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Original Research Article

Productivity Enhancement of Lentil *(Lens culinaris Medik)* through Front Line Demonstration of Integrated Crop Management Technologies

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A B S T R A C T

The frontline demonstrations were conducted at Krishi Vigyan Kendra, Sonbhdra on 155 farmer's fields in the ten adopted villages of two block namely Ghorawal and Rabertsganj in Sonbhadra Bindhya region of Uttar Pradesh during rabi seasons of 2013-14 to 2017-18 in rainfed condition with medium fertility status under lentil cropping system to study the productivity enhancement of lentil through improved production technologies. The results revealed that integrated crop management practices reduced the wilt disease incidence in lentil from 3.8 (86.0 percent over farmers), spray of systemic insecticide imidacloprid 17.8 SL reduced the aphid population from 4.20 per plant (77.89 percent over farmers) in average various years. The seed yields of lentil under improved technology with average yield of 21.0 q/ha which was 79.0 percent higher over the farmer's practice (8.40 q/ha). However, maximum average gross returns (Rs.74070 /ha) as well as benefit cost ratio (7.02) were recorded under improved technologies as compared to farmer's practice (Rs.29775/ha). Adoption of 100 percent of the respondent adopted the good land preparation and timely sowing for maintaining optimum plant density which was followed by 49.68 percent of the respondent adopted the water management practices, majority of the respondent constraints faced by not existing of the market (100 %), it was also fallowed by lack of technical guidance (70.97%), complexity (67.74%). Therefore the study concludes that FLDs conducted by KVK, Sonbhdra made significant impact on horizontal spread Impact (% Change of 242.85) of this technology.

Keywords

Lentil, Front line demonstration, Integrated crop management technologies

Introduction

India is the world's largest producer and consumer of a wide variety of pulses which is dominated by tropical and sub-tropical crops such as chickpea, black gram, red gram (pigion pea), green gram (mungbean), lentil and so on, high in protein, fiber, vitamins, and also suppliers of high quality carbohydrates, minerals and vitamins. Pulses in general are one of most sustainable crop utilizing just 359 liter of water to produce one kg of pulses, as compared with 1,802 for soybeans and 3,071 for groundnut. They also contribute to soil quality by fixing nitrogen in the soil. In India, production of pulses is around 19.3 million tonnes (ESI 2015) with a very low average productivity of 764 kg/ha. Currently, total area under pulses is 26.3 million ha (Choudhary and Suri, 2014), there is a massive yield gap between India and other developed countries and also within

India, between research station yield and farmers' yields. Pulses is still rainfed resulting in poor crop productivity (Choudhary 2013). The world pulse production, area and yield during 2013 was 73 million tones (MT), in nearly 80.8 million ha and 904 kg ha-1respectively (FAOSTAT 2015) as compared to India's production of different pulses like chickpea (13.1 MT), pigeon pea (4.74 MT), lentils (1.13, MT), dry peas (0.6 MT), groundnut with shell (9.4 MT) and soybean (11.95 MT) (FAOSTAT 2015). Chickpea (gram or chana), pigeon pea (tur), mungbean (green gram or mungbean), urdbean (black gram or mash), lentil (masoor) and field pea (matar) are most common pulses grown in India. During 2013-14, India produced 19.27 MT of pulses, and about 3.18 MT of pulses worth more than Rs. 11038 crore (US$1.8 billion) were imported from Canada, Australia, Myanmar, Turkey, Syria, Tanzania, etc. The overall productivity of pulses increasing to an impressive 786 kg/ ha during 2012-13 as compared to 577 kg/ha during 2004-05. The credit for which goes to the improved varieties and production of breeder seed, demonstration of pulses production technologies through technology demonstrations, frontline demonstrations, policy support and various schemes like National Food Security Mission (NFSM), India ranked first in lentil area and second in the production with 39.79% and 22.79% of world area and production respectively. The highest productivity was recorded in Croatia (2862 kg/ha) followed by New Zealand (2469 kg/ha). Canada rank first in production (41.16%) due to very high level of productivity (1633 kg/ha) as compared to India (611 kg/ha). (FAO State., 2014). During Twelfth Plan (2012-15) the country's area under Lentil was 14.79 lakh hectares with a production of 10.38 lakh tonnes. Madhya Pradesh ranks Ist in acerage i.e., 39.56% (5.85 lakh ha) followed by UP 34.36 % and Bihar 12.40%. While in terms of production UP ranks Ist at 36.65% (3.80 lakh tonnes) followed by Madhya Pradesh (28.82%) and Bihar (18.49%).The highest yield was recorded by the state of Bihar (1124 kg/ha) followed by W.B. (961 kg/ha) and Jharkhand (956 kg/ha). The National yield average was (753 kg/ha). The lowest yield was observed in the state of Maharashtra (379 kg/ha), C.G. (410 kg/ha) followed by and M.P. (634 kg/ha) (DES., 2015-16). It is a valuable human food, mostly consumed as dry seeds (whole decorticated, seed decorticated and split). In Indian sub-continent mostly consumed as 'Dal' by removal of outer skin and separation of cotyledons, snacks and soup preparation etc. It is easy to cook and easily digestible with high biological value, hence also referred to patient. Dry leaves, stems, empty and broken pods are used as valuable cattle feed. Nutritive value of lentil given below-

