www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 3243-3246

www.thepharmajournal.com
Received: 03-04-2022
Accepted: 16-06-2022

Rabindra Prasad
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

Nakkala Divakar Reddy
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

Ashish Narayan
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

T Alam
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

GS Giri
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

PP Singh
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

Corresponding Author
Rabindra Prasad
Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India

Field efficacy of botanical insecticides against sweet potato weevil, *Cylas formicarius* Fab. (Coleoptera: Brentidae)

Rabindra Prasad, Nakkala Divakar Reddy, Ashish Narayan, T Alam, GS Giri and PP Singh

Abstract
A study was conducted to know the field efficacy of botanical insecticides against sweet potato weevil. The experiment was laid during September, 2019 at research farm of Dholi, Bihar in randomized block design with 03 replications and 10 treatments. The sweet potato variety "Cross-4" is used as a susceptible test variety for sweet potato weevil. Experimental evidence has shown that the sweet potato weevil has a damage potential upto 50% in Bihar and 90% at National level. The sweet potato weevil is considered to be the single most destructive pest of sweet potato. Plants containing active insecticidal phytochemicals are gaining attention because of their broad spectrum insecticidal activity, safety, biodegradability and integrated crop management approaches as they are probable candidates for alternatives to chemical and synthetic insecticides. Treatments comprised of foliar application of botanical insecticides *viz*., Vine treatment with chlorpyriphos @ 1lit/ha, neem oil @ 2% aqueous, Yam bean seed extract @ 5% aqueous, Karanj oil (@ 2% aqueous, Tobacco decoction @5% aqueous and combination of vine treatment with chlorpyriphos 20 EC @ 1lit/ha along with application of Neem oil @ 2%, Yam bean seed extract @ 5%, Karanj oil @ 2% and Tobacco decoction @ 5% aqueous solution. Results indicated that minimum per cent of weevil infestation was recorded in vine treatment with chlorpyriphos 20 EC @1lit/ha along with spraying of neem oil @ 2%), followed by vine treatment with chlorpyriphos 20 EC @1lit/ha along with spraying of karanj oil @ 2% in terms of reducing vine infestation, tuber infestation and also offered protection to tubers in storage up to one month after harvesting, while the lowest efficacy and marketable tuber yield (t/ha) is recorded in treatment with chlorpyriphos 20 EC @ 1lit/ha., when applied alone. However, all the treatments were superior over untreated control. On the basis of benefit-cost ratio spraying of neem oil @ 2% having B:C ratio of 1:14.1 proved to be more economical as compared to other treatments.

Keywords: Field efficacy, botanical insecticides, sweet potato weevil

Introduction
Sweet potato (*Ipomea batatas* L.) belongs to family *Convolvulaceae* is a staple food and feed for human and animal consumption respectively. Sweet potato known to be cultivated in more than hundred developing countries, and is ranked as the 5th most essential foodstuff in over 50 of those countries and globally 7th amongst the entire food production (Clark *et al*., 2013and Narayan *et.al.*, 2022) [1, 2]. In India, sweet potato is mostly grown in Odisha, Bihar, Jharkhand, Uttar Pradesh, Madhya Pradesh, Assam, West Bengal, Tamil Nadu and, Kerala. In India, it is cultivated in an area of 0.13 million ha with a total production of 1.47 million tons (FAO, 2017) [3]. In Bihar, it is commercially cultivated in an area of 910 ha with a total production of about 8480 metric tons and productivity 9.3 metric tons/ha (FAO, 2017) [3]. Sweet potato weevil (*Cylas formicarius* Fab.) has been reported to be the most serious and potential pest during crop season causing heavy damage to sweet potato throughout India in general and Bihar in particular. In many parts of the country, weevil infestation ranges from 20 to 50 per cent and can even reach 100 per cent, depending on season and variety. The sweet potato weevil has become widely dispersed, mainly in tropical and subtropical regions of the world, and recently has been found in higher latitude areas as well. Weevil is the most severe soil insect pest of sweet potato which attacks both in field and during storage.
Adult of *C. formicarius* feeds on leaves, tender buds, storage roots and vines whereas larvae, the most destructive stage, feed and tunnel into mature stems and storage roots (Chalfant *et al*., 1990) [4]. Infestation of storage roots makes them unfit for human or animal consumption, even if only a small proportion of the flesh is damaged, because the damaged tissue produces

