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Impact of Dissemination and Adoption of Insecticide Resistance Management (IRM) Strategies against Cotton Pests – A Case Study in India

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ABSTRACT

The IRM strategy was devised for pest management in Bt and non-Bt cotton was implemented and evaluated in cotton growing villages of Warangal district in a Telangana state of India during the year 2015-16. The application of insecticides was moderate in IRM villages i.e, Kannaipally & Kanchanpally and the insecticide consumption was high in non IRM village i.e. Gabbeta. The whole crop season was divided into "4" window periods. The chemicals like Monocrotophos was given to the plants by stem application method in IRM villages. Stem application is employed as only less amount of insecticide is utilized, it doesn't have any effect on the non target and other useful insects, and also there will be no spilling of the insecticide here and there. The number of insects per 3 leaves per plant reduced to a great extent in IRM villages. This eventually leads to more productivity and less cost of production in IRM villages than that of the non-IRM village. The Aphid, Jassid, Thrips and Whitefly population ranged 13.35, 0.82, 10.04 and 0.31/ 3 leaves in IRM villages while, it was 17.24, 1.04, 10.32 and 0.32/ 3 leaves in non –IRM village. The mean cost of sprayings was higher in non-IRM villages (Rs.3968) as compared to IRM villages (Rs.2301). Cotton yield was higher in IRM adopted villages (17.7 q/ha) as compared to non-IRM village (17.1 q/ha) and net profit per/ha was more in IRM villages (Rs.18, 910) than non-IRM villages (Rs.8,860). Farmers, by adopting IRM strategies realized higher net returns by saving in plant protection cost due to less number of insecticidal sprays and increased seed cotton yield.

Introduction

Cotton is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. Almost 65% of the area under cotton is rain fed with erratic and poorly distributed rains during the cropping season. India has the largest area under cotton cultivation in the world. Cotton in India provides direct livelihood to "6" million farmers and about 40-50 million people are employed in the cotton trade and its processing. Cotton shares 35% of fiber market with an income of 42,000 crores from the exports. For such an important cash crop, the loss of hundreds of acres worth of harvest due to pest attacks proves to be a big loss to farmers as well as the industry. To counter the effects of insect attacks, many pesticides were being applied; to which insects are getting resistance (Reed and Pawar 1982). For this reason, the IRM strategy has become a solution. The IRM strategies are designed to reduce the development of insecticide resistance and are based on the use of a rational and sensible sequence of insecticides that are effective on the target species, cause least disturbance to beneficial fauna. Resistance management strategies should incorporate all available methods of control for the insect pest concerned and helps in conservation of ecosystem and management of field selected and practical resistance that reduces the efficacy of a pesticide and has practical consequences for pest control (Tabashnik 1994,Tabashniket al. 2000, Burknesset al. 2001). Of all the crops, cotton crop has been subjected to maximum pesticide exposure of 50% than any other crop (Kranthi et al 2002). Though, the insecticides increased the agricultural production, their utility has been limited by the evolution of resistance in many major pests. Insecticide use has been causing undesirable ecological consequences for cotton cultivators. Even the genetically engineered Bt cotton is also nowadays prone to insect attacks, as the insects are getting resistance to Bt-toxins. This strengthened the development or design of new IRM strategies, which have now, became a powerful tool of evolutionary biology. The IRM strategies are meant to overcome the existing resistance crisis through specific strategies to ensure efficient pest control and mitigate the problem of resistance. The management strategies will slow down the resistance property of the insects to the insecticides. More reliable and rapid assays to detect resistance and understanding of the population dynamics of cotton pests are also needed to assess and predict the response of the pest populations to counter measures. IRM strategies are boon for the dissemination of insecticide resistance of the insects.

Materials & Methods:

The farmer's participatory window based IRM strategies for cotton pests were implemented in 2 villages in Warangal district of Telangana state in the year 2015-16.

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An area of 150 acres was undertaken for IRM evaluation with the participation of 38 farmer's from the 2 villages. In addition, one more village Gabbeta has taken as non-IRM village with an area of 51 acres. The impact of insecticide usage pattern for cotton pest management was implemented and evaluated in the farmer's fields of IRM villages Kannaipally & Kanchanpally. The insecticide usage pattern was done by the farmers under the guidance of IRM staff. In Gabbeta, the non-IRM village, no such guidance was given to the 15 farmers.

Table 1. List of IRM and Non IRM Villages of Warangal District.

