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On-farm management of leaf curl disease in chilli under arid farming system

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Abstract

In order to assess efficacy of a bio-management strategy for leaf curl disease (LCD) of chilli a 2- year "on-farm" experiment was conducted in farmers' fields of Narwa and Manai villages in Jodhpur district in western Rajasthan. Chilli seeds were treated with raw cow's milk (RCM) for 24 hours in 1:1 ratio (i.e. RCM diluted to 50% by adding water) at the room temperature (30±2°C) and *Trichoderma viride* (6 g kg^{-1} seed) and *T. viride* (10 g m^{-2}) in nursery soil followed by dipping of nursery-raised saplings in RCM (15%) for 20 minutes before transplantation. After 20- days of transplanting the plants were sprayed with RCM (15%) for four times at 15 days interval. The farmers' practice (FP) was treated as control. Treatment of bio-control agents was found superior over FP in all the replications providing about 17 to 65% protection over FP. Yield attributes like plant height, root length, number of branches $plant^{-1}$, number of fruits $plant^{-1}$, fruit size, fruit weight and fruit yield $plot^{-1}$ showed an increase when compared to FP. Besides reduced incidence of LCD and yield attributes, the net monitory return was more (Rs. 8849.47 ha^{-1}) in the treatment of bio-agents (RCM and *T. viride*) in comparison to the FP with benefit: cost (B: C) ratio of 1.68: 1.31 in the treatment and FP, respectively.

Key words: Chilli, *Capsicum annuum* L., leaf curl disease, on-farm research, bio-control, raw cow's milk, *Trichoderma viride*, arid zone.

Introduction

Hot pepper or chilli *(Capsicum annuum* L.) is an important and widely cultivated vegetable and spice crop. In India the crop occupies an area of 0.915 million ha with the production of 1.018 million tonnes. The export share of chilli is about 16% of the total spices exported from India. However, the average yield of chilli in India is very low (0.8 t ha^{-1}) as compared to the other chilli producing countries like Korea and Indonesia where it ranges from 2 to 3 t ha^{-1}. Rajasthan is the sixth largest state in the country producing around 51,000 tons red chilli in all the districts under seven regions. In arid areas of Rajasthan chilli is widely cultivated in irrigated areas as a cash crop. The share of Jodhpur region, which comes under arid area, is about 42.7% [1]. Jodhpur district alone contributes 30.25% of total production of red chilli in the State [2]. Most popular cultivars like Mathania-Red, Mehsana, Mandoria and Haripur-Raipur having large, inflated and fleshy fruits are mostly cultivated in this region. Green fruits are valued chiefly as vegetable and for making pickles whereas, brilliant red-coloured powder of dried ripe fruits with mild pungency and rich spicy flavour is a culinary delight of *Marwar* region. Chilli has been proposed as a potential vegetable crop under assured irrigation system as field crop in Luni basin agro-ecological zone [3].

The susceptibility of popular cultivars to leaf curl disease (LCD) is the main reason for low yield of chilli in the area. In about a decade, the yield of chilli in Jodhpur region has been reduced to 28% due to incidence of LCD, consequently forcing local farmers to abandon chilli in favour of crops like cotton, castor and groundnut. Leaf curl disease is caused by Tobacco Leaf Curl Gemini Virus (TLCuV) [4]. The plant is affected at all the growth stages. The affected leaves show curling, puckering and distortion with blistering of inter-veinal areas and shortening of internodes. In severity axillary buds of affected plants are stimulated to produce clusters of leaves of reduced size with fewer flowers and fruits. The disease is transmitted by insect vectors such as white fly (*Bemisia tabaci*) and thrips (*Scirtothrips dorsalis* and *Polyphagotarsonemus latus*). The disease appeared in severe form in Western parts of Rajasthan during 1996-1997 [5-7]. Farmers extensively use a number of insecticides singly or in combinations to protect the crop from LCD. However, pesticides use has failed to minimize the losses. The indiscriminate use of pesticides leads to serious environmental pollution, resistance in insect vectors and health hazards [7]. Investigations on the performance of the cultivars procured from Punjab and Haryana showed that resistant cultivars, though giving the highest number of fruits per plant, were poor performers in terms of yield and other growth parameters and have poor acceptance by the farmers of this region[8]. The present scenario thus necessitated the development of alternative eco-friendly management strategies like exploitation of biological agents and timely integration of various components to reduce the load of chemicals.

Milk and its components have been reported as possible inhibitors of virus multiplication in Tobacco Mosaic Virus in tomato, pepper and tobacco; Urdbean Mosaic Virus, Potato virus Y in potato and sugarcane mosaic virus in sugarcane [9-12]. In the state of Gujarat the farmers are using milk for the control of plant diseases [13]. Based on these findings it has been strongly emphasized that milk should be used as an indigenous knowledge (IK) for managing viral diseases in crops. Like any other new approach, IK will only be accepted if its success is demonstrated. An attempt was, therefore, made to integrate the use of raw cow's milk (RCM) and *Trichoderma* to manage LCD in chilli.

Table 1. Raw cow's milk and *Trichoderma viride* induced protection.

