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Research Article

Verification of disease management technology on lentil against Stemphylium blight at farmer's field in Nepal

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ABSTRACT

Technologies generated from lentil (*Lens culinaris* Medik) stemphylium blight (*Stemphylium botryosum* Walr) management experiments were verified at farmers field of 5 districts viz., Chitawan, Rautahat, Dang, Parsa and Banke during two winter seasons of 2013-2014 and 2014-2015. The experiment was laid out in randomized complete block design with factorial arrangement of treatments and replicated 4 times. The plot size was 340 m^2 (1 Kattha) with 25 cm row to row spacing. There were altogether 3 factors of the experiment i.e. year (2013-2014 and 2014-2015), location (5 districts) and package of practice (improved and farmers practice). The higher crop yield (1142.50 kg/ha) with lower disease index (34.95%) and higher benefit cost ratio of 2.42 were recorded in the farmers field of Banke district following seed rate (30 kg/ha), 8 hour primed improved variety (Black lentil), fertilizer doze of (20:40:20 NPK kg/ha+ 1 kg/ha B basal doze) and subsequent 3 sprays of Dithane M-45 @ 2.5 g/l of water at 10 days interval.

Keywords: Lentil, management, stemphylium blight, technology, verification

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INTRODUCTION

Stemphylium blight caused by *Stemphylium botryosum* Walr is a serious threat to lentil cultivation in Nepal. This disease caused leaf blight that can result in large scale defoliation of plants. The disease was first reported in 1993 in Nepal and widespread throughout major growing areas (Bayaa et al., 1998) and later observed increasingly in Banke, Bardia, Rupandehi, Chitwan, Nepalgunj, Makwanpur, Bara, Parsa and Rautahat districts (Joshi, 2006) and in some crop growing districts estimated yield losses of 60-90% have been assessed (GLRP, 2012). Banniza et al. (2004) reported 62% yield loss due to stemphylium blight in Bangladesh. Various technologies regarding the improved varieties and different crop management practices of lentil have so far been developed and released in Nepal. However studies regarding the adoption of technologies were very limited. The role of extension services for the technology demonstration and dissemination are so vital for the adoption of so called verified technologies in farmer's field. The on-station research works focusing on integrated disease management of lentil stemphylium blight were carried out at Grain legumes Research Programme, Rampur, Chitwan during 2011-2014. The technology that was developed on-station including appropriate agronomic practices with disease resistant variety and timely application of fungicides should be verified at farmer's field first and then recommended and delivered through extension services.

In view of the above facts, the present research work was undertaken with the objective of evaluation of the best disease management technology against lentil stemphylium blight in farmers field.

MATERIALS AND METHODS

Technologies generated from lentil stemphylium blight management experiments were verified at farmers field of 5 districts viz., Rampur (Chitawan), Dumariya (Rautahat), Lalmatiya (Dang), Bagwana (Parsa) and Baijapur (Banke) during two winter seasons of 2013-2014 and 2014-2015. The experiment was laid out in randomized complete block design with factorial arrangement of treatments and replicated 4 times. The plot size was 340 m^2 (=1 Kattha) with 25 cm row to row spacing. There were altogether 3 factors of the experiment i.e. year (2013-2014 and 2014-2015), location (5 districts) and package of practice (improved and farmers practice). Improved practice includes improved variety (Black lentil- (Source-Nuwakot, Pedigree- Black lentil, Origin-Nepal)) + seed priming + Recommended seed rate (30 kg/ha) + fertilizer doze (20:40:20 NPK kg/ha+ 1 kg/ha B basal doze) + mancozeb 2.5 g/l of water (3 sprays at 10 days interval during vegetative stage) with till while farmers practice includes high seed rate (60 kg/ha) in relay condition only. The observations were recorded on Percent Disease Index (PDI) and yield (kg/ha). Disease severity data was recorded using 1-9 scoring scale from 25 randomly tagged plants/plot (Morrall and Mckenzie, 1974).Similarly Percent Disease Index (PDI) was computed on the basis of recorded data according to the formula (Wheeler, 1969). The benefit cost analysis was also carried out to assess the profitability of the generated technology in farmers field.

