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Full Length Research Paper

Biocontrol approach to management of greenpeach aphid *Myzus persicae* in garden peas for a sustainable ecosystem

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Green peach aphid has been a significant pest of garden peas in Kenya for many years, because of its capacity to transmit viruses. Despite advances in integrated pest management, and frequent use of insecticides, the industry is still plagued by the insect. Adding to the problem is the fact that the peach aphid has proved to be resistant to various insecticides; there is a need to shift emphasis on biological control agents and softer chemicals. The aim of this study was to evaluate hard and soft chemical products in their ability to control *Myzus persicae* and their effects on aphid parasitoids. The treatments evaluated were dish washing soap with insecticidal properties, Teepol®, neem based insecticide, Achook® and a pyrethroid, Karate®. Efficacy was evaluated by taking aphid and parasitized aphid counts on 2 cm portion of the shoot tip/leaves of selected shoots before treatments were applied, once a week for four weeks. The treatments were applied at the concentrations recommended by the manufacturers. The three insecticides controlled the aphids. There was no significant difference in aphid numbers between the three insecticides. The population of aphids on the control was high. Except for the Karate treatment, the other two insecticides tested did not have an adverse effect on aphid parasitoid. Teepol and Achook promise to be useful agents for controlling green peach aphids in garden peas and at the same time are friendly to the aphid parasitoid.

Key words: Integrated pest management, *Pisium sativum*, parasitoid, *Myzus persicae*, biocontrol.

INTRODUCTION

Garden pea, *Pisum sativum* is a cool season annual crop produced worldwide for human consumption and animal feed. It originated in the near East and Mediterranean Regions, and has been grown since early Neolithic times (Food, Agriculture and Environment, 2003). In recent years, garden pea has become a major horticultural export in Kenya and represents 40 to 50% of vegetable production (Mrskos and Muehlbauer, 2000). It is consumed for its high protein content, vitamins and minerals such as phosphorus. In Kenya, garden peas are grown in Central, Eastern, Rift Valley and Western provinces. Major production constraints for peas include; adverse environmental conditions such as frost, drought and excessive heat, diseases such as powdery mildew, downy mildew, fusarium wilt and rot, crop pests such as thrips, leaf miner, and white flies. The green peach aphids are a major pest for peas (Kraft and Pfleger, 2001). Aphids can inflict various kinds of damages on a crop, nymphs and adults extract food materials from a plant leading to retarded growth. They extract large quantities of sap which reduces leaf photosynthesis, affecting production. Pathogenic viruses are also introduced through aphid feeding (Van Schett, 2003). The green peach aphid, *Myzus persicae* is probably the most notorious pest of garden peas, because of its wide host range, worldwide distribution and number of viral diseases that it vectors for example pea venation mosaic virus, pea leaf roll virus, pea streak virus and red clover vein mosaic virus (Kraft and Pfleger, 2001). Various methods have been attempted in the control of aphids. These include using a strong jet of water from a hose which dislodges aphids, but it has not been practical for the soft stemmed annuals

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Plate 1. Arrangement of experimental plants.

(Pauline et al., 1992), use of ash mixed with water in vegetable kitchen gardens, intercropping of garden peas with lemon grass and onions but this has not been practical in large scale production and the use of both hard and soft chemicals. Soft chemicals include those with short-lived residues, have a natural origin either from plants, animals or even water, they are the least toxic chemicals. Hard chemicals are synthetic and have persistent residues. Insecticidal soap is also classified as a least toxic chemical since it has non-persistent residues. Soaps only control aphids present on the day they are sprayed, so applying non-persistent insecticides like soap may provide more effective long term control (Cranshaw, 1996). Biological control using parasitoids has also been attempted for example. In Washington; aphid- attacking parasitic wasps have been successfully used in the control of green peach aphid in potatoes (Pike et al., 1999, 2000). Up till now, parasitoids have been subjected to substantial toxic sprays in potatoes, which have limited their occurrence and activity in the crop (Pike et al., 2000). Various synthetic chemicals from different classes have been used in control of green peach aphid in potatoes. These include; pyrethroids: deltamethrin, permethrin, resmethrin; organophosphates: malathion, guthion; and carbamates: lindane and kelthane. Research shows that all these insecticides induced aphid outbreaks once multiple applications of insecticides from the same class were used. This was attributed to their selective killing of the predators and parasites that naturally keep green peach aphid population under control (Robert et al., 1998).

