Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 1207-1212

Received: 16-03-2017
Accepted: 17-04-2017

Taimur Ahmad
Institute of Chemical Sciences, University of Peshawar, Pakistan

Rasool Khan
Institute of Chemical Sciences, University of Peshawar, Pakistan

Tariq Nawaz Khattak
Nuclear Institute for Food and Agriculture, NIFA, Peshawar, Pakistan

Ihsan-Ullah
Nuclear Institute for Food and Agriculture, NIFA, Peshawar, Pakistan

Ayaz Khan
Institute of Chemical Sciences, University of Peshawar, Pakistan

Muhammad Salman
Institute of Chemical Sciences, University of Peshawar, Pakistan

Correspondence
Taimur Ahmad
Institute of Chemical Sciences, University of Peshawar, Pakistan

Comparative potential of a new synergistic bio-pesticide and synthetic pesticide on pest control and crop yield

Taimur Ahmad, Rasool Khan, Tariq Nawaz Khattak, Ihsan-Ullah, Ayaz Khan and Muhammad Salman

Abstract
A new, cost effective and green synergistic bio-pesticide has been development from neem oil and white oil using NIFA developed adjuvant in 35:60:05 ratios respectively. The newly developed bio-pesticide synergist is an organic product and was found the most potent and green pesticide than synthetic pesticide. Our newly developed synergistic bio-pesticide showed good results than synthetic bifenthrin in controlling the pest population and resulted in improved crop yield. Furthermore, the product was found fungi-static as no fungal attack was observed during synergistic treatments, while both of the control and synthetic bifenthrin plots were attacked *by Alternaria Solani,* causing early blight disease. This synergistic bio-pesticide has been proved as a safe pest controlling agents since it is non-toxic and biodegradable. Due to safe ingredients, it is claimed to be an excellent candidate to produce export quality agro-products by control of MRL (EU). This product may serve as effective biological pesticide in organic farming

Keywords: Bio-pesticide, synergism, neem oil, mineral oil, adjuvant

1. Introduction
Pesticides act as important weapon against the pest of the agriculture and play a pivotal role in crop protection. But the extensive application of synthetic pesticides have caused various problems to humans and environment (Carroll *et al*., 2009; Daniels *et al*., 2009) [1, 2]. These pesticides have mammalian toxicity, pest's resistance tendency, high cost and damage to beneficial insects etc. There is need to reduce the use of the synthetic pesticide. Botanicals or biologicals pesticide are the safe alternatives to synthetic pesticides (Damavandian, 2010; Zeb *et al*., 2011) [3, 4]. Neem oil extracted from the seeds of neem plant (*Azadirachta indica*) possesses anti-feeding and repellent properties. The main component in neem oil is Azadirachtin which has the structural similarities with Ecdysone, responsible for controlling the process of metamorphosis (Kumar, 2010) [5]. Azadirachtin acts as ecdysone blocker. The release of various important hormones required during the metamorphosis is blocked by Azadirachtin and thus breaking the life cycle of the insects (Islam *et al*, 2010) [6]. The main advantage of the neem oil is that insects cannot develop resistance against it and is also environment friendly, and no residues are found in the crops. Mineral or white oil is also used to control pests. White oil is obtained by the crude oil refining. It is colorless, non-toxic, chemically inert oil. It is free from Sulphur and aromatic residue and find its application in cosmetics, pharmaceuticals, liquid soaps, baby oil, food processing and has also been used in integrated pest management program to control aphids, mites, thrips, scale insects, white flies and mealy bugs (Ameline, 2009; Silverio, 2009) [7, 8]. The white oil lowers the ability of the aphids to transmit the viral diseases to the healthy plants from the infested plants (Boiteau *et al*, 2009) [9]. The white oil may also act as fungi-static, thereby inhibiting the fungal growth instead of killing the fungi. White oil is so safe as compared to other pesticides that its ingestion in small quantity by human is not toxic and used as laxatives.
The neem oil provides a slow action against the pests, in order to increase the action of the neem oil, a synergistic bio-pesticide of neem oil and white oil has been formulated with enhanced efficacy. The synergism is a phenomenon in which two or more ingredients are formulated to cause an effect which is more than the sum of their individual effects. Neem oil and white oil are not soluble in the water and surf or detergents are added to make them