IRM village	Name of the village	No. of Farmers	Area in acre
1	Kannaipally	22	75
2	Kanchanpally	16	75
	total	38	150
Non-IRM village			
1	Gabbeta	15	51

The following window based system was implemented.

Window-I: (sucking pest management 1st week of July)

The temperature during this window period ranged between 24^{0c} & 31^{0c} with an average rainfall of 72.2 mm. For conserving the initial build up of natural enemies, sucking pest tolerant varieties have to be selected. Bt cotton varieties like Jaadoo, ATM, Sarpanch, First class, Dr.Brent, Neeraja, Jackpot, Balwan,Yuva, KCH-999, Pooja etc were sown in both IRM & non-IRM villages. Chemical seed treatment was done to delay the first spray. Seed treatment with Imidacloprid is done during this stage. To avoid Mealy bug infestation weed plants has to be removed as they generally grow on them. Spacing adopted is 90x60 cm.

Window-II: (1st-4th week of August)

The temperature during this period is between 23^{0c} & 29^{0c} with an average rainfall of 156.8mm. Sucking pest were more in number in this period. Farmers were advised to avoid excessive use of insecticide both on Bt-cotton & non Bt-cotton in IRM villages, as it hastens the development of bollworm resistance to the chemicals. Further, they were advised to employ the stem application method which is an integral part of the eco-sustainable insecticide resistance management programmes. Stem application has been done at 30, 45 & 60 days after sowing. In this way three times stem application was done in this period. In the 1st week of August the first stem application was done with monocrotophos and water in the ratio of 1:4 for sucking pests. Second stem application was done in the 4th week of August (i.e., after 40 days) with monocrotophos for sucking pests. Apart from this 5% Neem seed extract which is a biological pesticide was applied. In this window period Aphids, Jassids, and Thrips were seen more in number and traces of white fly were also noticed.

Window-III: (September- October)

The temperature ranged between 22^{0c} & 29^{0c} in this window period with an average rainfall of 333 mm in September and 6.6 mm in October. 3rd stem application was done in the 3rd week of September (60 days) with monocrotophos. 5% Neem seed extract was also applied. In IRM villages, the beneficial fauna were still persistent due to eco-friendly practices. This resulted in the less usage of further insecticides. Whereas in non-IRM village more number of insecticides were applied due to the loss of beneficial fauna. Traces of Spodoptera were found in one plant during this window period. In this period the number of insecticide applications was more in non-IRM than that of IRM villages.

Window-IV: (November – December)

The temperature ranged between 16^{0c} & 27^{0c} with almost no rainfall in both the months. Farmers showed no interest in spraying insecticides due to lack of rain. Sucking pests like Aphids, Jassids, Thrips were still found in this window period. Apart from these, traces of spiders and coccinellids were also seen. By the end of November farmers started picking. However, by the end of December most of the farmers started picking in their fields. By the end of January, farmers picked 90% bolls in their fields which got completed by the end of February. Manual picking was preferred as it preserves the fiber characteristics of cotton intact. Nevertheless, some farmers extended their crop season by providing good irrigation facilities in such fields the Pink bollworm was found. By the introduction of Bt cotton Pink bollworm was almost eradicated, but they re-appeared, which is a good example for the current scenario of Bt resistance.

Results:

Window-I:

The selection of pest resistant variety plants has avoided primary infestation by the pests. Removal of weeds resulted in the eradication of the mealy bug. Seed treatment with Imidacloprid reduced the usage of chemical insecticides in IRM village & non-IRM village. Seed treatment and selection of pest resistant varieties resulted in the avoiding of the first spray in this window period. In the early period the numbers of insects are however more in IRM villages than that of non-IRM village.

Window-II:

Stem application method was very much effective on the insects in this window period. In this window period, sucking pests were more. Hence insecticide sprays were used against them. However the number of sprays in the IRM villages was less than that of the non-IRM villages

Window-III:

By the stem application process done in the 2nd window period the number of insects are relatively low in the IRM villages. Of all the window periods, the insecticide applications were more in this window period. Organophosphates like Monochrotophos were used against the sucking pests. The insecticides used in more quantity in the non-IRM village than the IRM villages.

Window-IV:

It was the period of harvesting. Due to the earlier stem applications, there was no need arised for further sprays and was almost reduced in the IRM villages, as the insect number gradually decreased.

