Research Article

DEVELOPMENT OF SPRAY SCHEDULE INVOLVING COMMERCIAL AND INDIGENOUS BIOPESTICIDES FOR INSECT PEST AND DISEASE MANAGEMENT IN SOYBEAN CROP

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ABSTRACT

Application of natural biopesticides in organic production system reduces the amount of toxic synthetic pesticide use in farming and help minimizing chemical leaching, thus, protect and conserve environment to a great extent. A field experiment was conducted during *kharif* seasons (rainy) of 2008-2011 to evaluate the efficacy of different biopesticides against major insect pests and diseases of susceptible soybean variety (JS-80-21) in mid hills of Meghalaya. Nine biopesticide treatments comprising Neem oil 3 ml/l, Panchagavya (combination of five products of cow milk and excreta viz., cow milk, curd, ghee, urine and fresh dung) 3%, *Beauveria bassiana* 4 g/l, Derisom 2 EC (a product of *Derris indica* commonly called karanjin) 3 ml/l, anosom 1 EC or annonin (a product of *Annona mucosa* called Custard Apple) 3 ml/l, Panchagavya 3% + Lantana leaf extract 10% + Vermiwash 10%,Derisom 3 ml/l + Panchagavya 3%, Derisom 3 ml/l + Panchagavya 3% + Cow urine 3% and untreated control were tested against soybean rust (disease), leaf folder and *Myllocerus* spp. Results revealed that significantly the least rust disease index (34.9%), *Myllocerus* spp. (0.61) and leaf folder population (0.36) with high seed yield (0.87 t/ha) were observed with Derisom 3ml/l + Panchagavya 3% + cow urine 3%and the maximum pest and disease incidence were observed with untreated control (45.8%, 1.38, 0.51, 0.63 t/ha). Among the biopesticides, *Beauveria bassiana* (4 g/l) was the least effective in controlling disease (9.3%) and insect pests (1.02 and 0.44 for *Myllocerus* spp. and leaf folder, respectively) as well as gave the lowest soybean seed yield (0.71 t/ha). However, all the organic biopesticide products were superior to control. However, Derisom 3ml/l + Panchagavya 3% + cow urine 3% was found to be the most effective in managing rust disease and population of *Myllocerus* spp. and leaf folder with high seed yield. Thus, environment friendly management with these biodegradable organic products will lead towards sustainable organic crop production in studied ecosystem of north east India.

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] also called as a golden bean, is one of the most important legume crops of the planet. Soybean evolved from *Glycine ussuriensis*, a wild legume native to Northern China. Soybean seeds are important for both protein meal (40%) and vegetable oil (20%). It's a rich source of protein, fat, carbohydrates and mineral salts like calcium, sodium, phosphorous and vitamins (C&A). Industrially it is used in manufacturing of plastics, paints, adhesives, fertilizers, printing inks and a variety of other products. Soya and soya based food has medicinal value which helps to control diabetics, melts all kinds of stones in the bladder, kidney and urinary tract, besides curing nervous weakness. Soybean is also a most promising component of artificial diet of honey bee (Pande *et al.*, 2010). In India it occupies an area of 10.88 million hectare (mha) with the production of 10.44 million tonnes (mt) and productivity of 959 kg/ha which is much lower as compared to world productivity (Jain, 2014).

There are a number of important abiotic and biotic constraints that limits soybean production by directly reducing seed yields and/or seed quality. More than hundred pathogens, and 273 species of insects have been reported to affect the soybean crop (Hoffman and Moscardi, 2004; Pande, 2006). Most of thediseases of soybean are caused by fungi, and 35 of them are considered to be of economic importance (Sinclair and

Backman, 1989). Sachan and Gangwar (1980) observed that 20 species of insect causing damage to soybean crop at different stages of plant growth at khasi hills of Meghalaya. In recent years, soybean rust caused by *Phakopsora pachyrhizi* (Sydow), has become one of the major diseases which was known to occur in Korea, Japan, Australia, China and India (Miles *et al*., 2003). Some diseases like soybean rust may be explosive by producing copious amounts of air-borne spores. Yield losses are reported in the range of 20-80% invariety JS 335 depending on its severity, stage of occurrence and favourable climatic conditions in Northern Karnataka (Jahagirdar *et al*., 2011). Similarly, damage due to insectpests arealso economically important because of the reduction of seed quantity as well as quality. Among the insect pests, grey weevil (*Myllocerus* spp.) and leaf folder (*Nacoleiadimenalis, N. vulgalis, N. indicata*) are the major insect pests found in this region and also equally important in relation to seed yield loss. Average avoidable losses in soybean yield in different states ranges from 8-70% (Purwar and Yadav, 2003; Pande, 2006; Sharma *et al*., 2014). *Myllocerus* spp. are typically polyphagous insect and larvae feed on rootlets (Anonymous, 2000; O' Brien *et al.,* 2006).

