RESISTANCE MONITORING OF *Helicoverpa armigera* TO INSECTICIDES ACROSS DIFFERENT LOCATIONS OF KARNATAKA

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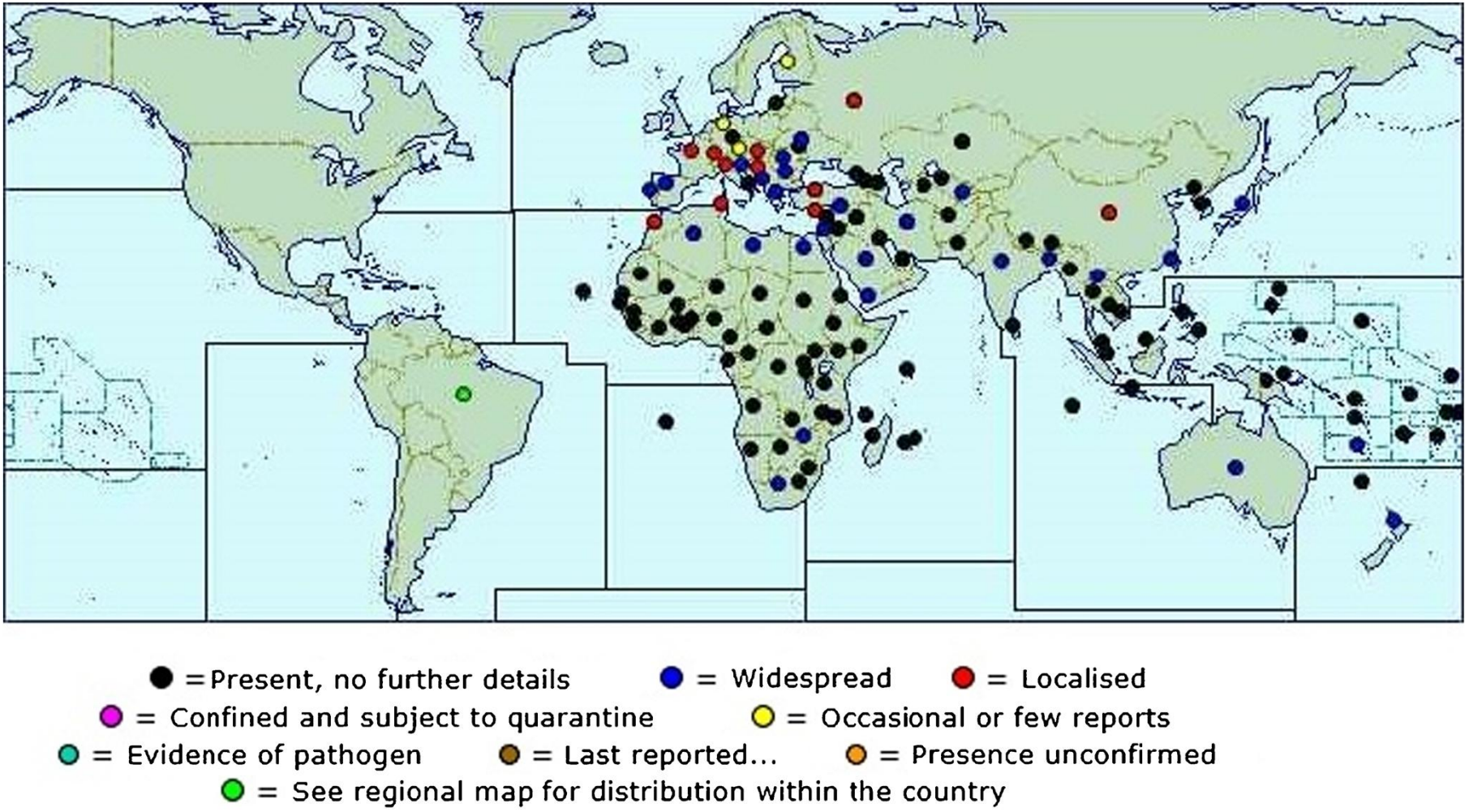
Loss caused by *Helicoverpa armigera*

Crop	Common Name	% Yield Loss	Source
Sorghum	Earhead caterpillar	18-26	K. V. S. Reddy and Usha B. Zehr, 4th International Crop Science Congress
Pigeon pea	Pod borer	14-100	
Sunflower	Capitulum borer	30-60	
Cotton	American Bollworm	20-80	
Tomato	Fruit borer	15-46	
Okra	Fruit borer	22	
Chilli	Fruit borer	NA	
Chick pea	Pod borer	10–80%	Yelshetty, 1999

