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Integrated Disease Management of Leaf Curl Virus in Chilli on farmers' fields of Hathras District

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Abstract

Chilli leaf curl virus and low yield potential diseases susceptible varieties, indiscriminate use of insecticides for leaf curl virus management are the major limiting factors, which cause substantial yield loss in chilli. Present investigation on resistant varieties having higher potential with integrated disease management proven technologies reveled that chilli higher yield could be achieved by adopting these technologies. Among the technologies, the highest yield and net return and less leaf curl virus incidence was found in technology-3, Kashi Early+ raise Marigold (tall African variety golden age bearing yellow and orange flowers) nursery 15-20 days before chilli nursery+ One week after germination of seeds, spray the seedlings with (Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l)+Apply Neem cake 250 kg/ha ridges at the time of preparing land+ Dip the roots of seedlings (do not dip the foliage as it may cause burning of leaves) with Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l for 5 minutes. Fifteen days after planting spray Imidacloprid 200 SL @ 0.4ml/l or Thiomethoxam 25 WP @ 0.3g/l for leaf curl vector (whitefly) control+ Destroy leaf curl and other virus affected plants as soon as the symptoms appear in a few plants to minimize their spread followed by technology-2 as compared to farmers' practices.

***Key words**: Chilli, leaf curl disease, on farm research, insecticides*

Introduction

Chilli (*Capsicum annum*) is one of the most popular and widely grown spices cum vegetable crop of India. Indian chilies are known for their pungency and coloring India, it occupies an area of about 0.925 million hectares producing over 1.018 million tones /ha. In Uttar Pradesh, the crop is cultivating to an extent of 85.26 thousand hectares with a production of 17.52 lakh tones and productivity of 27.3 tons/ha. (Anon., 2019). Hathras district situated in south western semi-arid eco-system (Zone - IV) of U.P. There are 4-sub-divisions and seven development blocks in district. The small and marginal farmers are growing tomato, chilli, cucurbits, brinjal and onion as main vegetables crops of the area. Although area (570 ha), with an annual production 2565 tones and productivity 350 q/ha under chilli crop is suffering from large number of diseases. Among them leaf curl virus complex caused by chilli leaf curl begomo virus and its vector whitefly *(Bemisia tabaci*) is the major limiting factors, which cause substantial yield loss in India and worldwide. The susceptibility of mostly varieties to leaf curl disease is the main reason for low yield of chilli in India[3].

Chilli cannot be grown in plains during June-October owing to high temperature and stagnation of water in fields during rainy season. But, it can be grown successfully under rain fed conditions in well drained soils of the undulating terrain.

Thus, sloppy lands and precipitation mainly received during June to September provide congenial conditions for growing rainy season chilli in certain areas and it can be a boon in supplementing the income of small and marginal farmers of the regions. Though rainy season tomato cultivation is becoming increasingly attractive for cash generation in the undulating terrain of this agro climatic zone, but, the productivity of crop is very low due to several production problems like high mortality of seedlings at nursery stage, high incidence of leaf curl virus, blight diseases and non availability of suitable varieties and insectides for the rainy season, thus, limiting chilli cultivation on a commercial scale[4].

While assessment of integrated modules (IDM) for management of leaf curl virus of chilli with promising cultivars for rainy season in terms of good yield and comparatively less damage from leaf curl virus. Uses of tolerant/ resistant varieties for effective management of leaf curl virus disease for rainy season production. Though there are many reports on varietal selection, appropriate time of planting and leaf curl virus disease management measures for rainy season chilli, these constraints still prevail in the farmer's field. For promoting rainy season chilli production as a remunerative enterprise in the undulating terrain, availability of varieties tolerant to heat, rains and leaf curl virus has became major constraint. Majority of chilli growers purchase chilli seeds from the market with no certainty of good performance. To provide alternative option of IDM suitable modules to the vegetable growers, the experiment was conducted to assessment of different proven technologies with two leaf curl virus resistant varieties of chilli especially recommended for rainy season cultivation against the variety (Pusa sadabhar) cultivated by most of the farmers during rainy season.

