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Pest scenario and appropriate management for Bt cotton in Belgaum Karnataka

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ABSTRACT

Prior to introduction of Bt cotton the Belgaum district had more area under short staple and very less area under extra long staple cotton. After the introduction of Bt cotton in 2003-2004 in Belgaum district, the area under cotton decreased however, yield levels increased drastically. Bt cotton suppressed bollworms which were major threat but at the same time minor sucking pests such as mealy bug and mirid bug emerged as major pests, with the regularly occurring jassids, thrips, white flies and natural enemies, disease and disorders. The increased length of cropping period for extra long Bt hybrids was the reason for more occurrence for pest and diseases. The unscientific follow up of general recommendations with more number of sprays, lowered the interest of farmers in taking up Bt cotton. However, the study area followed scientific and appropriate management practices with minimum dosage and less number of sprays for control of pests. This resulted in acceptance of Bt cotton in and around project area. The project was carried out in Belgaum district of Karnataka state covering 42 villages for consecutive years till 2014. The study carried out over the years at selected locations has demonstrated avoidable losses due to important pests and diseases on cotton.

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INTRODUCTION

Cotton occupies only 5 per cent of the total cultivable land but consumes more than 55 per cent of the insecticides used in the industry. Insecticide resistance in the cotton bollworm and other pests leads to poor pest control and consequently repeated and indiscriminate application of insecticides. Resistance problem in the cotton bollworm *Helicoverpa armigera* resulted in a pesticide 'treadmill', poor yields, excessive expenditure and thus, financial losses thereby leading to farmer suicides in some parts of India.

The current strategies are based on results of a network project and yearly documented database of cotton cultivation fields. The strategies place emphasis on efficient use of insecticides to conserve the ecosystem for better pest management. These have been extensively tested over 4-5 years in hundreds of acres in farmer's

fields and were found to reduce insecticide use by 50-90 per cent with yield increases of 10-25 per cent.

MATERIAL AND METHODS

Out of 10 taluk of Belgaum district 5 taluk have been purposively selected which have more cotton growing area in the district. From each taluk five villages have been selected based on the more area covered under Bt cotton. Based on the situation every year 10-25 per cent villages were replaced to understand the pest hot spot and also to spread the cotton protection technologies to new area. Totally 42 villages covered in the project period of five years and all details were collected from the selected fields of 20 villages each consecutive years. The completed data book was consolidated and results were tabulated and interpreted. Pest data was recorded from 20 villages of the district in each year. These villages were selected based on cotton area and totally 5 taluk which had more cotton area were selected.

RESULTS AND DISCUSSION

Pest data in Table 1 to 2 are the average of 20 village fields and five year data are presented in these tables. Sucking pests like Jassids, White fly, Thrips and Aphid data are presented in Table 1. The data of these pests was recorded for 28th to 51st standard meteorological week (SMW) and five years average data is given. The data shows that Jassids population was high between 31st to 38th week and 46th week to 51st week. The pest population was observed less between 39th and 45th week period and that was because of more rainfall occurred. The Jassids population during these five years period not reached ETL but reached only 25 per cent of ETL level.

White fly population (Table 1) was also recorded during the study period. Average population was slight high between standard week of 33rd to 36th, 43rd and 50th to 51st. In all the five years, pest load was little high during 2013. The average data in Table 1 shows that pest did not reach ETL but could reach upto 25 per cent ETL status.

Thrips pest average data (Table 1) shows that higher population recorded between the periods of 30th to 40th week. The pest reached 50 per cent of ETL status in 33rd week and in the remaining crop period it was below 25 per cent of ETL level. The observations of individual year shows that thrips pest load was higher in 2012 and 2011 and pest crossed ETL in long dry spell of 2013 between 32nd and 33rd week period (Table 1). The population was very low during 2011 because of heavy rainfall throughout the crop season.

Aphid population recorded data (Table 1) shows that the pest was present throughout the crop season in all the five years and it reached ETL status in all the five years between 31st and 33rd week. During 2010 the pest level was higher for longer period of early vegetative and square initiation period.

