International Journal of Engineering Research & Management Technology
ISSN: 2348-4039
Volume 9, Issue-3 May-June 2022
Email: editor@ijermt.org
www.ijermt.org

Cost-benefit analysis under various insecticides used in potato crop (*Solanum tuberosum* Linn.)

Ankit Kajla

School of Agricultutal Sciences, Shri Venkateshwara University, Amroha, India-244236

Ajay Kumar

Department of Plant Protection, Ch. Charan Singh University, Meerut, India-250004

C.P. Kushwaha

Corresponding author

Prof. C. P Kushwaha

School of Agricultural Sciences

Shri Venkateshwara University

Amroha

India-244236

Email: kushwahacp@gmail.com

Mobile: 9336965506

INTRODUCTION

These vegetables are not only the sources of various nutrient and non-nutrient molecules, but they also play a very vital role in reducing the chances of various life-threatening acute diseases. In view of above health benefits, the demand for vegetables is very high and ever increasing which in turn generating need for more efficient cultivation technologies having potential for high productivity. Among the three most widely consumed vegetable crops – potato, onion, and tomato – the maximum increase in production has been seen in potato, with a surge of over 10.55 per cent. The potato, *Solanum tuberosum* L., is one of the most productive and widely grown food crops in the world. India ranks third in area and second in production in the world. More than 85 percent of India's potatoes are grown in the vast Indo-Gangetic plains of north India during the short winter days from October to March. The states of Uttar Pradesh, West Bengal, and Bihar account for more than 75% of India's potato-growing area and approximately 80% of total production (Pandey and Kang 2003). Potential for exporting potatoes from India if very high for both for seed and table purposes to our neighbouring countries. Even potatoes can be exported to some of the European countries during March-May when fresh potatoes are not available in these countries.

Potatoes are winter season crops that need low temperature, low humidity, less wind and bright sunny days. It performs well in conditions ranging from well-distributed rain or moist weather to high temperatures. However, the production of this crop is hampered by various biotic and abiotic factors. Insect pests associated with this crop are major factors for its low production (Mishra *et al.*, 2001). In Indian agriculture, ensuring the sustainable production of potatoes is an crucial challenge as insect pests, especially vectors, are major biotic constraints affecting potato yield and tuber quality. Insect pests cause variable and complex problems for potato farmers (Bhatnagar, 2007, Chandel *et al.*, 2013). India has a great diversity of insect pests that attack potatoes from planting to harvest. Some of these insects had been transported to new locations with seed tubers, while others had already been present in locations where potatoes grown and expanded their host ranges to take advantage of the new plant. Because potato crops are vegetative propagated from whole or cut tubers, which easily carry insect pests, many insect pest problems have followed potatoes to areas where they are grown (Chandel *et al.*, 2007). These insect pests can damage potato plants by feeding on leaves and efficiently by attacking stems, weakening them and by attacking potato tubers destined for consumption or use as seed (Chandel et al., 2003). The crop is attacked by a robust complex of phytophagous insects, some of which can destroy the potato crop in the absence of adequate control measures (Bhatnagar, 2007; 2008). The management of insect pests on potatoes is predominantly achieved through the application of pesticides. India, many cost-effective and efficient management practises for insect pests of potatoes have been reported. In view of abovementioned facts, there is urgent need to evaluate the efficacy of various insecticiteds against insect pests and cost-benefit analysis for potato crops in India.

Material and methods

The present study has been conducted over two seasons (2019-19 and 2019-20) at experimental fields near Shri Venkateshwara University, Amroha, UP. The study area lies between 77^0 42’ East longitude and $29^0$17’

North latitude with 237 m above MSL with subtropical, semi-arid climate having hot-dry summer and severe-cold winter. The long-term annual average rainfall is ca. 817 mm and is mostly received in July-September. The soil of the experimental field was sandy loam with an average fertility level.

The experiment was designed in a randomised block design (9 treatments replicated thrice) having plot size 3.0 m x 3.6 m. The seed bed was prepared by the standard methods and ridges were made 45 cm apart having height 15 cm. Seed material (variety *Kufri Pukhraj*) was planted on ridges at 20 cm distance in the first week of November during both years.

The treatments were given by using a knapsack sprayer. The spray solution of insecticides was prepared by using water at the rate of 300–400 litres per hectare as per the height of the crop. The three consecutive sprays were given at a 15-day interval. The first spray was given on the 25th day after emergence, and the second and third sprays were made at 40 and 55 days after emergence, respectively. To compare the efficacy of insecticidal treatments the control (untreated) was established. The details of treatments along with respective doses and methods of application have been described in the Table 1.

