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The effects of extract of *Azadirachta indica* (*Neem*) oil and Imidacloprid (IRON 30SC) on the population dynamics of *Brevicoryne brassicae, Lipaphis pseudobrassicae* and *Plutella xylostella* on white cabbage

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Abstract

The effects of neem seeds oil and Imidacloprid (Iron 30SC) systemic insecticide on the populations of three cabbage pests, *Brevicoryne brassicae*, *Lipaphis pseudobrassicae* and *Plutella xylostella* were studied. The study was conducted between June and September 2015. Oil extracts of neem were sprayed on cabbage plants to control these pests. A standard systemic chemical insecticide (IRON 30SC) was used as comparative product. The experiment was conducted in a randomized complete block design and each treatment was replicated four times. The effects of plant extracts on the population dynamics of the pests' species, the loss level and yield were assessed. Significantly more pests infested the control plants compared to treated plants ($P \leq 0.05$). The mean weight of cabbage heads on the sprayed plots was not significantly heavier than that of the control unsprayed plots. The use of *A. indica* seeds oil and Imidacloprid systemic insecticide reduced the loss level by 6.06% and 9.92%, respectively. So, the use of this neem extracts can be ameliorated by spraying at a weekly basis and can be incorporated into an overall control programme of these pests.

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Introduction

Cabbage (*Brassicae oleracea var. capitata* Linnaeus) is an important vegetable widely cultivated in Africa (Munthali and Tshegofatso, 2014). It is grown in four important regions in Cameroon (West, North West, Centre and South West regions). It is cultivated mainly in urban and periurban zones (Nguegang, 2008). Cabbage production is limited by attacks of insects' pests (Legwaila *et al.*, 2014). Of these, *Brevicoryne brassicae* Linnaeus (Hemiptera: Aphididae), *Lipaphis pseudobrasssicae* Davis (Hemiptera: Aphididae) and *Plutella xylostella* Linnaeus (Lepidoptera: Plutellidae) are the most important and cause considerable damage to cabbage leaves (Saethre *et al.*, 2010; AVRDC, 2009). The feeding of adults and nymphs aphids harm plants directly, while indirect damage can result from the secretion of honeydew, the transmission of plant diseases, and the contamination of the harvested crop (Spence *et al.*, 2007). Leaves infested with aphids become curled or twisted, and when aphid populations are large, the entire plants become wilted, distorted or yellowish (Bhatia *et al.*, 2011; Dedryver *et al.*, 2010). Small plants can be killed. Infested plants may produce small, unmarketable heads (Mochiah *et al.*, 2011; Ulusoy and Bayhan, 2006).

Cabbage aphid (*B. brassicae*) is body heavily covered with white waxy powder. They infested leaf surface with distinct white waxy powder. Turnip aphid (*L. pseudobrassicae*) have thin layer of white waxy powder (Blackman and Eastop, 2007).

Diamondback moth (DBM) larvae feed especially on leaves. Its damage level in commercial crops is about 10 larvae/plant in Taiwan, South Africa and New Zealand (Mkize, 2003; Walker *et al*; 2002). DBM can be found on crucifers throughout the year if the host crop is planted continuously (Tufail and Mohd, 2010).

AVRDC-IITA (2009) relates that farmers knowledge of cabbage pests is poor and more than 90% of the farmers use pesticides. Despite the efficiency, and the facility of utilization, synthetic pesticides lead to environmental contamination and water pollution (Baidoo *et al.*, 2012). In the same report of AVDRC-IITA (2009), farmers expressed a wish to use alternatives methods such as botanical insecticides, resistant varieties, biological and cultural methods.

Many chemical pesticides, including Neem, horticultural oil and insecticidal soaps have been developed and promoted for aphid control in many temperate and tropical countries (Grzywacz *et al.*, 2010). Saucke *et al.* (2000) found that best results were achieved in field trials with the commercial Neem formulation Neem Azal (*Azadirachta indica* A. Juss.) more than *Bacillus thuringiensis* products (Deftin and Thuricide) in Papua New Guinea. Neem also controlled the false mustard aphid *L. erysimi* (Kalt). Michael and Raja (2012) discovered that *B. brassicae* in the field is reduced significantly by the application of aqueous neem seed extract at 5%. The experiment in laboratory revealed that Neem EC inhibited larval development, greatly increased mortality, had antifeedant/deterrent effects and acted as a growth regulator for *M brassicae* larvae and pupae (Metspalu *et al.*, 2010).

