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EFFICACY OF SOME BOTANICAL EXTRACTS ON THE POPULATION AND SEVERITY OF INFESTATION OF FLEA BEETLES ON OKRA (*Abelmoschus esculentus* L. Moench)

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ABSTRACT

A field trial was carried out at the Teaching and Research farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State (latitude $9^{0}.40^{1}$ North and longitude $6^{0}.30^{1}$ East) in 2017 cropping season to determine the efficacy of some bio-pesticides for the management of flea beetle infestation on okra. There were 15 plots, each having four ridges 4m long and 0.75m apart, each plot had a $12m^2$ gross area separated with 1m margin in between plots. Three bio-pesticide formulations: Neem-bark extract (10 grams per litre), Hot-pepper wax (10 grams per litre), mixture of neem-bark extract and hot pepper wax (5 grams each per litre) compared to a synthetic insecticide (laraforce) at 2 ml per litre, and an untreated control. All the treatments used had three (3) replications arranged in a Randomized Complete Block Design (RCBD). The population of flea beetles (Podagrica uniforma and Nisotra dilecta) were taken before and after treatments for four weeks from third week after planting. All data collected were analysed using analysis of variance (ANOVA) and the means separated with Least Significant Difference (LSD) test at 5% level of significance. The results showed that all the treatments had significant effect on the flea beetle population, and infestation of okra leaves.

Keywords: *Flea beetles, bio-pesticides, mixture, neem-bark, hot pepper wax, laraforce.*

INTRODUCTION

Okra, *Abelmoschus esculentus* L. (Moench), is a commercially grown vegetable crop widely cultivated in Africa and Asia. Within 2009 and 2010, a global area of 0.43 million hectares was cultivated with total production standing at 4.54 million tons. India is the largest producer (67.1%), with Nigeria following at (15.4%) and Sudan (9.3%) (Varmudy, 2011). Okra plays a vital role in human diet (Saifullah and Rabbani 2009) by providing phosphorus, calcium, sulphur, iron, fibre, fats, proteins, carbohydrates and vitamins (Dilruba *et al.*, 2009). The okra fruit is normally boiled in water to give slimy soup sauces relished to taste. The fruits are also used to thicken soups, the seed can be dried, is nutritious and can be used to prepare vegetable curds, or roasted and ground for use as additive or substitute to coffee (Moekchantuk and Kumar 2004).

In industries, the mucilage from okra is often used to produce glace papers and confectioneries. Medically, okra serves as a replacement for blood plasma as well as a blood volume expander (Kumar *et al.*, 2010), it is also a useful remedy against genito-urinary problems, chronic dysentery and spermatorrhoea. Okra has also been reported to cure ulcers and hemorrhoids (Adams, 1975). Results of tests conducted in China holds that alcoholic extracts from okra leaves have a potential to remove free radicals, reduce proteinuria, and generally improve renal functions (Liu *et al.*, 2005). The cultivation of this vegetable has indeed known success. However, it has also been greeted with a handful of constraints which include but may not be limited to; disease infections; infestation by insect pests; inadequate management practices; natural and uncontrollable changes in climate and the environment such as drought and flood. The okra plant is prone to attack by flea beetle (*Podagrica spp, and Nisotra dilecta*) which infests okra seedlings causing significant losses through their feeding on the leaves. White flies (*Bemisia tabaci*), Jassids (*Empoasca lubica*) and Aphids (*Aphis gossypii*) also attack okra. These pests infest the plant leaves, stems, branches and pods. Pods and flowers are the major targets of spiny bollworm (*Earias insulana*); the caterpillar of the African bollworm (*Heliothis armigera*) targets the reproductive tissues of the plant, alongside buds, flowers and fruits. Some diseases to which okra plants are prone are leaf curl virus and infection by some diseases caused by fungi such as powdery mildew. In response to these constraints, man has overtime devised several strategies and methods for the management of these setbacks to crop production and agriculture in general. Some of these methods are; Cultural which entails the use of basic farm operations to indirectly control insect pests on the farm, operations like proper tillage, adequate spacing between stands. Physical method of management which is the physical removal of these pests, closely related to this is the use of machines and farm implements in the mechanical removal of insect pests. Another measure is the use of chemicals called pesticides/insecticides, this method has become the major or the most commonly used among farmers because of its almost immediate indication of success in the eradication of these insects, this however makes those who use the chemicals oblivious of the long term side effect of continued or excessive use of the synthetic formulations (the pesticide). More so, there is a serious need to enlighten farmers on safer, yet effective measures which are useful with almost no side or residual negative effects; measures such as biological control of insect pests with other insects that prey on target pests; use of parasitoids and pathogenic micro-organisms that can also infect insect pests and literally kill them, and also the use of botanical and natural plant extracts also called extracts (plant or herbal), bio-pesticide

