Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; SP6: 251-254

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International Web-Conference On New Trends in Agriculture, Environmental & Biological Sciences for Inclusive Development (21-22 June, 2020)

Technology interventions through cluster front line demonstartion for enhancing yield of lentil under biotic stress and nutrient deficient soil

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Abstract
A package of technology interventions through frontline demonstration was conducted in rabi season of two consecutive years 2017-18 and 2018-19 for enhancing the yield of lentil by managing the infestation of fusarium wilt, insect attack especially aphid and poor soil nutrition at farmer's field in following manner: Soil amendment with *Trichoderma* spp. (@ 5 kg/ha) and PSB (@ 5 kg/ha) incorporated in vermicompost 1 ton/ha + Seed treatment with Carbendazim @ 2 g/kg seed and *Rhizobium* spp. @10 g/kg seed +Spray of Imidachloprid (17.8 SL) @250 ml ai/ha. It resulted in reduction in wilt incidence (77.27 %, 71.80%) and aphid population (62.5%, 52.63%) demonstration plot in comparison to farmer's plot in the year 2017-18 and 2018-19 resulting in total increase in yield to 53.76% and 44.87% in 2017-18 and 2018-19 respectively. The technology interventions seems more viable and beneficial for farmers with higher Benefit cost ratio which increased up to 2.96 and 2.52 in demonstration plot in comparison to farmer's plot 2.82 and 2.45 in 2017-18 and 2018-19 respectively.

Keywords: lentil, wilt, aphid, yield, benefit cost ratio.

1. Introduction

Lentil (*Lens culinaris* Medik) is the second most important pulse crop in terms of both area and production (Anon., 2014). In India pulses constitute an integral part of the daily diet as a direct source of protein for human beings. It is cultivated throughout Northern and Central India. It is one of the oldest crops that originated in near east and Mediterranean region. Masur or lentil is a bushy, annual shrub plant that is popular for its lens shaped seeds, which are consumed as food in stew or other forms all over the world. These seeds have a vast range of colors from yellow to red-orange to green, brown and black and also have second highest levels of proteins and fiber after soybeans. The area under lentil in India is around 1.59 m. ha with a production of 0.94 m. t and productivity 697 Kg/ha (Anonymous, 2011) [1].

Owing to biotic and abiotic stresses, the crop yield is below attainable levels. Among the biotic factors, diseases are serious threat to lentil production. Lentil suffers from a number of diseases which are caused by fungi, bacteria, viruses, nematodes and plant parasites (Khare *et al*., 1979) [2]. In Saharsa district of Bihar Fusarium wilt, insect pests especially aphid significantly reduce lentil production. Fusarium wilt is one of the major constraints in lentil production. 20-25% yield loss is reported due to fusarium wilt (Maheshwari *et al*., 2008) [3]. Under favourable environmental condition, complete crop failure is observed (Choudhary and Amarjit, 2002, Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019) [4]. Among other biotic factors major insect pests like aphids and others also cause damage to the production of lentil in Saharsa district of Bihar. Apart from this, poor soil nutrition significantly lowers yield of lentil. The cumulative effect of all these constraints account for approximately 3.45-4.75 q/ha of lentil yield than expected 8.0-12.2 q/ha (Tripathi 2016) [5]. Several interventions like seed treatment and soil amendment with *Trichoderma* spp. and carbendazim suppress wilt in lentil significantly (Singh *et al*., 2017) [6]. Another major constraint in lentil production is the inadequate supply of nutrients and poor practices in soil

(Singh and Khan, 2003) [7]. Treatment of *Rhizobium* spp. with the seeds also significantly enhance yield of lentil (Huang *et al*., 2016; Ahemad and Khan 2010) [8, 9]. The major objective of this demonstration was evaluating the technology interventions for enhancing the lentil yield at farmers' field through the approach of cluster front line demonstration and the economic viability of this technology package.

