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Relative resistance of Bihar hairy caterpillars to insecticide mixtures

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ABSTRACT

The relative toxicity of emulsions of various insecticide mixtures was evaluated against Bihar hairy caterpillar, *Spilarctia obliqua* in laboratory by two different techniques *viz.,* direct spray and leaf residue method. On the basis of LC_{50} values, Virat, Bulldockstar, Anaconda. Polytrin C, Ducord, Nurelle D, Sparak, Nagata and Spectrum were 5. 36, 5. 88, 5. 04, 3. 40, 3.23, 2.74, 1.68, 1.62 and 1.13 times more toxic than Super D. Koranda was 0.87 times less toxic than Super D when evaluated by direct spray method. Leaf residue method showed 6.45, 2.70, 2.42, 2.41, 1.75, 1.41, 1.38, 1.29, 1.21 and 1.17 times respectively more toxicity than the direct spray method in case of bulldockstar, Anaconda, Spark, Spectrum, Nagata, Polytrin C, Super D, Virat, Koranda and Anakonda. A comparision of the relative resistance based on LC_{50} values of *S. obliqua*, *Spodoptera litura* and *Helicoverpa armigera* to various insecticide mixtures indicated that *H. armigera* was relatively resistant amongst these three pests.

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The hairy caterpillar, *Spilarctia obliqua* and non-hairy caterpillars, *Spodoptera litura* and *Helicoverpa armigera* are responsible to a great extent for appreciable losses in vegetables, pulses and oil seed crops. *S. litura* has emerged as one of the serious and dominant pest in cotton (Nagesh Kumar, 1998). It also causes enormous losses to various commercial crops (Krishnamurty Rao *et al.,* 1983). The economic losses have been estimated to be Rupees 5.5 crores in tobacco and chillies in Andhra Pradesh alone. *H. armigera,* a polyphagous pest attacks about 200 crop species, belonging to 45 families (Sharma, 2001) and globally yield losses worth about US$ 2 billion annually have been reported (ICRISAT, 2003). In India, the annual loss due to this pest on pigeon pea and chickpea was estimated as 200 million US dollars (Jackson *et al*. 1989). The development of resistance to various insecticide groups in these pests is well documented (Dhingra, 1995; Murugesan and Dhingra, 1995; Dhingra *et al.,* 2002). The premix formulations may give better control of complex of pests whose susceptibilities to active ingredients of the mixtures differ. The Central Insecticide Board and Registration Committee of India have accorded registration under section 9(3) of Insecticide Act, 1968, for various insecticidal mixtures and many more are forthcoming. Use of mixtures can aid in better management of pests that are resistant to individual pesticides, synerzise the effects of certain insecticides, and result in manipulation of rates so that lower concentrations can be used to give satisfactory, economical control of target insect pest (Wolfenbarger and Cantu, 1975; Anonymous, 1999). But the resistance level of various lepidopteran pests differ with the various insecticide mixtures. Therefore studies were carried out to find out the specificity of these mixtures and diffrential susceptibility of related groups of insects.

MATERIALS AND METHODS

Different concentrations of the insecticidal emulsions representing various treatments were prepared using only distilled water for the dilution of emulsifiable concentrate. Larvae of *Spilarctia obliqua* were collected from green gram (*Vigna radiata*) crop at the farm of Indian Agricultural Research Institute, New Delhi. There after, rearing was done in the laboratory on castor leaves under controlled conditions (27 ± 1°C and 70 ± 5 %). The larvae of *S. obliqua* measuring 9 ± 1 mm were sorted out and kept for 2 hrs in the laboratory for pre-conditioning. The response of the larvae to above mentioned insecticide mixtures was evaluated by two different methods.

Direct spray method: Ten larvae of equal size were taken in each petri-dish (10 cm dia) and were directly sprayed with one ml of each concentration of various insecticide mixtures under potters tower at 24 cm mercury pressure. For each mixture, a series of 5 to 7 concentrations were simultaneously tested to obtain the mortality response of the test insect. The sprayed petri-dishes containing larvae were then transferred to separate glass jars containing fresh untreated castor leaves as food. The jars were kept at 27 ± 1°C and the mortality was recorded 24 hrs after treatment. The moribund insects were also counted as dead. There were three replications for each concentration as also control. The data so obtained were subjected to probit analysis (Finney 1971) for calculating regression equations and LC_{50} values. The values of relative toxicity of different combination products were calculated by taking the LC_{50} value of Polytrin C as unity.