All data were analyzed statistically using Microsoft Excel and MSTAT-C computer package program. Treatment mean was compared using Duncan's Multiple Range Test (DMRT) at 1 and 5% levels of significance.

RESULTS

Year

The grain yield was highly significant (P≤0.05) with the lentil season of different years in technology verification experiment conducted at 5 districts of Nepal. During second year of experimentation (2014-2015), the higher grain yield (735.15 kg/ha) was found with the lower percent disease index (53.47%) however disease index was not significantly different among the years of cultivation (Table 1).

Table 1. Stemphylium blight disease severity and yield of lentil in on-farm participatory technology verification experiment as affected by cropping season.

Lentil cropping seasons	Stemphylium blight (PDI)	Yield (kg/ha)
2013/14 (Y1)	54.55†	689.97
2014/15 (Y2)	53.47	735.15
F Test	NS	**
CV%	5.78	10.78

† Means of 4 replication. PDI-percent disease index, kg/ha- Kilogram per hectare. NS- not significant, ** - highly significant

Location

The stemphylium blight disease index and crop yield both were significant (P≤0.05) among 5 different locations in technology verification experiment during 2013-2015. The higher crop yield (744.37 kg/ha) with lower disease index (51.94%) was recorded in farmers field of Rautahat district followed by 52.14% percent disease index with 739.19 kg/hacrop yield at Parsa district. The lower crop yield (677.87 kg/ha) with higher disease index (56.84%) was recorded in Chitwan district (Table 2).

Table 2. Stemphylium blight disease severity and yield of lentil in on-farm participatory technology verification experiment as affected by locations during 2013-2015.

Location	Stemphylium blight (PDI)	Yield (kg/ha)
Chitwan (L1)	56.84†	677.87
Rautahat (L2)	51.94	744.37
Dang (L3)	53.39	716.69
Parsa (L4)	52.14	739.19
Banke (L5)	55.76	684.69
F Test	**	*
CV%	5.78	10.78

† Means of 4 replication. PDI-percent disease index, Kg/ha- Kilogram per hectare. *- significant, **- highly significant

Interaction effect between year and location

The stemphylium blight disease index and lentil yield both were highly significant (P≤0.05) with the interaction effect between year and locations in technology verification experiment in the farmers field of 5 districts of Nepal. The higher crop yield (811.50 kg/ha) with lower percent disease index (50.68%) was recorded in the farmers field of Rautahat district in the second year of experiment (2014-2015) followed by the farmers field of Parsa district in first year (2013-2014) of experiment i.e. 51.00% disease index with 780.75 kg/ha lentil yield. The lower crop yield (605.62 kg/ha) with higher disease index (58.99%) was recorded in the farmers field of Banke district during first year of experimentation (Table 3).

Table 3. Interaction effect between cropping season year and location on disease severity and lentil yield in on-farm technology verification experiment during 2013-2015.

Year × Location	Stemphylium blight (PDI)	Yield (kg/ha)
Y1L1	55.26 †	684.37
Y1L2	56.82	677.25
Y1L3	53.19	701.87
Y1L4	51.00	780.75
Y1L5	58.99	605.62
Y2L1	56.86	671.37
Y2L2	50.68	811.50
Y2L3	52.54	731.50
Y2L4	53.27	697.62
Y2L5	51.52	763.75
F Test	**	**
CV%	5.78	10.78

† Means of 4 replication. PDI-percent disease index, kg/ha- Kilogram per hectare. Y1- 2013/14, Y2- 2014/15, L1- Chitwan, L2-Rautahat, L3-Dang, L4- Parsa, L5- Banke. **- highly significant

Cultivation Practice

The cultivation practices had highly significant (P≤0.05) effect in reducing the disease (PDI) and increase in yield in farmer's field of Chitwan, Rautahat, Dang, Parsa, and Banke districts during 2013-2015. The lower disease index (39.14%) with higher yield (1032.30 kg/ha) was recorded in recommended improved practice while farmers field practiced with their own technology had higher disease index (68.89%) with lower crop yield (392.82 kg/ha) (Table 4).

