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Integrated pest management of cluster bean (*Cyamopsis tetragonoloba* L.)

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Abstract
Clusterbean (*Cyamopsis tetragonoloba* L.) is an important crop of Rajasthan. Insect pests are the major constraints in the production and productivity of clusterbean. On this basis, an experiment was laid out with the view to find out the possibility of minimum incidence of insect pests during *Kharif* 2015 and 2017. Eight different treatment combinations along with untreated control were laid out in randomized block design with three replications. Minimum pooled PDI(10.48), minimum aphid incidence (0.7) and minimum jassid incidence (0.87) was achieved with the treatment T7 (Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + (Seed treatment with fipronil 5% SC @ 4 ml/kg seed) + (Foliar spray with streptocycline @ 250 ppm + copper hydroxide @ 0.2% at 15 days interval) + (Foliar spray with Thiomethoxam 25 WG @ 0.3 g/liter followed by Acetamipride 20 sp @ 0.2 g/liter at 15 days interval).

Keywords: Clusterbean, bacterial blight, aphid, chemicals, antibiotic, control

Introduction
Clusterbean (*Cyamopsis tetragonoloba* L. Taub.) also known as guar, is an annual legume crop mostly cultivated under resource constrained conditions in arid and semi-arid regions for vegetable, fodder, gum and green manure. India enjoys sole status in the cultivation of guar in the world because of favourable climatic conditions for the crop production. India is in prime position for cluster bean production and contributing 80% of world's total production. In India, the crop is mainly grown in the states of Rajasthan, Haryana, Gujarat, Punjab and Uttar Pradesh under rain-fed conditions. Rajasthan has largest area under cultivation of guar (82.1%) followed by Haryana, Gujarat and Punjab which in turn producing 64, 22, 12 and 2 per cent of guar seeds (Bagenia and Chaturvedi, 2018) [3].

It is grown for different purposes. Green and tender pods of clusterbean are the most preferred vegetable in many parts of the world. The tender pods are dried and eaten after frying in various parts of our country during off season. Green plants are cut and fed as forage to the cattle. After processing of cluster bean seed coats and cotyledons are used as high protein cattle feed. Clusterbean has also great significance value due to its good quality gum content, its endosperm contains 19-43% galactomannan gum and its derivatives are used in several industries *viz.* food processing, pharmaceuticals, cosmetics, mining, textile, paper, ceramics synthetic vaccines, paints, oil industries, oil drilling and explosive industry. Gum from its seeds is becoming an important commodity in International trade. Cluster bean suffers from a number of insect pests which are the major constraints in the production and productivity of cluster bean. Among them, whitefly, *Bemisia tabaci* (Genn.), aphid, *Aphis craccivora* Koch; pod borer, *Helicoverpa armigera* (Hub.), *Acaudaleyrodes rachipora* (Singh); leaf hopper, *Empoasca motti* Pruthi; leaf perforator, *Dichomeris inthes* Meyr, *Maruca testulalis* Geyer*; Protaetia terrosa* G.&P. are important infesting cluster bean (Muralidharan *et al*, 1999; Reddy and Rao, 2001; Arora and Kashyap, 2002; Khan *et al.*, 2002 and Singh, 2004) [8, 2, 7].

Bacterial blight of cluster bean is one of the most devastating disease caused by *Xanthomonas axonopodis* p.v. *cyamopsidis* (Patel *et al*, 1953) [10] which limits cluster bean productivity in all growing regions and responsible for 58% yield loss (Gandhi and Chand 1985) [4]. Scattered rains, high humidity, cloudy weather and warm temperature (28oC-30oC) are predisposing factors for the development of bacterial leaf blight (BLB) during monsoon (Singh and Swarup, 1987) [4] and favours disease development to epidemic proportions. The pathogen is internally seed borne in nature and provides primary inoculums for secondary spread, later the infection

from blighted leaves spread to stem through petiole and in advance stages, stem gets cracked. The pods also show heavy spotting. Early infection may reduce the yield to a greater extent Yadav and Nath (2006) [11]. Seed treatments as well as spraying schedules play a vital role for management of bacterial blight. This entails the need for designing effective disease management strategies in order to minimize the disease and maximize the crop production therefore, required to monitor persistence and distribution of this pathogen, hence an experiment was planned to monitor and manage the bacterial blight through seed treatment with different spraying schedules in clusterbean.

Materials and Methods

Field experiments were conducted in a randomized block design with four replications during three cropping seasons of *Kharif* 2015, 2016 and 2017 at research farm of Rajasthan Agricultural Research Institute, Durgapura. Seed were pre--inoculated with *Xanthomonas axonopodis* p.v. *cyamopsidis* seven days old culture. Clusterbean variety M-83 which is highly susceptible to bacterial leaf blight was sown at a distance of 30cm×10cm. The disease intensity were recorded at just initiation of disease and subsequent recordings were made at weekly intervals from 20 randomly selected plants from each net plot by using 1-9 scale as : 1 = 1-5% disease leaf area; 3=6-12% disease leaf area; 5=13- 25% disease leaf area; 7=26-50% disease leaf area; 9=>50% disease leaf area. Based on these observations, percent disease intensity (PDI) of BLB was worked out by using standard formula (Mckinney, 1923) [9]. The experimental data was analysed by using standard methods to test of the significance (Gomez and Gomez, 1984) [5].

