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Original Research Article

Response of Linseed Bud Fly, *Dasyneura lini* on Linseed, *Linum usitatissimum* L. Based Intercropping System

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A B S T R A C T

A field experiment was conducted at research cum instructional farm, Raipur (Chhattisgarh) during three consecutive *rabi* season of 2015, 2016 and 2017 with an objective to find out appropriate row combination of linseed and intercrop for bud fly management. There were ten treatments consisting of six intercropping systems *viz*., linseed with gram, field pea, and lentil in 4:1 and 4:2 row ratio in additive series and five sole crops of the component crops involved in intercropping systems. The experiment was laid out in RBD with a plot size of 4 x 5m replicated thrice. The performance of various intercrops tested with linseed crop excelled either in 4:1 or 4:2 row ratios compared to their sole cropping except sole Bengal gram. The pooled results of three years revealed that, linseed + gram (4:2) noticed considerably higher equivalent yield (1889.40 kg/ha) followed by linseed + gram in 4:1 row ratios (1684.23 kg/ha) while, gram (sole) also showed better performance then Linseed + Lentil and Linseed + Field pea at 4:2 ratios (1628.13 and 1500.50 kg/ha, respectively) compared with rest of the intercropping systems. Similarly, among intercropping systems linseed + gram in 4:2 and 4:1 row ratio was more remunerative over linseed (sole). Further, intercropping of linseed + sorghum in 4:2 and 2:1 row ratio recorded significantly higher Land Equivalent Ratio (LER) of 1.30 and 1.29, respectively followed by linseed + Bengal gram in 4:2 and 2:1 row ratio (1.21 and 1.20, respectively).

Keywords

Linseed, Linseed bud fly, Linseed equivalent yield

Introduction

Linseed, botanically known as *Linum usitatissimum* L. has been under cultivation since prehistoric times. Linseed is one of the most important industrial crops of India and stands next to rapeseed mustard in *rabi* oilseeds in area and production. This important crop occupies an area of 26.25 lakh hectare yielding 26.54 lakh tones with an average productivity of 1011 kg per hectare in the world. In our country the crop occupied 2.84 lakh hectare with a production of 1.41 lakh tones culminating in low productivity of 496 kg per hectare in coming growing Nations. India contributes about 10.81% and 5.31% to world area and production. The major linseed growing state of country are Madhya Pradesh Chhattisgarh Uttar Pradesh Maharashtra Bihar Orissa Jharkhand West Bengal Nagaland and Assam according for about 97% of total area of nation. its continued cultivation on marginal and sub marginal soil under input starved condition being the major factor leading to low production of crops however the area under crop in the country is reducing having the socio-economic

interdisciplinary attachment of the crop (Anonymous, 2017). Linseed (*Linum usitatissimum* Linn.) is cultivated in area of 525.50 thousand hectares in India with average productivity of 4.03 q/ha (Anonymous, 2005). Linseed crop is infested and damaged by more than 8 insect pests. Among these insect pest, linseed budfly (*Dasyneura lini* L.) has been rated the most destructive pest of the flower buds (Anonymous, 2005).

In present agriculture scenario, diversification and intensification of crop and their combination and sequence both in space and time with new adoptable and remunerative crops and their species has become absolutely necessary as the present food base has been narrowed down coupled with effect of climate change making it prone to frequent crop failures. The high input based agriculture in present situation is showing signs of stress, and long term cereal based or nutrients exhaustive crops are putting a question mark on long term sustainability especially under dry land situations. As practiced from earlier days, intercropping is a useful proposition for increasing the productivity and income per unit area/time in agriculture besides enhancing the water and land use efficiency under rainfed conditions. Intercropping is also reduces the pest incidence. Hence, linseed intercropped with other *rabi* crop in different row combination to evaluate the response of linseed bud fly in this crop diversity under rainfed conditions.

Materials and Methods

Experiments were conducted in research cum instructional farm, IGKV, Raipur, Chhattisgarh, India. In this region, cropping is limited to a single rain–fed crop per year, grown in the southwest monsoon season from June-September. The soils were shallow sandy loams with low water holding capacity and poor soil fertility. The fields were located on nearly level land (< 2% slope). The experiment was laid out in randomized block design (RBD) with 10 treatments (six linseed–based intercropping systems with four sole crop of chickpea, field pea, lentil and linseed monocrop).