Interaction effect between cropping season year and practice

The stemphylium blight disease index was significant (P≤0.05) with the interaction effect between lentil cropping season year and practice in technology verification experiment in the farmers field of 5 districts of Nepal. The lower percent disease index (37.77%) with the higher crop yield (1060.00 kg/ha) was recorded in farmers field following recommended practice during second year of experimentation although crop yield was not significantly different with the interaction effect between cropping seasons and cultivation practice. The higher disease index (69.18%) with lower crop yield (375.35 kg/ha) was found in the farmers field following their

own practice of cultivation during first year of experimentation (Table 5).

Table 4. Stemphylium blight disease and yield of lentil in on-farm technology verification experiment as affected by cultivation practice during 2013-2015.

Practice	Stemphylium blight (PDI)	Yield (kg/ha)
Recommended practice (P1)	39.14†	1032.30
Farmer practice (P2)	68.89	392.82
F Test	**	**
CV%	5.78	10.78

† Means of 4 replication. PDI-percent disease index, kg/ha- Kilogram per hectare. Improved practice (P1) includes improved variety (Black lentil) + seed priming + Recommended seed rate (30 kg/ha) + fertilizer doze (20:40:20 NPK kg/ha+ 1 kg/ha B basal doze) + mancozeb 2.5 g/l of water (3 sprays at 10 days interval during vegetative stage) with till while farmer practice (P2) includes only high seed rate (60kg/ha) in relay condition. **- highly significant

Table 5. Interaction effect between cropping season year and practice on disease index and lentil yield in on-farm technology verification experiment during 2013-2015

Year × Practice	Stemphylium blight (PDI)	Yield (kg/ha)
Y1P1	40.50†	1004.60
Y1P2	69.18	375.35
Y2P1	37.77	1060.00
Y2P2	68.60	410.30
F Test	*	NS
CV%	5.78	10.78

† Means of 4 replication. PDI-percent disease index, kg/ha-Kilogram per hectare. Y1- 2013/14, Y2- 2014/15, Improved practice (P1) includes improved variety (Black lentil) + seed priming + Recommended seed rate (30 kg/ha) + fertilizer doze (20:40:20 NPK kg/ha+ 1 kg/haB basal doze) + mancozeb 2.5 g/l of water (3 sprays at 10 days interval during vegetative stage) with till while farmer practice (P2) includes only high seed rate (60kg/ha) in relay condition. *- significant, NS- not significant

Interaction effect between location and practice

The crop yield and disease index both were significant ($P \leq 0.05$) with the interaction effect between location and cultivation practice in on-farm technology verification experiment during 2013-2015. The higher crop yield (1066.87 kg/ha) with lower disease index (35.79%) was recorded in the farmers field of Rautahat district who followed recommended practice followed by Dang district with recommended practice i.e. 36.96% disease index and lentil yield (1061.86 kg/ha). The lower crop yield (322.50 kg/ha) with higher disease index (71.85%) was recorded in the farmers field of Banke district following their own cultivation practice (Table 6).

Table 6. Interaction effect between location and practice on disease severity and lentil yield in on-farm technology verification experiment during 2013-2015.

Location × Practice	Stemphylium blight (PDI)	Yield (kg/ha)
L1P1	43.25[†]	937.50
L1P2	68.49	418.25
L2P1	35.79	1066.87
L2P2	66.91	421.85
L3P1	36.96	1061.86
L3P2	70.44	371.50
L4P1	39.67	1048.37
L4P2	66.77	430.00
L5P1	40.01	1046.84
L5P2	71.85	322.50
F Test	*	**
CV%	5.78	10.78

[†] Means of 4 replication. PDI-percent disease index, Kg/ha- Kilogram per hectare. L1- Chitwan, L2- Rautahat, L3-Dang, L4-Parsa, L5- Banke. Improved practice (P1) includes improved variety (Black lentil) + seed priming + Recommended seed rate (30 kg/ha) + fertilizer doze (20:40:20 NPK Kg/ha+ 1 kg/haB basal doze) + mancozeb 2.5 g/l of water (3 sprays at 10 days interval during vegetative stage) with till while farmer practice (P2) includes only high seed rate (60kg/ha) in relay condition. *- significant, **- highly significant

Interaction effect among cropping year, location and cultivation practice

The higher crop yield (1142.50 kg/ha) with lower disease index (34.95%) was recorded in the farmers field of Banke district following recommended practice during second year of experimentation although both variables were not significant with the interaction effect among year, location and cultivation practice in technology verification experiment.

