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CHEMICAL CONTROL OF FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE) UNDER FIELD CONDITIONS

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ABSTRACT

Maize holds significance as a primary staple crop and is ranked third in global production. Many factors affect the yield of this crop, but the most important problem is insect pests. Fall armyworm (FAW) is a very destructive pest of maize. This study was conducted to check the effect of some synthetic insecticides (monomehypo, lambda cyhalothrin, emamectin benzoate, chlorpyrifos and carbofuran) against FAW in the maize field. The study was organized using a randomized complete block design, and it included three replicates. The insecticidal sprays were applied twice, and the data regarding FAW mortality were recorded after 3, 7 and 10 days. The maximum mortality was recorded as 75% with monomohypo after 10 days of the first application, while the minimum mortality (49%) was observed due to emamectin benzoate application after first spray with same time intervals. The other insecticides showed 68%, 65% and 58% FAW mortality due to chlorpyrifos, lambda cyhalothrin, and carbofuran applications, respectively. It concludes that monomehypo was the best insecticide against FAW in maize crop.

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INTRODUCTION

Agriculture holds a pivotal position in Pakistan's economy, contributing significantly to the uplifting of country's economy. Maize is the highest yielding crop after wheat, rice, cotton and sugarcane. Maize is enriched with essential nutrients including fatty acids, sugar, protein and vitamins. Maize products are used in the form of oil for humans, fodder for animals and as a byproduct in poultry feed. Maize flourishes in soil within the pH range of 6.5–7.5. It serves as a rich source of nutrients, including proteins (10%), starch (72%), fatty acids (10%), vitamins (3-5%), and sugar (3%) (Adnan and Bilal, 2020). Maize cultivation spans 1.3 million hectares across varied ecologies, spanning from 30 meters above sea level in all provinces of Pakistan. Reports indicate that Khyber Pakhtunkhwa (KPK) contributes 56%, Punjab contributes 39%, while Sindh and Baluchistan collectively contribute 5% to the total

cultivation area (Qadir et al., 2013). Yield of maize crop in Pakistan is very low as compared to other countries due to attack of insect pests and diseases. Various pests affect maize throughout its growth stages, from cultivation to harvesting. These include *Spodoptera* species, maize borers, jassid, and shoot fly. Amongst, *Spodoptera frugiperda* has garnered significant attention due to its capacity to inflict substantial losses (Ferdu et al., 2002; Gondal et al., 2021a; 2021b, 2022).

The fall armyworm (*Spodoptera frugiperda* Smith) is an invasive and destructive pest that originated in America and Mexico but has now established a global presence. The FAW was first reported in African regions like Benin, Togo, and Nigeria (Goergen et al., 2016; Chormule et al., 2019; Nagoshi et al., 2019). Later on, the pest spread to various Indian states and then to many Asian countries. The presence of the fall armyworm has also reported in Pakistan during the recent past (Day et al., 2017; Sisay et al., 2019). The last three larval stages of the fall armyworm are particularly voracious, consuming 98% of the maize produce. During their feeding, fall armyworms (*S. frugiperda*) exhibit a tendency to consume virtually all parts of the plant, with a notable preference for the reproductive components, particularly during the final instar stage. At whorl stage of maize crop, the larvae typically live inside the whorl and feed on leaves and stem. Feeding suppresses tassel formation during the late whorl stage or improperly encourages it. Larval injury to the cob silk diminishes the likelihood of pollination or reduces number of kernels per ear. FAW larvae also target the cob, deteriorating it by tunneling and consuming the kernels. Their feeding near the ear base weakens the cob's attachment site. After feeding, the leaves exhibit irregular white markings and a mesh-like appearance due to their chewing mouth parts, encouraging fungal growth (Ali et al., 1990; Acharya et al., 2020). This species poses a significant threat to food security in Pakistan, necessitating the development of an effective and comprehensive management strategy to control this notorious and destructive pest. Keeping in view the threat of FAW to maize production in Pakistan, this study aimed to control this formidable pest using a variety of insecticides.

