*Indian Journal of Agricultural Sciences* **79** (10): 808–12, October 2009

# Development of integrated pest management technology for sesame (*Sesamum indicum*) and its evaluation in farmer participatory mode

D B AHUJA[1], T S RAJPUROHIT[2], MALAM SINGH[3], Z S SOLANKI[4], R K KALYAN[5], USHA RANI AHUJA[6], A DHANDAPANI[7] and M M SUNDRIA[8]

*Agricultural Research Station, Rajasthan Agricultural University, Mandor, Jodhpur 342 304*

Received: 21 February 2009; Accepted: 24 August 2009

ABSTRACT

Field studies were conducted from 2001 to 2002 on development of integrated pest management (IPM) technology in rainfed sesame (*Sesamum indicum* L.) at Agricultural Research Station, Mandor, Jodhpur, and the same were later validated during 2003–04 in farmer's participatory mode at 2 locations in Osiana tehsil of Jodhpur district in arid zone 1a of western Rajasthan. Adoption of IPM technology comprising intercropping of sesame with greengram and spray of 9 ppm azadirachtin at flowering stage reduced the per cent incidence of major pests such as *Antigastra catatlaunalis* and *Macrophomina phaseolina* from 24.79 and 16.88 in unprotected treatment to 13.04 and 6.25 in IPM module, respectively. IPM technology was found economically viable as indicated by incremental cost:benefit ratio ranging from 1:1.93 to 1:2.70 that was at par with non-IPM (1:1.53 to 1:2.71), besides, sesame seed was produced without any application of toxic synthetic pesticides.

**Key words**: *Antigastra catalaunalis*, *Macrophomina phaseolina*, Sesame management

A great number of insects and diseases have been reported to be responsible for low productivity of sesame, beside several other factors that reduces the seed yield of sesame. Among pests, leaf webber/capsule borer (*Antigastra catalaunalis* (Dup.) and stem and root rot (*Macrophomina phaseolina*) have been found to reduce seed yield substantially. There are many reports available which showed that productivity of sesame can be substantially raised if the losses due to the pest are suitably reduced (Rohilla *et al*. 2003). Past, as well as recent, research has provided techniques to manage these pests individually, primarily focusing the use of synthetic pesticides (Tripathi *et al.* 2007). This may lead to contamination of seed with pesticide residues, causing many environmental and health hazards, besides risking export embargo. Soaring prices, the growing domestic demand for edible oil, coupled with the emergence of sesame as a potential export crop, provides good opportunity for farmers to take up the cultivation of this crop intensively. Therefore, urgent need was felt to devise means other than pesticides or making their use judiciously. Present study comprising host plant resistance against the pests, cultural practices and use of neem-based formulation were practised together to evolve an IPM module which was tested in replicated manner at Agricultural Research Station for 2 years which was later validated in farmers' participatory mode at village level for another 2 years to evolve eco-friendly management technique for pests of sesame.

[1]Principal Scientist (e mail: deshbandhu4@rediffmail.com), NCIPM, Pusa, New Delhi 110 012; [2,3]Associate Professor (e mail: rajpurohitts@rediffmail.com, mschandawat56@yahool.com), [4]Professor (e mail: solankizs25 @rediffmail.com), [5,8]Assistant Professor (e mail: manu2015 @rediffmail.com, rkkalyan @rediffmail.com), Agricultural Research Station, Banswara, Rajasthan.

[6]Principal Scientist (e mail: urani7@rediffmail.com), National Centre for Agricultural Economics and Policy Research, Library Avenue, DPS Marg, Pusa, New Delhi 110 012.

[7]Principal Scientist (e mail: dhandapani.appavoo@gmail.com), National Academy of Agricultural Research Management, Rajendra Nagar, Hyderabad, Andhra Pradesh 500 407.

## MATERIALS AND METHODS

Based on the research results of the previous studies, 2 IPM modules comprising host plant resistance, inter-cropping of sesame with legume crop and application of neem-based formulation were prepared. First, IPM modules comprised mono crop of sesame and 2 sprays of 9 ppm azadirachtin (3 ml/l of 3 000 ppm formulation) at vegetative (20 days post sowing) and flowering stage (45 days post sowing) of the crop (M 1). Second, IPM module comprised intercropping of sesame with greengram 'K 851' *Vigna radiata* (L.) R. Wilczek

in 1:1 ratio and one spray of 9 ppm azadirachtin at flowering stage (45 days post sowing) (M 2). Seed treatment with *Trichoderma viride* at 4 g/kg seed, containing $10^8$ conidia/g of the formulation, was uniformly given in module 1 and 2 to protect the crop from *M. phaseolina.* The conidia count/g was confirmed using a haemocytometer. Seed quantity was determined on the basis of the recommended seed rate of 4 kg/ha. A white seeded 'RT 46' sesame variety that is recommended for cultivation at national level was reported to have lesser damage from *A. catalaunalis* and *M. phaseolina* (Bhatnagar *et al.* 2005) was used for raising the crop of sesame.

