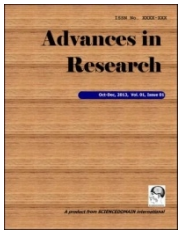

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Parasitization of *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*) by four Indigenous *Trichogrammatid* Species/Strains in a Mixed Cropping System of Tomato and Okra

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SS and AK conceived and designed the study. Author SH fine-tuned the methods. Author AK performed the experiments, analyzed the data and wrote the first draft while JMM managed literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Egg parasitoids, *Trichogramma* are recognised as natural enemies of many lepidoptera pests worldwide. In Kenya, a number of indigenous parasitoids species have been recovered. We evaluated the relative preference (parasitism) by four *Trichogrammatid* egg parasitoid species/strains, namely, *T*. sp. nr. *mwanzai* (L), *T*. sp. nr. *lutea* (H), *T*. sp. nr. *mwanzai* (M) and *T*. sp. nr. *lutea* (M) for the African bollworm *Helicoverpa armigera* on two of its host plants, tomato and okra usually intercropped in smallholder farms in Kenya.
Study Design: Host parasitism on host plants.
Methodology: Evaluations of parasitism for *H. armigera* by *Trichogrammatid* species/strains on Tomato and Okra in bioassays in both laboratory and field cages, in choice and no-choice conditions were undertaken.
Results: In general, species/strains exhibited significant differences in parasitism for the host (F=2.8; df =3, 7; P= 0.05) but neither the host plant nor host plant x species/strain

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interaction affected parasitism. Chi-square analyses showed no significant preference by species/strains between the two host plants although there was greater tendency by the parasitoids to go for *H. armigera* on okra than tomato.
Conclusion: The results give useful insights in planning for augmentation biological control of *H. armigera* in mixed farming agroecosystems. The four *Trichogrammatids* could effectively be used in augmentation programs in the tomato-okra cropping systems.

Keywords: Trichogramma; host plant; preference; biological control; mixed cropping.

1. INTRODUCTION

Vegetables are a major component of the horticulture sub sector, a very important agricultural enterprise in many countries in Africa. They are not only important for improving food security and nutrition but also provide a source of income when sold in domestic and export markets. Vegetables are also a source of employment among producers, mainly the rural communities. Tomato and Okra are regarded as high value vegetable crops in Kenya grown by smallholder farmers in a mixed cropping system. Other vegetable crops of major importance include cabbage, onions, kale; french beans and the usually neglected but highly nutritious indigenous leafy vegetables such as African night shade and amaranth.

Pests are a major constraint in vegetable production. In tomato and Okra agrosystems, pests include whiteflies, aphids, mites, thrips and bollworms. The biggest threat to such vegetable crops is the African bollworm *Helicoverpa armigera* (*Lepidoptera: Noctuidae*), a polyphagous pest in many economically important crops and whose larvae burrow into the fruit thereby causing damage and loss to the farmers.

Egg parasitoids of the genus *Trichogramma* (Hymenoptera: *Trichogrammatidae*) are very important natural enemies of many Lepidoptera pests in agriculture and forestry [1]. More than a 100 species are known worldwide and they are regarded as effective natural enemies of various insect pests [2,3]. In Kenya, several indigenous *Trichogrammatid* collections have been made and species identified [4]. Evaluations of indigenous species for climatic adaptation to a range of conditions prevalent in Kenyan agroecologies have been made and best strains/species of *Trichogrammatids* selected for augmentation biological control of *Lepidopteran* pests of vegetable crops in Kenya [5]. Indigenous species are usually more effective against target pests and more tolerant of environmental conditions of their host than exotic species [6].

The host plant is an important factor that may influence the parasitoid's host selection and therefore effectiveness in biological control [7,8].

In this study, we evaluated the performance (parasitism) of four indigenous *Trichogrammatid* species/strains for parasitizing the host *H. armigera* on two host plants Tomato and Okra in laboratory and field studies. These studies are necessitated by the need to maximise the impact that these natural enemies may exert if released in augmentation programs in mixed cropping systems of tomato and okra in Kenya.

2. MATERIALS AND METHODS

2.1 Parasitoid Species

Four indigenous *Trichogrammatid* species/strains collected from Kenya namely, *T*. sp. nr. *mwanzai* (L), *T*. sp. nr. *lutea* (H), *T*. sp. nr. *mwanzai* (M) and *T*. sp. nr. *lutea* (M)) were used in this study . The four species/strains were selected based on their relatively high performance, adaptation to climatic extremes and higher reproductive rates [5]. The species/strains were reared on the grain moth *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) prior to the experiments and maintained at 25°C and 70-80% RH at the Institute for Biological control (BBA), Darmstadt, Germany.