The study therefore aimed to:
1. Determine the effect of the application of Neem Bark Extract and hot pepper wax on Flea beetle *(Podagrica uniforma and Nisotra dilecta)* infestation on okra.
2. Compare the effect of the applications of neem extracts and hot pepper wax to that of Laraforce (Lambdacyhalothrin) in the control of Flea beetles *(Podagrica uniforma and Nisotra dilecta)* on okra.
3. Determine the combined effect of Neem Bark Extract and Hot Pepper Wax on Flea beetle *(Podagrica uniforma and Nisotra dilecta)* infestation on okra.

MATERIALS AND METHODS

Study Area

The experiment was carried out at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State during 2017 rainy season.

Field Preparation and Experimental Layout

The land was prepared by spraying with a non-selective herbicide (ForceUp a.i paraquat) and later mapped out according to the Randomized Complete Block Design (RCBD) for the experiment with a gross plot area of 264m2 (11m x 24m), net plot area of 180m2 (12m2 for each of 15 plots), inter-plot spacing of 1m.
There were five (5) treatments with three (3) replications each and the treatments used were;

- 30g of the neem bark powder applied to the okra plants.
- 30g of the hot pepper wax applied to the okra plants.
- 30g of mixture of neem bark powder and hot pepper wax (15g each).
- 2ml/ltr of Laraforce a.i Lambdacyhalothrin 2.5 % E.C (used as reference chemical insecticide).
- Control, without any treatment for insect control.

The effect of the different treatments above against the flea beetle (*Podagrica uniforma* and *Nisotra dilecta*) was studied.

Okra variety and sowing

The target crop was Okra (*Abelmoschus esculentus* L.) and the 'FOURTY DAYS' local variety common to the Gidan Kwano community was used. After the preparation of the plot for the study, okra seeds were sown on the ridges at intra-row spacing of 50cm and inter-row spacing of 75cm at two (2) seeds per stand which was later thinned to one seedling per stand.

Preparation of Neem Bark Extracts

The neem bark was prepared by; peeling off the bark from a neem tree using a cutlass; the neem bark was oven-dried in the laboratory at a temperature of 130°C until it was dried enough for pounding; it was reduced to smaller bits with a mortar and pestle and further ground to powder using an electric blender; Thirty (30) grams of the powder obtained was dissolved in one litre of water to form a mixture. The mixture obtained was allowed to stand for a day during which it was stirred from time to time for complete extraction of the substance *azadirachtin* into the solution. The solution was then filtered to remove large neem-bark particles. The filtered solution was made up to 3 litres with clean water and applied using a knapsack sprayer to spray the solution on the okra plants.

Preparation of Hot Pepper Wax

The hot pepper (*Capsicum frutescens*) otherwise called the '*bird eye pepper*' was dried and grounded to powder; Thirty (30) grams of the pepper wax was weighed and dissolved in one litre of clean water to form a solution. The solution thus obtained was left to stand for a day for complete extraction into the solution. The solution was filtered to take out large particles. The filtered solution was then made up to three (3) litres and applied with a knapsack sprayer by spraying the solution onto the foliage of the okra plants.