Use of agrochemicals is a simple practice intended to destroy or control pests of all kinds. However, excessive or indiscriminate use of agrochemicals may lead to health hazards, and damage to crops, livestock, wildlife and the environment. It is therefore, important that alternative, environmental friendly methods of plant protection are adopted. Integrated management of diseases and insect pests through organic leads to sustainable agriculture which integrates environmental health, long-lastingeconomic profitability, and social and economic equity etc. Further, organic farming is getting momentum in the north eastern region and there is urgent need for devising location specific insect pest and disease management practices for organic food production. In the light of above background, the present study has been undertaken with the objectives of developing of spray schedule involving commercial and indigenous bio-pesticides against diseases and insect pests of soybean and asses their impact on soybean seed productivity.

MATERIALS AND METHODS

The field experiment was conducted in the Agronomy Organic Farm, Division of Crop Production, ICAR Research Complex for NEH region, Umiam (21.5°N - 29.5°N latitude, 85.5°E -97.3°E longitude and 950 m MSL), Meghalaya during rainy (*kharif*) seasons of 2008-2011. Nine combinations of commercial and indigenous biopesticides comprising neem oil 3 ml/l, Panchagavya (fermented and diluted product of Fresh cow dung -1 kg, cow urine -3 liter, fresh cow milk-2 litre, curd-2 kg, cow ghee -1 kg) 3%, *Beauveria bassiana*4 g/l, Derisom 2 EC (a product of *Derris indica* commonly called karanjin) 3 ml/l, anosom or annonin 1 EC (Organic pesticide, commonly called annonin) 3 ml/l, Panchagavya 3% + Lantana extract 10% + Vermiwash 10%, Derisom 3 ml/l + Panchagavya 3 %, Derisom 3 ml/l + Panchagavya 3% + cow urine 3% and untreated control (water spray) were evaluated for their efficacy against the insects and diseases in soybean. The investigation was designed in a randomised block design (RBD) with three replications. Thesoil of the experimental site was acidic with pH 5.4. The soil was high in organic carbon content (2.4%) and medium in available nitrogen (232.1 kg/ha) and available potassium (230.6 kg/ha). The average rainfall received in the study area is about 2450 mm annually with about 70% received during kharif season (June to September). The average maximum and minimum daily temperatures during the study period were 29.4^{0}C and 5.6^{0}C, respectively.The average relative humidity (morning) was recorded maximum in the month of September (90.1%) and minimum in the month of March (46.5%). Due to the receiving of more normal rainfall during the cropping period (August-September months) resulted in epiphytotics of rust. Thus, development strategies for rust management were more congenial during the seasons.

Soybean variety JS-80-21 (100 days duration) was sown at 30 x 15 cm^2 spacing. The crop was raised as per recommended organic crop management practices (30 an 60 kg of N, P_2O_5 through FYM and rockphosphate)as rainfed crop. Only one hand weeding was given at 30 days after sowing. A total of three sprayings for all the treatments was given at an interval of 10-12 days, starting first spraying at immediately appearance of the rust symptoms in the field (45-50 DAS).

Observation on the disease was recorded after each spraying and last observation was recorded at 15 days after last spraying. Five plants per treatment per replication was selected randomly and tagged for recording the observations. Disease severity was assessed by using 0-9 scale (Srivastava and Gupta, 2010) and described as 0= No lesions/spots, 1= 1% leaf area covered with pustules, 3 = 1.1-10% leaf area covered with pustules, 5 = 10.1-25% leaf area covered with pustules, 7 = 25.1-50% leaf area covered with pustules and 9 = More than 50% area covered with pustules. Percent disease index (PDI) was worked out by using the formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of individual ratings}}{\text{No. of plants examined x Maximum disease scale}} \times 100$$

The per cent disease control (PDC) was worked out by the following formula (Shivankar and Wangikar, 1993).

$$PDC = \frac{\text{PDI in untreated check} - \text{PDI in treated}}{\text{PDI in untreated check}} \times 100$$

The per cent increase in yield by various treatments was calculated by using the formula,

$$\frac{\text{Yield in treated plot} - \text{Yield in check plot}}{\text{Yield in check plot}} \times 100$$

The observations were recorded, one day before and 3, 7 and 10 days after spraying. For observation on insect populations standard sampling techniques were followed as described by Anonymous (1969) and Bhattacharya and Rathore (1977).