Intercropping systems that have been found to be effective along with some other systems, both popular and/or suggested by the farmers were included. Intercrops were sown in between rows of linseed in an additive manner to keep the population of linseed plants constant across the six cropping systems. All other intercrops were sown in two rows 25 cm apart from each other and 30 cm away from linseed rows on either side. Routine agronomic practices such as application of recommended doses of fertilizers to linseed, intercrops, and interculture were taken up at appropriate growth stages of the crops.

No pest control measures were undertaken during the entire crop growth period. Weekly insect counts were recorded from 10 randomly labeled linseed plants in each plot at weekly intervals. Sampling and recording of the population was done from the different plants of the respective plots at weekly intervals. Three terminals per plant were selected for recording the absolute population.

Field observations of insect pest and predator populations were recorded during the cool hours of the day (07:00-09:30 and 16:00-18:00). The abundance of insect pests and predators was determined for each system at weekly intervals in three consecutive 2014-15, 2015-16 and 2016-17. The data recorded on damage caused by *D. lini* L. across intercropping systems and monocrop.

Results and Discussion

The experiment was conducted in Randomized Block Design with ten treatments replicated thrice. Chickpea, dwarf field pea and lentil varieties recommended for the region were intercropped with linseed in 4:1 and 4:2 row arrangements. But fly infestation at dough stage of linseed was recorded replication- wise and seed yield at harvest. Linseed equivalent yield (LEY) was calculated on the basic of yield of main as well as intercrops considering the market rates.

Linseed bud fly infestation

The incidence of linseed bud fly was observed during consecutive three *rabi* season *viz.* 2014-15, 2015-16 and 2016-17. Ten plants selected randomly were observed for the presence of insect pests at weekly interval and are presented in Table 1 and Figure 1. It remained active throughout the cropping period on linseed.

The activity of bud fly increased gradually after first appearances and damage caused during flowering to bud formation. When gram, lentil, field pea, intercropped with linseed give you an idea about different combinations effect on infestation of bud fly. Bud fly infestation varied between 11.5-14.5 % in different intercropping treatment against the maximum of 25.30% bud infestation on sole linseed in 2014-15, and next year bud fly infestation varied between 12.1-16.5% in different intercropping treatment against the maximum of 28.70% bud infestation on sole linseed (Table 5.4.1). Similarly, in third consecutive year bud fly infestation varied between 11.5-15.7% in different intercropping treatment against the maximum of 28.40% bud infestation on sole linseed. The bud fly infestation (BFI) varies from 11.70 to 27.47%. Ratio combination of linseed + gram (4:2) and linseed + gram (4:1) showed 11.70 and 12.53% bud fly infestation. While linseed +field pea (4:2) and linseed + lentil (4:2) found 13.37 and 14.10% BFI comparatively less infestation among other Linseed + Field pea, Linseed + Lentil and its sole crop *viz.*, 14.60, 15.57 and 27.47% BFI.

Performance of sole and intercrops

Intercropping of linseed + gram (4:2) proved the best treatment harboring lowest bud fly infestation of 11.5% with maximum Linseed equivalent yield (LEY) of 2057.5 Kg /ha (table 2 and figure 2) followed by linseed + gram (4:1) and linseed + field pea (4:2) showing 11.8% and 12.3% bud infestation with 1566.7 and 1375.5 kg/ha LEY, respectively in 2014-15 and next year also intercropping of linseed + gram (4:2) proved the best treatment harboring lowest bud fly infestation of 12.1% with maximum Linseed equivalent yield (LEY) of 1506.7 Kg /ha followed by linseed + gram (4:1) and linseed + field pea (4:2) showing 12.3% and 14% bud infestation with 1453 and 1217 kg/ha LEY, respectively. Likewise, in 2016-17 intercropping of linseed + gram (4:2) proved the best treatment harboring lowest bud fly infestation of 11.5% with maximum Linseed equivalent yield (LEY) of 2104 Kg /ha followed by linseed + lentil (4:2) and linseed + gram (4:1) showing 12.9% and 13.5% bud infestation with 1970 and 2033 kg/ha LEY, respectively. Overall response of linseed with intercrop revealed that linseed + gram (4:2) proved best among the other treatment.

