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Seed treatment and intercrop systems for the management of leaf folder (*Nacoleia vulgalis*) and stem fly (*Ophiomyia phaseoli*) in soybean (*Glycine max*)*

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Soybean [*Glycine max* (L.) Merr] is one of the important legume crops in Meghalaya and attacked by several insects, particularly the pyralid leaf folder (*Nacoleia vulgalis* Guen, *N. diemenalis* Guen) and stem fly *(Ophiomyia phaseoli* Tryon) cause significant yield loss (Thakur 1985). Several workers from NEH region recommended various chemical (foliar spray or granular application) measures to control these insect pests (Thakur 1993, Thakur and Gangwar 1989). The manifestations of these sprays or granular application by broadcasting in the soil before sowing are of concern in view of the conservation of soil dwelling as well as aerial moving biocontrol fauna. The importance of considering the first (plant) trophic level in integrated pest management systems and manipulating the components of cropping systems to provide improved and sustainable insect pest management have not been extolled. Experiments on tri-trophic interactions pertaining to insect pests have expanded rapidly during the past few years (Moraes *et al.* 2008, Shelton and Perez 2006). The manipulation of the first trophic level through alterations in plant nutritional source to create a partial nitrogen stress to certain period of crop growth which is called induced resistance combined with various pro-crop pest management practices like planting intercrops (or trap crops) and seed treatment have been studied rigorously in groundnut to create an equilibrium between the pests and natural enemies without compromising on yield (Rajasekhara *et al*. 2001 a,b). Such intensive studies linking laboratory and field experiments in this context are lacking and in view of such demand a field study was conducted to explore the potential of manipulating crop-pest-predator interaction through improved practices of pest management in soybean.

Two field experiments were conducted from June to October in rainy (*kharif*) season during 2003 and 2004 to compare maize and rice as intercrops in soybean combined with different seed treatment chemicals under two-host plant-nutritional regimes with fertilizer and with neem cake powder. The fertilizer used was NPK @ 40-60-40 kg/ha and the de-oiled neem cake powder (5-1-1.5% NPK) @ 0.77 tonnes/ha. The first experiment with direct fertilizers as plant nutrition consisted of 7 treatments, viz. $T_{1,}$ fertilizer-no seed treatment (control); $T_{2,}$ fertilizer + carbofuran seed treatment; $T_{3,}$ fertilizer + imidachloprid seed treatment; $T_{4,}$ fertilizer + carbofuran seed treatment + maize intercrop; $T_{5,}$ fertilizer + imidachloprid seed treatment + maize intercrop; $T_{6,}$ fertilizer + carbofuran seed treatment + rice intercrop; $T_{7,}$ fertilizer + imidachloprid seed treatment + rice intercrop. The second field experiment with neem cake powder as plant nutrition consisted of 8 treatments, viz $T_{1,}$ fertilizer-no seed treatment (control); $T_{2,}$ neem cake powder - no seed treatment (control); $T_{3,}$ neem cake powder + carbofuran seed treatment; $T_{4,}$ neem cake powder + imidachloprid seed treatment; $T_{5,}$ neem cake powder + carbofuran seed treatment + maize intercrop; $T_{6,}$ neem cake powder + imidachloprid seed treatment + maize intercrop; $T_{7,}$ neem cake powder + carbofuran seed treatment + rice intercrop; $T_{8,}$ neem cake powder + imidachloprid seed treatment + rice intercrop. The field experiments were conducted in randomized block design with three replications. Carbofuran 3G @ 250 g/kg seed and imidachloprid 200 SL @ 5 ml/kg seed were used for treating soybean one hr before sowing. The carbofuran granules were immersed in 2 litres of water and the seed was soaked in that water for one hr. The inorganic fertilizer was applied on the day of sowing and the neem cake was applied one week before sowing in furrows. Intercropping of soybean was done with maize (4: 2: 4) and rice (4: 2: 4) (soybean: maize/rice: soybean in 4: 2: 4) with a view to enhance the activity of natural enemies.