soluble. But we have developed an adjuvant to make the emulsion of the neem and white oil. This adjuvant acts as emulsifier, spreader and sticker. This emulsion is stable for 3 years and can be mixed with water and used as pesticide. The NIFA developed adjuvant can emulsify 20 liters of the oil and the total cost of its manufacture is 2 U.S Dollars per liter. The NIFA adjuvant is shown in figure 1.

Potato is an important vegetable crop of Pakistan. The total area under the production of potatoes in Pakistan in 101 thousand hectares. It also ranks as the fourth most abundant crop by volume of production in this country. It usually gives a high yield and return to the farmers. Potato consists of 75 percent of water. It has a good taste, nutritive and easily digested by the body. Hundred grams of potato contains 22 grams carbohydrates, 13 milligram Ca, 1.2 milligram vitamin B3, 11 milligram vitamin B2, 17 milligram ascorbic acid and other are minerals and fiber. It can be eaten alone or may be mixed with other vegetables. Potato snacks are also very popular.

The potato plant is attacked by various pests including aphids, potato leaf hopper and fungi (Davis and Radcliffe, 2008) [10]. Aphids are the soft bodied pest which cause a damage to the plant directly by sucking the sap of the plant foliage and also act as the carrier of viral disease (Yankova *et al*, 2009; Morita *et al*, 2007) [11, 12]. Potato leaf hopper is also the major pest of the potato (Gudugi, 2013) [13]. It has a wedge shape with green coloration and possesses a piercing mouth for sucking the sap (Davis, 2009) [14]. The nymph is similar to adult but has no wing. The leaf hopper extract the sap from the vascular tissue through mouth. If the population is not controlled, the vascular system is blocked and photosynthesis is disturbed causing a decreased in yield (Thul, 2009) [15]. The present study was carried out to compare the efficacious effect of the bio-pesticide synergist and bifenthrin on pest control and crop yield of potato.

2. Materials and methods

2.1 Site of experiment

The site of experiment was selected in village Koladher district Charsadda. It is situated 36 kilometers to the east of Peshawar. Charsadda has a semi-arid climate and the average annual rainfall is 460 mm. The annual mean temperature is about 23 ºC.

2.2 Design of experiment

The plot was divided into three equal sub-plots designed as block-1, block-2 and block-3 for control, bio-pesticide and synthetic treatments respectively. The total area of the plot was 21780 square feet and each sub-plot has the area of 7260 square feet. The width and the length of each sub-plot were 40 and 180 feet respectively. Each block received the following treatments

Block-1= control i.e. no treatment. This block was not treated with any pesticide.

Block-2= this block was treated with synergistic bio-pesticide.

Block-3= this block was treated with synthetic bifenthrin.

2.2.1 Land preparation

The soil was properly ploughed using tractor and the soil surface was evenly prepared. Weeds were also removed from the soil.

2.2.2 Seed sowing and harvesting

Red skin variety known as Oscar was purchased from the local agriculture seed market. Three hundred kilogram of the seeds having uniform size and weight were purchased. Hundred kilogram of seed were sown in each block. The seeds were sown in ridges with a distance of two feet between the ridges and at a depth of 4-5 inches in the ground. The date of sowing was first of the October 2016. The potato were irrigated after five days of sowing. Fifty kilogram of DAP was used as fertilizer in first irrigation and 50 kg urea was also used in second irrigation. The potato crop was harvested when fully matured and the shoot dried on 5th January 2017.

