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Insecticide usage Pattern against *Helicoverpa armigera* (Hubner) in Karnataka State, India

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A B S T R A C T

An interactive survey was conducted during 2016-17 to document insecticide usage pattern adopted by the farmers of Karnataka state to manage polyphagous pest *Helicoverpa armigera* in different host crops growing areas. Among the different group of insecticides the most popular amongst the farmers were emamectin benzoate 5 SG (39.44 %), rynaxypyr 18.5 SC (27.22 %) and profenophos 50 EC (23.89 %). The dominant host crops for *H. armigera* different in the state were cotton, pigeonpea in Raichur and Kalaburgi, chickpea (Gadag), chilli (Haveri) and tomato (Kolar). Manually operated knapsac sprayer was commonly used in all localities except in Raichur and Kalaburgi where power operated sprayers were used. The refugia usage in *Bt* cotton was about 40% farmers only.

Introduction

Helicoverpa armigera Hubner (Noctuidae: Lepidoptera) is a widely distributed insect pest in Europe, Africa, Asia and South Pacific regions. The currently noticed global distribution of *H. armigera* suggests that the pest may be most closely associated with deserts and xeric shrub lands; Mediterranean scrub; temperate broadleaf and mixed forests; tropical and subtropical grasslands, savannas, and shrub lands; and tropical and subtropical moist broadleaf forest (Wasihun, 2016). It has a wide host range of over 360 plant species that includes most crop hosts are tomato, cotton, pigeonpea, chickpea, sorghum and cowpea and other hosts dianthus, rosa, pelargonium, chrysanthemum, groundnut, okra, peas, field beans, soybeans, lucerne, *Phaseolus spp*, tobacco, potatoes, maize, flax, a number of fruits (Prunus, Citrus), forest trees and a range of vegetable crops (Multani and Sohi, 2002; CAB, 2006).

H. armigera solely cause losses up to Rs. 10,000 million in crops like cotton, pigeonpea, chickpea, groundnut, sorghum, pearl millet, tomato, and other crops of economic importance (Raheja, 1997). In chickpea and pigeonpea *H. zea* caused an estimated loss of $ 927 million in worldwide apart from $ 5.0 billion in different crops as reported by

Sharma (2001) and annual loss of over $350 million in pigeonpea. Yield loss in cotton was reported in Tamil Nadu and Karnataka to the range of 35-38 % and insecticides worth of 28,800 billion rupees were used annually on all crops in India of which 50% was used on cotton alone (Rai *et al*., 2009). However, with the extensive use of chemicals a widespread resistance to insecticides has been acquired by *H. armigera* in India. It is possessing by far the most reported cases of insecticide resistance worldwide with evolved resistance against pyrethroids (50-100% metabolic resistance and <5.0% target site), organophosphates (low – moderate 1-10%), carbamates (moderate – high 30-50%), organochlorines and recently against the macrocyclic lactone spinosad (very low <2%) and *Bacillus thuringiensis* derived toxins (low <5%) oxadiazines (low, but increasing 5-12%) diamides (very low <1%), whereas zero level of resistance to avermectins, nuclear polyhedrosis virus and paraffinic spray oils in Australia as reported by Paul *et al*., (2018). Earlier reports indicated that cypermethrin and fenvalerate effectively reduced *H. armigera* population and damage. Due to continuous use of pesticides against this pest resulted in the development of resistance was evidenced (Jadhav and Armes, 1996) by very high level of resistance to synthetic pyrethroids, which occupied 50-70 per cent of the insecticides sprayed over the cotton in India. Thus ineffectiveness of insecticide predominantly has arisen from highly pesticide prone areas where intensive agriculture is in vague. Since then there is lot of change in insecticide usage pattern by growers to contain this pest, but, still it remains as dominant insect pest in India. It gives a scope to relate the degree of development of resistance in the population from different geographical areas vis-à-vis the diversity and/or intensity of pesticide usage by farmers. Over >15 years transgenic Bt cotton hybrids are cultivated in Karnataka which is likely to influence *H. armigrea* susceptibility in other crops also. Insecticide usage diversity, sprayer types and refugia adoption across the Karnataka have been reported in this study to know the status of resistance management of *H. armigera* presently.