The observations on the counts of soybean insect pests, viz. leaf folder (*N. vulgalis*, *N. dimenalis*), stem fly (*O. phaseoli*), leaf beetles (*Monolepta signata* Oliv. and *Chaetocnema basalis* Baly); natural enemies abundant in soybean in the field, viz. coccinellids (*Coccinella*

*Short note

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septumpunctata L., *Coccinella transversalis* Fab., *Cheilomenes sexmaculatus* Fab., *Scymnus latemaculatus* Motsc., *Pharoscymnus horni* (Wise) and *Sticholotis quadrisignata* Weise and different species of spiders were recorded at weekly intervals from 20 days after sowing till the harvest of the crop. The data was pooled and averaged. Transformation of the data was done according to Gomez and Gomez (1984). Analysis of variance was done for the transformed data and Duncan's Multiple Range Test (DMRT) was used for comparing the transformed and original means.

In general, the experiment that received neem cake powder as soybean plant nutrition recorded less infestation of leaf folder, stem fly and leaf beetle than the experiment which received direct fertilizers as a nutritional source (Table 1). Among the treatments that received fertilizers with other practices, the plot with imidachloprid seed treatment and rice

Table 1 Observations of insect pests of soybean and their predators when the plots were given fertilizer and neem cake powder as nutritional source (pooled data of 2003 and 2004)

Treatment	Pest			Predator		Soybean yield (kg/ha)	Inter-crop yield (kg/ha)	Soybean equiva-lent yield (kg/ha)	Benefit: cost ratio
	Leaf folder (% damage)	Stem fly[#] (% damage)	Leaf beetles[$]/ 10 plants	Cocci-nellids[$]/ 10 plants	Spiders[$]/ 10 plants				
Experiment 1									
T_1, fertilizer - no seed treatment (control)	42.5f	25.3 d(5.01)	35.0 c(1.55)	20.3 b(1.31)	8.0 b(0.94)	1 432		1432a	1.49a
T_2, fertilizer + carbofuran seed treatment	28.5d	09.7 b(3.09)	18.33 abc(1.28)	7.66 a(0.93)	5.33 a(0.79)	1 628		1628c	1.63b
T_3, fertilizer + imidachloprid seed treatment	33.4e	06.4 a(2.47)	15.33 ab(1.20)	8.0 a(0.94)	6.33 a(0.85)	1 712		1712d	1.68bc
T_4, fertilizer + carbofuran seed treatment + maize intercrop	22.7c	13.7 c(3.68)	23.66 bc(1.38)	35.33 d(1.56)	13.66 c(1.16)	1 230	746	1541b	1.62b
T_5, fertilizer + imidachloprid seed treatment + maize intercrop	24.9c	12.1 c(3.46)	24.33 bc(1.39)	40.0 d(1.60)	14.66 d(1.25)	1 324	822	1667c	1.71c
T_6, fertilizer + carbofuran seed treatment + rice intercrop	14.3b	8.3 b(2.85)	13.0 ab(1.13)	25.33 bc(1.41)	20.0 de(1.31)	1 345	612	1702d	1.82d
T_7, fertilizer + imidachloprid seed treatment + rice intercrop	9.1a	5.4 a(2.29)	10.33 a(1.04)	27.66 c(1.44)	21.33 e(1.34)	1 420	680	1817e	1.92e
Experiment 2									
T_1, fertilizer - no seed treatment (control)	42.5d	25.3 e(5.01)	35.3 e (1.55)	20.33 e(1.31)	8.0 c(0.94)	1 506		1506bc	1.57ab
T_2, Neem cake powder - no seed treatment (control)	20.3c	6.2 d(2.44)	10.33 d(1.05)	5.33 b(0.78)	3.33 b(0.61)	1 412		1412a	1.54a
T_3, Neem cake powder + carbofuran seed treatment	11.5b	4.3 bc(2.05)	4.33 b(0.71)	3.33 a(0.61)	2.0 a(0.45)	1 558		1558cd	1.63bc
T_4, Neem cake powder + imidachloprid seed treatment	12.1b	3.7 b(1.92)	4.66 b(0.73)	3.33 a(0.61)	2.33 ab(0.51)	1 624		1624d	1.65c
T_5, Neem cake powder + carbofuran seed treatment+ maize intercrop	9.7b	5.3 cd(2.30)	8.33 c(0.96)	16.33 d(1.22)	6.33 c(0.83)	1 176	682	1460ab	1.62bc
T_6, Neem cake powder + imidachloprid seed treatment+ maize intercrop	10.3b	5.5 d(2.34)	8.66 c(0.97)	18.66 d(1.28)	6.33 c(0.85)	1 264	768	1584cd	1.73d
T_7, Neem cake powder + carbofuran seed treatment + rice intercrop	5.2a	2.5 a(1.56)	3.33 a(0.61)	8.0 c(0.95)	15.66 d(1.20)	1 228	584	1619c	1.76de
T_8, Neem cake powder + imidachloprid seed treatment + rice intercrop	3.3a	2.10 a(1.43)	3.00 a(0.59)	9.33 c(1.01)	15.66 d(1.21)	1 348	654	1734e	1.81e

