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Bio-efficacy of botanical insecticides against lepidopteran insect pest infesting black gram

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Abstract
Nine treatments of different botanicals and absolute control were evaluated in a field experiment against lepidopteran insect pest infesting black gram under Randomized Block design in the year *Kharif* 2016 at B. A. College of Agriculture, Anand Agricultural University, Anand. Among the different botanicals, Azadirachtin 0.15 EC 0.0006 percent, Neem Seed Kernel Extract (NSKE) 5 percent, neem oil 0.3 percent and neem leaf extract (NLE) 10 percent were found highly effective in managing *Spilosoma obliqua* Walker and *Maruca testulalis* (Geyer) in black gram. A treatment of Azadirachtin 0.15 EC 0.0006 percent, NSKE 5 percent neem oil 0.3 percent and neem leaf extract 10 percent registered the higher grain yield of black gram.

Keywords: Bihar hairy caterpillar, spotted pod borer, black gram

Introduction
Black gram, *Vigna mungo* (L.) Hepper belongs to the family Fabaceae and the genus Vigna [1]. Black gram is a member of the Asiatic Vigna crop group [2]. India produces about 18.294 lakh tone of urd annually from about 31.285 lakh ha of area with yield about 585 kg per hectare. Gujarat produces about 0.52 lakh tone of urd annually from about 0.84 lakh ha of area with yield about 620 kg per hectare during twelfth plan (2016) [3].
In India, about 18 to 20 species of insect pests damage the black gram [4]. The black gram growers use various insecticides to control the pest. The indiscriminate use of pesticides causes phytotoxicity and destruction of beneficial organisms such as predators, parasitoids, microorganisms and pollinators [5]. To compensate the yield losses caused by destructive insect pests without applying costly chemical insecticides and to increase the production and productivity of a crop in India as well as in Gujarat, some effective botanicals against lepidopteran insect pests were designed carefully and their impact was studied. Therefore the present investigations were carried out on bio efficacy of botanical insecticides against lepidopteran insect pests of black gram.
The study carried out on mixtures of neem and eucalyptus leaf extracts with extracts of other plant species for the management of major post flowering insect pests (pod borers, *M. vitrata*) of cowpea. The results revealed that mean number of *M. vitrata* was reduced (< 1.0/flower and/or pod) on plots sprayed with leaf extracts of Neem + Lemongrass, Neem + African curry, Neem + Tomato, Neem + Bitter leaf, and Eucalyptus + African Bush tea. These extracts mixtures caused great reductions in pod damage per plant and ensured higher grain yield [6]. NSKE 5% and neem oil 5% registered low pod borer damage (16.3 and 16.8 percent, respectively) in pigeonpea, while the commercial botanicals like neemolin and neemol registered higher damage (19.0 and 21.3 percent, respectively) as against control (35.0 percent) [7].

Materials and Methods
Field Experiment
A field experiment was conducted to evaluate the relative efficacy of various botanical insecticides (Table 1) against major insect pests of black gram at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *Kharif* 2016. Black gram variety Gujarat Urd-1 was grown in gross plot of 3.0 x 2.7 m with net plot of 2.1 x 1.8 m at 45 × 10 cm in a Randomized Block Design (RBD) in three replications. Treatment wise application of insecticide was given when economic threshold level of insect pests population by using high volume sprayer (knapsack) with required concentration. Subsequent one spray was given after 10 days.

The observations of lepidopteran insect pests were recorded from five randomly selected plants per treatment per replication before spraying and three, five, seven and ten days after each sprays. The data on black gram yield also recorded plot-wise and converted to quintal per hectare.

Statistical analysis

The data on number of lepidopteran pests were subjected to square root transformation and statistically analysed for interpretation by following standard statistical technique [8].

Results and Discussion

Bihar hairy caterpillar, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae)

The data on pooled over sprays and periods, significantly the lowest (7.06 larvae/plant) larval population of Bihar hairy caterpillar was noticed in the plot treated with Azadirachtin 0.15 EC 0.0006 percent and it was at par with NSKE 5 percent (7.28 larvae/plant), neem oil 0.3 percent (7.40 larvae/plant) and NLE 10 percent (7.57 larvae/plant) (Table 1 and Fig 1). Plot treated with tobacco decoction 2 percent registered 11.61 larvae/plant and it was significantly more effective than remaining treatments. Neem leaf extract (NLE) 5% + eucalyptus leaf extract (ELE) 5% (14.79 larvae/plant) and Neem leaf extract (NLE) 5% + lemongrass leaf extract (LLE) 5% (15.02 larvae/plant) were at par with each other. Among the evaluated botanical insecticides, the highest (20.84 larvae/plant) larval population of Bihar hairy caterpillar was recorded in lemongrass leaf extract (LLE) 10 percent and it was at par with eucalyptus leaf extract (ELE) 10 percent (20.29 larvae/plant). Both the treatments found less effective against this pest.

