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Bio-efficacy and Eco-friendly Management on the Incidence of Major Insect Pests of Green Gram, *Vigna radiata* L. Wilczek

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Abstract: *A field experiment was conducted in the Experimental Research Farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema campus during July to September, 2013 to study the eco-friendly management on insect pest complex in green gram. The study was conducted in Randomized Block Design (RBD) with three replications having eight treatments viz., Costus speciosus stem extract @ 40ml/lit, Eucalyptus bark ash extract @ 20 ml/lit, Max Ranger @ 5 ml/lit, Max Swarna @ 5ml/lit, Citronella oil @ 5 ml/lit, Neem oil @ 5ml/lit, Imidacloprid 17.8 SL @ 0.4 ml/lit and untreated control. Several insect pests were found to infest the crop in different stages viz.,Bean fly,Melanagromyza (Ophiomyia) phaseoli; Leaf webber, Lamprosema indica (F.); Green semilooper, Anomis flava Fab.; Tobacco caterpillar, Spodoptera litura; Green stink bug, Nezara viridula L.; Pod bug,Clavigralla spp.; Plant bug, Riptortus spp.; Blister beetle, Mylabris pustulata Thunberg and Pod borer, Helicoverpa armigera Hubner were observed. Out of these, blister beetle,Mylabris pusulataand plant bug, Riptortus spp. were found to be the major insect pests during the season and caused economical losses to the crop. Among the botanicals, the best result was indicated by Citronella oil @ 5ml/lit for controlling the Mylabris pustulata population of whereas the best result was indicated by Costus speciosus @ 40ml/lit in controlling the Riptortus spp. population. Among the plant products Citronella oil @ 5ml/lit was found to obtain the highest Benefit Cost ratio.*

Key words*: Green gram, Incidence, Botanicals, Benefit Cost ratio.*

INTRODUCTION

Pulses in general are the second most important food after cereals in many parts of the world especially South East Asia and in India. Several pulse crops are grown under various climatic conditions and cropping systems (Baruah, 1990). They provide nutritious food for man, make high quality fodder for animal and enrich the soil fertility through biological nitrogen fixation (Swaminathan, 1981). In regions where animal protein is scarce, pulses provide the alternative source of protein to the people (Norton *et al*. 1985). Scientific research has confirmed that the protein of green gram is more readily digestible than that of other pulses (Swaminathan, 1971).

India is the largest producer and consumer of green gram in the world which accounts about 10-12% of the total pulseproduction in the country. Green gram is widely cultivated pulse crops after chickpea and pigeonpea; the major producing states in India being Andhra Pradesh, Orissa, Maharashtra, Madhya Pradesh and Rajasthan accounting for about 70% of totalproduction (Mogotsi, 2006).

In India, green gram occupies an area of about 342.79 thousand hectares with the total production of about 1034.60thousand tonnes (Anonymous, 2012). Among the states, Rajasthan occupied the largest area of about 127.22 thousand hectares with highest production of 373.20 thousand tonnes (Anonymous, 2012). In Nagaland, the total production of green gram was 31.0 tonnesfrom an area of about 31.0 hectares with a productivity of 1000 kg/ha (Anonymous, 2014).

Lal (1985) reported 64 species of insects that attacking green gram in the field, among these sucking insect pests whiteflies, jassids, and thrips are of the major importance (Khattak *et al*. 2004). According to Saxena (1972), the yield reduction due to insect pests in green gram ranges from 53 to 98 per cent.

Improper use of synthetic pesticides, sub-standard products, and excessive dosage resulted in

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many unwanted effects such as insecticide resistance, pest resurgence, health and environmental hazards as well as toxic to insects of economic importance.

Use of plants or botanicals is not new and has been in practice centuries back as eco-friendly pesticides. Albert *et al*. 2014, reported that plants extracts like *Litseacitrate* seed extract, *Costus speciosus* stem extract, *Chenopodium ambrosioides* seed extract found to be very effective against insect pest of rice. It does not cause environmental hazards and are not toxic to human and other beneficial natural enemies. North east India particularly, Nagaland is endowed with rich biodiversity of florawhich hasrich bio-pesticidal properties. So, by keeping all this in mind present investigation was carried out.