2.2.3 Formulation of bio-pesticide

The synergistic bio-pesticide was formulated by the combination of the mineral oil and neem oil in the presence of NIFA adjuvant developed at Nuclear Institute of Food and Agriculture NIFA, Tarnab, Peshawar. This synergistic bio-pesticide contains neem oil, mineral oil and NIFA adjuvant in ratio of 35:60:5. In first step 35 mL of neem oil was mixed with 60 mL of mineral oil and then 5 mL of the NIFA adjuvant was added to mixture to form a bio-pesticide synergist. The neem seeds were purchased from the Qissa Khwani market Peshawar. The neem oil was extracted from the neem seeds using solvent extraction method, and the white oil was imported from Raj Petro Specialties' (Pvt.) Limited India. These three component were mixed together to form a thick black solution.

Fig 1: showing the NIFA adjuvant

2.2.4 Optimization of effective synergistic concentration for spray

The bio-synergistic pesticide contains a combination of neem oil and white oil and may have a phytotoxic affect if not used in proper concentration. The effective concentration of the synergistic bio-pesticide for the application of spray was found by spraying various concentrations i.e. 4%, 5%, 7% and 10% experimentally on potato and tomato plants respectively. Twenty plants each of tomato and potato were selected and the aforementioned concentration were sprayed on 5 plants respectively. The two low concentrations that is 4, 5 and 7 percent showed no burning affect and 10% concentration caused a mild burning effect on some leaves. So 5% concentration was the optimum dose for the spray with no phytotoxic effect on potato and tomato plants.

2.2.5 Data Collection
The potato field was treated twice with the pesticides. The pretreatment data of the aphids and potato leaf hopper was collected. The number of aphids were measured by in-situ counting and the nymph and adults of potato leaf hopper were measured by counting method and also by using the sweep net method. Similarly the average shoot length, average leaf area, and the total yield were calculated for potato crops in each of control, bio-pesticide synergist and synthetic treatments respectively.

3. Results and discussion
The synergistic bio-pesticide showed good results in controlling the pest of potato. The increase in the yield of the potato was also observed in case of bio-pesticide treatment. The comparative effect of the bio-pesticide synergist and synthetic bifenthrin on the pest control, shoot length, leaf area and yield of potato are discussed as follows.

3.1 Aphids Control
The aphids appeared on the back side of potato leaves when the shoots were one month old. The aphids spread over all potato plants in the field. Almost 80 percent of the potato plants were affected by the aphids. The two potato blocks were sprayed by the application of bio-pesticide synergist and bifenthrin having the concentration of five percent using knapsack sprayer. The pesticide was sprayed at late evening. One plot was left untreated i.e. control. The pest population were determined before treatment in each block by using mechanical counter at morning time as the pests are in-active at morning time. The pretreatment data shows that the number of aphids in control, synergistic bio-pesticide and synthetic treatment were almost the same and have the mean value of 25.54, 24.00 and 26.00 for block-1, block-2 and block-3 treatments respectively. After the application of the first spray, on fourth day, the number of aphids were counted. The number of aphids were the same in control block as was after first observation, while the number of aphids in case of bio-pesticide synergist and synthetic treatment were reduced, with mean values of 19.50 and 15.00 respectively. The second treatment of the pesticides were done after thirteen day of first treatment. A five percent each of the bio-pesticide and bifenthrin was sprayed on respective plots and the number of aphids were counted in each block after the 4th day of application. The number of pests were almost the same in the control treatment block as after the first application of the spray and was calculated to be 24.50, while the mean values of aphids in case of bio-pesticide synergist and bifenthrin treatments were 4.60 and 6.50 respectively. The number of aphids were greatly reduced after second treatment in case of bio-pesticide synergist as compared to the synthetic treatment, while the reduction in the number of aphids were more in case of the bifenthrin after first treatment. This is due to the fact that bio-pesticide contains neem oil and it affect the insects by its feeding deterrent nature. The insect memory is lost and insect death occur due to starvation and this is a slow process and takes a few day. While synthetic pesticide show a fast effect against the pest by its chemical action and the pest can develop resistance to it. The results of the aphids control are shown in figure 8.

