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Short communication

Economic analysis of sustainable IPM technology for onion seed crop in a farmers' led approach

H.R. Sardana* and M.N. Bhat

ICAR- National Research Centre for Integrated Pest Management, New Delhi 110012

ABSTRACT

A field experiment was conducted during 2013-14 and 2014-15 at Karnal, Haryana with a view to develop and validate adaptable IPM technology and study its economic viability for onion seed crop in a farmers' led approach. The IPM technology comprising of mainly dipping the seed bulb in carbendazim 50 WP (0.1%) + carbosulfan 25 EC (0.2%), need based spray of profenophos 50 EC (0.1%) in November after sprouting against thrips, prophylactic spray with mancozeb 75 WP (0.25%) and need based spray with carbendazim (12%) + mancozeb 63% (0.2%) / hexaconazole 5 EC (0.1%) / propiconazole 25 EC (0.1%) against *Stemphylium* blight during February-March-April, application of biopesticide / nereistoxin analogue cartap hydrochloride 4 G or spray of spinosad 45 SC @ 75 g *a.i.* ha^{-1} against thrips during March, installation of pheromone traps against borer for monitoring *Helicoverpa armigera* and spray of *Ha*NPV @ 250 LE/ha and keeping fields clean to reduce thrips population with a view to contain iris yellow spot virus, was very effective in reducing the incidence of pests and minimizing the yield losses. The adoption of IPM technology, resulted in reducing the number of chemical sprays to 12-14 from 25-27 with higher onion seed yields of 6.62 and 6.25 q/ha in IPM compared to 5.85 and 5.20 q/ha in non-IPM fields and with marginally higher CBR of 1:10.87 and 1:10.56 in IPM than 1:9.10 and 1:8.19, respectively in non-IPM fields. There was a net income increase of Rs. 1,61,675 and 2,18,638/ ha in IPM fields over non-IPM ones.

Key words: *Allium cepa,* farmers' led approach, IPM, onion seed crop.

Onion (*Allium cepa* L.), also known as 'Queen of kitchen' is a widely cultivated vegetable crop all over the country and is of global importance. It is mainly a cold-summer season crop which is easy to grow because of its hardiness and wider adaptability. India need to produce 7,000 tonnes of quality seed annually to meet the onion seed requirement in the country. India is still far behind many countries in terms of seed productivity, which is quite low owing to growing of short day type of onion, which is low yielder (Tomar, 7). In India, short day onion types seed is produced mostly in parts of Maharashtra, Madhya Pradesh and Gujarat. However, Northern states like Punjab, Haryana and Rajasthan are less preferred for seed production due to the severe attack of insect pests and diseases during the cropping season, which adversely affects the yield and productivity. Though, the pest spectrum in onion seed crop is not very large, thrips (*Thrips tabaci* Lind.), *Stemphylium* blight (*Stemphylium vesicarium* Wallr.), iris yellow spot virus, purple blotch {*Alternaria porri* (Ellis). Cif.} (in Punjab) and sporadically head borer (*Helicoverpa armigera* Hubner) cause substantial yield loss (Gupta *et al*., 1). Quicker control strategy against these pests and quest of getting higher yields, has led to indiscriminate and excessive use of chemical pesticides. It is not unusual for the onion seed growers to give 20-25 chemical sprays in a season, which most of the times are unnecessary and without any appreciable increase in the yield. Numerous management strategies for the pests of onion crop raised for seed production have been developed but these have mostly been dealt in isolation and individually and thus have met with little desired success. The integration of all the pest management strategies in a farmers' led approach could reduce application of harmful chemical pesticides to a great extent. Keeping this in view, validation of multifaceted adaptable IPM technology in onion crop meant for raising quality seed was carried out in a participatory manner at farmers' fields to reduce the over dependence on chemical pesticides and protecting the ecosystem as a whole.