MATERIALS AND METHODS

The research took place during the maize growing season of 2022 in a field area situated at Punjab University, specifically at Behkwal Mor, Lahore. The experimental area covered 20 marlas (equivalent to 1 kannal). Throughout the study duration, all the necessary agronomic practices, including cultural, physical, and mechanical approaches, were meticulously maintained. The field efficacy evaluation of various insecticides against fall armyworm was designed using a randomized complete block design. The insecticides evaluated were lambda cyhalothrin, chlorpyrifos, emamectin benzoate (emulsified concentration), carbofuron and monomehypo (granular). Each treatment was replicated three times. Spraying was performed using a manually operated hand knapsack sprayer equipped with a hollow cone nozzle. Each treatment underwent two spray applications during each planting date. The first spray was administered at a 15-day interval from the date of sowing, followed by the second spray at a 15-day interval after the first spray.

Data for percent larval mortality recorded from field trials were subjected to a one-way analysis of variance (ANOVA) by keeping insecticide as the main factor. Means were separated by using Tukey's honest significant difference test ($P \leq 0.05$). All the analyses were carried out using the Statistix 8.1 software.

RESULTS AND DISCUSSION

The mortality of fall army worm larvae was significantly influenced by different pesticides ($F_{5,17} = 7364.55$, $P = 0.0000$). Among the five pesticides tested, varied levels of mortality were observed against fall armyworm larvae. Monomehypo exhibited the maximum control (36%) followed by chlorpyrifos (29%), lambda cyhalothrin (26%), carbofuran (18%) and the lowest by emamectin benzoate (10%). This trend was consistent across multiple experiments, demonstrating the effectiveness of these pesticides in controlling fall armyworm larvae (Figure 1).

The effect of different pesticides on fall armyworm larval mortality remained significant across various trials ($F_{5,17} = 6869.91$, $P = 0.0000$). Monomehypo consistently showed the highest mortality (ranging from 55 to 71%) among the pesticides tested, followed by chlorpyrifos, lambda cyhalothrin, carbofuran, and emamectin benzoate, respectively. The mortality rates for these pesticides were as follows: chlorpyrifos (48 to 64%), lambda cyhalothrin (45 to 61%), carbofuran (38 to 54%), and emamectin benzoate (30 to 46%). These results are illustrated in Figure 2; emphasize the potency

of monomehypo in effectively managing the fall armyworm larvae across varied experimental conditions.

Previously, management of fall armyworm has been done using different management methods including the use of insecticides, biocontrol agents, and pheromone traps in various field trials. In the present study, efficacy of five insecticides was evaluated against this pest. Synthetic pesticides are considered critical management options for the fall armyworm (Ramzan et al., 2021; Sisay et al., 2019). In regions like Mexico, chlorpyrifos, phoxim, methamidophos, and methyl parathion are employed for chemical control of the fall armyworm. To combat this pest, various chemical insecticides are regularly applied to sweet corn three to four times every week in the USA. The fall armyworm poses a significant challenge to maize in Florida, and insecticides are employed to safeguard the crop at various growth stages (Sisay et al., 2019).

Table 1: Detail of insecticides used and treatment allocation.

Treatments	Trade name	Active ingredient	Dose	Formulation
T_1	Karate®	Lambda cyhalothrin	200 mL ac^{-1}	2.5% E.C
T_2	Chlorpyrifos®	Chlorpyrifos	1000 mL ac^{-1}	40% EC
T_3	Emamectin®	Emamectin benzoate	2000 mL ac^{-1}	1.9% EC
T_4	Furadon®	Carbofuran	8 kg ac^{-1}	Granules
T_5	Monomehypo®	Monomehypo	7 kg ac^{-1}	Granules
T_6	Control	-	-	-