METHODOLOGY

An experiment was carried out in the Entomological farm School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema campus situated at 25º 4′5, 45"N latitude and 93º 5′5 04′ E longitude elevated at 310 metres above mean sea level. Rainfall ranges from 2000-2500 mm and the mean temperature ranges from 25º to 35 ºC during summer and upto 8 ºC in winter. The cultivar K851 was used for carrying out the experiment. Three locally and cheaply available plant products viz., *Costus speciosus* stem extract; Eucalyptus bark ash extract and Citronella oil were collected from in and around Medziphema and other parts of Nagaland for use as treatments for present investigation. *Costus speciosus*stem extractand Citronella oil was obtained by crushing the stem andleaves with the help of metallic mortar and squeezing out the juice liquid and then filtered through What man filter paper respectively. Eucalyptus bark about 150gm was dried and burned and the ash so obtained was soaked in 3 litres water for overnight and filteredwith the help of Whatmanfilter paper.

Five plants per plot were randomly selected and tagged and the population count was estimated by counting the number of beetles and plant bugs on five tagged plants/plot and five sweeps/plot respectively at weekly intervals throughout the cropping period starting from 30 days after sowing.

Observations on the efficacy of certain insecticides employed for carrying out the experiment were recorded as pre-treatment and post-treatment count. The data collected were subjected to Arc sine or angular transformation and before that percentage reduction was statistically analyzed.

The percent reduction on the pest infestation was calculatedby using the formula:

$$Percent(\%)\,reduction = \frac{Pre-treatment\ count - Post\ treatment\ count}{Pre-treatment\ count}$$

Gross return was estimated considering the monetary value of the economic produce of different treatments based on the prevailing market prices per ha of the different produce. Net return for each treatment was estimated by subtracting the total cost of cultivation from the gross return treatment wise.

Net return = Gross return – Cost of cultivation

Benefit Cost ratio was calculated by the following formula:

$$BCR = \frac{Net\ return}{Cost\ of\ cultivation}$$

The transformed values were subjected to one way analysis of variance (ANOVA) by Randomized Block Design (RBD). 'F' test was used to determine the significance and non-significance of the variance due to different treatments at 0.05% level of significance. Further, comparison between the different treatments was carried out by Duncan's Multiple Range Test (DMRT) to find out the significant differences between mean values.

RESULTS AND DISCUSSION

(i) Pest complex observed during the investigation

Nine insect pests were recorded during the course of investigation exhibiting different feeding behavior in all crop stages (Table 1), they were Bean fly, *Melanagromyza (Ophiomyia) phaseoli*; Leaf webber, *Lamprosema indica* (F.); Green semilooper, *Anomis flava* Fab.; Tobacco caterpillar, *Spodoptera litura*; Green stink bug, *Nezara viridula* L.; Pod bug, *Clavigralla*spp.; Plant bug, *Riptortus* spp., Blister beetle, *Mylabris pustulata* Thunberg and Pod borer,*Helicoverpa armigera* Hubner were observed. The present findings are in conformity with Rahman (1979) who found out twelve insect pests attacking green gram during summer season viz. Flea beetle, *Monolepta* sp.; Jassid, *Empoasca kerri*; White grub, *Holotricha* sp.; Coreid bugs, *Riptortus* spp.; Semilooper, *Plusia orichalca* Fabr.; Leaf roller, *Nacoleia vulgalis* Guenee and Red cotton bug, *Dysdercus koenigii* Fabr.