terpenes which give the flesh an unpleasant odor and bitter taste. Damage by weevil continues to increase during storage (Chalfant *et al*., 1990) [4]. Heavy feeding on the vines destroys tissues resulting in a significant reduction in the yield, due to the poor translocation of photosynthates and nutrients. Experimental evidence has shown that the sweet potato weevil has a damage potential of 80-90%. On-farm survey among sweet potato farmers revealed that the loss ranged from 5-55% in Kerala, 25-45% in Orissa and 5-50% in Bihar and Uttar Pradesh (Pillai *et al*., 1984; Palaniswami, 2000) [5, 6]. Plants containing active insecticidal phytochemicals having broad spectrum insecticidal activity, safety, biodegradability are gaining attention and integrated crop management approaches are more fruitful in controlling this serious pest. Therefore, field efficacies of some botanical insecticides prepared as Neem oil, Yam bean seed extract (YBSE), Karanj oil and Tobacco decoction are being reported against sweet potato weevil adjudged on the basis of calculated marketable tuber yield (Singh *et al.*, 2019) [7].

Materials and Methods

To study the field efficacy of botanical insecticides against sweet potato weevil, a field experiment was conducted at research farm of T.C.A., Dholi (Muzaffarpur), Bihar. Dholi falls in the Gandak command area of North Bihar and is situated at 25.5^0 N latitude, 85.4^0 E longitude and an altitude of 52.12 m above mean sea level. The soil texture, in general is predominately loamy to sandy loam with a pH ranging from 8.12-9.00. Dholi is subjected to moderate weather conditions and represent Agro-climatic Zone-1 of Bihar. The hottest months are April-May with maximum temperature around 37^0C and January is the cold month with the average temperature of 8^0C or below. The experiment is conducted in randomized block design with 10 treatments and each treatment is replicated thrice. The sweet potato variety Cross-4" is used as a test variety was planted on September, 2019. The treatment details are given below.

Treatment details and schedule of spray taken

T_1: Vine treatment with chlorpyriphos (20EC) @ 2ml/lit
T2: Spraying of Neem oil @ 2% at 30,45,60 and 75DAP
T3: Spraying of YBSE @ 5% at 30,45,60 and 75DAP
T4: Spraying of Karanj oil @ 2% at 30,45,60 and 75DAP
T5: Spraying of Tobacco decoction@ 5% at 30,45,60 and 75DAP
T6=T1 + T2
T7=T1+ T3
T8 = T1+ T4
T9 = T1 + T5
T10: Untreated control

Spraying is scheduled at 30, 45, 60 and 75 DAP (Days after planting) and observation regarding per cent vine infestation is collected at 1DBS (Day before spraying), 3DAS (Days after spraying), 7 DAS (Days after spraying), 10 DAS (Days after spraying) for all the four sprayings. Tubers from each plot were harvested at 120 days after planting by using a hoe. Observation regarding tuber infestation is recorded at the time of harvesting by taking weight of healthy and infested tubers for each treatment. The infested tubers are sorted out from the healthy one based on presence of ovipositional punctures on the external tuber periderm. The infested and healthy tubers are weighed separately. After harvesting, one Kg of infested tuber from each treatment are sorted separately in a polythene bag (400 gauge) to determine the number of immature stages of weevil present. The stored tubers are cut into pieces for counting all stages of weevil after one month and finally mean number of weevil per Kg of the infested tuber is computed. Data obtained is used to work out vine and tuber infestation by using the following formula:

$$\%\ Vine\ infestation = \frac{\text{Number of vines infested}}{\text{Total number of vines}} X\ 100$$

$$\%\ Tuber\ infestation = \frac{\text{Weight of weevil infested tubers}}{\text{Total weight of tubers}}\ X\ 100$$

Results and Discussion

For providing better protection against sweet potato weevil infestation foliar application of different treatments *viz*., Vine treatment with chlorpyriphos (@ 1lit/ha), neem oil @ (2% aqueous), yam bean seed extract @ (5% aqueous),Karanj oil (@ 2% aqueous), tobacco decoction (@5% aqueous) and combination of vine treatment with chlorpyriphos 20 EC @ 1lit/ha along with neem oil @ 2%, Yam bean seed extract @ 5%, karanj oil @ 2% and tobacco decoction @ 5% are evaluated during September,2019-20. Spraying was scheduled at 30, 45, 60 and 75 DAP (Days after planting) and readings regarding per cent vine infestation is collected at 1DBS (Day before spraying), 3DAS (Days after spraying), 7 DAS (Days after spraying), 10 DAS (Days after spraying) for all the four sprayings. Data regarding per cent tuber infestation is collected at the time of harvesting, and average weights of tubers from each plot are collected and stored in polythene bag for one month and mean number of weevils emerged from the tubers is computed and efficacy of the treatment in storage is determined. Finally the treatments are judged based on the cost-benefit ratio.