Two IPM modules were compared with completely protected sole sesame crop by seed treatment with *T. viride* at 4 g/kg seed and spraying endosulfan 35 EC (3 ml/litre) each at vegetative (20 days post sowing) and flowering (45 days post sowing) stage of the crop and farmers' practice (sole sesame without any plant protection). Two sprays, one each at most vulnerable stage to pests damage such as vegetative and flowering, were given as recommended by Bhatnagar *et al.* 2005 to optimize the seed yield. Samples of readymade preparations of azadirachtin 3 000 ppm, endosulfan 35 EC were obtained from the market. Sample of *T. viride* was obtained from TNAU, Coimbatore. A solution of 6.0 litre was prepared for spraying endosulfan or azadirachtin, which was sufficient for all the 10 replications/ treatment (Bhatnagar *et al.* 2005) with the help of backpack sprayer having a capacity of 15 litres.

IPM modules were tested during rainy (*kharif*) season in 2001 and 2002 at research farm of Agricultural Research Station, Mandor (Jodhpur) in randomized block design in a plot size 4 m × 3 m with 10 replications. The 'RT 46' sesame was sown with spacing of 30 cm and 15 cm between lines and plants, respectively. In the inter-cropped plots single row of sesame was alternated with 1 row of mungbean. All recommended agronomical practices were followed (Bhatnagar *et al.* 2005) and the crop was raised under rainfed farming situation at the onset of monsoon in first fortnight of July. Observations on various insects, diseases and mite were recorded at weekly interval starting from first week after germination. Major damage occurred only due to *A. catatlaunalis* and *M. phaseolina,* hence number of plants infested by *A. catalaunalis* and *M. phaseolina* and total number of plants in 1 $m^2$ area/plot were recorded to work out the per cent plant infestation due to the *A. catalaunalis* and due to *M. phaseolina* just before the harvest of the crop. Observations on damage caused by *A. catalaunalis* were recorded at 30 days and 50 days post sowing. The seed yield data per replication was recorded at harvest and converted to sesame seed yield/ha. In case of intercrop plots, sesame seed yield equivalent was calculated as following formula.

$$\text{Yield of intercrop} \times \frac{\text{Price of intercrop}}{\text{Price of sesame seed}}$$

All the data were subjected to ANOVA using SAS software. Pair-wise comparison between treatment means for each treatment was done using Tukey's Honest Significant Difference. Pooled analysis for yield and pests observation was carried out using Proc mixed of SAS and the comparisons were made using Tukey adjustments.

The IPM module M2 was also validated in farmers' participatory mode in rainy seasons of 2003 and 2004 at farmers' field in 4 acre area covering 4 farmers' families in villages Bhavi and Kiramsaria of Osiana *tehsil* of Jodhpur district. IPM technology comprising seed treatment of sesame 'RT46' with *T. viride at* 4 g/kg seed, followed by spray of neem-based formulation at flowering stage in intercropping of sesame with mungbean (1:1 ratio). Crop was sown in the second week of July at the onset of monsoon. Sole crop using 'RT46' variety of sesame was raised in non-IPM field and all recommended agronomic practices (Bhatnagar *et al*. 2005) were followed uniformly in both IPM and non-IPM fields except as mentioned above. All the farmers used similar seed in non-IPM fields. Cost of cultivation for both IPM and non-IPM fields were calculated and economic analysis was made to calculate cost:benefit ratio. Major pests, parasite and predators were also recorded.