(ii) Incidence andCorrelation of *Riptortus* spp. and *Mylabris pustulata*Thunb. population with weather parameters

(a) Incidence of Blister beetle and its correlation: Blister beetle, *Mylabris pustulata* was first observed on the43rd standard week i.e.6th August, 2013 with a mean population of 0.37 (Table 2). The highest mean population of *Mylabris* i.e. 5.67 observed on 47th standard week,with maximum temperature of 30.8ºC, minimum temperature of 20.6ºC, relative humidity of 60% and rainfall of 8.1mm. The lowest mean population of *Mylabris pustulata* 0.27 was observed on 50th standard week with maximum temperature of 30.3ºC, minimum temperature of21.9ºC, relative humidity of 56% and rainfall of 54.6 mm. *Mylabris pustulata* were found to be more active during morning and evening hours. Correlation studies between weather parameters and blister beetle, *Mylabris pustulata* (Table 3) population had shown negative non significant correlation with maximum and minimum temperature, mean relative humidity and rainfall. The present findings is in conformity

Table 1
Insect pests recorded on green gram during the investigation

	Common Name	*Scientific Name/Order/Family*	*Crop Phenology*	*Feeding Site*	*Pest Status*
DEFOLIATORS					
1	Green semilooper	*Anomis flava* Fab. (Lepidoptera: Geometridae)	Vegetative stage	Foliage	Minor
2	Leaf webber	*Lamprosema indica* Fab. (Lepidoptera: Pyralidae)	Vegetative stage	Foliage	Minor
3	Tobacco caterpillar	*Spodoptera litura* Fab. (Lepidoptera:Noctuidae)	Vegetative stage	Foliage	Minor
SUCKING PEST					
1	Plant bug	*Riptortus* spp. (Hemiptera: Coreidae)	Fruiting stage	Pods	Major
2	Pod bug	*Clavigralla* spp. (Hemiptera: Coreidae)	Fruiting stage	Pods	Minor
3	Green stink bug	*Nezara viridula* Linn. (Hemiptera: Pentatomidae)	Vegetative and fruiting stage	Plant parts, pods	Minor
CORTEX FEEDER					
1	Bean fly	*Melanagromyzaphaseoli* Tryon. (Diptera:Agromyzidae)	Early vegetative stage	Stem	Minor
POD BORER					
1	Gram pod borer	*Helicoverpa armigera* Hub. (Lepidoptera: Noctuidae)	Fruiting stage	Pods	Minor
FLOWER FEEDER					
1	Blister beetle	*Mylabris pustulata* Thunb. **(**Coleoptera: Meloidae)	Reproductive stage	Buds and flowers	Major

Table 2
Incidence of major insect pests of green gram during July-September, 2013

Standard week	*Temperature(°C)*		*Relative Humidity (%)*	*Rainfall (mm)*	*Major insect pests*	
	Maximum	*Minimum*			*Mylabris pustulata*	*Riptortus spp.*
42nd	31.70	22.30	100.00	52.10	0.00 (0.71)	0.36 (0.93)
43rd	30.30	22.00	100.00	0.00	0.37 (0.93)	0.61 (1.05)
44th	31.60	21.10	68.00	72.10	0.41 (0.95)	1.02 (1.23)
45th	30.50	22.10	52.00	0.00	1.52 (1.42)	1.61 (1.45)
46th	32.10	22.50	64.00	23.90	2.15 (1.63)	1.87 (1.54)
47th	30.80	20.60	60.00	8.10	5.67 (2.48)	3.34 (1.96)
48th	32.40	20.00	58.00	30.90	2.81 (1.82)	1.21 (1.31)
49th	31.90	21.70	56.00	56.40	0.57 (1.03)	0.37 (0.93)
50th	32.30	21.90	56.00	56.40	0.27 (0.88)	0.17 (0.82)

Note: Figures in the table are mean values and those in parenthesis are square root transformed values.

with Mahal *et al.* (1989) who reported that the adults appeared in late August and fed on flowers till October. They also found that adults were most active during the morning and evening and were found to be in an aggregated distribution. They were found to feed mainly on flower and newly formed bud which is in conformity with the findings of Singh and Oswalt (1992) who concluded that the blister beetle attack in green gram is severe at the flowering stage.