Protein - 24-26%, Carbohydrate- 57– 60%, Fat-1.3%, Fiber-3.2%, Phosphorus - 300 mg/100 g, Iron-7 mg /100 g, Vitamin C-10-15 mg/100g, Calcium- 69mg/100g, Calorific value-343 Kcal/100g and Vitamin A- (450 IU).

Materials and Methods

To assess the economic feasibility of technology transfer for pest management and better productivity of lentil, The present study was carried out by the Krishi Vigyan Kendra, Sonbhadra Achrya Narendra Deva University of Agriculture & Technology, Ayodhya (U.P.) during rabi season of 2013-14 to 2017-18 five consecutive years in the farmer's field in two block Ghorawal and Robertsganj of 10 adopted villages viz., Silhata, Pagia, Bari, Obradeeh, Banjaria, Pithori, Gourahi, Ailahi,Papi, Ghuwani and Manapur of Sonbhadra district. The soil was red, black with shallow depth and rocky nature located in undulated terrain is another problem of the

district. Each demonstration was conducted in an area of 0.4 ha and 0.4 ha area adjacent to the demonstration plot as farmer's practices i.e. prevailing cultivation practices served as local check. All 155 front line demonstrations in 50 ha area were conducted in different villages. The improved technologies package included chickpea wilt resistant varieties, line sowing, integrated nutrient management and timely weed removal. The variety of lentil Pant Lentil 8, in fertilizer 20:50:20 NPK as basal application. Seeds were treated with Carboxin + Thiram (Vitavax power) @ 2 g kg^{-1} seed and inoculated with Rhizobium and PSB @ 10 g kg^{-1} seed. Seed sowing was done between October 25 to 31 in every year with a seed rate of 25 kg /ha in line sowing with row to row spacing of 30 cm and 10 cm between plants in the row. Recommended dose of fertilizer (20:50:20 NPK kg ha^{-1}) was applied through urea, single super phosphate and murate of potash as basal application. One hand weeding was done at 25 DAS for control of weeds. Foliar spray of Imidacloprid 17.6 SL was done at flower initiation stage for management of aphid. The crop was harvested during March 15 to 25 March after the leaves turn yellow and start dropping. In the second plot, locally available mix seed of lentil treated with Carbendazim 50 W P @ 2 g kg^{-1} was sown with basal dose of DAP 50 kg ha^{-1} and maintained as farmers practice. Foliar spray of Spray of NAA 40 mg/lt and Salicylic acid 100 mg/lt once at pre-flowering and another at 15 days thereafter; b. i) For rice fallow crops foliar spray of DAP 20 g/lt once at flowering and another at 15 days thereafter ii) For irrigated and rainfed crops, foliar spray of DAP 20 g/litre or Urea 20 g/litre once at flowering and another at 15 days thereafter.; c. Foliar spray of salicylic acid 100 mg/litre once at preflowering and another at 15 days thereafter. Pre emergence application of Pendimethalin 3.3 litres/ha on 3 days after sowing using sprayer fitted with flat fan nozzle using 500 litres of water for spraying one ha followed by one hand weeding at 20 DAS (or) application of quizalofop ethyl @ 50 g ai/ha and imazethapyr @ 50 g ai/ ha on 15 – 20 DAS. If herbicides are not applied give two hand weedings on 15 and 30 days after sowing. The data on incidence of wilt disease was recorded from flowering to crop maturity stages, whereas, aphid population was recorded from flowering to podding stages. The data on seed yield, cost of cultivation and gross and net monetary return were collected from technological demonstration plot. In addition to this, data on farmer practices were also collected from the equal area. The benefit cost (B:C) ratio was calculated based on gross return. The following formulae were used to calculate the parameters as suggested by Das *et al.*, (1998):