On perusal of Fig.1, it was revealed that all the treatments were superior over untreated control. The mean percent tuber infestation due to sweet potato weevil varied from 18.7% to 58.55% with minimum and maximum being in T_8(Vine treatment with chlorpyriphos (20 EC) @1lit/ha + Spraying of karanj oil @ 2%) and T_{10} (Untreated control) respectively. Remaining treatments *viz*; T_1-Vine treatment with chlorpyriphos (20 EC) @ 1 litl/ha (43.28%), T_2- Spraying of Neem oil @ 2% (24.61%), T_3- Spraying of Yam bean seed extract @ 5% (40.35%), T_4-Spraying of karanj oil @ 2% (27.71%), T_5- Spraying of Tobacco decoction @ 5% (24.79%), T_6-T_1+T_2 (22.19%), T_7-T_1+T_3 (37.44%), T_9-T_1+T_5 (31.39%) are intermediate between these two values. Per cent reduction in infestation over control highest per cent reduction in tuber infestation over control is in T_8-T_1+T_4 (68.07%), whereas lowest mean per cent tuber infestation (%) is in T_1-Vine treatment with chlorpyriphos (20 EC) @ 1lit/ha (26.09%). Decreasing order of mean per cent tuber infestation T_{10}: Untreated control (58.55%) >T1:Vine treatment with chloropyriphos (20EC) @ 1lit/ha (43.28%) > T_3: Spraying of YBSE @ 5% (40.35%) > T_7=T_1+ T_3 (37.44%) > T_9 = T_1 + T_5 (31.39%) >T_4: Spraying of Karanj oil @ 2% (27.71%) >T5:Spraying of Tobacco decoction@ 5% (24.79%) > T_2:Spraying of Neem oil @ 2% (24.61%) > T_6=T_1 + T_2 (22.19%) > T_8 = T_1+ T_4 (18.7%).

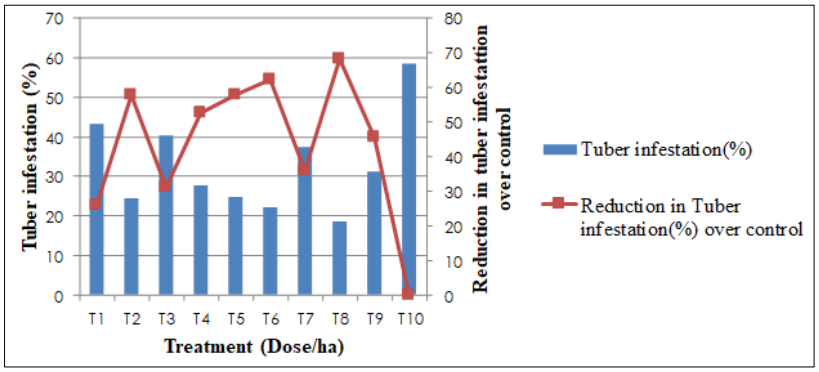

Fig 1: Effect of botanical insecticides on per cent tuber infestation

After the first spray, the overall mean data of different treatments which were tested for their field efficacy against the sweet potato weevil for per cent vine infestation was found to be significantly superior over untreated control, Treatment-T_6 was found to be highly effective with mean per cent vine infestation of 36.94% and untreated control is with highest per cent of vine infestation 51.13%. Remaining treatments are in between these two treatments.

After the second spray, treatment-T6 was found to be highly effective with mean per cent vine infestation of 28.77% and highest mean per cent vine infestation is in treatment-T1 (51.77%) among all other treatments. Remaining treatments are in between these two treatments. All the insecticidal treatments were significantly superior over untreated control and treatment T8 is significantly at par with treatment-T6.

