Assessment of incidence of chilli leaf curl virus, role of environment and disease management

Abstract

The present study "Assessment of incidence of chilli leaf curl virus, role of environment and its management" was carried out at Chilli LCV pone are of Bundelkhand region at Tikamagarh location of Madhya Pradesh. Among diseases affecting chilli crop, leaf curl virus is one of the major threat. In experiment, 10 chilli cultivars namely ZH-927, Gypsy, Pusa Jawala, Surya Pariksha, Surya-31, Meenam-(074), Mahy-Yasash, Disha, Pride and Arka Harita were screened under open field conditions for leaf curl virus. 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. In screening among all cultivers, ZH-927 was identified as resistant whereas Surya Pariksha, Disha and Arka Harita showed susceptible reaction. In case of management of leaf curl virus vector, Imidacloprid and Acetamaprid were found effective in inhibiting the leaf curl disease incidence followed by Thiomethoxam, NSKE, Methyl demeton and dimethoate. Temperature was found positive correlation with disease incidence. As the temperature increases, there is a corresponding increase in the incidence of the disease. Relative humidity and rainfall showed negative correlation with disease incidence as relative humidity and precipitation increased the disease incidence will decrease

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

Introduction

Chilli (*Capsicum annum* L.) is an important commercial and spice 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 can be grown best at temperature ranges from 20–30°C but its growth and yield suffer when temperature exceeds 35°C or drops below 15°C for extended periods (Chaubey and Mishra, 2018).

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.*, 2006). Chilli Leaf Curl Virus (genus *Begmoviruse*; Family Geminiviridae) which 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 loss in susceptible plantings. The population dynamics of whitefly varies depends on seasons of the year because it is greatly influenced by atmospheric humidity, temperature and total rainfall (Horowitz, 1984). In Bundelkhand zone the severity of the leaf curl virus increase since last couple of years which make heavy loss of farmers and also the management of LCV is needful to overcome this disease. In keeping of this fact under

consideration the present study was carried out to evaluate diseases resistant cultivar along with its management.

Materials and Method

The present investigation was carried out during *Rabi* season at Research field of college of Agriculture Tikamgarh, JNKVV, (M.P.). 10 chilli cultivars viz. ZH-927, Pusa Jawala, Surya Pariksha, Surya -31, MEENAM-(074), Mahy-Yasash, Disha, Pride, Arka Harita with check Gypsy cultivar 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 disease.

The experiment was carried out in randomized block design with three replications. Screening was done based on the rating scale 0-5 developed by Banerjee and Kalloo (1987).

Chart 1 : Description of Reaction

Rating	Reaction Description
0	shows no symptoms appearance
1	5% curling and clearing of upper leaves
2	6-25% curling, clearing of leaves and swelling of veins
3	26-50% curling, puckering and yellowing of leaves and swelling of veins
4	51-75% curling, stunted plant growth and blistering of internodes
5	More than 75% curling and deformed small leaves, stunted plant growth with small or no fruit set.

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. Disease incidence and disease recovery percentage was calculated with the help of following formula given by Vincent (1927).

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plant per plot}}{\text{Total number of plant per plot}} \times 100$$

$$\text{Disease Recovery (\%)} = \frac{\text{\% Disease in untreated plot - \% Disease in Treatment}}{\text{\% Disease in Treatment}} \times 100$$

The seasonal disease incidence of chilli leaf curl with abiotic factors was correlated on the basis of following formula.

$$\text{Correlation coefficient (r)} = \frac{\sum x_i y_i - n\bar{x}\bar{y}}{\sqrt{(\sum x_i^2 - n\bar{x}^2)(\sum y_i^2 - n\bar{y}^2)}}$$

Where,

r = Correlation coefficient, Σ xy = Sum of product of both variable x and y Σ x = Sum of variables x, $\Sigma \bar{x}^2$ = Sum of square of variable x, Σy^2 = Sum of square of variable y, n = Total no. of observations

After correlating significant and non-significant findings, t-test value (n-2) degrees of freedom were calculated.

Result and Discussion

The data presented in the Table 1 shows that, 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 (38.69%), Surya 31 (44.93%) and Meenam-074 (46.49%) respectively. As per the rating scale an examination of data presented in Table 1 indicate that, cultivars *viz.* Surya pariksha, Disha and Arka-Harita were found as susceptible against leaf curl disease whereas moderate susceptible reactions were recorded for Meenam-074, Mahy yasash (hybrid) and Surya 31.

Screening results are very indicative and it was clear that, those cultivar had susceptible for chilli leaf curl virus must not be used for cultivation by farmers. Muhammad *et al*. (2017) had earlier screened fourteen different chilli lines / varieties for their resistance/susceptibility towards Chilli leaf curl in open field trials. 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 under field conditions. The similar findings were reported by Thakur *et al*. (2019), Magsi *et.al.* (2017) and Gomez *et al. (*2009).