https://www.pesticideresistance.org/search.php

Distribution map of *Helicoverpa armigera*

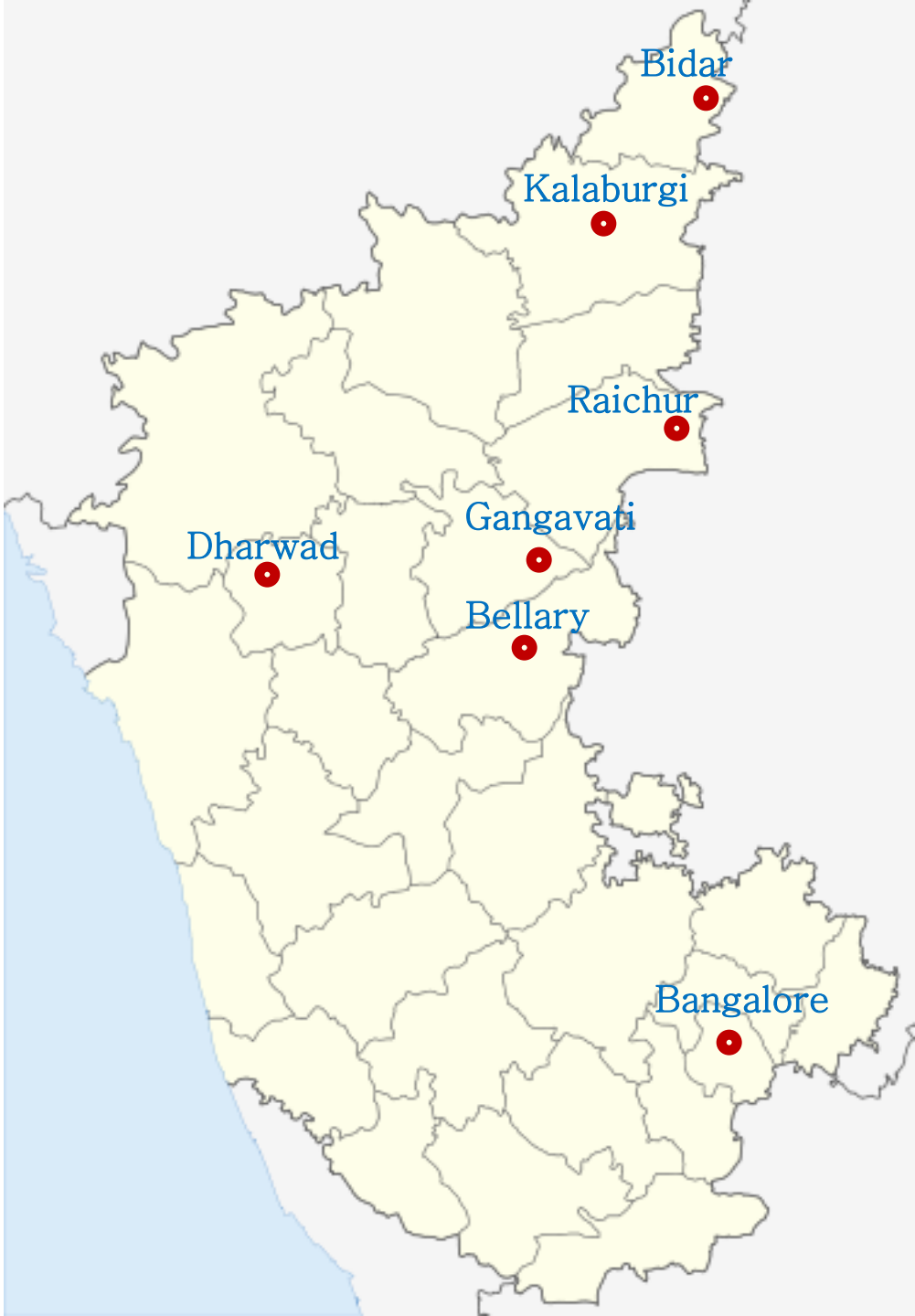


Shown Resistance to Active Ingredient (s)

- Abamectin
- Azinphos-methyl
- *Bacillus Thuringiensis* (Var. Unspecified)
- *Bacillus Thuringiensis* Cry1ac
- *Bacillus Thuringiensis* Var. *Kurstaki*
- Bifenthrin
- Carbamates - Unspecified In Literature
- Carbaryl
- Chlorpyrifos
- Cyfluthrin
- Cyfluthrin-beta
- Cyhalothrin
- Cyhalothrin-gamma
- Cyhalothrin-lambda
- Cypermethrin
- Cypermethrin + PBO
- Cypermethrin-alpha
- Cypermethrin-zeta
- DDT
- Deltamethrin
- Deltamethrin + DEF
- Deltamethrin + PBO
- Emamectin Benzoate
- Endosulfan
- Endrin
- Esfenvalerate
- Etofenprox
- Fenvalerate
- Flucythrinate
- Flumethrin
- Indoxacarb
- Isoxathion
- Malathion
- Methomyl
- Monocrotophos
- MVP II (Cry1ac)
- Parathion-methyl
- Permethrin
- Phoxim
- Profenofos
- Quinalphos
- Spinosad
- Tau-fluvalinate
- Tefluthrin
- Tetramethrin
- Thiodicarb
- Toxaphene
- Transfluthrin

Locations for sample collection

- Raichur
- Kalaburgi
- Bidar
- Dharwad
- Bellary
- Bangalore and
- Gangavati



Insecticides selected for the bioassay study

Sl. No.	Insecticide
1	Chlorpyriphos 20% EC
2	Methomyl 40% SP
3	Thiodicarb 70% SP
4	Profenophos 50% EC
5	Spinosad 45% SC
6	Emamectin benzoate 5% SG
7	Flubendiamide 37.9% SC
8	Chlorantraniliprole 18.5% SC

Bioassay study

- Study was conducted for three years *viz.*, 2014-15, 2015-16 & 2016-17.
- Newly moulted third instars (30-40 mg) from F1 laboratory cultures.
- Topical bioassay method recommended by the Insecticide Resistance Action Committee.
- Number of larvae: 75-120 per location per treatment.
- After the treatments, larvae were placed in the semi synthetic diet.
- Observation on mortality was recorded after 48 hrs of exposure.