Materials and Methods

Survey area

The survey was carried out during 2016-17 in different locations of Karnataka *viz*., Dharwad, Vijayapur, Belagavi, Gadag, Haveri, Raichur, Kalaburgi, Shivamogga and Kolar encompassing all agro climatic zone of the state where *H. armigera* host crops are regularly grown.

Interview and questionnaire

The interview with farmers was done to know about the extent of exposure to different types of pesticides, major host crops (considered by more than 50 % area covered with particular crops in each farmers field), frequency of insecticide applications and other pest management practice for *H. armigera* including refugia in Bt cottons. In each district 20 farmers having better knowledge about pest management practices prevailing amongst them were consulted for this survey. The data collection was on a questionnaire based. The data collected was entered in the MS-Excel master worksheet, classified and used for further statistical analysis.

Results and Discussion

From the survey variation in dominance of host crops of *H. armigera* in different locations of Karnataka was evident (Table 1) like tomato in Kolar, chilli in Haveri, maize in Shivamogga, chickpea in Gadaga, cotton in Belagavi, Dharwad, pigeon pea in Raichur and Kalaburgi. In these areas where more than fifty percent holding of individual growers was covered by these crops. Thus based on crop acclimatization and environmental conditions the cropping pattern has a definite impact on management practices.

The average number of insecticides application by the farmers in order to conquer the *H. armigera* predicament varied on a average from 1.0 to 3.7 rounds of sprays. Maximum numbers of 3.7 sprays was recorded from the Raichur followed by 3.3 sprays from Kalaburgi. Whereas, lowest number of spray was recorded from Shivamogga (1.0 spray) followed by Belagavi (1.6 sprays) and Gadag (2 sprays) among different locations of Karnataka (Table 2). Similarly Fakruddin *et al.*, (2004) observed more spray frequencies in Raichur against *H. armigera* itself. Thus Raichur and Kalaburgi have remained as high insecticide usage areas of Karnataka where pigeonpea, chickpea and irrigated cottons are predominantly grown.

The usage of different selected insecticides by the growers to combat *H. armigera* in different locations varied from 0 to 60 % as depicted in Figure 1. Among the different insecticides the highest usage of rynaxypyr (60%) was reported in Kolara (against tomatoes) which was followed by 50 per cent in botanicals as well as emamectin benzoate. Further, among the selected insecticides which were used by farmer the usage varied from 1.67 to 23.89 %.

The highest percent of farmers used emamectin benzoate (39.44 %) followed by rynaxypyr (27.22 %) and least usage of insecticides were bioagents, pyrethroids, carbamates and biorationales (Fig. 2). Thus the present study revealed reliance on newer group of insecticides much along with some conventional insecticides (OP groups) which could be due to experienced ineffectiveness of earlier used conventional insecticides.

Type of sprayer/nozzles and spray volume also has lot of influence on efficacy of insecticides and could be a cause for development of resistance. In the present study the spray equipment usage varied much across the regions. The manual operated knapsack sprayer was most common (Table 3) and about 15 to 80 % farmers showed dependency on it except Raichur and Kalaburgi farmers. Power sprayer users ranged from 5 to 65 % which was common in Raichur, Kalaburgi and Vijayapur districts for its reachability to high canopy of pigeonpea crop predominantly grown in these districts. Battery operated knapsack sprayer usage ranged from 15 to 25% mostly dominated in Raichur and Kalaburgi again. The spray equipment dependency is always related to canopy coverage, availability water and labour. However the dosage management is important rather than sprayers in pest management. The present study could not notice striking pitfall in spray equipment related issues. Growing non Bt cotton as structured refugia has been recommended as IRM practice in India. Even after 15 years of introduction of *Bt* cotton in India refugia adoption could not go beyond 40% (Fig. 3) as noticed in Dharwad district. The farmers have reasons like; loss in area for Bt crop due to refugee seeds, more pest infestation on refugia, poor knowledge about refuge requirement etc for non compliance of refugia. However, this could be potential threat for sustainability of Bt technology as evidenced in *Bt* cotton impact evaluation (Anonymous, 2014) studies.

