Pakistan J. Zool., vol. 44(2), pp. 313-320, 2012.

Management of Potato Leaf Hopper (*Amrasca devastans* Dist.) with Biopesticides in Comparison with Conventional Pesticides on Autumn Potato Crop*

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Abstract.- Considering the importance of organic farming and the demand for safe food globally, the experiments regarding the performance evaluation of biopesticides (Biosal-neem formulation and bacterial derived Spinosad) in comparison with conventional insecticides (imidacloprid, endosulfan and profenofos) were carried out against potato leaf hopper on autumn potato crop. The crop was sown in a randomized complete block design (RCBD) with three replicates each having six treatments including control. The crop was sprayed when the insect population reached at economic threshold level (ETL). Pre treatment insect count was recorded before 24 hours and post treatment data were collected after 24, 72 and 168 hours of spray. In this manner the data for three sprays were collected. The data were computed to percent efficacy using Henderson-Tilton formula. All the conventional insecticides were found effective against potato leaf hopper. The order of effectiveness was found to be imidacloprid> endosulfan> profenofos *i.e.* 88.59, 73.32, and 64.87% respectively. Biosal showed moderate effectiveness (55.91%), while Spinosad exerted least affects with 15.63% reduction in potato leaf hopper population.

Key words: Efficacy, biopesticides, conventional pesticides, *Amrasca devastans*, potato.

INTRODUCTION

Potato (*Solanum tuberosum*) is the world's most important food crop. It provides carbohydrates and micronutrients like potassium, phosphorus, magnesium, iron and Vitamins essential for human health (US, NND, 2009). Its world wide annual production is more than 325 million tons (MT) cultivated on 16.8 million hectares (FAO, 2008). Potato crop is attacked by different insect pests among them the potato leaf hoppers possess considerable importance. About 79 species of leaf hoppers have been found infesting the potato crop (Ramirez and Ramos, 1982). In Pakistan one of the species, *Amrasca devastans* Dist. (Jassid) is very common, which not only attacks potato but also cotton, okra and brinjal crops. Anwar *et al.* (1987) found, in average, 1.22 *Amrasca devastans* per plant at full vegetation of potato crop. Both adult and nymph of this incest sucks the cell sap from leaves by mechanically plugging the phloem and xylem vessels, ultimately causing stunting, curling and browning of the leaves (Borror *et al*., 1981).

In Pakistan potato was produced 2.5 MT on 0.13 hectares in 2007 as compared to 1999 with 1.8 million tons on 0.11 hectares, with the production share of Punjab, NWFP, Baluchistan and Sindh as 125.7, 6.7, 2.1 and 0.1% respectively (Anonymous, 2008). Pakistan exported 0.16 million tons potatoes worth of 26 millions US $ in 2006-07 which was almost more than three times increase as compared to 2000-01 (Anonymous, 2008). The production and earning by potato may increase even more by adopting Good Agricultural Practices (GAP) including environment friendly pest management techniques. Nevertheless, the insect pests cause 35-40% yield losses that may reach up to 60-70% (Salim, 1999). The extent of damage varies depending upon weather conditions, pest population and availability of alternate hosts. Pesticides are quick solution for insect control and are important in increasing agricultural production (Mehmood *et al*., 2001). About one third of the pesticides used in

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0030-9923/2012/0002-0313 $ 8.00/0

Pakistan are applied on fruits and vegetable crops (Hussain *et al.*, 2002). As a crucial component of Integrated Pest Management (IPM) pesticides can increase the yield by reducing the losses caused by insects. However, their haphazard use is showing negative affects on the non-target organisms in the environment (Akobundu, 1987) and human health as well (Soomro *et al.*, 2008). Masud and Nusrat (1992) found higher than maximum residual limit set by Codex (1993) for pesticides in fruits and vegetables in Pakistani markets.

In view of the environmental and health issues the biopesticides are holding attention by scientists and researchers as they are safe and environment friendly. Several attempts have been made to manage *Amrasca devastans* (Akbar *et al.*, 2005, 2006, 2007) by biopesticides on different crops other than potato. Neem based pesticides are good source for the control of different insects in the form of neem oil, neem extract and even neem seed water extract (Jacobson, 1988). They are well known for their safety and good performance (Schmutterer, 2002) and have been found effective in controlling pests like jassid, (Ambedkar *et al.*, 1999) aphid, whitefly (Akbar *et al.*, 2008, 2009), flea beetle (Emosairue and Ukeh, 1997), spider mite (Bhandevi *et al.*, 1995; Kumar *et al.*, 1993; Singh and Singh, 1999) and fruit borer (Shukla *et al.*, 1996).

