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EFFECT OF INSECTICIDE APPLICATION REGIMES ON CEREAL APHIDS AND THEIR COCCINELLID PREDATORS ON WHEAT

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ABSTRACT
Understanding the effectiveness of pesticides on the target pests and their negative effects on beneficial insects is an emerging issue in integrated pest management (IPM) programmes. An experiment was conducted to evaluate the effect of insecticide application regimes on cereal aphids and their coccinellid predators. The assays were conducted using a field-cage experiment in a randomised complete block design replicated three times. The treatments involved a systemic seed dress, a systemic foliar insecticide and an untreated control. Aphid and beetle counts were taken at four wheat growth stages. The highest aphid and coccinellid populations were recorded at booting and flowering wheat growth stages across all insecticide application regimes. The untreated plots recorded the highest aphid (15.5 and 14.5), coccidellid adult (3.5 and 4.6) and coccinellid larval (4.5 and 6.6) counts during the booting and flowering wheat stage respectively. Seed dressing recorded a significant reduction in aphid counts (7.2 and 4.6) and moderate increase in coccinellid adult (2 and 2.3) and larval (1.5 and 2.4) populations at booting and flowering stage respectively. The foliar sprayed plots recorded the lowest aphid (1 and 2.9) and coccinellid counts (1 and 1) during the booting and flowering wheat stage respectively. Overall yields were higher in the seed dressed cages (0.55 kg) and no significant differences in yield were observed between the control (0.31 kg) and foliar insecticides treatments (0.30 kg). The research concluded that the correct use of seed dressing has less deleterious effects on coccinellid predators and can be efficient in cereal aphid control.

KEY WORDS: pesticides; predators; toxicity.

INTRODUCTION

Aphidophagous coccinellids have been found to play a significant role in the biological control of aphids (Brodeur and Rosenheim, 2000; Nyaanga, *et al.*, 2014). Although these predators are well known for their ability to control pests in a wide range of cropping systems, they have not been purposefully established in annually disturbed wheat production fields. Wheat production is characterized by extensive and indiscriminate use of insecticides and hence predators are often exposed to chemicals directly through insecticide application or indirectly by consuming insecticide contaminated preys. Insecticidal applications are therefore the key impediment to the implementation of conservation and augmentative programs for coccinellid beetles as biological control agents on wheat. Coccinellid species are good bio-indicators for organic vs. non-organic management systems (Cotes *et al.,* 2009). Extensive research has centred on the search for appropriate insecticides with toxicity to pest organisms, but not to flora and fauna. Studies done by Guru et al, (2013) showed high toxicicity of acetamiprid to grubs of *Cheilomenes sexmaculata* among other insecticides tested. Sakthivel and Qadri (2010) also reported drastic reductions in the population of coccinellid beetles in the plots treated with dichlorovos, phosalone, dimethoate and metasystox insecticides. Conservation of natural enemies involves identifying the factors which may limit the effectiveness of a particular natural enemy and modifying them to increase the effectiveness of the beneficial species. Maredia *et al.* (2003) observed that some of the factors that influence the ability of using natural enemies with pesticides include whether the natural enemy is a parasitoid or predator, natural enemy species, life stage sensitivity, rate of application, timing of application, and mode of action of a particular insecticide. Understanding the effectiveness of pesticides on the target pests and their negative effects on beneficial insects is an emerging issue of integrated pest management (IPM). It is therefore imperative to assess the potential compatibility of using natural enemies in conjunction with pesticides. This will provide a well-defined and selective insecticide application programmes in commercial wheat production systems. A study was initiated to monitor the change in aphid and coccinellid populations on wheat throughout the season in relation to different chemical application regimes.

