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# Field resistance of *Spodoptera litura* (lepidoptera : noctuidae) to newer chemistry insecticide indoxicarb in Vidarbha

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ABSTRACT

The present studies were carried out to evaluate resistance in the population of *Spodoptera litura* Fab. (Lepidoptera, Noctuidae) from eight districts of Vidarbha region in India to indoxicarb from 2011-2013 using standard leaf dip bioassay method. For indoxicarb, resistance ratio compared with a susceptible strain were in range of 2.66 to 6.14 fold. However, relatively low level of resistance to indoxicarb was observed in all eight populations.

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## INTRODUCTION

The tobacco leaf eating caterpillar, *Spodopteralitura* Fab. (Lepidoptera, Noctuidae) is a as a serious noctuid pest with high reproductive capacity and ability to migrate over a long distance in adult stage. In India it has attained the status of national pest, particularly notorious in most tobacco growing regions. However, in the last three and half decades, it has extended its host range to other crops such as cotton, soybean, mungbean, sunflower, cabbage and leafy vegetables, including groundnut (Maree *et al.*, 1999). *S. litura* has been shown to be resistant to a wide range of insecticides, which has led to sporadic out breaks of the pest and failure of crops (Ahmad *et al.*, 2007a). Groundnut yield losses up to 71 per cent have been reported in the irrigated tracts of Andhra Pradesh, Karnataka and Tamil Nadu, the southern states of India (Nair, 1986 and Amin, 1988). The control of *S. litura* has depended mostly on application of various chemical insecticides. The indiscriminate and extensive uses of insecticides in past few decades have led to development of resistance to against wide variety of insecticides including organophosphate, carbamate, pyrethroids and some selected newer chemistry insecticides with field control failure observed very frequently (Kranthi *et al.*, 2001 and Saleem *et al.*, 2008).

Resistance to insecticides is a major problem associated with the chemical control of insect pest which is characterized by rapid evolution under strong selection of gene(s) that confers survival to insecticides (Ahmad *et al.*, 2008). The development of resistance is a result of the selection pressure exerted on sprayed populations increasing the frequency of resistant individuals (Torres-Vila *et al.*, 2002). With high resistance to conventional insecticides, newer insecticide oxadiazine insecticide DPX- JWO62 (Indoxicarb) bearing novel mode of action was recently introduced for management of the pests. The extensive use of this newer insecticide against *S. litura* have provided an ideal environment for its evolution of resistance and *S. litura* was found to have inherent risks for resistance to indoxicarb (Wang *et al.*, 2009). Previous exposure and selection with insecticides can confer resistance to newly introduced insecticides through cross-resistance (Sayyed *et al.*, 2008), reducing the effectiveness of many new insecticides.

Following reports of poor efficacy of the newer chemistry insecticides against *S. litura*, in present investigation we surveyed resistance to the newer chemistry compound, Indoxicarb against *S. litura* from various districts of the Vidarbha region of India to ascertain whether or not the resistance was indeed evolving. The study is expected to be helpful in devising management strategies to overcome the resistance problems and to control *S. litura* under field conditions in the future.

## MATERIAL AND METHODS

**Insects :**

A laboratory susceptible strain of *S. litura* obtained by single pair crosses of a field – collected population of *S. litura* and reared in the laboratory for 10 generations without exposure to insecticides. For bioassay different populations of *S. litura*at fourth or fifth- instar larvae were collected from the field crops grown in different locations of Vidarbha from 2011 to 2013. The details of locations have been presented in Table A and depicted in Fig. A. The larvae collected were reared on semi-synthetic diet (Ahmad *et al.*, 2008) in the laboratory at (Temp : 25± 2ºC, RH :75 ± 5 % and photo period of 13 hrs light : 11 hrs darkness), in glass jars for two generations before the bioassay were carried out. Diet was replaced after 24 h and pupae were collected on alternate days. Moths were shifted to glass cages with mesh sides for ventilation and fed on a solution containing 10 per cent honey soaked onto cotton wool ball (Ahmad *et al.*, 2007b). The neonate larvae were fed with semi-synthetic diet. The field collected populations were reared in the laboratory to accommodate to laboratory conditions and to obtain sufficient insect numbers for bioassay.

**Preparation of insecticide solution :**

Indoxacarb 15.8 EC trade name Avaunt was used for the present investigation.

**Table A : Collection of *Spodoptera litura* larvae and egg masses from different locations of Vidarbha during 2011-12 and 2012-13**

| Sr. No. | Location |
|---|---|
| 1. | Akola |
| 2. | Amravati |
| 3. | Yavatmal |
| 4. | Nagpur |
| 5. | Washim |
| 6. | Buldhana |
| 7. | Wardha |
| 8. | Pusad, Dist. Yavatmal |

The insecticide solutions were prepared using the above commercial formulation which was diluted with distilled water. Fresh solution was prepared as and when required.