Synthetic Insecticide

2 milliliters of Laraforce® (Lambdacyhalothrin 2.5 % E.C) for each litre of water was used for comparison with the neem bark extract and hot pepper wax.

Application of the treatments

The application of the neem bark extract, hot pepper wax and Laraforce commenced at three weeks after planting using foliar sprays at one week interval until the sixth week (application was done four times in all) at the rate of 30g in 3 litres of water for the neem bark extract and hot pepper wax and 2 ml in 1 litre of water for the synthetic insecticide (Laraforce). They were applied using a knapsack sprayer.

Cultural practices

Weeding

Weeding of the plots was done twice using a hoe (manual weeding) at three and six weeks after sowing (Imoloame, 2013).

Fertilizer application

To improve soil fertility, N.P.K 15:15:15 was applied at three weeks after sowing at 200 kg/ha thus 5.28 kg was applied on the plot (264m2).

Data collection

A total of 10 plants in each plot were tagged as sample plants from which observation and data collection (insect count) were made. Data collection began at 3 weeks after planting at 1 week interval until 6 weeks after planting. Data were collected on the following parameters:

Damage Assessment

Insect count

A pre-treatment (before the application of the neem-bark extract, hot-pepper wax, biopesticide mixture, and the laraforce) count of insects was done two weeks after sowing to determine the presence of target insects especially the flea beetle on the okra plants. This counting was carried out on 10 plants (from each plot) which were randomly selected. Actual counting began at three weeks after sowing just immediately before treatments and 24 hours after treatments from the third to the sixth week after planting. The number of flea beetles counted on the tagged plants was recorded.

Severity of infestation

The severity of flea beetle infestation was observed by counting the holes on the youngest fully developed leaf of each plant using grades; 0 (no hole on leaf), I (1-5 holes on leaf), II (6-10 holes on leaf), III (11-15 or more holes on leaf).

Yield Assessment

Mature okra fruits were harvested from each plot for a period of three (3) weeks from first matured fruit at four days interval and the combined weight of fruit from each plot were used to compare the yield from plots subjected to the aforementioned treatments.

Statistical Analysis

Data were analysed using analysis of variance (ANOVA) and the means were separated using LSD (Least Significant Differences test) at 5% level of significance.

RESULTS

Insect pests encountered on the okra plants.

During the experiment for this study, two species of the flea beetle were observed, they were; *Podagrica uniforma* (brown flea beetle) and *Nisotra dilecta* (blue flea beetle), of the two, the brown flea beetle was dominant (figure 3).

Effect of different treatments on flea beetle population on okra at Gidan Kwano in 2017 cropping season

Table 1 shows the effect the different treatments (insecticides) on the mean population of flea beetles, the results showed that before treatments there was higher incidence of flea beetle on the experimental plots and no significant difference among the plots for the different treatments and the untreated plot. However, the population count of flea beetles was significantly reduced ($P \leq 0.05$) after the application of the different treatments (neem-bark extract, hot-pepper wax, mixture of the two biopesticides, and laraforce) and the untreated control plots had higher population count of the beetle. Before the treatments, the untreated plot had a higher population of the beetle. The second week treatments significantly reduced ($P \leq 0.05$) the population of *Podagrica uniforma and Nisotra dilecta* on the plots with laraforce-treated plots having the lowest insect count followed by both plots treated with neem-bark extract and hot-pepper wax having equal level of significance ($P \leq 0.05$) in the reduction of flea beetle infestation. At the third week of treatment, there was significant difference ($P \leq 0.05$) among the treatments and also between the treated and untreated plots with plots treated with neem-bark extract recording lower population count of the beetle compared to other biopesticide-treated plots.