Mean separation in a column by DMRT (P<0.05)

The figures in parentheses are square root transformed[#] and log (X+1) transformed[$] values in the respective columns

as intercrop recorded lowest (9.1%) leaf folder damage, followed by carbofuran seed treatment plot with rice and carbofuran or imidachloprid seed treatment plots with maize as intercrop. More or less similar trend was noticed in case of stem fly damage. The lowest number of leaf beetles (10.33/10 plants) were recorded in fertilizer + imidachlorpid seed treatment + rice intercrop plot when compared to the straight fertilized control plot (35/10 plants). In the second field experiment, wherein neem cake powder was used as nutritional source, very less damage by leaf folder, stem fly and leaf beetles was recorded when compared to all the treatments of first experiment except the straight fertilized control. This showed the superiority of reduction of pests in neem cake powder applied plots than the fertilizer applied plots (Table1). The plot that received neem cake alone could not reduce the pests but lowered their damage or incidence significantly, i e 2 to 3 times when compared to the plot received fertilizer alone.

These results showed the combined advantage of using seed treatment as a method of control measure of leaf folder and stem fly (up to more than 30 days) and intercropping of soybean with maize or rice to enhance the activity of natural enemies in reducing the pest abundance. When fertilizer is used as nutritional source the incidence of pests was more even with other combined practices of pest management when compared to neem cake powder used as nutritional source. When plant nutrition is provided through organic source, the plants get some sort of stress for nutrients uptake, especially for nitrogen (N) and deter insects feeding on foliage because of low levels of nitrogen in the leaves and at the same time there will be an increased production of anti-herbivore compounds like phenols and tannins under such nutritional stress (Cornell and Hawkins 2003, Rajasekhara Rao *et al*. 2001a).

Treatment of soybean seed with carbofuran or imidachloprid has resulted in significant reduction in damage or incidence of pests under study when compared to control. Carbofuran belong to phenyl carbamate and the imidachloprid to the nitroguanidines group possessed a phytotonic effect (Rajasekhara Rao *et al*. 2001b). Comparatively the number of coccinellids or spiders was more in plots with fertilizer rather than with neem cake powder. It was attributed as lower pest incidence in neem cake powder plots or might be due to the prey (pest) feeding on leaves of neem cake applied plants was not preferred by these predators. The seed treated plots recorded less number of coccinellids and spiders when compared to remaining treatments. Similarly, Rajasekhara Rao *et al*. (2001b) reported the lower abundance of coccinellids, spiders and chrysopids in neem cake applied groundnut plots than the straight fertilized plots.

