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Evaluation of efficacy of selected botanical and cypermethrin against infestation of pod borer (*Etiella zinkenella*) on Pea (*Pisum sativum* L.)

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Abstract
Experiment was conducted at the central farm at the research field, Sam Higginbottom Institute of Agriculture, Technology and Sciences Allahabad, during rabi season 2012-13 to evaluate the efficacy of selected botanical and cypermethrin against *Etiella zinkenella* (Treitschke) on pea (*Pisum sativum l.*) seven treatments using randomized block deign, namely, Cypermethrin 25EC, Neem oil 1%, Ethanol and alcohol Neem Seed Kernel Extract 5% (NSKE) and one combination of Cypermethrin + Neem oil, Ethanol and Alcohol seed extract of *Annona squamosa 5%* were applied as foliar sprayed. The pod damage observation was recorded one day before spraying and subsequently at 3rd, 7th and 14th day after spraying. The maximum pod damage reduced 80.85 % was observed Neem oil + cypermethrin (0.5 + 0.009%) followed by cypermethrin 0.018% (71.63%) and minimum in control.

Keywords: Botanical insecticides, cost benefit ratio, cypermethrin, *Etiella zinkenella*, grain yield

Introduction
Pea (*Pisum sativum* L.) is a native to the Middle East and has been cultivated over several hundred years [6]. Pea is a benefit over many other crops that it is an important source of protein (21-32%). It is consumed as green form vegetables in Asian countries and dry seed in America, Australia, Mediterranean regions, and European countries. The mature pea is highly nutritive containing high proportion of digestive protein (22.5%), carbohydrate (62.1%), fat (1.8%), mineral (calcium, iron) and vitamin (riboflavin, thiamin) etc. Pea has the ability to fix its own nitrogen. It is mostly grown in Haryana, Uttar Pradesh, Rajasthan, Punjab, Jammu and Kashmir [16]. Pea plant has a tap and shallow root system with weak stem. It is susceptible to drought and heat. Loamy, clayey and well-drained soils are best for pea plant [15].
Pea is affected by several insect pest species but *Etiella zinkenella* (Treitschke), *Helicoverpa armigera* (Hubner), and *Ophiomyia phaseoli* (Diptera, Agromyzidae) are the major insect pest [10].
Pea pod borer (*Etiella zinkenella*) is cosmopolitan and widely distributed in India. It is a serious pest of pea. The moths emerge in February and March. The eggs are laid both singly and in clusters on various parts of the plants. The newly emerged larval feed on foliage for some time and later enter into the pods and feed on the green grains. The larval stages are completed in 10-27days and pupate in the soil. Life cycle completes in 45-56 days and passes through 5 generations in one year and often causes heavy loss on pea crop especially in dry season.
The strategy adopted by farmer in overcoming the insect pest in crop is by using synthetic insecticides to control insect infestation has been wildly applicable and is now causing concern because of environmental hazards, insect resistance and toxicity to humans. Many efforts have been made to reduce the use of synthetic insecticides; one of the major efforts is adoption of botanical insecticides is novel and safer alternative strategy [3].
The Botanical insecticide which contains plant extracts as active components are safer as well as eco-friendly than synthetic insecticide. Plant is endowed with a potential to produce a range of secondary metabolites like Alkaloid, Terpenainds, Flaonoids, Phenals, Glycosides, Sitosteral and Tannins. These phytochemicals control the insect pest [2]. However, production of phytochemicals varies from plant to plant. Further, like to parameter age of plant, part of plant.

(Root, leafs, Fruits, Flowers and Seeds) reported to effect the production of phytochemical. The phytochemical produced in response to insect pest attack effect reading and oviposition of insects on the plant application of bio-pesticides protect to have positive impaction bollworm population management [5].
The aim of the study is that the Pea pod borer (*Etiella zinkenella*) is cosmopolitan and widely distributed in India. It is a serious pest of pea and The Botanical insecticide which contains plant extracts as active components are safer as well as eco-friendly than synthetic insecticide. Plant is endowed with a potential to produce a range of secondary metabolites like Alkaloid, Terpenainds, Flaonoids, Phenals, Glycosides, Sitosteral and Tannins. These phytochemicals control the insect pest (Ahmad, 2007) [2] However, production of phytochemicals varies from plant to plant. Further, like to parameter age of plant, part of plant (Root, leafs, Fruits, Flowers and Seeds) reported to effect the production of phytochemical. The phytochemical produced in response to insect pest attack effect reading and oviposition of insects on the plant application of bio-pesticides protect to have positive impaction bollworm population management (Ge and Ding, 1996) [5].
Screening of plant extracts for deleterious effects on insects is one of the approaches used in the search for novel botanical insecticides. The most promising botanical insecticide for use at present time and in the future are specific plant *Datura metal* (Datura), Neem, Guldaudi (*Chrysanthemum coronarium*), Sadabahar (*Cantharanthus roseus*) and *Annona squamosa*.