Material and Methods

The present study was carried out by the Krishi Vigyan Kendra, Hathras, C. S. Azad University of Agriculture & Technology, Kanpur (U.P.) during rainy seasons of two consecutive years 2017-18 to 2018-19 in the farmers fields of 05-villages of Sasni block of the district in agro-climatic zone - IV of Uttar Pradesh to 2017-18 in irrigated condition on medium soils with low to medium fertility. Each demonstration was conducted in an area of 0.1 ha and 0.1 ha area adjacent to the demonstration plot as farmer’s practices i.e. prevailing cultivation practices served as local check. All 25-on farm testing trails demonstrations in 2.5 ha area was conducted. The experiment was arranged in a randomized block design (RBD) with 5 replications, farmer as replication.

The IDM technologies modules were T1 (check-1)= Farmers practice (Variety-Pusa sadabhar+ indiscriminate use of insecticides), T2 (technology-2)= Variety Pant C-1 + Seed treatment with Imidacloprid, netting of nursery, spray 4% NSKE minimize whitefly population, TLCV and leaf miner incidence + Pre transplanting application of Imidacloprid @ 0.3 ml/lit in nursery protects the newly planted crop from whitefly infestation.(source of technology IIVR,Varansi,year of technology,2009-10) and T3 (technology-3)= Variety Kashi Early+ Raise Marigold (Tall African variety golden age bearing yellow and orange flowers) nursery 15-20 days before chilli nursery+ One week after germination of seeds, spray the seedlings with

(Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l)+Apply Neem cake 250 kg/ha ridges at the time of preparing land+ Dip the roots of seedlings (do not dip the foliage as it may cause burning of leaves) with Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l for 5 minutes. Fifteen days after planting spray Imidacloprid 200 SL @ 0.4ml/l or Thiomethoxam 25 WP @ 0.3g/l for leaf curl vector (whitefly) control+ Destroy leaf curl and other virus affected plants as soon as the symptoms appear in a few plants to minimize their spread (source of technology,IIHR,Bangore, year of technology,2009-10)

All these IDM technologies modules were used in chilli crop for leaf curl virus management. The seed sown in the raised nursery beds on 15th of June 2017-18 and 2018-19. After 25 days, these seedlings were transplanted in the experimental plots on 1st July of 2017-18 and 2018-19. The individual plot size was 15 m^2 (3 X 5 m) per treatment. Seedlings were transplanted at a spacing of 45 cm on ridges spaced at 45 cm apart, counting a total of 60 plants per plot. The experimental plots were interspaced at 1.0 m. Each cultivar was given the same management treatments i.e. fertilization, irrigation, weeding and different IDM technologies modules against leaf curl virus disease. Compost @25 tons/ha and NPK@ 50:60:60 kg/ha was applied as basal dose during field preparation and additional dose of nitrogen @70 kg/ha was applied as top dressing in two equal splits at 30 and 50 days after transplanting. Irrigation was applied as and when necessary.

Normal cultural practices were adopted to raise the crops successfully. The observations in each plot every year to record the on number of fruits/cluster, fruits/plant, average fruit weight, marketable fruit yield, non-marketable fruit yield and plant stand (survivability) at harvest and the yield was recorded on plot basis. The leaf curl virus incidence and severity were recorded 75 days after transplanting. The severity was rated in 3 grades, 1- mild symptom (light foliar yellowing), 2- moderate symptoms (light foliar yellowing, curling and slight plant stunting) and 3-severe symptoms (very severe plant stunting, leaf size reduction, leaf curling and yellowing). The mean data for all observations over two years were pooled and statistically analyzed following standard procedure.