Mohammad *et al.* (2007) found that Imidacloprid used at 5 mol/L and 30 mol/L in the laboratory conditions considerably reduced the average numbers of nymphs reproduced per female of *B. brevicoryne* as compared with the control. Travis and Rick (2000) found that DBM larvae are controlled by carbaryl, permethrin, spinosad, and tebufenozide more than *Bacillus thuringiensis,* or Imidacloprid in the larval-dip bioassay 72 h after treatment. Samira *et al.* (2013) obtained results indicated that diazinon and imidaclopride in the laboratory conditions were moderate toxic (33-66%) to egg of *C. montrouzieri* (Coleoptera: Coccinellidae).

Knowing such information's on the effects of Neem and Imidacloprid would be of considerable importance in the integrated management control of cabbage pests in Cameroon. With having the above points in view, this study was carried out to determine the effect of plant extract and Imidacloprid on

population buildup of pests on white cabbage. This adjustment may help to minimize pest infestation.

Materials and methods

Research site

This research was done in the West Region of Cameroon in a the Research and Investigation Field of the University of Dschang (5°24'23"- 5°26'23" (Latitude), 10°04'05"- 10°07'43" (Longitude) and 1440 m (elevation)) during the rainy season in year 2015.

Plant material

A variety of white head cabbage, «Green Coronet » (commercial hybrid tropical high altitude cabbage) was chosen for the experiment. It is very resistant to heat. The choice was based on the fact that it is the most widely known and cultivated variety in the high land zone of Cameroon.

Cabbage nursering and land preparation

The cabbage nursery bed was prepared during the first week of June 2015 and the seeds were sown. The seedlings with three or four true leaves were transplanted on first week of July 2015. The plants were spaced 50 × 50 cm on the plots. Organic manure (chicken) at the rate of 5 t/ha was applied to the beds the same day before seedlings were transplanted and NPK (20-10-10) fertilizer was applied at 300 kg/ha three weeks after transplanting. Weeding was done every three weeks after transplanting.

Experimental design

The experiment was done with four replications using the complete randomised block design in two treatments. The experimental plots had 3 m × 3.5 m area and two blocks were distant by a row of 1 m length to avoid spray drift between adjacent plots. Totally, 8 plots were selected, 4 plots were considered as control with no spraying. The remaining 4 plots were considered as 4 replications in which Neem seed extract and 4 replications in which Imidacloprid was sprayed. A separate 15L capacity knapsack sprayer was used to apply each for the treatments solutions. Applications commenced 3 weeks after transplanting of seedling and were reapplied monthly thereafter.

Population fluctuations of *B. brassicae* (nymphs and adults), *L. pseudobrassicae* (nymphs and adults), *P. xylostella* (larvae and pupae), entomopathogenic fungi (aphids mummies) and predators (eggs, pupae and adults) counting began two weeks after transplanting (July 21st) and the experiment went till September 30th 2015, one month after the last spray.

During counting, three leaves of outer and inner were removed to avoid repeated counting of one and the same aphids on the same plant. Observations were performed weekly, eight counting in total.

Five plants per replication were selected randomly from the two innermost rows of each plot. Before spraying, aphids in the treated and control plots were counted. The control plots were maintained during the experiment without spraying. The first spray began three weeks after transplanting. *M. azedarachta* (Neem) seed oil was sprayed at 5 l/ha. These seeds oil, were obtained from a local market in the Far North Region were villagers process Neem oil traditionally. Imidacloprid IRON 30 SC was used according to manufacturer instructions for insects control applications (1l/ha). The applications of systemic insecticides and Neem extracts on the leaves were performed twice. The first application was carried out three weeks after transplanting and the second four weeks after the first spraying.

The damage caused by the pests in the field was assessed by counting the total number of pests starting one day after spraying and continuing at a weekly interval.

At harvest time, 5 plants from inner rows of each plot were used for yield and loss level. 20 cabbage heads were weighed to have the total weight heads total (kg) and the economic weight (20 heads of cabbage without infested leaves). Loss level was calculated as follow:

Loss level= (Total weight (kg) – Economic weight (kg)/Total weight (kg))*100.

Statistical analysis

All graphs were drawn using the Excel software and data analysis was carried out using ANOVA method. The means comparison was done using Tukey test and all Statistical data analyses were done using JMP 8.0 software (SAS).