1. Increase in grain Yield= Grain yield from Demo plot– Grain yield from FP plot /Grain yield from Demo plot X 100.

2. Net Return= Gross Return – Cost of cultivation

3. Benefit/ Cost Ratio= Gross Return / Cost of Cultivation X 100

The data were collected through personnel interview, tabulated and analyzed to find out the results and draw the conclusion. The statistical tool like percentage was employed to analyze the data. The constraints as perceived by respondents were scored on the basis of magnitude of the problem as per (Meena and Sisodiya, 2004). The responses were recorded and converted in to mean percent score and ranked accordingly as per (Warde *et al.*, 1991). From front line demonstration plots and farmers practice plot (control plot) and finally extension gap, technology gap, and technology index were calculated as given as formula suggested by

Samui *et al.,* (2000) and Dayanand *et al.,* (2012) as given below.

Technology gap = Potential yield – Demonstration yield
Extension gap = Demonstration yield – farmers yield
Technology index = [(Potential yield – Demonstration yield) /Potential yield] x 100

The data of adoption and horizontal spread of technologies were collected from the farmers with the interaction them. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of lentil crop.

Impact of yield = Yield of demonstration plot- yield of control plot/Yield of control plot X 100

Impact on adoption (% change) = No. of adopters after demonstration- No. of adopters before demonstration /No. of adopters before demonstration X 100

Impact on horizontal Spread (% change) = After area (ha) - Before area (ha)

On the other hand, in partial and full adoption condition 17.50 and 7.50 per cent farmers increased in adopter condition over non adopter condition respectively. (Verma, 2013) shows the distribution of beneficiaries according to their change of area after conducting the FLD on their field. Unfortunately use of local varieties and poor nutrient management results in very low yield.

Results and Discussion

Disease and pest incidence

Overall adoption level of lentil grower about recommended cultivation practices The analysis on overall adoption level of lentil grower about recommended cultivation practices revealed that majority of the respondent had medium level of adoption. The data on wilt disease incidence, aphid population, yield and yield attributing characters of lentil for 5 years presented in Table-1 revealed that occurrence of wilt disease in improved technology (use of wilt resistant variety and seed treatment by vitavax power) was 3.28 percent as against farmers practice having 24.75 (86.0) percent during the years respectively. Which may due to protection from *Fusarium oxysporum* f.sp. lentis in seed as well as in soil. Earlier Maheshawari *et al.,* (2008) also found reduction in wilt incidence with the seed treatment of systemic fungicide significantly. Balance fertilizer application showed better number of pods per plant. Numbers of pods per plant under improved production technology were 23.20 in farmer's practice were 10.40 per plant during the years. Precautionary spray of systemic insecticide Imidacloprid 17.8 SL reduced the aphid population from 4.20 per plant (77.89 percent) in various years. The productivity of lentil in Bindhya region of Uttar Pradesh.