Materials and Methods

Two rounds of insecticidal treatments were applied at fortnightly interval. Liquid formulations of insecticide were applied with the help of hand compression sprayer. The population of pea pod borer was in the peak infestation recorded one day before first spraying subsequently at 3rd, 7th and 14th days after spraying. The population of pod borer was recorded by counting the number of damaged pods and healthy pods on 5 plants were randomly selected and labeled from each plot. A total of five plants per plot were determined for each replication.
The materials required for the studies like pea seed (variety PSM-3). Various insecticide, fertilizers, botanicals, land, agricultural implements, tags, pegs, fencing, knapsack sprayer, measuring cylinder, weighing box, labors *etc*.
One new insecticide, five botanicals and one combination were evaluated against the pea pod borer, *Etiella zinkenella* (table 1). The sprays were done by using hand compression sprayer @ 400-500 liters of spray solution/hectare. Volume of spray solution depends on stage of the crop. The details of treatment such as common name, trade name, formulation of insecticides and botanicals source of supply etc, are given below in Table 1.

Table 1: Details of chemical and botanical insecticides which used in trial as treatments

Treatments	Common Name	Concentration ml/lit.
T_0	Control	----------
T_1	Neem oil 1%	4
T_2	Neem oil + Cypermethrin 25EC	2+0.35
T_3	Cypermethrin 25EC	0.70
T_4	Ethanolic seed extract of annona squamosa 5%	10
T_5	Alcoholic seed extract of annono squamosa 5%	10
T_6	Ethanolic NSKE 5%	3
T7	Alcoholic NSKE 5%	3

The desire concentration as per treatment was freshly prepared every time at the site of experiment site just before the start of spraying on the crop. The quantity of spray solution required for crop was gradually increased as age of crop.
Following formula was used for prepare desired concentration of spray solution.

$$V = \frac{C\ X\ A}{\%\ a.i.}$$

Where
V = Volume/ weight of commercial insecticide ml or g.
C = Concentration required.
A = Volume of solution to be prepared.
% a.i. = Percentage of active ingredient in commercial product.

Results and Discussion

Percent reduction of pod damage due to application of botanicals and chemical insecticides (1st spray) table 2 and 3.

Table 2: Efficacy of botanical and cypermethrin on reduction percent pod damage by *Etiella zinkenella* in pea during rabi season, 2012-2013 (1st spray)

Treatments	Before spray	3 DAS	7 DAS	14 DAS
Control	15.79	0.00	0.00	0.00
Neem oil 1%	13.89	42.32	46.38	41.91
Neem oil + Cypermethrin 25EC	10.00	65.39	75.64	77.44
Cypermethrin 25EC	13.13	50.05	58.52	66.11
Ethanolic seed extract of *Annona squamosa* 5%	12.82	42.32	53.69	61.30
Alcoholic seed extract of Annona squamosa 5%	12.75	50.05	61.00	56.43
Ethanolic NSKE 5%	11.61	50.05	53.69	61.30
Alcoholic NSKE 5%	14.94	50.05	48.79	48.40
Overall Mean	13.12	43.78	49.71	51.61
F-test	NS	S	S	S
S. Ed. (±)	2.893	0.970	1.574	1.431
C. D. (P=0.05)	6.133	2.056	3.336	3.034

Third day after 1st spraying
According to their reduction % the descending order of different treatments is given below.

CD Value (2.056)
T_2 T_7 T_3 T_5 T_6 T_1 T_4 T_0
65.39 50.05 50.05 50.05 50.05 42.32 42.32 0.0

The data on percent pod damage reduction over control on three days after spraying revealed that all the treatment were significantly superior over control. Among the treatment combination of Neem oil + cypermethrin @ 0.5% + 0.009 % recorded highest reduction of pod damage (65.39%) followed by Alcoholic NSKE 5% (50.05%), cypermethrin 25 EC Alcoholic seed extract of *annona squamosa* 5% and Ethanolic NSKE (5%) with 50.05%, Ethanolic seed extract of *annona squamosa* (5%) and Neem oil 1% with 42.32%, Neem oil (42.32%) was least effective among the treatments during 3rd day after 1st spray.
Treatments Alcoholic NSKE 5%, cypermethrin 25 EC, Alcoholic seed extract of *annona squamosa* 5% and Ethanolic NSKE (5%) were non-significant and statistically at par with each other. Treatments of Ethanolic seed extract [*annona squamosa*, (5%)] and Neem oil 1% were also non-significant and statistically at par with each other.