MATERIALS & METHODS

The research was carried out in 2009 at Egerton University situated in the Rift valley province of Kenya. The experiment was conducted in outdoor cages using a randomised complete block design (RCBD) replicated three times. The treatments involved three insecticide application regimes namely; a systemic seed dress with Gaucho (Imidachloprid) 350 FS which was applied at a rate of 200ml/100kg before planting, a systemic foliar insecticide (Metasystox) which was applied at a rate of 750ml/ha when the crop was at six-leaf stage and a control where no chemical was applied. Experimental plots measuring 1.5m x 2 m with an inter-row spacing of 20 cm were planted according to recommendations for commercial wheat production. A screen mesh enclosure (cage) was erected around each plot immediately after planting to exclude any aphids or predators flying in or out of the plots. The cages were made from wooden frames with polyester screen covers of mesh size 0.4 by 0.5 mm and thread thickness of 0.1 mm on the sides and fine wire mesh size 0.5 by 0.5 mm at the top.

Twenty fourth instar cereal aphids (total sixty) from each of the three species; *Ropalosiphum padi* (Linnaeus), *Metapolophium dirhodum* (Walker) and *Sitobion avenae* (Fabricius) were collected from greenhouse cultures and randomly inoculated onto the wheat plants at Zadock growth stage 12 (2-leaf stage) in all the caged plots. The aphids were allowed to establish on the plants for two weeks (two generations) before two female coocinellid beetles with a maximum age difference of 24hr since eclosion were evenly distributed in all plots. One adult male beetle was also placed in the plots with female beetles after 2h. Aphid counts were taken from ten plants and their tillers randomly selected in each plot while the adult and larval coccinellid beetle counts were taken by observing the whole plot at four growth stages; GS 32 (stem elongation stage) GS 45 (booting stage) 69 (flowering stage) GS 91 (ripening stage) (Zadok *et al*., 1974). The data on aphid counts was first transformed using the √(x+1)) to homogenize and stabilize the variance before being subjected to analysis of variance (ANOVA) and mean separation. (Gomez and Gomez, 1983; SAS, 1996).

RESULTS

An aphid count in the untreated plots was generally higher than the treated plots at all the wheat growth stages (Fig 1a). The least aphid population was recorded in the plots that were foliar sprayed. Booting and flowering stages recorded the highest aphid population which reduced drastically at ripening stage across all the insecticide application regimes. There were significant differences ($P<0.05$) among treatments in the population of coccinellid adults during the different sampling stages (Figure 1b). Like the aphids booting and flowering stage recorded the highest beetle populations across the insecticide application regimes tested. Foliar sprayed plots recorded a significant (78%) reduction in adult beetle counts while the seed dressed plots recorded only 50% reduction over the untreated (control) plots during the flowering wheat growth stage. Similarly, the foliar sprayed plots recorded significantly ($P<0.05$) fewer coccinellid numbers during the ripening stage (1) compared to both the seed dressed (3.5) and the control (6.7). Unlike the aphids, the adult beetle population remained high at ripening stage. There were significant differences ($P<0.05$) in larval abundance observed among the different chemical application regimes during the different wheat growth stages (figure 1c). Numbers of larvae observed in the untreated and seed dressed plots was ten times and seven times more than in the foliar sprayed plots during the booting and flowering stages respectively. The abundance of larval stages however reduced drastically to approximately 30% of the overall cocinnellid population during the wheat ripening stage. Results from this study showed that the wheat yields increased significantly ($P < 0.05$) in the seed dressed field cages (0.55) kg/m^2 compared to the control treatments (Figure 2). There was however no significant difference in wheat yield between the control (0.3) kg/m^2 and the foliar insecticide treatment (0.31) kg/m^2.