The mirid bug was observed in all the five years. The data in Table 1 shows that mirid incidence was very less in 2010 and 2011. The incidence of the pest noticed between 33rd to 51st weeks in 2012 and 2013. The pest incidence was much higher in 2013 compared to other years. The mirid bug crossed ETL level (6.13/plant) in 36th week during 2013.

The data in Table 1 shows that mealy bug incidence was not noticed in the project village during 2010 and the pest incidence noticed during 2011 between 32nd SMW and 35th SMW. In 2012 and 2013 pest incidence was observed from 31st SMW to 49th SMW. In 2014, mealy bug population was very less.

Bollworms like American bollworm, spotted bollworm, pink bollworm and spodoptera pest population was recorded for five years and average data of five years presented in Table 2. The table shows that the population of ABW reached ETL status of 25 per cent during 35th to 44th SMW, SBW reached ETL status of 25 per cent during 31st to 37th SMW and PBW reached ETL status of 25 per cent during 40th to 45th SMW. The population of spodoptera reached ETL status of 25 per cent during 30th to 31st SMW and 33rd to 40th SMW. In the remaining weeks bollworm population was not found.

Data in Table 3 shows that the populations of natural enemies (coccinellids, chrysoperla and spider) were present in the field throughout season. The population of coccinellids was found more compared to chrysoperla and spider.

The data shows that the population of coccinellids per plant was in higher range (0.50 to more than 1.00) between 28th to 42nd SMW. Population per plant was in moderate range of 0.25 to 0.5 during 43rd to 48th SMW.

The population of Chyrsoperla per plant was in the moderate range of 0.25 to 0.5 during 30th to 31st and 33rd SMW. In the remaining weeks population was low upto 0.25 per plant. The population of spider per plant was in