After the fourth week of treatment, there was significant reduction in the population of flea beetles compared to the pre-treatment count. There was a significant reduction ($P \leq 0.05$) in the population of beetles especially between the insecticide-treated plots and untreated plots with plots treated with Laraforce having the lowest population count of the beetles. All the treated plots performed significantly better ($P \leq 0.05$) than the untreated plots, for instance, the plots treated with neem-bark extract had a 70% reduction in the mean population of flea beetles while the untreated plots had only 14% reduction through the period of treatment on other plots. The result also showed that in the fourth week, the mean population of flea beetles after treatment on the untreated plots increased more than it was before the treatment.

Effect of different treatments on the severity of okra plant-leaf infestation by flea beetles during 2017 cropping season

The effect the different treatments had on the severity of infestation of okra plant-leaves with flea beetles (figure 1). In the first week there was no significant difference between hot-pepper-wax-treated plots, plots treated with the biopesticide mixture and the untreated plots, but there was a significant difference ($P \leq 0.05$) however, on the laraforce-treated and neem-extract-treated plots. The laraforce-treated plots had a higher significance ($P \leq 0.05$) in curtailing severity of infestation by flea beetles on plant leaves. In the second and third week, no significant difference existed in terms of leaf infestation severity on plots treated with biopesticide mixture and the untreated plots. The other plots had a significant difference ($P \leq 0.05$) decreasing in the order of laraforce-treated plots, neem-extract-treated plots, and hot-pepper-wax-treated plots. In the fourth week, there was a significant difference ($P \leq 0.05$) between the different treatments except for the hot-pepper-wax-treated plots and the plots treated with a mixture of the biopesticides.

Effect of the different treatments on the number of flea beetles before and after each week treatment during 2017 cropping season

The difference in the population of flea beetles before and after treatment (Figure 2.) The result showed that all treatments except the untreated control plot significantly reduced the population of flea beetles on the plots.

Effect of different treatments on the yield of okra (*Abelmoschus esculentus*)

The result of yield in Table 2 showed that highest fruit yield was obtained from okra plots that were treated with laraforce (987.38 kg/ha) followed by neem treated plots (985.57 kg/ha) while lowest fruit yield was recorded in neem-pepper treated plots (738.67 kg/ha) but no significant different among the treatments.

DISCUSSION

The growth of okra (*Abelmoschus esculentus* L.) is most often threatened by infestation from insect pests, especially the flea beetle which attacks the plants from a few days of emergence and continues throughout the lifetime of the crop. There are various genera of flea beetles, all members of the Chrysomelidae family, and flea beetles damage okra plants by cutting round holes on the leaves and severe infestation can lead to complete defoliation of the plants. Usually, plant extracts contain certain complex bioactive substances; the metabolites of plants can also produce toxins which make insects refrain from feeding on such plants (Russel and Lane, 1993). The chemical active components of such plants may disturb the growth and development of insects; inhibit oviposition (Gerard and Ruf, 1991; Emimal Victoria, 2010). *Podagrica uniforma* and *Nisotra dilecta* are major defoliators and fruit eaters (Parh *et al.,* 1997) causing heavy defoliation of up to 80% of okra leaves (Dabire-Binso *et al.,* 2009). Thus, high reduction in the population of flea beetles on okra plants by the biopesticides also led to a reduction ($P \leq 0.05$) in the damage caused by flea beetles on the plant leaves. The result of this study showed that the two plant-extracts used were effective in the reduction of flea beetle infestation levels consequently resulting in higher yield. This is in concord with the findings of other researchers (Adesina *et al.,* 2013; Afolabi *et al.,* 2014) who discovered that okra plants which were treated with biopesticides gave higher yield in contrast to the yield obtained from the untreated control plots.

There was also a lower damage on the leaves of the okra plants treated with the biopesticides than there was on the control. This may be because the biopesticides are able to effectively control flea beetle population compared to the control. Biopesticides made from neem are not very stable and are quickly broken down; it becomes necessary to apply neem- based insecticides at short time intervals. The neem plant contains substances called limonoids like; azadirachtin A and B, Meliantrol and Salannin which exhibit repellant properties, Nimbin or Nimbidin which has an anti-viral effect (Stoll, 2000). These properties of the neem plant coupled with its systemic mode of action (acting as a stomach poison) could be the reason for the neem extracts role in effective reduction of the flea beetle population.