Yield and contributing characters

The yields contributing characters like no. of pods/plant obtained over the years under recommended practice as well as farmers practice are presented in table 1. Observation revealed that, ear head numbers were high registered with FLD plots compare to farmer's practice. no. of pods/plant mean of 23.20 with improved practices on farmer's field as against a mean of 10.40 in farmer's practice. The productivity of lentil from mean grain yield of 21.00 q/ha under improved practice on farmer's field as compared to farmer's practices mean of grain yield 8.40 q/ha and grain yield increase 79.00% over farmer's practices. This corroborate with the finding of Mukherjee (2016).

Table.1 Wilt disease incidence, insect population, seed yield of Lentil as affected by improved and local practices on farmer's field and Impact of FLD

Yields parameter	Year										Mean		Increase %
	2013-14	2013-14	2014-15	2014-15	2015-16	2015-16	2016-17	2016-17	2017-18	2017-18	IP	FP	
	IP	FP	IP	FP	IP	FP	IP	FP	IP	FP			
Wilt incidence	2.30	22.50	3.10	24.60	4.10	26.20	3.20	24.80	4.20	22.60	3.38	24.14	86.00
Reduction percentage		89.78		87.40		84.35		87.10		81.42		86.00	
Aphid population/Plant	4.00	12.00	2.00	18.00	6.00	19.00	5.00	22.00	4.00	24.00	4.20	19.00	77.89
Reduction percentage		66.67		88.89		68.42		77.27		83.33		77.89	
No. of pods per plant	22.00	10.00	24.00	12.00	23.00	9.00	25.00	11.00	22.00	10.00	23.20	10.40	76.80
Yield kg/ha.	21.00	8.00	22.00	9.00	19.00	7.00	22.00	9.00	21.00	9.00	21.00	8.40	79.00
Potential grain yield (q/ha)	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00	
Extension gap (q/ha)		13.00		13.00		12.00		13.00		12.00		12.60	
Technology gap (q/ha	2.00	15.00	1.00	14.00	4.00	16.00	1.00	14.00	2.00	14.00	2.00	14.60	
Technology index	0.10	1.88	0.05	1.56	0.21	2.29	0.05	1.56	0.10	1.56	0.10	1.74	

Table.2 Area and no. of farmers of FLD

Year	No. of FLD	Area
2013-14	32	8
2014-15	30	9
2015-16	33	10
2016-17	25	12
2017-18	30	11
Total	150	50

Table.3 Economics of FLD of lentil as recommended practices as well as farmer's practices

Year	Potential grain yield (q/ha)	Cost of cash input		Additional cost in demonstrations (Rs./ha)	Sale price of grain (MSP) (Rs./qt)	Grain Yield (q/ha)		Total returns Rs. (ha		Extra returns	Increm ental Benefit: Cost ratio
		FLD	FP			FLD	FP	FLD	FP		
2013.-14	23	8950	8687	263	2950	21.00	8.00	61950	23600	38350	6.92
2014-15	23	9250	9100	150	3075	22.00	9.00	67650	27675	39975	7.31
2015-16	23	10500	9800	700	3400	19.00	7.00	64600	23800	40800	6.15
2016-17	23	11200	10233	967	3950	22.00	9.00	86900	35550	51350	7.76
2017-18	23	12800	11459	1341	4250	21.00	9.00	89250	38250	51000	6.97
Mean	**23**	**10540**	**9856**	**684**	**3525**	**21.00**	**8.40**	**74070**	**29775**	**44295**	**7.02**

Table.4 Overall adoption of lentil seed grower about improved cultivation practices (N =155)

Categories	Frequency	Percentage
Low	41	26.45
Medium	89	57.42
High	20	12.90

Table.5 Adoption of individual recommended cultivation practices of lentil seed growers

