Assessment of chilli leaf curl virus on chilli (*Capsicum annum L.*) it's management and role of environment in disease incidence

Abstract

The present study was undertaken on "Study of chilli leaf curl virus on chilli *(Capsicum annum)* and their management" which is wide spread disease in chilli growing area. Chilli crop is infected by several fungi, bacteria, viruses and nematodes which cause severe yield losses. Among these factors leaf curl virus is a major threat in chilli production. Ten chilli cultivars namely ZH-927, GYPSY, Pusa Jawala, Surya Pariksha, Surya-31, MEENAM-(074), Mahy-Yasash, Disha, Pride and Arka Harita were screened under field conditions. Among them one cultivar ZH-927 was identified as resistant, 3 cultivars namely Surya Pariksha, Disha, Arka harita showed susceptible reaction. It was found that Imidacloprid and Acetamaprid were most effective in inhibiting the leaf curl disease incidence followed by Thiomethoxam, NSKE, Methyl demeton and dimethoate. The environmental factor maximum temperature was found to have a positive correlation with disease incidence. As the temperature increases, there is a corresponding increase in the incidence of the disease. Relative humidity was found as negatively significant in correlation with disease incidence when relative humidity increased then disease incidence will decrease and rainfall was found as negatively in significant with the disease incidence when rainfall increased then disease incidence will decrease.

Key words: Chilli, Leaf curl virus, Imidacloprid, Environment, Resistance

Introduction

Chilli (*Capsicum annum* L.), generally known as pepper, is an important valuable crop belonging to the family *Solanaceae* and is a native to South America (Mexico) where it was cultivated around 6000 years ago and was brought to Asia during the 16th century by Portuguese navigators. Chilli grows best at 20–30°C temperature but its growth and yield suffer when temperature exceeds 35°C or drops below 15°C for extended periods.

Chilli crop is infected by several fungi, bacteria, viruses and nematodes which cause severe yield losses. Among these factors leaf curl virus is a major threat in chilli production, in case of severe infections, crop losses may reach up to 70 - 95% resulting in total crop failure (Kumar *et al.* 2006b). Chilli LCV (genus *Begmoviruse*; Family Geminiviridae) has circular single stranded DNA genome with associated beta satellites (Fauquet and Stanley, 2003) and transmitted by whitefly (*Bemesia tabaci*) in persistent - circulative manner. Main symptoms of disease include vein clearing, curling and puckering of leaves, stunting of plants, fruits remain small (Senanayake *et al.* 2012). The severity of disease depends on the population of whitefly that can rapidly disseminate viruses in field even when population is not appreciable, and causes severe crop damage in susceptible plantings. The population dynamics of whitefly varies during different seasons of the year because it is greatly influenced by atmospheric humidity, temperature and total rainfall (Horowitz, 1984). Chilli leaf curl disease can be managed by the controlling the vector, growing of resistant varieties that provide long term and eco friendly control of viral disease of plants (Gomez *et al.* 2009).

Method and Materials

The investigation entitled 'Study of chilli leaf curl virus on chilli (*Capsicum annuum L.*) and their management' was carried out during *Rabi* season 2018-19 at Research field, JNKVV, College of Agriculture Tikamgarh (M.P.). Ten chilli cultivars viz. ZH-927, GYPSY, Pusa Jawala, Surya Pariksha, Surya -31, MEENAM-(074), Mahy-Yasash, Disha, Pride and Arka Harita were sown in nursery bed and transplanted in the main field 24 to 30 days after sowing to test the resistance of chilli genotypes against chilli leaf curl complex disease the experiment was carried out in completely randomized block design having 10 cultivars with three replications.

The experimental field was prepared by plough thrice by cultivator followed by planking to make fine tilt and smooth surface. Standard management practices were followed as recommended. Screening was done based on the rating scale 0-5 developed by Banerjee and Kalloo (1987). The percent disease incidence or disease severity among 10 plants of each row were selected randomly and disease response for each line were scored at 30 days, 60 days, 90 days and 120 days after transplanting on a symptom severity grade of 0-5 and the variable measured based on disease scoring was disease severity.

Looking for this an experiment was laid out in randomized block design (RBD) and a susceptible variety of chilli namely 'Pride' was transplanted in the field with the spacing of 50 × 40 cm. Normal fertilizers doses and recommended agronomical practices were adopted. A total of six insecticides *viz.*, Methyle dematon 25 EC @ 0.025%, Imidacloprid 17.8 SL @ 0.003%, Acetamaprid 20 SL @ 0.025%, Diamethoate 30 EC @ 0.5%, Thiamethoxam 70 WG@ 0.005% and Neem seed kernel extract @ 5% were tested against disease and all the treatments were applied as foliar spray. Disease incidence and per cent decrease in disease over control was calculated with the help of following formula given by Vincent (1927).