Spotted pod borer, *Maruca testulalis* (Geyer) (Lepidoptera: Crambidae)

Looking to the data on pooled over sprays, significantly the lowest (0.03 larvae/plant) larval population of spotted pod borer was noticed in the plot treated with Azadirachtin 0.15 EC 0.0006 percent and it was at par with NSKE 5 percent (0.12 larvae/plant), neem oil 0.3 percent (0.16 larvae/plant) and NLE 10 percent (0.24 larvae/plant) (Table 2 and Fig 1). Plot treated with tobacco decoction 2 percent registered 0.85 larvae/plant and it stood next in order. The treatments of NLE 5% + ELE 5% (1.24 larvae/plant) and NLE 5% + LLE 5% (1.38 larvae/plant) were at par with each other and found equally effective. Among the evaluated botanical insecticides, the highest (2.70 larvae/plant) larval population of spotted pod borer was recorded in LLE 10 percent and it was at par with ELE 10 percent (2.49 larvae/plant).

Impact of botanical insecticides on seed yield of black gram

The data on seed yield of black gram recorded in various botanical insecticidal treatments were presented in Table 3 and Fig 1. The highest (11.11 q/ha) seed yield of black gram was obtained from the plots treated with Azadirachtin 0.15 EC 0.0006 percent and it was at par with NSKE 5 percent, neem oil 0.3 percent and NLE 10 percent with seed yield of 11.07, 11.03 and 11.00 q/ha, respectively. Plot treated with tobacco decoction 2 percent recorded 9.50 q/ha seed yield which is at par with NLE 5% + ELE 5% and NLE 5% + LLE 5% and recorded moderate yield of 9.05 and 9.00 q/ha, respectively. Of the evaluated botanical insecticides, the lowest (7.50 q/ha) yield was obtained from LLE 10 percent and it was at par with ELE 10 percent (7.52 q/ha), whereas untreated plot produced 6.01 q/ha black gram which is significantly differ from all treatments.

The present findings are in accordance with the reports on phosalone and neem seed kernel extract were equally effective in controlling defoliators in green gram [9]. A NSKE @ 5% a.i./ha of was found to be the most effective treatment in minimizing the pest population and also recorded maximum yield of brinjal [10]. Neem based formulations Neemazal–F (0.1%) and neem seed kernel extract were found most effective against *M. vitrata*. Vanguard (0.4%) was also effective [11]. The study carried out in Indonesia showed that neem leaf (*A. indica* A. Juss) extract contains antifeedant activity which lead to antifeedant's work mechanism confirm by producing feeding inhibition stimulant such that it disturbs the stimulation perception for eating and affects the growth and the development of hormonal system [12]. Furthermore, it also acts as ecdysone blocker that insects fail to moult their skin (moulting inhibition) such that it causes anatomical abnormality and death [13]. With an ever-increasing emphasis on organic agriculture and integrated pest management, neem pesticides have become a key input in various pest management strategies [14]. Sequential application of biopesticides *Viz.*, NSKE-*Ha*NPV-Bt found effective against insect pests of field bean ecosystem at Chickaballapura (Bangalore) and also recorded higher grain yield [15]. Two sprays of neem seed kernel extract 5% + soap 1% (12.5 kg NSKE + 2.5 kg soap in 250 l water 0.4 ha), the first at 50% flowering and second a fortnight dates, have been found to be effective against pod borers of pulse crops [16]

Table 1: Bio-efficacy of different botanical insecticides against Bihar hairy caterpillar, *S. obliqua* in black gram