In the past twenty years, the concern has been to increase yield of vegetables by all means to meet the high demand regardless of the impact on the environment and sustainability of the agro ecosystem. Therefore, farmers rely on use of chemical pesticides to control aphid pest (Ushirika, 2007). In attempt to curb the pests' population with synthetic pesticides evidence of irrational use appeared and seems to be responsible for many environmental hazards and contamination risks of vegetable products (Abdelrahman et al., 1994). Repeated use of pesticides has led to pest resistance to pesticides, pest resurgence, pesticide substitution and lethal effects on non-target organisms including human as well as environmental pollution (Norris et al., 2003). Due to these limitations, there was need to find alternative control measures with different modes of action that would be effective, user and environment friendly.

METHODOLOGY

Experimental site

The research was conducted at Chepkoilel Campus in Uasin Gishu District, Rift Valley Province. Annual rainfall is between 900 to 1000 mm, an altitude of 2180 asl, longitude 35° 15'E and latitude 0° 30'N, annual mean temperature is 17°C. The experiment was conducted under a shade under temperatures varying from 22 to 32°C daily.

Experimental design and treatments

The experimental design was a completely randomized design (CRD) whereby there were four treatments with three replications (Plate 1). Treatments consisted of: dish washing soap, Teepol® with insecticidal properties, at a rate of 3 ml of Teepol in 1 L of water; botanical insecticide which is a neem product, *Azadiracta indica* Achook® 0.15% EC at a rate of 1 ml of Achook in 1 L of water and Chemical control using Karate® 1.75 EC at a rate of 1 ml of lamdacyhalothrin in 4 L of water and a control where no insecticide was

Plate 2. Clean Karate treated plants with no aphids nor parasitized aphids.

applied.

Planting

Planting was done in perforated polythene pots, each pot was filled with soil at a ratio of 2:1:1:1 of normal soil, murram, manure and sand respectively. Five seeds of garden peas were planted per pot (Plate 1).

Crop maintenance

Weeding was done twice; 2nd and 5th week after planting. Prevalent weeds were couch grass and Macdonald eye. Diseases were not prevalent, only damping off affected the plants at the early seedling stage; this was controlled by rouging of infected plants. Irrigation was done when required using a watering can. Top dressing using Easygro® foliar feed was done on the 2nd, 4th and 6th week after planting. This was done by dissolving 25 g of fertilizer in 20 L of water and spraying on the leaflets of the plant by use of a hand sprayer. Inoculation of aphids was done on the 4th week after planting. Aphids were collected from a garden pea farm (Can ken farm, Eldoret) by picking the leaflets that were highly infested and put them in a jam jar whose lid had a freeze net to let in air. Inoculation was done on the same day; approximately 20 aphids were introduced per pot by brushing them off from the leaflets to the various pots using a brush with soft bristles. The aphids were allowed 4 days for multiplication before application of the insecticides. Treatment application was done on the 5th week from planting, and there after on weekly intervals until the 7th week after planting.

Data collection

Data was collected on two plants per pot that had been tagged. The number of live aphids (small green insects) and parasitized aphids (cocoon inside the aphid cuticle that is hard, leathery brown to golden yellow casing known as a mummy or parasitized aphid) were recorded on 2 cm of the young growing shoot since aphids were densely populated at that point. This was done on all the pots in various treatments on a weekly basis starting from the 5th week till the 8th week after planting.

Data analyses

Data were subjected to 'analysis of variance' using the statistical package SPSS for windows 10.0. Means that were significantly different were separated using Duncan multiple range test. The significance differences were identified at 95% level of confidence.