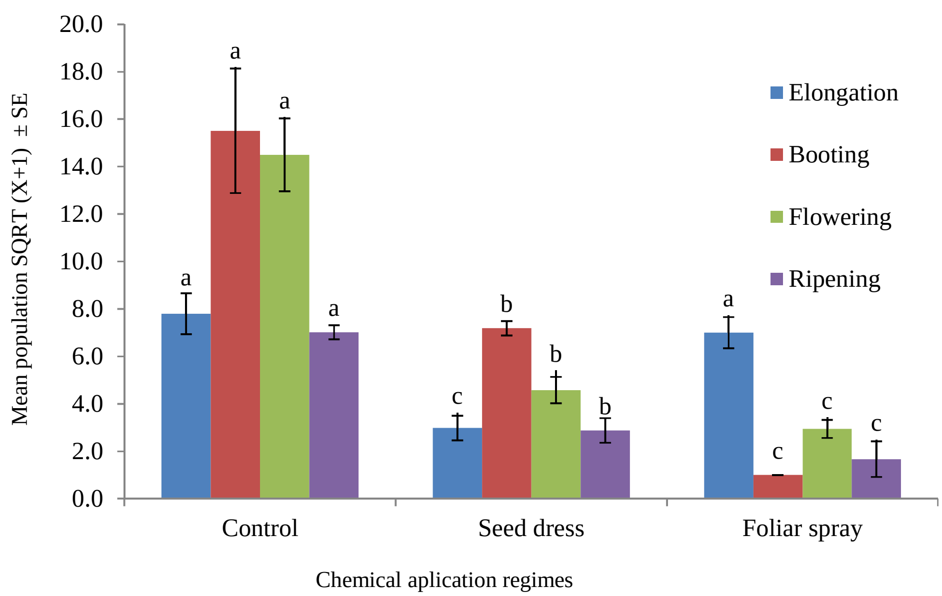

FIGURE 1a Effect of insecticide application regimes on cereal aphid counts at different wheat growth stages.

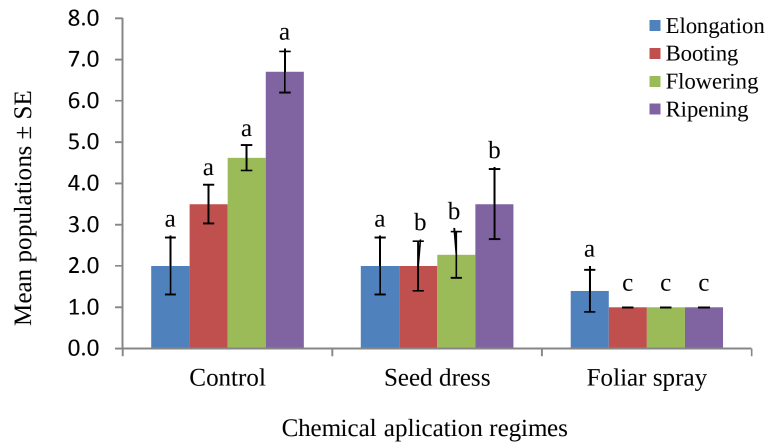

FIGURE 1b Effect of insecticide application regimes on coccinellid adult abundance at different wheat growth stages.

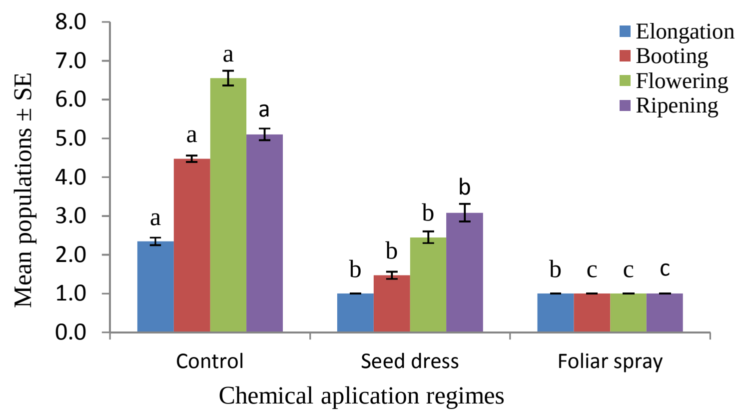

FIGURE 1c Effect of insecticide application regimes on coccinellid larval abundance at different wheat growth stage.