Table 1. Information on novel insecticides used in field trials against major insect pests of the potato crop

S. No.	Insecticides	Dose	Trade name	Method of application	Company
1.	*Abamectin benzoate 1.9% EC*	125 ml/ha	Abacin	Foliar spray	Crystalcrop protection Ltd.
2.	*Thiamethoxam25 WG*	150 gm/ha	Actara	Foliar spray	Synganta India Ltd.
3.	*Imidacloprid 17.8 SL*	150 ml/ha	Confidor	Foliar spray	Bayar India Ltd.
4.	*Chlorantraniliprole 18.5% SC*	150 ml/ha	Coragen	Foliar spray	Ei Dupont India
5.	*Indoxacarb 14.5% SC*	250 ml/ha	Avanut	Foliar spray	Kalyani Industries Ltd.
6.	*Flonicamid 50% WG*	150 ml/ha	Ulala	Foliar spray	UPL India
7.	*Flubendiamide 39.35% SC*	125 gm/ha	Fame	Foliar spray	Bharat Agro Chemicals & Fert.
8.	*Spinosad 45% SC*	150 ml/ha	Tracer	Foliar spray	Kalyani Industries Ltd

9.	*Control (wáter spray)*	–	–	-	-

NPK fertilizers were applied at recommended doses (180:80:100 kg ha^{-1}) with condition that whole amount of phosphorus and potassium were applied during the showing but only half nitrogen was applied as a basal dose. The remaining quantity of N was given in two split doses at 30 days and 45 days after planting.

At weekly intervals, the insect pest complex associated with potato crops was recorded right from the germination of the crop till the harvest on 10 randomly selected plants in each plot. The observations on the population build-up of various insect pests were recorded at different stages of crop growth between 7.00 AM and 9.00 AM till the harvesting of the potato crop. Insects were collected by counting adult and immature stages on the upper, middle, and lower compound leaves of potato plants. The flying insects were collected using a sweep net having a 60 cm long cloth bag, 30 cm in diameter at the mouth, and a 65 cm handle, which was used in the present study. The collected insects were separated into different groups according to insect order.

The incidence of major insect pests of potatoes was recorded at weekly intervals from each plot. The observations on the incidence of whitefly, aphids, and leaf hopper nymphs on potato plants were recorded at weekly intervals from 10 randomly selected potato plants from 3 leaves each of the upper, middle, and lower compound leaves of the plant throughout the crop season, and data was obtained on the number of insects per 3leaves/plant.

The yield increase of potato in various treatments was worked out by deducting the yield recorded in the control plot. The monetary value of the increased yield was computed in rupees using the local market price of potato. A comparison of the cost involved in different treatments was also done based on the maximum retail price printed on the smallest pack. The net return for each treatment was calculated by deducting the cost of treatment from the monetary value of the increased yield. The cost benefit ratio, or net return per rupee invested, was calculated by using the following formula:

Cost: benefit ratio = Cost of increased yield (Rs/ha)/ Cost of treatment (Rs/ha)

Further, the percent increase in tuber yield was calculated.

Results and discussion

The economics and cost-benefit ratio of potato cultivation is based on the data of two concecutive years (Table 1). Among various treatments, thiamethoxam (@ 150 g ha^{-1}) was the most effective against sucking pests of potatoes, with a maximum per hectare tuber yield of 29.45 t/ha and a cost benefit ratio of 1:6.37, respectively. Thiamethoxam was followed by imidacloprid (@150 ml ha^{-1}) with a 29.27 t ha^{-1} tuber yield and a 1: 5.28 cost-benefit ratio, respectively. Whereas, flonicamid at (@ 150 g ha^{-1}) was in third place with a 29.08 t ha^{-1} tuber yield and a 1:5.46 cost-benefit. Noticeable is that in term of cost benefit ratio flonicamid was in second place. Among other insecticides, greater yield (per hectare) have been recorded compared to the control. The cost-benefit ratio of flubendiamide, indoxacarb, spinosad, and chlorantraniliprole was recorded at 2.94, 2.45, 2.43, and 2.00, respectively. The least economical of the tested insecticides was chlorantraniliprole with 1: 2.00 cost-benefit ratio.

The maximum increase in pooled mean tuber yield of 2.445 t/ha was recorded with thiamethoxam 25 WG @ 150 gm/ha (T1), also with a per cent increase in pooled mean tuber yield of 9.05%, followed by imidacloprid at 2.265 t/ha and 8.380%, respectively (Table 4.14). Among all the treatments tested against sucking insect pests of potato crops, the highest net returns were obtained during both the years (2018-19 and 2019-20) of study from thiamethoxam @ 150 gm/ha, with a maximum cost benefit ratio (Fig. 1). Thus, it is said that the use of thiamethoxam at 150 gm/ha can be considered as the most effective tool for the management of sucking insect pests on the potato crop, followed by imidacloprid and flonicamid.

