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EFFICACY AND ECONOMIC OF SULFOXFLOR 12% SL AGAINST SUCKING INSECT PESTS OF POTATO

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ABSTRACT: The field efficacy of sulfoxaflor 12% SL insecticide was evaluated against sucking insect pests (whiteflies and leafhoppers) on seven popular potato cultivars (Kufri Chipsona-1, Kufri Anand, Kufri Chipsona-3, Kufri Surya, Kufri Neelkhant, Kufri Bahar and Kufri Khyati) during 2018-19 and 2019-20. Results showed that, sulfoxaflor 12% SL exhibited excellent activity against *Bemisia tabaci* (Gennadius) and *Amrasca beguttula beguttula* Isida during both the years. The whitefly and leaf hopper population were low on protected potato cultivars as compared to unprotected cultivars. Similarly, highest pooled mean tuber yield (49.33 t/ha) was recorded of K. Khyati when crop was protected by three sprays of sulfoxaflor 12% SL followed by K. Anand (46.90 t/ha) and K. Bahar (40.56 t/ha). By working out cost benefit ratio it is evident that K. Khyati ranked first indicating the maximum return of Rs. 3.18 per rupee invested followed by K. Chipsona-3 with Rs.2.54 and K. Anand Rs.2.47. The present study suggests the use of sulfoxaflor 12% SL is preferred insecticide and could be incorporated in integrated pest management of sucking insect pests of potato.

KEYWORDS: Potato cultivars, whiteflies, leafhoppers, sulfoxflor 12% SL

INTRODUCTION

Potato (*Solanum tuberosum* Linn.) is considered very important tuber crop in India. It is cultivated under different eco-environmental conditions for local consumption and available throughout the year (Rana and Pandey, 2007). The potato is presently produced 53.02 million tonnes from 2.16 million ha area with an average productivity of 24.54 t/ha (Annual report, 2019). Whitefly and leafhoppers are highly polyphagous insect pests, feeding on many horticultural and agricultural crops throughout India (Bhatnagar, 2007; Bhatnagar, 2008; Chandel *et al*. 2013;Bhatnagar, 2013). The leafhoppers and whitefly are most important due to sucking the sap directly from tender parts and transmitting important viral diseases, resulting degeneration of potato. However, whitefly is already established as a vector and transmitting potato apical leaf curl New Delhi virus in potato especially in Western India. Several insecticides belonging to different groups, mainly chlorinated hydrocarbons and organophosphate have been recommended for their control but farmers generally complain the effectiveness of these insecticides against *whitefly* and *leafhoppers* on potato crop. Several conventional and synthetic insecticides have been tried against whitefly, leafhoppers and aphids on various crops in the past (Thakur *et al*., 1991, Singh and Gupta, 1993). Sulfoxaflor 12% SL is a new insecticide used against sap-feeding insects belonging to the family of sulfoximine; that act as nicotinic acetyl choline receptor (nAChR) competitive modulators. Sulfoxaflor binds tonAChR in place of acetylcholine and acts as an allosteric activator of nAChR. Sulfoxafloracts on the same receptors of neonicotinoids as nicotine and butenolides, but it binds differently. It binds to insects nAChRs more strongly than to mammals' ones, so it is much less toxic for mammals and man (Bacci *et al*., 2018)

The major problem in the productivity of potato varieties is its perpetual insect pest infestation throughout crop growth. The new insecticides are playing very important role in

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reducing pest damage with least disturbance to eco-system. Hence, the present study was carried out to evaluate the 7 promising potato cultivars (Kufri Anand, Kufri Surya, Kufri Chipsona- 1, Kufri Neelkhant, Kufri Chipsona -3, Kufri Bahar and Kufri Khyati) against whitefly and leafhoppers harboring on crop under sprayed and unsprayed conditions beside the population buildup of whitefly and leafhoppers on potato cultivars, yield and its yield attributing factors.