Insecticide Resistance work in Karnataka on *Helicoverpa armigera*

- Fakrudin *et al.* (2003) reported that varied conventional insecticides (chlorpyriphos, quinalphos and carbaryl) resistance to *Helicoverpa armigera* from different location of South India.
- Vijaykumar and Patil (2004) studied the susceptibility of *Helicoverpa armigera* to new molecules and compared to resistance to old molecules.
- Rajesh *et al.* (2010) conducted the baseline susceptibility studies on *Helicoverpa armigera* to chlorantraniliprole (Rynaxypyr).
- Suvarna Patil *et al.* (2012) reported the *Helicoverpa armigera* resistance to synthetic pyrethroids particularly to cypermethrin in Dharwad and Raichur area from cotton ecosystem.

Due to its wide host range, production of multiple generations per year, high fecundity, migratory behaviour and pronounced resistance to many insecticides, the control up to desired level has become difficult (McCaffery *et al.*, 2010)

Moderate to high level of resistance to conventional insecticides such as (chlorinated hydrocarbons, organophosphates, carbamates and pyrethroids) as well as to neonicotinoids pesticides and Insect Growth Regulator (IGR) has been reported in field populations of *H. armigera*

(Nauen, 2002)

Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Emamectin benzoate 5% SG	Raichur	2014-15	75	0.35	0.16	1.26	1.09 ± 0.85	3.74	0.54
		2015-16	105	0.44	0.21	1.37	1.44 ± 1.05	2.15	0.65
		2016-17	75	0.39	0.16	1.30	1.50 ± 0.50	1.95	0.75
	Kalaburagi	2014-15	90	0.38	0.18	1.59	1.18 ± 0.46	2.96	0.77
		2015-16	105	0.47	0.23	1.55	1.35 ± 0.58	2.74	0.49
		2016-17	75	0.43	0.18	1.48	1.26 ± 0.28	2.05	1.00
	Bidar	2014-15	75	0.32	0.15	0.93	1.66 ± 0.21	1.78	0.91
		2015-16	90	0.35	0.17	1.01	1.08 ± 0.76	1.98	0.57
		2016-17	90	0.31	0.12	0.94	1.00 ± 0.34	2.14	1.05
	Dharwad	2014-15	90	0.29	0.13	3.04	1.55 ± 0.31	2.04	0.59
		2015-16	75	0.34	0.16	0.88	2.05 ± 0.20	2.05	0.74
		2016-17	90	0.30	0.11	0.81	1.92 ± 0.11	1.96	0.78
	Bellary	2014-15	75	0.28	0.21	1.02	1.19 ± 0.52	2.55	0.72
		2015-16	90	0.31	0.15	0.97	2.11 ± 0.44	1.75	1.05
		2016-17	75	0.28	0.10	0.91	2.01 ± 0.25	1.55	1.00
	Bangalore	2014-15	105	0.39	0.24	1.22	2.04 ± 0.73	2.08	0.56
		2015-16	105	0.35	0.14	1.08	1.89 ± 0.51	2.41	0.83
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	75	0.38	0.19	0.83	1.35 ± 1.02	2.16	1.00
		2015-16	75	0.26	0.18	1.05	1.68 ± 0.73	1.59	1.10
		2016-17	75	0.22	0.13	1.00	1.36 ± 0.16	1.31	1.00

Lowest LC_{50} value : Gangavati population

Highest LC_{50} : Kalaburagi population

lower LC_{50} value (0.049 mg a.i. L-1) for emamectin against a laboratory reared susceptible strain of the pest.

Hirooka *et al.* (2007)

2nd instar *H. armigera* larvae under laboratory conditions for emamectin benzoate was more toxic and recorded lower LC_{50} values than indoxacarb and spinosad.

Gupta *et al.* (2005)

Insecticides	Location	Year	n	LC_{50} (ppm	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Spinosad 45% SC	Raichur	2014-15	90	0.48	0.35	0.71	1.96 ± 0.11	2.18	0.76
		2015-16	90	0.52	0.39	0.79	2.05 ± 0.08	2.24	0.55
		2016-17	75	0.48	0.34	0.72	2.05 ± 0.08	1.75	0.75
	Kalaburagi	2014-15	75	0.41	0.33	0.65	1.81 ± 0.09	1.95	0.54
		2015-16	75	0.44	0.35	0.62	1.93 ± 0.15	2.00	0.93
		2016-17	75	0.40	0.30	0.55	1.93 ± 0.15	2.25	0.56
	Bidar	2014-15	75	0.46	0.29	0.81	1.59 ± 0.47	1.88	0.48
		2015-16	102	0.38	0.19	0.91	1.75 ± 0.30	1.75	0.81
		2016-17	90	0.33	0.15	0.82	1.75 ± 0.30	1.54	1.03
	Dharwad	2014-15	75	0.49	0.38	0.56	2.17 ± 0.17	2.41	0.91
		2015-16	90	0.43	0.21	0.55	2.05 ± 0.15	2.09	1.02
		2016-17	90	0.39	0.16	0.46	2.05 ± 0.15	1.76	0.82
	Bellary	2014-15	75	0.58	0.43	1.39	1.55 ± 0.15	1.95	0.85
		2015-16	75	0.51	0.38	1.12	2.15 ± 0.22	1.93	0.79
		2016-17	75	0.47	0.33	1.03	2.15 ± 0.22	2.58	1.16
	Bangalore	2014-15	105	0.51	0.38	0.70	1.66 ± 0.12	2.13	0.73
		2015-16	75	0.53	0.37	0.98	1.93 ± 0.10	1.82	0.88
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	75	0.45	0.31	1.02	1.56 ± 0.18	2.03	0.71
		2015-16	105	0.47	0.30	1.05	1.95 ± 0.05	2.05	1.10
		2016-17	90	0.43	0.25	0.96	1.95 ± 0.05	3.05	0.68