The plant shaking method was employed for estimating the population of lepidopterans larvae and *Myllocerus* beetle. Rectangular beating sheet made up of a piece of heavy white cloth, covered with polythene sheet (50 cm x 60 cm) was used for this purpose. Both left and right ends of the cloth were folded over 1.5 cm thick wood stick so that cloth can be rolled and unrolled to fit into the row width. The cloth was unrolled at the ground level between the two central rows having known number of plants and with the help of extended arms the plant were shaken vigorously. Two such random samples were taken in each plot under each replication.

At physiological maturity, crop was harvested and observations on rust index and seed yield per treatment per replication was recorded and seed yield data was expressed on hectare basis.

Statistical analysis

The experimental data pertaining to each parameter of study were subjected to statistical analysis by using the technique of analysis of variance and their significance was tested by "F" test (Gomez and Gomez, 1984). Standard error of means (SEm±) and least significant difference (CD) at 5% probability (p=0.05) were worked out for each parameter studied to evaluate differences between treatment means.

RESULTS AND DISCUSSION

Impact of natural bio-pesticides on disease

The results (Table 1) indicated that all the treatments tested inhibited the disease significantly compared to unsprayed control and increased the seed yield.All the treatments had significant effect on rust percent disease index (PDI) as well as per cent disease control (PDC). Mean PDI and its mean PDC over unsprayed control ranged from 34.9% with Derisom + Panchagavya + cow urine to 41.7%with *Beauveriabassiana* and 9.3%with *Beauveriabassiana* to 24.4% with Derisom + Panchagavya + cow urine per cent. Significantly lower mean PDI of34.9% was observed underDerisom (3ml/l) + Panchagavya (3%) + cow urine (3%) with PDC of 24.4% than untreated control (PDI, 45.8%).The second and third best treatments wereDerisom @ 3ml/l and Panchagavya (3%) which recorded rust index of 36.2 and 37.2%, respectively and disease control were 21.6 and 19.4%, respectively. PDI in the range of 37.7 to 41.7 %and PDC of 18.2 to 9.3% were observed for rest of the treatments. Similar results to our study have ben also reported by several other researchers (Adiver *et al*., 1995; Suresh *et al*., 1997; Hundekar,1999 and Jahagirdar *et al*., 2010). Leaf extracts of higher plants have been considered to be a useful source of fungitoxic substances (Tripathi *et al*., 1978). Plant derivatives possessing pesticidal properties are gaining worldwide interest as alternatives or as supplements for the existing pesticides (Toriyama, 1972, Seethapathy *et al*., 2016).The plant based compounds reduced the number of pustules, consequently the disease severity and increased yield.

Impact of natural bio-pesticides on insect pests

Combination of organic pesticides followed by their sole application was found effective in reducing the insect pests population relative to unsprayed control. Among all treatments, Derisom (3ml/lit) + Panchagavya (3%) + cow urine (3%) was the most effective which recorded thelowest incidence of weevil (0.61%) and leaf folder (0.36%) over untreated control. The second and third best treatments in managing insect populations were Panchagavya (3%) + lantana leaf extract (10%) + vermiwash (10%) and Derisom (3ml/l) + Panchagavya (3%) which recorded weevil incidence of 0.84 and 0.86%, respectively. But leaf folder incidence was found lower in Panchagavya (3%) + lantana leaf extract (10%) + vermiwash (10%). The incidence was statistically similar for the treatments Derisom (3ml/l) + Panchagavya (3%), Derisom (3ml/l) and Panchagavya (3%). The result of the present study was similar to those reported by Purwar and Yadav (2002)