The higher disease index (73.57%) with lower crop yield (260.00 kg/ha) was observed in farmers field of Banke district who followed their own practice of cultivation (P1) during first year of experimentation. (Table7).

Relationship between disease index and crop yield

A linear negative correlation between yield and PDI was observed during 2013-2015. The lentil yield was found significantly negative correlation (r = -0.99) with the percent disease index of stemphylium blight in technology verification experiment conducted at farmers field of 5 districts. The equation Y= -21.44X + 1870 and R^2 = 0.99 gave the best fit (Figure 1).

The estimated regression line indicated that the unit rise in the PDI of stemphylium blight disease in farmers field of 5 districts followed recommended and their own cultivation practice during two years of experimentation (within 1-9 scale), there existed possibilities of yield reduction by 21.44 kg/ha.

Table 7: Interaction effect between cropping year, location and practice on disease severity and lentil yield in on-farm technology verification experiment during 2013-2015.

Year ×Location × Practice	Stemphylium blight (PDI)	Yield (kg/ha)
Y1L1P1	43.45[†]	942.50
Y1L1P2	66.47	426.25
Y1L2P1	43.25	998.75
Y1L2P2	70.47	355.75
Y1L3P1	35.70	1068.75
Y1L3P2	70.85	335.00
Y1L4P1	35.87	1061.75
Y1L4P2	65.85	499.75
Y1L5P1	43.25	951.25
Y1L5P2	73.57	260.00
Y2L1P1	44.40	932.25
Y2L1P2	67.07	410.25
Y2L2P1	35.52	1135.00
Y2L2P2	66.12	488.00
Y2L3P1	36.57	1055.00
Y2L3P2	67.97	408.00
Y2L4P1	38.40	1035.00
Y2L4P2	70.40	360.25
Y2L5P1	34.95	1142.50
Y2L5P2	70.12	385.00
F Test	1.17	0.96
CV%	5.78	10.78

[†] Means of 4 replication. PDI-percent disease index, Kg/ha- Kilogram per hectare. Y1- 2013/14, Y2- 2014/15, L1- Chitwan, L2- Rautahat, L3-Dang, L4- Parsa, L5- Banke. Improved practice (P1) includes improved variety (Black lentil) + seed priming + Recommended seed rate (30 kg/ha) + fertilizer doze (20:40:20 NPK Kg/ha + 1 kg/ha B basal doze) + mancozeb 2.5 g/l of water (3 sprays at 10 days interval during vegetative stage) with till while farmer practice (P2) includes only high seed rate (60kg/ha) in relay condition. NS- not significant

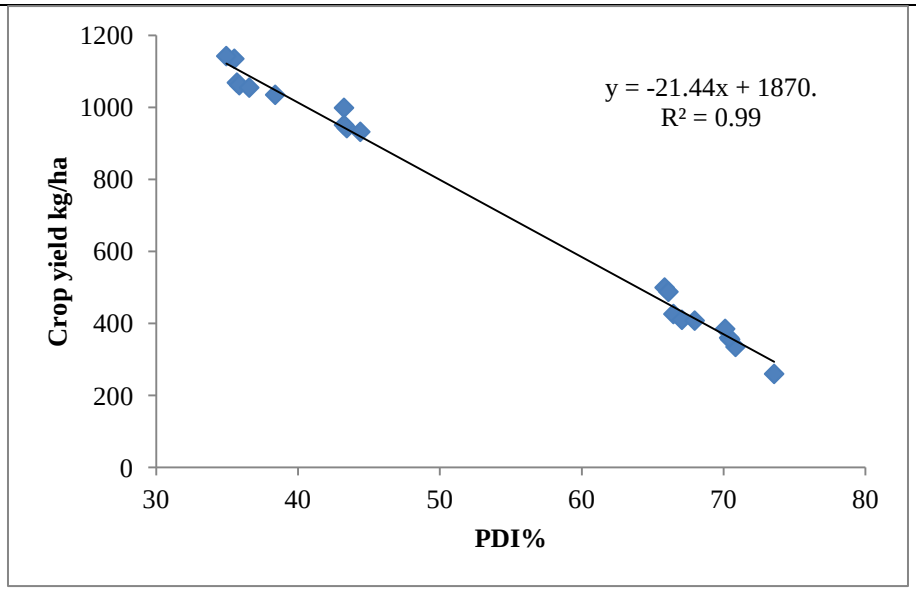

Figure 1. Relationship between PDI and crop yield in on-farm technology verification experiment at five lentil growing districts during 2013-2015

Benefit-cost analysis

The benefit cost analysis of lentil production at farmer's field of Chitwan, Rautahat, Dang, Parsa and Banke districts from on-farm technology verification experiment during 2013-2015 is presented in Table 8.

