Crop Health Management: Perspectives in IPM

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Article History

Article ID: IJEP99
Received in 24th March, 2016
Received in revised form 20th April, 2016
Accepted in final form 6th May, 2016

Abstract

Integrated pest management (IPM) has evolved over time through integrated crop production to integrated farming system targeted at improved crop health. IPM is knowledge intensive, requires holistic approach, expert advice, timely decision making and actions on fast track. Recent interactions with the farming communities revealed that 93% of the farmers in India had adopted chemical control, 51% farmers get their plant protection advice from dealers, while 22% from extension officials and majority of the farmers (73%) initiate the plant protection based on the appearance of the pest, irrespective of their crop stage, damage relationships and their population. Programmes on training of both the extension workers and farmers in the Integrated Pest Management (IPM) were started throughout the country. In fact, the Government of India had adopted IPM as a cardinal principle of plant protection in 1985. Even though, adoption of IPM has not been encouraging as biopesticides capture hardly 2% of the agrochemical market. Biological control is also a very effective component of crop protection. Due to public awareness about the hazards related to use of chemical pesticides, there has been a lot of interest generated for use of eco-friendly strategies targeted at management of crop pests. For this purpose, bio-pesticides could be a cost-effective, eco-friendly and sustainable option.

Keywords: Biological control, biopesticides, crop health, IPM

1. Introduction

Philosophy of integrated pest management (IPM) has evolved over time through integrated crop production to integrated farming system targeted at improved crop health. IPM is knowledge intensive, requires holistic approach, expert advice, timely decision making and actions on fast track. Needs of farmers in pest management revolves around pest diagnostics, surveillance, forecasting and dissemination of expert information in short time.

Insect pests are well recognized as one of the major limiting factors in enhancing and sustaining agricultural production in India. Recent improvements from research brought considerable change in the cropping systems and allowed farmers to grow several crops throughout the year, which were very seasonal in the past. This also brought significant shift in the insect population dynamics and change in the status of several insect pests. Recent interactions with the farming communities revealed that 93% of the farmers in India had adopted chemical control, 51% farmers get their plant protection advice from dealers, while 22% from extension officials and majority of the farmers (73%) initiate the plant protection based on the appearance of the pest, irrespective of their crop stage, damage relationships and their population. The cost of plant protection on various crops ranged from 7 to 40% of the total crop production cost. Though integrated pest management (IPM) has been advocated for the past two decades, only 3.2% of the farmers adopted IPM practices in various crops. IPM research in the past decade brought out changes in the farmers' attitude in pest management, which resulted reduction in pesticide use in different crops. The recent farmer participatory approach working in a consortium mode proved very effective in the exchange of technology. Though the results are encouraging, there is a need to further strengthen the IPM adoption in Indian agriculture through increased investments in both basic as well as applied research in plant protection to overcome the prevailing three evil "Rs" (Resistance, Resurgence, and Residues). To be more effective, readdressing the policies for encouraging eco-friendly options and strengthening extension, involving farmers should be considered as high priority.

The declining trend in pesticide use in agriculture during the 1990s can be attributed to central government's fiscal policy and technological developments in pest management. During 1990s, taxes were raised on pesticides and phasing out of subsidies was initiated. Programmes on training of both the extension workers and farmers in the Integrated Pest

Management (IPM) were started throughout the country. In fact, the Government of India had adopted IPM as a cardinal principle of plant protection in 1985. Even though, adoption of IPM has not been encouraging as biopesticides capture hardly 2% of the agrochemical market. Despite its techno-economic superiority over conventional chemical control, adoption of IPM remains restricted to hardly 2% of the area treated with plant protection inputs. The structure of agrochemical market also suggests a similar level of adoption; bio-pesticides share only 2% of the agrochemical market in India. There could be a number of technological, social, economic, institutional and policy factors restricting large scale adoption of IPM.

India has successfully reduced pesticide consumption without adversely affecting the agricultural productivity. This was facilitated by appropriate policies that discouraged pesticide use, and favoured IPM application. Despite it, adoption of IPM is low owing to a number of socio-economic and other constraints. Lack of commercial availability of biopesticides and inappropriate institutional technology transfer mechanisms are the critical impediments to increased application of IPM. The presence of private sector in biopesticide production and marketing is trivial which needs to be improved. On the demand side, farmers though are aware of technological failure of pesticides to control pests, and their negative externalities to environment and human health, pest risk is too high to experiment with newer approaches to pest management. IPM is a complex process and farmers lack understanding of biological processes of pests and their predators and methods of application of new components. There are a number of IPM practices that work best when applied by the entire community and in a synchronized mode. Though many technology programs are based on community approach, they do not have any proper exit policy to sustain the group approach. The IPM policy should also provide incentives to farmers to adopt IPM as a cardinal principle of plant protection.