Commercial biopesticide Derisom is obtained from *Derris indica* (Lam.) Bennett, which is having antimicrobial properties like phenolic constituents (Flavones, isoflavones, chalcones, furanoflavonoids and

pyranoflavonoids) (Sajid *et al*., 2012). Neem has been identified as most promising against insect pests and diseases due to its legendary insect repellent and medicinal properties by National Research Council, Washington, USA (NRC,1992). Rahman and Kanujia (2003) observed that neem seed kernel extract (NSKE) adversely affect the length, weight, survival and population of larva of *Spodopteralitura.*Rajkumar and Shri Ram (2002) reported that one and two sprays of NSKE water extract at 24 kg/ha effectively control the defoliators. Larvae of *Spilarctiaobliqua* can effectively be controlled by mixture of NSKE 5% with Dipel (Pande 2008). Presence of naturally occurring beneficial microorganisms predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi were detected in organic liquid manures (Swaminathan,2005). Because of the inherent hazardous effects involved in conventional chemical pest management, the alternative ecofriendly and safe plant protection measures like organic farming, use of FYM, green manuring, neem oil, botanicals and animal by-products such as cow urine, buttermilk are getting popularity (Nene, 2003). Patil (2008) reported that among the commercially available neem based products tested viz ., neem oil, margotricure, nimbicidine and neem gold at 0.5 per cent and wanis at 1.0 per cent, sprayed thrice at an interval of 10 days starting from the onset of disease were found promising in reducing the soybean rust severity with significant increase in seed yield and 100 seed weight. Among plant products, the highest B:C ratio (2.74) was recorded in neem oil followed by margotricure (1.12) and nimbicidine (0.96). Three sprays of either cow urine (1:10), cow milk (1:10), vermiwash (1:2) and panchagavya (3%) at 10 days interval starting from the onset of disease were found to be the best among the different indigenous technical knowledge (ITK's)base practices in reducing the rust severity and increasing the grain yield (Patil, 2007). More than 500 arthropods pest species have been reported to become resistant to one or more insecticides (Georghiou and Lagunes-Tejada, 1991).

Biological control is an effective, eco-friendly and alternative approach for the management of soybean rust disease.Our results indicated that all tested products caused significant reduction in the growth of *P.pachyrhizi*. Investigations on mechanisms of disease suppression by plant products have suggested that the active principles present in plant extracts may either act on the pathogen directly (Amadioha, 2000), or induce systemic resistance in host plants resulting in reduction of disease development (Kagale *et al*., 2004). Joseph and Sankarganesh (2011) studied the antifungal activity of panchagavya and cow urine against soil borne pathogens. Chadha *et al.* (2012) investigated efficacy of some of vedickrishi inputs, viz. panchagavya, vermiwash, compost tea, matkakhad, beejamrit and jiwamrit for management of various plant diseases under organic farming conditions. Panchagavya was found to be the most effective (88.9%) in controlling the stalk rot of cauliflower as compare to untreated control.

Plant derivatives possessing pesticidal properties are evoking worldwide interest as an alternative or as supplements for the existing pesticides for several reasons (Toriyama, 1972). Integration of chemicals, plant extracts, and biotic agents along with resistance for managing plant diseases are considered as a novel approach (Papavizas, 1973). The mode action of the plant extracts may be due to the action of their bioactive compounds against fungi growth through preventing the growth of pathogens. Botanicals degrade more rapidly than most chemical pesticides, and therefore are considered to be eco-friendly and less likely to kill beneficial pests than synthetic pesticides with longer environmental retention.

Seed yield

The soybean seed yield was significantly influenced by all the treatments. Significantly the highest mean seed yield (0.87 t/ha) was recorded with Derisom (3 ml/lit) + Panchagavya (3%) + cow urine (3%) which was 35.0% higher than unsprayed control. The second and third best treatments in terms of higher yields were Derisom @ 3 ml/lit and Panchagavya (3%) which recorded seed yield of 0.85 and 0.84 t/ha. These two treatments had 34.6% and 31.5% higher seed yields than that of control, respectively. Rest of the treatments gave seed yield in the range of 0.71 to 0.83 t/ha.

Benefit cost ratio

All the organic products effectively managed the disease and insect pests, and thereby increased the grain yield over untreated control. Among all, Neem oil 3 ml/l recorded the highest benefit cost ratio (1.56:1) followed by Anosom 3 ml/l (1.54:1) and Derisom 3 ml/l (1.53:1).