RESULTS

Plants treated with Karate caused total mortality of aphids and they had no parasitization (Plate 2). There was high infestation of aphids on all the garden pea plants on the various treatments by the beginning of the 6th week prior to insecticide application, leading to high parasitization (Plate 4). Plants not treated with any insecticide were heavily infested by aphids on the seventh week after planting; the plants turned yellow to light brown, and then dried up by the 8th week (Plate 3). Another observation noted was that *Aphidius ervi* a parasitoid of the green peach aphid was seen flying in between garden pea plants showing compatibility of some insecticides with biocontrols (Plate 5). In general there was a significant difference in aphid numbers between the treated plants and the control (Table 1). There was no significant difference in the number of aphids on plants treated with Karate, Teepol and Achook. In the 6th week after planting, the various insecticides were sprayed. Teepol, Achook and Karate did not show significance in the reduction of aphid numbers but they differed significantly

Plate 3. High infestation of aphids on a plant in control.

from the control ($p<0.05$). However, Karate caused total mortality of aphids after the first spray of the insecticide (Plate 2). In the 7th week after planting, plants treated with Teepol, Karate and Achook had no significance difference in the number of aphids. In the 8th week all the treatments were not significantly different in their reduction of aphid numbers (Table 1). On the 5th week no insecticides had been sprayed, the number of parasitized aphids was not significantly different across the treatments. After insecticide application, the number of parasitized aphids was significantly different between control and the other treatments ($p < 0.05$), from week 6 to 8. Plants treated with Karate had no parasitized aphids (Table 2) (Plate 2).

DISCUSSION

In Kenya garden peas, *P. sativum* is an important vegetable crop both for local consumption and export produce. The most important pest for garden peas is green peach aphid (Kraft and Pfleger, 2001). These pest's population exploded as a result of the wide use of synthetic insecticides in the late 1950s (Dittrich and Ernst, 1990). In this investigation, soft and hard chemicals were evaluated for possible use in management of green peach aphid in garden peas. The evaluation of performance of a botanical insecticide Achook®, dish washing soap Teepol® and a pyrethroid Karate® was based on aphid and parasitized aphid counts in the treated plots as well as the control. In the 5th week aphid and parasitized aphid numbers were high and there was no significant difference between the treatments since no insecticides had been applied. On the 6th week aphid numbers reduced in plants treated with Teepol and Achook while those treated with karate caused 100% mortality of aphids (Plate 2). Due to the reduction in aphid numbers, parasitized aphids also reduced in numbers in plants treated with Teepol and Achook while plants treated with Karate had no parasitism. In the control aphid population increased, at these stage aphids were stabilizing and clinging on the plant since no treatment had been applied (Plate 4). Parasitized aphids on the other hand increased on the control, this finding was also reported by Norris et al. (2003) that parasitic wasp, *A. ervi* parasitizes aphids best when they are under high population (Plate 4). On the 7th week aphid numbers reduced in plants treated with Teepol and Achook while Karate treated plants had neither aphids nor parasitization. Aphid numbers on the control reduced due to the high numbers of aphids on the previous week that had caused extensive sucking of plant sap, plants turned yellow to light brown to dark brown then drying up by the 8th week (Plate 3). These findings are similar to those reported by Petit and Smilowitz (1982) aphid sucking causes water stress, wilting and retarded growth. Aphids started developing wings since plant sap had reduced and therefore there was a decline in the number of aphids on the 7th week. These findings are similar to those reported by van Schelt (2003) where aphids develop wings and migrated once there is reduced plant quality. Parasitization of aphids was at its peak on the 7th week since the previous week the aphids were at their peak hence the parasitoid is very active when the aphid population is high (Tables 1 and 2). On the 8th week aphid numbers were not significantly different across the

Plate 4. High aphid numbers with high parasitization.

Plate 5. A parasitic wasp (*Aphidius ervi*) flying in-between the treatments.

Table 1. Effect of Achook; a botanical insecticide, Teepol; dish washing soap, Karate; a pyrethroid on green peach aphid (*Myzus persicae*) numbers over time.