2. Biological Control

Biological control is also a very effective component of crop protection. Due to public awareness about the hazards related to use of chemical pesticides, there has been a lot of interest generated for use of eco-friendly strategies targeted at management of crop pests. For this purpose, bio-pesticides could be a cost-effective, eco-friendly and sustainable option, when proven source of host resistance or tolerance against several pests is not available. However, the quality, quantity, application method and timeliness play a significant role in determining the level of success of biological control. There are several success stories of biological control doing a commendable job in the field of crop protection. Successful biological management of papaya mealy bug and sugarcane woolly aphid alone have saved >Rupees 2.5 thousand crore (>4100 m US$) in two years for the Nation. Garlic bulb aqueous extract (2% w/v) has also been adopted by farmers and Govt. of Rajasthan in managing pests of Indian mustard. Use of quality strains of *Trichoderma, Pseudomonas fluorescens,* etc. in recommended quantity even as seed treatment has been found very successful in managing dreaded diseases of different field and horticultural crops, which could safeguard from high yield losses. When they are combined with soil application and / or foliar spray, they result in even better impact not only in reducing pests, increasing yields, economic benefits but also in safeguarding the environment from dangerous chemical pesticide load.

A few states have been more progressive in encouraging biological control of crop pests viz., Gujarat, Tamil Nadu, West Bengal, etc. Safeguarding intellectual property on strains of bioagents is an important issue in the present era. Accordingly, there is need to have DNA bar-code data of all such strains in order to sustain IPR. There is need to undertake a specific policy to encourage biopesticides, streamlining their label claim issues, simplification of process of registration for biopesticides with strict and adequate quality check from Govt Departments (CIPMCs, SAUs, etc.), increased support to biopesticide industry for scaling up of production as a matter of Govt. policy (viz., subsidies to biopesticides, higher taxes on chemical pesticide industries, etc.), which shall also enable generation of employment for small or micro-industries at village level in line with concepts of model bio-village. This shall bring a paradigm shift in the chemical pesticide industry and transform them towards producing biopesticides (Birah et al., 2014a).

3. Seed Treatment

One of the most common approaches that have been adopted by many countries is pre-sowing treatment of seed. Seed treatment is defined as chemical or biological substances applied to seed or vegetatively propagated material to manage diseases organisms, insect-pests, etc. Seed treatment pesticides include bactericides, fungicides and insecticides. Most seed treatments are applied to true seeds, such as corn, wheat, or soybean, which have a seed coat surrounding an embryo. However, some seed treatments can be applied to vegetatively propagated material, such as bulbs, corms, setts or tubers (Cox et al., 2007).

Seed treatments should be considered as tools in an integrated pest management (IPM) plan. IPM is the use of a combination of cultural practices, host resistance, biological control, and chemical control methods to simultaneously (1) minimize economic losses due to pests, (2) avoid development of new pest biotypes that overcome pesticides or host resistance, (3) minimize negative effects on the environment, and (4) avoid pesticide residues in the food supply. An IPM plan should identify important pests, determine pest management options, and blend them together to achieve the goals listed above. To use seed treatments effectively, it is important to understand the purposes of seed treatment, alternatives or supplements to seed treatments, and the various advantages and disadvantages of seed treatments. Natural enemy cum beneficial fauna population such as coccinellids, spiders and *Chrysoperla*, pollinators and honey bee remain unharmed due to seed treatment (Birah et al., 2014b).

In Pusa Basmati 1121, *Bakanae* emerged as a serious disease soon after the release of the variety in Punjab, Haryana and western part of Uttar Pradesh. Disease incidence in different rice fields ranged 20−70%. During large-scale IPM validation trial carried out by NCIPM in *basmati* rice in Haryana and western Uttar Pradesh, the disease appeared at low level (1-3%) as compared to farmers' practices (FP or non-IPM), where the disease incidence was more than 50%. In IPM module, seed treatment with carbendazim (2 g kg^{-1} of seed) was an important intervention, which could reduce the incidence of *Bakanae*. The disease was further reduced to traces in IPM trials by including one more intervention i.e., dipping of rice seedlings in *Pseudomonas fluorescens* (10 ml l^{-1} of water) for ½ hr.