## RESULTS AND DISCUSSION

*Impact of IPM modules on the incidence of pests*

Seedlings of sesame as well as of greengram were started emerging within 3–4 days of sowing. Sesame crop and intercrop (greengram) were observed for damage due to insect, mite and disease pests after 7 days of sowing. Several insects and a mite were recorded on sesame and greengram (Table 1). Leaf webber/capsule borer, myrid bug at all stages of the crop, sesame leaf hopper, white fly, black weevil at vegetative stage, thrip at flowering stage, gall fly and lygid bug at pod formation stage and a broad mite at vegetative and flowering stages of sesame were recorded. Among these, white fly, thrip and mite were observed on both sesame as well as greengram. Damage due to *A. catalaunalis* alone was considered significant. Rise in damage was observed from second week of July till end of August when pod started maturing. Its damage at pod maturity stage did not occur. Population of other insects and mite remained very low and no damage occurred due to them during entire period of crop growth of sesame as well as of inter-crop, ie greengram. Diseases recorded were *macrophomina* stem and root rot *phytophthora* blight, *cercospora* leaf spot and *alternaria* leaf spot. Only *M. phaseolina* caused economic loss, level of incidence of other diseases remained very low. Lace wing bug and spiders were observed predating sucking pest fauna and small larvae of leaf webber/capsule borer. *Bracon hebetor* and *Trathala flavo orbitalis* were found parasitizing the larvae of *A. catalaunalis* in IPM fields, however such natural enemies were not found in non-IPM fields.

Table 2 shows that per cent plant infestation at 30 and 50 days post sowing by *A. catalaunalis* during 2000 and 2001

Table 1 Pest complex and natural enemies recorded on *Sesamum indicum* during *kharif* season

| Common name | Scientific name |
|---|---|
| *Pest* | |
| *Insect* | |
| Leaf webber/ capsule borer | *Antigastra catalaunalis* (Dup.) |
| Myrid bug | *Cyrtopeltis tennuis* (Reut.) |
| Sesame leaf hopper | *Orosius albicinctutus* Dist. |
| Gall fly | *Asphondylia sesami* Felt |
| Thrips | *Frankliniella schultzei* Trybom |
| White fly | *Bemisia tabaci* (Genn.) |
| Black weevil | *Cyrtozemia dispar* Mshll. |
| Lygid bug | *Elasomolomus sordidus* Fab. |
| *Mite* | |
| Broad mite | *Polyphagotarsonemus latus* (Banks) |
| *Diseases* | |
| Stem and root rot | *Macrophomina phaseolina* (Tassi) Goid |
| *Phytophthora* blight | *Phytophthora parasitica* (Dustur) var. sesami |
| Cercospora leaf spot | *Cercospora sesami* Zimm. |
| Alternaria leaf spot | *Alternaria sesami* (Kawamura) |
| *Natural enemies* | |
| Lace wing bug | *Chrysoperla* sp. |
| Larval parasitoid | *Bracon hebetor* Say |
| Larval parasitoid | *Trathala flavo orbitalis* Cameroon |

as well as pooled data for the 2 years, were statistically similar with each other for both the IPM modules 1 and 2, but significantly lower compared to unprotected control. The data suggested that intercropping of sesame with greengram and sprays of azadirachtin or 2 sprays of azadirachtin alone were effective in reducing the pest damage due to *A. catalaunalis* closer to economic threshold level (ETL) of 10–14% plant infestation, an increase above this may result economic loss. The adoption of any of the above module may also avoid use of highly toxic synthetic insecticides, ie complete replacement of synthetic insecticide by neem-based formulation in case of module 1 and reduction in number of sprays to 50% and replacement of spray of synthetic insecticide by neem-based formulation in case of module 2. Per cent incidence due to *M. phaseolina* was lowest in module M 2 that was statistically lesser than module M1 as well non-IPM and unprotected treatment during 2000 and 2001. Pooled mean of per cent incidence for both the years also showed similar trend. Cardona (2008) and Nair *et al*. (2006) found *Trichoderma* effective for management of *M. phaseolina* in sesame. Ahirwar *et al.* (2008) and Gupta (2003) reported neem oil at 10 ml/litre as effective as endosulfan in reducing flower and capsule damage due to *A. catalaunalis* on sesame and provided higher economic returns as compared to untreated control plots. Neem-based formulations have been reported to be effective against *M. phaseolina* (Rajpurohit and Bishnoi 2006). Azadirachtin was also found effective against other pests such as *Lipaphis erysimi* (Ahuja *et al*. 2009). Neem-based formulations when sprayed against pests in sesame were also not found to have deterrent effect on the foraging by honeybees (Patnaik and Mohapatra 2005). Inter-cropping/mixed cropping is known to influence the pest build-up. There are several examples of crop diversification with host or non-host plants bringing about definite impact in delaying as well as in minimizing the pest incidence (Singh *et al*. 2004). Greengram being non-host plant for *A. catalaunalis* was able to reduce the pest damage. Rajpurohit (2002) demonstrated low proliferation of *M. phaseolina* in