2.2 Bioassay

To evaluate relative preference (parasitism) for the host *H. armigera*, *Trichogrammatids* were offered to the host in choice and no-choice experiments on the two host plants, tomato and okra in laboratory and field cages.

To determine if the parasitoids showed preference between tomato and okra in the laboratory, 30 eggs of *H. armigera* were placed singly on fresh leaves of the two host plants in a petri dish (7 cm diameter by 2 cm height). The leaves were placed such that okra leaves covered half of the petri dish, while tomato leaves covered the other half. The leaves were of the same age. A single one-day-old naïve *Trichogrammatid* female was then released in the center of the petri dish. The petri dish was then kept in an environmental chamber at 25°C and 70-80% RH. Seventeen replicates were made. After 24h, the female parasitoid was killed and eggs monitored for blackening. Five days after exposure, the number of parasitised (black) eggs was counted under a stereo compound microscope. In the cage experiment, potted plants of Okra and tomato were placed in glass cages (48 cm length x 65 cm width x 100 cm height) at BBA, Darmstadt, Germany. Eggs of *H. armigera* (30) were glued to the leaf surfaces of the plants using traganth-pulver (adhesive gum). The eggs were placed at equal distances from each other. Female parasitoids (one day old) were then released into the cage in a ratio 1:1 to the host eggs. After 24 h, parasitoids were killed and eggs on plants observed for blackening.

2.3 Data Analysis

Two-way Analysis of Variance (Proc GLM [9]) was used to examine main effects (Species/strains and host plant) and their interactions on parasitism performance. Choice comparisons of the number of eggs parasitized by each species/strain on okra and tomato were analysed using Chi-square [9].

3. RESULTS

In the laboratory, parasitism was significantly affected by strain (F=2.8; df=3,7; P=0.05), while host plant and its interaction with strain did not (F=0.7; df=3,72; P=0.42 and F=0.2; df=3,72; P=0.91, respectively). Levels of parasitism of *H. armigera* by the four-*Trichogrammatid* species/strains on the two plants were variable (Fig.1).

Choice tests in the laboratory showed significant preference for okra to tomato by *T*. sp. nr. *mwanzai* (L) (X^2 = 0.11.6; P =0.001). The other strains did not show significant preference

between the two plants (X^2 = 0.1; P =0.8 for *T*. sp. nr. *lutea* (H); X^2 = 1.5; P = 0.3 for *T*. sp. nr. *mwanzai* (M) and X^2 = .5; P =0.5 for *T*. sp. nr. *lutea* (M)). Similarly, in the field cages, there were no significant differences in parasitism between Okra and tomato among the four species/strains (X^2 = 0.6; P =0.4 for *T*. sp. nr. *mwanzai* (L); X^2 = 0.3; P =0.1 for *T*. sp. nr. *lutea* (H); X^2 = 0.4; P = 0.5 for *T*. sp. nr. *mwanzai* (M) and X^2 = 1.7; P =0.2, respectively).

