Higher slope (-14.67 & -20.62) was found negative and significantly different than zero for PBNV disease severity index and the season. The regression line intercept at 32.1 and 46.25 on PBNV severity index scale. While, there was low but negative slope for initial ToLCV severity (-0.45) and season but it was increased at the final stage (-4.93).

Table 4. Correlation among yield and season, entry, ToLCV and PBNV in tomato.

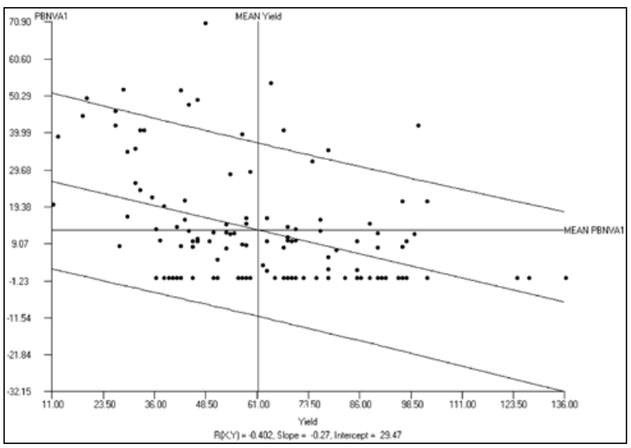
	Season	Replication	Entry	Yield	ToLCV1	ToLCV2	PBNV1	PBNV2
Season	1.000	0.000	0.300	0.286	-0.150	-0.211	-0.426	-0.467
Replication		1.000	0.000	0.007	0.273	0.200	-0.140	-0.150
Entry			1.000	0.440	0.051	-0.038	-0.231	-0.242
Yield				1.000	-0.166	-0.227	-0.402	-0.415
LCVA1					1.000	0.881	-0.068	-0.022
LCVA2						1.000	0.010	0.055
PBNVB1							1.000	0.969
PBNVB2								0.000



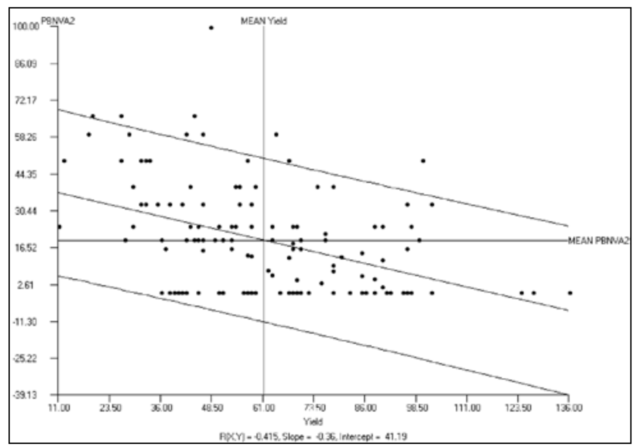
Correlation = -0.17 (ToLCV 1 & yield) SE-1.37