Linseed equivalent yield

The data presented in Table 2 revealed that during 2015 significantly higher linseed equivalent yield of 2057.5 kg/ha was obtained with linseed + gram in 4:2 row ratio, while during 2016 and 2017 as well as on pooled basis 1506.7, 2104 and 1889.40 kg/ha, respectively.

Table.1 Effect of intercropping on bud fly infestation in linseed

Sr. no.	Treatment	Bud Fly Infestation (BFI) %			
		2014-15	2015-16	2016-17	pooled data
1	T_1 Linseed + Gram (4:1)	11.8 (20.1)	12.3 (20.5)	13.5 (21.3)	12.53
2	T_2 Linseed + Gram (4:2)	11.5 (19.8)	12.1 (20.4)	11.5 (19.4)	11.70
3	T_3 Linseed + Field pea (4:1)	14.3 (22.2)	14.8 (22.6)	14.7 (22.0)	14.60
4	T_4 Linseed + Field pea (4:2)	12.3 (20.5)	14.0 (22.0)	13.8 (21.2)	13.37
5	T_5 Linseed + Lentil (4:1)	14.5 (22.4)	16.5 (24.0)	15.7 (22.7)	15.57
6	T_6 Linseed + Lentil (4:2)	13.9 (21.9)	15.5 (23.2)	12.9 (20.4)	14.10
7	T_7 Linseed	25.3 (30.1)	28.7 (32.4)	28.4 (30.5)	27.47
8	T_8 Gram	-	-	-	-
9	T_9 Field pea	-	-	-	-
10	T_{10} Lentil	-	-	-	-
	SE (m) ±	**0.36**	**0.50**	**0.38**	
	CD	**1.56****	**2.1****	**1.20**	

NB: figures in parenthesis are angular transformed values. BFI- Bud Fly Infestation

Table.2 Linseed equivalent yield (LEY) of linseed based intercropping system

Sr. No.	Treatment	Linseed equivalent yield (LEY) (Kg/ha)				Yield more than linseed (sole)
		2014-15	2015-16	2016-17	pooled data	
1	T_1 Linseed + Gram (4:1)	1566.7	1453	2033	1684.23	396.73
2	T_2 Linseed + Gram (4:2)	2057.5	1506.7	2104	1889.40	601.90
3	T_3 Linseed + Field pea (4:1)	1445	1111	1820	1458.67	171.17
4	T_4 Linseed + Field pea (4:2)	1375.5	1217	1909	1500.50	213.00
5	T_5 Linseed + Lentil (4:1)	1412	1296.7	1735	1481.23	193.73
6	T_6 Linseed + Lentil (4:2)	1554.7	1359.7	1970	1628.13	340.63
7	T_7 Linseed	970.8	1366.7	1525	1287.50	-
8	T_8 Gram	1408.3	1619.3	2000	1675.87	388.37
9	T_9 Field pea	872.4	1220.3	1412	1168.23	-
10	T_{10} Lentil	1373.4	1405.3	1622	1466.90	179.40
	SE (m) ±	**72.8**	**83.9**	**57.68**		
	CD	**296.5****	**249.3***	**177.74***		

NB: figures in parenthesis are angular transformed values. LEY- Linseed equivalent yield