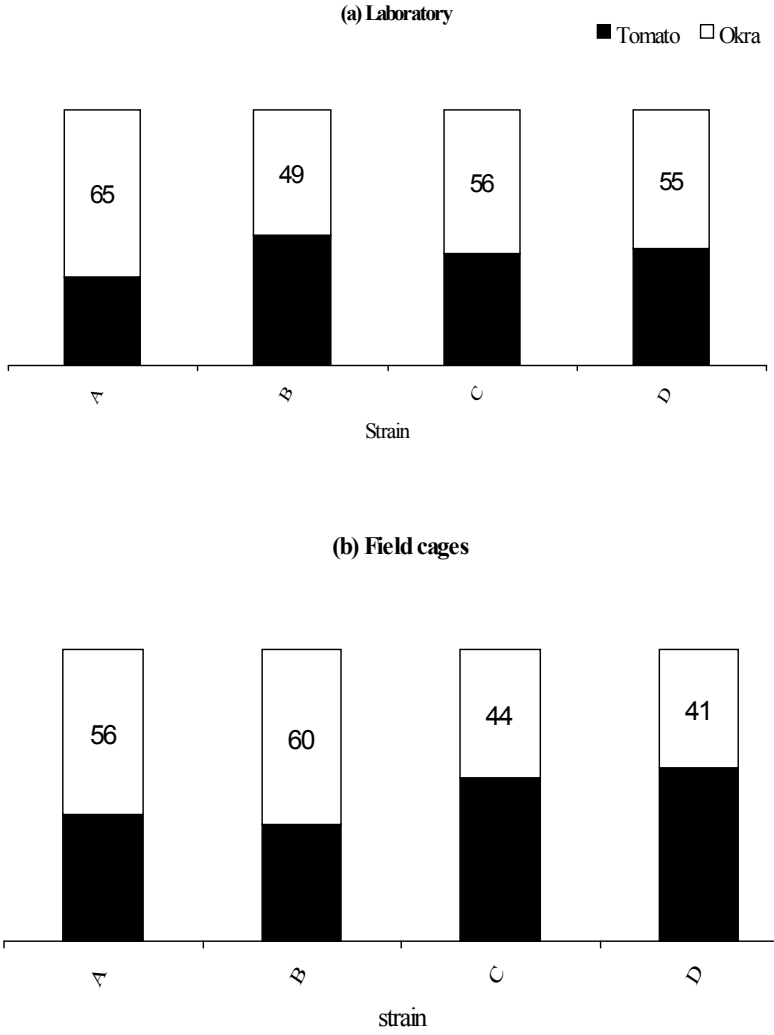

Fig. 1. Relative choice preference (% parasitism) of *H. armigera* on tomato and okra by four *Trichogrammatid* species/strains in the laboratory and field cages. Strains-A = *T*. sp. nr. *mwanzai* (L), B =*T*. sp. nr. *lutea* (H), C =*T*. sp. nr. *mwanzai* (M), D = *T*. sp. nr. *lutea* (M)

4. DISCUSSION

The role of the plant in mediating the ecological interactions between host insect and its parasitoids has long been recognized [7,8,10]. *Trichogramma* are known to be more habitat

specific than host specific and the host plant is one important factor that may influence the parasitoids host selection [11,12].

In the present study, there was no significant difference in parasitism for the host insect *H. armigera* on the two host plants by the *Trichogrammatid* species/strains evaluated. Although *T*. sp. nr. *mwanzai* (L) parasitized more hosts on okra than tomato in the laboratory, field cage experiments indicated no significant differences in parasitization between the two host plants by all four *Trichogrammatids*. Generally, field experiments tend to be more reliable compared to laboratory studies since conditions are more realistic. The unique behavior of *T*. sp. nr. *mwanzai* (L) in a laboratory study does indicate that indeed some individual species behavioral differences do occur within the group, as exemplified by the significant effect of species/strain on parasitism for the host. Nevertheless, between the two host plants, there was greater tendency by the parasitoids to go for *H. armigera* on okra than tomato. In choice studies, Abera found *T*. sp. nr. *mwanzai* to have stronger preference for maize plant than for tomato when offered in choice tests [4]. The tendency for a lower parasitism in tomato may be the result of a relatively higher density of hairs on tomato than okra, which may constrain effective movement of parasitoids. Many authors recognize that physical/morphological features of plants such as dense trichomes [13,14], waxy leaves [15,16], leaf surface area [17] and complex plant structure [18] have all been shown to reduce the effectiveness of predators or parasitoids. Other authors have found an interactive effect between parasitism and plant structure on foraging behavior when they found *T. evanescens* and *T. pretiosum* to perform better on cabbage (simple structure) than Brussels sprouts [19]. The lack of significant preference by many of *Trichogrammatid* species/strains tested may also mean that these indigenous species are more generalist than specialist. Original host records indicate that the *Trichogrammatids* were recovered from *H. armigera, Chilo partellus* on maize and the Diamondback moth *Plutella xylostella*, whose host plant range is equally wider [4]. Since egg parasitoids rely on sex pheromones and plant volatiles to detect presence of host eggs on plants [20,21,22], we may also assume that the differences in plant odors from the two plants are smaller than wide [23], although this will require further investigation.

5. CONCLUSION

In a mixed cropping system of Okra and tomato, the four *Trichogrammatids* can be used effectively well although they will have a greater tendency to okra. The results give useful insights in planning for augmentation biological control of *H*. *armigera* in mixed farming agroecosystems

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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