ISSN-1997-2571 (Online) & ISSN-2075-1648 (Optical)
J. Innov. Dev. Strategy 4(2):1-5(December 2010)

MANAGEMENT OF APHIDS AND THEIR VECTORED DISEASES ON SEED POTATOES IN KENYA USING SYNTHETIC INSECTICIDES, MINERAL OIL AND PLANT EXTRACT

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Accepted for publication on 15 November 2010

ABSTRACT

Olubayo F, Kibaru A, Nderitu J, Njeru R, Kasina M (2010) Management of aphids and their vectored diseases on seed potatoes in Kenya using synthetic insecticides, mineral oil and plant extract. *J. Innov. Dev. Strategy* 4(2), 1-5.

This study was conducted in two seasons of 2002 at Tigoni, Central Kenya to determine effectiveness of insecticides; neem extract and mineral oil in managing potato aphids and their associated virus diseases. The treatments were arranged in randomized complete block design (RCBD) with four replications. In each season, the number of aphids in five randomly selected plants per treatment was recordced *in situ*. Virus symptoms (incidence) were scored and expressed as a percentage to the total plant population per plot. Forty-five days after emergence, 10 plants each from guard rows and inner rows were randomly selected and serologically assayed for Potato Virus Y (PVY) and Potato Leaf Roll Virus (PLRV) using DAS ELISA test. Results showd that three aphid species *Aphis gossypii* (Glover), *Macrosiphum euphorbiae* (Thomas) and *Myzus persicae* (Sulzer) colonized on the variety with *A. gossypii* being the most dominant while *M. persicae* was least. Higher aphid population coincided with the short rains experienced in one of the seasons. Synthetic insecticides (Bifethrin and dimethoate) were the most effective among the treatments in reducing aphid infestation while the neem extract and mineral oil (DC-Tron) had no significant ($P<0.05$) difference. However, mineral-oil treated plots recorded the lowest PVY incidence while bifenthrin-treated plots had the lowest PLRV incidence. It is suggested that a combination of synthetic insecticides and mineral oil could play a major role in reduction of the aphids and their associated vectors.

Key words: *aphis gossypii, Macrosiphum euphorbiae, Myzus persicae, PVY, PLRV, neem*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the second most important food crop in Kenya with local per capita consumption increasing from 10-15 kg in 1970s (Ballestrem 1971) to current 29 kg (GoK 2009) annually. Production is mainly by small holder farmers. Virus spread to the potato field from neighbouring fields is almost exclusively by alate aphids. Insecticides use in control of aphids is an indirect control of potato viruses such as PLRV and PVY (Woodford and Gordon, 1990). Radcliffe (1982) observed that insecticides applied in furrows at planting or side dressed at the time of emergence are more effective in suppressing aphid populations and also minimize virus spread in potato fields. Nderitu (1983) found use of oxydemeton methyl and dimethoate as foliar sprays and disulfalton and carbofuran as soil insecticides to be efficient in reducing aphid population in potato plots. PLRV is persistently transmitted and it is therefore, appropriate to use insecticides as a major component of its control (Hanafi 2000). Non-persistent viruses such as PVY can be transmitted within the first few seconds of vector probing, thus making insecticides and roguing ineffective. Bradley *et al.* (1962) showed that fatty substances inhibited the transmission of non-persistent viruses by aphids. The technique remains marginally used, mainly due to the high cost of weekly applications. A better determination of the period during which PVY spread actually takes place, might lead to a reduction in the number of sprays required. Handizi and Legorburu (2002) demonstrated that crude neem oil (used as an aphid repellent) could give partial control of PVY and PLRV. Generally, potato virus control has been associated with an increase in insecticide application (Pickup *et al*. 2002). Field-tests described below evaluated pesticides for their efficacy in the management of potato aphids and aphid-vectored viruses in seed potato.

MATERIALS AND METHODS

This study was conducted at National Potato Research Center, Tigoni. Certified seed potato variety ‘Desiree’ was planted in furrows at a spacing of 75cm between rows and 30cm between plants within a row in a plot sizes of 3 by 3 meters. In each potato seed hole, 10 grams of diammonium phosphate (DAP) was put and thoroughly mixed before placing the seed tuber. Two outer rows of each plot were guard rows, while the inner three were the sampling rows. Weeding in the plots was done three times, while ridging was done once after emergence of the potatoes. Late blight was controlled by three spray applications of Mancozeb (Dithane M 45) 2.4 kg a.i/ha (a protective fungicide) and two spray applications of Metalaxyl (Ridomil) 2.4 kg a.i/ha (curative fungicide) in each season. The treatments were DC-Tron Plus (mineral oil) (5l a.i/ha), brigade (bifenthrin) (2.4 l a.i/ha), dimethoate (2.4l a.i/ha), neem extract (56ml a.i/15 l of water) and control (tap water). Treatments were replicated four times and arranged in a Randomized Complete Block Design (RCBD). First application of treatments was done two weeks after emergence using knapsack sprayer calibrated at 0.28 Kg/cm^2 and repeated once every month for three months.