Seventh day after 1stspraying
According to their reduction % the descending order of different treatments is given below.

T_2 T_5 T_3 T_4 T_6 T_7 T_1 T_0
75.64 61.00 58.52 53.69 53.69 48.69 46.38 0.0

The data on percent pod reduction over control on seventh day after spraying revealed that all the treatment were significantly superior over control. Among the treatments combination of Neem oil + cypermethrin @ 0.5% + 0.009% recorded highest reduction of pod damage (75.64%) followed by Alcoholic seed extract of *annona squamosa* 5% (61.00%), cypermethrin (0.018%) with 58.52%, Ethanolic seed extract of *annona squamosa* (5%) with 53.69%, Ethanolic NSKE (5%) with 53.69% Alcoholic NSKE (5%) with 48.79%. and neem oil 1%, with 46.38%. Neem oil (46.38%) was least effective among all the treatments during 7th day after 1st spray.
Treatments Alcoholic seed extract of *annona squamosa* 5% and cypermethrin (0.018%) were found non-significant and statistically at par with each other. Treatments Ethanolic seed extract of *annona squamosa* (5%) and Ethanolic NSKE (5%), Alcoholic NSKE (5%) and neem oil 1% were also found non-significant and statistically at par with each other.

Fourteenth day after 1st spraying
According to their reduction % the descending order of different treatments is given below.

CD Value (3.034)
T_2 T_3 T_4 T_6 T_5 T_7 T_1 T_0
77.44 66.11 61.30 61.30 56.43 48.40 41.91 0.0

The data on percent pod damage reduction over control on fourteenth day after spraying it is revealed that all the treatment was significantly superior over control. Among the treatment highest reduction of pod damage (77.44%) was recorded from combination of Neem oil + cypermethrin @ 0.5% + 0.009 % followed by cypermethrin @ 0.018% (66.11%), Ethanolic seed extract of *annona squamosa* (5%) with 61.30%, Ethanolic NSKE (5%) with 61.30%, Alcoholic seed extract of *annona squamosa* (5%) with 56.43%, Alcoholic NSKE (5%) with 48.40% and neem oil 1% with 41.91%. Neem oil (41.91%) was found least effective among all the treatments during 14th day after 1st spray.
Treatment Ethanolic seed extract of *annona squamosa* (5%) and Ethanolic NSKE (5%) was found statistically at par and non-significant with each other.
Percent reduction of pod damage due to application of botanicals and chemical insecticides (2nd spray)

Table 3: Efficacy of botanical and cypermethrin on reduction percent pod damage by *Etiella zinkenella* in pea during rabi season, 2012-13 (2nd spray)

Treatments	Before	3 DAS	7 DAS	14 DAS
Control	27.30	0.00	0.00	0.00
Neem oil 1%	12.84	54.35	59.65	59.60
Neem oil + Cypermethrin 25EC	6.62	77.17	80.71	80.85
Cypermethrin 25EC	7.61	68.47	71.10	71.63
Ethanolic seed extract of *annona squamosa* 5%	8.38	67.40	71.05	71.63
Alcoholic seed extract of *annono squamosa* 5%	10.49	63.15	64.92	65.95
Ethanolic NSKE 5%	8.56	66.31	66.65	66.70
Alcoholic NSKE 5%	12.04	57.61	59.65	58.90
Overall Mean	11.73	56.81	59.22	59.41
F-test	NS	S	S	S
S. Ed.(±)	7.048	1.215	1.574	1.150
C. D. (P=0.05)	14.942	2.576	3.336	2.437

Third day after 2nd spraying
CD Value (2.576)
The descending order of different treatments according to their reduction % is given below.
T_2 T_3 T_4 T_6 T_5 T_7 T_1 T_0
77.17 68.47 67.40 66.31 63.15 57.61 54.35 0.0
The data on percent pod damage revealed that reduction over control on three days after spraying all the treatment were significantly superior over control. Among the treatment highest reduction of pod damage (77.17%) was recorded from combination of Neem oil + cypermethrin @ 0.5% + 0.009 % followed by cypermethrin 0.018% (68.47%), Ethanolic seed extract of *annona squamosa* 5% with 67.40%, Ethanolic NSKE 5% with 66.31%, Alcoholic seed extract of *annona squamosa* (5%) with 63.15%, Alcoholic NSKE (5%) with 57.61% and Neem oil 1% with 54.35%. Neem oil (54.35%)

was found least effective among all the treatments during 3rd day after 2nd spray.
Treatments cypermethrin 0.018%, Ethanolic seed extract of *annona squamosa* 5% Ethanolic NSKE 5% was found statistically at par and non-significant with each other.