MATERIALS AND METHODS

Field trials were conducted to evaluate the efficacy of new insecticide sulfoxflor 12% SL against whitefly, *Bemisia tabaci* (Gennadius) and leafhoppers *Amrasca beguttula beguttula* Isida on potato cultivars at ICAR-Central Potato Research Institute Campus, Modipurum, Meerut (U.P.) during two consecutive years 2018-2019 and 2019-20. The experiment was laid out in a randomized block design with plot size of 3 m x 3 m. Potato cultivars, T1- Kufri Chipsona-1, T2- Kufri Anand, T3- Kufri chipsona-3, T4- Kufri Surya, T5-Kufri Neelkhant, T6-Kufri Bahar, and T7- Kufri Khyati were planted in the 1st week of November during main crop season with three replications. All the agronomical package and practices recommended for the region were followed in raising a good crop. There sprays of Sulfoxaflor 12% SL @ 0.03% (3ml/10 lit of water) were given when crop was 30, 45 and 55 days old at 15 days interval.

The observations on the population buildup of whitefly and leafhoppers were recorded on 05 randomly selected plants covering upper, middle and lower leaves of each plant at before and 24hrs and 48hrs after each spray from both sprayed and unsprayed potato cultivars. The yield data was recorded from net plot after removing halum in the first week of February during both the years. The other plant growth parameters like % germination (30 days old crop), average plant height, average compound leaves/ plant and % apical leaf curl diseased plants (50 days old crop) along with other yield attributing characters like percent & total over size, seed size and small size tubers were recorded at the time of harvest in sprayed and unsprayed plots. Benefit-Cost analysis was expressed in terms of Benefit: Cost ratio by using the following formula

$$\text{Cost benefit : ratio} = \frac{\text{Net return (Rs. ha}^{-1})}{\text{Cost of treatment (Rs. ha}^{-1})}$$

The data was further subjected to statistical analysis. Similarly, the % increase in tuber yield over unsprayed crop was calculated as follows-

$$\text{\% Increase in tuber yield} = \frac{\text{Tuber yield in sprayed plot - Tuber yield in unsprayed plot}}{\text{Tuber yield in unsprayed plot}} \times 100$$

RESULTS AND DISCUSSION

Population buildup of Whitefly, *B. tabaci* and leafhoppers *A. beguttula beguttula* on potato cultivars

A day before spray the mean population of whitefly and leafhoppers was almost uniform across the experimental plots on potato cultivars (2.33-3.67/ 5plants) and (1.67-4.33/ 5plants), respectively. It did not differ significantly one and two days after first spray on potato cultivars during both the years. The lowest number pooled mean of whitefly per 05 plant was recorded in the K. Khyati (0.50 whiteflies/ 05 plant) followed by K. Chipsona-1, K.Nilkhant and K.Surya (0.83 /5 plants) in sprayed plot of sulfoxaflor 12% SL (Fig 1 & 2). Similarly, no significant difference among the sprayed potato cultivars was noticed even after second spray of Sulfoxaflor when crop was 45 days old. However, one day before second spray again