Lowest LC_{50} value : Bidar population

Highest LC_{50} : Bellary population

variation in spinosad toxicity to *H. armigera* could be attributed to the fact that the pest has been reported to have developed variable level of resistance against the chemical

Ahmed *et al.* (2005)

The toxicity of spinosad was relatively less variable falling within LD_{50} range of 0.023 to 0.24 µg/larvae and LD_{90} of 0.27 to 4.33 µg/larvae.

Kranthi *et al.*, 2000

Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Thiodicarb 70% SP	Raichur	2014-15	75	11.71	10.16	14.55	2.74 ± 0.45	0.57	0.79
		2015-16	105	12.54	10.74	15.14	1.94 ± 0.74	1.25	0.55
		2016-17	75	15.15	11.24	18.07	1.32 ± 0.15	1.02	0.70
	Kalaburagi	2014-15	90	13.49	11.85	17.76	1.86 ± 0.51	1.89	0.88
		2015-16	105	14.32	12.43	18.45	2.00 ± 0.49	2.84	0.69
		2016-17	75	13.37	9.55	14.76	1.70 ± 0.26	1.88	1.00
	Bidar	2014-15	75	12.81	10.73	17.29	1.95 ± 0.15	1.57	1.08
		2015-16	75	13.74	11.31	17.88	2.25 ± 0.33	1.56	1.02
		2016-17	90	14.57	10.12	17.50	2.05 ± 0.35	2.34	1.05
	Dharwad	2014-15	75	12.49	10.21	16.46	1.93 ± 0.35	2.14	1.01
		2015-16	105	13.44	10.79	14.25	3.16 ± 0.61	1.08	0.73
		2016-17	105	12.44	7.55	13.63	2.24 ± 0.10	2.10	0.85
	Bellary	2014-15	90	12.93	10.35	15.91	2.19 ± 0.73	1.02	0.80
		2015-16	90	13.89	10.93	16.6	2.97 ± 0.48	0.79	0.62
		2016-17	90	14.72	9.74	16.22	3.07 ± 0.21	1.25	0.56
	Bangalore	2014-15	75	15.15	12.18	17.44	1.81 ± 0.18	2.15	0.73
		2015-16	75	16.02	12.76	18.03	2.43 ± 0.29	1.15	1.09
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	105	10.73	8.16	13.25	2.05 ± 0.57	1.67	0.55
		2015-16	75	11.61	8.74	14.01	1.99 ± 0.42	0.83	1.15
		2016-17	75	14.27	9.60	13.87	2.09 ± 0.37	0.92	1.00

Highest LC_{50} : Raichur, Bidar, Gangavati during 2016-17
: Bangalore during 2014-15 & 2015-16

The effect of thiodicarb on the larval population of *H. armigera* was found to be moderate

Ramasubramanian and Regupathy, 2003

Prasad Rao and Grace (2008) reported that LC_{50} value of thiodicarb for *H. armigera* was much higher than that of spinosad, emamectin benzoate and methomyl.

Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Flubendiamide 37.9% SC	Raichur	2014-15	75	0.21	0.16	0.32	1.68 ± 0.19	1.65	0.75
		2015-16	75	0.47	0.30	0.53	1.59 ± 0.28	1.25	0.59
		2016-17	75	0.99	0.66	1.23	1.66 ± 0.31	1.30	0.51
	Kalaburagi	2014-15	105	0.29	0.19	0.51	2.04 ± 0.24	2.49	0.59
		2015-16	75	0.43	0.32	0.58	1.96 ± 0.10	1.64	0.72
		2016-17	75	1.07	0.73	1.39	1.54 ± 0.20	2.34	0.63
	Bidar	2014-15	90	0.25	0.17	0.62	1.14 ± 0.82	1.77	0.68
		2015-16	75	0.42	0.31	0.51	1.51 ± 0.41	1.88	0.91
		2016-17	75	1.00	0.70	1.24	1.75 ± 0.28	2.08	1.00
	Dharwad	2014-15	105	0.19	0.11	0.38	1.75 ± 0.12	1.83	0.99
		2015-16	90	0.41	0.27	0.50	1.49 ± 0.74	2.05	0.84
		2016-17	75	1.10	0.67	1.39	2.29 ± 0.67	1.95	0.83
	Bellary	2014-15	60	0.29	0.12	0.41	2.08 ± 0.08	1.15	0.63
		2015-16	90	0.52	0.28	0.66	1.76 ± 0.55	1.70	1.01
		2016-17	60	1.05	0.69	1.26	2.36 ± 0.15	3.20	1.00
	Bangalore	2014-15	90	0.27	0.17	0.49	1.72 ± 0.38	1.92	1.00
		2015-16	105	0.45	0.32	0.60	2.14 ± 0.41	1.59	0.96
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	90	0.18	0.06	0.39	1.84 ± 0.27	1.93	0.66
		2015-16	90	0.43	0.23	0.55	2.29 ± 0.12	2.00	0.59
		2016-17	75	1.01	0.62	1.28	2.54 ± 0.10	2.14	0.94