Two year trials on validation of IPM technology in onion seed crop were carried out during 2013-14 and 2014-15 at Rambha, Karnal district, Haryana. Before initiation of validation of IPM technology, adaptable IPM module for onion crop was synthesized based on the base line information collected on the crop, pests status and their management from farmers in Singoha-Singohi-Rambha; recommendations made by National Horticultural Research & Development Foundation, Nasik (NHRDF) and Directorate of Onion

*Corresponding author's E-mail: hrsardana@rediffmail.com

& Garlic Research (DOGR), Pune (Srinivas *et al*., 6) for onion seed crop pest management and research literature published by eminent workers on onion for seed crop pest management. The synthesized IPM module was thus validated during 2013-14, initially in an area of 1.0 acre comprising two farming families with the interventions, *viz*., dipping of seed bulb in carbendazim 50 WP (0.1%) and carbosulfan 25 EC (0.2%), need based spray of profenophos 50 EC (0.1%) in November after sprouting against thrips, prophylactic spray with mancozeb 75 WP/ chlorothalonil 75 WP (0.25%) and need based (if rains) spray of carbendazim (12%) + mancozeb 63% (0.2%)/ hexaconazole 5 EC (0.1%)/propiconazole (0.1%) against *Stemphylium* blight during late February-March-April, application of biopesticide/ nereistoxin analogue cartap hydrochloride 4G or spray of spinosad 45 SC @ 75 g *a.i.* ha^{-1} against thrips during March, installation of pheromone traps against head borer for monitoring *Helicoverpa armigera* and spray of *Ha*NPV @ 250 LE/ha and keeping fields clean to reduce thrips population with a view to contain iris yellow spot virus.

The results on the pest incidence/natural enemy population and the economic viability of IPM were compared with FP (Farmers' own way of managing the pests), which consisted of only chemical pesticides applied either alone or as a cocktail mixtures such as, carbendazim 50 WP @ 1.5 kg/acre along with fertiliser at the time of field preparation; mancozeb 75 WP @ 0.2% + thiamethaxam 25 WG @ 25 g *a.i. /* ha; blue copper 50 WP @ 0.3% + lambda cyhalothrin 5 SC (0.005%); chlorothalonil 75 WP (0.2%) + imidacloprid 17.8 SL (0.4 ml $ltre^{-1}$); carbendazim (12%) + mancozeb (63%), @ 0.25% + malathion 50 EC @ 0.05%; blue copper 50 WP @ 0.3% + fipronil 5 SC @ 800 g/ha; thiamethaxam 25 WG @ 25 g a.i. / ha; metalyxyl 4% + mancozeb 64% (0.2%) + spinosad 45 SC @ 75 g a.i. ha^{-1}; pendimethilin 30 EC @ 1.5 kg a.i. /ha; copper oxy chloride @ 0.2% imidacloprid 17.8 SL (0.4 ml $ltre^{-1}$); cymoxanil 4 + mancozeb 64 (72 WP) @ 0.3% + chlorantraniliprole 18.5% SC; mancozeb 75 WP @ 0.2% + indoxacarb 15.5 SC @ 0.007% ; blue copper 50 WP (0.3%); mancozeb 75 WP (0.2%) + metalyxyl (0.2%) and pendimethilin 30 EC @ 1.5 kg a.i. /ha *etc*. The farmers usually tend to give higher than the recommended dose and thus the accurate dose of pesticide application by the non-IPM farmers is difficult to present as the container lid is oftenly used by farmers to measure the dose of pesticides.

During 2014-15, the adaptable IPM technology was refined and revalidated in a larger area of 2.5 acres comprising of five farming families. The installation of blue coloured sticky traps meant for thrips trapping was stopped as it attracted large number of syrphid flies, which affected the natural enemy predator and as pollinator population in onion seed cropping system. Use of acephate insecticide was also stopped as it was harmful to natural enemies and highly bad smelling and thus not easily preferred by the onion growers. Observations on the population of thrips (both nymphs & adults), predatory spiders and syrphid flies were recorded during March-April weekly in 20 randomly selected stalks/ umbels/ plants from each field and means were computed. *Stemphylium* blight severity was recorded by following the method of Mayee and Datar (3) at 10 day interval and means of severity over the season were computed. Number of total stalks and stalks infected by iris yellow spot virus per 20 plants were counted and per cent incidence was computed. For economic analysis, number of chemical sprays, biopesticide sprays, cost of cultivation including plant protection (Rs./ ha), yield (t/ ha), net returns (Rs./ ha) and C:B ratios were computed.