Table 1: Pest Scenario of Bt cotton in Belgaum of Karnataka during 2010-2014

Pest	Year	Standard meteorological week																							
		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Jass-	2010	0.13	0.38	0.78	0.97	2.62	1.82	1.71	1.48	1.18	1.37	1.42	1.09	0.41	0.33	0.13	0.19	0.24	0.58	0.72	0.94	1.20	1.34	1.10	1.22
ids	2011	0.28	0.42	0.61	1.06	1.92	1.24	2.30	1.94	1.24	1.38	1.57	1.12	1.01	0.69	0.51	0.42	0.53	0.68	0.81	0.86	0.70	0.92	0.82	0.67
	2012	0.35	0.65	0.82	0.93	0.82	1.55	1.65	1.61	1.66	1.51	1.66	0.17	0.11	0.21	0.31	0.23	0.41	0.62	0.90	0.93	1.03	1.10	0.67	0.81
	2013	0.46	0.64	0.88	1.06	1.76	2.00	1.44	1.14	1.31	1.37	1.22	0.97	0.72	0.78	2.03	2.34	2.61	2.01	2.04	2.67	3.01	3.24	3.04	2.97
	2014	0.27	1.65	1.29	0.81	0.93	1.01	1.22	0.83	0.95	0.81	1.24	1.06	0.90	0.93	1.03	1.08	1.04	0.97	0.82	0.79	0.80	0.80	1.97	2.4
	Average	0.30	0.75	0.88	0.97	1.61	1.52	1.66	1.4	1.27	1.29	1.42	0.88	0.63	0.59	0.80	0.85	0.97	0.97	1.06	1.24	1.35	1.48	1.52	1.61
White	2010	0.19	0.29	0.64	0.59	0.62	0.91	1.09	1.40	1.41	1.04	0.58	0.50	0.92	1.27	1.16	1.20	1.17	0.91	1.10	1.01	1.20	1.10	0.94	0.82
fly	2011	0.21	0.30	0.81	0.38	0.72	0.93	1.03	1.81	1.30	0.94	0.74	0.81	0.52	0.62	0.60	0.72	0.68	0.62	0.34	0.36	0.61	0.68	0.64	0.59
	2012	0.32	0.45	0.48	0.40	0.43	0.82	0.85	1.12	1.10	0.82	0.89	0.85	0.90	0.84	0.81	0.88	0.98	1.15	0.83	0.53	0.50	0.62	0.53	0.75
	2013	0.55	0.64	0.98	1.55	1.96	2.09	1.38	1.05	1.23	1.19	1.45	1.43	0.94	0.88	1.37	1.34	1.38	1.46	1.67	1.54	1.50	1.43	1.36	1.02
	2014	0.0	1.75	1.28	0.95	1.17	0.98	0.84	0.91	1.18	0.82	1.18	0.74	0.75	0.83	0.93	0.84	0.75	0.77	0.61	0.52	0.54	0.44	1.60	2.28
	Average	0.25	0.69	0.84	0.77	0.98	1.15	1.04	1.26	1.24	0.96	0.97	0.87	0.81	0.89	0.97	1.00	0.99	0.98	0.91	0.79	0.87	0.85	1.01	1.09
Thr-	2010	1.20	4.21	3.91	9.03	13.82	23.50	21.2	19.40	13.7	9.52	6.31	8.37	12.7	8.6	2.20	3.64	1.94	0.94	1.41	0.41	0.74	0.59	0.55	0.48
ips	2011	2.70	7.63	7.44	13.00	23.91	15.84	18.62	20.30	21.6	23.21	20.10	12.30	10.14	9.11	6.12	5.41	1.42	1.20	0.94	0.86	1.07	0.64	0.63	0.51
	2012	0.42	4.65	7.64	11.73	11.92	16.82	6.22	7.74	6.57	6.88	10.40	7.54	4.27	3.86	3.39	3.02	0.96	2.30	1.55	0.95	0.43	0.46	0.312	0.31
	2013	2.02	7.46	21.73	23.10	44.57	55.72	26.16	17.38	18.38	16.67	13.95	14.49	23.05	1.94	2.38	1.92	0.94	1.24	0.97	1.02	0.34	0.61	0.52	0.38
	2014	1.42	4.25	2.50	5.94	4.61	5.54	7.03	5.79	6.69	5.54	6.63	5.16	3.61	2.96	3.21	2.95	1.7	1.76	1.12	0.59	0.37	0.55	1.44	1.83
	Average	1.55	5.64	8.64	12.76	19.77	23.48	15.85	14.12	13.39	12.36	11.48	9.57	10.75	5.29	3.46	3.39	1.39	1.49	1.20	0.77	0.59	0.57	0.69	0.70
Aph-	2010	0	0	1	1	1	1	1	1	0.84	0.71	0.41	0.67	0.20	0.31	0.47	0.5	0.62	0.51	0.48	0.57	0.31	0.12	0.12	0.06
ids	2011	0.41	0.61	0.72	1	1	1	1	0.87	0.47	0.52	0.82	0.68	0.41	0.53	0.62	0.71	0.45	0.31	0.19	0.24	0.09	0.08	0.13	0.17
	2012	0.58	0.67	0.69	1	1	1	0.54	0.44	0.83	0.71	0.91	0.12	0.07	0.04	0.11	0.27	0.22	0.20	0.16	0.14	0.13	0.14	0.11	0.18
	2013	0.29	0.35	0.38	1	1	1	1	0.69	0.71	0.84	0.54	0.61	0.69	0.46	0.25	0.18	0.15	0.30	0.45	0.53	0.21	0.18	0.11	0.13
	2014	0.0	0.0	1	1	1	1	1	0.71	0.43	0.42	0.41	0.36	0.47	0.48	0.34	0.31	0.27	0.26	0.24	0.22	0.30	0.19	0.39	0.45
	Average	0.32	0.41	0.76	1.00	1.00	1.00	0.91	0.74	0.66	0.64	0.62	0.49	0.37	0.36	0.36	0.39	0.34	0.32	0.30	0.34	0.21	0.14	0.17	0.20