Treatments	Conc. (%)	No. of larvae/plant days after spray											
		Before	First Spray					Second Spray					Pooled over spray
			3	5	7	10	Pooled	3	5	7	10	Pooled	
Neem Seed Kernel Extract	5	3.83a (14.17)	3.00a (8.50)	2.98a (8.38)	2.90a (7.91)	2.98a (8.38)	2.96a (8.26)	2.66a (6.58)	2.64a (6.47)	2.61a (6.31)	2.52a (5.85)	2.61a (6.31)	2.79a (7.28)
Neem oil	0.3	3.94ba (15.02)	3.01a (8.56)	2.99a (8.44)	2.92a (8.03)	3.00a (8.50)	2.98a (8.38)	2.68a (6.68)	2.67a (6.63)	2.64a (6.47)	2.55a (6.00)	2.64a (6.47)	2.81a (7.40)
Azadirachtin 0.15 EC	0.0006	3.79a (13.86)	2.98a (8.38)	2.95a (8.20)	2.87a (7.74)	2.97a (8.32)	2.94a (8.14)	2.65a (6.52)	2.60a (6.26)	2.55a (6.00)	2.44a (5.45)	2.56a (6.05)	2.75a (7.06)
Neem leaf Extract	10	4.13cba (16.56)	3.02a (8.62)	3.00a (8.50)	2.98a (8.38)	3.04a (8.74)	3.01a (8.56)	2.70a (6.79)	2.68a (6.68)	2.65a (6.52)	2.62a (6.36)	2.67a (6.63)	2.84a (7.57)
Tobacco decoction	2	4.22cba (17.31)	3.67b (12.97)	3.65b (12.82)	3.67b (12.97)	3.75b (13.56)	3.68b (13.04)	3.30b (10.39)	3.26b (10.13)	3.25b (10.06)	3.26b (10.13)	3.27b (10.19)	3.48b (11.61)

Lemongrass leaf extract	10	5.08cb (25.31)	5.09d (25.41)	4.65e (21.12)	4.61c (20.75)	4.66c (21.22)	4.75d (22.06)	4.60d (20.66)	4.53c (20.02)	4.50c (19.75)	4.32c (18.16)	4.49d (19.66)	4.62d (20.84)
Eucalyptus leaf extract	10	5.04cb (24.90)	5.06d (25.10)	4.59c (20.57)	4.57c (20.38)	4.62c (20.84)	4.70d (21.59)	4.56d (20.29)	4.40c (18.86)	4.38c (18.68)	4.28c (17.82)	4.41d (18.95)	4.56d (20.29)
Neem leaf extract 5%+ Lemongrass leaf extract 5%	10	4.54cba (20.11)	4.38c (18.68)	3.94b (15.02)	3.89b (14.63)	4.01bc (15.58)	4.05c (15.90)	3.95c (15.10)	3.81b (14.02)	3.78b (13.79)	3.75bc (13.56)	3.82c (14.09)	3.94c (15.02)
Neem leaf extract 5%+ Eucalyptus leaf extract 5%	10	4.43cba (19.12)	4.34c (18.34)	3.90b (14.71)	3.86b (14.40)	3.99bc (15.42)	4.02c (15.66)	3.93c (14.94)	3.79b (13.86)	3.75b (13.56)	3.72bc (13.34)	3.79c (13.86)	3.91c (14.79)
Control	-	5.10c (25.51)	5.90e (34.31)	5.91f (34.43)	5.92f (34.55)	5.96d (35.02)	5.92e (34.55)	5.99d (35.38)	6.01d (35.62)	6.02d (35.74)	5.98d (33.49)	6.00e (35.50)	5.96e (35.02)
S. Em. ± Treatment(T)		0.34	0.21	0.21	0.22	0.23	0.11	0.20	0.19	0.20	0.21	0.10	0.07
Period (P)							0.07					0.06	0.05
T × P							0.21					0.19	0.15
F test		NS	S	S	S	S	S	S	S	S	S	S	S
C. V. %		13.31	9.17	9.51	10.09	10.26	9.50	9.27	9.18	9.42	10.23	9.22	9.51

Note: 1. Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values
2. Treatment means with the letter/letters in comon are not significant by DNMRT at 5% level of significance
3. S = Significant and NS = Non-significant

Table 2: Bio-efficacy of different botanical insecticides against Spotted pod borer, *M. testulalis* in black gram