Table 2 Impact of IPM modules on the pest incidence in sesame

| Module | Per cent plant infestation due to *Antigastra catalaunalis* at** | | | | | | Per cent plant infestation due to *Macrophomina phaseolina*** at harvest | | |
|---|---|---|---|---|---|---|---|---|---|
| | 30 days post sowing | | | 50 days post sowing | | | | | |
| | 2000 | 2001 | Mean | 2000 | 2001 | Mean | 2000 | 2001 | Mean |
| IPM 1 | 13.83 (18.39)[a] | 11.25 (19.53)[a] | 12.54 (18.96)[a] | 22.50 (28.30)[a] | 11.80 (20.07)[a] | 17.15 (24.19)[a] | 10.00 (18.39)[a] | 8.75 (17.17)[a] | 9.38 (17.78)[a] |
| IPM 2 | 14.71 (18.34)[a] | 11.37 (19.63)[a] | 13.04 (18.99)[a] | 20.00 (26.53)[a] | 12.20 (20.38)[a] | 16.11 (23.46)[a] | 7.50 (15.87)[b] | 5.00 (12.89)[b] | 6.25 (14.38)[b] |
| Non-IPM | 8.15 (15.86)[b] | 7.68 (16.07)[b] | 7.92 (15.97)[b] | 7.50 (15.89)[b] | 8.19 (16.62)[b] | 7.85 (16.26)[b] | 10.00 (18.34)[a] | 8.50 (16.90)[a] | 9.25 (17.62)[a] |
| Unprotected | 30.28[c] (24.71) | 19.30 (26.05)[c] | 24.79 (25.38)[c] | 42.50 (40.68)[c] | 24.30 (29.55)[c] | 33.43 (35.12)[c] | 17.50 (24.71)[c] | 16.25 (23.76)[c] | 16.88 (24.24)[c] |

Means with at least one letter common are statistically non-significant (column-wise).

**Figures in parentheses are arc sine values

M 1, Seed treatment with *T. viride* @4 g/kg seed, Two sprays of 9 ppm Azadirachtin at appearance of pest about 20 days after sowing (DAS) and second at 45 days after sowing; M 2, seed treatment with *T. viride*, One spray of Azadirachtin 0.03% at 45 days after sowing and intercropping with mungbean '(K 851)' in 1:1 ratio; Non-IPM, seed treatment with *T. viride*, 2 sprays of Endosulfan 35 EC at 0.07%, first at appearance of pest about 20 days after sowing (DAS) and second at 45 days after sowing; Unprotected = no treatment

Table 3 Seed yield and economic returns in different treatment applied in sesame

| Treatment | Seed yield (kg/ha) | | | Gross returns (Rs/ha) | Increase in returns over control (Rs/ha) | Cost of plant protection (Rs/ha) | Cost: benefit ratio (Rs/ha) |
|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | Mean | | | | |
| IPM 1 | 190[a] | 429[a] | 309[a] | 7 725 | 2 700 | 1 750 | 1:1.54 |
| IPM 2 | 220*[b] | 451*[a] | 336*[a] | 8 400 | 3 375 | 1 250 | 1:2.70 |
| Non-IPM | 270[c] | 517[b] | 394[b] | 9 850 | 4 825 | 1 780 | 1:2.71 |
| Unprotected | 90[d] | 312[c] | 201[c] | 5 025 | | | |

Sesame seed equivalent yield, Market price of the produce Rs 25/kg, labour charges Rs100/day (5 labour/ha)

sesame intercropped with greengram due to lowering of temperature brought about by intercropping. Spray of azadirachtin and intercropping of sesame with greengram brought about complimentary effect in reducing the incidence of *M. phaseolina* that was reflected from the data on disease incidence (Table 2) which was significantly lower in module 2 as compared to module 1. Thus, greengram as intercrop could reduce the damage due to both *A. catalaunalis* and *M. phaseolina* in sesame and such cropping system resulted conditions non-conducive for the development of major pests, curtailing the application of synthetic insecticides as well as replacing them with safer biopesticides like *T. viride* and azadirachtin for pest management. There are other examples where intercropping is known to influence pest development Intercropping of sesame with squash suppressed the *Meloidogyne incognita* population (Youssef and El-Nagdi 2004).