(b) Incidence of Plant bug and its correlation: The incidence of plant bug, *Riptortus* spp.was first observed on the 42nd standard week i.e. 30th July, 2013 with a mean population of 0.36 (Table 2). The highest mean population of *Riptortus* spp. i.e. 3.34 were observed on 47th standard week.with maximum temperature of 30.8°C, minimum temperature of 20.6°C, relative humidity of 60%and rainfall of 8.1mm. The lowest mean population of *Riptortus* spp. i.e. 0.17 were observed on 50th standard week with maximum temperature of 30.3°C, minimum temperature of 21.9°C, relative humidity of 56% and rainfall of 54.6 mm. Correlation studies between weather parameters and plant bug, *Riptortus* spp. (Table 3) showed negative non significant correlation with maximum and minimum temperature, mean relative humidity and rainfall. The present findings are in conformity with Bharathimeena *et al.* (2006). They recorded that the adult population of *R. pedestris* and *R. linearis* peaked significantly during the first and second fortnights of June 2006 respectively, when compared to most other periods of the year. There was no significant correlation between the population of *Riptortus* spp. with the abiotic factors which was also found out by Sarma and Dutta (1997) who observed that none of the meteorological factors has any significant effect on *Riptortus* spp. populations.

(iii) Efficacy of certain plant products against insect pests of green gram

(a) Efficacy of certain plant products on the population of blister beetle, Mylabris pustulata Thunb: The population of *Mylabris pustulata* was considerably reduced by using all the botanicals as well as Imidacloprid 17.8 SL (Table 4), where Imidacloprid 17.8 SL gave the highest per cent reduction in the 3rd (90.00) and 5th (54.30) days after first spray and in the 1st day (73.93) after 2nd spraying and the botanicals also gave significant results but were less effective than Imidacloprid. Among the botanicals citronella gave highest reduction of pest in first spray (83.50). Work done by Boopathi *et al.* (2009) who conducted field trials to study the effectiveness of three Neem pesticides, two microbial pesticides, two synthetic pyrethroids and seven conventional insecticides against blister beetles, *Mylabris pustulata* and *Epicauta* spp. in green gram. Study revealed that all treatments were noticed significantly superior over untreated check in reducing the blister beetles population. Spraying with Malathion (98.69%) and Imidacloprid (98.27%) were noticed significantly more effective in reducing the adult population of Mylabris pustulata fifteen days after treatment. Neem pesticides and microbial pesticides proved moderately effective against blister beetle.

(b) Efficacy of certain plant products on the population of plant bug, Riptortus spp.: The chemical imidacloprid 17.8 SL was found to give the best result in reducing the pest population of *Riptortus* spp. in all the spraying schedules and with highest reduction of about 90.00 in second spraying (Table 5). It also gave the highest yield which was similar with the findings of Bharathimeena and Sudharma (2013) who found out that Imidacloprid 0.005% treated plants recorded significantly lower counts of *R. pedestris* nymphs and the highest yield. Among the botanicals *Costus speciosus* gave the best result with highest reduction of about 81.44, in first spraying followed by Citronella (80.00), Max Ranger (75.00), Max Swarna (73.11), Neem oil (65.08) and lastly Eucalyptus bark ash (65.08) which in case of neem oil is similar with Bharathimeena and Sudharma (2013) who found that among the botanical insecticides, crude neem oil emulsion was on par with 0.03% azadirachtin emulsion in reducing the nymphal counts of *R. pedestris* and significantly

Table 3
Correlation coefficient (r) of green gram insect pest population with weather parameters

Weather parameters	*Pearson's correlation coefficient*	
	Mylabris pustulata	*Riptortus spp.*
Maximum temperature (°C)	-0.15528^NS	-0.33770^NS
Minimum temperature (°C)	-0.57948^NS	-0.36930^NS
Relative humidity (%)	-0.39649^NS	-0.33421^NS
Rainfall (mm)	-0.50025^NS	-0.55267^NS

Note: NS = Non-significant at 5% level of significance

Table 4
Field efficacy of different treatments against blister beetle at first and second application during Kharif season, 2013