Results

Insect pests on cabbage

A number of insect pests were found on the plants. These included *L. pseudobrassicae*, *B. brassicae (Hemiptera:Aphididae), P. xylostella (Lepidoptera: Plutellidae)*. These pests appeared at different stages of growth of the plants. *L. pseudobrassicae* and *P. xylostella* were the first to attack the plants and at 2 weeks after transplanting (WAT). They were found on all the plots. However, after spraying with the various insecticides their numbers were significantly reduced on the treated plants (Fig. 1 and 2), ($P \leq 0.05$); except *P. xylostella* where Imidacloprid treated plants show no significant difference with control treated plants. Infestation by *B. brassicae* on all the treated plots differ significantly ($P \leq 0.05$). Imidacloprid treated plants was more efficient than Neem treated plants and control. Eventhough their numbers with the growth of plants remained reduced until harvest (Fig. 2). *L. pseudobrassicae* infestation was observed 2 WAT. Infestation was rather high; reaching its peak 5 WAT. Imidacloprid and Neem treatments highly reduced pest numbers with the growth of the plants, they remained high on the control plants than Neem treated plants and Imidacloprid. *P. xylostella* infestation was observed 2 WAT. Infestation was rather high; reaching its peak numbers 4 weeks after spraying (WAS) on the control plants. Significantly more insect pests were recorded on the control plants and Imidacloprid treated plants compared to Neem treated plants. *Neem* treated plants recorded the least number of *P. xylostella*. However, the difference in the pest numbers on the Imidacloprid treated plants and control was not significant ($P \leq 0.05$). This pest remained on all the plots until harvest even though their numbers were significantly lower on all the plots (Fig. 3) ($P \leq 0.05$).

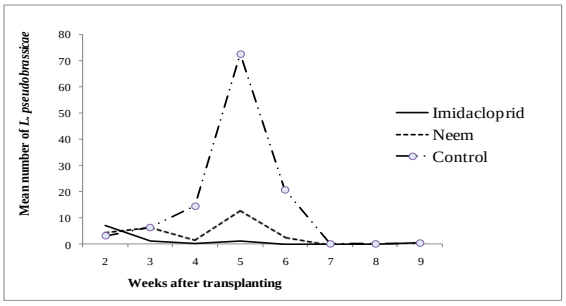

Fig. 1. Mean numbers of *L. pseudobrassicae* a weeks after transplanting according to treatments Imidacloprid, Neem oil extract and Control.

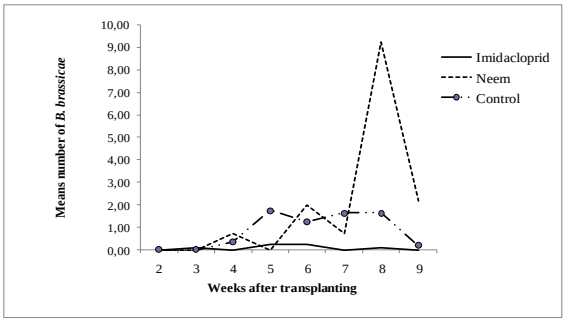

Fig. 2. Mean numbers of *B. brassicae* a weeks after transplanting according to treatments Imidacloprid, Neem oil extract and Control.

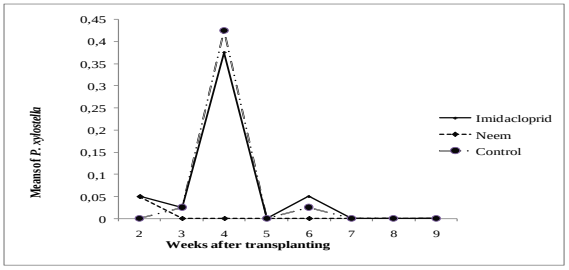

Fig. 3. Mean numbers of *P. xylostella* a weeks after transplanting according to treatments Imidacloprid, Neem oil extract and Control.

Weight of cabbage heads

Cabbage total weight heads from the control plots were the heaviest with a mean weight of a head being 2.51 kg. However, the difference in the total weight, total economic weight of cabbage heads on the treated plots and control did not differ significantly ($P \leq 0.05$). The use of Imidacloprid and *Neem* reduced the

loss level of the cabbage heads by 9.92% and 6.06%, respectively compared with the control plants.

Loss Level

Loss level on the plants ranged from 24.97 in Imidacloprid treated plants to 27.72 in the control plants (Table 1). Loss level was high in the control plants compared to treated plants ($P \leq 0.05$). No significant difference was observed between the Imidacloprid-treated; Neem-treated plants and control ($P \leq 0.05$).

Table 1. Effect of treatments on the means number of *B. brassicae*, *L. pseudobrassicae*, *P. xylostella* and means total weight, economic weight of cabbage heads and the loss level.