T1-Farmers practice- Variety-Pusa sadabhar+ indiscriminate use of insecticides

T2-Variety Pant C-1 + Seed treatment with Imidacloprid, netting of nursery, spray 4% NSKE minimize whitefly population, TLCV and leaf miner incidence + Pre transplanting application of Imidacloprid @ 0.3 ml/lit in nursery protects the newly planted crop from whitefly infestation, Source of technology, IIVR,Varanasi,2009-10

T3-Variety , Kashi Early+ raise Marigold (tall African variety golden age bearing yellow and orange flowers) nursery 15-20 days before chilli nursery+ One week after germination of seeds, spray the seedlings with (Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l)+Apply Neem cake 250 kg/ha ridges at the time of preparing land+ Dip the roots of seedlings (do not dip the foliage as it may cause burning of leaves) with Imidacloprid 200 SL @ 0.3 ml/l or Thiomethoxam 25 WP @ 0.3 g/l for 5 minutes. Fifteen days after planting spray Imidacloprid 200 SL @ 0.4ml/l or

Thiomethoxam 25 WP @ 0.3g/l for leaf curl vector (whitefly) control+ Destroy leaf curl and other virus affected plants as soon as the symptoms appear in a few plants to minimize their spread

In OFT demonstration plots, critical inputs in the form of quality seed and treatment, farm manure, balanced fertilizers and agro-chemicals were provided by KVK. For the study, assessment and refinement of different IDM technologies for suitability at local or microclimatic situation so that these technologies would be further accepted or rejected or refined as per feedback of technological and farmers. The suitable modules were assessed for large scale demonstrated among more farmers for diffusion and adoption of technology for management of leaf curl virus of tomato. The technological gap, extension gap and technology index[5].

Technology gap = Potential yield- Demonstration yield

Extension gap = Demonstration yield-Farmers yield

$$\textbf{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

Results and Discussion

1. Effect on Chilli yield, growth parameters and disease

1.1 Chilli fruit yield

The yield of chilli under different integrated leaf curl virus disease management technologies ranged from 115.5 to 280 q/ha with highest average yield 277.5 q/ha. The cultivation of chilli with leaf curl management technologies, the yield ranged from with mean average 145.0 to 150.0 q/ha,(average mean (147.6 q/ha) with leaf curl virus resistant variety Pant C-1 with IDM technology-2, while in technology-3 with resistant variety Kashi early 275 to 280 q/ha with an average mean yield (277.5 q/ha) during 2017-18 to 2018-19 (Table-1) as against a yield ranged 115.5 q/ha to 117.2 q/ha with a mean of 116.3 q/ha recorded under farmer's practices (technology-1, local check) in an average mean of both the years[1,2].

The additional chilli fruit yield under technology-2 over local check ranged from 115.5 to 117.2 q/ha with a mean of 116.3 q/ha. In comparison to local check there was an increase of 95.1 % in yield of chilli with technology 1 in both the years' means. The increased chilli yield with variety Pant C-1 + IDM technology-2 was mainly because of use improved leaf curl virus resistant variety and IDM technology. While the additional yield of chilli fruit over local checked ranged from 145 to 150 q/ha with a mean of 147.5 q/ha in leaf curl virus resistant variety Kashi early + IDM technology-3 for leaf curl virus management in mean of both the years. The increased in comparison to over farmer practice was 137.1% in both the years mean. The overall performance among technologies, the highest yield and increased over farmers check was in Technology-2. This finding is in corroboration with the findings of many others[2].

1.2. Effect on growth parameters of chilli

Data on other parameters i.e. number of fruits/plant and weight of fruit (gm) of chilli was also found increased in both the technological intervention over farmers' practices (Table 1). The average number of Chilli fruits 45.9 and 58.5 with an increased 14.2% and 22.9% in an average mean of both the years respectively, in technology-2 and technology-3 over farmer practices 445.9. The average mean weight of fruit was also recorded an increased trend 61.1 (g) and 66.2 (g) with increased 35 % and 44.9 % over farmers practices (45.7g). The highest performance in all parameters of chilli was recorded on technological intervention-2 (T-3).

Table 1 Effect of different technologies of management for leaf curl virus disease in chilli on yield (q/ha), decreased in disease incidence, No. of fruits/plant and weight of fruit/plant at farmers' fields during two consecutive years (2017-18to 2018-19).