Seventh day after 2nd spraying
CD Value (3.336)
According to their reduction % the descending order of different treatments is given below.

T_2 T_3 T_4 T_6 T_5 T_7 T_1 T_0
80.71 71.10 71.05 66.65 64.92 59.65 59.65 0.0

The data on percent pod damage reduction over control on seventh day after spraying revealed that all the treatment were significantly superior over control. Among the treatments highest reduction of pod damage (80.71%) was recorded combination of Neem oil + cypermethrin @ 0.5% + 0.009 % followed by cypermethrin 0.018% (71.10%), Ethanolic seed extract of *annona squamosa* 5% with 71.05%, Ethanolic NSKE 5% with 66.65%, Alcoholic seed extract of *annona squamosa* (5%) with 64.92%, and both Alcoholic NSKE (5%) and Neem oil 1% with 59.65%, Neem oil (59.65%) was found least effective among all the treatments during 7th day after 2nd spray.
Treatments cypermethrin 0.018% and Ethanolic seed extract of *annona squamosa* 5% were found non-significant and statistically at par with each other. Treatments Ethanolic NSKE 5% and Alcoholic seed extract of *annona squamosa* (5%) & treatments Alcoholic NSKE (5%) and Neem oil 1% was found statistically at par and non-significant with each other.

Fourteenth day after 2nd spraying
CD Value (2.437)
According to their reduction % the descending order of different treatments is given below.

