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Impact of various intercrops on the incidence of major sucking insect-pests and seed yield of cluster bean

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Abstract
A field experiment was conducted during *kharif* 2015 and 2016 at the Agronomy Farm, College of Agriculture, SKRAU, Bikaner (Rajasthan) to assess the performance of intercrops against major sucking insect pests of cluster bean. The lowest incidence (4.05/three leaves, 3.46/three leaves and 1.81/central shoot of jassid, whitefly and aphid, respectively) was recorded when cluster bean was intercropped with pearl millet at the ratio of 3:1 and highest incidence was recorded in sole crop (cluster bean). The equivalent yield of cluster bean was highest (1065 kg ha^{-1}) in intercropping with pearl millet at 3:1 ratio followed by cluster bean + green gram at the ratio of 3:1 (974 kg ha^{-1}) and cluster bean + moth bean at the 3:1 ratio (933 kg ha^{-1}).

Keywords: Cluster bean, intercrops, insect-pests, seed yield

Introduction
Studies on formulation of an appropriate blend of agronomic, genetic, biological and chemical methods of pest control are very essential in lowering the pest population below ETL to reduce pesticide consumption. Ecological maneuvering at the micro level was aimed through various agro techniques. The tactics of appropriate intercropping are gaining momentum within the overall ways in the present scenario of pest management strategy (Singh and Singh, 1978) [3]. It is demonstrated that intercropping with similar plant type accentuates the pest problem. Further, the sense modality stimuli offered by the main crop could be invisible by varied intercrops (Aiyer, 1949) [1]. In such system, many photophilic pests avoid crops when they are shaded by taller crops. The species diversity or the population level of natural enemies may be influenced by the complex environment of the crops. Various combinations of crops are grown by farmers, particularly in un-irrigated areas, not all of which are entomologically sound. Therefore, intercropping system based on the extent of co-operation generated between the companion crops should now be developed which may create non overlapping pest sensitivity. This paper deals with the effect of various intercropping systems on the population of jassid, whitefly and aphid associated with the cluster bean.

Materials and Methods
A field experiment on the impact of various intercrops on the incidence of major sucking insect pests and seed yield of cluster bean was laid out in a simple randomized block design with four replications having plots measuring 3.0 x 2.7 m^2 each at the Agronomy Farm, College of Agriculture, SKRAU, Bikaner (Rajasthan) during *kharif* 2015 and 2016. The intercrops sown with the main crop (cluster bean variety RGC-1003) were pearl millet (MH-171), sesame (RT-46), moth bean (RMO-40) and green gram (RMG-162). The crop was sown in last week of July during both the years at row to row and plant to plant distance of 30 X 10 cm, respectively. In intercrop plots, three rows of cluster bean were alternated with one row each of the intercrop. The experiment was conducted as per recommended agronomics practices. The fertilizer dose of 20 kg N ha^{-1} as a starter and 40 kg P_2O_5 ha^{-1} as basal dose was applied before sowing.
The observations on population of jassid, *Empoasca motti* Pruthi; whitefly, *Bemesia tabaci* (Genn.) and aphid, *Aphis craccivora* Koch were recorded soon after their appearance. Observations on target pest population were recorded early in the morning from three leaves, *viz.*, one each from top, middle and lower canopy of the plant in case of jassid and whitefly. The aphid was recorded from the central shoot of each five randomly selected tagged plants from each plot. The data were converted in to $\sqrt{x+0.5}$ values for analysis of variance.

The seed yield of various intercropping systems were converted in to equivalent yield of cluster bean at prevailing market rate of cluster bean and other crops with the help of following expression and data so obtained were subjected to analysis of variance.

Equivalent yield ($q\ ha^{-1}$)	=	Seed yield of main crop ($q\ ha^{-1}$)	+	Seed yield of Intercrop ($q\ ha^{-1}$)	X	Price of Intercrop ($q\ ha^{-1}$)	÷	Price of main crop ($q\ ha^{-1}$)

Results and Discussion

Intercropping systems brought about differential response on the pattern on incidence of insect pests infesting successive crop growth stages of cluster bean. In general, intercropping with non host or dissimilar plant type delayed the pest appearance and produced suppressing impact on the pest population build up, whereas, when similar host plant was put as intercrop, the pest situations were further accentuated. The pest wise incidence in different cropping systems has been discussed in successive paragraphs.