Leaf-dip method: The larvae of *S. obliqua* were exposed to insecticidal residues on castor leaves. After washing the leaves thoroughly the leaf-discs of approximately 6 cm diameter were cut from well-grown castor leaves. They were later dipped in the required concentrations of each of the mixture for twenty seconds and then dried. The treated leaf-discs were then transferred to clean jars (15 cm x 10 cm). In each jar 10 larvae were placed and each treatment was replicated thrice.

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RESULTS AND DISCUSSION

Among the various insecticide mixtures evaluated by direct spray method, Virat and Bulldockstar was found to be the most toxic insecticide mixtures followed by Anaconda, Polytrin C, Ducord, Nurelle D, Spark, Nagata, Spectrum, Super D and Koranda. The former nine insecticide mixtures were found to be more toxic than Super D, being 5.36, 5.28, 5.04, 3.40, 3.23, 2.74, 1.68, 1.62 and 1.13 times respectively as toxic as Super D (Table 1). On the other hand Koranda was equal in toxicity to Super D. When the toxicity of above mentioned insecticide mixture was evaluated by leaf dip method there was change in the order of toxicity of various insecticide mixtures. With relative toxicity values in parentheses the changed order of toxicity was; Bulldockstar (24.65) > Nurelle D (5.36) > Virat (5.03) > Anaconda (4.29) > Polytrin C (3.47) > Spark (2.93) > Nagata (2.05) > Spectrum (1.97) > Super D (1.00) > Koranda (0.87). (Table 2).

Table 1. Toxicity of commercial formulation of insecticide mixtures against third instar larvae of *Spilarctia obliqua*, after 24 hrs of treatment by direct spray method.

Insecticide	Heterogenity df χ^2	Regression equation Y =	LC_{50}	Fiducial limit	Relative toxicity
Virat	3 = 0.8156	10.0170 + 2.6471x	0.0127	0.0113-0.0143	5.36
Bulldockstar	3 = 7.1201	8.6962 + 1.9577x	0.0129	0.0110-0.0152	5.28
Anaconda	4 = 6.6227	6.8520 + 0.9897x	0.0135	0.0105-0.0172	5.04
Polytrin C	3 = 5.9667	8.2336 + 1.9025x	0.0200	0.0172-0.0232	3.40
Ducord	5 = 7.3731	7.7637 + 1.6491x	0.0211	0.0161-0.0274	3.23
Nurelle D	4 = 8.4747	10.4034 + 3.3639x	0.0248	0.0228-0.0269	2.74
Spark	4 = 8.1340	7.2502 + 1.6176x	0.0407	0.0345-0.0479	1.68
Nagata	4 = 8.1633	7.0921 + 1.5180x	0.0419	0.0353-0.0497	1.62
Spectrum	4 = 6.0448	9.1951 + 3.4401x	0.0603	0.0512-0.0711	1.13
Super D	4 = 6.0701	7.2189 + 1.9013x	0.0681	0.0524-0.0883	1.00
Koranda	3 = 2.3966	7.8870 + 2.4789x	0.0685	0.0611-0.0767	0.99

In none of the cases, the data were found to be significantly heterogenous at P= 0.05, Y= probit kill and X= Log concentration, LC_{50}=concentration calculated to give 50 % mortality.

Table 2. Toxicity of commercial formulation of insecticide mixtures against third instar larvae of *Spilarctia obliqua*, after 24 hrs of treatment by leaf dip method.

Insecticide	Heterogenity df $\aleph^2$	Regression equation Y =	LC_{50}	Fiducial limit	Relative toxicity
Bulldockstar	3=2.3112	9.5550 + 1.6855x	0.0020	0.0016-0.0025	24.65
Nurelle D	4=1.2914	8.5027 + 1.7186x	0.0092	0.0079-0.0106	5.36
Virat	3=1.5251	10.6400 + 2.8094x	0.0098	0.0089-0.0109	5.03
Anaconda	4=7.0355	10.0895 + 2.6268x	0.0115	0.0094-0.0141	4.29
Polytrin C	5=6.1746	8.0458 + 1.6493x	0.0142	0.0107-0.0188	3.47
Spark	4=2.2356	8.8324 + 2.1610x	0.0168	0.0131-0.0215	2.93
Nagata	3=5.3169	7.9467 + 1.8510x	0.0240	0.0220-0.0297	2.05
Spectrum	3=0.0837	8.1536 + 1.9677x	0.0250	0.0216-0.0288	1.97
Super D	3=4.5237	6.3407 + 1.0258x	0.0493	0.0316-0.0770	1.00
Koranda	4=8.3471	7.0047 + 1.6068x	0.0566	0.0483-0.0662	0.87

In none of the cases, the data were found to be significantly heterogenous at P= 0.05, Y= probit kill and X= Log concentration, LC_{50}=concentration calculated to give 50 % mortality.