The data on the incidence of sucking pests in IRM fields revealed that the aphid seasonal mean incidence was 13.35/ 3 leaves and 17.24/ 3 leaves in non-IRM fields. Among the sucking pests, thrips was the major pest and considerable activity was observed from July to September end. The number of thrips increased with increase in temperature and decrease with increase in rain. Their number was more in the month of September with an average of 31.3/top 3 leaves in IRM villages and 35.41/top 3 leaves in non-IRM village. Jassids were more in the month of September with 2.72/ 3 leaves in IRM village while, in non-IRM village it was 2.40/ 3 leaves. The white fly number generally increases from the month of October to February. In IRM village the number was more in the month of November.

Table 2. Seasonal mean of Insect Pest & Natural Enemies in IRM and Non-IRM fields of Warangal district (Telangana).

Number of insects/ 3 leaves*				No. of *Helicoverpa* affected squares/ plant	No. of *Spodoptera* affected leaves/ plant	% Pink boll worm damage	Number of spiders/ plant	Number of coccinellids/plant
Aphids	Jassid	Whitefly	Thrips					
IRM village (Bt cotton)								
13.35	0.82	0.31	10.04	0.0	0.16	0.02	0.21	0.08
Non IRM village (Bt cotton)								
17.24	1.04	0.32	10.32	0.0	0.0	0.08	0.31	0.05

In IRM villages, the number was on an average 0.31/top 3 leaves, whereas in the non-IRM village the average number was 0.32/top 3 leaves.

The strategic positioning of insecticides coupled with eco friendly technologies led to an abundance of natural enemies in the cotton ecosystem in IRM fields.Insect management actions were taken at the economic threshold levels and thus prevented the insect density that would reach the economic injury level.

Insecticide sprays

The insecticide sprays were done to reduce the sucking pests. In two IRM villages 5 times insecticidal sprays were done on an average for an area of 150 acres. Whereas in non-IRM village 7 insecticidal sprays were done an average for an area of 51 acres.

Yield in IRM and non-IRM villages

Early planting i.e., before the onset of monsoon increases the yield. In both the IRM & non-IRM the planting was done in the first fortnight of July. The minimum usage of pesticides and eco-friendly programs in IRM villages fetched more yield than the non-IRM village.The yield in IRM village was 17.7 q/ha while it was 17.1q/ha in non-IRM village.

Cost of production

Due to less use of insecticides, the cost of production was relatively low in the IRM villages with Rs.53,660/ha.The more number of insecticides we use, the more expensive it becomes to manage the cotton crop, this has become true in the case of non-IRM village, whose cost of production was Rs. 61,250/ha.

Income & Profit

The eco friendly ways brought an income of Rs.72,570 /ha with a net profit of Rs.18,910/ha in IRM village.In non-IRM village the income was Rs.70,110/ha with net profit of just Rs. 8860/ha. At last, one of the best ways to retard resistance evolution is to use insecticides only when controls by natural enemies fail to limit economic damage.

Table 3. Impact Of IRM Technology In Warangal district (Telangana).

Attributes	IRM village	Non-IRM village
No. of Sprays	05	07
Cost of Sprays(Rs)	2301	3968
Cotton Yield(qt/ha)	17.7	17.1
Gross Income(Rs/ha)	72570	70110
Net profit(Rs/ha)	18910	8860

Discussion.

Impact of IRM-strategies on cotton in Warangal district during 2015-16

Incidence of sucking pests

By implementing IRM strategies the major sucking pests of cotton were controlled effectively and present study revealed that the seasonal mean incidence of aphids, jassids and whitefly were lower in the IRM fields compared to non IRM fields.

A low incidence in IRM fields could be attributed to ecofriendly technologies like seed treatment, stem application with insecticides, conservation of natural enemies with the low usage of insecticides for sucking pests. According to Mohpatra and Patnaik (2006) seed treatment with imidacloprid suppressed the sucking pests and also attributed to conservation of natural enemies in IPM plots. Wang et al.1994 reported that painting of stems with 7% monocrotophos or carbofuran was the most effective method compared to spraying and seed treatment against aphids in cotton. Ramarao et al.1998 reported that stem application with imidacloprid (200 SL) at 1:20 dilution at 20, 40, 60DAS was highly effective in controlling aphids, leaf hoppers and mealy bugs in cotton.

Economics

By implementation of IRM strategies farmers had realized higher seed cotton yield with a low investment on insecticides by reduced number of insecticidal sprays.Monitory benefit of Rs. 18,910/ha was achieved by farmers in IRM fields by saving in plant protection cost and increased seed cotton yield compared to non IRM fields. The IRM strategies let the farmers reduce the number of insecticidal sprays on cotton and consequently reduce plant protection cost, preventing development of resistance to insecticides and environmental risk and finally achieve sustainable cotton ecosystem in addition to higher net returns from cotton cultivation. According to Patil et al. (1992) IPM module realized the higher seed cotton yield with higher cotton cost benefit ratio.