Spinosad, a combination of spinosyns A and D, is derived from naturally occurring soil bacterium *Saccharopolyspora spinosa* by aerobic fermentation of actinomycete species. It possesses both contact and stomach poison activity against a wide range of insect groups including members of Lepidoptera, Diptera, Hymenoptera, Coleoptera, Thysanoptera, Isoptera and Siphonoptera (Elzen *et al.*, 1998), with some obscure effectiveness against sucking insects (Thompson *et al.*, 2000; Cowles *et al.*, 2000; Tjosvold and Chaney, 2001). Some studies, however, show its obvious effectiveness against jassids, aphids and whiteflies (Anonymous, 2006; Kumar *et al.*, 2007).

Keeping in view the economic importance and export value of potato crop, adverse effects of synthetic insecticides on human health, two biopesticides (Biosal and Spinosad) were tested as safer alternatives of crop protection for the effective control of potato leaf hopper. The effectiveness of these pesticides was compared with three other conventional pesticides in a randomized control field trial.

MATERIALS AND METHODS

Experiments were conducted in the agricultural fields of District Malir Karachi and experimental field of University of Karachi (as a part of Ph. D. work). Potato seeds procured from local market were sown on ridges in the plots measured 5x4 meters with a row to row distance of 75 cm and plant to plant distance of 60 cm. The plots were arranged in a randomized complete block design (RCBD) with three replicates, each having six treatments including control. Three meter distance was kept between each treatment and replicates as a buffer to avoid spray drift.

The leaf hopper population was recorded from each treatment early in the morning. Ten plants were selected from each treatment for insect population counts taking 3 leaves from each plant alternatively from top, middle and bottom (Singh and Kushik, 1990). Insecticides *viz,* Imidacloprid, Endosulfan, Profenofos, Spinosad and Biosal were sprayed at recommended dose rates (Table I) when populations of leaf hopper reached at the economic threshold level (ETL) *i.e.* average 1to1.5/leaf. The crop was sprayed in morning before 10 a.m. Pre-treatment counts were made before 24 hours of each spray and post-treatment data were recorded after 24, 72 and 168 hours of each spray. The insect population reduction percentage was computed through Henderson-Tilton's formula *i.e.* % efficacy= [1-Ta/Ca*Cb/Tb]*100, (Henderson and Tilton, 1955), where,

Tb = Infestation in the treated plot before treatment
Ta = Infestation in the treated plot after treatment
Cb = Infestation in the control plot before treatment
Ca = Infestation in the control plot after treatment

The data thus obtained were subjected to analysis of variance (ANOVA) using statistical software package SPSS (version 14.0). Significant differences among treatment means were tested with Duncan multiple range test at 5% significant level. The pest population in various treatments was used

Table I.- Insecticides used in efficacy trials against potato leaf hopper.

Pesticides		Type	Source	Dose
Common name	**Trade name**			
Imidacloprid	Imidacloprid 25 WP	Neonicotinoid	Arysta Life Sciences	49.4 g. a.i./ha
Endosulfan	Thiodan 35 EC	Organochlorine	Bayer Crop Science	642.2 g. a.i.ha
Profenofos	Curacron 500 EC	Organophosphate	Syngenta	988 g. a i/ha
Spinosad	Tracer 240 SC	Derived from soil bacterium (*Saccharopolyspora spinosa)*	Dow Agro Sciences	15.8 g. a.i./ha
Azadirachtin	Biosal 10 EC	Neem formulation containing 0.32% Azadirachtin	HEJ, Institute of Chemistry, University of Karachi	1.58g. a.i./ha

as an indicator of insecticide efficacy *i.e.* lower population of insect pests represents higher efficacy and vice versa.