Correlation = -0.23 (ToLCV 2 & yield) SE 10.47

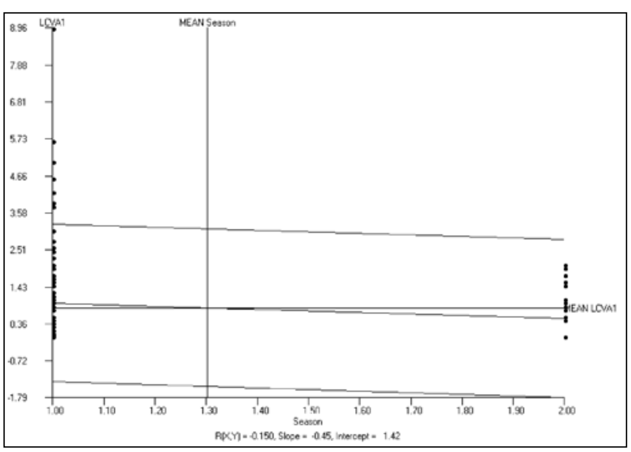


Correlation = -0.40 (PBNV 1 & yield) SE 14.53

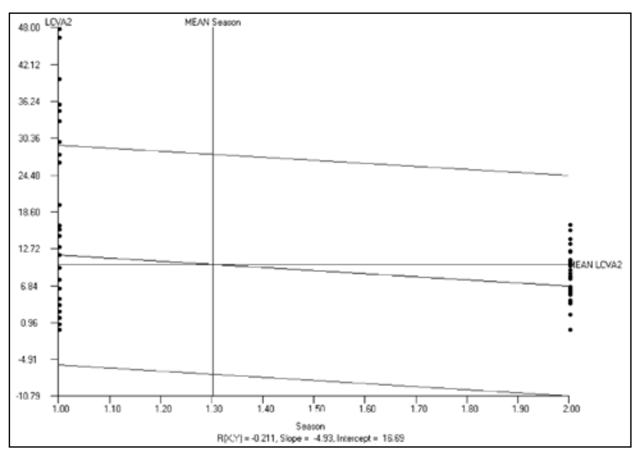


Correlation = -0.41 (PBNV 2 & yield) SE 18.53

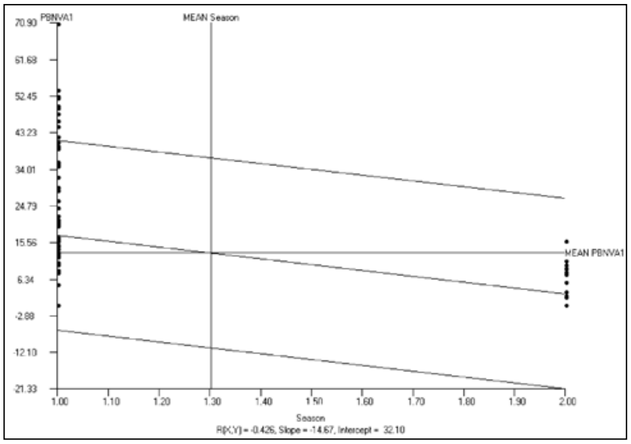
Fig.1. Relationship and X vs Y plot between yield and disease severity index.



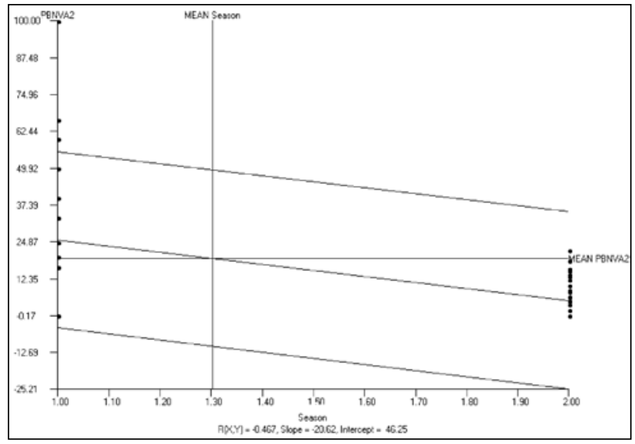
Correlation = -0.15 (season & ToLCV 1) SE 1.37



Correlation = -0.21 (season & ToLCV 2) SE 10.51



Correlation = -0.43 (season & PBNV 1) SE-14.35

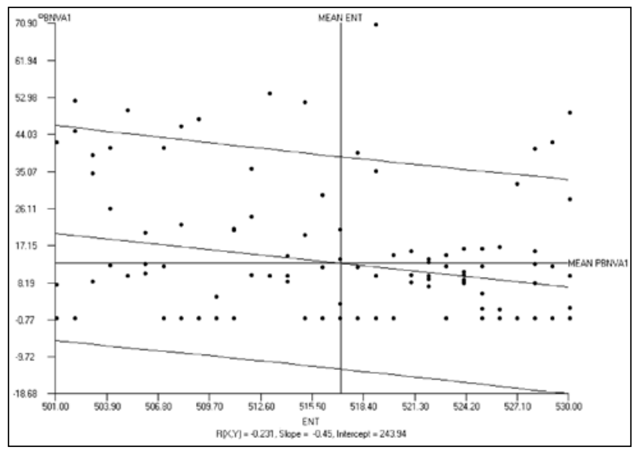


Correlation = -0.47 (season & PBNV 2) SE-18.01

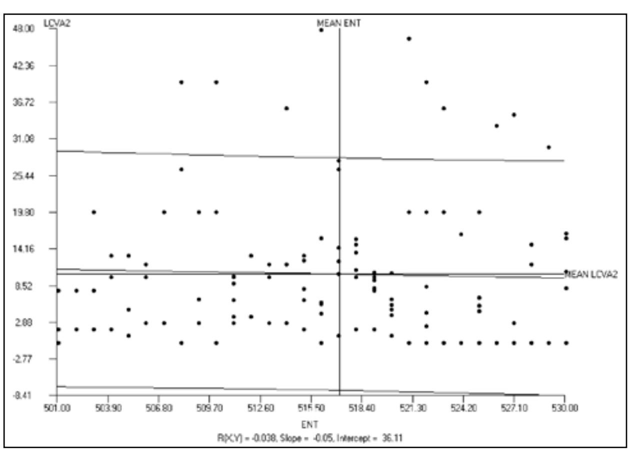
Fig. 2. Relationship and X vs Y plot between season and disease severity index.