In contrast to fungicide treatments, obtained data was represented in Table 2. The findings of this study mentioned that, the lowest incidence of 33.33% was recorded in plot treated with Imidacloprid followed by Acetamaprid (37.50%) and Thiomethoxam (39.72%). 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%).

In contrast to yield data, the highest yield was observed under the plot treated with Imidacloprid (47.11 qha^{-1}) and moderate yield 43.33 qha^{-1} obtained from plot treated with Acetamaprid followed by Thiomethoxam (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 (27.33 qha^{-1}) over control. The lowest yield was obtained from the untreated plot (control) (16.24 qha^{-1}). Panday *et al.* (2010) reported that the plant seed extract as Neem Seed kernel extract (5%) was found to be most effective for reducing chilli 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 results were also obtained 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.

From Table 3 it was clearly understood, the disease incidence in check cultivar Gypsy was significantly affected by environmental factors. The first leaf curl disease symptoms were obsrved from first week of January and the disease incidence was recorded as 14.17 percent which is increased highly up to 92.50 percent at end of observation. Notably the disease incidence was raised in 2^{nd} and 3^{rd} week, then reduced on 4^{th} week and slightly increase in 5^{th} week which again decrease from 6^{th} to 8^{th} week in the week 9 the disease incidence rate was suddenly increase from 3.33 to 11.67 percent and again reduced from 10^{th} to 12^{th} 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 11.23 % on 20 week, whereas lowest increasing rate was found in 7 week with 0.83 percent.

It was evident from Table 3, 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 4^{th} week, 1.0 mm on 6^{th} week and 3.2 mm on 7^{th} week respectively.

Thus, these experiments clearly revealed that the disease incidence was directly influenced by the environmental factors influence the vector populations since it has ben vector transmitted begmovirus. Similar study was carried out by Naveed *et al.* (2015) in the correlation between TLCV incidence on different lines/varieties and the environmental factors (temperature, relative humidity and rainfall). Furthermore, he explained that the whitefly population was also correlated with the environmental factors. His finding strongly supported 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 disease is an important disease of chilli caused by chilli leaf curl virus and cause crop loss up to 70 – 95 % worldwide. The screening of 10 cultivars of chilli against chilli leaf curl virus, only one cultivar ZH – 927 was found to-be resistant and remaining all are moderate to highly susceptible. In systemic insecticides spray all the insecticide 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 and minimum temperature were found as significantly positive correlated with disease incidence, relative humidity and rainfall was negatively correlated with disease incidence.

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Screening of Chilli for Leaf Curl Virus Infected Plant

General View of

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

S. No.	Name of Cultivars	Grade (0-5)	Disease reactions
1.	ZH-927	2	R
2.	Gypsy (F1 hybrid)	3	MS
3.	Pusa jawala	5	HS
4.	Surya pariksha	4	S
5.	Surya 31	3	MS
6.	MEENAM- 074	3	MS
7.	Mahy-yasash	3	MS
8.	Disha	4	S
9.	Pride	5	HS
10.	Arka-Harita	4	S

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

S. No.	Name of treatments	Disease Incidence (%)	Disease Recovery (%)	Yield (qha^{-1})
1.	Methyl demeton 25EC	43.13	29.82	32.66
2.	Imidacloprid 17.8SL	33.33	45.76	47.11
3.	Acetamaprid 20SL	37.50	38.98	43.33
4.	Diamethoate 30EC	45.17	26.50	27.33
5.	Thiomethoxam 70WG	39.72	35.37	40.55
6.	Neem seed kernel extract	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

Standard weeks	Relative Humidity (%)	Rainfall (in mm)	Min Temp (^{0}C)	Max. Temp (^{0}C)	Disease incidence	Disease increase (%)
1	69.0	0.00	6.4	24.0	14.17	14.17
2	74.0	0.00	5.2	20.8	17.50	3.33
3	72.0	0.00	5.8	24.8	23.33	5.83
4	79.0	2.20	9.4	21.5	27.50	4.17
5	68.0	0.00	6.6	22.4	32.50	5.00
6	68.0	1.00	6.4	24.1	35.83	3.33
7	70.0	3.20	5.9	24.8	36.67	0.84
8	60.0	0.00	12.1	25.1	40.00	3.33
9	59.0	0.00	10.7	27.9	51.67	11.67
10	61.0	0.00	14.1	32.8	57.50	5.83
11	56.0	0.00	13.8	32.8	65.00	7.50
12	44.0	0.00	16.0	36.5	68.33	3.33
13	44.0	0.00	17.8	39.5	80.00	11.67
14	37.0	0.00	21.8	40.9	91.23	11.23
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	-	-

Table 3: Effects of environmental factors on chilli leaf curl incidence