Table 1: Aphids at each observation

S. No.	Mean aphids population at each observation			
	Pre treatment	1st observation	2nd observation	Mean
Control	25.54	26.40	24.50	25.48
Synergist	24.00	18.44	4.60	15.68
Bifenthrin	26.00	15.00	6.50	15.83

Fig 2: Potato leaves effected by aphids

3.2 Leaf hopper
The leaf hopper were investigated using pest count and sweep net methods. The pest counting method was done directly in field by calculating the number of nymph and adults of leaf hoppers. The sweep net method was used to calculate the number of adult leaf hoppers. Two sample sites in each block were selected and 25 sweeps were applied at 180 degree in each sample site to find the number of the adult leaf hoppers and the number of nymph was found by visualizing the leaves. The pretreatment data shows that the number of nymph of leaf hopper were almost the same in all the three plots that is 5.25, 5.22 and 5.00 per 25 leaves for the control, bio-pesticide synergist and synthetic treatments, and the number of the adults were also nearly the same and calculated to be 32.00, 31.50 and 31.50 per 25 sweeps for control, bio-pesticide synergist and synthetic treatments respectively. After the first application of the bio-pesticide and synthetic spray, the number of the nymph of leaf hoppers were reduced to 3.5 and 3.1 per 25 leaves of potato for bio-pesticide synergist and synthetic treatments and the of the adults were found to be 21 and 17.5 per 25 sweeps for bio-pesticide synergist and synthetic treatments respectively as observed after the 4th day of the application. After the 2nd application of the bio-pesticide spray, the number of lymph per 25 leaves of the potato were observed to be 0.5 and the number of the adults were 7 per 25 sweeps respectively. Similarly the number of the nymph per 25 leaves were found to be 0.4 and the number of adults were 9.50 per 25 sweeps in case of synthetic treatment. The number of nymph and adults were almost the same in all observations in case of control. So the bio-pesticide has a greater effect than bifenthrin in controlling the nymph and adults of leaf hoppers. These results are shown in table 2 and figures 3 and 4 respectively.