Table 1 : Contd……

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Other sucking pest scenario

Pest	Year	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
		Standard meteorological week																							
Mirid	2010	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0.3	0.4	0	0	0	0	0.04	0.21	0.1	0
bug	2011	0	0	0	0	0	0.65	1.23	1	1.4	0.06	0.05	0	0	0	0	0	0	0	0	0	0.1	0.31	0.22	0.08
	2012	0	0	0	0	0	0.41	2.91	0.01	0.01	0.02	0.28	0.06	0.97	0.26	0.35	1.99	1.1	1.1	0.71	0.42	0.46	0.6	0.39	0.56
	2013	0	0	0	0	0	0.74	2.19	3.73	6.13	1.89	2.98	2.03	2.38	0.76	0.24	1.54	2.19	1.02	0.98	1.86	0.84	0.94	0.61	0.21
	2014	0	0	0	0	0	0.02	0.04	0.01	0.05	0.10	0.21	0.19	1.25	1.38	1.31	1.35	0.34	2.60	1.42	0.76	0.29	0.30	0.47	0.48
	Average	0	0	0	0	0	0.36	1.27	0.95	1.52	0.41	0.70	0.46	0.92	0.48	0.44	1.06	0.73	0.94	0.62	0.61	0.35	0.47	0.36	0.27
Mealy	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
bug	2011	0	0	0	0	0.1	0.01	0.03	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2012	0	0	0	0.01	0.17	0.10	0.10	0.09	0.14	0.13	0.14	0.14	0.16	0.12	0.16	0.15	0.09	0.10	0.06	0.02	0.007	0.006	0.01	0.04
	2013	0	0.03	0.02	0.02	0.02	0.03	0.05	0.04	0.02	0.03	0.05	0.06	0.04	0.03	0.04	0.04	0.03	0.14	0.04	0.15	0.002	0.001	0	0
	2014	0	0	0.08	0	0	0.002	0.003	0.004	0	0.002	0.002	0.01	0	0.002	0.02	0.02	0.01	0.03	0.03	0.05	0.03	0	0	0
	Average	0	0.008	0.020	0.006	0.058	0.028	0.037	0.047	0.032	0.032	0.038	0.042	0.040	0.030	0.044	0.042	0.026	0.054	0.026	0.044	0.008	0.001	0.002	0.008

higher range of 0.5 to 1.00 in 35th and 38th SMW and in moderate range of 0.25 to 0.5 during 29th to 34th, 37th, 39th to 40th and 46th to 47th SMW. During 41st to 45th SMW the population was upto 0.25 per plant.

Emerging secondary pests :

Mirid bug management practices :

– Mirid are important sucking pests in cotton and 2 to 4 sprays are usually required to manage them during the growing season.

– If the incidence of cotton mirid bug is seen take up spraying of Acephate 70SP@1g/lit of water. Imidacloprid 200SL @0.2ml/lit. Acetamiprid 20SL @ 0.15g/lit. Use of *Neem* based insecticides. Application of Fipronil 5SC @ 1 ml/lit or Monocrotophos @ 2 ml/lit of water is suggested as a short term emergency measure.

Thrips management practices :

– Avoid late sowing.

– Encourage the activity of parasitoids thripoctenus briu, Triphleps tantilus and mite campsid species.

– Spray 5 per cent *Neem* seed kernel extract or crude neem oil @1 per cent to suppress thrips population.

– Detergent /soap power @ 1 g/lit of spray fluid is to be added for getting uniform spray suspension.

– Spray systematic insecticide based on ETL 0.075g chlothionidion 50WDG, or 1 g acephate or 0.2 g. acetamiprid 20SP or 0.2 g. thiamethoxam 25WG or 0.25 ml imidacloprid 17.8SL or 2ml dimethoate 30EC or fipronil 5SC @ 1 ml/lit.

Bt cotton has a higher resistance to pests (Gaur and Choudhary, 2010) due to the toxic Bt toxin given out by the crop. In India, Bt cotton has been enveloped in controversies due to its supposed links with seed monopolies and farmer suicides. However, the link between the introduction of Bt cotton to India and a surge in farmer suicides has been refuted by other studies with farmer suicides actually having fallen since the introduction of Bt cotton (Plewis, 2014). Bt cotton accounts for 93 per cent of cotton grown in India (Jayaraman, 2012).