Treatment	Weeks after planting			
	5	6	7	8
Control	76.67^{a}	100.33^{b}	34.67^{b}	11^{a}
Karate	86.33^{a}	0^{a}	0^{a}	0^{a}
Teepol	74.67^{a}	18.33^{a}	13.33^{ab}	2^{a}
Achook	106.33^{a}	9.33^{a}	2.33^{a}	0^{a}

Figures labeled with the same lower case letter indicate no significance while those with different letters indicate significant difference ($p<0.05$, Duncan multiple range test).

Table 2. Effect of Achook; a botanical insecticide, Teepol; dish washing soap and Karate; a pyrethroid on aphid parasitization over time.

Treatment	Weeks after planting			
	5	6	7	8
Control	11.67[a]	30[b]	42.67[b]	35[b]
Karate	7.33[a]	0[a]	0[a]	0[a]
Teepol	6.33[a]	2.67[a]	5.33[a]	3.33[a]
Achook	12.67[a]	3[a]	8[a]	2.33[a]

Figures labeled with the same lower case letter indicate no significance while those with different letters indicate significant difference ($p<0.05$, Duncan multiple range test).

treatments. Karate treated plants had no aphids while plants treated with Teepol and Achook had very low numbers of aphids however control plants were not significantly different from the insecticide treated plants. This was due to the reduction in plant quality and therefore aphids had developed wings and flown away and only a few remained. On the other hand Karate treated plants had no parasitism while Teepol and Achook had low parasitization, since aphid numbers were also low.

On the control, parasitized aphid numbers were significant in comparison with the treated pots, this was because the parasitic wasp does not depend on the plant quality directly however, parasitized aphid numbers had decreased by the 8th week due to low aphid numbers. Highest mortality of aphids was recorded on pots treated with Karate®, with no parasitized aphids (Plate 2). This shows that Karate® is highly effective in control of aphids but research shows that under repeated application of the chemical, it will lead to green peach aphid resistance. It also wipes out the natural enemies that provide long term control of the aphid (Flint, 1999). Recent research done on the active ingredient of karate, Lamda cyhalothrin states that the cotton aphid has already built resistance in cotton (Jackson, 2001). Dish washing soap with Insecticidal properties, Teepol® has also been found to be effective in control of aphids. It was less toxic to parasitoids; these findings are similar to those obtained by Cranshaw (1996). Insecticidal soaps are considered selective insecticides because of their minimal adverse effects on other organisms. Lady beetles, green lacewings, pollinating bees and most other beneficial insects are not very susceptible to soap sprays. Research done to find environment friendly insecticides and harmless to non-target organisms to control *M. persicae* in peach orchards, stated that insecticidal soap reduced aphid population by 19.1% and it was not toxic to coccinellids; beneficial organisms of peach. A commercial based insecticide from neem product *A. indica*, Achook® was found to be effective in the control of aphids but there was no significance in the aphid number reduction compared to those in plants treated with Teepol and karate. Therefore neem is effective in the control of aphids, this finding are similar to those obtained by Nisbet et al. (1993). Use of a commercial formulation of Neem (RD-Repelin) successfully deterred aphids attempting to land, probe or oviposit on brinjals. Schmutterer (1990) reported reduced fecundity and longevity in aphids treated with Neem seed extract. On the other hand Achook® was least toxic to parasitoids; this was also reported by Copping (2001). Neem extracts are usually safe for beneficial organisms, such as bees, predators and parasitoids, mammals, and for the environ-ment. Azadiractin is reported to be relatively harmless to bees, spiders, lady beetles, parasitoid wasps and adult butterflies (Stark and Walter, 2001).

Conclusion

According to this investigation Neem based insecticide (Achook®) and Dish washing soap with insecticidal properties (Teepol®) can be good insecticidal options for Integrated Pest Management Program in the control of green peach aphid (*M. persicae*) in garden peas. They are selective, present a less negative impact on the ecosystem and works in association with biological control organisms.

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