The plot treated with laraforce (lamdacyalothrine) looked almost completely untouched by flea beetles but the overall yield from this treatment and that from other treatments especially the plots treated with neem-bark extracts were not significantly different ($P \leq 0.05$). This is an indication that the bio-pesticides even though they allow some level of infestation, keep the level of infestation below the economic injury level thus making plants produce appreciable yields with minimum infestation. The bio-pesticide mixture of neem-bark extract and the hot-pepper wax in this experiment showed to be least effective for the control of infestation severity, a possible reason could be that the mixture which had half the weight of each active ingredient used in the other bio-pesticide treatments was smaller than that needed, thus, it would be needful to try this mixture in another experiment using several but especially higher rates than that used in this experiment.

Finally, the results of this study showed that bio-pesticides can effectively help manage the population and severity of infestation of flea beetles on okra and farmers can rely on this measure to enable them break-even, make profits and ultimately alleviate their living standards, economically and otherwise.

CONCLUSION

The result of the study has shown that all four insecticide formulations (Neem-bark extract, Hot-pepper wax, mixture of Neem-bark extract and hot-pepper wax, and laraforce) reduced the infestation of flea beetles on the okra plants but in varying degrees of effectiveness. Laraforce (a synthetic insecticide) was most effective in controlling the population of flea beetles on the plots while neem-bark extract (a bio-pesticide) was next to laraforce followed by hot-pepper wax and then the mixture of the two botanicals. The severity of leaf infestation by flea beetles was effectively reduced by laraforce and neem-bark extract in the first week while other treatments did not significantly reduce infestation in the same week. In the second and third week however, Laraforce, and the botanicals treatments effectively reduced infestation severity compared to the untreated plots except the mixture of the botanicals, and in the fourth week all the treated plots recorded a reduction in the severity of infestation when compared with the untreated plots. Also, the yield from the laraforce-treated plots and those treated with botanicals were not significantly different.

RECOMMENDATIONS

The two treatments, neem extracts and hot pepper wax can be used effectively for managing the population and infestation severity of flea beetles on okra as their use recorded reduction in flea beetle infestation, thus improving yield above what is obtainable in untreated plots. The effect of the combined use of the botanicals need be studied using higher rates than that used in this study to ascertain whether or not a positive synergistic effect exists between the botanicals when mixed together. Laraforce effectively managed flea beetle infestation on the okra plants but was associated with distortion of the leaves, thus there should be minimum use of synthetic insecticides especially in cropping systems where okra leaves are also consumed as vegetable. The biopesticides also have the potential for managing insect pest resurgence at levels that are not hazardous to the normal cycle and processes in the environment. Thus, use of biopesticides can improve productivity and the income of local peasant farmers at low production cost.

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Table 4.1: Effect of different treatments on flea beetle population on okra at Gidan Kwano in 2017cropping season

	Mean population of flea beetles per plant							
	WEEK ONE		WEEK TWO		WEEK THREE		WEEK FOUR	
Treatment	Before	After	Before	After	Before	After	Before	After
Neem	33.00a	2.00c	14.00bc	5.00bc	16.00c	7.00c	24.00a	11.00bc
Pepper	31.00a	6.00c	28.00ab	8.00bc	26.00b	16.00b	30.00a	19.00b
Neem + Pepper	34.00a	11.00ab	24.00b	15.00b	24.00b	16.00b	25.00a	15.00b
Laraforce	29.00a	0.00c	2.00c	0.00c	3.00d	1.00d	1.00b	0.00c
Control	33.00a	16.00a	44.00a	43.00a	32.00a	26.00a	35.00a	40.00a
± SEM	2.63	1.90	6.35	3.42	1.86	1.85	3.97	3.96