Treatment	*Dose/lt water*	*Pre-treatment count*	*First spray*				*Pre-treatment count*	*Second spray*			
			Percent (%) reduction					*Percent (%) reduction*			
			1 DAA	*3 DAA*	*5 DAA*	*7 DAA*		*1DAA*	*3 DAA*	*5 DAA*	*7 DAA*
Costus speciosus stem extract	40 ml	1.46	71.34[ab] (57.63)	76.19[c] (60.79)	39.71[c] (39.06)	22.08[b] (28.03)	0.93	55.65[c] (48.24)	49.85[c] (44.91)	58.24[bc] (49.74)	58.75[c] (50.04)
Eucalyptus bark ash	20 ml	1.00	51.14[d] (45.65)	59.21[e] (50.31)	30.66[d] (33.62)	21.81[b] (27.84)	0.80	64.22[b] (53.26)	8.85[e] (17.31)	30.00[e] (33.21)	51.14[d] (45.65)
Max Ranger	5 ml	1.13	76.92[a] (61.29)	40.37[f] (39.45)	53.59[a] (47.06)	22.14[b] (28.07)	0.93	48.75[d] (44.28)	73.07[a] (58.74)	82.59[a] (65.34)	66.15[b] (54.42)
Max Swarna	5 ml	1.20	73.74[ab] (59.17)	69.52[d] (56.49)	33.24[d] (35.21)	22.95[b] (27.24)	0.93	71.19[a] (57.54)	49.85[c] (44.91)	39.48[d] (38.93)	74.56[a] (59.71)
Citronella oil	5 ml	1.46	70.00[b] (56.79)	83.50[b] (66.03)	45.17[b] (42.23)	33.42[a] (35.32)	0.87	71.24[a] (57.57)	34.30[d] (35.85)	53.87[c] (47.22)	51.24[d] (45.71)
Neem oil	5 ml	1.20	63.72[c] (52.96)	66.96[d] (54.91)	20.24[e] (26.74)	20.00[b] (26.57)	0.87	58.93[bc] (50.14)	58.93[b] (50.14)	33.24[e] (35.21)	33.24[e] (35.21)
Imidacloprid 17.8 SL	0.4 ml	1.13	73.93[ab] (59.30)	90.00[a] (71.57)	54.30[a] (47.47)	35.57[a] (36.61)	0.87	73.93[a] (59.30)	54.86[bc] (47.79)	60.00[b] (50.77)	66.96[b] (54.91)
Untreated control	------	1.33	0.00[f] (0.05)	0.00[g] (0.05)	0.00[f] (0.05)	0.00[c] (0.05)	1.13	0.00[e] (0.05)	0.00[e] (0.05)	0.00[f] (0.05)	0.00[f] (0.05)
SEm±		***0.87***	***1.92***	***1.99***	***1.54***	***1.37***	***0.65***	***1.94***	***1.78***	***1.67***	***1.89***
CD (p=0.05)		***2.64***	***5.82***	***6.04***	***4.67***	***4.16***	***1.97***	***5.88***	***5.40***	***5.07***	***5.73***

Note: DAA- Days after application
Figures in the table are mean values and those in parenthesis are angular transformed values
Same small letter(s) in a column after mean values indicates non-significant different from each other at 5% level of significance

Table 5
Field efficacy of different treatments against plant bug at first and second application during Kharif season, 2013