Jassid, *E. motti*

The population of jassid, *E. motti* gradually increased in sole crop as well as in the cluster bean intercropped with other crops. The peak activity was observed in second and third week of September during 2015 and 2016, respectively which has been expressed in pooled data in 37 SMW. The mean pooled data of both the years on jassid population revealed that maximum population (7.01 /3 leaves) was observed on sole crop and minimum population was observed on cluster bean + pearl millet intercrop combination (4.05 /3 leaves) (Table 1). The cluster bean + green gram (5.03 jassids /3 leaves), cluster bean + sesamum (5.17 jassids /3 leaves) and cluster bean + moth bean (5.57 jassids /3 leaves) intercrop combination harboured significantly lower population than the sole crop. The maximum reduction (42.23%) in jassid population over that of sole crop was found in the cluster bean crop intercropped with pearl millet followed by cluster bean with green gram (28.21%) and sesamum (26.28%) whereas; minimum reduction was recorded with moth bean crop (20.59%).

The present findings are in conformity with that of Singh and Singh (1978) [3], Swaminathan *et al*. (2002) [8], Bairwa *et al.* (2007) [4], Chakravorty and Yadav (2013) [6], Manju and Singh (2015) [10], Suman Devi (2018) [9] and Yadav *et al.* (2017) [5] who reported that intercropping system had considerable effect of minimizing the incidence of major insect pests in comparison to sole crop. In the present investigation, the intercropping of cluster bean + pearl millet, cluster bean + sesamum and cluster bean + green gram with cluster bean as main crop had minimum population as compared to sole crop which gets support from Dhuri *et al.* (1986) [2] who also supported that the intercrops reduced pest population invariably than the sole crop.

Whitefly, *B. tabaci*

The pooled data revealed a definite impact of intercropping system on the whitefly, *B. tabaci* incidence. The peak whitefly population ranged from 6.17 to 13.04 /3 leaves (Table 1). The pooled mean data revealed that the maximum population of whitefly was observed on the sole crop (7.65 /3 leaves) followed by cluster bean + moth bean (5.83 /3 leaves) and cluster bean + sesamum (5.28 /3 leaves). The minimum infestation was observed in cluster bean + pearl millet (3.46 /3 leaves) intercrop combinations in both the years. The maximum reduction (54.75%) in whitefly population was found in the sole crop intercropped with pearl millet followed by green gram (34.09%) and sesamum (30.95%) whereas; minimum reduction was recorded with moth bean (23.76%). The present findings get favor from that of Dhuri *et al.* (1986) [2], Bairwa *et al.* (2007) [4], Chakravorty and Yadav (2013) [6] and Yadav *et al.* (2017) [5] who reported that the intercrops invariably reduced pest population in the sole crop.

Aphid, *A. craccivora*

Pooled data of aphid, *aphis craccivora* during *kharif*, 2015 and 2016 showed that sole crop (cluster bean) had maximum population as compared to intercropped main crop. The peak activity of aphid population ranged from 4.02 to 7.27 /central shoots (Table 1). The pooled mean data revealed that the maximum population of aphid was observed on the sole crop (3.51 /central shoot) followed by cluster bean + moth bean (3.11 /central shoot), cluster bean + green gram (2.97 /central shoot) and cluster bean + sesamum (2.78 /central shoot). The minimum infestation was observed in cluster bean + pearl millet intercrop combination (1.81 /central shoot). The maximum reduction (48.53%) in aphid population was found in the cluster bean crop intercropped with pear millet followed by sesamum (20.89%) and green gram (15.37%) whereas; minimum reduction was recorded with moth bean (11.54%). The present findings are in conformity with that of Yadav *et al.* (2017) [5] who reported that aphid population in cluster bean sole crop was reduced with intercropping pearl millet (2.8 /central shoot) and sesamum (4.6 /central shoot). Similarly result finding by Soundarajan and Chitra (2012) [7].