Conclusion

With the above results, we conclude that the IRM strategies were found to be very effective in reducing the insecticide resistance and thereby increasing the yields.

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References

Burkness, E.C., Hutchison, W.D., Bolin, P.C., Bartels, D.W., Warnick, D.F., Davis, D.W., (2001). Field efficacy of sweet corn hybrids expressing a Bacillus thuringiensis toxin for management of Ostrinia nubilalis (Lepidoptera:Crambidae) and *Helicoverpa zea* (Lepidoptera: Noctuidae). J. Econ. Entomol. 94, 197–203.

Dhawan, A.k. (2004). Insecticide resistance management strategy: Awareness and Monitoring. Department of Entomology, Punjab Agricultural University, Ludhiana.

Dhawan, A.k., Singh,K., Arora, P.k., kumar, T., Sing, R. and saini, S. (2009). Adoption and impact of insecticide resistance management strategy in cotton under Punjab conditions. Environment and Ecol.27 :250-58.

Dhawan A.K, S.Singh, and S.Kumar (2009). Inegrated pest management (IPM) helps reduce pesticide load in cotton.J.Agr.Sci.Tech.Vol.11:599-611.

Horowitz AR, Ishaaya I and Forer G. (1992). Insecticide resistance management strategy in cotton fields in Israel. Resistance Pest manage 4 : 26-27.

Kranthi, K. R., Banerjee, S.k. and Russell, D. (2000). IRM Strategy for sustainable cotton pest management in India. Pestology 24: 58 67

Kranthi, K.R., Jadhav , D.R., Kranthi, s., Wanjari, R.R., Ali, S. and Russell, D. (2002). Insecticide resistance in five major insect pests of cotton in India, Crop Protection.21:449-460

Mohpatra L.N., Patnaik R.K. (2006). Validation of IPM technology for rain fed cotton in western Orissa. J. Cotton Res. Dev. 20(1): 102–108.

PATEL L.C. and N.J. MAITRA*(2013). Impact of dissemination and adoption of insecticide resistance management(IRM) strategies against cotton pests in South 24 Parganas district of West Bengal. International Journal of Farm Sciences 3(1): 99-111.

Patil B.V., Thimmaiah G., Thyagarajan K.S., Hard Castle M.J. (1992). Conservation of ecosystem with higher profit

through Integrated Pest Management in cotton. Entomon.16: 391–398.

Prasad N.V.V.S.D. *, M.S.R.Krishna, V.Chinna Babu Naik (2009). Area wide implementation Of insecticide resistance management strategies on Bt cotton - A case study in India. Journal of Plant Projection Research Vol.49,No.2.

Radhika1 P. and G.V Subbaratnam. (2006). Insecticide resistance management in cotton-Indaian scenario.Agric.Rev.27(3):157-169.

Ramarao B., Rao N.H.P., Raghunada Rao. (1998). Stem application a new technique for controlling sucking pests of cotton. J.Cotton Res. Dev. 12 (1): 127–129.

Reed, W. & Pawar, C.S.(1982) Heliothis: a global problem.pp.9–14 inReed, W. & Kumble, V. (Eds) Proceedings of the International Workshop on Heliothis Management.Pantanchera, India, ICRISAT

Rishi Kumar, D Monga, S. L Jat, A. K Indoria, R. Chauhan and K. R. Kranthi (2012). Impact evaluation of insecticide resistance management strategies in cotton under Technology Mini-Mission on cotton(Gossypium hirsutum).Indian Journal of agricultural Sciences 82(10):852-7.

Tabashnik, B. E. (1994). Evolution of resistance to Bacillus thuringiensis. Annu. Rev. Entomol. 39: 47-79.

Tabashnik, B. E., A. L. Patin, T. J. Dennehy, Y. Liu, Y.Carriere, M. A. Sims, and L. Antilla. (2000). Frequency of resistance to Bacillus thuringiensis in Þeld populations of pink bollworm. Proc. Natl. Acad. Sci. U.S.A. 97: 12980- 12984.

Wang K.V., Mu L.Y., Zhang S.A. (1994). Studies on the control action of different application methods of insecticides for the cotton aphid. J. Shandorg Agricul. University 25 (4): 424–428.