Integrated Wilt Management in Chickpea (*Cicer aritinum* L.) in Bundelkhand Region

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ABSTRACT

Chickpea wilt incited by Fusarium oxysporum f. sp. ciceris is one of the severe diseases causes heavy losses (20-100%) depending upon stage of infection and wilting. Minimizing this disease can only be accomplished by careful crop management. On-farm demonstration on use of resistant variety JG-16, summer deep ploughing, Trichoderma viride, PSB, Rhizobium and fungicides was conducted during Rabi (Oct-February) 2011-12 and 2012-13 in two villages of Datia district (M.P) in Bundelkhand region. The field experiments comprised of four treatments module. In treatments module 1 (T1), where summer deep ploughing (SDP) + resistant variety (JG-16), wilt incidence was recorded 8.7% at village Sitapur and 9.04% at village Kakraua. In treatments module 2 (T2), where treatments module 1 (T1) + seed treatment with the combination of Carbendazim (1.0g) + Thiram (2.0g) per kg seed followed by Trichoderma viride @ 5.0 gram/kg were applied as seed treatment, wilt incidence was 5.2% at village Sitapur and 5.46% at village Kakraua. In treatments module 3 (T3), where treatments module 1 (T1) was applied followed by seed were treated with PSB and Rhizobium, wilt incidence was 7.7% at village Sitapur and 8.10% at village Kakraua. Highest seed germination per cent (87.22), 100 seed weight (17.65 g), yield (22.35q/ha), Benefit Cost ratio (3.61) and reduction in wilt incidence (69.26%) was found in treatments module 4 (T4) at village Sitapur where integration of the treatments module 1(T1), treatments module 2 (T2), and treatments module 3 (T3) followed by Trichoderma viride 4.0 kg/ha with 200 kg farm yard manure (FYM) was applied as basal application at the time of field preparation.

Key words: *Resistant variety; Wilt incidence; IPM; INM; BCR;*

Chickpea, *Cicer aritinum* L. is the world third most important pulse crop. India rank first in terms of chickpea production and consumption in the world. Low yield of chickpea is attributed to its susceptibility to several fungal, bacterial and viral diseases. Chickpea wilt incited by *Fusarium oxysporum* f. sp. *ciceris* is one of the serious diseases causes annual loss at 10 per cent in yield (*Dubey et al., 2007*). It is an important pest in chickpea growing areas of the world particularly in United State, India, Mexico and in the Mediterranean region (*Andrabi et al., 2011; Harveson 2011; Arvayo-Ortiz et al., 2012*). The pathogen of chickpea wilt disease is seed-borne (*Pande et al., 2007*) as well as soil borne (*Jiménez-Fernández et al., 2011*). The spores of fungus enter in the plants passing through the roots. When the spore reaches in the vascular system they produce certain enzymes that disgrace the cell walls and obstruct the plant's transport system. Discoloration occurs inside tissues from the root to the aerial parts. Yellowing and wilting of the foliage occur and finally there is necrosis (*Leslie and Summerell, 2006*). *F. oxysporum* survive as mycelium and chlamydospores in seed and soil, and also on infected crop residues, roots and stem tissue buried in the soil for up to 6 years and yield losses of up to 72.16 per cent may occur under favourable condition (*Kumar, S. and V.A. Bourai, 2012*). Chemical management of its infection by systemic fungicides is extravagant but also cause ecological problem. Hence, scientists are steadily looking out for non-perilous and eco-friendly measures for plant

disease management. Integrated management strategies should include solution to maintain plant health. These strategies should include minimum use of chemicals for checking the pathogen population, encouragement of beneficial biological agents to reduce pathogen inoculums, modification of cultural practices and use of resistance varieties (*Moradi et al. 2012*).

The aim of present investigation to minimize the wilt incidence and develop an economically justified and sustainable system of crop protection that leads to maximum productivity of chickpea.

METHODOLOGY

In order to evaluate the efficacy of integrated use of cultural, biological, and chemical practices for the effective management of wilt disease in chickpea. The experiment was conducted during the post rainy season at farmers' field at Sitapur and Kakraua villages in Datia district (M.P) of Bundelkhand region during Rabi 2011-12 and 2012-13. Chickpea wilt resistant variety JG-16 was used during the experiments with a seed rate of 75 kg/ha. The crop was sown during the third week of October at a spacing of 30x10 cm. Fertilizer NPKS @ 20, 60, 20 and 30 kg/ha in the form of Urea, SSP and Muriate of potash respectively were applied as basal at the time of sowing seed. The experiment was conducted completely randomized block design (RBD) replicated three times.

The field experiments comprised of 4 treatments module and control (untreated check). The IDM treatment modules viz.:

T1—Summer ploughing + certified seed of resistant variety (JG-16)

T2— T1 + seed treatment with the combination of Carbendazim (1.0g) + Thiram (2.0g) per kg seed followed by *Trichoderma viride* (Jawahar Trichoderma, JNKVV, Jabalpur) @ 5.0 gram/kg seed.