Aphid population assessment

Three leaves were clipped from top, middle and bottom of each of the five randomly selected plants from every treatment in each week for aphid sampling after 40% of the plants in a plot had emerged. Aphids were brushed off from the leaves with a camel brush on to petri-dishes. The aphids were carefully transferred to a universal bottle half-filled with 70% alcohol for identification and counting in the laboratory.

Serological virus incidence

During the first season, 45 days after emergence, twelve plants from guard rows and twelve plants from inner rows were randomly selected from each plot and three leaves clipped from bottom, middle and top part of each plant. At the same period in the second season, leaves from ten plants in the guard rows and ten from the inner rows were clipped from bottom, middle and top part of each plant. The leaflets were processed for PLRV and PVY indexing using Double Antibody Sandwich Enzyme Linked Immunosorbent Assay (DAS-ELISA) as described by Clark and Adam (1977). Serological incidence was expressed as the percentage of the number of test plants per plot that tested positive. All the data collected was subjected to analysis of variance (ANOVA) using Genstat 6th edition package. The means were separated by least significant difference (LSD).

RESULTS

Aphid population assessment

Aphis gossypii was the most abundant, while *M. persicae* was the least abundant throughout the season. There was significant difference (P<0.05) in the number of aphids between all the treatments. Bifenthrin (Brigade) was found to be the most effective (Table 1). Bifenthrin and Dimethoate treated plots were not significantly (P=0.05) different in reducing aphid population.

Table 1. Mean number of aphids, per 15 leaves during the long and short rains of 2002 at NPRC, Tigoni

Treatments	Long rains			Short rains		
	Aphid numbers			Aphid numbers		
	M. e	*M .p*	*A. g*	*M. e*	*M .p*	*A. g*
Brigade	7.0	4.6	9.4	3.2	2.0	7.8
DC Tron	17.0	12.0	21.8	6.6	5.4	14.8
Dimethoate	9.0	6.3	11.8	2.9	2.8	10.3
Neem	21.0	15.1	28.9	7.9	6.0	14.8
Control	33.6	21.8	45.6	12.8	8.8	26.8
P=0.05	< .001	< 0.001	< 0.001	< 0.001	< 0.001	<0.001
LSD	4.7	3.5	5.4	0.4	0.3	0.6
CV %	17.3	22.2	19.0	23.7	22.2	25.6

M. e. = Macrosiphum euphorbiae; M. p. =Myzus persicae; A. g. = Aphis gossypii

Serological virus incidence

The serological incidence of PLRV and PVY were significantly (P=0.05) different among the treatments during the two seasons (Table 2). More virus-infected plants were serologically identified in the outer rows than in inner rows. There was lower incidence in long rains season than in the short rains season. Serological incidence of PLRV and PVY was significantly (P<0.05) different in all treatments in the growing periods. The incidence of both viruses was highest in control plots as compared to the treated plots. Plots treated with DC-Tron had the lowest PVY incidence while those plots treated with brigade had the lowest PLRV incidence throughout the two growing seasons. PVY incidence was lowest in DC-Tron treated plots and highest in control plots in both seasons. Incidence of PLRV was lower, while PVY was higher in brigade and dimethoate treated plots. There was no significant difference in PLRV and PVY incidence in control and neem treated plots.

Table 2. Serological incidence of PLRV and PVY in outer and inner rows during the long and short rains of 2002 at NPRC, Tigoni

Treatments	Short rains 2002		Long rains 2002		Short rains 2002		Long rains 2002	
	PLRV inner rows	PLRV outer rows	PLRV inner rows	PLRV outer rows	PVY inner rows	PVY outer rows	PVY inner rows	PVY outer rows
Brigade	10.0	7.5	4.2	4.2	22.5	27.5	12.5	25.0
DC Tron	12.5	22.5	6.2	20.8	7.5	15.0	6.2	12.5
Dimethoate	7.5	17.5	10.4	10.4	22.5	32.5	16.6	25.0
Neem	12.5	32.5	14.6	25.0	27.5	35.0	22.9	27.1
Control	17.5	40.0	14.6	33.3	32.5	45.0	25.0	47.5
P= 0.05	0.522	<0.001	0.021	<0.001	<0.001	<0.001	0.001	<0.001
LSD	12.4	6.6	7.0	8.3	4.9	8.8	7.9	7.6
CV %	17.2	17.8	15.7	18.7	14.1	18.4	20.8	19.4