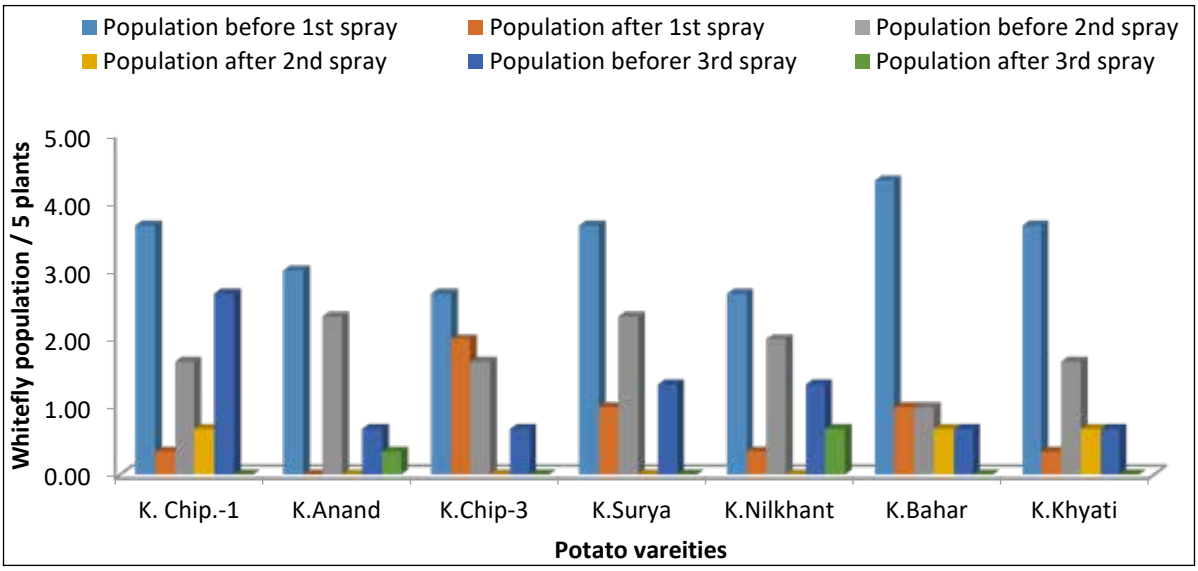

Fig. 1. Mean population buildup of whiteflies on potato cultivars (sprayed and unsprayed) under field conditions (pooled data of 2018-19 and 2019-20)

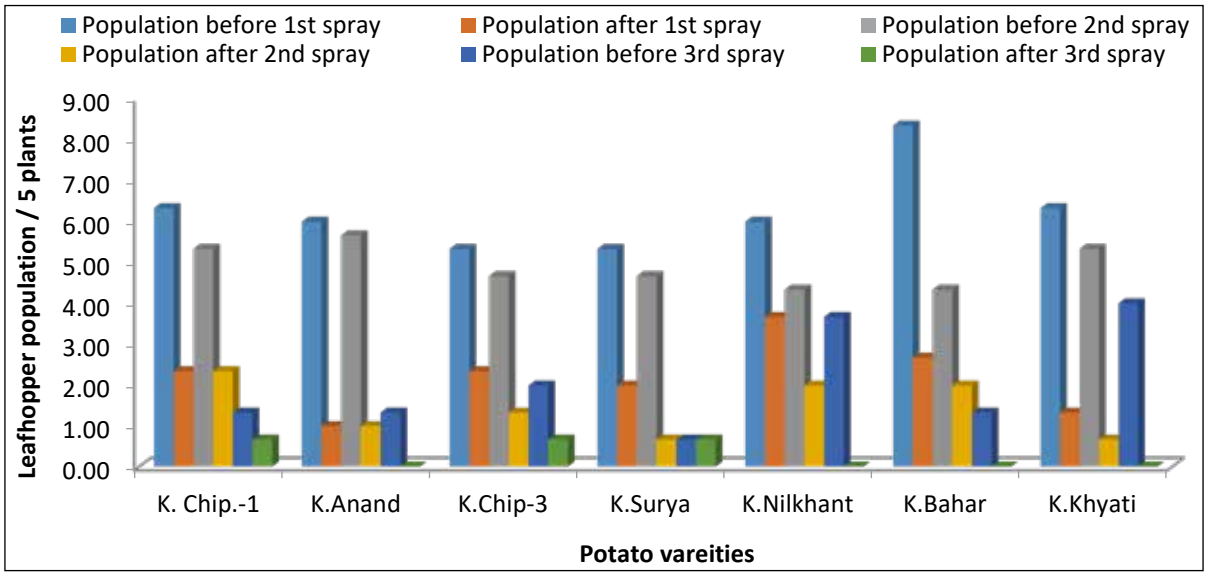

Fig. 2. Mean population buildup of leafhoppers on potato cultivars (sprayed and unsprayed) under field conditions (pooled data of 2018-19 and 2019-20)