RESULTS AND DISCUSSION

Conventional/synthetic pesticides

Reduction in population of potato leaf hopper/Jassid (Table II) indicated that all the tested insecticides were effective against potato leaf hopper except Spinosad. The percentage reduction over pre treatment in comparison with control plot was higher with imidacloprid and endosulfan followed by profenofos and biosal (a.i. azadirachtin). There was significant difference ($p<0.05$) between treatments when compared in over all efficacy. In case of conventional insecticides; imidacloprid was found highly effective with 83.63% reduction after 24 hours of first spray with increasing trend in efficacy as 89.97% after 72 hours; however its effectiveness decreased at 168 hours to 85%. Whereas endosulfan proved to be a good controlling agent with 75.79% reduction at 24 hours with decreasing trend after 72 and 168 hours of spray with 72.48 and 67.47% reduction. Profenofos was comparatively at a lesser effective status than imidacloprid and endosulfan as it gave 64.40% reduction after 24 hours though it increased after 72 hours to 68.23% reduction but again it was found less efficient after 168 hours of first spray as 57.95% reduction was observed. Comparable results were observed by Misrah and Senapati (2003) with significant dominance of imidacloprid among different pesticides against okra jassid (*Amrasca biguttula biguttula*). Santharam (2003) assessed the performance of different doses of imidacloprid as seed treatment and root dip of seedlings and found effective up to 45 days after treatment, whereas foliar spray at different dose rate significantly reduced the thrips population on chilli crop. Akbar *et al.* (2008) found imidacloprid most effective against mustard aphid as compared to endosulfan and biosal, where as Patel *et al.* (1997) found endosulfan very effective against jassids on Okra crop. Akbar *et al*. (2006, 2007) evaluated the effectiveness of endosulfan and profenofos against jassid on okra and brinjal crops at different time intervals and found endosulfan more effective than profenofos on brinjal crop and vice versa in case of okra crop.

Narottam (2006) studied the effect of endosulfan and azadirachtin and found azadirachtin in middle order of effectiveness when used alone, whereas it varied in efficacy when used in combination as endosulphan+bt (*Bacillus thuringiensis*) and azadirachtin + bt. However, in any case azadirachtin was found comparatively less effective than endosulfan. Misrah (2002) also used similar combinations of pesticides along with profenofos against aphids and jassids of okra and observed significant dominance of some pesticides among others, profenofos being moderate but yet more effective than neem product (azadirachtin).

Biopesticides

Unlike synthetic pesticides plant based pesticides have diverse pest control properties. Plant products affect different physiological processes in insects like metamorphosis including insect growth regulation, adult fertility, toxicity and also having anti-feedant and oviposition deterrent effects (Naqvi, 1996). Schmutterer (1990) reported that

Table II.- Percent efficacy of different insecticides against potato leaf hopper.

Treatment	24 h	72 h	168 h	Mean
1st spray				
Imidacloprid	83.63± 8.91[a]	89.97± 10.06[a]	85.05± 10.94[a]	86.22±9.13[a]
Endosulfan	75.79± 9.06[ab]	72.48± 9.42[ab]	67.47± 11.71[ab]	71.91±9.49[b]
Profenophos	64.40± 10.98[b]	68.23± 11.73[b]	57.95± 10.20[b]	63.53±10.53[bc]
Spinosad	4.77± 6.45[d]	10.78± 8.06[c]	15.71± 9.84[c]	10.42±8.56[d]
Biosal	48.35± 7.91[c]	60.15± 10.84[b]	56.54± 10.06[b]	55.01±9.89[c]
2nd spray				
Imidacloprid	88.79± 10.15[a]	92.50± 9.02[a]	90.12± 9.85[a]	90.47±8.54[a]
Endosulfan	80.61± 10.48[ab]	72.48± 9.42[ab]	69.25± 9.11[b]	75.04±9.84[b]
Profenophos	66.77± 9.26[bc]	70.85± 9.81[b]	66.30± 9.13[b]	67.97±8.43[b]
Spinosad	14.40± 9.28[d]	19.20± 9.02[c]	20.43± 10.98[c]	18.01±8.92[d]
Biosal	49.54± 9.42[c]	58.88± 11.81[b]	57.07± 11.93[b]	55.16±10.54[c]
3rd spray				
Imidacloprid	88.42± 10.04[a]	90.18± 9.87[a]	88.65± 10.06[a]	89.08± 8.69[a]
Endosulfan	75.62± 11.17[ab]	72.97± 10.08[ab]	70.44± 11.84[ab]	73.01± 9.83[b]
Profenophos	62.59± 11.89[bc]	66.45± 9.19[b]	60.25± 9.20[b]	63.10± 9.22[b]c
Spinosad	17.08± 9.99[d]	19.55± 11.12[c]	18.75± 11.93[c]	18.46± 9.63[d]
Biosal	52.31± 10.30[c]	62.12± 11.81[b]	58.23± 12.90[b]	57.55± 10.41[c]
Overall percent efficacy				
Imidacloprid	88.59±8.64[a]			
Endosulfan	73.32±9.43[b]			
Profenophos	64.87±9.33[c]			
Spinosad	15.63±9.47[e]			
Biosal	55.91±9.95[d]			