After the Third spray, Treatment-T_6 was found to be highly effective with mean per cent vine infestation of 28.41% and highest mean per cent vine infestation is in treatment-T_1 (53.25%) among all other treatments. Remaining treatments are in between these two treatments. All the insecticidal treatments were significantly superior over untreated control.

After the fourth spray, again treatment-T6 was found to be highly effective with mean per cent vine infestation of 21.02% and highest mean per cent vine infestation was in treatment-T1 (59.08%) among all other insecticide treatments. Remaining treatments are in between these two treatments. All the insecticidal treatments were significantly superior over untreated control. Research work done by earlier workers demonstrated the efficacy of botanical insecticides against sweet potato weevil and it was found effective in reducing weevil infestation (Facey *et al*., 2006; Muffok *et al*., 2008; Minista *et al*., 2017; Nta *et al*., 2018) [8, 9, 10, 11].

Field performance of various botanical pesticides were further adjudged on the basis of calculated marketable tuber yield illustrated in Fig. 2 The marketable tuber yield ranged from 12.43 t/ha in untreated control to 21.05 t/ha in Treatment-T_6 (Vine treatment with chlorpyriphos (20EC) @ 1lit/ha + Spraying of Neem oil @ 2%). It is noted that marketable tuber yield in all the treatments is higher than that of untreated control. Highest marketable tuber yield was recorded in treatment-T_6 (21.05 t/ha), followed by T_8 (19.11 t/ha), T_2 (18.45 t/ha), T_5 (17.60 t/ha), T_4 (17.03 t/ha), T_9 (16.00 t/ha), T_7, (15.95%), T_3 (15.52 t/ha), T_1 (13.51 t/ha), and T_{10} (12.43 t/ha). Marketable tuber yield of sweet potato increased by 8.68, 24.85, 28.31, 28.72, 37.00, 41.59, 48.43, 53.74 and 69.34 per cent over untreated control with the Vine treatment with chloropyriphos (20 EC) @ 1lit/ha,Spraying of YBSE @ 5%,Vine treatment with chloropyriphos (20EC) @ 1lit/ha+ Spraying of YBSE @ 5%,Vine treatment with chloropyriphos (20EC) @ 1lit/ha+ Spraying of Tobacco decoction@ 5%,Spraying of Karanj oil @ 2%,Spraying of Tobacco decoction@ 5%,Spraying of Neem oil @ 2%,Vine treatment with chlorpyriphos (20EC) @ 1lit/ha+Spraying of Karanj oil @ 2%,Vine treatment with chloropyriphos (20EC) @ 1lit/ha+ Spraying of Neem oil @ 2%, respectively.

These treatments continued to afford protection to the tubers in storage for one month after harvesting. The mean number of weevils emerged for one kg of infested tubers ranged from 15.0 to 45.6 with minimum and maximum being in treatment-T_6 (vine treatment with chlorpyriphos 20EC @ 1lit/ha+ Spraying of Neem oil @ 2%) and untreated control, respectively. Remaining treatments performed significantly superior over untreated control.

The data indicated that number of weevils emerged from kg of infested tubers after one month of harvesting decreased from 67.14% to 9.48% over untreated control, with highest per cent reduction in treatment-T_6 and lowest per cent reduction in treatment-T_1 among other botanical pesticide treatments. All the treatments performed better over untreated control. Results reported earlier by few workers lent a good support to the present findings on the performances of Neem oil and *Nicotiana tabacum* leaf extracts (Minista *et al*., 2017) [10].

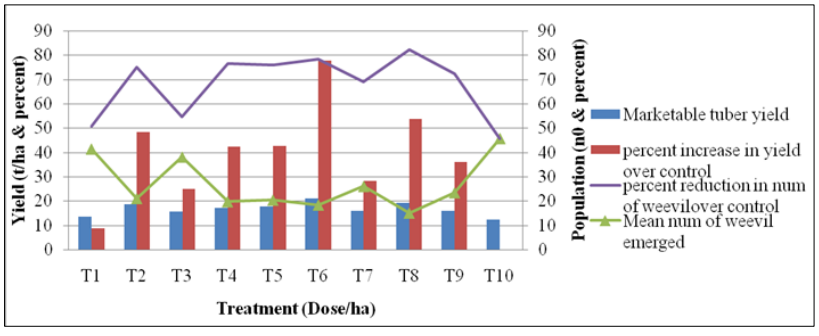

Fig 2: Effect of botanical pesticides on marketable tuber yield and weevil population

On the basis of benefit-cost ratio calculated for different treatments (Table 1) it can be summarized that investment in treatment T_2 (spraying of neem oil @ 2%) with cost-benefit ratio of 1:14.1 proved to be more economical when compared to other treatments.