non-sprayed potato cultivars showed no significant difference with respect to number of whiteflies and leafhoppers. The lowest number of pooled mean of whitefly per 05 plant was recorded in the K. Chipsona-3 and K. Nilkhant (0.0 whiteflies/ 05 plant) followed by K. Surya and K. Anand (0.33/5 plants) in sprayed plots. Similarly, it was 0.67/ 05 plants for leafhoppers on K. Khyati followed by K. Surya and K. Bahar (1.0/ 05 plants). The maximum number of pooled mean of whiteflies and leafhoppers population were (1.0/ 05 plants) and (2.66/ 05

plants), respectively on K. Khyati and K. Chipsona-1 in sprayed crop. No significant difference of whitefly population was noticed among sprayed potato cultivars before and after third spray in 55 days old crop. However, significant difference was recorded before third spray against leafhopper population on potato cultivars while no differences was noticed one day and second day after third spray. There was decline of temperature after third week of December, resulting slightly lower population of whitefly and leafhopper on main potato crop during the experimental period. However, Bhatnagar *et al.,* 2013 also reported that sharp decrease in temperature after mid-November decreased whitefly and leafhoppers population drastically. Incidence of whitefly and leafhoppers population did not differ significantly in relation to plant protection treatments on potato crop.

Gradual reduction in percentage of whitefly and leafhoppers population as a result of sulfoxflor insecticide treatments on potato cultivars were recorded during both the years (Tables 1). The highest pooled mean reduction percentages of whitefly were recorded on K. Chipsona-3 followed by K. Surya where the mean reduction percentages were 84.19%, 78.72%, 76.81%, 71.62% and 61.36%% on K. Nilkhant, K. Chipsona-1, K. Khyati, K. Bahar and K. Anand, respectively. The least pooled mean reduction percentage of whitefly population was recorded on K. Anand where the mean reduction percentages were 58.38 and 64.37% during the years 2018-19 and 2019-20, respectively. Similarly, field evaluation of Sulfoxaflor on potato cultivars against leafhoppers revealed that the highest pooled mean reduction percentages 87.21 and 79.66 were achieved on K. Khyati and K. Bahar, where the mean reduction percentages were 81.51% and 92.81% and 70.66% and 88.20% during the respective years. The least mean pooled reduction percentage was recorded on K. Chipsona-1. The earlier results indicate that, neonicotinoids provide excellent control of many sucking pests including leafhoppers and whitefly (Bhatnagar, 2007). Our results are in agreement of Bacci *et al*., 2018 who reported that sulfoxaflor was effective against sap-feeding insect pests that are resistant to other classes of insecticides, including many that are resistant to the neonicotinoids.

The population of *B. tabaci* and *A. beguttula beguttula* was active on potato crop throughout

Table 1: Mean (%) reduction of whitefly and leafhoppers on different potato cultivars after each spray during main crop season (pooled data)

Potato cultivars	Mean reduction of whiteflies over unsprayed (%)				Mean reduction of leafhoppers over unsprayed (%)			
	1st spray	2nd spray	3rd spray	Mean	1st spray	2nd spray	3rd spray	Mean
K. Chipsona-1	80.83	55.33	100.0	78.72	75.65	39.49	68.98	61.38
K. Anand	73.89	84.80	25.38	61.36	61.67	65.22	100.0	75.63
K. Chipsona-3	62.54	100.0	100.0	87.52	68.95	71.52	73.20	71.23
K. Surya	73.81	87.64	100.0	87.15	75.97	79.30	71.24	75.51
K. Nilkhant	77.38	100.0	75.19	84.19	28.55	69.29	92.66	63.50
K. Bahar	64.86	50.00	100.0	71.62	71.35	79.30	88.33	79.66
K. Khyati	90.32	40.11	100.0	76.81	86.60	87.42	87.59	87.21