Highest LC_{50} : Raichur, Bidar, Bellary and Gangavati during 2016-17

Naresh Kanwar *et al.* (2012) found in their studies, flubendiamide 480 SC was relatively more toxic when compared to the old chemistries. Order of toxicity was flubendiamide 480 SC > indoxacarb14.5 SC > beta-cyfluthrin 2.5 SC > lambda-cyhalothrin 5 EC

Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Chlorantraniliprole 18.5% SC	Raichur	2014-15	90	0.18	0.11	0.38	2.73 ± 0.24	3.52	0.87
		2015-16	105	0.23	0.12	0.41	2.34 ± 0.43	2.59	0.59
		2016-17	75	0.70	0.59	1.17	1.76 ± 0.25	1.74	0.95
	Kalaburagi	2014-15	90	0.25	0.17	0.45	1.86 ± 0.12	2.61	0.76
		2015-16	105	0.43	0.23	0.63	2.19 ± 0.10	3.04	0.90
		2016-17	75	0.94	0.71	1.52	2.25 ± 0.15	2.95	0.88
	Bidar	2014-15	75	0.19	0.13	0.43	1.54 ± 0.59	3.16	1.00
		2015-16	75	0.20	0.13	0.45	1.86 ± 0.21	2.76	1.05
		2016-17	75	0.76	0.56	1.28	3.05 ± 0.20	1.86	1.00
	Dharwad	2014-15	75	0.17	0.10	0.29	2.19 ± 0.26	1.72	0.68
		2015-16	105	0.24	0.10	0.51	2.00 ± 0.10	1.95	1.11
		2016-17	90	0.71	0.61	1.34	2.10 ± 0.36	3.90	0.92
	Bellary	2014-15	75	0.22	0.09	0.36	1.85 ± 0.32	2.58	1.05
		2015-16	90	0.25	0.08	0.39	1.58 ± 0.26	2.44	0.74
		2016-17	90	0.75	0.58	1.40	2.11 ± 0.22	3.20	1.05
	Bangalore	2014-15	90	0.39	0.22	0.55	2.05 ± 0.25	1.86	0.58
		2015-16	90	0.27	0.17	0.49	2.22 ± 0.13	3.15	0.64
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	75	0.20	0.11	0.64	2.13 ± 0.51	2.29	1.06
		2015-16	75	0.19	0.11	0.28	2.09 ± 0.38	2.83	0.85
		2016-17	75	0.74	0.60	1.30	2.00 ± 0.31	1.99	1.13

Highest LC_{50} : Raichur, Bidar, Bellary and Gangavati during 2016-17

LC_{50} for rynaxypyr (0.1 ppm) were significantly lower when compared to two standard insecticides indoxacarb (1.5 ppm) and cypermethrin (13.5 ppm) in a insecticide-treated diet assay on a laboratory colony of tobacco budworm

(Anonymous, 2007)

Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Profenophos 50% EC	Raichur	2014-15	90	29.25	18.2	37.75	1.72 ± 0.38	1.63	0.86
		2015-16	120	34.77	28.43	43.49	2.25 ± 0.74	2.05	1.00
		2016-17	90	33.28	25.66	40.61	1.75 ± 0.54	1.15	0.96
	Kalaburagi	2014-15	105	31.42	20.41	40.82	1.56 ± 0.43	2.14	0.93
		2015-16	120	32.25	22.5	44.59	1.85 ± 0.31	1.80	0.85
		2016-17	75	30.76	19.73	41.71	2.05 ± 0.25	1.93	1.00
	Bidar	2014-15	75	30.28	19.86	42.25	1.29 ± 0.79	1.85	0.56
		2015-16	75	32.07	21.95	46.02	1.55 ± 0.50	2.13	0.93
		2016-17	75	30.58	19.18	43.14	1.55 ± 0.40	2.05	1.00
	Dharwad	2014-15	75	26.41	17.78	32.54	2.04 ± 0.22	1.76	0.88
		2015-16	90	28.20	19.87	36.31	1.93 ± 0.40	2.05	1.05
		2016-17	90	26.71	17.10	33.43	1.03 ± 0.13	2.41	0.95
	Bellary	2014-15	75	27.60	20.23	34.79	1.86 ± 0.22	1.52	0.55
		2015-16	90	29.39	22.32	38.56	2.05 ± 0.20	1.79	1.10
		2016-17	105	27.90	19.55	35.68	1.85 ± 0.25	1.25	1.05
	Bangalore	2014-15	90	33.28	26.34	39.72	1.73 ± 0.56	1.95	1.02
		2015-16	120	31.04	20.29	41.52	2.15 ± 0.29	1.55	1.01
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	90	27.39	20.76	38.22	2.04 ± 0.29	1.98	1.04
		2015-16	75	28.45	22.85	41.99	2.49 ± 0.15	2.00	1.09