Treatments	Conc. (%)	No. of larva(e)/plant days after spray											
		Before	First Spray					Second Spray					Pooled over spray
			3	5	7	10	Pooled	3	5	7	10	Pooled	
Neem Seed Kernel Extract	5	1.66ab (2.26)	0.77a (0.09)	0.75a (0.06)	0.79a (0.12)	0.91a (0.33)	0.81a (0.16)	0.84a (0.21)	0.79a (0.12)	0.74a (0.05)	0.72a (0.02)	0.78a (0.11)	0.79ab (0.12)
Neem oil	0.3	1.72abc (2.46)	0.80a (0.14)	0.78a (0.11)	0.82a (0.17)	0.93a (0.36)	0.83a (0.19)	0.87a (0.26)	0.82a (0.17)	0.75a (0.06)	0.73a (0.03)	0.79a (0.12)	0.81ab (0.16)
Azadirachtin 0.15 EC	0.0006	1.63a (2.16)	0.74a (0.05)	0.72a (0.02)	0.73a (0.03)	0.77a (0.09)	0.74a (0.05)	0.74a (0.05)	0.73a (0.03)	0.71a (0.00)	0.71a (0.00)	0.72a (0.02)	0.73a (0.03)
Neem leaf Extract	10	1.91bcd (3.15)	0.82a (0.17)	0.79a (0.12)	0.87a (0.26)	0.98a (0.46)	0.86a (0.24)	0.92a (0.35)	0.87a (0.26)	0.83a (0.19)	0.80a (0.14)	0.84a (0.21)	0.86b (0.24)
Tobacco decoction	2	1.96cde (3.34)	1.13b (0.78)	1.11b (0.73)	1.18b (0.89)	1.26b (1.09)	1.17b (0.87)	1.21b (0.96)	1.18b (0.89)	1.12b (0.75)	1.09b (0.69)	1.15b (0.82)	1.16c (0.85)
Lemongrass leaf extract	10	2.19e (4.30)	1.91d (3.15)	1.76c (2.60)	1.80c (2.74)	1.60c (2.06)	1.77d (2.63)	1.90d (3.11)	1.88c (3.03)	1.76c (2.60)	1.74d (2.53)	1.82d (2.81)	1.79e (2.70)
Eucalyptus leaf extract	10	2.12de (3.99)	1.89d (3.07)	1.60c (2.06)	1.65c (2.22)	1.57c (1.96)	1.68d (2.32)	1.88d (3.03)	1.85c (2.92)	1.73c (2.49)	1.71d (2.42)	1.79d (2.70)	1.73e (2.49)
Neem leaf extract 5%+ Lemongrass leaf extract 5%	10	2.08de (3.83)	1.51c (1.78)	1.20b (0.94)	1.27b (1.11)	1.41bc (1.49)	1.35c (1.32)	1.54c (1.87)	1.30b (1.19)	1.25b (1.06)	1.40c (1.46)	1.37c (1.38)	1.36d (1.35)
Neem leaf extract 5%+ Eucalyptus leaf extract 5%	10	2.05de (3.70)	1.48c (1.69)	1.18b (0.89)	1.25b (1.06)	1.39bc (1.43)	1.32c (1.24)	1.50c (1.75)	1.24b (1.04)	1.19b (0.92)	1.37c (1.38)	1.32c (1.24)	1.32d (1.24)
Control	-	2.22e (4.43)	2.34e (4.98)	2.35d (5.02)	2.43d (5.40)	2.44d (5.40)	2.39e (5.55)	2.46e (5.55)	2.48d (5.65)	2.50d (5.75)	2.52e (5.85)	2.49e (5.70)	2.44f (5.45)
S. Em. ± Treatment(T)		0.14	0.09	0.08	0.09	0.08	0.04	0.09	0.09	0.09	0.09	0.04	0.03
Period (P)							0.03					0.02	0.02
T × P							0.09					0.09	0.06
F test		NS	S	S	S	S	S	S	S	S	S	S	S
C. V. %		12.38	12.28	11.96	11.83	10.39	11.30	11.60	12.37	11.95	11.96	11.62	11.44

Note: 1. Figures in parentheses are retransformed values; those outside are $\sqrt{X+0.5}$ transformed values
2. Treatment means with the letter/letters in comon are not significant by DNMRT at 5% level of significance
3. S = Significant and NS = Non-significant

