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Evaluation of selected botanical insecticides against radish flea beetles (*Phyllotreta chotanica* Duv.)

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Abstract
Radish crop is frequently attacked by flea beetles (*Phyllotreta* spp.). Farmers use many broad spectrum insecticides for management of this pest, which has several adverse effects on human health, environment and natural enemies. Therefore, an ecofriendly approach to manage this pest is need of the hour. Keeping these points in view, the investigation was undertaken to evaluate the efficacy of selected botanicals against flea beetles in radish crop. Study was conducted during 2016-17 at College of Agriculture, UAHS, and Shivamogga. Seven different botanical insecticides were evaluated against radish flea beetle while using Malathion 50EC as standard check. The mean population of flea beetle was least in Malathion 50 EC (3.30) and NSKE (5%) (4.17) treated plots as compared to other treatments. The mean population was highest in untreated check (8.93). The per cent leaf damage also followed same trend as beetle mean population. The highest root yield of 160.78 q ha^{-1} was recorded with treatment Malathion 50EC which was on par with NSKE 5% (157.33 q ha^{-1}). The untreated check recorded lowest root yield of 143.00 q ha^{-1}.

Keywords: Botanicals, radish, flea beetle

Introduction
Radish (*Raphanus sativus* L.) is a root vegetable which belongs to family Brassicaceae. It is most likely to be originated in the area between the Mediterranean and the Caspian Sea [4]. The economical and edible parts of radish crop are its tender tuberous roots and fresh succulent leaves. Radish consumption has numerous health benefits as it aids in digestion, maintains blood pressure, boosts immunity etc. It can be grown as cover crop or catch crop also. Insect pests are predominant among wide variety of pests and diseases that attack radish crop. Major insect pests that attack radish in India are aphids (*Brevicoryne brassicae* (L.), *Lipaphis erysimi* (Kalt.), *Myzus persicae* Sulz. and *Toxoptera aurantii* (Fon.), flea-beetles (*Phyllotreta chotanica* Duv. *Chaetocnema basalis* (Baly) and *Monolepta signata* Olivier), the sawfly *Athalia lugens proxima* (Klug) [2]. Radish plants are frequently attacked by flea beetles (*Phyllotreta* spp.) adults and larvae as well. The adults feed on the leaves during the spring and early summer and also during the late summer while grubs remain in soil and underground parts [1]. For management of this notorious pest, many broad spectrum insecticides are being used intensively and indiscriminately by farmers. The use of chemical pesticides has increased sharply in recent years, particularly in India. Synthetic chemicals have gained lot of importance and proved their positive effects in improving food security but their continuous and indiscriminate use in has led to development of resistance in insects, health hazards in humans, detrimental effects on environment, adverse effects on non-target organisms, and destruction of natural enemies. Therefore, finding alternatives to synthetic chemicals for flea beetle management in an eco-friendly manner is need of the hour. Botanical insecticides can be good alternative to chemical insecticides as are nontoxic to human beings, beneficial insects and other non-target organisms. Keeping these points in view, the study was undertaken to evaluate the efficacy of botanicals against flea beetles in radish crop.

Material and Methods
A field experiment was carried out during *rabi* and *kharif* 2016-17 at College of Agriculture, Shivamogga to find out the efficacy of botanical insecticides against flea beetles on radish. The field experiment was laid out in randomized block design (RBD) with three replications

and nine treatments *viz.*, T_1 Neem seed kernal extract; T_2 Sweet flag rhizome extract T_3 Onion bulb extract; T_4 Garlic extract; T_5 *Vitex negundo* leaf extract; T_6 Karanja oil; T_7 *Clerodendrum inerme* leaf extract; @ 5% T_8 Malathion 50 EC (Standard check) @ 0.2%; T_9 Control (Untreated check). The radish variety Chetki long was sown in plots of size 3x2m at recommended spacing of 30 x 10 cm. Fertilizer was applied at the ratio of 75:38:38 (N, PO_4 and K_2O) and irrigation was done twice a week.

In each plot five plants were selected at random and tagged. Efficiency of seven different botanicals was evaluated by keeping malathion50 EC as standard check. First spray was given at 18 days after sowing during *kharif* and 13 days after sowing during *rabi* when more than 20 per cent damage on foliage was noticed. Number of beetles present on each tagged plant, total number of leaves present in each plant and number of leaves damaged by flea beetle were recorded at one day before, three, seven and fifteen days after application of botanical insecticides. The tuber yield per plot was recorded at each harvest separately for each treatment and summed up after last harvest to obtain the yield in terms of q/ha. The data was subjected to statistical analysis using ANOVA after suitable transformation.