The implementation of adaptable IPM technology resulted in considerable reduction in incidence of the thrips, *Stemphylium* blight, iris yellow spot virus and borer and incidence of these pests was marginally higher in FP fields (Table 1) as against IPM fields. Trend and appearance of all pests was similar during both the years under trial except minor variations when there was excessive rainfall during March-April in 2014-15, which affected the disease occurrence and pollinators activity. During 2013-14, thrips over wintering in bulbs scales became active after germination in October but the initial build up was very low and it was significantly brought down by application of profenfos 50 EC insecticide in November. One spray of spinosad 45 SC @ 75 g *a.i.* ha^{-1} in IPM onion fields brought down the thrips population, which multiplied in a large number during March-April on stalk, bolters and flowers, to 4.7 and 3.6 per plant as against marginally higher population of 14.2 and 8.5 per plant in FP fields (Table 1)

Table 1. Pest and natural enemy scenario in IPM and non-IPM seed onion fields during 2013-15 in Karnal, Haryana.

Pest/ natural enemy	2013-14		2014-15	
	IPM	FP	IPM	FP
Thrips/ plant	4.7	14.2	3.6	8.5
Head borer (%)	2.1	5.3	1.8	3.4
Stemphylium blight (PDI)	18.3	34.0	26.0	42.3
Iris yellow spot virus (%)	8.0	19.2	6.2	11.5
Predatory spiders/ 10 plants	0.6	0.2	0.8	0.2
Syrphid flies/10 plants	4.0	2.6	5.2	2.0

during 2013-14 & 2014-15, respectively. During the study, it was observed that with the reduction in temperature during November no application of any chemical pesticide was required for thrips in the initial stage of the crop. Further, green labeled pesticide spinosad was sprayed during early March before opening of umbels. Thus, only one spray of ecofriendly green labelled spinosad 45 SC (75 g *a.i.* /ha or 0.4 ml litre^{-1}) during March could keep the thrips population at reasonably low levels without affecting the pollinators activity during April-May 2014-15 as against non-IPM fields where random, non-selective and unnecessarily excessive number of insecticides were applied by farmers (Table 2). Initially during 2013-14, two sprays of pesticide application against thrips increased the cost of plant protection, which was brought down to one spray in the subsequent year. While applying pesticides with high pressure and spray volume in IPM fields, utmost care was taken to see that the spray fluid reached stalk, base of the leaves and bolters where majority of the thrips were present. Blue coloured sticky traps used for thrips detection and monitoring during 2013-14 were stopped in subsequent year, *i.e.*, during 2014-15 as these attracted large number of syrphid predators. Sardana *et al.* (5), reported green labelled biopesticide spinosad to be highly effective against thrips in bell pepper. Thrips population build up during 2014-15 in general was observed to be lower in IPM as well as non-IPM onion fields as against during 2013-14 because of unseasonal rains received during March-April, which is time for bolter and umbel formation and thrips multiplication and build up. Head borer, though present sporadically in seed onion crop, cuts the pedicel of flowers and feed on stalk, thus causing severe economic damage to crop as one larva could cut several stalks. Installation of pheromone traps against head borer for monitoring *Helicoverpa armigera* coupled with spray of *Ha*NPV @ 250LE could keep the head borer damage to a very low levels of 1-2% in IPM fields which was slightly higher in non-IPM fields being 3-5%. It was also observed that only installation of traps could contain the head borer and didn't require any spray of pesticide. *Stemphylium* blight caused by *Stemphylium vesicarium* was the major disease observed during two years 2013-15 of IPM programme, which initiated in February end with the light rains and cloudy weather and reached its peak only in March-April. Young plants are infected earlier because of their close proximity to soil containing disease debris of preceding crop. *Stemphylium vesicarium* is known to sporulate abundantly in decaying vegetable matter in soil (Miller, 4). With the interventions of prophylactic and need based spray of mancozeb 75WP, hexaconazole 5EC @ 0.1% / propiconazole 25EC @ 0.1% in IPM fields, *Stemphylium* blight severity was significantly kept under check to lower levels of 18.3 and 26.0 (PDI) during 2013-14 and 2014-15, respectively as against high incidence levels of 34.0 and 42.3 (PDI) in FP onion seed fields where only non-selective, indiscriminate and mixtures of fungicides were applied. It was also observed that unseasonal rains during March-April 2015 marginally aggravated the blight severity as against low severity during 2013-14. Iris yellow spot virus (tospo virus) transmitted by thrips was significantly reduced to a lower levels of 8.0 and 6.2% in IPM fields by managing thrips using clean cultivation by removing weeds, maintaining uniform plant density, giving selective and judicious use of insecticides *etc.* as against higher incidence of 19.2 and 11.0 per cent observed in non-IPM fields where only non-selective chemical pesticides were sprayed. Studies in Israel demonstrated a positive relationship between the incidence of *T. tabaci* in onion crops and the incidence of plants infected with IYSV (Kritzman *et al*., 2).

