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Effect of Dichlorvos against Fall Armyworm (*Spodoptera frugiperda* J. E. Smith) (Lepidoptera:Noctuidae)

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Abstract: Fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith) is one of the most destructive pests in tropical and subtropical regions of world and is introduced to Indian subcontinent, causing substantial damage on variety of crops. Considering the necessity of developing pest management strategies we made an attempt to evaluate the effect of insecticide dichlorvos against Fall Armyworm (*Spodoptera frugiperda*) under laboratory conditions. Our investigation revealed the toxic effects of dichorvos against third instar larvae of FAW. Dichlorvos is found to be effective against the pest.

Keywords: Fall armyworm, Mortality, Dichlorvos, Third instar larvae

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Introduction

Maize is third widely grown crop in India after rice and wheat. Maize often found infested by many insect pests like stem borer, stem fly, pink stem borers and aphids. Among them, recently introduced invasive pest fall armyworm (FAW), (*Spodoptera frugiperda* (J. E. Smith); Lepidoptera: Noctuidae) is found most destructive, causing substantial damage to all stages of the host plant (Koffi *et al.*, 2020). FAW is native of tropical and subtropical regions of America and also introduced in Africa (Day *et al.*, 2017) causing severe food insecurity. In India it was reported from Karnataka (Ali *et al.*, 1990), soon spread to all southern states of India including Maharashtra (Andrews, 1990; Belay *et al.*, 2012). FAW has been reported highly polyphagous and attained ability to infest wide variety of field crops and vegetable crops (Daves *et al.*, 2009).

The initial larval instars of FAW cause damage by feeding (scratching) on the foliage, whereas the later instars feed on the growing point of plant which causes dead heart symptoms. When FAW infests the older plants they feed on maize cob and kernels which leads to drastic reduction in yield and quality of the production (Capinera, 2017, Ganiger *et al.*, 2018). Chemical control of insect pests is one of the commonest methods to combat the infestation of pests. Insecticides are popular among the farmers because of their quick action and recovery of infected plants. Cotton is one of

the hosts of FAW, and its control on cotton is difficult with insecticides. Larvae are usually distributed low in the plant canopy (Malo *et al.*, 2004), and inadequate insecticide deposition in the lower portions of the cotton plant seems to be one limiting factor in controlling this pest (Mink and Luttrell, 1989). Insecticides that are used to control the tobacco budworm, *Heliothis virescens* (F.), and the cotton bollworm, *Helicoverpa zea* (Boddie), often are ineffective against fall armyworms (Prasanna *et al.*, 2018).

Dichlorvos is effective against mushroom flies, aphids, spider mites, caterpillars, thrips, and whiteflies in greenhouses and in outdoor crops. It is also used in the milling and grain handling industries and to treat a variety of parasitic worm infections in animals and humans. It is fed to livestock to control botfly larvae in manure. It acts against insects as both a contact poison and an ingested poison. It is available as an aerosol and soluble concentrate. It is also used in pet flea collars and "no-pest strips" in the form of a pesticide-impregnated plastic; this material has been available to households since 1964 and has been the source of some concern, partly due to misuse. In this study, an attempt to evaluate the effect of insecticide dichlorvos against Fall Armyworm (*Spodoptera frugiperda*) under laboratory conditions.

Materials and Methods

Insect Rearing:

Rearing was initiated using the larvae collected from maize fields of College of Agriculture, Kolhapur, India. The collected larvae were reared in the laboratory at 22±3 C and 70±5 % RH. The larvae were fed with fresh and healthy maize leaves in the rearing chamber. Pre-pupal state were identified and displaced to plastic container containing three-fourth of solarized soil. Subsequently, plastic containers were covered with black cloth for pupation. Emerged adults were provided with 10% honey solution soaked cotton. Fresh maize leaves were provided every day for egg deposition. The laid eggs were collected on daily basis and kept for incubation at 38 C. Third instar larvae of this generation were used for bioassay.

Preparation of insecticide solutions:

Insecticide (Dichlorvos 76% EC) was purchased from local market. Different concentrations of insecticide (Dichlorvos 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 and 5%) were prepared using distilled water.

Bioassay:

Third instar larvae were used to perform bioassay. 10 µl of each concentration of dichlorvos were separately applied topically using micropipette on each larva. Further, the larvae were transferred to a plastic container provided with fresh leaves of maize. Only one larva was allowed in each container to avoid cannibalism which is very common in this species. Mortality was observed at 24, 48 and 72 h and results were recorded. Ten replications were carried out for each test solution.