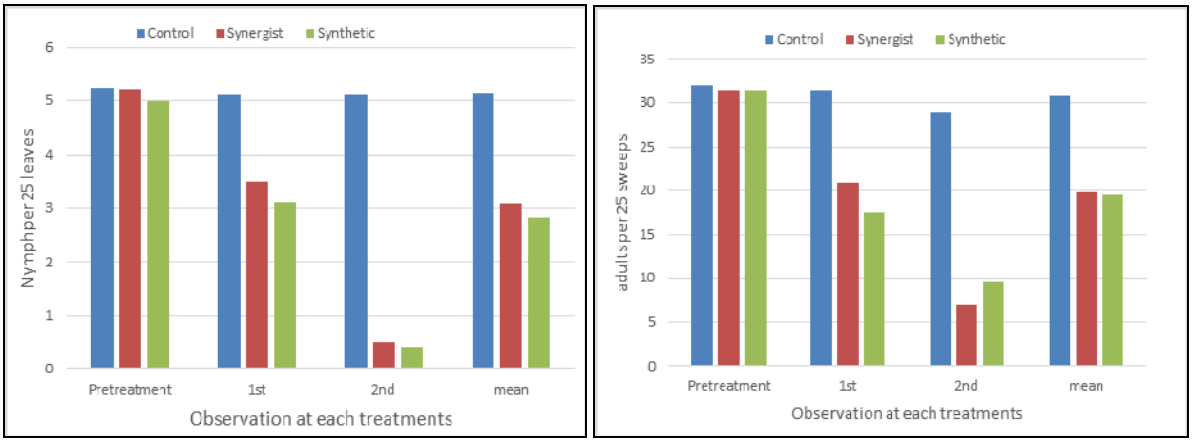

Fig 3, 4: showing the number of nymph and adults of leaf hopper

Table 2: Number of nymph and adults of leaf hoppers at each observation

S. No.	Pretreatment		1st treatment		2nd treatment	
Treatments	Nymph/25 leaves	Adult/25 sweeps	Nymph/25 leaves	Adult/25 sweeps	Nymph/25 leaves	Adult/25 sweeps
Control	5.25	32.00	5.1	31.50	5.1	29.00
Synergist	5.22	31.50	3.5	21.00	0.5	7.00
Synthetic	5.00	31.50	3.1	17.5	0.4	9.50

3.3 Effect of treatments on the Shoot Length and leaf area of potato

There were little effect of bio-pesticide synergist on the shoot of the potato. The mean values of the shoot length for the control, synergistic and synthetic pesticide were 30.6, 32.03 and 31.17 cm respectively as seen in the figure 5. Similarly there was no much difference in the leaf area of the potato in three treatments. The mean values for the leaf area were 13.10, 13.71 and 13.30 in case of control, bio-pesticide synergist and synthetic treatments respectively as shown in the figure 6.

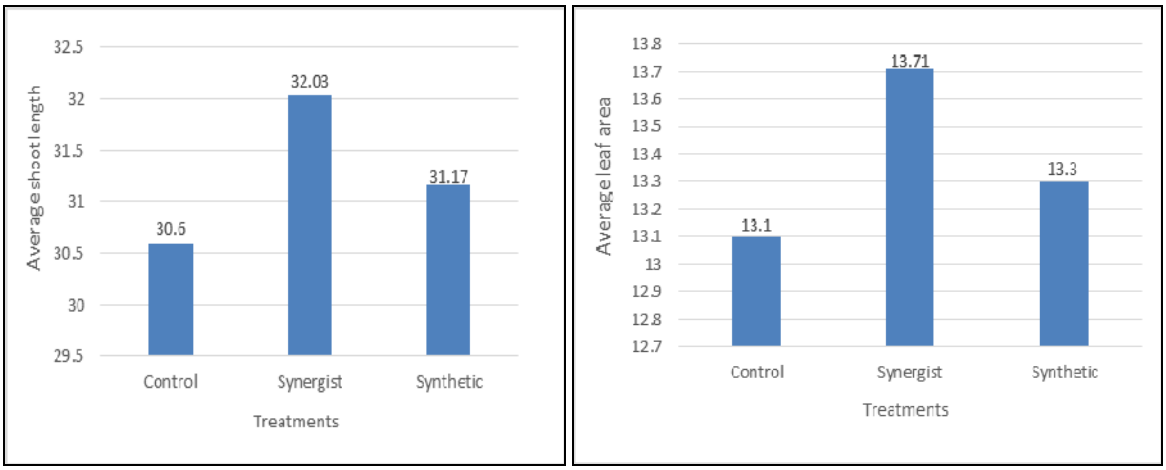

Fig 5, 6: showing the average shoot length and average leaf area of potato

3.4 Effect on the overall yield of the potato

The increase in the overall yield of the potato was observed in case of synergistic bio-pesticide. The total yield of the potato was 1898 kg. The weight of the potato obtained from the block-1 which was left controlled was 570 kg, while the block-2, treated with synergistic bio-pesticide gave the maximum yield of 680 kg. The block-3, treated with bifenthrin produced 648 kg of the potato. These results showed that potato plants treated with the synergistic bio-pesticide produced the highest yield of the potato than both the control and the synthetic treatments respectively. The increase in the yield of the potato in case of synergistic treatment is due to the fact that attack of aphids and leafhoppers were effectively controlled than the control and bifenthrin treatments. The aphids lowered the potato yield by sucking the sap of the plant in control and synthetic treatments. Similarly this increase may also be due to the reason that early blight was not observed in the bio-pesticide synergist treatment, because the synergistic bio-pesticide containing oil makes the leaf surface oily and the frost or dew slip over the leaf surface and fungal growth is discouraged. So this bio-pesticide synergist also acted as fungi-static. The yield of potato for all the three treatments are shown in figure 6.