Means within the same column with the same letters are not significantly different ($P \leq 0.05$)

Neem = Neem-bark extract, Pepper = hot pepper wax, Neem + Pepper = mixture of neem bark extract and hot pepper wax

Table 4.2: Effect of the different treatments on the yield of okra (*Abelmoschus esculentus*)

Treatment	Total yield (kg ha^{-1})
Neem	985.57a
Pepper	850.96a
Neem + Pepper	738.67a
Laraforce	987.34a
Control	562.46a
± SEM	257.83

Means within the same column with the same letter are not significantly different at $P \leq 0.05$.

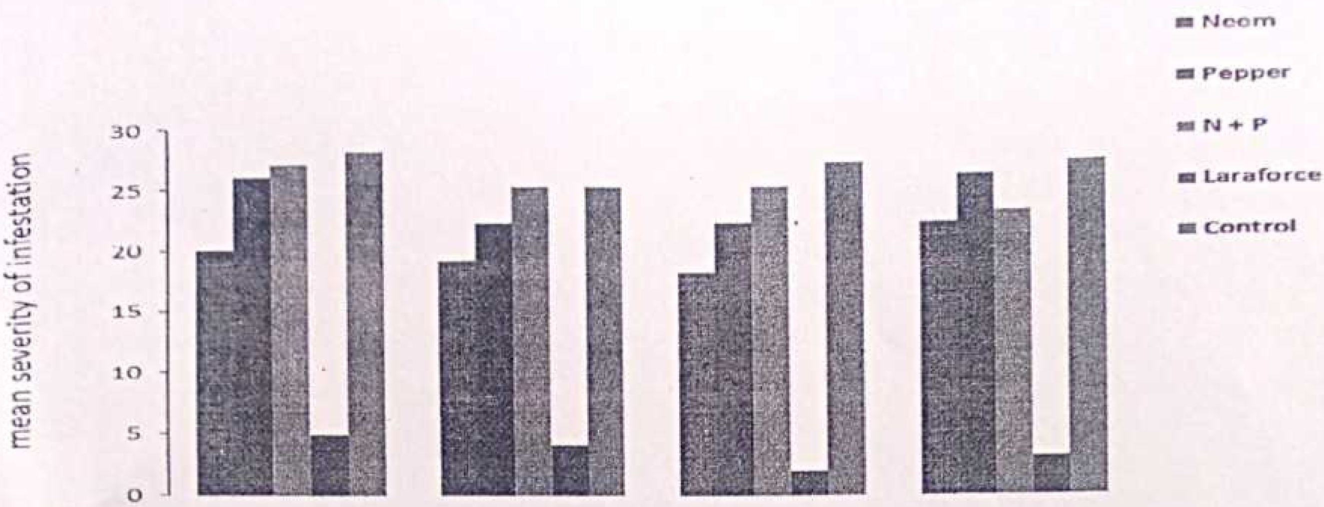

Figure 1: Effect of the different treatments on the severity of okra plant-leaf infestation with flea beetles.