Table 1. Yield and economics of various insecticides for the management of potato insect pests.

Treatment	Yield (t ha^{-1})	Yield increase over control (t ha^{-1})	% Yield increase over control	Value saved (Rs ha^{-1})	Total treatment cost (Rs ha^{-1})	Net income (Rs ha^{-1})	Cost: benefit ratio	Rank
Thiamethoxam25 WG	29.5	2.45	9.1	15940	2160	13780	1:6.4	**1**
Imidacloprid 17.8 SL	29.3	2.27	8.4	14775	2350	12425	1:5.3	**3**
Flonicamid 50% WG	29.1	2.09	7.8	13585	2100	11485	1:5.5	**2**
Abamectin benzoate 1.9% EC	28.8	1.78	6.6	11687	2500	9187	1:3.7	**4**
Indoxacarb 14.5% SC	28.2	1.15	4.3	7600	2200	5400	1:2.5	**6**
Flubendiamide 39.35% SC	28.5	1.45	5.4	9575	2430	7145	1:2.9	**5**
Spinosad 45% SC	28.2	1.20	4.4	7900	2300	5600	1:2.4	**7**
Chlorantraniliprole 18.5% SC	28.0	1.00	3.7	6600	2200	4400	1:2.0	**8**
Control (wáter spray)	27.0	-	-	-	-	-	-	-

Labour rate per day = Rs 250/labour, Market price of potato @ Rs 6500/t

The results obtained in the present study are in agreement with Akashe *et al.* (2009) who reported that while testing the efficacy of nine insecticides against sucking pests, they identified Thiamethoxam as 0.005% most effective against the aphid population, with the highest tuber yield of 1224 kg ha^{-1} and the highest cost-benefit ratio (2.28). These findings are also in accordance with Khan *et al*. (2011) *who* reported maximum potato tuber yield from thiamethoxam at 105.26 a.i. gm/ha and recorded the lowest *Myzus persicae* (Sulzer) population on potato as compared to imidacloprid treated plots. Patel and Patel (2014) reported that the application of thiomethoxam 25 WG was more economical because of its higher cost-benefit ratio and was relatively less toxic to potent natural enemies associated with the crop during crop growth. Our results agreed fully with the previous findings of Nag *et al.* (2018) who reported that thiamethoxam in combination with imidacloprid was the most effective against sucking pests with the highest benefit-to-cost ratio.