During the long rains, aphid population increased sharply in control plots and neem treated plots while it declined for the other treatments between 2nd and 3rd week after plant emergence (Figure 1). The aphid population increased thereafter in brigade, DC-Tron and dimethoate treated plots, attaining a peak on 5th week after emergence during the long rains season. The aphid population did not increase after the 6th week in brigade and dimethoate treated plots. In the short rains, there was no significant ($P>0.05$) difference in the treatments between 1st and 3rd week after emergence. Aphid populations increased in control plots, DC-Tron and neem treated plots while it declined in brigade and dimethoate treated plots. In 5th to 6th week, there was slight increase in populations in dimethoate and control plots while it leveled off for DC-Tron and neem treated plots. While the population was decreased on 6th to 7th week after plant emergence in control, brigade, DC-Tron and dimethoate, it was increased in neem treated plots.

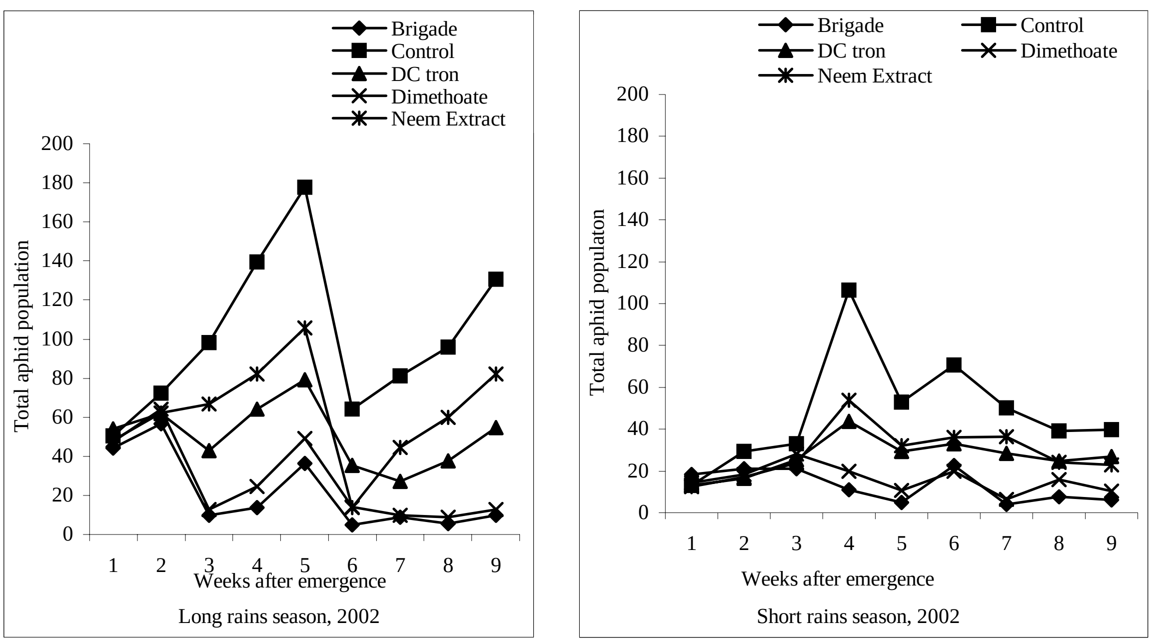

Figure 1. Aphid population in response to various treatments during the long rains and short rains at NPRC, Tigoni