Values sharing the same letter (s) in a column are not significantly different at P=0.05

they are environmental friendly, therefore, they seems to have some superiority over synthetic pesticides. Moreover, a variety of plant species are available with diverse types of controlling effects as over 2400 plants have been identified with pest control properties in this respect (Grainge and Ahmed, 1988).

In case of biopesticides, azadirachtin based biosal was found effective against potato leaf hopper as 48.35, 60.15 and 56.54% reduction after 24, 72 and 168 hours respectively which is comparable with profenofos as there was statistically no significant difference after 168 hours of spray ($p<0.05$). Adilakshmi *et al.* (2008) evaluated the efficacy of different neem based ready made products and observed comparatively less effective against sucking pests than endosulfan but proved superior to untreated plot. The work of Dhingr *et al*. (2008) also support our findings, as they tested the field efficacy of Azadirachtin-A, its stable derivative tetrahydroazadirachtin-A (THA) and NeemAzal (NZ) pesticides in comparison with endosulfan against the complex pests of okra including jassid and whitefly and found Azadirachtin-A effective up to 7 days where as THA had the potential to control the pests up to 10 days. Endosulfan was found to be most effective with 82.9% reduction in whitefly population followed by THA, Aza-A and NZ 60%, 58.7% and 57.5%. Against jassid it was 62% with endosulfan followed by THA, Aza-A and NZ as 40.2, 35.1 and 31% respectively. Akbar *et al.* (2007) evaluated the effectiveness of Biosal (neem formulation) in comparison with endosulfan and profenofos against jassid on brinjal at different time intervals and found moderate effect of Biosal against jassid with 47% mortality.

Naqvi *et al*. (1989) tested crude extracts of neem and Margosan-O (pesticide of neem origin from USA, containing 0.3 % Azadirachtin as active

ingredient) in comparison with Malathion 57 EC against white fly on brinjal and found effectiveness as Malathion > Margosan> crude neem extracts after 48 hours while after 96 hours crude neem extracts were more persistent than Margosan and Malathion respectively. Similarly different attempts were made to test the efficacy of neem preparations against aphid and whitefly (Basedow *et al*., 2002; Pun *et al.*, 2005). Ali *et al.* (2005) found neem extract effective but inferior to imidacloprid against the spread of okra yellow vein mosaic virus by controlling whitefly population. Aslam and Naqvi (2000) found neem extract more effective against jassid, white fly and thrips on cotton as compared to perfekthion which lost its efficacy after 4 days while neem product was persistent up to 6 days and was much safer and none polluting. In present study we also found azadirachtin based Biosal effective up to 7 days after treatment. In a comparative study with Baythroid ™, Khattak *et al.* (2006) found significant reduction in the population of jassid, whitefly and thrips on cotton up to 168 hours when used neem oil 2% and neem seed water extract at 3% but efficacy declined at 336 hours. Neem oil was effective with 56, 54 and 57% reduction in the population of jassid, whitefly and thrips, respectively, while neem seed water extract was relatively less effective with 49, 46 and 54% reduction against three insects.

Though, significant work has not been reported for field efficacy of Spinosad against sucking insects like jassid and whitefly. However previous reports (Thompson *et al*., 2000; Cowles *et al*., 2000; Tjosvold and Chaney, 2001) against sucking pest are consistent with our findings. Spinosad was found less effective against potato leaf hoppers with only 4.7, 10.78 and 15.71% reduction after 24, 72 and 168 hours of first spray with increasing trend in efficacy after 2nd and 3rd spray (Fig. 1). However, this effect was not statistically significant due to large variation in effectiveness (Table III).