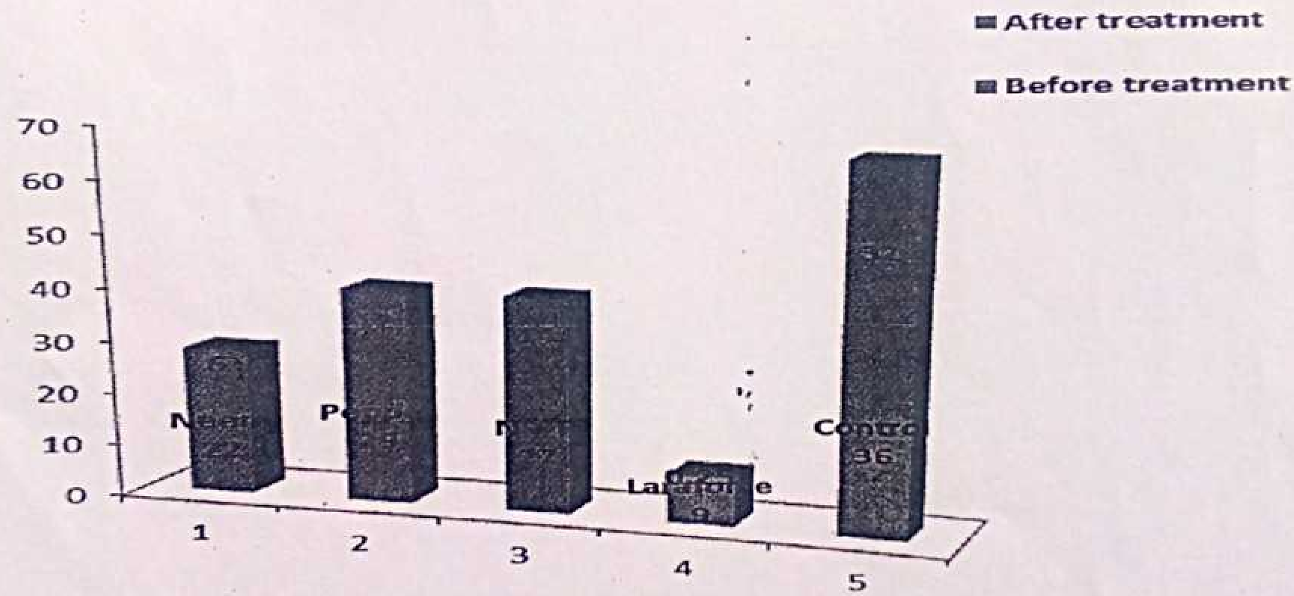

Figure 2: Effect of the different treatments on the number of *Podagrica uniforma, and Nisotra dilecta* per plot before and after treatment through a period of four weeks.

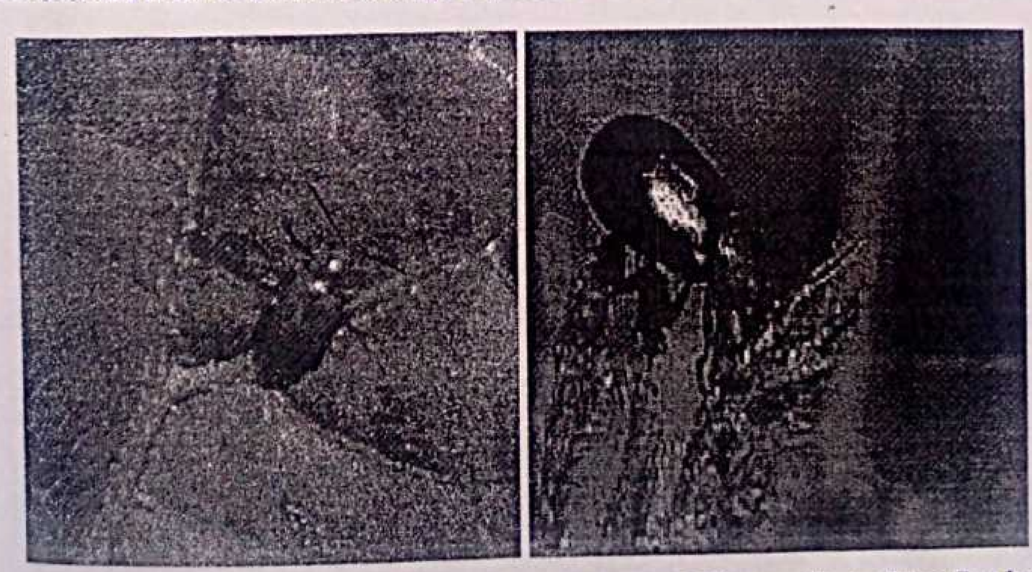

Figure 3: *Podagrica uniforma* (brown flea beetle) and *Nisotra dilecta* (blue flea beetle