Fig.1 Comparative linseed bud fly infestation of three consecutive year

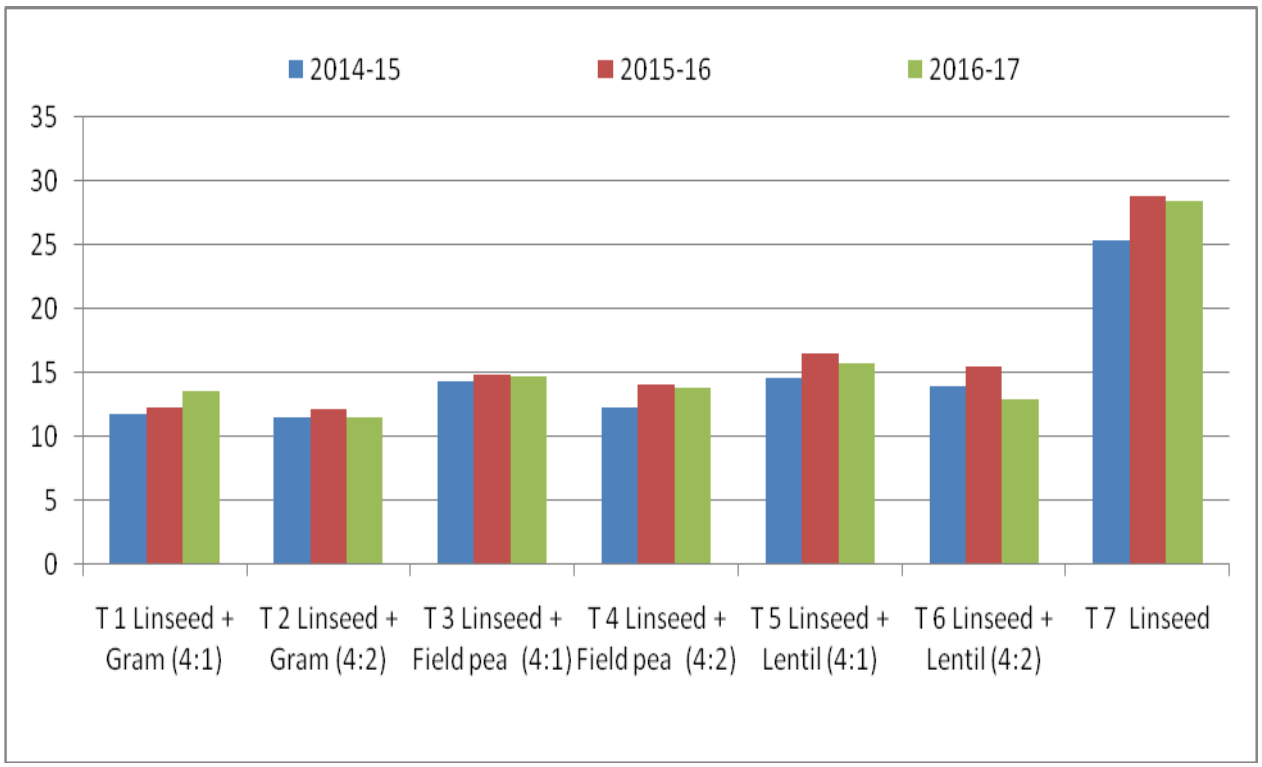