Conclusions

Future food security and economic independence of developing countries like India would depend on improving the productivity of biophysical resources through the application of sustainable production methods, by reducing crop losses caused by insect pests and diseases. Indigenous agricultural practices can play a key role in the design of sustainable and eco-friendly agricultural systems, increasing the likelihood that the rural population will accept, develop and maintain innovations and interventions. In this context, eco-friendly methods are being considered as environmentally safe, selective, biodegradable, economical and renewable alternative for use in organic farming system. In light of the present results commercial and indigenous biopesticides could be a promising, ecologically safe, non-hazardous, eco-friendly and globally acceptable approaches against a wide spectrum of insect pests and diseases for organic food production.

Table 1. Effect of organic products against rust disease intensity (PDI) and percent disease control (PDC) in soybean

Treatments	PDI*					PDC*				
	2008	2009	2010	2011	Mean	2008	2009	2010	2011	Mean
Neem oil 3 ml/l	27.2 (31.5)	48.8 (44.3)	36.7 (37.3)	38.2 (38.2)	37.7 (37.8)	22.6 (28.4)	15.0 (22.8)	17.8 (25.0)	17.2 (24.5)	18.2 (25.2)
Panchgavya 3%	26.8 (31.2)	48.5 (44.1)	35.7 (36.7)	37.8 (38.0)	37.2 (37.5)	24.0 (29.3)	15.5 (23.2)	20.0 (26.6)	17.9 (25.1)	19.4 (26.0)
*Beauveria bassiana*4 g/l	31.0 (33.9)	52.7 (46.6)	40.9 (39.8)	42.1 (40.5)	41.7 (40.2)	11.9 (20.2)	8.1 (16.6)	8.3 (16.7)	8.7 (17.2)	9.3 (17.7)
Derisom 3 ml/l	25.5 (30.3)	47.2 (43.4)	35.1 (36.3)	36.9 (37.4)	36.2 (36.9)	27.6 (31.7)	17.7 (24.9)	21.4 (27.5)	20.0 (26.5)	21.6 (27.7)
Annonin3 ml/l	28.5 (32.3)	49.9 (45.0)	38.7 (38.5)	39.3 (38.8)	39.1 (38.6)	18.9 (25.8)	13.0 (21.1)	13.4 (21.5)	14.8 (22.6)	15.0 (22.7)
Panchagavya 3% + lantana leaf extract 10% + vermiwash 10%	29.9 (33.2)	51.6 (46.0)	39.5 (39.0)	41.3 (40.0)	40.6 (39.5)	15.0 (22.8)	10.0 (18.4)	11.4 (19.8)	10.3 (18.8)	11.7 (19.9)
Derisom 3 ml/l + Panchagavya 3%	29.3 (32.8)	51.0 (45.6)	38.9 (38.6)	40.7 (39.7)	40.0 (39.2)	16.8 (24.2)	11.1 (19.5)	12.8 (21.0)	11.7 (20.0)	13.1 (21.2)
Derisom 3 ml/l + Panchagavya 3% +cowurine 3%	24.3 (29.5)	46.0 (42.7)	33.9 (35.6)	35.7 (36.7)	34.9 (36.1)	31.1 (33.9)	19.9 (26.5)	24.1 (29.4)	22.6 (28.4)	24.4 (29.6)
Non-treated Control (water spray)	35.2 (36.4)	57.4 (49.3)	44.6 (41.9)	46.1 (42.8)	45.8 (42.6)	--	--	--	--	--
SEm (±)	0.21	0.20	0.17	0.19	--	--	--	--	--	--
CD (*p=0.05*)	0.62	0.61	0.51	0.56	--	--	--	--	--	--

*- Average of three replications Figures in parenthesis are angular transformed values

Table 2. Effect of organic products against major insect pests incidence in soybean