Name of village and replication	*LCD incidence (%) 2001-2002		Protection over FP (%)	LCD incidence (%) 2002-2003		Protection over FP (%)
	T_1	T_2		T_1	T_2	
Narwa						
R 1	11.3	28.8	60.7	56.0	86.1	34.9
R 2	11.3	28.8	60.7	27.1	52.1	47.9
R 3	8.3	24.0	65.4	-	-	-
Narwa						
R 1	11.5	13.8	16.6	-	-	-
R 2	19.6	43.9	55.3	-	-	-
R 3	10.7	19.2	44.2	-	-	-
CD at 5%	7.43			8.31		

*T_1 Seed treatment with raw cow's milk (RCM) (50% dilution with water for 24 h) with *Trichoderma viride* (0.6%) and soil treatment with *T. viride* (10 g m^{-2}), T_2 Farmer's Practice — Data not recorded

Material and Methods

'On-farm' studies were conducted in Narwa and Manai villages of Jodhpur district during 2001 to 2003 to manage LCD using environment-friendly technology. Chilli seeds were procured from the respective farmer of the village before treatment. The treatment consisted of T_1-seed treatment with raw cow's milk (RCM) for 24 hours in 1:1 ratio (i.e. RCM diluted to 50% by adding water) at the room temperature (30±2°C) and *Trichoderma viride* (6 g kg^{-1} seed) and *Trichoderma viride* (10 g m^{-2}) in nursery soil followed by dipping of nursery raised saplings in RCM (15%) for 20 minutes before transplantation. After 20-days of transplanting the plants were sprayed with RCM (15%) for four times at 15 days interval, and T_2 - farmer's practice (FP), which included a variety of practices that varied from farmer to farmer. However, most of these practices were non-organic chemical sprays with or without any seed treatment. The design of trial was RBD. Besides recording per cent incidence of LCD and yield parameters (plant height, root length, number of branches per plant, number of fruits per plant, fruit size, fruit weight and fruit yield per plot) net returns were also calculated.

Results and Discussion

Seed treatment with raw cow's milk (RCM) with *Trichoderma viride* and soil treatment with *T. viride* (T_1) appeared to have an edge over FP in reducing the LCD incidence (Table 1). *T. viride* applied as soil or seed treatments, grow readily along with the developing root system of the treated plant and protected the roots from the initial infection [14]. Results indicated about additive effect of RCM probably through induced resistance [15]. Amino acid proline and potassium phosphate in the milk are known to boost immune system in plants[16-17]. In the treatment all yield attributes showed an increase except in case of number of branches, which was almost at par with FP (Table 2). In terms of reduced incidence of LCD and yield attributes, the net monitory return was more (Rs. 8849.47 ha^{-1}) in the treatment of bio-agents (RCM and *T. viride*) in comparison to the FP (Table 3) because of considerable slash in the cost of pesticides and fertilizers. Nevertheless, the cost of labour is slightly increased. The benefit: cost (B: C ratio) was calculated as 1.68: 1.31 in the treatment and FP, respectively.

Continuous use of chemicals (insecticides) results in resistance in the pathogen [18] but such risks are not involved with bio-control agents like RCM and *T. viride*. Recently, it has been reported that pesticide-free produce contains a significantly greater amount of polyphenolic anti-oxidants than conventionally grown crops [19]. In the present scenario of globalization where pesticide-free produce will only find the market and also fetch better prices, it is high time that more such indigenous practices should find a respectable place in research to ward-off crop diseases after scientific validation, assessment and refinement along with modern bio-pesticides. Therefore, seed treatments with RCM and *T. viride* besides soil application of the latter can be taken as beneficial components of integrated (as *T. viride* will also take care of die-back) disease management in chilli under arid farming system.

Table 2. Average yield parameters of chilli in two treatments.

Treatment *	Plant height (cm)	Root length (cm)	No. of branches	No. of fruits $plant^{-1}$ (g)	Fruit size (cm)		Fruit wt $plant^{-1}$ (g)	Yield** $plot^{-1}$ (4 x 3 m^2) kg^{-1}
					Length	Width		
T_1	66.3	20.2	12.9	66.4	10.4	4.5	306.2	3.32
T_2	57.5	13.9	13.0	40.1	9.2	3.9	219.4	2.72

*T_1 Seed treatment with raw cow's milk (RCM) (50% dilution with water for 24 h) with *Trichoderma viride* (0.6%) and soil treatment with *T. viride* (10 g m^{-2}). T_2 Farmer's practice
**Yield of second picking only.

Table 3. Cost and return from chilli crop (Rs ha^{-1}).

Particular	Farmer's practice (T_2)	Improved method Raw cow's milk + *T. viride* treatment (T_1)
Cost		
Seed	375.00 (1.49)	375.00 (1.52)
FYM	1990.74 (7.92)	1990.74 (8.06)
Fertilizer	1226.85 (4.88)	1171.71 (4.74)
Pesticides	1157.41 (4.61)	281.48 (1.14)
Irrigation	14814.26 (58.97)	14880.26 (60.26)
Machinery	2078.70 (8.27)	2078.70 (8.42)
Labour	3481.48 (13.86)	3916.08 (15.86)
Total	25124.44 (100.00)	24693.97 (100.00)
Return		
Production (q ha^{-1})	110	138 (25.45)
Production (Rs ha^{-1})	33000	41400
Unit cost of production (Rs q^{-1})	228.40	178.94
Net return (Rs ha^{-1})	7875.56	16706.03
B-C ratio	1.31	1.68

Figures in parentheses are percentages to the total.

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