**Bioassays :**

Bioassays were conducted with newly third-instar larvae of *S. litura*using a standard leaf disk method (Ahmad *et al.*, 2007b). Serial dilutions of the test compounds were prepared. Castor leaves were cut into small 5 sq. cm. leaf disc and dipped into the insecticide solution for 10 s. These leaves were air dried at ambient temperature for 5-10 min by spreading on a towel paper. leaves were dipped in sterile distilled water only to use as controls. Leaves treated with insecticides were then transferred to each Petri dish lined with moistened filter paper. At least five concentrations and three replications (10 larvae per replication) were used to estimate each concentration mortality line thus, total numbers of tested larvae per concentration were 30. The bioassays were kept at a temperature of 25 ± 2ºC and 75 ± 5 per cent relative humidity, and photoperiod of 13:11 (light:dark). Mortality data were scored 24 hours till 76 hours after exposure for insecticides. Larvae were considered dead if they failed to make a co-ordinated movement when prodded with a brush.

**Data analysis :**

Data obtained were corrected for control mortality using Abbott's formula (1925) where necessary, and were analyzed by probit analysis through POLO-Plus (LeOra, 2003) to estimate $LC_{50}$ values and their 95 per cent fiducial limits (FLs). Resistance ratios (RRs) were determined as $LC_{50}$ values of field strain/ $LC_{50}$ values of susceptible strain.


**Fig. A : Sampling sites of *Spodoptera litura* (Fab.) field populations from Vidarbharegion during 2011-12 and 2012-13**

## RESULTS AND DISCUSSION

In present investigation efforts were made to monitor levels of indoxacarb resistance in *Spodoptera litura*(Fab.) collected from various locations of Vidarbha, M.S., India during the years 2011-12 and 2012-13. The levels of indoxacarb in Vidarbha region were examined and results revealed that the resistance to indoxacarb was visible with low levels of resistance during both the years. Among the different strains the Amravati and Wardha strains showed higher resistance level. The resistance levels recorded in Amravati strain (5.403 ppm at $LC_{50}$ and RR 6.07) was found highest amongst all the areas sampled during 2011-12, whereas, the Wardha strain (3.856 ppm at $LC_{50}$ and RR 4.33 as compared to laboratory susceptible strain), where the pesticides usages are also at higher level in various cropping systems. During 2012-13 the similar trend was observed, the Amravati and Wardha populations were found most tolerant to the indoxacarb as compare to all other strains. The Amravati strain was having 5.469 ppm $LC_{50}$ and the $LC_{50}$ of Wardha population was 4.324