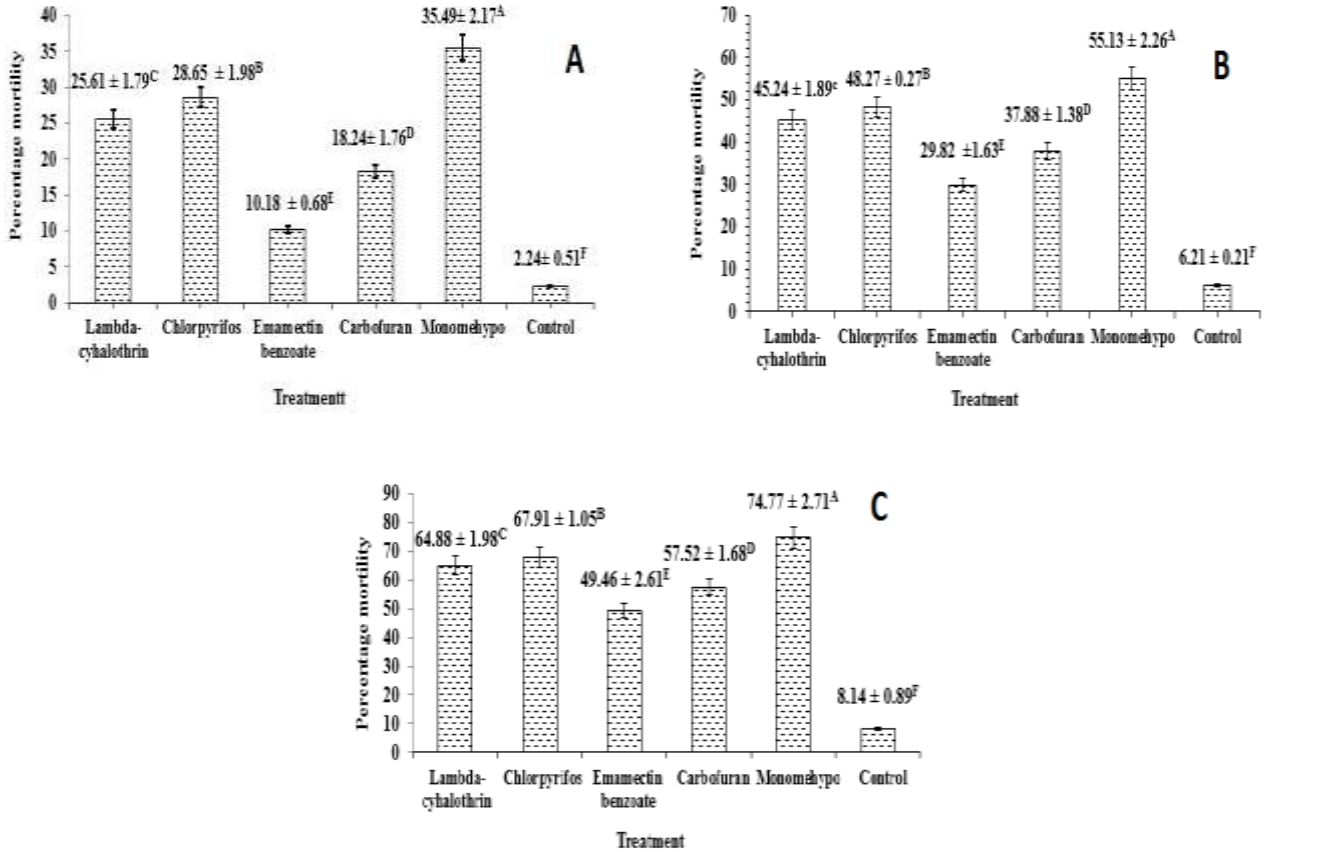

Figure 1: Percentage mortality of 3rd instar larvae of fall army worm, (*Spodoptera frugiperda*) against different insecticides after 1st application (A = 3 days; B = 7 days, 10 days post treatment intervals)

All the tested insecticides effectively reduced pest population. As the dose of insecticides increased, the mortality percentage also increased. Similar findings have also been reported by Deshmukh et al. (2020) who

reported that emamectin benzoate and lambda cyhalothrin induced significant mortality in fall armyworm population in field trials. The treatments were applied twice, and data on mortality were collected after 3, 7, and 10 days post-application. The findings revealed that the maximum mortality (75%) of fall army worm was recorded in the plots treated with monomehypo after 10 days post-application, while the minimum mortality (49%) of fall armyworm was recorded in the treatment with emamectin benzoate at the same time intervals. The rest of the insecticides showed mortality (ranging from 68% to 58%) of fall army worm, following the order of chlorpyrifos, lambda cyhalothrin, and carbofuran, respectively.