Treatment	Dose/lt water	Pre-treatment count	First spray: Percent (%) reduction				Pre-treatment count	Second spray: Percent (%) reduction			
			1 DAA	3 DAA	5 DAA	7 DAA		1DAA	3 DAA	5 DAA	7 DAA
Costus speciosus stem extract	40 ml	1.07	81.44[a] (64.48)	52.09[b] (46.20)	52.46[c] (46.41)	38.85[e] (38.56)	0.47	63.24[d] (52.68)	52.09[c] (46.20)	52.46[c] (46.41)	11.75[e] (20.05)
Eucalyptus bark ash	20 ml	0.67	38.24[c] (38.20)	45.00[c] (42.13)	50.00[c] (45.00)	31.75[f] (34.30)	0.87	16.92[g] (24.29)	45.00[d] (42.13)	50.00[c] (45.00)	21.14[d] (27.37)
Max Ranger	5 ml	0.87	38.24[c] (38.20)	75.00[a] (60.00)	75.00[a] (60.00)	61.75[c] (51.80)	0.73	41.75[e] (40.25)	75.00[a] (60.00)	75.00[a] (60.00)	28.25[c] (32.11)
Max Swarna	5 ml	1.07	68.89[b] (56.10)	43.07[c] (41.02)	73.11[a] (58.76)	73.07[b] (58.74)	0.87	71.14[c] (57.51)	43.07[d] (41.02)	73.11[a] (58.76)	43.08[b] (41.02)
Citronella oil	5 ml	1.20	66.06[b] (54.37)	80.00[a] (63.43)	61.76[b] (51.80)	61.76[c] (51.80)	0.60	78.24[b] (62.19)	80.00[a] (63.43)	61.76[b] (51.80)	60.00[a] (50.77)
Neem oil	5 ml	1.13	65.08[b] (53.78)	58.07[b] (49.64)	53.89[c] (47.23)	50.16[d] (45.09)	0.67	35.16[f] (36.37)	58.07[b] (49.64)	53.89[c] (47.23)	39.39[b] (38.87)
Imidacloprid 17.8 SL	0.4 ml	1.20	66.96[b] (54.91)	75.00[a] (60.00)	75.06[a] (60.04)	83.09[a] (65.72)	0.53	90.00[a] (71.57)	75.00[a] (60.00)	75.06[a] (60.04)	65.00[a] (53.73)
Untreated control	------	1.33	0.00[d] (0.05)	0.00[d] (0.05)	0.00[d] (0.05)	0.00[g] (0.05)	1.13	0.00[h] (0.05)	0.00[e] (0.05)	0.00[d] (0.05)	0.00[f] (0.05)
SEm±		***0.89***	***1.97***	***2.12***	***1.89***	***1.97***	***0.76***	***1.75***	***1.87***	***1.72***	***2.01***
CD (p=0.05)		***2.70***	***5.98***	***6.43***	***5.73***	***5.98***	***2.31***	***5.31***	***5.67***	***5.22***	***6.10***

Note: DAA- Days after application
Figures in the table are mean values and those in parenthesis are angular transformed values
Same small letter(s) in a column after mean values indicates non-significant different from each other at 5% level of significance

superior in terms of yield when compared with 1% azadirachtin emulsion.

Yield was recorded highest in the plots treated with imidacloprid 17.8 SL followed by *Costus speciosus* stem extract, Eucalyptus bark ash and Max Swarna gave equal yield which was followed by Citronella oil, Neem oil and the least was found in the control plot.

All the treatments resulted in benefit over cost (Table 6) in which Imidacloprid 17.8 SL was found to gives the highest with 1.74. The botanicals exhibited similar benefit over cost in the sequence of Citronella oil, *Costus speciosus*, Eucalyptus bark ash, Max Ranger, Neem oil and Max Swarna with 1.39, 1.20, 1.15, 0.76, 0.71 and 0.34 respectively.

Table 6
Benefit Cost ratio of green gram, *Vigna radiata* L. Wilczek

Treatment	*Cost of cultivation (Rs/ha)*	*Gross return (Rs/ha)*	*Net return (Rs/ha)*	*Benefit Cost ratio*
Costus speciosus stem extract	25044.32	55215.16	30170.84	1.20
Eucalyptus bark ash extract	25044.32	54065.00	29020.68	1.15
Max Ranger	39794.32	70169.44	30375.12	0.76
Max Swarna	39794.32	53489.32	13695.60	0.34
Citronella oil	24944.32	59819.32	34875.00	1.39
Neem oil	26169.32	44862.53	18693.21	0.71
Imidacloprid 17.8 SL	24506.82	67294.04	67048.35	1.74
Control	24044.32	46587.64	22543.32	0.93

CONCLUSION

The plant products like *Costus speciosus*, Eucalyptus barkand Citronella oil was observed to be very effective against insect pests. So, further research and investigation is recommended to bring out more effective pesticidal control measures.

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