T_2 T_3 T_4 T_6 T_5 T_1 T_7 T_0
80.85 71.63 71.63 66.70 65.95 59.60 58.90 0.0

The data on percent pod damage reduction over control on fourteenth days after spraying revealed that all the treatment were significantly superior over control. Among the treatment highest reduction of pod damage (80.85%) was recorded from combination of Neem oil + cypermethrin @ 0.5% + 0.009 % followed by cypermethrin 0.018% (71.63%), Ethanolic seed extract of *annona squamosa* 5% with 71.63%, Ethanolic NSKE 5% with 66.70%, Alcoholic seed extract of *annona squamosa* (5%) with 65.95%, Alcoholic NSKE (5%) with 58.90% and Neem oil 1% with 59.60%. Neem oil (59.60%) was found least effective among all the treatments during 14th day after 2nd spray.
Treatments cypermethrin 0.018% and Ethanolic seed extract of *annona squamosa* 5% were found non-significant and statistically at par with each other. Treatments Ethanolic NSKE 5% and Alcoholic seed extract of *annona squamosa* (5%) & treatments Alcoholic NSKE (5%) and Neem oil 1% was found statistically at par and non-significant with each other.
In the present investigation, Ethanolic seed extract of *annona squamosa* gave the best result among the plant products treatments. Leatemia and Murray (2004) [9] reported that Ethanolic seed extract of *annona squamosa* gave the best result among the plant products against pod borer *Etiella zinkenella.* Kumar *(*2009) [8] reported that *Annona squamosa* acetogenins extracts from leaves and seeds have insecticidal or insect antifeedant properties. Seeds, flours, and leafs extract of *Annona squamosa* is toxic and has potent growth reducing activity to insect. These findings are close agreement with Yadav *et al.,* (2000) [18] who reported that treatment of cypermethrin shown the lowest pod damage (3.11%) followed by deltamethrin (3.45%) treated plots. There is no exact studies are undertaken but following studies are similar to this study, Neupane and Sah (1988) [11] conducted an field-plot studies were conducted in Nepal against the noctuid *Heliothis armigera* [*Helicoverpa armigera*] infesting the pigeon pea [*Cajanus cajan*] variety ICPL 366 and reported that The highest initial kill (after 1 day) was obtained with cypermethrin (90%), followed by deltamethrin and fenvalerate (both 80%), and parathion-methyl and endosulfan (both 20%). Panchabhavi *et al.,* (1994) [12] conducted an field study of a number of treatments consisting of application of neem seed extract and insecticides against *Helicoverpa armigera* on pigeon pea in Karnataka, India, in 1989-90, the lowest percentage pod damage and highest grain yield were recorded when fenvalerate was applied twice at 15-day intervals followed by neem seed extract at another 15-day interval. The highest cost-benefit ratio was obtained when cypermethrin was applied twice followed by neem seed extract (again at 15-day intervals).
Singh *et al.,* (2001) [17] conducted an field study of 48 plants extracts against pod borer under laboratory condition only 6 plant extracts exhibited antifeedant activity. These included the extracts from the leaves and roots of *Achyranthus aspera*, *Acorus colomus*, leaf and oil of *Azadirachta indica*, leaves of *Chrysanthemum cinerariefolium*, *Derris elliptica* and *Datura alba* under laboratory conditions. The pods treated with these plant extracts did not show injury due to *H. armigera*. Among the treatments the least antifeedant effect was observed with the leaf extract of *Annona squamosa* showing 60.43 per cent damage to the treated pods. Abdullah *et al.,* (2001) [1] conducted an field experiment Cypermethrin 10 EC at 1 litre/ha, neem (*Azadirachta indica*) at 1 litre/ha extract and *Bacillus thuringiensis* (53 000 spores per unit mg) at 400 g/ha to check efficacy of controlling insect pests on soyabean (*Glycine max* cv. AGS292) *Melanagromyza sojae, Spodoptera litura, S. exigua, Helicoverpa armigera, Lamprosema indicata* [*Omiodes indicata*], *Etiella zinckenella* and *Bemisia tabaci* were the most abundant pest species in both seasons. Insecticide applications were done at 10, 20, 30, 40, 50 and 60 days after sowing. Cypermethrin significantly controlled the majority of the insect pests better than the other treatments and the control in both seasons, and resulted in the highest yield (9.83 t/ha).
Ramteke *et al*., (2002) [13] reported that bio-pesticides such as Neem seed kernel extract 5%, Neem oil (300 ppm) and Endosulfan 0.07%, respectively in the same order of efficacy were found to economically suppress pest in order to lowest profitable yields against *Helicoverpa armigera* (Hub.). Rouf and Sardar (2006-07) [14] evaluated crude seed extract of neem, black pepper, mahogany, and garlic bulb with three doses were evaluated against legume pod borer in the country bean field in two seasons kharif 2006 and rabi 2006-07. The neem seed extract applied @150 and 100g/l and mahogany seed extract @ 100 g/l of water at 7 days intervals showed better performance in the reduction pod damage with

significantly higher yield of bean in both the seasons. The seed extracts lost the efficacy against legume pod borer after 7 days of application.

Husain (2007) [7] evaluated the efficacy of some synthetic and biopesticides against pod borer, Helicoverpa armigera (Hubner) damage in chickpea and recorded that significantly lowest pod damage was observed in cypermethrin (5.75%) and HNPV (5.86%) sprayed plots followed by carbaryl (6.05%) and dimethoate (7.92%) treated plots. The bio-control agent, HNPV, showed equally the best performance like synthetic insecticides and also showed higher efficacy than neem based insecticides like cimbicidine (Azadiractin 0.03% EC). Significantly the highest yield (1856 kg/ha) was obtained from HNPV sprayed plots which was stastically identical to cypermethrin followed by Azadiractin 0.03% EC. Gawade *et al.*, (2009) [4] studied five plant products, namely neem seed powder, vekhand (*Acorus calamus* L.) powder, castor oil, mustard oil and neem oil and four synthetic insecticides, viz., deltamethrin, cypermethrin, fenvalerate and malathion as seed protectants against the pulse beetle, *Callosobruchus maculatus* (F.) on cowpea and showed that cypermethrin (50 ppm) was second most effective against pulse beetle after deltamethrin. Among the botanicals, vekhand powder (2.5 g/kg) and neem oil (2.5 ml/kg) were significantly more effective than the rest.

Summary and Conclusion

Two sprays of Neem oil + cypermethrin @ (2 + 0.35 ml/l) and cypermethrin @ 0.7 ml/l proved significantly superior over rest of the treatments. These treatment could reduce the pod damage to the extent of 79.58% and 70.40%, respectively whereas, Ethanolic NSKE (5%), Alcoholic seed extract of *annona squamosa* (5%), Alcoholic NSKE (5%) and neem oil 1% registered equal effectiveness against *Etiella zinkenella* (66.55 to 57.87 percent reduction).

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