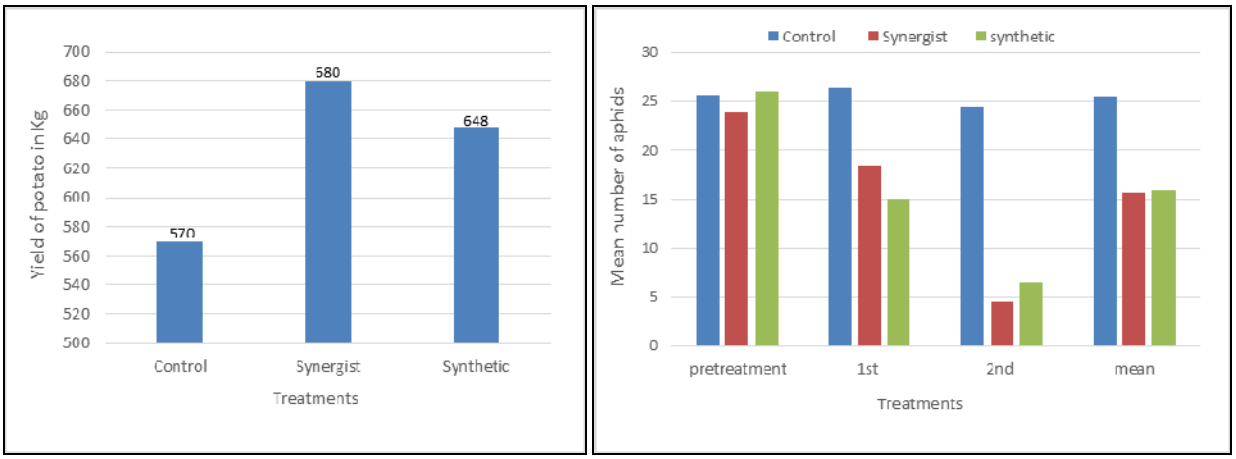

Fig 7, 8: representing the yield of potato and number of aphids for each treatment

3.5 Early Blight Control

After 15th December, some potato plants in control and synthetic treated plots were attacked by the fungus *Alternia Solani.* Almost 40% plants were infested by the fungus each in control and synthetic treated plots. The disease caused by this fungus known as early blight appeared in the form of dark spot and was controlled in early stage using mancozeb fungicide on the control and synthetic treated plots only. This disease was mainly caused by the dew which occurred during the late December. This is a serious disease and cause a great damage to the plants if not controlled in early stage. The bio-pesticide synergist treated plot was not affected by this disease. The main reason of this is that bio-pesticide synergist contained mineral oil making the leaf surface oily and this oil was spread and stick by the NIFA adjuvant uniformly on the leaf surface and the water droplets cannot accumulate on the leaf surface, preventing the fungal attack. The fungal attack is favored by the wet leaf surface. This synergistic bio-pesticide showed both insecticide and fungi-static activity.

4. Conclusion

The synergic combination of neem oil with mineral oil showed comparatively good results than synthetic pesticide in pest control. The aphids and potato leaf hopper which are the serious pests of the plants were effectively controlled by the synergistic bio-pesticide. This bio-pesticide synergist has the advantage that it has no residual effects on the crops and is less susceptible that insects develop resistance to it. Similarly the rain water cannot easily remove this product when applied on the leaves due to oily nature of the product. In the future, further studies are recommended to evaluate the efficacy of this product on other crops and other pests. This product is also recommended for the famers, interested in export-oriented program of agricultural commodities, as this product is safe and develop no pesticide residues in crops and vegetables when properly used. The residues of the synthetic pesticides are the trade irritant in the export of fruits and vegetables to foreign countries.