Lowest LC_{50} value : Dharwad population

Highest LC_{50} : Raichur population

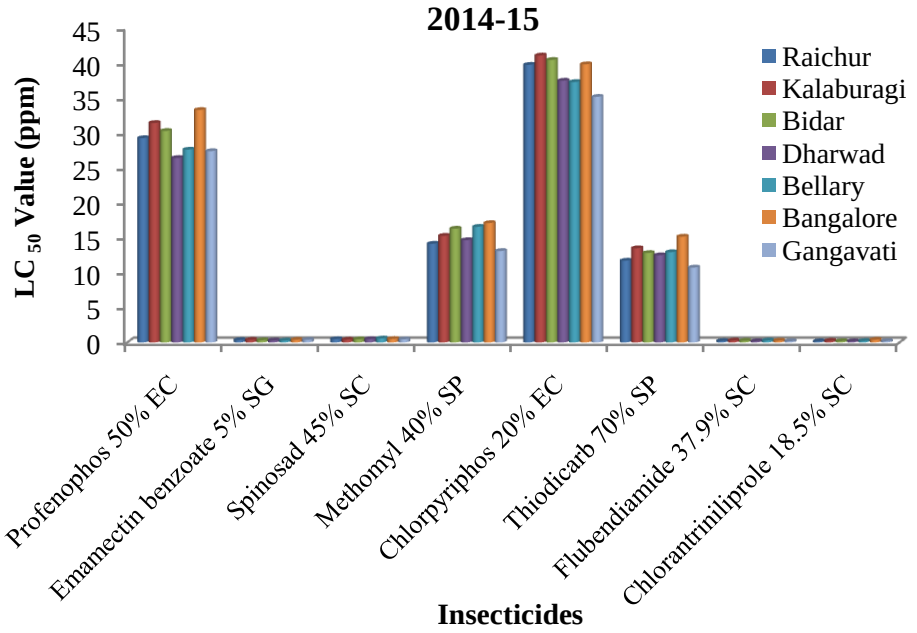
Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Methomyl 40% SP	Raichur	2014-15	90	14.13	10.17	15.88	2.55 ± 0.15	2.09	0.93
		2015-16	105	15.62	11.14	18.79	1.85 ± 0.10	1.98	1.05
		2016-17	75	18.34	13.96	21.15	1.85 ± 0.10	1.11	0.93
	Kalaburagi	2014-15	90	15.27	12.09	18.26	1.75 ± 0.23	2.26	0.79
		2015-16	105	16.76	13.06	21.17	2.45 ± 0.31	2.05	1.00
		2016-17	75	17.05	13.72	22.04	2.45 ± 0.31	2.05	0.59
	Bidar	2014-15	90	16.29	11.86	20.43	1.89 ± 0.28	1.77	1.01
		2015-16	90	17.78	12.77	22.45	2.04 ± 0.10	2.14	0.95
		2016-17	45	18.07	13.43	23.32	2.04 ± 0.10	2.61	0.69
	Dharwad	2014-15	75	14.65	11.96	20.42	1.58 ± 0.34	1.89	0.84
		2015-16	75	16.14	12.59	22.13	2.15 ± 0.20	2.52	1.14
		2016-17	60	16.43	13.25	23.00	2.15 ± 0.20	1.85	0.77
	Bellary	2014-15	90	16.56	12.33	17.37	1.73 ± 0.28	3.05	0.70
		2015-16	75	18.05	13.3	20.28	1.88 ± 0.37	2.79	0.83
		2016-17	90	15.91	11.80	19.66	1.88 ± 0.37	1.77	1.15
	Bangalore	2014-15	90	17.10	13.56	19.08	2.11 ± 0.18	1.79	0.58
		2015-16	90	18.59	14.41	20.99	1.95 ± 0.25	2.00	1.09
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	75	13.10	11.86	17.30	1.66 ± 0.35	1.78	0.66
		2015-16	105	14.59	12.23	19.21	2.05 ± 0.22	1.93	0.78
		2016-17	75	14.88	12.89	20.08	2.05 ± 0.22	2.06	1.04

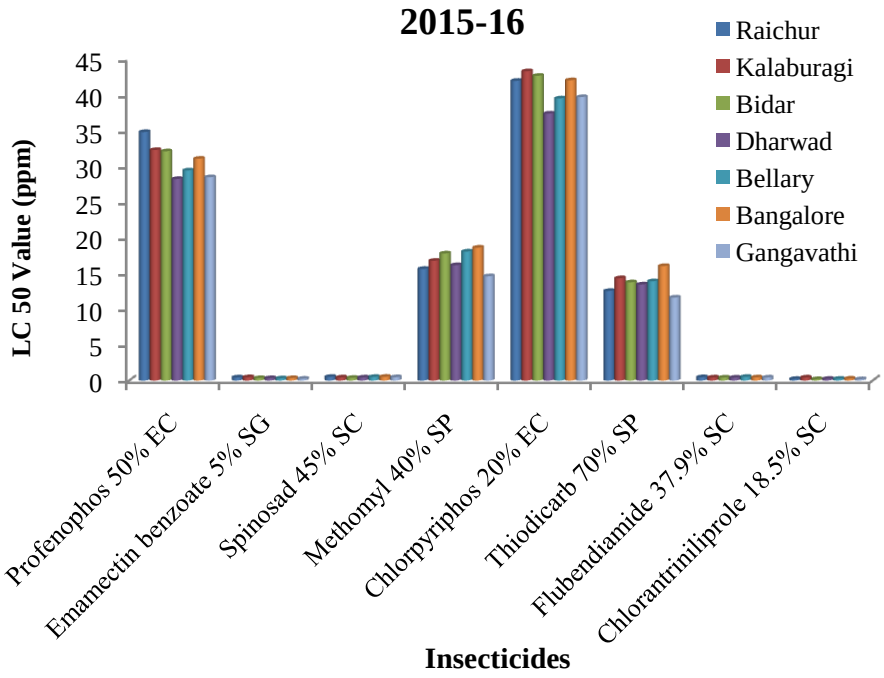
Lowest LC_{50} value : Gangavati population