Different intercrop combinations significantly influenced the equivalent yield of cluster bean (Table 2). The maximum equivalent yield was obtained from cluster bean + pearl millet (1065 kg ha^{-1}) followed by cluster bean + green gram (974 kg ha^{-1}) and cluster bean + moth bean (933 kg ha^{-1}) intercrop combination. The minimum yield was obtained from sole crop (763 kg ha^{-1}).

Table 1: Incidence of pests population on cluster bean under different intercrop combinations pooled data of *kharif*, 2015 and 2016

S. No.	Intercrop combinations	Mean pest population per three leaves at different SMW										Mean incidence	Mean incidence sole crop as base	Mean per cent reduction over sole crop
		33	34	35	36	37	38	39	40	41	42			
	Jassid													
I.	Cluster bean +	1.65	3.34	5.06	6.38	7.57**	6.97	4.57	2.54	1.50	0.57	4.05	57.77	42.23

	Pearlmillet	(1.47)*	(1.96)	(2.35)	(2.62)	(2.84)	(2.73)	(2.25)	(1.74)	(1.41)	(1.03)	(2.13)		
II.	Cluster bean + Sesamum	2.43 (1.71)	4.92 (2.33)	6.11 (2.57)	8.13 (2.94)	9.11 (3.10)	8.64 (3.02)	6.16 (2.58)	3.31 (1.95)	1.90 (1.55)	0.99 (1.22)	5.17 (2.38)	73.72	26.28
III.	Cluster bean + Moth bean	2.61 (1.76)	5.41 (2.43)	6.90 (2.72)	8.59 (3.02)	9.63 (3.18)	9.12 (3.10)	6.55 (2.66)	3.57 (2.02)	2.19 (1.64)	1.10 (1.26)	5.57 (2.46)	79.41	20.59
IV.	Cluster bean + Green gram	2.36 (1.69)	4.73 (2.29)	5.93 (2.54)	7.93 (2.90)	9.01 (3.08)	8.33 (2.97)	6.07 (2.56)	3.23 (1.93)	1.84 (1.53)	0.90 (1.18)	5.03 (2.35)	71.79	28.21
V.	Cluster bean sole crop	3.01 (1.87)	6.01 (2.55)	8.38 (2.98)	10.80 (3.36)	12.19 (3.56)	11.85 (3.51)	8.32 (2.97)	5.09 (2.36)	2.76 (1.80)	1.71 (1.48)	7.01 (2.74)	100.00	-
	S.Em±	0.03	0.04	0.06	0.07	0.04	0.06	0.05	0.05	0.03	0.04	0.05	-	-
	CD (p=0.05)	0.10	0.14	0.21	0.22	0.15	0.20	0.18	0.16	0.11	0.12	0.16	-	-
Whitefly														
I.	Cluster bean + Pearlmillet	1.09 (1.26)*	2.09 (1.61)	4.03 (2.13)	5.69 (2.49)	6.20** (2.59)	6.17 (2.58)	4.28 (2.18)	2.56 (1.75)	1.55 (1.43)	0.98 (1.22)	3.46 (1.99)	45.25	54.75
II.	Cluster bean + Sesamum	1.94 (1.56)	3.82 (2.08)	6.28 (2.60)	8.77 (3.04)	9.63 (3.18)	8.96 (3.08)	5.82 (2.51)	3.44 (1.99)	2.51 (1.74)	1.65 (1.47)	5.28 (2.40)	76.24	23.76
III.	Cluster bean + Moth bean	2.23 (1.65)	4.35 (2.20)	7.01 (2.74)	9.05 (3.09)	10.35 (3.29)	9.77 (3.20)	6.94 (2.73)	4.02 (2.13)	2.77 (1.81)	1.82 (1.52)	5.83 (2.52)	69.05	30.95
IV.	Cluster bean + Green gram	1.77 (1.50)	3.54 (2.00)	6.01 (2.55)	8.39 (2.98)	9.32 (3.13)	8.68 (3.03)	5.62 (2.47)	3.27 (1.94)	2.38 (1.70)	1.45 (1.39)	5.04 (2.35)	65.91	34.09
