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Yield gap analysis of rapeseed-mustard in context of *Lipaphis erysimi* (Kalt)

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Abstract

Rapeseed-Mustard is an important *Rabi* season oilseed and vegetable crop of the Punjab state. The present study was carried out to know the yield gap between recommended practices and farmer's practices of rapeseed-mustard crop. Therefore, efforts have been made through frontline demonstrations (FLD) on insect-pest management to demonstrate improved plant protection technologies to increase productivity of rapeseed-mustard crop in the district. Fifty frontline demonstrations were conducted on rapeseed-mustard covering an area of 20 hectares and the latest mustard aphid, *Lipaphis erysimi* management technologies were exhibited. Farmers were randomly selected from adopted villages for conducting frontline demonstration. The average percent increase in yield of rapeseed-mustard under the demonstration fields over farmer's practices were recorded as 8.11 per cent. Improved insect-pest management practices in rapeseed-mustard Var. GSC-7 gave the highest yield 21.35 q/ha and 21.48 q/ha as compared to the farmers' practice through the average yield was recorded as 19.29 q/ha and 19.75 q/ha in the year 2017 and 2018, respectively. The mean technology gap, extension gap and technology index were found 0.84 q/ha, 1.89 q/ha and 3.75 percent, respectively. The improved plant protection technologies gave higher mean net return of ₹67537 per hectare with a benefit cost ratio 5.85 as compared to farmers practice having the mean net return of ₹ 60980 per hectare with a benefit cost ratio 5.48. The study on the efficacy of new insecticide Thiamethoxam 25 WG @100 gm per hectare against mustard aphid, *Lipaphis erysimi* revealed that 7 days after spray gave maximum mortality of this pest (88.98% and 90.77%) as compared to Dimethoate 30 EC @ 1.0 ltr gave (78.33% and 77.77%) mortality during the year 2017 and 2018, respectively.

Keywords: Rapeseed-mustard, *Lipaphis erysimi*, frontline demonstration, net-return, yield

Introduction

Rapeseed-mustard is the third essential edible oilseed crop of the world after soybean and palm oil. It is mainly cultivated in the tropical and subtropical areas of the world (Panday *et al*., 1999; Balai *et al*., 2012; Choudhary *et al*., 2014) [15, 4, 5]. Major countries that produce mustard are China, Canada, India, Pakistan, Poland, Bangladesh, Sweden and France. India is the third largest rapeseed-mustard producer in the world and the fourth foremost mustard consuming Nation (Verma *et al*., 2012) [27]. In India it is grown on the 35 per cent area of the total cultivated area of the world with a 16 per cent share in production (Darekar and Reddy, 2018) [8]. In Punjab, rapeseed-mustard is grown on an area of 31 thousand hectares with the production of 38.7 thousand tonnes (Anonymous, 2018) [1]. A new variety of rapeseed-mustard (Canola GSC-7) has been released for cultivation under irrigated conditions in the Punjab. The average edible oil content of this variety is 40.5 per cent which is used as a cooking medium. With the increase in health awareness, urbanization and per-capita consumption, the demand for canola oil is also increasing steadily. India has imported 0.37 million tonnes of canola oil at the cost of about 326 millions dollars to meet burgeoning requirements during year 2016-2017. Canola oil from variety GSC-7 is good for health because it possesses 62.2 percent oleic acid (MUFA), 30.2 percent PUFA and only 0.5 percent erucic acid (Sandhu and Kaur, 2018) [18].

Frontline Demonstration is the new concept of demonstration evolved by the Indian Council of Agricultural Research, New Delhi with the inception of the Technology Mission on Oilseed Crops during mid eighties (Ghintala *et al*., 2018) [10]. Frontline demonstration is one of the most powerful tools of extension because farmers, in general, are driven by the perception that '*Seeing is believing'* (Sharma *et al*., 2011) [19].The main objective of FLD is to demonstrate newly released crop production and protection technologies at the farmers' field under different agro-climatic conditions and farming situations (Chaudhary *et al*., 2018) [6]. The available agricultural technology does not serve its purpose till it reaches and adopted by its ultimate user, the farmer. The production and productivity of the rapeseed-mustard are not adequate in the district due to use of poor quality of seeds, infestation of diseases and attack of insect-pests from sowing to harvesting. Amongst, the insect-pests mustard aphid, *L. erysimi* is considered as limiting factors in the successful cultivation of rapeseed-mustard. The colonies of mustard aphid feed on the new shoots, inflorescence and underside of leaves which cause loss in yield up to 75-91.3 per cent (Kumar *et al*., 2011; Singh and Sachan, 1994; Sharma and Kashyap, 1998) [12, 22, 20] and 15 per cent in oil content (Verma and Singh, 1987) [28]. Therefore, it is necessary to demonstrate improved insect-pest management technologies to the farmers which are not adopted by them. Taking into the consideration, frontline demonstrations on management of aphid in rapeseed-mustard were conducted.