Results and Discussion

Results obtained in kharif and Rabi seasons were in line with each other with respect to overall effect of botanicals on flea beetles. The results on evaluation of botanical insecticides against flea beetle *P. chotanica* on radish during 2016-17, showed that least overall mean beetle population (3.30) was recorded in standard check (Malathion 50 EC) being statistically on par with NSKE 5% (4.17). *Vitex negundo* leaf extract (4.64) proved to be next best treatment. Sweet flag rhizome extract (5.58) was moderately effective. Onion bulb extract and *C. inerme* leaf extract recorded higher beetle population of 6.41 and 6.36 respectively thus proving least effective but they were not inferior to untreated check (8.93). The results obtained are in accordance with findings of Ojo and Oladimeji [5, 6] who reported that neem leaf extract was effective in reducing flea beetle (Podagrica spp.) population in okra crop.

The lesser beetle population in NSKE 5% treated plots may be attributed to group of alkaloids (tetranorterpenoids) present in neem seeds. Several studies have proved the antifeedant, repellent and growth modifying properties of neem on the insects, which were essentially due to the terpenoids (azadirachtin) from the neem fruits [8].

Among the different botanicals the lowest per cent leaf damage was recorded in NSKE 5% (43.98%) being statistically on par with standard check, Malathion 50 EC (40.76%). Next best treatments were *V. negundo* leaf extract (47.13%) and sweet flag rhizome extract with 50.12 per cent leaf damage. Further, onion bulb extract recorded 55.91 per cent leaf damage being on par with untreated check. Untreated check was least effective by recording highest mean per cent leaf damage (62.10%).

The highest root yield of 63.47 q ha^{-1} was recorded with treatment Malathion 50EC which was on par with NSKE 5% (61.27 q ha^{-1}). *Vitex negundo* leaf extract treated plots (59.07 q ha^{-1}) recorded next highest yield. The least yield was recorded in untreated check (48.60 q ha^{-1}) Malathion 50EC proved superior to all the botanical insecticides evaluated in the present study. The present research findings are in line with the findings of Chitwan [3] who also reported superiority of malathion (0.05%) over different botanical insecticides in managing *Phyllotreta* spp. on cabbage.

The botanical insecticides in the decreasing order of their efficacy were NSKE 5% > *V. negundo* leaf extract > sweet flag rhizome extract > garlic leaf extract > *C. inerme* leaf extract > Karanjia oil > onion bulb extract. In a nutshell, overall results during *kharif* and *rabi* indicated that NSKE 5% is very effective by recording lowest beetle population (4.17 larvae/ plant) and less per cent leaf damage (43.98%). The greater efficiency may be due to antifeedant and repellent properties of neem product [7].

Table 1: Overall efficacy of botanical insecticides on mean number of flea beetles in radish during 2016-17

Treatments	Mean number of flea beetles per plant				Mean	Root yield(q/ha)
	1 DBS	3DAS	7 DAS	15 DAS		
T_1- Neem seed kernal extract 5%	7.37(2.79)	2.60^{de}(1.75)	2.97^{d}(1.86)	3.73^{cd}(2.05)	4.17^{de}(2.12)	61.27^{ab}
T_2- Sweet flag rhizome extract 5%	7.97(2.89)	3.50^{bcd}(2.00)	5.27^{bc}(2.38)	5.60^{b}(2.47)	5.58^{bc}(2.45)	57.07^{cd}
T_3- Onion bulb extract 5%	7.40(2.80)	4.73^{bc}(2.28)	6.60^{b}(2.65)	6.90^{b}(2.72)	6.41^{b}(2.62)	53.80^{e}
T_4- Garlic extract 5%	7.30(2.79)	3.58^{bcd}(2.00)	5.60^{bc}(2.47)	5.80^{b}(2.51)	5.57^{bc}(2.45)	56.40^{de}
T_5- *Vitex negundo* leaf extract 5%	7.50(2.82)	2.87^{cd}(1.83)	4.07^{cd}(2.13)	4.13^{c}(2.15)	4.64^{cd}(2.24)	59.07^{bc}
T_6- Karanji oil 5%	7.13(2.74)	4.50^{bcd}(2.21)	6.23^{b}(2.58)	6.40^{b}(2.60)	6.07^{bc}(2.56)	54.60^{de}
T7- *Clerodendrum inerme* leaf extract 5%	7.53(2.81)	5.13^{b}(2.33)	6.40^{b}(2.62)	6.37^{b}(2.62)	6.36^{b}(2.61)	55.33^{de}
T8- Malathion 50 EC (Std. check) @ 2ml/l	7.87(2.89)	1.20^{e}(1.30)	1.37^{e}(1.36)	2.77^{d}(1.80)	3.30^{e}(1.84)	63.47^{a}
T9- Untreated check	8.10(2.92)	8.60^{a}(2.99)	9.43^{a}(3.15)	9.60^{a}(3.18)	8.93^{a}(3.07)	48.60^{f}
SEm ±	0.19	0.16	0.15	0.10	0.11	1.08
CD @ P= 0.05	0.58	0.47	0.44	0.30	0.32	3.25
CV%	11.75	12.94	10.84	7.13	9.93	4.39
F TEST	NS	*	*	*	*	*