Fig.2 Comparative linseed equivalent yield of three consecutive year

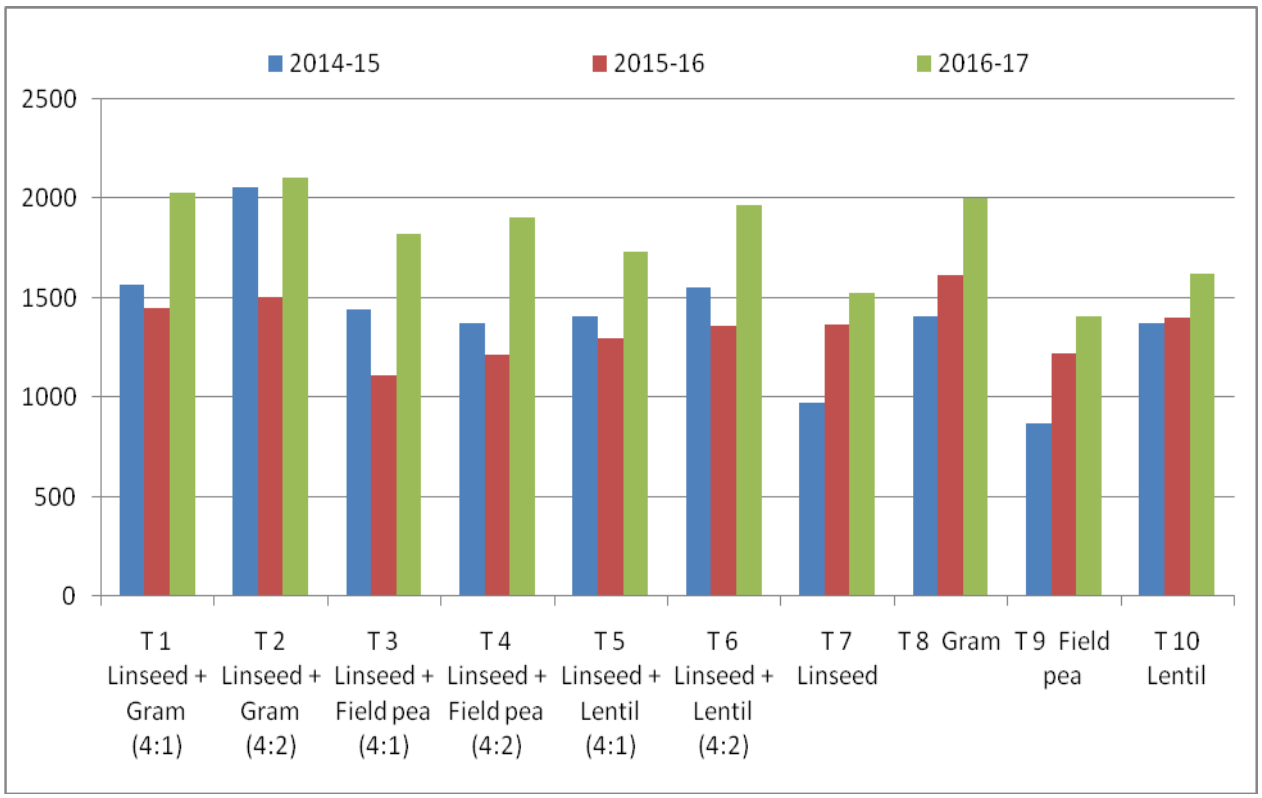
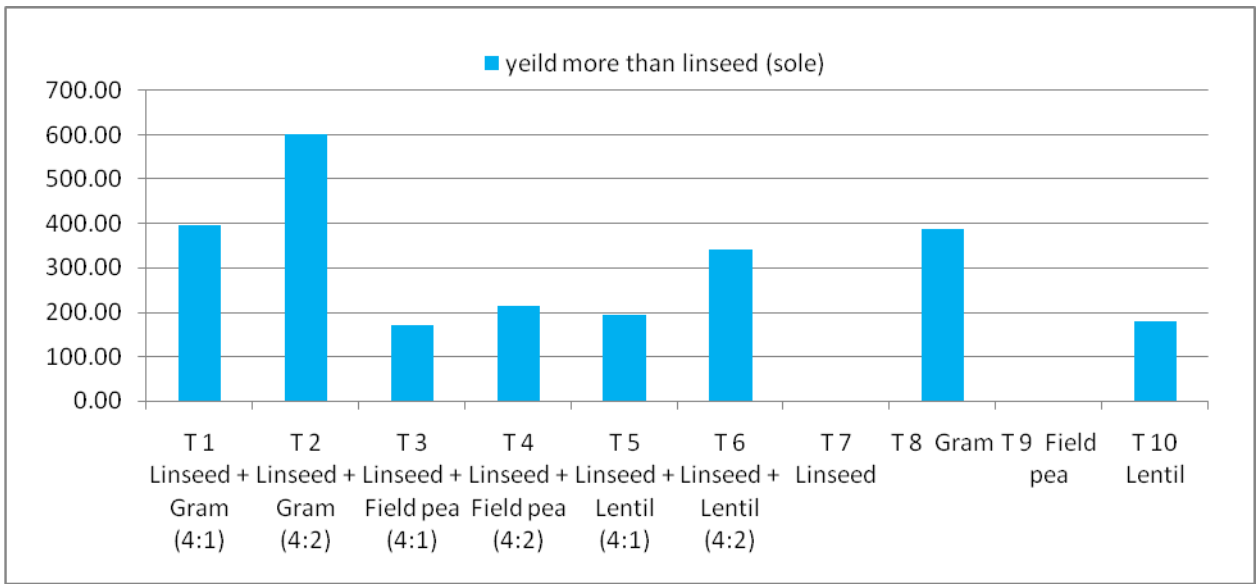