Years	Data on parameters of observations																							
	Yield (q/ha)			Increased over T1 (%)			Disease incidence (%)			Decreased over T1 (%)			No. of fruits/plant			Increased over T1 (%)			Weight of fruit/plant			Increased over T1 (%)		
	T1**	T2***	T3****	T2	T3	Av.	T1	T2	T3	T2	T3	Av	T1	T2	T3	T2	T3	Av	T1	T2	T3	T2	T3	Av.
2017-18	115.5	145.0	275	25.8	89.6	102.6	67.5	7.8	2.5	88.4	96.2	92.3	45.0	51.0	58.0	13.3	15.5	14.8	45.5	61.5	65.1	35.1	43.0	78.1
2018-19	117.2	150.2	280	28.1	96.6	110.6	66.2	6.5	2.2	90.1	96.6	93.3	46.0	53.0	60.0	15.2	30.4	22.8	46.1	61.7	67.1	35.2	46.8	82.0
Total	232.7	295.2	555	53.9	186.2	213.2	133.7	14.3	4.7	178.5	192.8	185.6	91.0	104	118	28.5	45.9	37.6	91.6	123.2	132.2	70.3	89.8	160.1
Average	116.3	147.6	277.5	26.9	93.1	106.6	66.8	7.1	2.3	89.2	96.4	92.8	45.5	52.0	59.0	14.2	22.9	18.8	45.8	61.6	66.1	35.1	44.9	80.05

Note = ** T1= (Farmers, practice), *** T2= Technology-1, ****T3 =Technology-2, AV= Average

1.3 Decreased in leaf curl virus disease (%) of chilli

The significant data on highest decreased in leaf curl virus of chilli were recorded 89.2% and 96.4% in both the years mean over farmers' practices, respectively in technology-2 and technology-3. The incidence of leaf curl virus was recorded least 2.3% in technology-2 while 7.1% in technology-1 while disease incidence was highest 66.8% in farmers practice on the mean basis of both the consecutive year (Table 1).

2. Economics analysis

2.1 Net Return

The economic viability of improved technologies over traditional farmer's practices was calculated depending on prevailing prices of inputs and outputs costs (Table-2). It was found that cost of production of chilli varied from Rs.45000 and 46800 to 46000 and 47000/ha with an average of Rs. 45900/ha and Rs. 46500/ha of improved technologies as against the variation in cost of production from Rs.32000 to 33000/ha with an average of Rs.32500/ha in local check in both the years. The improved production technologies registered an additional cost of production ranging from Rs. 13000/ha and 14000 with a mean of Rs.13400/ha and 14000/ha over local check, respectively, technology-2 and technology-3. The additional cost incurred in the improved technologies as compared to farmer's practices was mainly due to more costs involved in inputs of technologies. Cultivation of chilli under improved technologies gave higher net return ranged from Rs.111300 to 13200 /ha, with a mean value of Rs.122500/ha and Rs. 243000 to 275000/ha, with a mean value of Rs. 259000/ha as compared to local check mean value of Rs. 89710/ha.

There was an additional net return of Rs.159500 to 179080/ha and Rs.94500 to 1075580/ha in the years respectively, technology -2 and technology-3 under demonstration plots. The improved technologies also gave higher benefit cost ratio 5.1 to 8.9 compared to 3.7 under local check in the corresponding seasons in technology-2 and 3, respectively. This may be due to higher yields obtained under improved technologies compared to local check (farmers practice)[1,2].

Table 2 Economical analysis of cost of cultivation, gross cost, net return (Rs/ha) and cost benefit ratio of different technological modules for management of leaf curl virus disease in chilli at farmers' fields during two consecutive years (2017-18 to 2018-19).