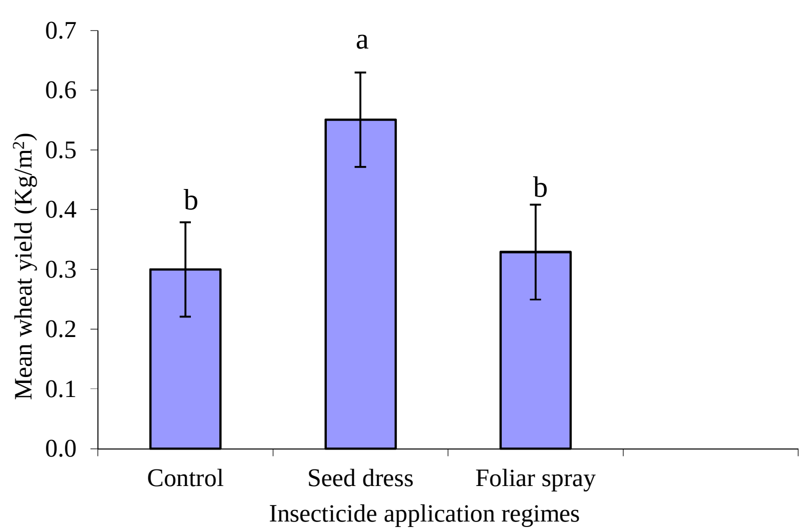

FIGURE 2: Effect of insecticide application regimes and wheat yield

DISCUSSION

The aphid population trends observed in the untreated plots was consistent with that recorded in earlier surveys by Yoshitaka and Masako (2005) and Nyaanga *et al*. (2006). They reported that aphid densities in the open fields increased with each sampling date with the exception of the last (ripening) date. Nyaanga *et al* 2009 also observed that Coccinelid population closely lagged behind the aphid population giving a clear indication of a positive prey/predator association.

The study indicated that seed dressing insecticide treatments posed little threat to coccinellids as it recorded low aphid populations and high coccinellid populations particularly during the booting and flowering stage. Similar observations were made by Katole and Patil (2000) who reported biosafety of seed dressing against predators including lady bird beetles. This can be attributed to the fact that Gaucho (Imidachloprid) is a systemic insecticide and beneficial coccinellids do not directly feed on wheat leaf contents where seed dress toxins are concentrated. The presence of some aphids recorded in the seed dressed plots during the booting and flowering stage may have also supported the moderate coccinellid populations. The low levels of beetle abundance recorded in the foliar sprayed plots in this study is consistent with Sakthivel and Qadri (2010) who also reported drastic reductions in the population of coccinellid beetles in plots which were treated with dichlorovos, phosalone, dimethoate and metasystox. This may have resulted from high mortalities due to direct contact during spraying and the residual exposure thereafter. Exposure of coccinellid predators to pesticides, may occur as a result of ingestion of treated prey, contact with treated surfaces or by direct exposure to sprays (Wiles and Jepson 1995). Indirect effects on the other hand may occur when their food sources has been reduced by insecticides or through secondary poisoning by contaminated preys (Stark et al 2007). The reproductive biology of coccinellid predators may also be affected by pesticides as was observed by Khani1*et al*, (2012) who reported that exposure of females to imidacloprid and abamectin insecticides resulted in *C. montrouzieri* adults with reduced number of eggs and shorter life spans. Coccinellid larvae were most abundant in the untreated and seed dressed plots compared to the foliar sprayed plots during booting and flowering wheat growth stages. Generally natural enemies and particularly the immature stages are more susceptible to insecticides than insect pests because of their great mobility on plants, less concealed habitats and perhaps their relatively poorer ability to detoxify chemical poison (Waage and Thomas, 1996). The significantly higher larval abundance observed in the plots that were only seed dressed suggest that like the adults, coccinellid larvae were not negatively impacted by seed dressing. Although foliar insecticide treatments significantly reduced aphid populations, this did not translate into increase in wheat yield. The heavy aphid infestation present before the insecticide was applied may have negatively influenced the yield components (Lee et al; 1981; Tétard-Jones, and Leifert, 2011). The high wheat yield recorded in the seed dressed can therefore be partly attributed to the low aphid numbers recorded during the early wheat growth stages.

CONCLUSION

The research concludes that the correct use of seed dressing has less deleterious effects on coccinellid predators and is efficient in the management of cereal aphids in wheat. This insecticide regime may therefore present effectiveness against pests and low impact on the survival, reproduction and behavior of natural enemies. The high population of larval coccinellids occurring during the economically important booting and flowering wheat growth stages seem to play an important role in aphid suppression and hence foliar insecticide treatments should be avoided during this period.

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