Highest LC_{50} : Raichur, Bidar and Bangalore population

Insecticides	Location	Year	n	LC_{50} (ppm)	95% (FL)		Slope ± S.E	χ2	P
					LL	UL			
Chlorpyriphos 20% EC	Raichur	2014-15	90	39.74	28.25	47.22	1.85 ± 0.34	3.46	0.55
		2015-16	105	41.93	29.73	48.41	2.14 ± 0.22	2.24	1.05
		2016-17	75	40.60	27.74	47.44	2.14 ± 0.22	2.75	0.76
	Kalaburagi	2014-15	75	41.08	34.78	54.78	2.36 ± 0.72	2.77	0.94
		2015-16	105	43.27	36.26	55.97	2.05 ± 0.51	1.86	0.89
		2016-17	60	41.94	34.27	54.81	2.05 ± 0.51	2.25	0.83
	Bidar	2014-15	90	40.44	32.70	51.78	1.73 ± 0.51	1.82	0.86
		2015-16	90	42.63	34.18	52.88	2.00 ± 0.35	2.54	1.10
		2016-17	60	41.30	32.19	51.91	2.00 ± 0.35	1.96	1.00
	Dharwad	2014-15	90	37.47	32.51	45.82.	2.00 ± 0.55	1.91	0.57
		2015-16	90	37.35	31.00	45.31	1.85 ± 0.29	1.95	0.75
		2016-17	75	36.02	29.01	44.34	1.85 ± 0.29	1.74	1.00
	Bellary	2014-15	90	37.28	26.12	43.18	2.25 ± 0.57	2.73	1.01
		2015-16	75	39.47	27.60	44.35	2.53 ± 0.25	2.74	1.24
		2016-17	75	38.14	25.61	43.38	2.53 ± 0.25	1.58	1.01
	Bangalore	2014-15	75	39.82	33.48	49.73	1.96 ± 0.76	2.08	0.51
		2015-16	105	42.01	34.96	50.92	1.82 ± 0.14	2.39	1.00
		2016-17	--	--	--	--	--	--	--
	Gangavathi	2014-15	90	35.16	29.52	44.18	1.98 ± 0.46	2.19	0.89
		2015-16	90	39.66	33.99	47.01	2.08 ± 0.25	2.10	0.68
		2016-17	75	38.33	32.00	46.04	2.08 ± 0.25	2.02	0.85

Highest LC_{50} value : Kalaburgi, Bidar and Raichur showed for all three years


2014-15
LC 50 Value (ppm)
45
40
35
30
25
20
15
10
5
0
Raichur
Kalaburagi
Bidar
Dharwad
Bellary
Bangalore
Gangavati
Profenophos 50% EC
Emamectin benzoate 5% SG
Spinosad 45% SC
Methomyl 40% SP
Chlorpyriphos 20% EC
Thiodicarb 70% SP
Flubendiamide 37.9% SC
Chlorantriniliprole 18.5% SC
Insecticides