2. Material methods

To assess the effect of integration of various technologies for the management of constraints of lentil cultivation viz., wilt, insect attack, poor soil nutrition frontline demonstration trial was conducted at farmers' field in Kahra and Sattarkataiya block of Saharsa district of Bihar for two consecutive years i.e. 2017-18 and 2018-19. The demonstration was laid out at 50 farmers field accounting 20 ha area (0.40 ha area each). The technology for the management of wilt, *Cuscuta* spp, insect pest infestation and poor soil nutrition was integrated in a following order:

1. Soil amendment with *Trichoderma* spp. and PSB prior to sowing of seeds @5kg/ha each incorporated in vermicompost 1 ton/ha
2. Seed treatment with Carbendazim @2g/kg seed
3. Seed treatment with *Rhizobium* spp@10g/kg seed
4. Spray of Imidachloprid (17.8 SL) @120 ml ai/ha

For enriching the soil, *Trichoderma* spp and PSB were mass multiplied on vermicompost and after that both the *Trichoderma* spp. and the PSB were mixed in soil at the time of field preparation. Seed treatment was performed with carbendazim and Rhizobium by following FIR (Fungicideds + Insecticides + Rhiobium) principle.

Two adjacent plot of 0.4 ha size was selected at farmers field. In demonstration plot, fertilizer 20:50:20 was applied through Urea, DAP and Potash as a basal application. Seed treatment was done with Carbendazim @ 2 g/kg seed. Further seed was inoculated with Rhizobium @10g/kg seed. Seeds were sown by broadcasting method using 40kg/ha of seed rate. Pendimethalin @ 3.3 litre/ha was sprayed 24 hours after sowing. Foliar spray of Imidachloprid (17.8 SL) @250 ml a.i./ha at 30 DAS. In farmers' plot, locally available seeds were broadcasted without seed treatment and only a basal dose of DAP 50 kg/ha was applied at the time of field preparation. The wilt incidence was recorded by using following formulae described by Iqbal *et al*., (2005) [10].

$$\text{Disease Incidence} = \frac{\text{Number of wilted plants}}{\text{Total Number of Plants}} \times 100$$

Aphid population was recorded from flowering to pod forming stage. The yield parameters seed weight per 10 plants of lentil were recorded after maturity of the crop. Yield increase, Net return, Benefit cost ratio was calculated by the formulae given by Das *et al*. (1998) [11]. The formulae are following:

$$\text{Increase in Grain Yield} = \frac{\text{Yield in Demonstration plot - Yield in farmers' plot}}{\text{Yield in Demonstration plot}} \times 100$$

$$\text{Net return} = \text{Gross return - Cost of cultivation}$$

$$\text{Benefit Cost ratio} = \frac{\text{Gross return}}{\text{Cost of cultivation}} \times 100$$

To calculate technology gap and extension gap, following formulae given by Kadian *et al*. (1997) [12] was used:

Technology gap = Potential yield – Demonstration yield

Extension gap = Demonstration yield – Farmers' yield

3. Result and Discussion

Assessment of technology interventions on wilt incidence, aphid population and total yield is presented in table 1. Wilt incidence in the year 2017-18 and 2018-19 in demonstration plot were 9.25 and 11.80 per cent while in farmers' plot were 40.69 and 41.85 per cent. Aphid population per plant in demonstration plot were 6 and 9 while in farmers' plot were 16 and 19 during the year 2017-18 and 2018-19. Total yield recorded in demonstration plot were 7.15 and 5.65 while in farmers' plot 4.65 and 3.90 during the year 2017-18 and 2018-19. It resulted in reduction in wilt incidence (77.27%, 71.80%), aphid population (62.50%, 52.63%) in demonstration plot in comparison to farmer's plot in the year 2017-18 and 2018-19. Wilt incidence and Aphid population in demonstration plot were significantly lower as compared to Farmer plot in both the year 2017-18 and 2018-19. Yield recorded in demonstration plot were significantly higher as compared to Farmer plot in both the year 2017-18 and 2018-19. It is assumed that lower wilt incidence, Aphid population and enhancement of soil nutrition due to *Rhizobium* spp. and PSB results in enhancing the total yield of lentil. Adoption of these integrated technology caused considerable increase in yield i.e. 53.76 and 44.87 during the year 2017-18 and 2018-19 respectively.