Table 1: Economics of botanical insecticides for the management of sweet potato weevil.

Treatment (Dose/ha)	Marketable tuber yield (t/ha)	Additional yield over control (t/ha)	Price of additional yield (Rs/ha)	Cost of treatment (Rs/ha)	Net profit over control	Cost benefit ratio
T_1:Vine treatment with chloropyriphos (20EC) @ 1lit/ha.	13.51	1.08	16,200.00	5586.00	10614.00	1:2.9
T_2:Spraying of Neem oil @ 2%	18.45	6.02	90,300.00	6376.00	83924.00	1:14.1
T_3: Spraying of YBSE @ 5%	15.52	3.09	46,350.00	6126.00	40224.00	1:7.56
T_4: Spraying of Karanj oil @ 2%	17.03	4.60	69,000.00	6216.00	62784.00	1:11.1
T_5:Spraying of Tobacco decoction@ 5%	17.60	5.29	77,550.00	5626.00	71924.00	1:13.7
$T_6=T_1 + T_2$	21.05	8.62	1,29,300.00	11962.00	117338.00	1:10.8
$T_7=T_1+ T_3$	15.95	3.52	52,800.00	11712.00	41088.00	1:4.50
$T_8 = T_1+ T_4$	19.11	6.68	1,00,200.00	11802.00	88398.00	1:8.5
$T_9 = T_1 + T_5$	16.00	3.57	53,550.00	11202.00	42348.00	1:4.7
T_{10}: Untreated control	-	-	-	-	-	-

Sweet potato production and economics in various Treatments
Number of sprays: 4
Labour charge: 336/day/person.
No. of labours required: 4 persons/spray/hectare.
Price of marketable tubers: Rs-15/kg.

References

1. Clark CA, Ferrin DM, Smith TP, Holmes GJ. (Eds.). Compendium of sweet potato diseases, pests, and disorders St. Paul, MN: APS press, 2013, 160.
2. Narayan A, Dileep K, Alam T, Singh RS, Giri GS, Prasad R, *et al*. Genetic diversity in sweet potato (*Ipomea batatas* L.), The Pharma Innovation J. 2022;11(6):2352-2355.
3. Food and Agricultural Organization. FAO, Statistics, Food and Agricultural Organization, Rome, Italy, 2017.
4. Chalfant RB, Jansson RK, Seal DR, Schalk JM. Ecology and management of sweet potato insects. Annual review of entomology. 1990;35(1):157-180.
5. Pillai KS, Palaniswami MS. Pests of tuber crops. Indian Farming. 1984;33:58-61.
6. Palaniswami MS. Biological and parabiological approaches for sweet potato weevil management in India. South and West Asia International Potato Centre News Letter. 2000;3(2):6-9.
7. Singh PP, Prasad R, Narayan A, Singh RS. Effect of yam bean seed extract (YBSE) aqueous solution on mustard aphid. J of Exp. Zoology, India 2019; 22(1):383-387.
8. Facey PC, Porter RBR, Williams LAD. The chemical composition and insecticidal activity of the essential oils from Jamaican Hyptiscapitata Jacq. Biologically active natural products for the 21st century. Research Signpost, Trivandrum, India, 2006, 13-19.
9. Mouffok B, Raffy E, Urruty N, Zicola J. The neem, an efficient biological insecticide. Tutorial S2 Projet Biological engineering, IUT, University Paul Sabatier, 2008, 15.
10. Minista I, Ngakou A, Younoussa L, Nchiwan E. Insecticidal efficacy of neem (*Azadirachtaindica* A. Juss.) products against the sweet potato (*Ipomeabatatas* L.) weevil (*Cylas puncticollis* Boh.) in storage. Journal of Entomology and Zoology Studies. 2017;5(5):1130-1137.
11. Nta AI, Okweche SI, Umoetok SB. Efficacy of three plant powders in the control of *Cylas puncticollis* (Boheman) (Coleoptera: Curculionidae) on sweet potato during storage. African entomology. 2018;26(1):141-149.