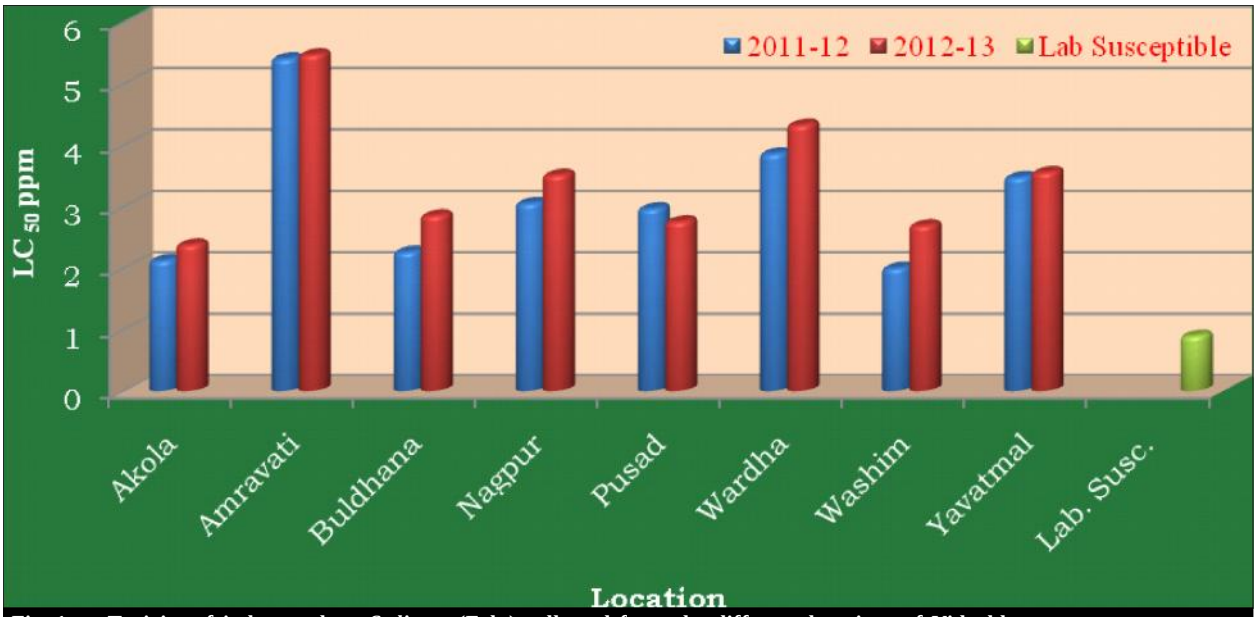


**Fig. 1 : Toxicity of indoxacarb to *S. litura* (Fab.) collected from the different locations of Vidarbha**

**Table 1 : Toxicity of indoxacarb to *S. litura* (Fab.) collected from the different locations of Vidarbha**

| Sr. No. | Strain | Year | $LC_{50}$ ppm (95% FL) | $LC_{90}$ ppm | Slope (S.E ±) | RR |
|---|---|---|---|---|---|---|
| 1. | Akola | 2011-12 | 2.120 (1.500-3.031) | 8.385 | 2.146 (± 0.62) | 2.38 |
| | | 2012-13 | 2.375 (1.762-3.061) | 7.282 | 2.634 (± 0.67) | 2.66 |
| 2. | Amravati | 2011-12 | 5.403 (4.792-6.060) | 9.423 | 5.306 (± 1.27) | 6.07 |
| | | 2012-13 | 5.469 (4.861-6.174) | 9.499 | 5.344 (± 1.42) | 6.14 |
| 3. | Buldhana | 2011-12 | 2.257 (1.627-2.993) | 10.439 | 1.927 (± 0.57) | 2.53 |
| | | 2012-13 | 2.849 (2.230-3.548) | 7.345 | 3.116 (± 0.80) | 3.20 |
| 4. | Nagpur | 2011-12 | 3.048 (2.427-3.688) | 8.068 | 3.032 (± 0.78) | 3.42 |
| | | 2012-13 | 3.509 (2.906-4.323) | 8.672 | 3.261 (± 0.87) | 3.94 |
| 5. | Pusad, Dist. Yeotmal | 2011-12 | 2.962 (2.240-3.701) | 6.995 | 3.434 (± 0.93) | 3.32 |
| | | 2012-13 | 2.750 (2.192-3.667) | 10.220 | 2.247 (± 0.61) | 3.08 |
| 6. | Wardha | 2011-12 | 3.856 (3.278-4.356) | 8.015 | 4.033 (± 0.99) | 4.33 |
| | | 2012-13 | 4.324 (3.715-4.862) | 7.579 | 5.259 (± 1.27) | 4.85 |
| 7. | Washim | 2011-12 | 1.993 (1.570-2.405) | 4.795 | 3.361 (± 0.82) | 2.23 |
| | | 2012-13 | 2.687 (2.043-3.281) | 6.247 | 3.497 (± 0.89) | 3.01 |
| 8. | Yavatmal | 2011-12 | 3.470 (2.944-3.964) | 7.012 | 4.194 (± 0.94) | 3.89 |
| | | 2012-13 | 3.552 (2.976-4.144) | 7.729 | 3.795 (± 0.95) | 3.99 |
| 9. | Lab. Susceptible | -- | 0.890 (0.688-1.087) | 2.060 | 3.518 (± 0.94) | -- |

ppm with RR 6.14 and 4.85 fold resistance, respectively as compared to laboratory susceptible strain having $LC_{50}$ 0.89 ppm (Table 1 and Fig. 1).

Earlier resistance reports in *spodopteralitura* from different geographical locations of India to various insecticides are reported by number of scientists, in the early 1980s (Ramakrishnan *et al.*, 1984), mid-1990s (Armes *et al*., 1997) and more recently (Kranthi *et al.*, 2002). From the central India, particularly western Vidarbha region of Maharashtra where the soybean crop is extensively grown along with cotton, pigeonpea and chickpea crops, on which insecticide consumption is comparatively high. In present investigation also, the tolerance to indoxacarb is higher in population of Amravati, Wardha, Yavatmal and Nagpur districts.

*Spodoptera litura* (Fab.) earlier known to be sporadic pest has emerged as major polyphagous pest in recent past. Jeyakumar *et al.* (2007) concluded their survey with the threat of *S. litura* (Fab.) an emerging pest on Bt. cotton (Cry 1Ac) under north Indian conditions. As, previously this is a non targeted pest in Vidarbha region and indoxacarb, is the relatively new molecule with novel mode of action, hence, not many reports on the resistance studies are available from Indian origin. However, according to Sayyed *et al.* (2008) reported resistance ratios of 15 fold for indoxacarb compared with a laboratory susceptible population. Hong *et al.* (2013) observed relatively low level of resistance to indoxacarb in all five test populations of different locations. Present findings also corroborate with the findings of (Shad *et al.*, 2012), who collected *S. litura* from eight different locations of various areas of Pakistan with variable temperatures and compare the toxicity of insecticides, they found very high level of resistance to spinosad, indoxacarb, and methoxyfenozide in all eight populations. Though the indoxacarb is relatively new molecule, there are several reports on the resistance development in field strain of economically important insect pests other than *Spodoptera litura*. Dhumale (2006) reported 362 fold resistance to indoxacarb in *P. xylostella* in Kolar, Karnataka strain as compared to susceptible strain from PDBC, Bangalore. Ghodki (2007) reported that Amravati and Akola strain of *H. armigera*, showed higher resistance levelto indoxacarb with $LC_{50's}$ 5.09 and 1.78 ppm, respectively and resistance ratio 15.42 and 5.36 resp. as compare to the most susceptible Hanamkonda (AP) strain ($LC_{50}$ 0.33 ppm).

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