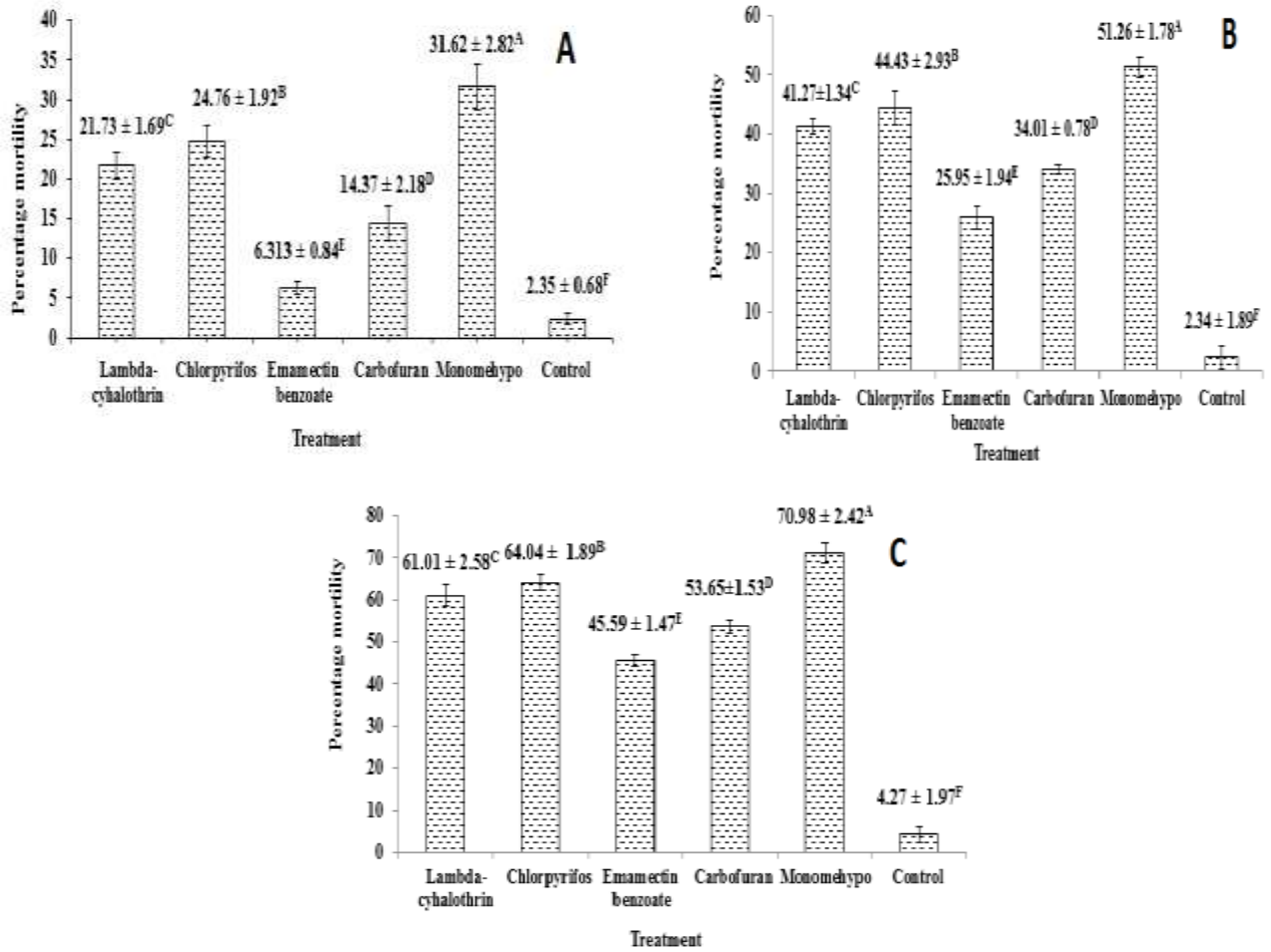

Figure 2: Percentage mortality of 3rd instar larvae of fall army worm, (*Spodoptera frugiperda*) against different insecticides after 2nd application (A = 3 days; B = 7 days, 10 days post treatment interval.

Hardke et al., (2011) reported that population of immature stages of fall armyworm was significantly reduced to 3 to 6% when treated with different insecticides. They reported that only lambda cyhalothrin resulted in 40% larval control. Similarly, according to Nagoshi et al. (2017), insecticides significantly reduced borer infestation in pomegranate orchards. In an experiment, Raghunandan et al. (2019) reported that insecticides like spinosad, methomyl and carbaryl were proved highly effective against fall armyworm after 15 days of post treatment application.

The present study concludes that monomehypo is the most effective insecticide against fall armyworm followed by chlorpyrifos and lambda cyhalothrin.

AUTHORS' CONTRIBUTION

SA and MU conceived the idea and designed the study; MU performed experiments and collected the data; MI

and AJ prepared graphs, carried out statistical analysis, participated in manuscript writing and did final editing of the work, SA and AHS helped in organizing the data; SA supervised the work; AJ co-supervised the work.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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