Treatments	Myllocerus					Leaf folder				
	2008	2009	2010	2011	Av.	2008	2009	2010	2011	Av.
Neem oil 3 ml/l	1.60	1.24	1.32	1.33	1.29	0.77	0.40	0.45	0.47	0.44
Panchgavya 3%	0.95	0.80	0.90	0.97	0.89	0.40	0.33	0.42	0.40	0.38
*Beauveria bassiana*4 g/l	1.13	0.87	0.97	1.24	1.02	0.50	0.40	0.42	0.50	0.44
Derisom 3 ml/l	1.10	0.90	0.92	0.97	0.93	0.45	0.33	0.42	0.40	0.38
Annonin3 ml/l	1.30	0.93	1.05	1.24	1.07	0.70	0.37	0.42	0.47	0.42
Panchagavya 3% + lantana leaf extract 10% + vermiwash 10%	0.70	0.73	0.84	0.94	0.84	0.35	0.33	0.40	0.37	0.37
Derisom 3 ml/l + Panchagavya 3%	0.85	0.77	0.87	0.95	0.86	0.39	0.33	0.42	0.40	0.38
Derisom 3 ml/l + Panchagavya 3% +cowurine 3%	0.65	0.50	0.65	0.67	0.61	0.30	0.33	0.40	0.34	0.36
Non-treated Control (water spray)	2.15	1.38	1.40	1.37	1.38	0.92	0.45	0.50	0.57	0.51
SEm (±)	0.15	0.12	0.16	0.14	--	0.06	0.06	0.08	0.04	--
CD (*p=0.05*)	0.46	0.37	0.46	0.41	--	0.19	0.18	0.25	0.10	--

*- Average of three replications

Table 3. Effect of organic products on seed yield and per cent increase yield over untreated control

Treatments	Seed yield (t/ha)*					Per cent increase in yield over untreated*				
	2008	2009	2010	2011	Mean	2008	2009	2010	2011	Mean
Neem oil 3 ml/l	1.14	0.66	0.79	0.74	0.83	30.4	28.9	30.9	29.4	29.9
Panchgavya 3%	1.15	0.67	0.80	0.75	0.84	32.2	29.8	32.7	31.3	31.5
*Beauveria bassiana*4 g/l	0.92	0.58	0.70	0.66	0.71	6.0	12.9	14.5	14.7	12.0
Derisom 3 ml/l	1.14	0.69	0.82	0.76	0.85	33.0	34.8	35.9	33.6	34.3
Annonin3 ml/l	1.06	0.63	0.77	0.73	0.80	22.2	23.1	26.6	28.7	25.1
Panchagavya 3% + lantana leaf extract 10% + vermiwash 10%	0.98	0.62	0.73	0.69	0.76	13.2	19.6	21.5	20.2	18.6
Derisom 3 ml/l + Panchagavya 3%	1.00	0.62	0.75	0.70	0.77	14.5	21.1	23.4	22.1	20.3
Derisom 3 ml/l + Panchagavya 3% +cowurine 3%	1.17	0.71	0.84	0.77	0.87	35.8	36.7	39.4	35.0	36.7
Non-treated Control (water spray)	0.87	0.49	0.61	0.57	0.63	--	--	--	--	--
SEm ($\pm$)	0.06	0.06	0.07	0.05	--	--	--	--	--	--
CD (*p=0.05*)	0.19	0.18	0.20	0.14	--	--	--	--	--	--

*- Average of three replications Figures in parenthesis are angular transformed values

Table 4. Economics of organic products for the management of disease and insect pests

Treatments	Cost of cultivation	Required dose/ha	Cost of spraying(Rs/ha)			Total cost	Mean yield (kg/ha)*	Gross Income** (Rs.)	Additional income/ha over control (Rs.)	Net Profit (Rs.)	B:C ratio
			Organic products	Labour charges	Total (Rs.)						
Neem oil 3 ml/l	25500	1.5 l	900	200	1100	26600	832	41583	9875	14983	1.56:1
Panchgavya 3%	25500	15 l	4500	200	4700	30200	843	42167	10459	11967	1.40:1
*Beauveria bassiana*4 g/l	25500	2 kg	800	200	1000	26500	714	35708	4000	9208	1.35:1
Derisom 3 ml/l	25500	1.5 l	2250	200	2450	27950	853	42625	10917	14675	1.53:1
Annonin3 ml/l	25500	1.5 l	300	200	500	26000	798	39917	8209	13917	1.54:1
Panchagavya 3% + lantana leaf extract 10% + vermiwash 10%	25500	15 l + 150 l + 150 l	4500	400	4900	30400	756	37792	6084	7392	1.24:1
Derisom 3 ml/l + Panchagavya 3%	25500	1.5 l + 15 l	6750	400	7150	32650	767	38333	6625	5683	1.17:1
Derisom 3 ml/l + Panchagavya 3% + cowurine 3%	25500	1.5 l + 15 l + 15 l	6750	400	7150	32650	872	43583	11875	10933	1.33:1
Non-treated Control (water spray)	25500	-	-	-	-	25500	634	31708	-	-	-

*-means of replications, **-selling rates of soybean @ Rs. 50

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