There are some studies that find that Bt cotton does not significantly increase yield and income and bollworms continue to grow, These studies identify a variety of factors for the failure of Bt cotton such as limited knowledge on how to use the technology, prevalence of a black market for un-improved Bt cotton varieties and

Table 2 : Bollworm pest scenario during 2010-14

Pest	Year	Standard meteorological week																							
		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
ABW	2010	0	0	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.0	0.02	0.01	0	0	0	0	0	0	0
	2011	0	0	0	0	0	0	0	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.04	0.02	0	0	0	0	0	0	0
	2012	0	0	0	0	0	0	0	0.05	0.01	0.01	0.01	0.04	0.01	0.02	0.01	0.01	0.01	0	0	0	0	0	0	0
	2013	0	0	0	0	0	0	0	0.02	0.01	0.02	0.02	0.03	0.03	0.01	0.01	0.09	0.10	0	0	0	0	0	0	0
	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.002	0	0	0
	Average	0	0	0	0	0	0	0	0.02	0.004	0.01	0.01	0.014	0.01	0.01	0.008	0.032	0.028	0	0	0	0.0004	0	0	0
SBW	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2011	0	0	0	0.01	0.02	0.20	0.05	0.04	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2012	0	0	0	0.04	0.06	0.05	0.0	0.01	0.02	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2013	0	0	0	0.01	0.03	0.11	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0
	Average	0	0	0	0.012	0.022	0.072	0.034	0.01	0.024	0.006	0	0	0	0	0	0	0	0	0	0	0	0.002	0	0
PBW	2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2011	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.02	0.03	0.1	0	0	0	0	0	0	0
	2012	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.09	0.01	0	0	0	0	0	0	0	0
	2013	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0.03	0.11	0.08	0.1	0.04	0	0	0	0	0	0
	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.008	0
	Average	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0.006	0.044	0.024	0.04	0.008	0	0	0	0	0.0016	0
Spod-	2010	0	0	0	0	0	0.1	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
optera	2011	0	0	0	0	0	0	0.04	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2012	0	0	0.01	0.02	0	0	0.02	0.0	0.01	0.01	0.02	0.0	0	0	0	0	0	0	0	0	0	0	0	0
	2013	0	0	0	0	0	0.01	0.01	0.0	0	0	0.01	0.01	0.03	0	0	0	0	0	0	0	0	0	0	0
	2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.002	0	0	0	0	0	0
	Average	0	0	0.002	0.004	0	0.022	0.016	0.002	0.002	0.002	0.006	0.002	0.006	0	0	0	0	0.0004	0	0	0	0	0	0