Thus, the present investigation reveals a considerable deal of insecticide usage against *H. armeigera* in its host crops with variation in patterns. However, in cotton the usage of insecticide for *H. armigera* management has been dwindled significantly due to effect of Bt technology.

Table.1 Dominance of *Helicoverpa armigera* host crops Karnataka State

District	Dominant crops	Other host crops
Haveri	Chilli, Cotton, Maize	Sunflower, Tomato, Bhendi
Vijayapur	Cotton, Pigeonpea	Chickpea, Sunflower, Safflower
Dharwad	Cotton, Chickpea,	Chilli, Sunflower, Maize, Safflower, Bhendi
Belagavi	Cotton, Chilli, Sorghum	Chickpea, Sunflower, Safflower
Shivamogga	Maize, Chilli	Sunflower
Kolar	Tomato	Maize, Bhendi
Raichur	Pigeonpea, Cotton	Chickpea, Sunflower
Kalaburgi	Pigeonpea, Cotton, Chickpea	Maize, Bhendi
Gadag	Chickpea, Cotton	Chilli, Sunflower, Maize, Safflower, Bhendi

Fig.1 Insecticide usage pattern against *H. armigera* in different locations of Karnataka

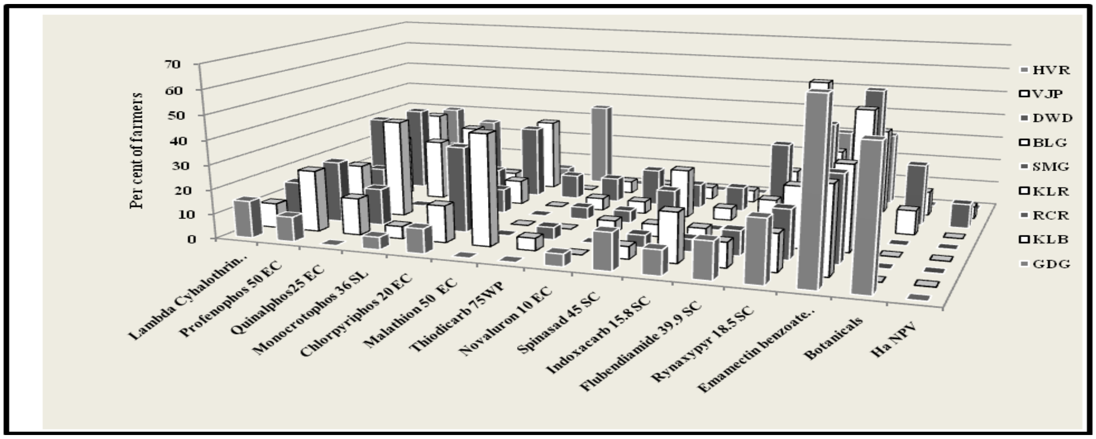


Fig.2 Percent of Farmers used different insecticides in Karnataka during 2016-17