DISCUSSION

The prevailing mean air temperatures (27°c) in the short rains compared to 22°c in the long rains could be used to explain the higher aphid population during the short rains. Probably the aphids flew greater distances when the temperatures were higher. Radcliffe (1982) reported that temperatures of less than 17.8°c greatly restrict the number of flights of *M. persicae* in the laboratory. This observation agrees with the findings of Thackray *et al*. (2002) who reported that rainfall promoted growth of weeds and pasture plants, aphids might build on and acquire BMYV before flying to crops. The peak occurrence of all aphid species on 4th week after emergence of the potatoes for the short rains could be the critical period when the maximum infection occurs. This observation is consistent with work done by Handizi and Legorburu (2002) who found that the first third of the vegetation period was the most important for virus infection, even if the aphid flights were relatively low. This period in our study coincides with 4th week after emergence and therefore, pesticides should be applied promptly on 3rd week after emergence. Insecticide use in control of aphids is an indirect means of potato viruses for example PLVR and PVY control (Woodford and Gordon, 1990). Oxydemeton methyl applied every two weeks was the most commonly used schedule, by the seed potato grower in Kenya (Nderitu 1983). It was evident that dimethoate and bifenthrin applied in the trials were the most effective in suppressing aphid population in the potato crop. Bifenthrin (pyrethroid) and dimethoate (organophosphate) are both systemic insecticides but bifenthrin has a rapid knockdown effect than dimethoate. The systemic insecticides are generally persistent enough to minimize the number of spray applications. Since all the synthetic insecticides tested suppressed the aphid populations to very low levels for the whole season, a monthly interval is enough for the management of the aphids. This study revealed that PVY was difficult to reduce significantly by use of convectional insecticides. However, use of insecticides for aphid control has been accepted as an indirect means of PLRV management within the potatoes (Till 1971).

This study revealed that oil did not immediately spread to a film on the leaf after spraying, but covered the leaf surface with small droplets, which stretched out and joined together between 24 and 36 hours after application, thus protecting the cuticle. This is in agreement with the findings obtained by Hanafi (2000) and Walkey (1991). Mineral oils were observed to persist in the field on potato plants for 10-14 days but may be washed off by rain or overhead irrigation and must be re-applied as new tissue develops. DC-Tron performed better than bifenthrin or dimethoate in reducing PVY incidence but had limited effect on PLRV. This confirms by Walkey (1991) who found that mineral oils did not impede the transmission of the circulative pea enation mosaic virus. The circulative nature of persistent viruses limits the practical use of oils to control the spread of these aphid borne viruses. Hanafi (1998) found that inhibition of non-circulative viruses occurred whenever there was a contact between virus carrying stylets and oil. Russel (1970) reported that spraying beets with a mineral oil reduces setting behaviour and larvioposition of *M. persicae* within 24 hours after the treatment and this may explain the low aphid population in DC-Tron treated plots as compared to the control. Hein (1971) reported that highly volatile essential oils did not inhibit the transmission of either virus, probably because they ddi not persist at the surface or inside the foliar tissues. High viscosity may prevent homogenous spray cover of the leaf surfaces. Inhibitory effects on the aphid transmission of non-persistent viruses were also found using plant lipids and milk fat (Bradley *et al.* 1966). These observations suggest that some properties common to these various compounds are responsible for the observed interference.

Although neem extract treated plots had lower aphid population and virus incidence than the control its performance was lower compared to convectional pesticides. This observation is in agreement with findings of Handizi and Legorburu (2002) who reported partial control of PVY by using of crude neem extract. In the United States, daily applications of neem extracts over a month's time to turnip plants infected with cauliflower mosaic virus did not reduce viral infections (NRC, 1992). A few success stories of virus control with neem are reported. Saxena *et al.* (1987) found that rice seedlings grown in soil treated with neem cake were significantly freer of rice tungro viruses (transmitted by leafhoppers and plant hoppers) than in untreated plants. There are reports that the main active ingredient, azadirachtin, is not systemic in potato (NRC, 1992). In comparison with bifenthrin and dimethoate, neem is slow acting. Neem treated insects die by delayed action. Although destructive power drops fast as the neem material take effect, it may persist for 2 weeks after application. This delayed action may be very critical for non-persistent viruses like PVY, which is transmitted in seconds by viruliferous aphids. Aphids are known to feed only on the phloem tissues, where for some unknown reasons, neem materials accumulate least (NRC, 1992). This lack of quick effect poses a challenge in promoting neem in pest control markets where farmers expect instantaneous results.

The higher serological incidence in the outer rows than in the inner rows signifies the mode of spread of virus-diseases. Ward and Jones (2002) demonstrated similar results while working with BWYV and pea seed borne mosaic virus (PSbMV) in faba bean (*Vicia faba*), which are vectored by *Aphis craccivora*. They reported clustering of the infection was mainly around these primary foci (outer edges of the field). The protection of the outer rows can limit the rate of spread of the viruses to the inner rows. The results of this study confirm that, inner rows had fewer virus infections and thus can be readily selected for seed by the farmers. This would result in decreased virus infection in ware potato production fields, and eventually lead to increase potato yields in the country.

ACKNOWLEDGEMENT

The authors wish to thank The Rockefeller Foundation under Forum for Agriculture and Husbandry for funding this study. We also thank Kenya Agricultural Research Institute National Potato Research Center (KARI-NPRC) for facilitating this study at their station.

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