5. Acknowledgement

We are highly grateful to Dr. Tariq Nawaz Khattak, assistant research officer, of Nuclear Institute for Food and agriculture, NIFA, Peshawar for providing laboratory facilities and chemicals, without his kind cooperation this work would not have been possible.

6. Disclosure

The authors declare no conflicts of interest, or specific financial interests, relationships or affiliations

7. References

1. Carroll M, Radcliffe E, MacRaeI, Ragsdale D, Olson K, Badibanga T. Border Treatment to Reduce Insecticide Use in Seed Potato Production: Biological, Economic, and Managerial Analysis. Am. J Potato Res. 2009; 86:31-7.
2. Daniels M, Bale JS, Newbury HJ, Lind RJ, Pritchard J. A sublethal dose of thiamethoxam causes a reduction in xylem feeding by the bird cherry-oat aphid (Rhopalosiphum padi), which is associated with dehydration and reduced performance. J Insect. Physio. 2009; 55:758-65.
3. Damavandian MR. Comparison of current insecticides with mineral oil for the control of Pulvinaria aurantii Comstock in Mazandaran citrus orchards and their efficacy on phytoseiid mites. *Appl. Entomol. Phytopathol*. 2010; 78(1):81-97.
4. Zeb Q, Badshah H, Ali H, Shah RA, Rehman M. Population of aphids on different varieties/lines of wheat and their effect on yield and thousands grain weight. Sarhad J Agric. 2011; 27:443-445.
5. Kumar J. Neem oil content and its chemical constituents in relation to the agro-ecological factors and regions in India. Pesticide Research Journal. 2010; 9:216-225.
6. Islam MT, Castle SJ, Ren S. Compatibility of the insect pathogenic fungus Beauveriabassiana with neem against sweetpotato whitefly, Bemisiatabaci, on eggplant, *Entomologia Experimentaliset Applicata.* 2010; 134:28-34.
7. Ameline A, Couty A, Martoub M, Giordanengo P. Effects of mineral oil application on the orientation and feeding behaviour of Macrosiphum euphorbiae (Homoptera: Aphidae). Acta Entomologica Sinica. 2009; 52:617-23.
8. Silverio FO, de Alvarenga ES, Moreno SC, Picanco MC. Synthesis and insecticidal activity of new pyrethroids. Pest Manag. Sci 2009; 65:900-905.
9. Boiteau G, Singh M, Lavoie J. Crop border and mineral oil sprays used in combination as physical control methods of the aphid-transmitted potato virus Y in potato. Pest. Manag. Sci. 2009; 65:255-9.
10. Davis J, Radcliffe E. The importance of an invasive aphid

species in vectoring a persistently transmitted potato virus: Aphis glycines is a vector of Potato leafroll virus. *Plant Disease* 2008; 92:1515-23.
11. Yankova V, Markova D, Todorova V, Velichkov G. Biological activity of certain oils in control of green peach aphid (Myzus persicae Sulz.) on pepper. *Acta Horticulturae* 2009, 619-26.
12. Morita M, Ueda T, Yoneda T, Koyanagi T, Haga T. Flonicamid. A novel insecticide with a rapid inhibitory effect on aphid feeding. *Pest. Manag. Sci* 2007; 63:969-73.
13. Gudugi IAS. Effect of cow dung and variety on the growth and yield of Okra (Abelmoschus esculentus (L.). Eu. J of Exp. Bio 2013; 3(2):495-498.
14. Davis J, Radcliffe E, Ragsdale D. Planter skips and impaired stand favors potato virus Y spread in potato. Am. J of Potato Res 2009; 86:203-8.
15. Thul SR, Patil RS, Mule RS. Field efficacy of some pesticides against flea beetle (Podagrica bowringi Baly. Coleoptera: Chrysomelidae) infesting Okra. J of Maharashtra Agri. Univ. 2009; 34:57-59.