Three sprays of sulfoxaflor 12% SL (3ml/10 lit of water) 30, 45 and 55 days old potato crop

the crop growth. The incidence of whitefly and leafhoppers population were resulted on main potato crop from residue population from natural host and weeds in the vicinity of the crop. However, the populations of whitefly and leafhoppers were remains low on sprayed potato cultivars when crop was protected by three sprays of sulfoxflor. The higher mean incidence of whitefly and leafhoppers was recorded in unsprayed potato cultivars due to change of environmental condition i.e., increase of temperature, decline of R.H. and maturity of seven potato cultivar. Low temperature and rains in the months of November and December also influenced the buildup of whitefly and leafhoppers on potato crop (Bhatnagar *et al*., 2016). A perusal of whitefly incidence data revealed that whitefly has become a severe threat to potato crop by not only sucking the sap directly from the tender parts of potato plant and also transmitting important APCLV, resulting quick degeneration of potato seed (Bhatnagar, 2007 and Chandla *et al*., 2001). Similarly, the incidence of leafhoppers has responsible for hopper burn especially in warmer region of the country.

Per cent germination, Av. Plant height and number of compound leaves, disease incidence, per cent different size of tubers, tuber yield and its attributing characters of potato cultivars along with its economic

Pooled per-cent mean germination data did not differ significantly among sprayed and unsprayed (89.0-100.0%) potato cultivars. However, pooled mean data on Plant height, number of compound leaves and % numbers of oversize tubers did differ statistically among the seven potato cultivars under both the conditions during the respective years (Table 2). Similarly, the pooled per cent mean disease incidence varied from

Table 2. Yield attributing plant and tuber characters of different potato cultivars (sprayed and unsprayed) under field conditions (pooled data of 2018-19 and 2019-20)

Potato cultivars	Yield and tuber characters of potato under sprayed condition								Yield and tuber characters of potato unsprayed condition							
	% Emergence	Av. Plant height/ plant (cm)	Av. Number of comp. leaves / plant	Over size tubers (t/ha)	Seed size tubers (t/ha)	Small size tubers (t/ha)	% Over size tubers	% Seed size tubers	% Small size tubers	% Emergence	Av. Plant height/ plant (cm)	Av. Number of comp. leaves / plant	Over size tubers (t/ha)	Seed size tubers (t/ha)	Small size tubers (t/ha)	% Over size tubers	% Seed size tubers	% Small size tubers
K. Chip.-1	96.00	63.27	16.87	8.65	21.40	2.75	13.07	57.91	28.07	94.63	62.50	16.27	8.59	19.20	2.44	11.72	59.97	27.69
K. Anand	99.57	69.87	16.80	18.42	24.23	2.54	16.97	59.31	23.60	100.0	68.0	15.53	18.72	21.45	3.16	17.88	55.67	26.77
K.Chip.-3	100.0	67.67	15.93	9.75	26.50	2.73	10.78	65.93	23.23	99.10	66.10	16.33	11.49	21.65	2.24	19.15	57.57	25.32
K. Surya	99.53	62.07	13.67	9.06	18.91	2.43	10.74	59.11	28.58	98.63	59.60	13.53	9.30	15.55	2.15	14.07	59.17	26.72
K. Nilkhant	99.57	64.13	15.20	11.50	22.85	3.68	11.80	52.50	36.03	100.0	60.73	14.07	11.64	20.33	3.34	13.31	56.13	30.51
K. Bahar	89.00	56.80	14.93	14.26	23.56	2.71	15.71	61.17	23.58	89.53	53.63	14.73	13.20	21.41	2.11	15.75	62.37	21.84
K. Khyati	98.63	61.27	18.80	31.92	17.51	1.54	30.87	47.33	20.90	98.17	57.67	17.33	27.48	16.14	1.42	27.81	48.63	20.13
S. Em±	3.95	2.22	0.57	2.72	1.79	0.29	3.34	3.13	3.02	4.21	1.78	0.64	3.00	1.84	0.48	5.01	4.27	2.65
CD @ 5%	NS	6.91	1.79	8.49	5.60	0.90	10.4	9.76	NS	NS	5.56	2.01	9.36	NS	NS	6.68	NS	NS

Three sprays of sulfoxaflor 12% SL (3ml/10 lit of water) 30, 45 and 55 days old potato crop

0.0-0.33% among the protected cultivars while it was from 1.13-1.38% among the unprotected cultivars (Table 3). The maximum pooled mean disease incidence (1.38%) was recorded in unsprayed K. Nilkhant. However, minimum mean disease incidence (0.0%) was recorded in sprayed potato cultivars of K. Khyati and K. Chipsona-1.