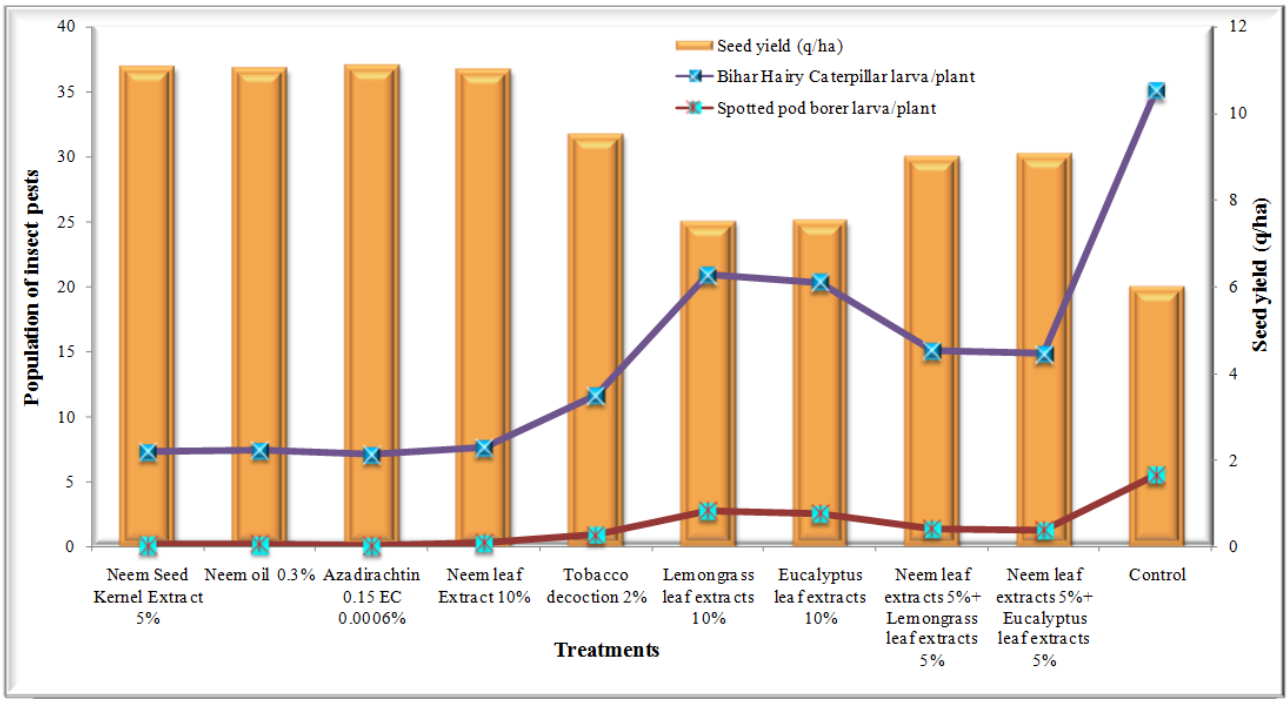

Fig 1: Effectiveness of different botanical insecticides against lepidopteran insect pests of black gram and its impact on yield

Table 3: Impact of different botanical insecticides on seed yield of black gram

Treatments	Conc. (%)	Yield (q/ha)
Neem oil	0.3	11.03a
Azadirachtin 0.15 EC	0.0006	11.11a
Neem leaf Extract	10	11.00a
Tobacco decoction	2	p9.50ab
Lemongrass leaf extract	10	7.50cde
Eucalyptus leaf extract	10	7.52cd
Neem leaf extract 5%+ Lemongrass leaf extract 5%	10	9.00bc
Neem leaf extract 5%+ Eucalyptus leaf extract 5%	10	9.05bc
Control	-	6.01f
S. Em. ±		0.49
F test		S
C. V. %		9.10

Note: 1. Treatment means with the letter/letters in comon are not significant by DNMRT at 5% level of significance
2. S = Significant

Conclusion

Azadirachtin 0.15 EC 0.0006 percent, NSKE 5 percent, neem oil 0.3 percent and NLE 10 percent were found highly effective in managing Bihar hairy caterpillar, *S. oblique* and spotted pod borer, *M. testulalis*. Considering the effectiveness of botanical insecticides against major insect pests botanicals tobacco decoction 2 percent, NLE 5% + ELE 5% and NLE 5% + LLE 5% were emerged out as moderately effective, whereas LLE 10 percent and ELE at 10 percent found to be less effective treatments. The treatment effects were also reflected on seed yield. Azadirachtin 0.15 EC 0.0006 percent, NSKE 5 percent neem oil 0.3 percent and NLE 10 percent were produced higher grains of black gram. Remaining treatments *viz.* tobacco decoction 2 percent, NLE 5% + ELE 5%, NLE 5% + LLE 5%, ELE 10 percent and LLE 10 percent were found poor in yield performance as they observed to be inferior in managing the insect pests. Considering the effectiveness of neem based insecticide against major insect pests black gram can well integrated as environmental friendly component of management strategy.

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