Sl. No.	Particular	Frequency	Percentage
1	High yield varieties	41	26.45
2	Land preparation	155	100.00
3	Seed treatment practices	32	20.65
4	Spacing	13	8.39
5	Sowing Mathed	9	5.81
6	Sowing time	155	100.00
7	Manuring	23	14.84
8	Recommended NPK	26	16.77
9	Cultural practices	19	12.26
10	Water management	77	49.68
11	Disease management	19	12.26
12	Pest management	57	36.77
13	Foliar application of nutrients	12	7.74

Table.6 Constraints faced by farmer

Sl. No.	Constraints	Frequency	Percentage
1	Lack of technical guidance	110	70.97
2	Complexity	105	67.74
3	Lack of financial support	73	47.10
4	Not existing of the potential market	155	100.00
5	Monopoly of Merchant in the market	72	46.45
6	Non-availability of skilled labour	56	36.13
7	Lack of marketing facilities	135	87.10

Table.7 Impact of Front Line Demonstration (FLDs) on horizontal spread of lentil.

Variety	Area (ha.)			
	Before demonstration	After demonstration	Change in area (ha)	Impact (% Change)
Pant Lentil 8	35	189	154	242.8571

Extension, technology gap and technology index

The extension gap 12.60 q/ha during the period of study emphasized the need to educate the farmers through various means for the adoption of improved agricultural production to reverse the trend of wide extension gap (Table 1).

The technology gap is the difference or gap between the demonstration yield and potential yield and it was varies during the year of observation. The trend of technology gap 2.0 q/ha reflected the farmer's cooperation (14.60q/ha.) in carrying out such demonstration with encouraging results during the period of study. As such, the reduction in technology index 0.10%, exhibited the feasibility of the demonstrated technology in this region.

Economics

The inputs and outputs price of commodities prevailed during the FLD period, were taken for calculating cost of cultivation, net returns and B:C ratio. (Table 3). The investment on production by adopting improved technology with a mean value of Rs. 10,450/ha against farmers practice where the variation in cost of production with mean value of Rs. 9,886/ha.

Cultivation of wheat under improved practices fetch higher net return of mean value Rs. 74,070 compared to farmer practice to mean amount of Rs. 29,775/ ha. The additional net return with mean value of Rs. 44,295/ ha over farmer practice. The B:C ratio of improved technology was 7.02. This figure may be due to higher yields obtained under improved practices compared to age old farmer practice.

Adoption of recommended cultivation practices of lentil growers by individual

The individual adoption level was assessed with the packages of practices for enhancing the higher seed production in lentil under Bindhya zone of Uttar Pradesh such as high

yield varieties, land preparation, seed treatment practices, spacing, sowing time, manuring, recommended NPK, cultural practices, water management, disease management, pest management and foliar application of nutrients. It is evident from table 5 that 100 percent of the respondent adopted the good land preparation and timely sowing for maintaining optimum plant density which was followed by 49.68 percent of the respondent adopted the water management practices. The same level of respondent recorded in cultural practices and pest management by 36.77 percent. The level of respondent adopted other recommended practices such as high yield varieties (26.45 percent), seed treatment practices (20.65 percent), spacing (8.39 percent), green manuring (14.84 percent), recommended NPK (16.77 percent) and foliar application of nutrients (7.74 percent). The similar findings were reported by Shani Kumar (Singh *et al.*, 2017).

Constraints faced by farmers

Table 5 revealed that majority of the respondent constraints faced by not existing of the market (100 %), it was also fallowed by lack of technical guidance (70.97%), complexity (67.74%), lack of marketing facilities (87.10%), lack of financial support (47.10%). Non-availability of skilled labour (36.13%), and monopoly of merchant in the market (46.45%)

The FLD produced a significant positive result and provided an opportunity to demonstrate the productivity potential and profitability of the latest technology (intervention) under real farming situation. Therefore the study concludes that FLDs conducted by KVK, Sonbhdra made significant impact on horizontal spread Impact (% Change of 242.85) of this technology (Table 7).

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