Highest pooled mean tuber yield (49.33 t/ha) was recorded of K. Khyati when crop was protected by three sprays followed by K. Anand (46.90 t/ha) and K. Bahar (40.56 t/ha) (Table 3). However, maximum (12.24 %) increase in tuber yield was recorded in K. Surya followed by K. Chipsona-3 (10.19) and K. Khyati (9.45) (Table 3). By working out cost benefit ratio it is evident that K. Khyati ranked first indicating the maximum return of Rs. 3.18 per rupee invested followed by K. Chipsona-3 with Rs.2.54 and K. Anand Rs.2.47. The maximum C: B ratio 1:3.18 was recorded in K. Khyati due to its high yield potential and protection against insect vectors. Jaykar *et al*. (2019) also reported that K. Khyati, K. Anand and K.Garima were recorded the highest tuber yield under protected conditions. Bhatnagar (2013) also confirmed that soil application of insecticides and two to three sprays of insecticides were required for complete protection of potato crop against insect's pests under field conditions.

CONCLUSION

Three sprays of Sulfoxaflor could be incorporated in spray schedule against sucking pests especially whiteflies and leafhoppers for getting potential yield of seven potato cultivars. The use of pesticides from the emergence of potato crop to 55 days old was effectively reduced the whitefly and leafhopper population, percent disease intensity and significantly increased tuber yield. It can be concluded that, sulfoxaflor is the preferred insecticides with less toxicity

Table 3. Yield and cost benefit ratios of different potato cultivars (sprayed and unsprayed) under field conditions (pooled data of 2018-19 and 2019-20)

Potato cultivars	% Diseased plants in sprayed plots (50 days old crop)	% Diseased plants in unsprayed plots (50 days old crop)	Mean Tuber yield in unsprayed crop (t/ha)	Mean Tuber yield in sprayed crop (t/ha)	Economics of treatments						
					% Increase in yield over control	increase in yield over control (t/ha)	*Cost of increase yield potato (Rs.)	**Cost of plant protection (Rs.) (1)	Net profit (Rs.) (2)	Benefit: Cost Ratio (1/2)	Rank
K. Chip.-1	0.0	1.27	30.08	32.80	9.04	2.72	19040	7128	11912	1:1.67	7
K. Anand	0.33	1.27	43.36	46.90	8.16	3.54	24780	7128	17652	1:2.47	3
K. Chip.-3	0.33	1.27	35.41	39.02	10.19	3.61	25270	7128	18142	1:2.54	2
K. Surya	0.33	1.27	27.02	30.39	12.24	3.37	23590	7128	16462	1:2.30	4
K. Nilkhant	0.33	1.38	35.24	38.02	7.88	2.78	19460	7128	12332	1:1.73	6
K. Bahar	0.33	1.27	37.68	40.56	7.64	2.88	20160	7128	13032	1:1.82	5
K. Khyati	0.0	1.13	45.07	49.33	9.45	4.26	29820	7128	22692	1:3.18	1
SEm±	0.1	0.11	2.26	1.79	-	-	-	-	-	-	-
CD (p=0.05)	NS	NS	7.05	5.58	-	-	-	-	-	-	-

Note: Three sprays of sulfoxaflor 12% SL (3ml/10 lit of water) 30, 45 and 55 days potato old crop * Cost of potato Rs. 7000/ t ** (Cost of plant protection- Labor+ spray product + Machine)

to the mammals and can be used to control sucking insect pests in potato IPM programs.

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