2015-16
LC 50 Value (ppm)
45
40
35
30
25
20
15
10
5
0
Raichur
Kalaburagi
Bidar
Dharwad
Bellary
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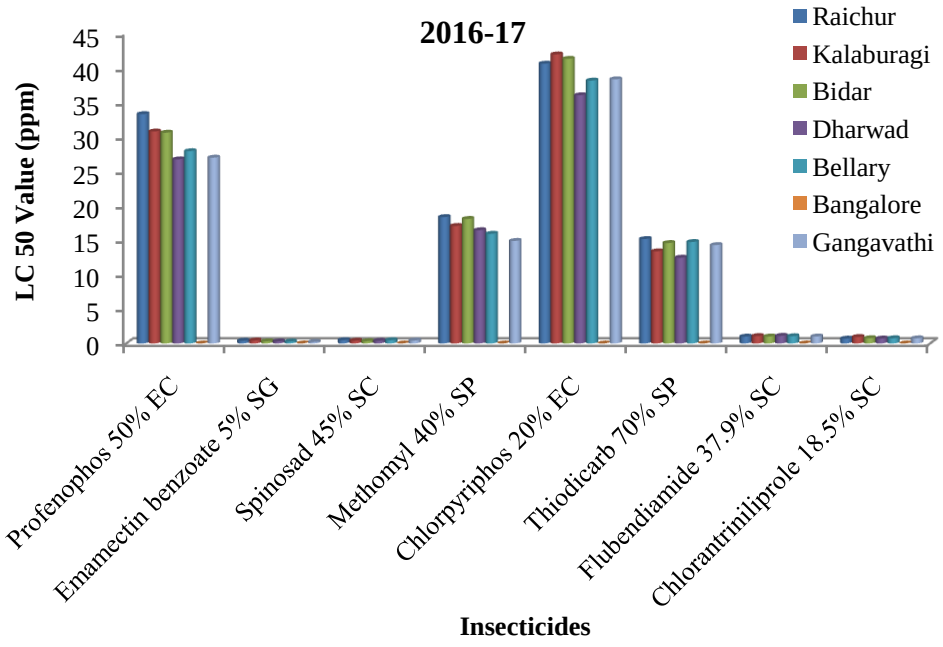
2016-17
LC 50 Value (ppm)
45
40
35
30
25
20
15
10
5
0
Raichur
Kalaburagi
Bidar
Dharwad
Bellary
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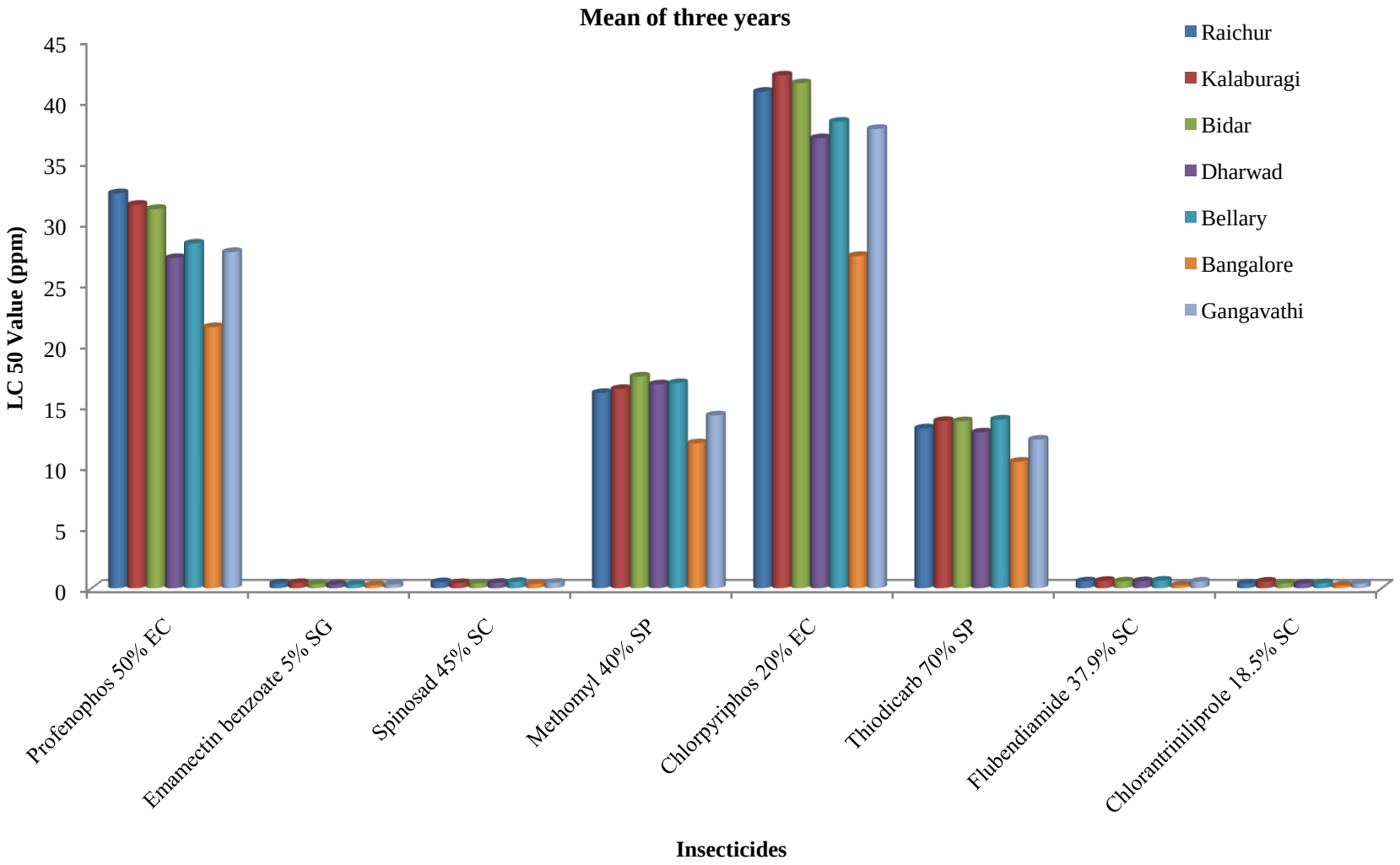

Fig. Effect of insecticides on development of resistance in *Helicoverpa armigera* collected from different areas

Among the tested conventional insecticides in the present study the highest LC_{50} values and slopes was recorded in chlorpyriphos followed by profenophos and both were least effective.

It implies that most of the individuals in the field population are resistant. The data also suggest that the higher inter-population variation in the slope indicates that there are qualitatively different resistance mechanisms developing among the strains.

Conclusion

Bioassay results showed varying degrees of resistance in populations of *H. armigera* collected from six different districts.

The order of toxicity of insecticides tested on *Helicoverpa armigera* was Chlorantraniliprole > Emamectin benzoate > Flubendiamide > Spinosad > Thiodicarb > Methomyl > Profenophos > Chlorpyriphos.

Thank You