DBS- Day before spraying, DAS- Days after spraying; Figures in the parentheses are √X + 0.5 transformed values. Figures with same alphabets are statistically on par with each other. NS – Non significant. * - Significant.

Table 2: Overall efficacy of botanical insecticides on per cent leaf damage by flea beetles in radish during 2016-17

Treatments	Per cent leaf damage per plant				Mean
	1 DBS	3DAS	7 DAS	15 DAS	
T_1- Neem seed kernel extract 5%	35.67(36.62)	43.25^{cd}(41.08)	46.58^{de}(43.00)	50.41^{d}(45.21)	43.98^{de}(41.50)
T_2- Sweet flag rhizome extract 5%	36.90(37.30)	47.46^{bcd}(43.52)	51.79^{bcd}(46.02)	68.30^{b}(55.75)	51.11^{bc}(45.66)
T_3- Onion bulb extract 5%	38.45(38.27)	54.29^{ab}(47.46)	62.62^{ab}(52.32)	64.74^{bc}(53.60)	55.02^{ab}(47.90)
T_4- Garlic extract 5%	38.34(38.22)	50.44^{bc}(45.24)	55.61^{bcd}(48.21)	64.01^{bc}(53.15)	52.10^{bc}(46.20)

T_5- *Vitex negundo* leaf extract 5%	38.47(38.24)	45.64^{bcd}(42.47)	49.31^{cde}(44.58)	55.08^{cd}(47.95)	47.13^{cd}(43.32)
T_6- Karanji oil 5%	37.97(37.96)	51.32^{abc}(45.74)	58.16^{bc}(49.72)	68.01^{b}(55.62)	53.87^{cd}(47.24)
T7- *Clerodendrum inerme* leaf extract 5%	39.10(38.68)	50.58^{abc}(45.31)	56.58^{bcd}(48.77)	67.62^{b}(55.40)	53.47^{bc}(47.01)
T8- Malathion 50 EC(Standard check) @ 2ml/l	37.40(37.58)	39.92^{d}(39.08)	41.59^{e}(40.07)	44.11^{d}(41.55)	40.76^{e}(39.65)
T9- Untreated check	39.29(38.76)	59.41^{a}(50.43)	69.83^{a}(56.72)	79.87^{a}(63.46)	62.10^{a}(52.30)
SEm ±	2.56	1.73	2.18	2.30	1.38
CD @ P= 0.05	7.67	5.17	6.53	6.89	4.01
CV%	11.67	6.78	7.98	7.60	6.02
F TEST	NS	*	*	*	*

DBS- Day before spraying, DAS- Days after spraying; Figures in the parentheses are arc sine transformed values. Figures with same alphabets are statistically on par with each other. NS – Non significant. * - Significant.

Conclusion

A total of seven botanical insecticides and malathion 50EC (Standard check) were evaluated against radish flea beetles. All the treatments were effective compared to untreated check. Among the treatments tested, malathion 50EC and NSKE 5% were on par with each other and found very effective against flea beetles followed by *Vitex negundo* leaf extract 5%. Sweet flag rhizome extract was moderately effective whereas remaining treatments were least effective in reducing the flea beetles populations. NSKE 5% proved to be the best among botanical insecticides.

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