Results and Discussion

Table 1 displays the effect of Dichlorvos on the mortality of 3rd instar larvae of fall armyworm. The 3rd instar larvae of FAW are quite resistant to lower concentration of dichlorvos. Dichlorvos at 0.5 and 1.0% caused no lethal effect till 72 h after treatment, but 1.5% caused 50% mortality at 72 h. Dichlorvos at 4.5 and 5% was very toxic against larvae which caused 70 and 73% mortality within 24 h, and 90 and 100% mortality at 72 h after application, respectively.

In this study, Dicholvos was found to be toxic to 3rd instar FAW larvae. In the laboratory bioassays, moderate to high larval mortality was achieved with Dichlorvos. It was noted that in the laboratory trials, the per cent larval mortality increased over time after insecticide application, which indicate residual toxicity of the synthetic insecticides to FAW. As is common with other insect pest species, synthetic insecticides are important management options in FAW control in the America (Andrews, 1990). In Mexico, chemical

Table 1: Bio-efficacy of Dichlorvos against third instar larvae of FAW

Concentration (%)	Mortality (%)		
	24 h	48 h	72 h
0.5	0	0	0
1.0	0	0	0
1.5	0	10±4	50±4
2.0	15±5	18±5	33±5
2.5	27±3	30±3	35±3
3.0	53±3	65±3	73±3
3.5	55±5	57±4	57±5
4.0	55±4	85±5	90±5
4.5	70±5	85±4	90±5
5.0	73±5	92±5	100±0

Values are mean ± SE of 10 replicates

control of FAW in maize is achieved by the application of methyl parathion, methamidophos, and phoxim, among other synthetic insecticides (Ganiger *et al.*, 2018). In Florida, FAW is one of the most important sweetcorn pests, and synthetic insecticides are applied against FAW to protect both the vegetative stages and reproductive stage of corn (Capinera, 2017). Several insecticide applications are required to kill larvae feeding deep in the whorl of plants. Some of the synthetic insecticides reported by those authors corroborate the findings of the present study. Kondidie (2011) reported >60% FAW mortality 16 h after application of Radiant, Orthene, and Larvin. In another study, Intrepid 2F, Lannate 2.4LV, Sevin XLR Plus 4F, and Tracer 4SC effectively reduced FAW larvae under fulfilled conditions (Daves *et al.*, 2009). Hence, sprayings should be spaced evenly during the growing period instead of concentrated at the silking period (Sisay *et al.*, 2019).

Although synthetic insecticides are effective to control FAW, in Africa the increased risk to human health due to a lack of appropriate safety precautions is a major concern about synthetic insecticide use (Day *et al.*, 2017). Resistance management is likely to be successful when combined with routine monitoring of pests, use of reasonable treatment thresholds, and the full use of non-pesticidal methods, such as biological and cultural control, field sanitation, and host plant resistance. Judicious and appropriate use of synthetic insecticides is essential for the successful management of FAW and to sustain the increased productivity of maize in Africa. The recent invasion of FAW has alarmed governments of numerous African countries and caused them to deploy a massive pesticide spraying program as an emergency response in FAW affected areas, mainly to maize fields to protect against crop damage and prevent the expansion of the pest. In Kenya and Ethiopia, it has been noted that farmers are applying different types of unregistered synthetic insecticides (Daves *et al.*, 2009), possibly because of the invasive nature of the pest, which requires a rapid response and a lengthy pesticide registration process.

In the present study, dichlorvos showed different levels of efficacy against FAW larvae. Development and deployment of an effective integrated pest management strategy, which can provide sustainable solutions to effectively tackle the adverse effects of FAW, is required. Lewallen and Wilder (1962) reported that dichlorvos (evidently active constituent added in acetone) was not lethal to either 1 week old or 1 month old fry of rainbow trout at 1 mg/l, but caused 100% lethality at 10 mg/l, can be an effective tool in Integrated Pest Management program of *Helicoverpa armigera*. On the basis of the present study, similar suggestion can also be given for dichlorvos for FAW.

Conclusion

It is very important to check the insecticide to exploit them in pest management programs; a pest like FAW has significant importance in several crops. In the present investigation it is apparent that all the three test insecticides are toxic to third instar larvae of FAW at different concentrations. Among the test insecticide dichlorvos comes first to control the pest at significantly low concentrations i.e. less than 1% under laboratory

conditions. Rest of test insecticides may need quite higher concentrations to kill the test insect larvae. Hence, it can be recommended to use dichlorvos

for pest management programs.

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