Treatments	*B. brassicae*	*L. pseudobrassicae*	*P. xylostella*	Mean total wt. of head (kg)	*Mean economic wt. of head (kg)*	*Loss level*
Imidacloprid	0.09±0.05b	1.32±0.37b	0.06±0.02a	2.28±0.14a	1.73±0.13a	24.97±1.60a
Neem	1.86±0.96a	3.43±1.30b	0.01±0.00b	2.43±0.11a	1.81±0.10a	26.04±1.30a
Control	0.85±0.29a	14.83±4.36a	0.06±0.03ab	2.51±0.13a	1.82±0.11a	27.72±1.96a

Within the same column means followed by the same letter are not significantly different ($P > 0.05$).

Discussion

The use of natural plant products have been considered for the management of agricultural insect pests (Ahmed, 2000). This is due to the fact that they are less detrimental to the environment compared to synthetic chemical insecticides. The integrated pest management brings more safety solution to face different limitations presenting various methods take solely (Talekar and Shelton, 1993). The appearance of the various pests species affected the growth of the plants (Dedryver *et al*., 2010). Even though some of the plots were sprayed with control agents, all the plots recorded some level of pest infestation. Before the application of the insecticides, all the plots were infested with *L. pseudobrassicae* and *P. xylostella*. These insects caused stunted growth, malformed and distorted leaves. These effects resulted in reduced head weight especially in the control plants. The feeding activities of *P. xylostella* in particular resulted in windowpanes and holes in the leaves. The significant decrease in the numbers of pests on the treated plots (Imidacloprid and Neem) indicates their effectiveness. The fact that no significant difference was observed between the numbers of the pests on the plots treated with the Neem extracts and control for *B. brassicae* and between the plots treated with Imidacloprid and Neem extracts for *L. pseudobrassicae* indicates that the frequency of Neem extracts spray was not effective in the management of these pests. The one month interval is too long to maintain the antifeedant propertie of the Neem oil extracts. It has been reported in the case of *A. indica* (Lowery and Isman, 1995) who found that Neem insecticides may be suitable for use in integrated pest management programs. Zaki (2008) found that 3 times applications of the plant extract Neem markedly (monthly) decreased the numbers of the aphid *B. brassicae*. Ahuja *et al*., (2009) reported that aphids *L. pseudobrassicae* (Davis) on *Brassica juncea* can be effectively controlled by one spray of Neem seed extract (5g/l of water) or azadirachtin (9ppm) at 60 day post sowing followed by another spray of Methyl Demetor at 75 days post sowing. Shanmugapriyan and Dhanalakshmi (2015) demonstrated that Neem oil at 2.5% concentration generated 53.33% mortality of *Henosepilachna vigintioctopunctata* pupae. Neem oil also resulted in 80.00% of inhibition on adult emergence at the same concentration. Grisakova *et al.* (2006) realized that Neem had both toxic and antifeedant effects but also acted as growth regulator for *Pieris brassicae*. In this study, the time needed for completion of the larval stages by individuals fed on treated cabbage increased significantly, compared with the control: 16-37 days in the test variant versus 11-18 days in the control. Also, the pupae of larvae that had been feeding on the control were heavier than those of the larvae feeding on the treated plants. Adriana and Mauricio (2008)

found that males of *Microtheca punctigera* were repelled by the Neem oil, the larvae mortality was higher than the control leaves. Ahmed (2000) demonstrates that aqueous suspension of Neem kernel powder reduces *Aphis gossypii* infestation by 35% on okra leading to significant increase in okra yield of 28 – 62%.This provides evidence of using Neem oil in the management of pests in the field.

From the numbers of *P. xylostella* collected, it appears that this pest is less present on the field and for them; Neem extracts are more effectives than Imidacloprid. Travis and Rick (2000) found that the larval mortalities rates at field were significantly higher with carbaryl, permethrin, spinosad, and tebufenozide when compared with *Bacillus thuringiensis,* or Imidacloprid in the larval-dip bioassay 72 h after treatment. *L. pseudobrassicae,* and *B. brasicae*, was completely protected by Imidacloprid insecticide while *L. pseudobrassicae* and *P. xylostella* was complelety protected by Neem seeds oil extracts. This explains why relatively low numbers were obtained on the plants even after one month insecticide application.

Conclusion

The reduction in pests' numbers on the treated plants was an indication that Neem oil extracts can be used as alternative to chemical insecticides. Our results showed that the insecticide Imidacloprid has significant effect on *B. brassicae* and *L. pseudobrassicae* suggesting that, it is likely that management of *B. brassicae and L. pseudobrassicae* using Imidacloprid under field conditions will be effective on all stage growth of cabbage. But Neem application and regular scouting for aphids should be implemented in support of Imidacloprid applications. The treatment with the Neem oil extract was not as efficient as Imidacloprid treatments but more sprays could give better results which we plan to examine in the future.

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