T3—T1 + Phosphate Solubilizing Bacteria (Jawahar PSB, JNKVV, Jabalpur) and Rhizobium culture (Jawahar Rhizobium, JNKVV, Jabalpur) @ 5.0g each/kg seed as a seed treatment.

T4—T2 + T3 + *Trichoderma viride* @ 4.0 kg/ha with 200 kg farm yard manure (FYM) was applied as basal application at the time of field preparation.

Control—Untreated check where seed was sown with imbalanced fertilizer (9.0 kg N and 23 kg P_2O_5)

The per cent field emergence was calculated based on following formula:

$$\frac{\text{No. of seed germinated}}{\text{No. of seed sown}} \times 100$$

The wilt incidence was recorded at 30 days intervals till harvest. In each plot, three rows, each 10 m long, were chosen arbitrarily. Plants in each row were examined and the number of plants showing symptoms of yellowing or wilting vascular noted. Disease incidence is expressed as the percentage of affected plants, counted in three rows by the total number of plants. Per cent disease incidence in each treatment was calculated using the following formula.

$$\text{Wilt incidence (\%)} = \frac{\text{No.of plants wilted}}{\text{No.of plants examined}} \times 100$$

The benefit cost ratio was calculated on the basis of prevailing market prices of chickpea and other inputs. Benefit cost ratio was calculated as follows:

$$BCR = \frac{Gross\ return}{Total\ cost}$$

RESULTS AND DISCUSSION

In the present study, seed treatment with chemical fungicide, PSB, *Rhizobium* and *Trichoderma viride* followed by soil application of *Trichoderma viride* and recommended dose of inorganic Nitrogen, Phosphorus, Potash and Sulfur were used to control wilt incidence effectively and increased chickpea yield significantly over other treatments. To find out the best disease management module by this study the result showed (Table 1) that at village Sitapur, T1, T2 and T3 individually gave 41.22, 64.86 and 47.97 per cent management of disease over the unprotected field, respectively. However, their integrated effects resulted in 69.26 per cent management of disease thereby given 47.70, 12.5 and 40.90 per cent additional management of disease over T1, T2 and T3, respectively. In the same way, results produce by the experiment at village Kakraua showed the best disease management in T4 (68.62%) fallowed by T2 (64.68%), T3 (47.61%) and T1 (41.52%) whereas, the lowest disease incidence was recorded at village Sitapur by T4 (4.55%).

The highest field emergence of 87.22 and 87.08 per cent were observed in T4 from both locations (Sitapur and Kakraua) where integrated application of all the treatments. Whereas, combined application of chemical and bio agents (T2) were used and showed 86.56 and 86.36 per cent seedling emergence. In T3, 85.46 and

Table 1. Detail of wilt incidence in chick pea field (Pooled data of 2011-12 and 2012-13)

Treatment	Village Sitapur					Village Kakraua				
	Wilt Incidence (%)				Reduction in disease (%)	Wilt Incidence (%)				Reduction in disease (%)
	After 30 days of sowing	After 60 days of sowing	After 90 days of sowing	Harvesting time		After 30 days of sowing	After 60 days of sowing	After 90 days of sowing	Harvesting time	
T1	0.60 (4.44)	4.60 (12.38)	7.47 (15.86)	8.7 (17.15)	41.22	0.62 (4.52)	5.10 (13.05)	7.67 (10.08)	9.04 (17.50)	41.52
T2	0.37 (3.49)	3.53 (10.83)	4.77 (12.62)	5.2 (13.18)	64.86	0.40 (3.63)	3.80 (11.24)	4.93 (12.83)	5.46 (13.51)	64.68
T3	0.47 (3.93)	3.87 (11.35)	6.07 (14.26)	7.7 (16.11)	47.97	0.49 (4.01)	4.43 (12.15)	6.17 (14.38)	8.10 (16.54)	47.61
T4	0.22 (2.69)	3.13 (10.19)	3.77 (11.20)	4.55 (12.32)	69.26	0.25 (2.87)	3.47 (10.74)	3.97 (11.49)	4.85 (12.72)	68.62
Control	0.67 (4.70)	5.37 (13.40)	12.07 (20.33)	14.8 (22.63)	00	0.73 (4.90)	8.07 (16.50)	12.47 (20.68)	15.46 (23.15)	00
SE(m) ±	0.19	0.095	0.14	0.09		0.23	0.18	0.12	0.12	
C.D. at 5%	0.60	0.311	0.48	0.31		0.76	0.60	0.40	0.39	

Figures in parenthesis represent angular transformed value

Table 2. Detail of percent seed germination, seed weight and yield of chick pea (Pooled data of 2011-12 and 2012-13)