*Impact of IPM modules on seed yield of sesame*

The effectiveness of module 1 and 2 in management of *A. catalaunalis* and *M. phaseolina* was further evident from the data (Table 3) on sesame seed equivalent yield in M 2 and sesame seed yield in M 1 which was at par with each other during both the years of the study as well statistically higher than the unprotected treatment. Modules M 2 was found as economical viable as non-IPM module as indicated by incremental cost : benefit ratio being 1:1.54 and 1:2.70, respectively in $M_1$ and $M_2$. Module 2 provided cost : benefit ratio equalling to treatment 3 (1:2.71) where 2 sprays of synthetic insecticide were given. Thus, module 2 was not only economically viable but also eco-friendly. The adoption of cultural practice like intercropping of sesame with greengram, seed treatment with *T. viride,* followed by 1 spraying of azadirachtin at 9 ppm at flowering stage or two sprayings of azadirachtin at 9 ppm at vegetative and flowering stages led to reduction of damage due to *A. catalaunalis* and *M. phaseolina* and provided higher sesame seed equivalent yield and sesame seed yield, respectively over unprotected treatment. Many studies from different parts of India (Gupta 2002) and the world (Bhati *et al*. 2005), have reported economic viability of intercropping of sesame and greengram as a good companion crop, while also reducing pest incidence. It is a common practice with farmers to grow sesame as intercrop with greengram as sesame offers diversification of cash income and greengram as important food crop, so as to secure the food requirements of the household, sesame in pure stand is considered too risky, while an intercrop, apart from risk avoidance, also puts less demand on labour and fertile land (Mkamilo 2004).

*Performance of IPM technology at farmers' field*

The IPM programme was compared with the growers' pest control practice (Table 4). Since few growers were willing to quickly adopt the new IPM approach on a large scale, the IPM Pilot Test was conducted from 2003 to 2004 initially at 4 farmers' fields in villages of Osiana *tehsil* of Jodhpur, Rajasthan. For both the years, higher mean seed equivalent yield of sesame was recorded in IPM fields as compared to non-IPM fields. On an average, the IPM programme increased sesame seed equivalent yields >14% and decreased the number of insecticide applications by 50%.

Table 4 Comparison of economics of sesame cultivation under IPM and non-IPM farmer's fields (mean of 2 years)

| | IPM | Non-IPM |
|---|---|---|
| Total cost of cultivation including plant protection (Rs/ha) | 5 715 | 6 245 |
| Cost of plant protection (Rs/ha) | 1 250 | 1 780 |
| Mean yield (converted into metric tonnes/ha) | 0.44* | 0.38 |
| Total returns (Rs/ha) | 11 025 | 9 450 |
| Net returns (Rs/ha) | 5 310 | 3 205 |
| Cost: benefit ratio | 1:1.93 | 1:1.51 |
| Per cent Incidence of *Antigastra catalaunalis* | 12.65 | 13.78 |
| Per cent Incidence of *Macrophomina phaseolina* | 6.76 | 10.25 |

*Sesame seed equivalent

Rates of sesame Rs 25/kg, Total cost included: labour cost for land preparation, sowing, fertilizer application, hand weeding/hoeing, harvesting and threshing, transport of produce, Material cost like seed fertilizers, spray and insecticides.

Not only reduction in number of sprays was brought about but also replacement of spray of endosulfan with biopesticide such as azadirachtin was achieved. Benefits provided by IPM were due to lowering of cost of production in terms of plant protection in IPM fields as compared to non-IPM fields. The economic analysis for cost : benefit ratio showed that the production of 441 kg/ha sesame seed equivalent in IPM required an investment of Rs 1 280 as against Rs 1 750 on plant protection. Net returns were Rs 5 310 and Rs 3 205 for IPM fields and non-IPM practice, respectively. Thus, the adoption of IPM yielded higher economic benefits. It leads to benefit of ratio of 1:1.93 in IPM over 1:1.53 in non-IPM.

The results established that IPM had the economic potential to substitute chemical pesticides without demanding any enhancement in cost of cultivation and over and above it also ensured higher economic returns as well as higher sesame seed yield equivalent with added advantage of no adverse effect on environment, natural enemies and human health. IPM programme for pests of sesame in Jodhpur district of Rajasthan should be an attractive incentive to many growers, regardless of whether they view themselves as risk averters or risk-takers. In addition to economic goals, the environmental benefits and costs for this IPM programme could also be evaluated. The adoption of IPM programme also brightens the chances of its export of sesame seeds which has recently touched Rs 10 000 million.