Years	Data on economical analysis of different technologies for management of leaf curl virus																				
	Cost of cultivation (Rs/ha)			Increased over T1 (Rs)			Gross return (Rs/ha)*			Increased over T1 (Rs)			Net return (Rs/ha)			Increased over T1 (Rs)			Cost benefit ratio		
	T1 **	T2 ***	T3****	T2	T3	AV.	T1	T2	T3	T2	T3	Av	T1	T2	T3	T2	T3	Av.	T1	T2	T3
2017-18	**32000**	**45000**	**46000**	**13000**	**14000**	**13500**	**115500**	**145000**	**275000**	**29500**	**159500**	**94500**	**83500**	**113000**	**243000**	**29500**	**159500**	**94500**	**3.6**	**4.5**	**8.5**
2018-19	**33000**	**46800**	**47000**	**13800**	**14000**	**13900**	**128920**	**165000**	**308000**	**36080**	**179080**	**107580**	**95920**	**132000**	**275000**	**36080**	**179080**	**107580**	**3.9**	**5.8**	**9.3**
Total	**65000**	**91800**	**93000**	**26800**	**28000**	**27400**	**244420**	**310000**	**583000**	**65580**	**338580**	**202080**	**179420**	**245000**	**518000**	**65580**	**338580**	**202080**	**7.5**	**10.3**	**17.8**
Average	**32500**	**45900**	**46500**	**13400**	**14000**	**13700**	**122210**	**155000**	**291500**	**32790**	**169290**	**101040**	**89710**	**122500**	**259000**	**32790**	**169290**	**101040**	**3.7**	**5.1**	**8.9**

*Sale rate of chilli @ Rs. 1000/quintal (2017-18), Rs. 1100 (2018-19), ** T1= (Farmers, practice),*** T2= Technology-1,****T3 =Technology-2, AV= Average,

Table 3 Extension gap (q/ha), Technology gap (q/ha) and technology index (%) on demonstration of IDM intervention

Year	Varieties	Yield (q/ha)					Extension gap (q/ha)	Technology gap (q/ha)	Technology Index (%)
		Potential	Improved technology			Local Check			
			T2	T3	Average	PUSA SADABAHAR			
2017-18	PANT C-1	300	145.5	275	210	115.5	94.5	90	31.5
2018-19	KASHI EARLY	350	150.0	280	215	117.2	97.8	85	24.2
Average		325	147.7	277.5	212.5	116.3	96.1	87.5	27.8

- Potential yield of Pusa Sadabhar (150 q/ha)

The results from the current study clearly brought out the higher potential yield and leaf curl disease resistant varieties as well as improved integrated disease management technologies in enhancing chilli production, reducing highest incidence of leaf curl disease and economic grains in Hathras district condition of Uttar Pradesh.

2. 2 Technology gap

The technology gap in the demonstration chilli yield over potential yield were 90.0 q/ha in pant c-1 and 85 q/ha in Kashi early with an average on both the years 87.5 q/ha in both the varieties and its respective technologies for leaf curl virus management in tomato (Table 3).The technological gap may be attributed to the dissimilarity in the soil fertility status and weather conditions

2.3 Extension gap

The highest extension gap of 117.2 q/ha was recorded in chilli variety Pant C-1 and the lowest was observed in 115.5 q/ha in variety Kashi early with its IDM. This emphasized the need to educate the farmers through various means for the adoption of improved tomato production technologies to reverse this trend of wide extension gap. More and more use of latest production and IDM technologies with high yielding and resistant varieties will subsequently change this alarming trend of galloping extension gap. The new technologies will eventually lead to the farmers to discontinue the old technology and to adopt new technology (Table 3). 2.4 Technology Index. The technology index shows the feasibility of the evolved technology at the farmer's fields and the lower the value of technology index more is the feasibility of the technology. The technology index was 24.5 per cent, while 31.5 % maximum technology index was in technology-3 with Kashi Early during 2017-18 to 2018-19 (Table 3).

Conclusion

The results were found highly significant increased in yield and growth attributes of chilli on resistant varieties of leaf curl virus with integrated disease management technologies and reduced disease incidence as comparison to farmer practices. The high yield and disease resistant varieties with disease management technologies were found the main factors to give the high achievement on tomato cultivation while farmers were unaware about these varieties and disease management practices. Farmers were convinced due to performance of technologies and accepted the ones but farmers want availability of new technologies inputs timely at local market. These technologies further could be taken under front line demonstration programme for large scale adoption horizontal and vertical spread among tomato grower of the district.

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