Treatment	Village Sitapur				Village Kakraua			
	Germination (%)	100 grain weight (g)	Yield (q/ha)	Increase in yield (%)	Germination (%)	100 grain weight (g)	Yield (q/ha)	Increase in yield (%)
T1	84.60(66.89)	17.42	18.5	27.06	84.00(66.42)	17.38	18.10	26.04
T2	86.56(68.49)	17.48	20.22	38.87	86.36(68.33)	17.4	19.98	39.14
T3	17.59	20.12	38.19	85.36(67.50)	17.51	19.94	38,86	
T4	87.22(69.05)	17.65	22.35	53.50	87.08(68.93)	17.59	21.85	52.16
Control	78.20(62.17)	17.18	14.56	—	77.82(61.90)	17.12	14.36	—
SE(m) ±	0.23	0.018	0.07		0.09	0.03	0.03	
C.D. at 5%	0.76	0.07	0.22		0.29	0.09	0.11	

Figures in parenthesis represent angular transformed value

85.36 per cent seed germination were observed where variety JG-16, summer ploughing and bio-inputs were applied. 84.60 and 84.0 per cent seed germination were found in T1 and the lowest germination per cent (78.20 and 77.82) was noted from village Sitapur and Kakraua in untreated check of T5 (Table 2). The present finding is partially supported by the observation made by *Amalraj et al. (2012)*. They recorded the highest seedling emergence in carbendazim treated seeds and it was on a par with a combination of chemical and bio-agents.

With regard to effect of all the 4 treatments on the 100 grain weight (g), Table 2 shows that the highest 100 grain weight (17.65g) was recorded in treatment 4 at village Sitapur and 17.59g at village Kakraua followed by treatment 3 (17.59g and 17.51g), treatment 2 (17.48g and 17.40g), treatment 1 (17.42g and 17.38g) and control at both village Sitapur and Kakraua experiment locations. The differences in these results were significant in each location and this indicates a significant effect of treatment in 100 seed weight. However, at both locations Treatment 4 was effective but significantly at par with treatment 3.

Data presented in Table 2 reveal that the highest mean yield of chickpea per field was recorded in T4 (22.35q/ha) at farmer's field from village Sitapur which is 53.50 per cent more than untreated field followed by T2 (20.22 q/ha), T3 (20.12q/ha), T1 (18.50q/ha) and the lowest yield was observed with control (14.46q/ha).

Table 3. Detail of Economics of treatments (Pooled data of 2011-12 and 2012-13)

Treatment	Village Sitapur				Village Kakraua		
	Cost of treatment (Rs.)	Gross return	Net Return (Rs)	BCR	Gross return	Net Return (Rs)	BCR
T1	3490	61050	41440	3.11	59730	40120	3.05
T2	3690	66726	46916	3.37	65934	46124	3.33
T3	3736	66396	46540	3.34	65802	45946	3.31
T4	4320	73755	53315	3.61	72105	51665	3.53
Control	00	48048	31928	2.98	47388	31268	2.94

Similar results obtained from Kakraua village whereas, the highest mean yield recorded in treatment 4 (21.85 q/ha) fallowed by T2 (19.98 q/ha), T3 (19.94 q/ha) and T1 (18.10q/ha).

Treatment 4 (T2+ T3 + *Trichoderma viride* 4.0 kg/ha with 200 kg farm yard manure) provided the highest gross returns (Rs. 73755/ha) in village Sitapur. Remaining other treatments provided identical gross return. The lowest gross returns (Rs. 47388/ha) was computed from untreated field at village Kakraua. The highest benefit cost ratio (3.61) with the highest net return (Rs 53315) was obtained from T4 at village Sitapur. Similarly, results found in other location at Kakraua followed by T2, T3 and T1at both locations. (Table 3)

Fusarium oxysporum f. sp. *ciceris* is one of the yield limiting factors of chickpea across the world. Use of bio-agents in combination with reduced doses of chemical fungicide has recently been emphasized for sustainable agriculture (*Someya et al. 2007; Andrabi et al. 2011*). Due to the soil borne nature of the disease, use of chemicals in controlling the chickpea wilt is hardly successful. Hence, the economical and feasible approach would be either to search for resistant source or resort of biological control. *T viride* was found most effective which is in accordant with report of *Pandey and Upadhyay (1999)* and the possible suppression of wilt incidence in chickpea is due to antagonistic activity by *T. viride* by producing various extracellular enzymes which play an important role in biological control (*Kredics et al., 2003). Ainmisha et al. (2011)* found that wilt of chickpea incited by *Fusarium oxysporum* f. sp. *ciceris* could be minimize by use of Carbendazim and *Trichoderma viride. Andrabi et al., 2011* also found that seed treatment with Carbendazim increased the disease reduction percentage 86.66 over control. *Kolte et al. (1998)* effectively controlled chickpea wilt with seed treatment by Rhizobium and T. *viride*. *De et al. (1996)* found that coating of chickpea seed with Carbendazim was more effective in reducing wilt and increasing seed yield by 25.9 to 42.65 per cent. Due to synergistic effects of both the chemicals seed treatment with Thiram (0.15%) + Carbendazim (0.1%) were found most effective against *F. oxysporum* f. sp. *ciceris* (*Gupta et al., 1997*).

CONCLUSION

It can be concluded from the present study that chemical seed dressing along with mixture of bacteria and fungi may be beneficial in reducing the intensity of wilt disease and enhancing seed germination percentage as well as productivity of chickpea.

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