## ACKNOWLEDGEMENTS

Authors wish to express their sincere thanks for financial assistance and facilities provided by National Agricultural Technology Project, Agro-ecosystem: Arid agro-ecosystem under PSR mode.

## REFERENCES

Ahirwar R M, Gupta M P and Banerjee S. 2008. Evaluation of natural products and endosulfan against incidence of *Antigastm catalaunalis* (Dup.) in sesame. *Annals of Plant Protection Sciences* **16** (1): 25–8.

Ahuja D B, Ahuja Usha Rani, Kalyan R K, Sharma Y K, Dhandapani A and Meena P C. 2009. Evaluation of different management strategies for *Lipaphis pseudobrassicae* (Davis) on *Brassica juncea*. *International journal of Pest Management* **55**: 11–8.

Bhatnagar S K, Solanki Z S, Jangir R P and Ahuja D B. 2005. *Recommended Technologies of Crop Production. Arid Western Plains Zone* 1a. pp 1–45. ARS/MND/2005/1. Agricultural Research Station, (Directorate of Research, Rajasthan Agricultural University), Mandor Jodhpur.

Bhatti I H, Riaz Ahmad and Nazir M S. 2005. Agronomic traits of sesame as affected by grain legumes intercropping and planting patterns. *Pakistan Journal of Agricultural Sciences* **42**: 56–60.

Cardona R. 2008. Effect of green manure and *Trichoderma harzianum* on sclerotia population and incidence of *Macrophomina phaseolina* on sesame. *Revista de la Facultad de Agronomia Universidad del Zulia* **25** (3): 440–54.

Gupta M P. 2002. Integrated pest management modules in sesame (*Sesamum indicum*) at Tikamgarh. Madhya Pradesh. *Indian Journal of Agricultural Sciences* **72** (9): 540–2.

Gupta M P. 2003. Comparative efficacy of neem products and endosulfan against major insect pests of sesame. *Indian Journal of Plant Protection* **31** (2): 96–7.

Mkamilo G S. 2004. *Maize–sesame Intercropping in Southeast Tanzania: Farmers' Practices and Perceptions and Intercrop Performance*, 112 pp.

Nair Radhika, Thakur K D, Shubhangi Bhasme, Jesmi Vijayan and Sunetra Tirthakar. 2006. Control of root rot (*Rhizoctonia bataticola*) of sesamum by different bioagents. *Journal of Plant Disease Sciences* **1** (2): 236–7.

Patnaik H P and Mohapatra L N. 2005. Honeybee foraging and *Antigastra catalaunalis* incidence in sesamum protected with insecticides/botanicals. *Journal of Applied Zoological Researches* **16** (2): 166–9.

Rajpurohit T S. 2002. Influence of intercropping and mixed cropping with pearl millet, greengram and mothbean on the incidence of stem and root rot (*Macrophomina phaseolina*) of sesame. *Sesame and Safflower Newsletter* **17**: 40–2.

Rajpurohit T S and Bishnoi H R. 2006. Integrated disease management of sesame (*Sesamum indicum* L.). *Sesame and Safflower Newsletter* **17**: 78–9.

Rohilla H R, Chhillar B S, Harvir Singh. 2003. Assessment of yield losses caused by *Antigastra catalaunalis* (Dup.) in different genotypes of sesame under agroclimatic conditions of Haryana. *Journal of Oilseeds Research* **20** (2): 315–6.

Singh A, Sardana H R and Sabir N. 2004. (Eds). Validated IPM technologies for selected crops. National Centre for Integrated Pest Management (ICAR), LBS, Building Pusa Campus, New Delhi.

Tripathi J K, Srivastava J P, Tripathi A and Neerja Agrawal 2007. Efficacy of different insecticides against *Antigastra catalunalis* (Dup.) infesting sesamum. *Journal of Plant Protection and Environment* **4** (2): 81–4.

Youssef M M A and El Nagdi W M A. 2004. Cellular alteration of root-knot nematode *Meloidogyne* incognita-infected squash plant and intercropping sesame plant or sesame oilseed cake as control measures. *Egyptian Journal of Phytopathology* **32** (1/2): 77–85.