The every value of season in prediction of average ToLCV and PBNV severity would be negative. The regression line intercepts at 1.42 and 16.69 for and ToLCV severity fruit yield at first and final disease severity recoding stage, respectively. Similarly, significant negative slope in X *vs* Y plot for entries and both the ToLCV and PBNV disease severity at two stages were observed (Fig. 3). Higher negative slope (-0.45) was found significantly different than zero for PBNV1 disease severity index and the entries; while lower negative slop in (-0.05) ToLCV 2 and entries. Hence, predicting the resistance in entries with disease severity would be negative. The regression line intercept at 36.11 and 243.94 on ToLCV and PBNV severity index scale, respectively.

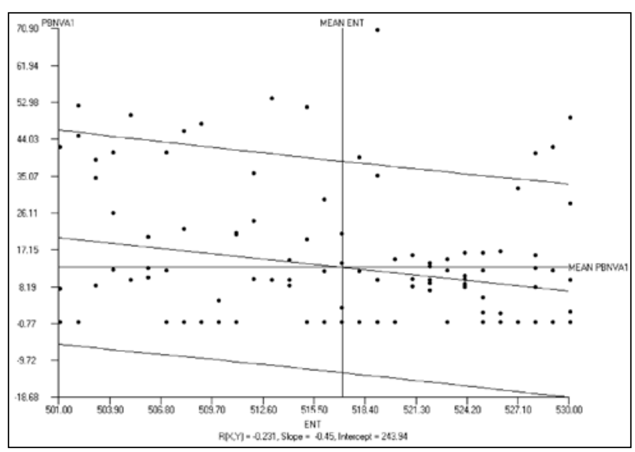
Although negative but low slope in X *vs* Y plot for ToLCV and PBNV disease severity at first observations



Correlation = -0.23 (Entry & PBNV 1) SE 15.44



Correlation = -0.04 (Entry & ToLCV2) SE 10.74



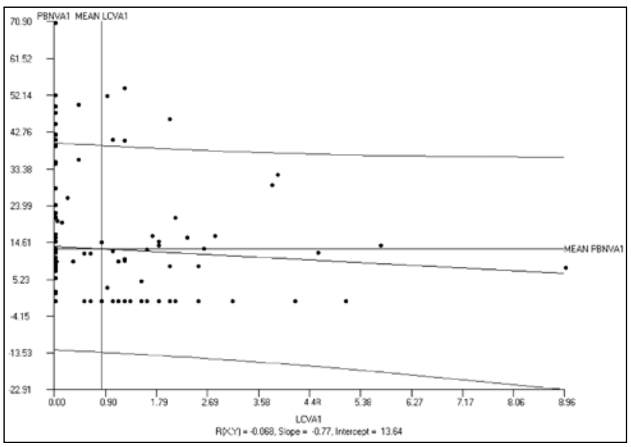
Correlation = -0.24 (Entry & PBNV 2) SE 19.76

Fig. 3. Relationship and X vs Y plot between entry, ToLCV and PBNV severity index.

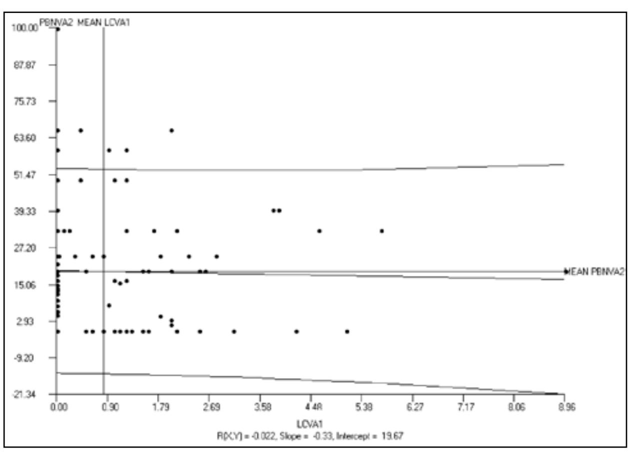
recorded, that suggested regression model could not be used to predict the disease severity integration between these two diseases on tomato lines (Fig. 4). However, X *vs* Y plot slope between final disease severity index stage (ToLCV2 and PBNV2) was recorded to be positive between (0.1), which suggest that regression model could be used to predict the severity of PBNV2 for every unit change in value of ToLCV disease severity. The regression line intercept at 18.33 on PBNV2 severity index scale.