The economic viability of these technology interventions on demonstration plot and farmer's plot was measured by calculating benefit cost ratio which are presented in table 3. Cost of cultivation in the demonstration plot was Rs. 14950 and Rs 16260 while in farmers' plot were 11630 and 12670 during the year 2017-18 and 2018-19 respectively. Gross return obtained demonstration plot were Rs 44380 and Rs 41005 while in farmers' plot were 32845 and 31125 during the year 2017-18 and 2018-19 respectively. Net return gained by farmer in demonstration plot were 29430 and 24745 while in farmers' plot Rs 21215 and Rs 18455 during the year 2017-18 and 2018-19 respectively. On calculation of benefit cost ratio, 2.96 and 2.52 in demonstration plot while 2.82 and 2.45 in farmers' plot was found during the year 2017-18 and 2018-19. Adoption of these technology interventions in better benefit cost ratio in demonstration plot than farmers' plot. In terms of economy viability of these technologies in lentil production, net return was higher in demonstration plot as compared to farmer's plot in both the year 2017-18 and 2018-19. Benefit cost ratio was higher in demonstration plot as compared to farmer's plot in both the year.

Technology gap implies the gap between potential yield and demonstration yield of the crop. Potential yield of the variety (HUL-57) used in demonstration was 14q/ha. It signifies about the scientific intervention required to increase the yield of the crop. Extension gap implies about the awareness of the farmers about farming technologies, availability of agricultural inputs in that particular locality and other facility like electricity, fuel etc. Technology gap and Extension gap were calculated using formulae given by [12]Kadian *et al*. (1997) and presented in table 2. In the year 2017-18 and 2018-19, technology gap calculated were 6.85 and 8.35 while extension gap were 2.50 and 1.75 respectively. This technology gap is mainly due to lack of awareness of farmer's about improved technology. Farmer's are also less skilled in integrating various technologies in package form.

Table 1: Technology interventions on wilt incidence, aphid population and yield on Farmers plot (FP) and Demonstration plot (DP)

Year	No. of demonstration	Area (ha)	Wilt incidence (%)			Aphid population per plant (No.)			Total Yield (q/ha)		
			FP	DP	Wilt incidence reduction (%)	FP	DP	Aphid population reduction (%)	FP	DP	Yield Increase (%)
2017-18	50	20	40.69	9.25	77.27	16	6	62.50	4.65	7.15	53.76
2018-19	50	20	41.85	11.80	71.80	19	9	52.63	3.90	5.65	44.87

Table 2: Economic viability of adoption of technology in demonstration plot and farmer's plot

	Cost of Cultivation		Gross return		Net return		BC ratio		Technology gap	Extension gap
Year	FP	DP	FP	DP	FP	DP	FP	DP		
2017-18	11630	14950	32845	44380	21215	29430	2.82	2.96	6.85	2.50
2018-19	12670	16260	31125	41005	18455	24745	2.45	2.52	8.35	1.75

4. Conclusion
Tripathi (2016) [5] conducted similar kind of investigation and integrated various technologies for lentil production. After integrating various technologies they found significant reduction of wilt incidence, aphid population and higher yield in demonstration plot than farmer's plot. They also reported higher net return and higher benefit cost ratio in demonstration field than farmer's field. Singh *et al*. (2017) [6] reported that seed treatment with Carbendazim and *Trichoderma harizianum* treatment results in reduction of wilt incidence in lentil. Rafique *et al*. (2016) [13] reported that integration of systemic fungicides with biocontrol agent cause reduction of wilt incidence in lentil. Rhizobium inoculation of lentil seed enhances nitrogen availability and enhance yield (Huang *et al*., 2016) [8]. Ray *et al*. (2010) [14], Singh and Barman (2011) [15] and Tripathi (2016) [5] reported technology gap and extension gap in the findings of these scientists is supporting the result of present finding.

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