Table 2. Economic analysis of IPM and non-IPM technologies in onion seed crop fields during 2013-14 & 2014-15 in Karnal, Haryana.

Parameter	2013-14		2014-15	
	IPM	FP	IPM	FP
No. of pesticide sprays	14.0 (23)	20.0 (27)	9.0 (14)	18.0 (25)
Cost of pesticide sprays including labour cost (Rs./ha)	22,575	29,350	18,812	27,450
Cost of cultivation including plant protection (Rs./ha)	121,875	128,550	118,262.5	126,900.5
Onion yield (q/ha)	6.625	5.850	6.25	5.20
Gross returns (Rs./ha)*	1325,000	1170,000	1250,000	1040,000
Net returns (Rs./ha)	1203,125	1041,450	1131,737.5	913,099.5
Cost: benefit ratio	1:10.87	1:9.10	1:10.56	1:8.19

*Wholesale market rate = Rs. 2,000/ kg; Figures in parentheses indicate the total No. of chemical pesticides used.

Only predatory spiders and, syrphid flies as natural enemies were observed in onion fields in fairly good numbers while coccinellid beetles were observed sporadically which was not recorded. Marginally higher population of syrphid flies and predatory spiders in IPM fields (4.0, 5.2 and 0.6, 0.8/ 10 plants, respectively) than non-IPM fields (2.6, 2.0 and 0.2, 0.2/10 plants, respectively) was observed (Table 1). These predators were present during April-May only when there was maximum flowering and crop growth. During 2014-15, reduced use of pesticides in IPM fields resulted in increased natural enemies population and activity. IPM technology implementation thus resulted in increased biodiversity. Earlier, Sardana *et al.* (5) also concluded that integrated pest management schedule was safer to syrphid flies and predatory spiders in onion and bell pepper ecosystems.

The adoption of IPM technology under expert supervision over the two years resulted in reducing the number of chemical sprays to 9.0 during 2014-15 from 18.5 in non-IPM fields with a higher seed yield adopted in IPM than farmers' practice fields with higher C:B ratios in IPM fields (Table 2). Lesser number of sprays resulted in lowering the cost of plant protection and so the cost of cultivation which was Rs. 1,21,875 and 1,18,262.5 in IPM fields as against higher cost of cultivation being Rs. 1,28,550 and 1,26,900.5 during 2013-14 and 2014-15, respectively. The mean seed yield obtained was higher, *i.e.*, 6.63 and 6.25 q/ha in IPM fields than farmer's practices fields where as it was 6.25 and 5.20 q/ha during 2013-14 and 2014-15, respectively. Occurrence of unseasonal rains during March-April 2015, slightly affected the pollinators activity at flowering time affecting seed setting and resulting in marginally lower yields. The data further revealed that installation of pheromone traps, spray of biopesticide spinosad and *Ha*NPV, clean cultivation and need based application of eco-friendly, optimal dose, green labelled pesticides was highly effective in reducing the pest population, which in turn resulted in increase of the yield. From the present studies it was also inferred that apart from insect pests and diseases, unseasonal rains also impacted the disease development and onion seed yields. Tripathi *et al.* (8) reported higher yields and C:B ratios in IPM managed bulb onion crop.

IPM technology used was not only environment friendly but also more sustainable vide increase in biodiversity (natural enemies, soil flora & fauna) due to less load of chemical pesticides. Feedback from the IPM farmers also indicated the increased knowledge, awareness and adoption of 75% of the IPM components for onion seed crop by majority of the adopted farmers. Adoption of IPM technology enabled the farmers to differentiate between the pests and bio-agents, increased knowledge about bio-pesticides, economic threshold levels, identification of natural enemies and avoidance of widely prevalent practice of using the mixtures of pesticides.

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