Similarly in mustard, seed treatment with *Trichoderma* has resulted in significant increase in the yield as compared to FP in Alwar region (Rajasthan). A field experiment examining an integrated disease management system for Indian mustard during three crop seasons (2006−09) at 11 locations to assess treatments suitable for the management of crop diseases indicated seed treatments with freshly prepared *Allium sativum* bulb aqueous extract (1% w/v) resulted in significantly higher initial plant stands, across locations and years. Seed treatment with *A. sativum* bulb extract, followed by its use as a foliar spray, resulted in significantly reduced Alternaria leaf and pod blight severity, reduced white rust severity, fewer stag heads $plot^{-1}$, reduced downy mildew and Sclerotinia rot incidence, and reduced powdery mildew severity, across locations and years. The combination also provided significantly higher seed yields compared with the control across locations and years and was at par with treatment by chemical fungicides. The combination used in the present study was as effective as the combination of seed treatment with *Trichoderma harzianum* and foliar spraying with *Pseudomonas fluorescens* and *T. harzianum*. Economic returns were higher when using biorational treatments (*A. sativum* bulb extract, *T. harzianum*, *P. fluorescens*). The combination of seed treatments with *T. harzianum* followed by its use as a foliar spray (17.22), and the similar combination of seed treatments and foliar spraying with the *A. sativum* bulb extract (17.18), resulted in a higher benefit to cost ratio (Meena et al., 2013).

Potential benefits of short-to-medium range weather forecast from numerical weather prediction (NWP) models or future climate projections have been least harnessed in India for regional crop protection services. Recent momentum to assimilate more updated satellite-based spatio-temporal atmospheric and land surface products from Indian geostationary satellites (Kalpana-1, INSAT 3A) for high resolution (5−15 km) weather forecasts from advanced NWP model such as WRF (Weather Research and Forecasters) is encouraging. Under the circumstances, precision pest management to reduce indiscriminate use of chemical pesticides could plan use of state-of-the-art technology through innovative and strategic research to enable devise *Integrated Decision Support System (IDSS) for Crop Protection Services* that suggests operational focus, research priorities and evolution in a phased manner, which could involve (A) periodic production of alarm zones encompassing 127 agro-climatic zones through well-tested models, weather forecast, high-resolution remote sensing data and operational crop map (B) (i) forecasting models for major pests, (ii) evaluation and improvement in quality of well-validated satellite-based products, improved data assimilation approaches, (iii) field-to-satellite-based remote sensing with high-resolution observations to differentiate among crops, among phenological stages within crop growth period, biotic stresses from abiotic stresses (moisture and nutrients), normal health and (C) Human Resources Development viz., (i) creation of experts on handling of spatial data, who could be intelligent enough to bring a positive change in the present practices of pest management and talented enough to complete the task, (ii) getting used to more of digital products for interpretation and (iii) regular feedback mechanism from farmers through network of *Krishi Vigyan Kendras* by using satellite communication; (iv) competence building at grassroots by increasing awareness of farmers.

Surveillance is the foundation of plant protection for early alert. But it is missing in most of the developing countries. In the recent past, the Information Communication Technology (ICT)-based system of real time pest surveillance has played an important role in our country in collection and transfer of data from remote villages to main station through internet. The information is compiled and displayed on the website in tabulated and graphical form and that can be directly accessed by SAUs for issue of advisory through State Agriculture Department by SMS to farmers and extension workers for implementation in farmers' fields. Potential of ICT has been witnessed by its impact on production and productivity under various programmes in different states as well as crops. There is dramatic reduction in outbreak of any major pest on selected crops since the inception of ICT activity in different states. As the farmers are getting regular SMSs for IPM interventions, therefore, there is much awareness about IPM. Chemical pesticides are applied only when they are needed. The technology has already become an important component of IPM in different programmes implemented by state departments and it will continue to make significant impact on future strategies.

Holistic planning provides farmers with the management tools they need to manage biological complex farming systems in a profitable manner. A successful IPM programme requires time, money, patience, short- and long-term planning, flexibility and commitment. The research managers must spend time on self-education and making contacts with extension and research personnel to discuss farming operations, which vary widely. This would aid in developing integrated plans. The government could create policy environment for promotion of IPM. The central and state governments must take lead in changing the pest control picture through measures that would make chemical control less attractive through legislation, regulatory and fiscal measures. The Indian Council of Agricultural Research (ICAR) and the Department of Agricultural Research and Education of the Ministry of Agriculture, Government of India, are committed to the development and promotion of IPM in our country towards enabling crop health management technologies for improved livelihood security of farmers.

4. Conclusion

Insect pests are well recognized as one of the major limiting factors in enhancing and sustaining agricultural production in India. Though integrated pest management (IPM) has been advocated for the past two decades, only 3.2% of the farmers adopted IPM practices in various crops. Though the results are encouraging, there is a need to further strengthen the IPM adoption in Indian agriculture through increased investments in both basic as well as applied research in plant protection to overcome the prevailing three evil "Rs" (Resistance, Resurgence, and Residues).

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