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Research Application Summary

Abundance and diversity of safflower insect pests and their natural enemies

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Abstract

A study was carried out in a farmer's field in Molepolole, Botswana to investigate diversity and abundance of different insect pests in five safflower genotypes. Thirteen insect species belonging to eight arthropod orders were observed during the study. Insect pests attacked all safflower genotypes, but population fluctuations were attributed to days after plant emergence. "Gila" recorded the highest number of individual species while "Kenya'' recorded the lowest. There was a notable difference in abundance and diversity of insects among plant growth stages. Flowering stage recorded the maximum number of individual species. The insect pest *Helicoverpa armigera* was of major concern causing considerable damage to safflower. *Cheilomenes lunata*, *Apies mellifera*, spider and *Formicidae* sp.1 were recorded as beneficial insects. Leaves and capitula were the most affected parts of safflower. Relative humidity and temperature significantly ($P < 0.05$) influenced insect pest population; an increase in temperature increased insect pest population while an increase in relative humidity decreased insect pest population.

Keywords: Botswana, Capitula, genotype, safflower, species richness, species evenness

Résumé

Une étude a été menée dans le champ d'un agriculteur à Molepolole, au Botswana, pour étudier la diversité et l'abondance de différents insectes ravageurs dans cinq génotypes de carthame. Treize espèces d'insectes appartenant à huit ordres d'arthropodes ont été observées au cours de l'étude. Les insectes ravageurs ont attaqué tous les génotypes de carthame, mais les fluctuations de population ont été attribuées aux jours après l'émergence des plantes. "Gila" a enregistré le plus grand nombre d'espèces individuelles tandis que "Kenya" a enregistré le plus bas. Il y avait une différence notable dans l'abondance et la diversité des insectes entre les stades de croissance des plantes. Le Stade de floraison a enregistré le nombre maximum d'espèces individuelles. L'insecte ravageur Helicoverpa armigera était une préoccupation majeure causant des dégâts considérables au carthame. Cheilomenes lunata, Apies mellifera, spider et Formicidae sp.1 ont été signalés comme insectes bénéfiques. Les feuilles et les capitules étaient les parties les plus touchées du carthame. L'humidité relative et la température ont influencé de manière significative ($P < 0,05$) la population d'insectes ravageurs; une augmentation de la température a augmenté la population d'insectes ravageurs tandis qu'une augmentation de l'humidité relative a diminué la population d'insectes ravageurs.

Mots-clés: Capitula, génotype, espèce, richesse spécifique, régularité spécifique

Introduction

Safflower (*Carthmus tinctorius* L.) is an important multi-purpose oil seed crop (Emongor *et al*., 2015). Safflower is a potential alternative crop in regions where water scarcity is a major factor limiting agricultural productivity (Bhattarai *et al*., 2020), thus making it an ideal crop for Botswana. According to Weiss (2000), insect pests contribute a major share in the reduction of safflower yield. Some insect pests are widespread while others are confined to certain regions and climates (Weiss, 2000). The key insect pests attacking safflower include *Acanthiophilus helianthi* (Rossi), *Helicoverpa armigera* and *Uroleucon carthami* (Hanumantharaya *et al*., 2008). Some of these pests have been reported in Botswana (Obopile and Mosinkie, 2007). Mehdi *et al*. (2012) identified *Acanthiophilus helianthin*, *Chaetorellia carthame*, *Trellia luteola*, *Larinus flavescens*, *Larinus liliputanus* and *Helicoverpa peltigera* as insects pests feeding inside the flower head (capitula) of safflower. According to Saeidi and Adam (2012), *Oxycarenus palens* and *Oxycarenus hyalipennis*, aphids, thrips and dermestid beetles fed on the outside of safflower capitula. Identification of insect pests and their natural enemies can give crucial information for pest management. This study was undertaken to investigate diversity and abundance of different insect pests attacking different safflower genotypes in Botswana, determine suspectable plant parts and plant growth stages, and to establish the relationship between safflower pests and abiotic factors.

Materials and Methods

A study was carried out in a famer's field in Molepolole in Botswana. The experiment was a randomized complete block design with five safflower genotypes as treatments ('Gila', 'Sina', 'Turkey', 'PI-537636' and 'Kenya-9819') replicated three times. The whole experimental field was 17 m by 15 m. Hand sowing was done on 9th October 2020.The experimental plots were subjected to natural infestation hence no insect control was done. Ten plants were randomly selected and tagged. Visual counts and collection of insects was done twice per week between 8:00-11:00AM from plant emergence until the plants reached physiological maturity. Plant part infested and growth stage of the plants were recorded. Temperature, relative humidity, and rainfall were recorded. Pest specimens were collected by hand-picking and sweep net from plant canopy. The specimen was killed in ethyl acetate, pinned, and dried in the oven at 40^{o}C for 72 hours. Collected larvae were reared to adult stage before identification. General morphological descriptions of insect pests were done under microscope and magnifying glass. The samples were identified using a dichotomous key and books.

Data collected were subjected to SAS 9.4 for analysis of variance (ANOVA) and Least Significant Difference (LSD) test at P= 0.05 was used to determine variation in insect abundance between genotypes, plant growth stages and days after emergence. Correlation and regression analysis were used to determine the relationship between individual species abundance and abiotic factors. The Shannon- Weaver Index (H'), Simpson Index, species Richness and Species Evenness were computed to determine arthropod diversity.