Spinosad has been reported to have both contact and stomach poison activity and effective against a wide range of insect groups like thrips as Eger *et al*. (1998) evaluated toxicity of Spinosad against western flower thrips *Frankliniella occidentalis* (Pergande) and other *Frankliniella* spp. and found it very effective against all three species with 90% mortality. Jones *et al. (*2005) also found Spinosad efficient against the life stages of immature and adult western flower thrips (*Frankliniella occidentalis)* in the lab bioassay and in the green house as well. In addition, Kumar *et al*. (2007) reported excellent results against the three nymphal stages of sweet potato whitefly under lab conditions and in green house too. Another study conducted at Central Cotton Research Institute Multan, shows 25% mortality in whitefly population after 168 hours of spray in cotton field (Anonymous, 2006).

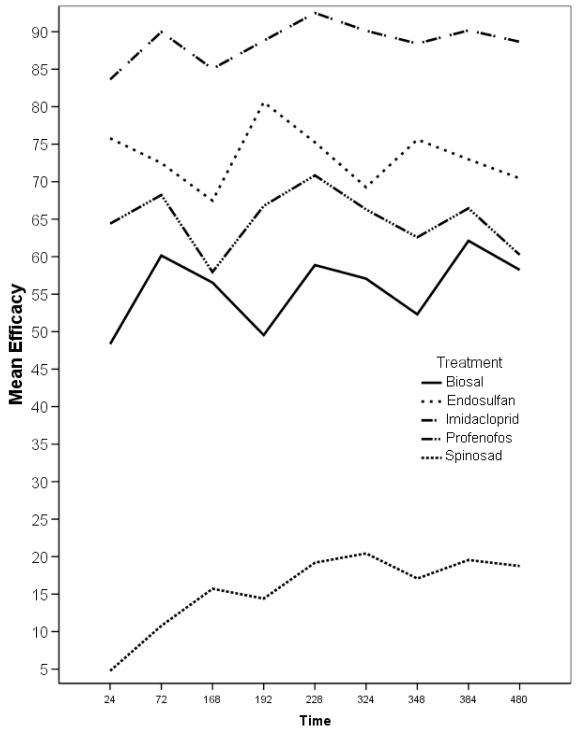

Fig. 1. Time wise efficacy of different insecticides against potato leaf hopper.

Over all performance of three successive sprays showed as mean efficacy against the population of potato leaf hopper by imidacloprid, endosulfan, profenofos, spinosad and biosal were as 88.59, 73.32, 64.87, 15.63 and 55.91%. Biosal was observed with increasing trend after three repeated sprays at different time intervals as shown in Table III and Figure 1. However this difference was not statistically significant due to large variation in data.

Table III.- Efficacy of different insecticides: effect of spray and time.

Treatment	Imidacloprid	Endosulfan	Profenophos	Spinosad	Biosal
Spray					
Spray 1	86.22± 9.13[a]	71.91± 9.49[a]	63.53± 10.53[a]	10.42± 8.56[a]	55.01± 9.89[a]
Spray 2	90.47± 8.54[a]	75.04±9.84[a]	67.97± 8.43[a]	18.01± 8.92[a]	55.16± 10.54[a]
Spray 3	89.08±8.69[a]	73.01± 9.83[a]	63.10± 9.22[a]	18.46± 9.63[a]	57.55± 10.41[a]
Time (h)					
24 h	86.95± 8.77[a]	77.34± 9.23[a]	64.59± 9.50[a]	12.08± 9.40[a]	50.07± 8.21[a]
72 h	90.88±8.45[a]	73.57± 8.58[a]	68.51± 9.12[a]	16.51± 9.27[a]	60.38± 9.39[a]
168 h	87.94± 9.20[a]	69.06± 9.58[a]	61.50± 9.05[a]	18.30± 9.71[a]	57.28± 10.15[a]

Values sharing the same letter (s) in a column are not significantly different at P=0.05

This could be concluded on the findings of the present study that sole dependency on conventional insecticides may easily be avoided by incorporating Biosal (neem formulation) as a part of pest management program, as neem based products are more safe and environment friendly.

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(Received 8 June 2010, revised 11 August 2010, accepted 13 January 2011)