Per cent disease intensity was recorded by using the formula:

$$\text{Percent disease intensity (PDI)} = \frac{\text{Sum of all numerical rating}}{\text{Total number of leaves examined X Maximum rating}} \times 100$$

The experiment was carried out in a randomized block design (RBD) with four replications. Each plot size was measured 3.0 x 2.7 m^2 and the crop was sown with a spacing of 30 x 10 cm. RGC-938 variety of clusterbean was sown. The populations of insect pests were recorded at weekly interval from their appearance till harvesting of the crop. All the observations were recorded early in the morning. The methods used for recording the population of major insect pests, *viz* aphid, *Aphis craccivora* and Jassids has been described below:

The population of aphid was recorded from the central shoot of each five randomly selected tagged plants in each plot. The population was recorded in the early morning hours. The crop had been grown in tune with natural environmental conditions without interception of any kind. For comparison of the yield data, the seed yields of different treatments were compared with yield of cluster bean, using prevailing market rate of cluster bean. The equivalent yield so obtained was subjected to analysis of variance.

Results and Discussion

Observations of the present findings revealed that all the treatments were significantly superior over control. Minimum Per cent disease intensity (PDI) (pooled PDI 10.48) was achieved with the treatment T_7 (Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + (Seed treatment with fipronil 5% SC @ 4 ml/kg seed) + (Foliar spray with streptocycline @ 250 ppm + copper hydroxide @ 0.2% at 15 days interval) + (Foliar spray with Thiomethoxam 25 WG @ 0.3 g/liter followed by Acetamipride 20 sp @ 0.2 g/liter at 15 days interval). First spray on at disease initiation and second at 15 days after first spray) Data also revealed that there was maximum yield (11.12 q/ha) obtained by the same treatment followed by T3 Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + Seed treatment with fipronil 5% SC @ 4 ml/kg seed. Similar results were reported by Choudhary *et al.* (2009) [12]. The results are in also conformity with reported by Yadav and Nath (2006) [11]. All the treatments were significantly differing with each other and significantly superior over untreated control. Recommended cultural operations were performed as per requirements of crop.

The data on aphid infestation revealed that the cluster bean was not found free from the attack of aphid, *A. craccivora*. The infestation of aphid was first observed in the second week of August. The infestation increased gradually and reached to peak in the last week of August and continued up to the second week of September. The mean aphid population ranged from 0.7 to 1.56/ central shoots in the present investigation. The minimum aphid incidence (0.7) and Jassid incidence (0.87)was observed on treatment T_7 (Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + (Seed treatment with fipronil 5% SC @ 4 ml/kg seed) + (Foliar spray with streptocycline @ 250 ppm + copper hydroxide @ 0.2% at 15 days interval) + (Foliar spray with Thiomethoxam 25 WG @ 0.3 g/liter followed by Acetamipride 20 sp @ 0.2 g/liter at 15 days interval). The maximum population of aphid was observed on treatment T_8 control per central shoot). The highest yield (11.12 q/ha) obtained by the same treatment followed by T3 Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + Seed treatment with fipronil 5% SC @ 4 ml/kg seed.

Integrated pest management for cluster bean *Kharif* 2015 to 2017

Pooled analysis of three years (2015 to 2017) data revealed that Minimum incidence of Aphids (0.70), Jassids (0.87) and bacterial blight disease (10.48) were observed in treatment T_7 with the maximum yield 11.12 qtl/ha While maximum incidence of aphids per leaf (1.56), Jassids per leaf (1.98) and minimum yield (5.25) q/ha. in T_8, whereas, maximum diseases intensity of BLB observed in treatment T_2 followed by T_8.

Table 1: Integrated pest management for cluster bean (Pooled analysis 2015 to 2017)

S. N.	Treatment	Incidence								Disease intensity (BLB) φ				Yield kg/ha.			
		Aphid/Leaf				Jassid/Leaf											
		2015	2016	2017	Pooled	2015	2016	2017	Pooled	2015	2016	2017	Pooled	2015	2016	2017	Pooled
1	T_1	1.18	1.05	1.04	1.09	1.84	1.54	1.37	1.58	17.84	28.27	27.42	24.51	9.87	6.58	6.33	7.59
2	T_2	1.09	1.01	1.00	1.03	1.52	1.37	1.19	1.36	35.13	36.11	34.20	35.15	9.46	8.23	7.01	8.23
3	T_3	1.2	1.00	0.99	1.06	1.52	1.65	1.63	1.60	11.89	21.88	20.79	18.19	12.55	8.84	7.81	9.73