Table 3 : Natural enemies complex during 2010-14

Pest	Year	Standard meteorological week																						
		28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Coccinellid	2010	0.86	0.66	0.54	1.0	0.5	0.7	0.18	1.15	1.12	1.02	2.01	1.01	0.90	0.48	0.84	0.59	0.67	0.46	0.58	0.37	0.20	0.13	0.11	0
	2011	1.14	1.32	1.2	1.1	1.5	1.6	1.83	0.83	0.31	0.10	1.94	1.05	1.12	0.96	1.24	0.85	0.64	0.16	0.84	0.94	1.40	0.45	0.16	0.10
	2012	1.40	1.61	1.72	0.70	0.56	0.44	1.24	0.53	1.46	0.37	0.37	0.31	0.35	0.35	0.19	0.25	0.26	0.25	0.18	0.15	0.13	0.1	0.1	0.16
	2013	0.38	0.4	0.59	0.93	1.00	1.17	0.87	0.89	0.83	0.70	0.54	0.41	0.41	0.41	0.35	0.34	0.29	0.36	0.48	0.68	0.59	0.52	0.11	0
	2014	0.0	0.0	1.44	0.61	0.64	0.66	0.72	0.82	0.57	0.53	0.42	0.39	0.25	0.35	0.29	0.22	0.23	0.25	0.20	0.18	0.14	0.16	0.38	0.55
	Average	0.95	1.00	1.10	0.87	0.84	0.91	0.97	0.84	0.86	0.54	1.06	0.63	0.61	0.51	0.58	0.45	0.42	0.30	0.46	0.46	0.49	0.27	0.17	0.16
Chrysoperla	2010	0	0	0.13	0.04	0.12	0.31	0.19	0.23	0.03	0.32	0.27	0.24	0.22	0.17	0.11	0.10	0.08	0.07	0.02	0	0	0	0	0
	2011	0	0.0	0.6	0.60	0.14	0.37	0.23	0.28	0.06	0.10	0.39	0.32	0.19	0.20	0.14	0.11	0.13	0.07	0.09	0.12	0.04	0.01	0	0
	2012	0	0.31	0.53	0.66	0.48	0.28	0.23	0.30	0.28	0.30	0.27	0.08	0.04	0.01	0.01	0.04	0.02	0.03	0.03	0.01	0.04	0.01	0	0
	2013	0.03	0.10	0.19	0.37	0.23	0.18	0.16	0.23	0.26	0.21	0.19	0.28	0.32	0.19	0.14	0.21	0.33	0.27	0.19	0.24	0.10	0.02	0.01	0
	2014	0.0	0.0	0.19	0.03	0.05	0.17	0.09	0.17	0.20	0.12	0.07	0.08	0.06	0.04	0.04	0.04	0.02	0.03	0.02	0.03	0.04	0.04	0.06	0.15
	Average	0.01	0.10	0.33	0.34	0.20	0.26	0.18	0.24	0.17	0.21	0.24	0.20	0.17	0.12	0.09	0.10	0.12	0.09	0.07	0.08	0.04	0.02	0.01	0.03
Spider	2010	0	0	0.4	0.4	0.3	0.3	0.1	0.4	0.4	0.6	0.79	1.02	0.5	0.24	0.24	0.19	0.23	0.20	0.27	0.23	0.25	0.18	0.17	0.03
	2011	0.6	0.9	0.7	0.8	1.1	1.1	1.3	1.3	1.0	0.91	0.84	0.42	0.24	0.21	0.09	0.14	0.17	0.11	0.24	0.14	0.04	0.01	0.01	0
	2012	0	0.06	0.21	0.27	0.41	0.42	0.37	0.38	0.44	0.40	0.43	0.04	0	0	0.01	0.06	0.09	0.13	0.16	0.13	0.12	0.21	0.22	0
	2013	0.31	0.22	0.21	0.24	0.23	0.25	0.27	0.32	0.31	0.28	0.30	0.28	0.29	0.28	0.26	0.26	0.24	0.43	0.49	0.6	0.42	0.21	0.29	0.06
	2014	0.0	0.0	0.19	0.12	0.14	0.20	0.19	0.20	0.17	0.20	0.16	0.23	0.23	0.25	0.25	0.25	0.22	0.22	0.21	0.18	0.13	0.15	0.27	0.27
	Average	0.23	0.30	0.34	0.37	0.44	0.45	0.45	0.52	0.46	0.48	0.50	0.40	0.25	0.20	0.17	0.18	0.19	0.22	0.27	0.26	0.19	0.15	0.19	0.07

climatic variations and other disasters.

Negating these findings are studies by Ali and Abdulai (2010), who indicate that the overall outcome of adopting Bt cotton is positive for all farm categories, but in varying degrees. While the literature on the impacts of Bt cotton on small farmers is mixed, other worries remain about the long term impacts of Bt cotton. Two public bads that can occur are the loss of biodiversity and genetic pollution (Park *et al*., 2011). Biodiversity loss may occur as farmers start planting only Bt cotton on their farms

Conclusion :

The pest scenario over the years serve as a platform to validate and refine IPM practices for cotton and other crops in tune with the emerging problems, assimilate knowledge base on pests, practices, products and personnel of the country, link public and private institutions for effective large scale IPM implementation, and offer training cum consultancy in crop protection techniques across the country.

Standardization of protocols for mass multiplication of bio agents and evaluation of IPM packages of major crops based on socio-economic and environmental quotient impacts formed active components of the centre's field extension programmes. Updating of crop pest database, model development for sucking pests, mealy bug, mirid bug predictions, development of information systems on mealy bug and mirid bug in Bt cotton serve to ensure effective monitoring and control of insect pests and there by sustainable production.

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