Result and Discussion

This screening trial revealed that only one tested cultivars were found completely free from chilli leaf curl complex infection. All the germplasm were found susceptible but some were found as moderate susceptible. In this investigation a total of ten cultivars were screened. Infected plants of chilli leaf curl virus developed small and leaf crinkle or abaxial and adaxial curling of leaf margin accompanied by puckering, thickening, swelling of veins and veinlets, reduction in leaf size, vein clearing and distortion, leaf malformation, and leaves some times may show enations on under surface.

The data presented in the Table 1 shows that the lowest severity percentage of leaf curl disease was recorded in the plot planted with chilli cultivar ZH-927 with 24.30 percent followed by GYPSY (F1 hybrid) (38.69%), Surya 31 (44.93%), MEENAM-074 (46.49%), Mahy yasash (49.83%), Surya pariksha (53.00%), Arka- Harita (56.23%), Disha (57.38), Pride (83.00%), Pusa Jawala (91.23%) percent respectively. As per the rating scale an examination of data presented in

Table 1 indicate that, three cultivars *viz.* Surya pariksha, Disha and Arka-Harita were found as susceptible against leaf curl complex and three were identified as moderate susceptible namely- MEENAM-074, Mahy yasash (hybrid), Surya 31 and GYPSY (F1 hybrid) and two cultivars namely Pusa jawala, pride were found as highly susceptible and only one variety ZH-927 was found as resistant. After this screening experiment it can be emphasized that these cultivars can be used for cultivation in Madhya Pradesh region with suitable management practices to reduce the leaf curl infection in chilli.

Screening results are very indicative and it is clear that, there was some quantum of chilli cultivars that are least susceptible to chilli leaf curl virus and this finding will be helpful in chilli cultivation to the farmers. Muhammad *et al*. (2017) had earlier screened fourteen different chilli lines / varieties for their resistance/susceptibility towards ChiLCV in open field trials. Out of fourteen only two cultivars Hybrid-46 and Hot Queen were found moderately resistant and remaining here found to be susceptible or highly susceptible. Similarly, Srivastava *et al*. (2017) recorded at the end of four seasons of screening trial, three lines namely DLS-Sel-10, WBC-Sel-5 and PBC-142 showed resistance against leaf curl disease. Mali *et al*. (2006) also identified two resistant cultivars namely HC-28 and HC-44. The promising resistance source were also reported by Thakur *et al*. (2019). These identified lines can be used as source of resistance.

This study evaluated that, all the treatments were found significantly superior over untreated control. Data obtain from the Table 2, indicate that, the lowest incidence of 33.33% was recorded in plot treated with Imidacloprid followed by Acetamaprid (37.50%), Thiomethoxam (39.72%), NSKE (41.83%), Methyl demeton (43.13%) and Dimethoate (45.17%).The data show that the highest percentage of disease incidence (61.46%) was recorded in untreated (control) plot. Among the all management practices, the highest disease reduction percentage of chilli leaf curl virus was recorded in plot treated with Imidacloprid (45.76%) followed by Acetamaprid (38.98%), Thiomethoxam (35.37%), NSKE (31.93%), methyl demeton (29.82%) and Dimethoate, (26.50%) respectively.

The highest yield was observed under the plot treated with Imidacloprid (47.11 qha^{-1}) and moderate yield as 43.33 qha^{-1} obtained in plot treated with Acetamaprid followed by Thiomethoxam with 40.55 qha^{-1}, NSKE (39.44 qha^{-1}), Methyl Demeton (32.66 qha^{-1}), the least yield was obtained from the plot treated with Diamethoate as 27.33 qha^{-1} over control. The lowest yield was obtained as 16.24 qha^{-1} from the untreated plot (control). Panday *et al*. (2010) reported that the plant seed extract as Neem Seed kernel extract (5%) was found to be most effective for reducing leaf curl disease incidence (60%) while in chemical insecticides Imidacloprid 17.8 SL (0.003%) gave the highest per cent reduction in disease incidence of leaf curl (78.95%) over control. Similar trend was also found by Naveed *et al.* (2015). Kumar *et al.* (2017) evaluated efficacy of different newer insecticides *viz.*, thiamethoxam 25 WG, imidacloprid 17.8 SL, acephate 20 SP, fipronil 5 SC, thiacloprid 240 SC and one conventional insecticide *i.e.* dimethoate 30 EC against *Bemisia tabaci*

and revealed that thiamethoxam 25 WG @ 100g/ha was found most effective insecticide in reducing the population of whitefly.

The data presented in Table 3 shows that the disease incidence significantly affected by environmental factors. In the week 1st the disease incidence was recorded as 14.17 percent which is increased with a variable increasing rate up to 92.50 percent at last week. The leaf curl disease was first observed in 1st week of January as standard meteorological week and raised in 2nd and 3rd week, then percent increase reduced abruptly on 4th week and slightly increase in 5th week which again decrease from 6th to 8th week in the week 9 the disease incidence rate was suddenly increase from 3.33 to 11.67 percent and again reduced from 10 to 12 week with 5.83, 7.5 and 3.33 respectively, which again suddenly increased from 3.33 to 11.67 % on 13 week and 11.67 to 12.50 % on 20 week, whereas lowest increasing rate was found in 7 week with 0.83 percent.