The cost of cultivation included all variable cost items such as human labour, power tiller, seed, manure, fertilizer, fungicides, insecticides etc. The average cost of cultivation of the farmers who followed improved technologies were NRS 36250 per hectare compared to NRS 18000 per hectare with traditional practices. With the cultivation of improved varieties along with the recommended practices lentil production was reached up to 1032 kg/ha compared to 393 kg/ha who followed farmers practice of cultivation.

The higher benefit cost ratio of 2.42 was found from the farmers field following recommended practice of cultivation while those farmers who followed their own cultivation practice (with higher seed rate) only had the benefit cost ratio of 0.97 (Table 8)

Table 8. Benefit-cost analysis of lentil production by farmers (in ha)

Cultivation Practice		Particulars	Unit	Quantity	Rate (NRs)	Total (NRs)
Recommended Practice						
Cost of cultivation						
	1	Foundation seed	kg/ha	30.00	130.00	3900.00
	2	Tractor ploughing cost	Min/ha	300.00	20.00	6000.00
	3	Di-ammonium phosphate (DAP)	kg/ha	90.00	60.00	5400.00
	4	Potash	kg/ha	30.00	40.00	1200.00
	5	Borax	kg/ha	1.00	150.00	150.00
	3	Mancozeb (DM-45) 3 spray	kg/ha	4.50	800.00	3600.00
	4	Rogor 2 spray	l/ha	1.00	1000.0	1000.00
	5	Labor cost	No/ha	50.00	300.00	15000.00
		Total				36250.00
Production (Yield)						
		Yield	kg/ha	1032.0	120.00	123840.0
		Benefit				87590.00
		Benefit/cost ratio				2.42
Farmer practice						
Cost of cultivation						
	1	Local Seed	kg/ha	60.00	100.00	60000.00
	2	Labor cost	No./ha	40.00	300.00	120000.0
		Total				180000.0
Production (Yield)						
		Yield	kg/ha	393.00	90.00	353700.0
		Benefit				17370.00
		Benefit/cost ratio				0.97

DISCUSSION

Technology demonstration and dissemination were the key factors to success in improving lentil production and productivity in Bangladesh (Afzal *et al.*, 1999). Along with disease resistant varieties, appropriate production technologies, including optimum planting time, seed rate, profitable seeding ratio in inter and mixed cropping, weed control, seed priming, relay cropping, diseases management, etc., have been developed, recommended, and delivered to the farmers through extension services. Sarker *et al.* (2004) also reported that to popularize the new technologies, the Government of Bangladesh has launched a technology transfer mission called the Lentil, Blackgram and Mungbean Development Pilot Project (LBMDPP) from its own resources in the 1996/97 cropping season.

Afzal *et al.* (1999) also reported that with the cultivation of improved varieties and adoption of appropriate production technologies, lentil production in Bangladesh have raised 28,000 ton per year. According to Neupane *et al.* (2013), poor access to improved seeds, technical knowledge and services among farmers lentil production sector was not developed so much in Nepal. Although Nepal Agricultural Research Council (NARC) has recommended improved varieties along with production technologies of lentil, the adoption at farmers field has been low due to which the average yield was far below than its attainable yield.

CONCLUSION

From the technology verification study, the higher crop yield (1142.50 kg/ha) with lower disease index (34.95%) were recorded in the farmers field of Sohanpur (Banke) following recommended practice during second year of experimentation while farmers field from same district were recorded higher disease index (73.57%) with lower crop yield (260.00 kg/ha) following their own practice of cultivation during first year of experimentation

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Author Contributions

S.S. designed and performed experiments, analysed data and wrote the paper; S. N. helped during conducting the experiments and recording observations.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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