Three lines-DR-4 (BL1176) and NC3220 × 20-21-5, were found to be free from ToLCV incidence in 2008 (Table 3). Similarly, Vijaya *et al.* (21) reported some varieties free from ToLCV, but those entries were different from the lines we tested.

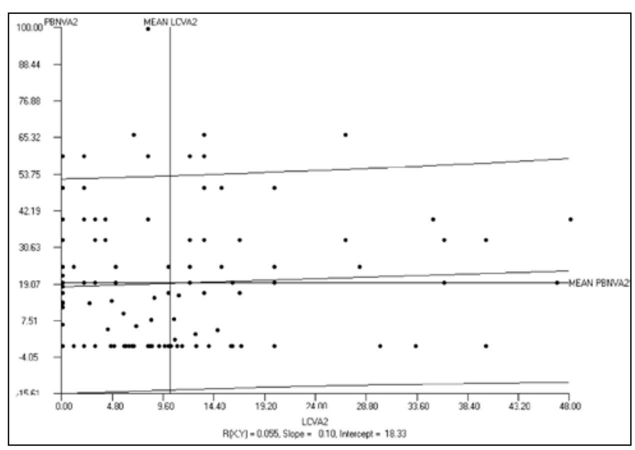
We observed that out of 30 and 13 lines evaluated for two consecutive years, 9 lines were found to be high yielding (>50 t/ha) during both the years. Out of these, four lines DR2-1 (BL 1173), DR-4 (BL1176), NC3220 × 57-27-3, and NC3220 × 57-22-1 performed best, yielding above 75 t/ha and showing good tolerance to PBNV and ToLCV diseases (Table 3). These lines are good candidates for tomato breeding programs to increase yield and ToLCV and PBNV resistance. Fruit of DR-4 (BL1176) and DR2-1 (BL 1173) is round, medium size, and orange red and dark red in colour, respectively; consumers prefer these traits. These two lines are indeterminate types and are suitable for net-house cultivation. However, determinate lines NC3220 × 57-27-3 and NC3220 × 57-22-1 with very large, round, and red fruit are specialty tomatoes suitable for fresh market cultivation in open fields.



Correlation = -0.07 (ToLCV1 & PBNV1)SE 15.83



Correlation = -0.02 (ToLCV1 & PBNV2) SE 20.36



Correlation = 0.06, (ToLCV2 & PBNV2)SE-20.33

Fig. 4. Relationship and X vs Y plot between ToLCV and PBNV severity index.

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Table 1. Marketable characteristics of tomato lines.

S. No.	Genotype	Plant type[a]	Fruit shape[b]	Fruit colour[c]	Av. fruit weight (g)
1.	CLN2768A	D	O	R	58.5
2.	CLN2777A	D	O	R	57.2
3.	CLN2777B	D	O	R	48.5
4.	CLN2777C	D	O	R	63.7
5.	CLN2777E	SD	O	R	50.3
6.	CLN2777F	SD	O	R	53.1
7.	CLN2777G	D	R	R	78.4
8.	BL1373-8-3-10	SD	R	R	119.6
9.	CLN2460E	SD	OR	R	52.5
10.	CLN2498D	SD	O	OR	60.5
11.	CLN2413R	SD	R	R	78.9
12.	CLN2418A	D	R	R	71.8
13.	CL5915-93D4-1-0-3	D	R	R	28.2
14.	CLN2001A	D	R	R	26.7
15.	CLN1621L	SD	R	R	33.8
16.	DR2-1 (BL1173)	ID	R	DR	59.1
17.	DR-2 (BL1174)	ID	R	DR	72.8
18.	DR-3 (BL1175)	ID	OR	R	74.2
19.	DR-4 (BL1176)	ID	R	OR	50.6
20.	NC03220 × -11-9-7	SD	R	R	146.4
21.	NC03220 × -20-6-4	SD	R	R	115.5
22	NC03220 × -20-21-5	SD	R	R	111.7
23.	NC03220 × -20-17-24	SD	R	R	153.6
24.	NC03220 × -57-1-2	SD	R	R	115.4
25.	NC03220 × -57-22-1	D	R	R	122.3
26.	NC03220 × -57-23-16	D	R	R	207.6
27.	NC03220 × -57-24-3	D	R	R	174.9
28.	NC03220 × -57-27-3	D	R	R	181.4
29.	NC03220 × -57-29-6	D	R	R	144.0
30.	NC03220 × -57-30-1	D	R	R	169.2

[a]SD = Semi-determinate; D = Determinate; ID = Indeterminate; [b]R = Round, O = Oval, OR = Oval round [c]R = Red, OR = Orange red, DR = Dark red.

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