There were differences among the two intercrops in favouring specific category of predators. Rice as intercrop in soybean favoured the build-up of spiders and maize as intercrop favoured the coccinellid build-up. It was interpreted that the web formation for spiders was easy in rice intercrop because the leaves in rice are clumped and close to each other. This facilitates rapid attack of the spiders on foliage feeding insects, whereas in case of maize the plant foliage is huge, tall and the leaves would be apart from each other and would not be congenial for web formation as was in rice. But these conditions in maize favoured coccinellid beetles. Through literature it was evident that coccinellid beetles were efficient predators of insect pests, our results showed that in spite of being their higher number in soybean + maize compared to soybean + rice, the insect damage in the respective plots was not lessened. From these results it was also evident that rice as intercrop was better than maize as intercrop as it created conditions favourable for building of spiders which were proved to be efficient predators on the insect pests under study suggesting that natural enemies would be more abundant in diverse rather than simple habitats. This was also evident with highest benefit : cost ratio of 1.92 with fertilizer + ST with imidachloprid + rice intercrop system (Table 1). There are many ways in which the microclimate of the crop can be altered with an aim to enhance biological control and reducing the intensity of insect pests. The results in this research are not universally applicable owing to the great diversity of cropping systems under heterogeneous farming practices. It is likely that those methods that encourage the effectiveness of a selected but restricted suite of natural enemies rather than just increasing the abundance of a wide range of predators and parasitoids will yield the best options for long-term and stable pest management in soybean.

SUMMARY

A field experiment was conducted during rainy *(kharif)* season of 2003 and 2004 on the use of integrated management practices, viz. (i) seed treatment of soybean either with imidachloprid 200SL @ 5.0 ml/kg seed or carbofuran 3G @ 250 g /kg seed, (ii) intercropping of soybean with either maize or rice to study the effects of these practices on major insects like leaf folder *Nacoleia vulgalis* Guen, *N. dimenalis* Guen. and stem fly *Ophiomyia phaseoli* (Tryon) and their natural enemies occurring in soybean ecosystem. The plot (fertilizer) with imidachloprid seed treatment and rice as intercrop recorded lowest (9.1%) leaf folder damage, followed by carbofuran seed treatment plot + rice, and carbofuran or imidachloprid seed treatment plots with maize as intercrop and highest benefit : cost ratio of 1.92. The damage by stem fly was significantly higher in maize intercrop and less in carbofuran seed treatment plot without maize as intercrop. When neem cake powder was used as nutritional source to soybean the damage by leaf folder, stem fly and leaf feeding beetles was less when compared to fertilized treatments. The combined advantage of using seed treatment as a method of control measure to leaf folder and stem fly up to more than

30 days and the intercropping of soybean with maize or rice to enhance the activity of natural enemies is recommended in reducing the pest abundance. Spiders were more active in soybean + rice intercrop system, whereas coccinellids were higher in soybean + maize intercrop system. The spider activity was very high (20 spiders/10 plants) in soybean + rice system.

REFERENCES

Cornell H V and Hawkins B A. 2003. Herbivore responses to plant secondary compounds: a test of phytochemical coevolution theory. *The American naturalist* **161**: 507–22.

Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research,* pp 680. John Wiley & Sons, New York.

Moraes M C B, Pareja M, Laumann R A, Hoffmann-Campo C B and Borges M. 2008. Response of the parasitoid *Telenomus podisi* to induced volatiles from soybean damaged by stink bug herbivory and oviposition. *Journal of Plant Interactions* **3**(2): 111–8.

Rao Rajasekhara K, Arjuna Rao P and Tirumala Rao K. 2001a. Influence of organic manures and fertilizers on the incidence of groundnut leafminer, *Aproaerema modicella* (Dev.). *Annals of Plant Protection Sciences* **9**(1): 12–5.

Rao Rajasekhara K, Arjuna Rao P and Tirumala Rao K. 2001b. Influence of fertilizers and manures on the population of coccinellid beetles and spiders in groundnut ecosystem. *Annals of Plant Protection Sciences* **9**(1): 43–6.

Shelton A M and Perez F R B. 2006. Concepts and applications of trap cropping in pest management. *Annual Review of Entomology* **51**: 285–308.

Thakur N S A. 1985. Yield losses caused by major soybean insect pests. *Agriculture Science Digest* **5**(4): 213–4.

Thakur N S A. 1993. Efficacy and economics of synthetic pyrethroids and conventional insecticides for the control of leaf folders (*Nacoleia* spp) of soybean at medium altitudes of Khasi Hills (Meghalaya*). Journal of Hill Research* **6** (1): 26–8.

Thakur N S A and Gangwar S K. 1989. Incidence and chemical control of soybean stem fly, *Ophiomyia phaseoli* (Tryon) in Meghalaya. *Journal of Hill Research* **2**: 94–6.