Results and Discussion

A total of 3374 insect specimens from 13 species belonging to eight arthropod orders were collected from five safflower genotypes for 13 weeks. The eight orders were Coleoptera, *Orthoptera*,

Diptera, Hemiptera, Hymenoptera, Lepidoptera, Thysanoptera and Araneae. Among them, nine species were pests while 3 and 1 species were predators and pollinator, respectively. The most abundant species were Thrips tabaci (n = 1914), *Amarasca biguttula biguttuala* (n = 674) and *Calidea panaethiopica* (n = 352). Abundance of other species were recorded in descending order as, *Helicoverpa armigera* (n = 160) < Tephritidae sp.1 (n = 65) < Formicidae sp.1 (n = 47) < Spilosthethus pandurus (n = 41) < *Elasmuch grisea* (n = 39) < *Curculionidae* sp.1 (n = 26) < Apis mellifera (n = 21) < *Zonocerus elegans* (n = 19) < Spiders (n = 12) < *Cheilomenes lunata* (n = 4). Mehdi *et al*. (2012) reported similar safflower insects in Iran. There was no significant (F 2,4 =0.6, P= 0.6710) difference observed in individual species among genotypes. Maximum insect population was observed on the genotype 'Gila' followed by 'Turkey', 'Sina', 'PI-537636' and 'Kenya-9819'. Individual species significantly (F2,12=9.61, P=0.0001) differed over days after plant emergence. Individual species were more abundant 81 days after plant emergence (week 10) while the lowest abundance was observed 91 days after plant emergence (week 11). Javed *et al*. (2013) found that population of *Amrasca biguttula biguttula* and *Helicoverpa amirgera* on safflower significantly differed among dates after plant emergence and not significantly different among genotypes. Significant (F 2,5 =20.06, P=0.0001) difference of individual species was observed between safflower growth stages (Figure 1). Numerically, individual species were more abundant at flowering stage (n = 1909) and lowest at elongation (n = 102) (Figure 1). Sousa-Souto *et al*. (2018) reported that high nitrogen content in the plant increased nutritional quality of plants making them more susceptible to insect pests.

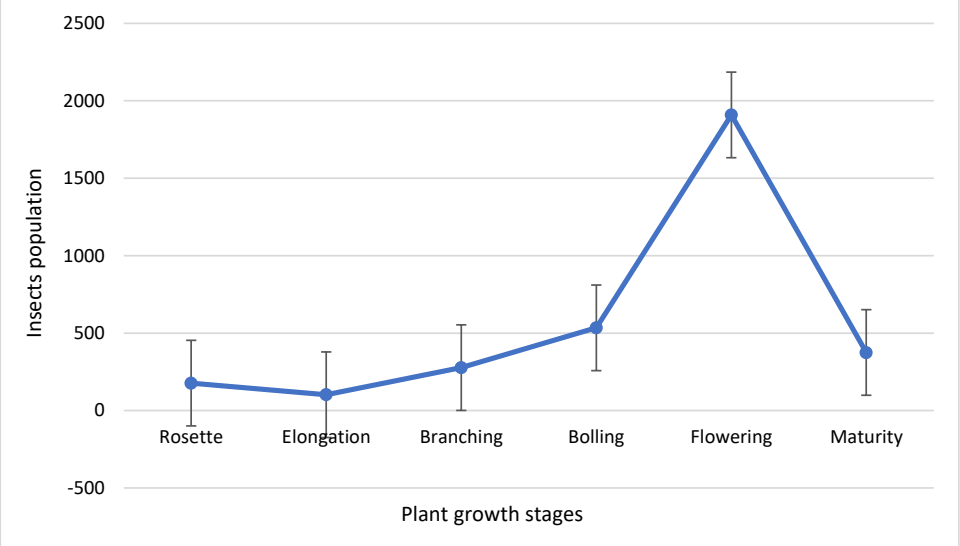

Figure 1. Insects population density over Safflower growth stages

Insect pests attacked all parts of safflower with exception of the stem. H*elicoverpa armigera, Spilosthethus pandurus, Elasmuch grisea, Calidea panaethiopica, Zonocerus elegans, Thrips tabaci* and *Tephritidae* sp.1 fed on the outside of capitula. *Spilosthethus pandurus, Helicoverpa armigera, Zonocerus elegans, Thrips tabaci* and *Curculionidae* sp.1 fed on the inside of the capitula. *Amarasca biguttula biguttula, Helicoverpa armigera, Curculionidae* sp.1, *Thrips tabaci*, *Tephritidae* sp.1 and *Calidea panaethiopica* fed on safflower leaves. The major insect pest of concern was *Helicoverpa armigera*, which caused prominent damage. At rosette and elongation

stages, the larvae of *Helicoverpa armigera* fed on the leaves resulting in perforation. At bolling stage the larvae of *Helicoverpa armigera* fed on bracts and bored into the developing capitula leaving perforated bracts and partially eaten capitula. All other pests were considered as minor. Saeidi *et al*. (2011) in Iran reported that insect pests consumed almost every part of safflower plants including leaves, shoot tips, and capitula.

The highest insect pest diversity index of 1.49 was recorded 66 days after plant emergence (week 8), while the minimum insect pest diversity index of 0.18 was recorded 81 days after plant emergence (week 10). The results of the present study depicted a weak positive correlation between insect pest population and temperature (r = 0.32) and a very weak negative correlation with relative humidity (r = -0.08). Low relative humidity and temperature has been reported to delay development of eggs and larvae, reduce egg hatching and larval survival as compared to high relative humidity and temperature (Guarneri *et al*., 2003; Han *et al*., 2008; Norhisham *et al*., 2013).

Conclusion

Results of this study showed that insect pests occurred in all safflower genotypes, but severity differed with time after plant emergence and stage of development. *Helicoverpa armigera* was found to have potential to be a major pest of safflower in Botswana.

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