It was reveal from the data presented in Table 3 that, there is a significant positive correlation of temperature either minimum or maximum indicated by r-value r=0.94 and r=0.95 respectively. The maximum disease incidence was observed between 21.8 ^{0}C to 40.9 ^{0}C whereas lowest incidence was observed between 6.0 ^{0}C to 24.6 ^{0}C these data shows that, the incidence was increased along with temperature increase. The incidence was drastically decreased when rainfall occurred 2.2 mm on 4th week, 1.0 mm on 6th week and 3.2 mm on 7th week respectively. The disease incidence was recorded as 5.83% to 4.17%, 5% to 3.33 and 3.33% to 0.84% respectively, but disease incidence was slightly increased from 0.84% to 3.33% in the week 8th when rainfall decreased.

Thus the experiment revealed that the disease incidence was directly influenced by the environmental factors because of these environmental factors effects the vector populations which resulted in transmission of leaf curl virus. Likewise, Naveed *et al.* (2015) studied the correlation between TLCV incidence on different lines/varieties and the environmental factors (temperature, relative humidity and rainfall). Furthermore, the whitefly population was also correlated with the environmental factors. His finding revealed that there is a strong positive and significant interaction in case of maximum and minimum temperature (8ºC-32ºC) and TLCV incidence but negative and significant interaction was observed in case of relative humidity and rainfall.

Conclusion

Chilli leaf curl virus is an important disease of chilli caused by chilli leaf curl virus, all the continents of the world, in India it caused up to 70 – 95 % crop losses. In screening of 10 cultivars one cultivar ZH – 927 was found as resistant and 4 cultivars namely Surya -31, MEENAM-(074), Mahy – Yasash and GYPSY was found as moderately susceptible. In field, all the six insecticides under study were significantly effective in controlling the disease incidence of chilli leaf curl virus over control. The least percent incidence and highest yield was recorded for Imidacloprid, Which was significantly superior over all other treatments. The environmental factors like maximum temperature, minimum

temperature were found as significantly positive correlated with disease incidence and relative humidity, rainfall was found as negatively significant in correlation with disease incidence.

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Table 1: Screening of chilli cultivars against chilli leaf curl virus Complex under field condition

S. No.	Name of Cultivars	Grade (0-5)	Percentage infection (%)	Severity Percentage (%)	Disease reactions
1.	ZH-927	2	6-25	24.30	R
2.	Gypsy (F1 hybrid)	3	26-50	38.69	MS
3.	Pusa jawala	5	>75	91.23	HS
4.	Surya pariksha	4	51-75	53.00	S
5.	Surya 31	3	26-50	44.93	MS
6.	MEENAM- 074	3	26-50	46.49	MS
7.	Mahy-yasash	3	26-50	49.83	MS
8.	Disha	4	51-75	57.38	S
9.	Pride	5	>75	83.00	HS
10.	Arka-Harita	4	51-75	56.23	S

Table 2: Effect of chemical treatments on chilli leaf curl disease

S. No.	Name of treatments	Doses (%)	Disease Incidence (%)	PDC	Yield (qha^{-1})
1.	Methyl demeton 25EC	0.025	43.13*	29.82	32.66
2.	Imidacloprid 17.8SL	0.003	33.33	45.76	47.11
3.	Acetamaprid 20SL	0.025	37.50	38.98	43.33
4.	Diamethoate 30EC	0.5	45.17	26.50	27.33
5.	Thiomethoxam 70WG	0.005	39.72	35.37	40.55
6.	Neem seed kernel extract	5	41.83	31.93	39.44
7.	Control	-	61.46	-	16.24
	SEM±	-	1.41	-	2.90
	CD at 5%	-	8.71	-	8.44
	CV	-	13.87	-	14.25

Table 3: Effects of environmental factors on disease incidence

Standard weeks	Relative Humidity (%)	Rainfall (in mm)	Min Temp (^{0}C)	Max. Temp (^{0}C)	Disease incidence	Disease increase (%)
1	69.00	0.0	6.4	24.0	14.17	14.17
2	74.00	0.0	5.2	20.8	17.50	3.33
3	72.00	0.0	5.8	24.8	23.33	5.83
4	79.00	2.2	9.4	21.5	27.50	4.17
5	68.00	0.0	6.6	22.4	32.50	5.00
6	68.00	1.0	6.4	24.1	35.83	3.33
7	70.00	3.2	5.9	24.8	36.67	0.84
8	60.00	0.0	12.1	25.1	40.00	3.33
9	59.00	0.0	10.7	27.9	51.67	11.67
10	61.00	0.0	14.1	32.8	57.50	5.83
11	56.00	0.0	13.8	32.8	65.00	7.50
12	44.00	0.0	16.0	36.5	68.33	3.33
13	44.00	0.0	17.8	39.5	80.00	11.67
14	37.00	0.0	21.8	40.9	92.50	12.50
Correl.	-0.93	-0.25	0.94	0.95	-	-
t table	2.178	2.178	2.178	2.178	-	-
t cal.	-9.544	-0.932	9.544	10.539	-	-