Fig.3 Comparative yield benefits from linseed (sole)



During 2015 and 2016, the intercropping systems involving in 4:1 or 4:2 row ratio, linseed + gram in 4:2 row ratio differed considerably and were on par with each other (Table 2). During 2017, linseed + gram in 4:2 row ratio recorded considerably higher linseed equivalent yield of 2104 kg/ha and similar trend was observed at 4:1 row ratio (2033 kg/ha). Three years pooled data presented in Table 2 indicated that linseed equivalent yield of 1889.40 kg/ ha was recorded with Linseed + Gram (4:2), followed by linseed + gram either in 4:1 row ratio with a yield of 1684.23 kg/ha, respectively compared to rest of the treatments. The extent of yield increase with linseed + bengal gram at 4:2, 4:1, linseed + lentil at 4:2 and linseed + field pea at 4:2 row ratio was 46.75%, 30.81%, 26.46% and 16.54% over sole linseed. It is mainly due to better utilization of natural resources by the various crops involved in intercropping systems with their different below and above ground growth behaviour with respect to plant stature and rooting pattern. Crop performance under a given environmental condition is also dependent on nature and composition of cropping system in vogue. For instance introduction of an intercrop not only alters the conditions available for the main crop but also influences through the complementary /competitive effects of one species over the other.

The sole crop of linseed (1287.50kg/ha) produced considerably more grain yield than LEY of field pea (1168.23kg/ha) sole, but LEY of sole gram is significant increased among other LEY of Field pea and lentil which was more over better sole crop than linseed, Field pea and lentil in present field trial. The maximum LEY increment recorded 601.90 and 396.73 Kg/ha in grain yield (table 2 and figure 3) with the intercropping of linseed + gram (4:2) and (4:1) row ratio over sole linseed, respectively.

In the present study, intercropping of linseed and other *rabi* crops gave considerably higher linseed equivalent yield over sole crop of linseed. Thus, the yield advantage of 46.75 to 13.29% was obtained due to linseed intercrop with other *rabi* crops over their respective sole crops. This was due to higher grain yields of component crops owing to

optimum nutrient availability coupled with higher price of both the crops which contributed to higher linseed equivalent yield. Similar, results of higher linseed equivalent yield were also reported in linseed + Bengal gram intercropping system (Kalaghatagi *et al.,* 2017). However, the system productivity (chickpea equivalent yield), total LER, net returns and B:C ratio of chickpea+linseed intercropping under both the row arrangements (5:1 and 4:2) were at par with sole chickpea and significantly higher over sole linseed (Tanwar *et al.,* 2011). Sole planting of linseed and dwarf field pea performed best among 80 % linseed + 20 % dwarf field pea (Bahadur, 2014). Likewise seed yield of linseed grown with wild oats (*Avena strigosa* Schreb.), or white mustard (*Sinapis alba* L.) was smaller than that in crimson clover (*Trifolium incarnatum* L.), red clover (*Trifolium pretense* L.) (Shioji *et al.,* 2016). On another aspect mustard [*Brassica juncea* (L.) Czernj. & Cosson], toria (*Brassica campestris* var. *toria*), wheat (*Triticum aestivum* L. emend. Fiori and Paol.) and linseed intercropping systems depressed the maize yield to significant level (Mishra, 2014). According to Ao *at el.* (2016) Toria equivalent yield (TEY) was higher in Toria + Yellow Sarson, Toria + buckwheat and Toria + linseed when row proportion was maintained at 2:2.

The present study indicated that intercropping of linseed, lentil, gram and field pea affects the yield of individual species and the economics of the cropping system. Results obtained from intercropping and the economics of the linseed + gram (4:2) mixtures indicated a significant advantage from intercropping which was attributed to better economics and land use efficiency than the other row ratios. It can be concluded that intercropping of linseed + gram and linseed + gram in 4:2 and 4:1 row ratios were found to be better for profitable production. The linseed + field pea and linseed + lentil intercropping under 4:2 and 4:2 had a yield advantage of intercropping for exploiting the resources of the environment compared with the other row ratios used in this study.

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