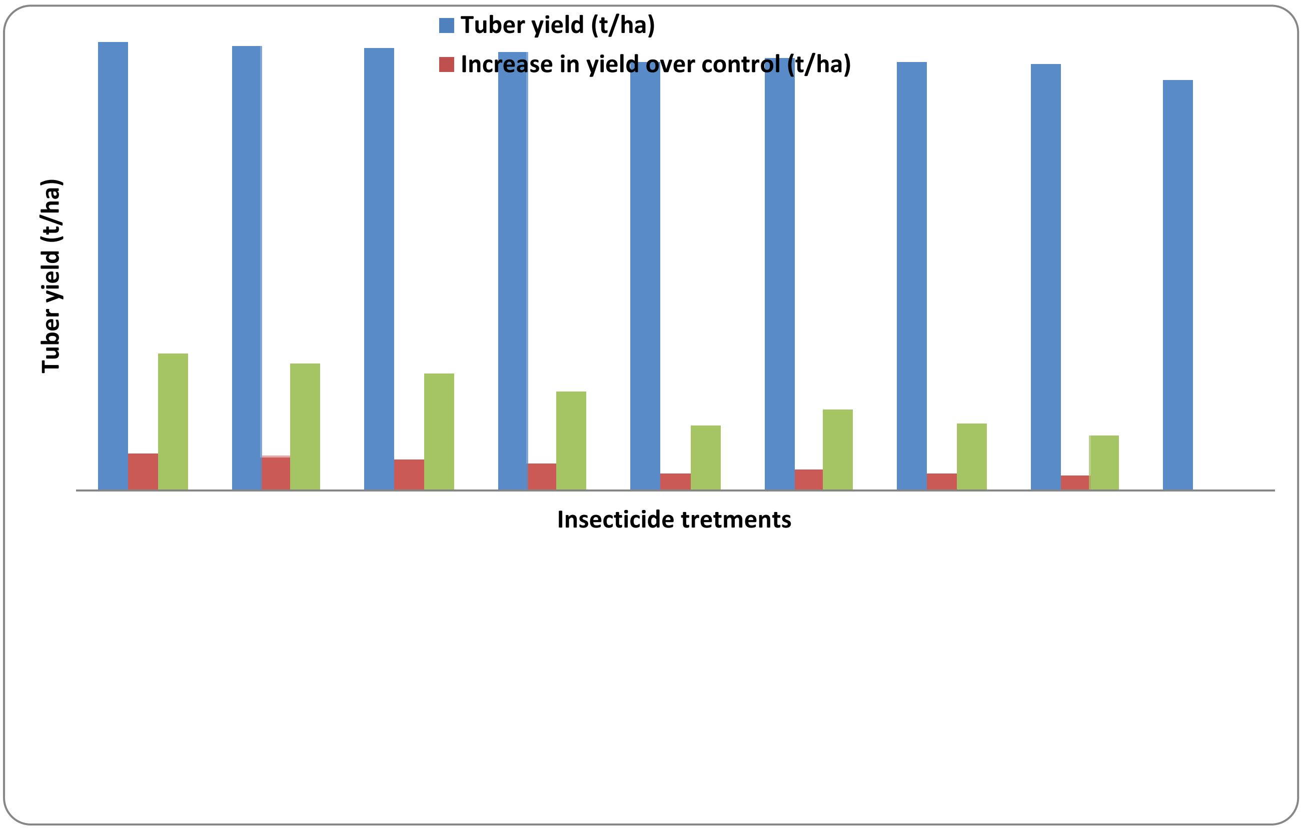

Figure 1. Potato tuber yield (t ha^{-1}) increase over control in various treatments.

The justified use of insecticides with synchronization of timing of pest population showed the potential for reduction in the pest damage and enhancement in the tuber yield which inturn improve the cost-benifit ratio. Among all the insecticides tested against sucking insect pests (whiteflies, aphid complex, and leafhoppers) of potato crops, the highest net returns were obtained with thiamethoxam @ 150 gm/ha, with a maximum cost benefit ratio. Thus, it is suggested that the use of thiamethoxam at 150 gm/ha can be considered as the most effective tool for the management of sucking insect pests on the potato crop, followed by imidacloprid and flonicamid.

References

Akashe, V. B., Gud, M. A., Shinde, S. K., Deshpande, A. N. (2009) Influence of weather parameters on Safflower aphid, *Uroleucon compositae* (Theobald) and its management. *International Journal of Agricultural Sciences*, 5(2): 453-458.

Bhatnagar, A (2007) Incidence and succession of thrips, leafhoppers and whitefly in combination of planting dates and potato varieties. *Ann.Pl. Prot. Sci*., 15(1): 101-105.

Bhatnagar, A (2008) Insect associated with potato in Madhya Pradesh. *Pest Management in Horticultural Ecosystem*, 13 (2): 21-24.

Chandel, R.S., Chandla, V.K. and Sharma, A (2003) Population dynamics of potato white grubs in Shimla hills. *Journal of Indian Potato Association* 30(1-2): 151-152.

Chandel, R.S., Chandla, V.K., Verma, K.S. and Pathania, M (2013) Insect pests of potato in India: Biology and Management. Insect pests of potato (Eds. Andrei Alyokhin, Charles Vincent and Philippe Giordanengo). 227-268.

Khan, M. A., Saljoqi, A. U. R., Hussain. N. and Sattar, S. (2011) Response of *Myzus persicae* (Sulzer) to imidacloprid and thiamethoxam on susceptible and resistant potato varieties. *Sarhad J. Agric*., 27(2): 263- 269.

Mishra AK, Singh R.S and Pandey S. K. (2001) Relative efficacy of chemicals and botanical insecticides against sweet potato weevil. *Ann. Pl. Protec. Sci*.; 9:201-204.

Nag, Dhananjay, Gupta, Rajeev, Bhargav, Pankaj, Kumar, Yeetesh and Bisen, Manmohan, Singh (2018) Relative Efficacy of Insecticides against Potato Aphid (*Myzus persicae* Sulzer), White Fly (*Bemisia tabaci* Genn.) and Lady Bird Beetle. *International Journal of Chemical Studies*, 6(1): 1182-1186.

Pandey, S. K. and Kang, G. S. (2003). Ecological and varietal improvement. In: Khurana, S. M. P., Minhas, J. S., Pandey, S. K. (Eds.), *The potato production and utilization in subtropics,* Mehta Publishers, New Delhi, India, pp. 48-60.

Patel, Y and Patel, P (2014) A Study on Efficacy and Economics of Some Modern Insecticides against Jassid *Amrasca* and *Biguttula biguttula* Ishida in Cotton. *Trends in Biosciences*, 7(10): 889-892.