Materials and Methods

The present study was conducted with aim to assess the affect of pest management practices on production of rapeseed-mustard. Frontline demonstrations on rapeseed-mustard (Var. GSC- 7) were conducted by Krishi Vigyan Kendra, Barnala on farmer's field at five different locations during Rabi season 2017-18 and 2018-19. For conducting frontline demonstration farmers were selected from adopted villages following the bench mark survey. Prior to conducting FLD's a training programme on production and protection technologies of rapeseed-mustard crop were also organized. The sowing was done during end of October under assured irrigated conditions. Seeds were sown in rows 45 cm apart with plant to plant distance of 10 cm by drill. Frontline demonstrations were conducted at fields of 50 farmers in the area of 20 hectare each. In demonstration quality seeds of improved variety and insect-pest management techniques were demonstrated on the farmer's field through frontline demonstration at different locations. The farmer's practices were maintained in case of local checks. Regular visits to the FLD's field by the KVK scientists for ensuring proper guidance to the farmers were done.

For the management of mustard aphid, *L. erysimi*, foliar spray of Thiamethoxam 25 WG @ 100 gm/ ha was given with the help of a knapsack sprayer at Economic threshold level (ETL) of 50 aphids/10 cm terminal portion of the central shoot. The population of mustard aphid was recorded from10 cm top portion of the terminal shoot of 10 randomly selected and tagged plants from each field. Pre-treatment counts of the aphids were made 24 hours prior to insecticide application while post-treatment counts were made at 1, 3, 7 and 10 days after the spraying. Per cent aphid mortality at each interval after spray was calculated. The data were subjected to analysis of variance for interpretation of results. The data output were collected from both FLD's fields as well as farmer's practices and cost of cultivation, net income and benefit cost ratio were also worked out (Samui *et al*., 2000) [17]. The technology gap, extension gap and technological index were also calculated by using following formula as given below

Technology gap = Potential yield - Demonstrated yield

Extension gap = Demonstrated yield - Yield under existing practice

$$\text{Technology index} = \frac{\text{Potential yield - Demonstrated yield}}{\text{Potential yield}} \times 100$$

$$\text{Corrected Mortality} = \left[1 - \frac{\text{n in Co before treatment*n in T after treatment}}{\text{n in Co after treatment*n in T before treatment}}\right] \times 100$$

Where; n= Insect population, T= Treatment, Co= Control

Results and Discussion

A Comparison of productivity levels between frontline demonstration and farmer's practices is shown in Table 1.Technologies undertaken in frontline demonstration (FLD's) plots and practices adopted by farmers, revealed that farmers were not adopted all improved plant protection practices in rapeseed-mustard crop as oil seed crops are considered marginal crop by the farmers. The grain yield of rapeseed-mustard under frontline demonstration varied from 21.35 q/ha to 21.48 q/ha, however in farmer's practice grain yield varied from 19.29 q/ha to 19.75 q/ha. In frontline demonstration fields mean higher grain yield 21.42 q/ha was recorded as compared to farmer practices (19.52 q/ha) (Table 1). In frontline demonstration fields there was increase in grain yield of rapeseed-mustard 10.68 and 8.76 percent during the year 2017 and 2018, respectively as compared to farmer's practices. The present results collaborated with finding of Surywaanshi and Prakash (1993) [24] and Matharu and Tanwar (2018 a) [13] who also reported that increase in grain yield of rapeseed-mustard under frontline demonstration fields. The superior grain yield of rapeseed-mustard crop obtained under frontline demonstration was due to the use of improved variety insect-pest management technologies. Similarly, Singh (2015) [23] and Dhaka *et al*., (2010) [9] also reported that use of recommended practices in different crop cultivation improve grain yield.

Technology gap, extension gap and Technology index

The technology gap ranged from 0.90 q/ha and 0.77 q/ha during the study period. The average technology gap was observed 0.84 q/ha. There exists a gap between the potential yield and demonstration yield. This may be due the poor soil health of south west district of Punjab. The extension gap varied from2.06 q/ha to 1.73q/ha during the period of study. The average extension gap was observed 1.89q/ha. Technology index varied from 4.04 to 3.46 and showed the feasibility of evolved technology at the farmer's field. The lower is the value of technology index, the more is the feasibility of technology demonstrated was also reported by Matharu and Tanwar (2018 b) [14].

Economics of frontline demonstration

The cost of cultivation, gross return, net return, cost benefit ratio and additional return presented in Table 2, revealed that the cost of cultivation varied from ₹ 13625 to ₹ 14107 per hectare with mean value of ₹ 13866per ha under frontline demonstration, however under farmer's practices cost of cultivation varied from ₹ 13110 to ₹ 13916 per hectare with mean value of ₹ 13513per ha. The highest net return was obtained under frontline demonstration ₹58965 and ₹ 76109 per ha as compared to ₹ 52476and ₹ 69304per ha under farmers practices during the year 2017 and 2018, respectively. The average benefit cost ratio of recommended practices was higher (5.85) then farmers practice (5.48). Higher average additional return was obtained frontline demonstration (₹ 6647) due to adoption of improved plant protection technologies. These results collaborate with the studies of Sharma and Sharma (2004) [21] and Ghintala *et al*., (2018) [10] who also reported that additional return was increased under frontline demonstration plots. Similarly, increase in grain yield of rapeseed-mustard under recommended practices also have been reported by Kumar *et al*., (2007) [11].