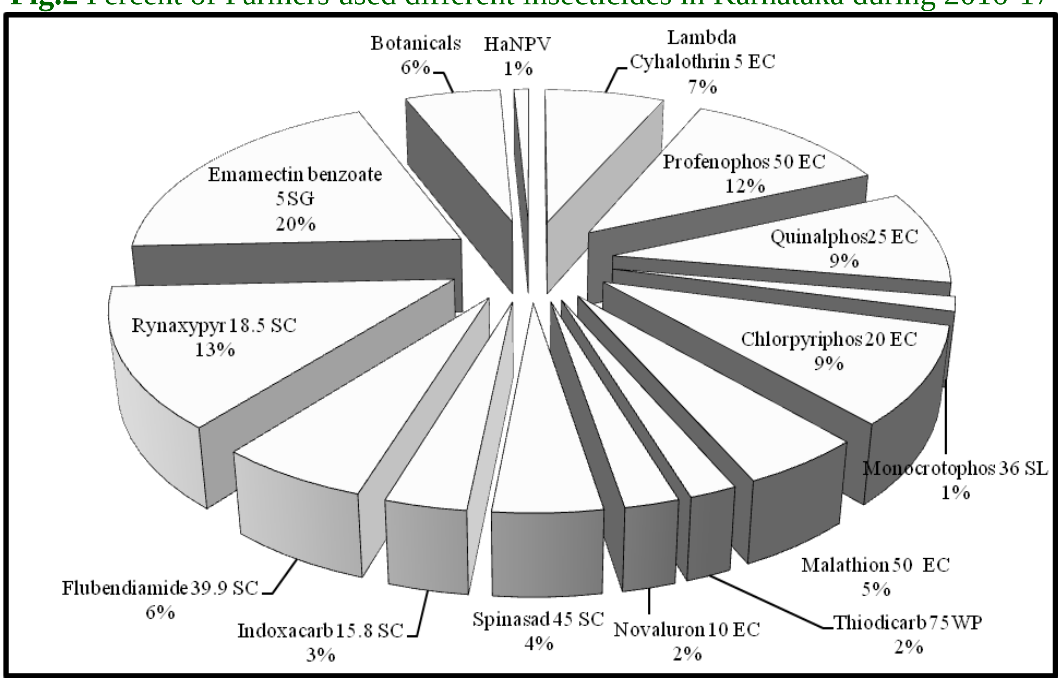


Table.2 Insecticide usage pattern against *Helicoverpa armigera* in different locations of Karnataka

Insecticide group	Insecticide	Number of farmers* (%)									Mean (%)
		HVR	**VJP**	**DWD**	**BLG**	**SMG**	**KLR**	**RCR**	**KLB**	**GDG**	
Pyrethroids	Lambda Cyhalothrin 5 EC	15	10	15	10	5	10	30	20	10	13.89
Organo phosphates	Profenophos 50 EC	10	25	25	20	15	25	35	30	30	23.89
	Quinalphos25 EC	00	15	15	40	0	25	20	25	25	18.33
	Monocrotophos 36 SL	05	5	0	0	0	0	10	5	0	2.78
	Chlorpyriphos 20 EC	10	15	35	25	10	10	30	30	5	18.89
	Malathion 50 EC	00	45	0	0	0	0	10	0	35	10.00
Carbamates	Thiodicarb 75WP	00	5	5	0	5	5	10	5	0	3.89
IGR's	Novaluron 10 EC	5	0	0	5	5	5	15	5	0	4.44
Spinosyns	Spinasad 45 SC	15	5	5	5	15	20	10	5	0	8.89
Oxadiazines	Indoxacarb 15.8 SC	10	20	5	5	0	5	10	5	0	6.67
Benzenes	Flubendiamide 39.9 SC	15	10	10	5	5	10	30	15	10	12.22
Diamides	Rynaxypyr 18.5 SC	25	15	20	25	5	60	40	25	30	27.22
	Emamectin benzoate 5SG	70	35	35	35	10	50	55	35	30	39.44
Plant product	Botanicals**	55	00	00	0	0	10	25	10	0	11.11
Bioagent	*Ha*NPV	00	00	00	0	0	00	10	5	0	1.67