4	T_4	1.40	1.20	1.18	1.26	1.84	1.75	1.69	1.76	23.01	22.15	22.14	22.43	8.23	5.76	5.33	6.44
5	T_5	1.24	1.42	1.40	1.35	1.51	1.2	1.18	1.30	37.83	31.07	29.53	32.81	6.70	8.02	6.86	7.19
6	T_6	1.02	1.20	1.19	1.14	1.33	1.17	1.14	1.21	23.63	21.88	20.36	21.96	9.17	6.17	7.50	7.61
7	T_7	0.69	0.71	0.69	0.70	1.04	0.80	0.77	0.87	11.89	9.76	9.80	10.48	14.40	10.28	8.66	11.11
8	T_8	1.28	1.71	1.70	1.56	2.10	1.95	1.88	1.98	37.33	32.93	32.33	34.20	7.07	5.34	3.33	5.25
	CD at 5%	0.48	0.31	0.30	0.23	0.29	0.37	0.17	0.16	7.29	8.34	9.46	6.42	2.51	4.17		1.95
	SEm ±	0.15	0.10	0.10	0.07	0.09	0.12	0.06	0.05	2.40	2.75	2.70	2.12	0.82	1.37		0.64

Details of Treatments

T_1	Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg
T_2	Seed treatment with fipronil 5% SC @ 4 ml/kg seed
T_3	$T_1 + T_2 =$ (Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + (Seed treatment with fipronil 5% SC @ 4 ml/kg seed)
T_4	Foliar spray with streptocycline @ 250 ppm + copper hydroxide @ 0.2% at 15 days interval
T_5	Foliar spray with Thiomethoxam 25 WG @ 0.3 g/liter followed by Acetamipride 20 sp @ 0.2 g/liter at 15 days interval
T_6	$T_4 + T_5 =$ (Foliar spray with streptocycline @ 250 ppm + copper hydroxide @ 0.2% at 15 days interval) + (Foliar spray with Thiomethoxam 25 WG @ 0.3 g/liter followed by Acetamipride 20 sp @ 0.2 g/liter at 15 days interval)
T_7	$T_3 + T_6$ = (Seed soaking for 30 minutes with streptocycline @ 500 ppm + seed dressing with carbendazim @ 2 g/kg) + (Seed treatment with fipronil 5% SC @ 4 ml/kg seed) + (Foliar spray with streptocycline @ 250 ppm + copper hydroxide @ 0.2% at 15 days interval) + (Foliar spray with Thiomethoxam 25 WG @ 0.3 g/liter followed by Acetamipride 20 sp @ 0.2 g/liter at 15 days interval)
T_8	Control

Table 2: Economics of different treatments in cluster bean

Treatment No.	Insecticides/ Fungicides	Qty of treatment (kg/lit per ha)	Price of the treatment (Rs./ha)	Labour cost (Rs/ha)	Total cost of treatment (Rs/ha)	Yield (q/ha)	Increase in yield over control	Gross Realization (Rs/ha)	Net Realization over control (Rs/ha)
T1	Streptocycline	0.0075kg	45.0	100.0	166.0	15.32	2.17	8680	8514
	Carbendazim	0.03kg	21.0						
T2	Fipronil	0.06 lit.	75.0	100.0	175.0	14.53	1.38	5520	5345
T3	Streptocycline	0.0075kg	45.0	100.0	241.0	16.78	3.63	14520	14279
	Carbendazim	0.03kg	21.0						
	Fipronil	0.06 lit.	75.0						
T4	Streptocycline	0.20kg	1166.0	1200.0	3566.0	15.91	2.76	11040	7474
	Copper oxycloride	1.6 kg	1200.0						
T5	Thiamethoxam	0.12kg	183.0	1200.0	1503.0	14.78	1.63	6520	5017
	Acetamiprid	0.08kg	120.0						
T6	Streptocycline	0.20kg	1166.0	1200.0	3869.0	16.80	3.65	14600	10731
	Copper oxycloride	1.6 kg	1200.0						
	Thiamethoxam	0.12kg	183.0						
	Acetamiprid	0.08kg	120.0						
T7	Streptocycline	0.0075kg	45.0	1300.0	4110.0	18.28	5.13	20520	16410
	Carbendazim	0.03kg	21.0						
	Copper oxycloride	1.6 kg	1200.0						
	Streptocycline	0.20kg	1166.0						
	Fipronil	0.06 lit.	75.0						
	Thiamethoxam	0.12kg	183.0						
	Acetamiprid	0.08kg	120.0						
T8	Control	-	-	-	-	13.15			

Price of pesticides:	Clusterbean price=4000/q	Streptocycline= Rs35/packet (6 gram)
Carbendazim =Rs 700/kg	Fipronil = 1250 Rs/kg	Copper oxycloride = Rs 750/kg
Thiamethoxam = Rs.1520/kg	Acetamiprid = Rs.1500/kg	Labour cost seed treatment = Rs 100, 2 spray =Rs 1200

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