V.	Cluster bean Sole	2.83 (1.82)	5.25 (2.40)	9.02 (3.08)	10.97 (3.38)	13.04 (3.68)	12.52 (3.61)	9.04 (3.09)	6.60 (2.66)	4.48 (2.23)	2.74 (1.80)	7.65 (2.85)	100.00	-
	S.Em±	0.04	0.08	0.07	0.05	0.06	0.06	0.05	0.05	0.06	0.04	0.06	-	-
	CD (p=0.05)	0.14	0.25	0.21	0.17	0.20	0.19	0.17	0.18	0.17	0.12	0.18	-	-
Aphid														
I.	Cluster bean + Pearlmillet	1.03 (1.24)**	2.17 (1.63)	3.38 (1.97)	4.02** (2.13)	3.34 (1.96)	1.98 (1.57)	1.02 (1.23)	0.78 (1.13)	0.35 (0.92)	0.00 (0.71)	1.81 (1.52)	51.47	48.53
II.	Cluster bean + Sesamum	1.83 (1.53)	2.87 (1.83)	5.54 (2.45)	6.30 (2.61)	4.34 (2.20)	2.69 (1.79)	1.62 (1.46)	1.41 (1.38)	0.80 (1.14)	0.37 (0.93)	2.78 (1.81)	79.11	20.89
III.	Cluster bean + Moth bean	2.16 (1.63)	3.05 (1.88)	6.03 (2.55)	6.82 (2.71)	4.73 (2.29)	3.18 (1.92)	1.78 (1.51)	1.58 (1.44)	1.00 (1.22)	0.67 (1.08)	3.11 (1.90)	88.46	11.54
IV.	Cluster bean + Green gram	1.93 (1.55)	2.95 (1.86)	5.87 (2.51)	6.77 (2.70)	4.52 (2.23)	2.99 (1.87)	1.62 (1.45)	1.48 (1.41)	0.92 (1.19)	0.55 (1.01)	2.97 (1.86)	84.63	15.37
V.	Cluster bean Sole	2.36 (1.69)	3.61 (2.03)	6.28 (2.60)	7.27 (2.79)	5.40 (2.42)	3.82 (2.08)	2.32 (1.68)	1.98 (1.57)	1.18 (1.29)	0.80 (1.14)	3.51 (2.00)	100.00	-
	S.Em±	0.04	0.05	0.07	0.06	0.05	0.04	0.03	0.05	0.04	0.06	0.05	-	-
	CD (p=0.05)	0.14	0.16	0.22	0.20	0.16	0.13	0.11	0.15	0.12	0.19	0.16	-	-

SMW-Standard Meteorological Weeks, *Figures in the parentheses are $\sqrt{x+0.5}$ values, **Peak population of insect pests during the crop seasons

Table 2: Effect of different intercropping combinations on seed yield of cluster bean

S. No.	Intercrop combinations	Yield (kg ha^{-1})								
		Main crop			Intercrop			Equivalent yield		
		2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
I.	Cluster bean + Pearl millet	877	830	854	615	595	605	1078	1053	1065
II.	Cluster bean + Sesamum	715	670	693	140	115	128	965	894	930
III.	Cluster bean + Moth bean	695	645	670	200	185	193	954	911	933
IV.	Cluster bean + Green gram	705	665	685	210	195	203	985	962	974
V.	Cluster bean Sole	785	740	763	0.00	0.00	0	785	740	763
	S.Em±							27.04	25.85	18.71
	CD (p=0.05)							88.20	84.30	56.08

Conclusion

The present study concluded that intercropping pearl millet a non leguminous with cluster bean had significant impact on the major sucking insect pests in cluster bean. After large scale demonstrations the component can be well fit into integrated pest management in cluster bean ecosystem as environmentally safe and cost effective strategy in small farmer holdings.

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