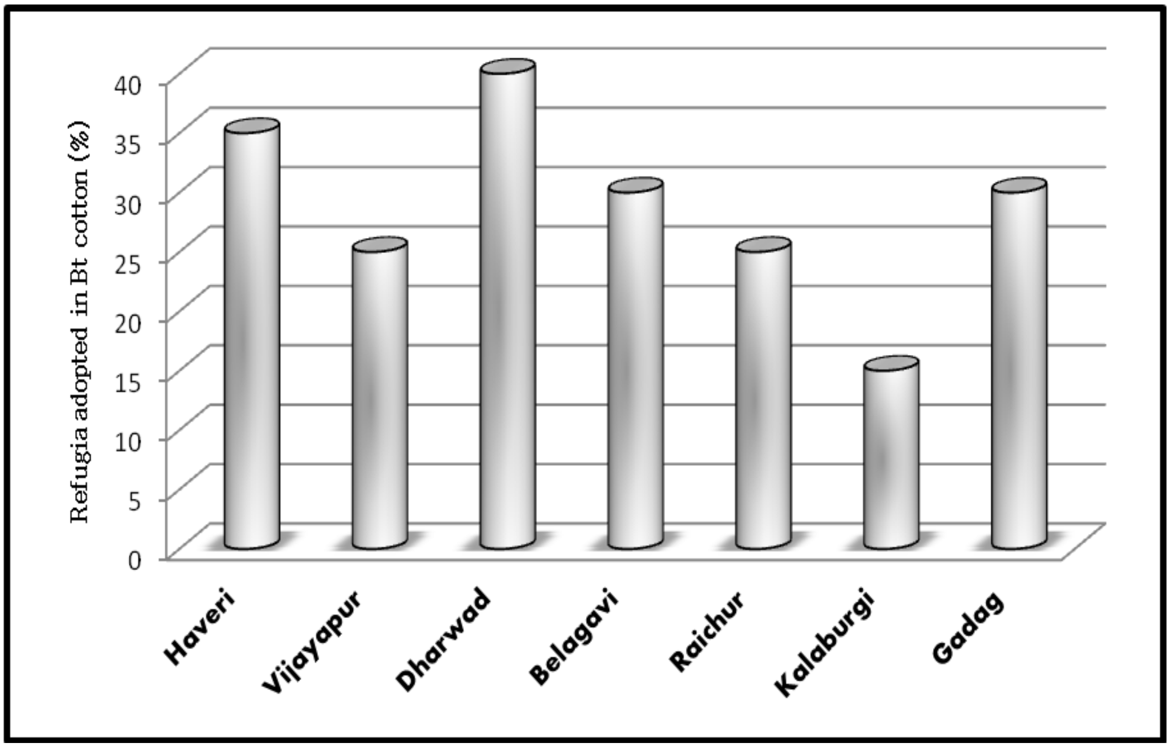
HVR- Haveri, VJP- Vijayapur, DWD- Dharwad, BLG- Belagavi, SMG- Shivamoga, KLR- Kolar, RCR- Raichur, KLB- Kalburgi, GDG- Gadag
*N= 20
** Bioneem, Brahmastra, Pro-47 and other plant products

Table.3 Insecticide usage diversity, sprayer types in different locations of Karnataka targeting *Helicoverpa armigera*

Locations	Crops	Rounds of insecticides used (No.)	Type of sprayers used by farmer (%)		
			Manual operated (Knapsack)	Power operated sprayer	Battery operated (Knapsack)
Haveri	A	5	80	05	15
Vijayapur	C & B	6	40	50	10
Dharwad	A & C	6	80	05	15
Belagavi	A& C	5	75	10	15
Shivamogga	A	4	85	05	10
Kolar	D	6	65	10	15
Raichur	B & C	9	15	60	25
Kalaburgi	B & C	7	15	65	20
Gadag	C	6	75	10	15

A- Chilli, B- Pigeonpea, C- Chickpea, D- Tomato; Sample size (n) = 20 / district

Fig.3 Refugia adoption by in major Bt cotton growing districts of Karnataka State



Farmers quite frequently rely on newer insecticide available in the market for successful management of the pest. It is good that presently farmers are depending much on new group of insecticides and doing away with conventional organophosphates and pyrethroids. Though such studies were not available for comparison with respect to *H. armigerea* as polyphagous single pest in different crops, the changes in insecticides usage patterns have been documented in cotton and vegetables (Silas *et al*., 2011), fruit crops (Lynn and Susan, 2003) and cereals (Heong *et al*., 2008) mentioning the resistance and change in insect pest scenario as root cause for the phenomenon. There appears in reduction over years in pesticides against dreaded pest *H. armigera* under the influence of Bt cotton too as in a multicropping system negative cross resistance operates reducing synthetic insecticide resistance. The studies on pesticide usage as in present case would guide the farmers also apart from generating information for pest management researchers and advisors. However. There should be more frequency in such studies across time and space for proper understanding of pest management issues spurting now and then.

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