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When effectiveness of the various insecticide mixtures evaluated by different techniques was compared, the leaf dip method was found to be better than direct spray method as LC_{50} values obtained for different combination products were significantly different. Leaf residue method showed 6.45, 2.70, 2.42, 2.41, 1.75, 1.41, 1.38, 1.29, 1.21 and 1.17 times more toxicity than the direct spray method in case of Bulldockstar, Anaconda, Spark, Spectrum D, Nagata, Polytrin C, Super D, Virat, Koranda and Anaconda (Table 3).

Table 3. Effect of different exposure methods on the effectiveness of insecticide mixtures.

Insecticide	LC_{50} Direct spray	LC_{50} Leaf residue	Relative effectiveness
Bulldockstar	0.0129	0.0020	6.45
Nurelle D	0.0248	0.0092	2.70
Spark	0.0407	0.0168	2.42
Spectrum D	0.0603	0.0250	2.41
Nagata	0.0419	0.0240	1.75
Polytrin C	0.0200	0.0142	1.41
Super D	0.0681	0.0493	1.38
Virat	0.0127	0.0098	1.29
Koranda	0.0685	0.0566	1.21
Anaconda	0.0135	0.0115	1.17

The relative resistance of hairy (*S. obliqua*) was compared with non-hairy caterpillars (*S. litura*, *H. armigera*) to various insecticide mixtures on the basis of LC_{50} values of *S. obliqua* as unity. It is evident from (Table 4) by the value on *S. litura* and *H. armigera* worked out by Dhingra *et al.* (2003) and Kodandram (2003) that *H. armigera* was relatively resistant to all the combination products, where as *S. litura* was relatively resistant to Virat, Polytrin C, Spectrum and Koranda. The order of toxicity of combination products to all the pests was similar in the case of Anaconda and Koranda (least toxic) Spark and Nagata was at 7 and 8 position, respectively, against *S. obliqua* and *S. litura* but against *H. armigera* they were at the 4 and 6 position Rest of the products exhibited differential toxicity.

Studies revealed that the specificity of insecticides and differential susceptibility of related groups of insects (such as the differences in the order of toxicity of various insecticide mixtures) have been found in larvae of the same order. Also the toxicity level of various insecticide mixtures can be looked upon as a sort of ready reckoner and would form the basis for the selection of insecticide mixtures for field trials.

Table 3. Specificity of insecticide mixtures against *S.obliqua*, *S.litura* and *H.armigera* with relative resistance values and order of toxicity to lepidopterous larvae.

Insecticide mixture	LC_{50} (%)			Relative resistance for			Order of toxicity		
	S.obliqua	*S.litura*	*H.armigera*	*S.obliqua*	*S.litura*	*H.armigera*	*S.obliqua*	*S.litura*	*H.armigera*
Viraat	0.0127	0.0265	0.1190	1.0	2.09	9.37	1	6	2
Bulldockstar	0.0129	0.0015	-	1.0	0.12	-	2	1	-
Anaconda	0.0135	0.0072	0.1373	1.0	0.53	10.17	3	3	3
Polytrin C	0.0200	0.0500	0.2213	1.0	2.50	11.06	4	9	7
Nurelle D	0.0248	0.0106	0.1435	1.0	0.43	5.79	6	4	5
Spark	0.0407	0.0322	0.2455	1.0	0.79	6.03	7	7	4
Nagata	0.0419	0.0448	0.2240	1.0	1.07	5.35	8	8	6
Super D	0.0681	0.0185	-	1.0	0.27	-	10	5	-
Spectrum D	0.0603	0.0942	-	1.0	1.56	-	9	10	-
Koranda	0.0685	0.1158	0.3523	1.0	1.69	5.14	11	11	8
Ducord	0.0211	0.0064	0.1013	1.0	0.30	4.80	5	2	1

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