Insect-Pest Incidence

Mustard aphid, *L. erymisi* is a major pest which causes significant yield reduction in mustard. Adult and nymph of aphid varied from 65.50 to 79.60 aphids / 10 cm terminal shoot before spray (2017-18). Under both the treatments population of aphid decreased significantly than untreated check even after 10th day of spraying. After the application of newly recommended insecticide Thiamethoxam 25 WG @ 100 gm per hectare in frontline demonstration fields maximum aphid population reduction (88.98% and 90.77%) after 7 DAS was observed, however, in farmers practice's spray of Dimethoate 30 EC @ 1.0 ltr per hectare leads to less reduction of aphid population (78.33% and 77.77%) during the 2017 and 2018 year, respectively (Table 3). In frontline demonstration fields significantly higher mean aphid population reduction (87.01 and 87.86%) was observed as compared to farmer's practices (72.33 and 71.60%) during the year 2017 and 2018, respectively. The effectiveness of the afore said insecticides in aphid control is in close conformity with the findings of Bakhetia *et al*., (1986) [3], Arora and Sidhu (1991) [2], Upadhyay and Agarwal (1993) [25], Vekeria and Patel (2000) [26], Rohilla *et al*. (2004) [16] and Choudhury and Pal (2005) [7].

Table 1: Grain yield and gap analysis of frontline demonstration on Rapeseed-Mustard

Year	Area (ha)	No. of farmer	Yield Q/ha			Percent increase over farmer's practices	Technology gap (Q/ha)	Extension gap (Q/ha)	Technology index (%)
			Potential	Demonstrated fields	Farmer practices				
2017-18	10	25	22.25	21.35	19.29	10.68	0.90	2.06	4.04
2018-19	10	25	22.25	21.48	19.75	8.76	0.77	1.73	3.46
Average			22.25	21.42	19.52	9.72	0.84	1.89	3.75

Q=Quintal, ha=Hectare

Table 2: Economics analysis of demonstrated fields and farmer practices

Year	Average cost of cultivation (₹ /ha)		Average gross return (₹/ha)		Average net return (₹ /ha)		B:C ratio		Additional return
	Demonstrated fields	Farmer's practices	Demonstrated fields	Farmer's practices	Demonstrated fields	Farmer's practices	Demonstrated fields	Farmer's practices	₹ /ha
2017-18	13625	13110	72590	65586	58965	52476	5.32	5.00	6489
2018-19	14107	13916	90216	82950	76109	69304	6.39	5.96	6805
Average	13,866	13,513	81,403	74,268	67537	60,890	5.85	5.48	6647

B: C ratio=Cost benefit ratio, ha=Hectare

Table 3: Effectiveness of insecticides against aphid, *Lipaphis erysimi* in mustard crop.

S. No	Year	Treatment	Pre count 1 DBS	Per cent reduction in aphid population over untreated check (%)			Mean reduction in aphid population (%)
				3DAS	7DAS	10DAS	
1	2017-18	Thiamethoxam 25 WG @ 100 gm/ha (New recommended technology)	79.60	87.41	88.98	84.64	87.01
		Dimethoate 30 EC @ 1.0 ltr/ha (Farmer's Practices)	66.30	73.10	78.33	65.57	72.33
		Mean		80.25	83.66	75.11	
		Untreated Check	65.50	125.20	105.40	129.60	
		CD (P=0.05): Treatment (A)= 1.45; Days after spray (B)= 1.77					
2	2018-19	Thiamethoxam 25 WG @ 100 gm/ha (New Recommended technology)	66.70	88.58	90.77	84.23	87.86
		Dimethoate 30 EC @ 1.0 ltr/ha (Farmer's Practices)	63.20	74.36	77.77	62.67	71.60
		Mean		81.47	84.27	73.45	
		Untreated Check	70.40	130.20	115.30	128.70	
		CD (P=0.05): Treatment (A)= 0.83; Days after spray (B)= 1.01					

DBS=Days before spray; DAS= Days after spray

Conclusion

The present findings concluded that the production of oilseed crops can be increased by adopting the new plant protection recommended technologies by the farmer. Thus conductance of frontline demonstration is an effective tool for increasing the productivity of Rapeseed-Mustard crop in the district. This may substantially increase the income as well as the livelihood of the farming community and also helps to create greater curiosity and motivation among other farmers who do not adopt improved practices of Rapeseed-Mustard cultivation. Therefore, there is dire need to educate farmers for the adoption of improved plant protection technology so as to reduce the extension gaps through various technology transfer centers.

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