International Journal of Biodiversity and Conservation Vol. 4(4), pp. 183-188, 1 April, 2012
Available online http://www.academicjournals.org/IJBC
DOI: 10.5897/IJBC12.015
ISSN 2141-243X ©2012 Academic Journals

Full Length Research Paper

Efficacy of different insecticides against mushroom phorid Fly, *Megaselia halterata* (Wood) in Punjab, Pakistan

Muhammad Hussnain Babar[1]*, Muhammad Ashfaq[1], Muhammad Afzal[2], Muhammad Hamid Bashir[1] and Muhammad Asif Ali[3]

[1]Department of Agriculture Entomology, University of Agriculture, Faisalabad, Pakistan.
[2]Department of Agriculture Entomology, University College of Agriculture, University of Sargodha, Sargodha, Pakistan.
[3]Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan.

Accepted 2 March, 2012

Phorid fly, *Megaselia halterata* is the most destructive insect pest of mushroom causing serious threat to mushroom production and cultivation in Pakistan. Chemical control is the most effective and quicker approach used by our farming community. So there was a dire need to evaluate some commercial insecticides against this pest. The present study was therefore, conducted to evaluate six commercial insecticides (deltamethrin, spinosad, spintoram, trichlorphon, malathion and permethrin) against phorid fly for three consecutive years (2008 to 2010). The insecticides evaluation was done on the bases of three parameters viz. percent reduction in adult emergence, mushroom damage rate by phorid fly larvae and mushroom yield per unit area. All insecticides caused significant reductions in adult emergence and mushroom damage rates as compared to control. On overall bases, the average of three years data revealed that maximum reduction of adult emergence and minimum damage rate by phorid flies as well as maximum yield per plot was observed in spinosad treated plots, followed by trichlorphon and deltamethrin which were statistically at par. The results of present study showed that deltamethrin, spinosad and trichlorphon may be employed in the field for controlling mushroom phorid fly in Pakistan.

Key words: Efficacy, insecticides, *Agaricus bisporus*, phorid fly.

INTRODUCTION

Mushroom is an important crop all over the world, which is full of proteins, vitamins and minerals, exceptionally high in vitamins, especially in vitamins of group B, like, thiamin (vitamin B1), riboflavin (vitamin B2), pantothenic acid (vitamin B3) and nicotinic acid (vitamin B5) (Chang and Miles, 1991). The fresh mushrooms contain 85 to 95% water, 3% proteins, 4% carbohydrates, 0.1% fats and 1% minerals (Agrahar-Murugkar and Subbulakshmi, 2005). Edible mushrooms are a rich source of some physiological agents, of medicinal importance, that possess antitumour, anticancerous, anticholesterolic, cardiovascular, antiviral and antibacterial agents (Nayana and Janardhan, 2000; Manpreet et al., 2004; Alam et al., 2007). They are also, found to be useful against the diabetes, ulcer and lung diseases (Halpern and Miller, 2002; Wasser, 2002). Mushroom flies are continuous threat to mushroom industry in Pakistan. Damage by phorid fly directly occurs, due to the feeding of their larvae on mycelia and fruiting body or indirectly due to the excreta secreted by the larvae which alter the chemical and physical properties of the compost (Greenslade and Clift, 2004). The adults of this insect are

*Corresponding author. E-mail: babar1235@yahoo.com.

vectors of *Agaricus bisporus* pathogens, especially of the *Verticillium* spp. and cause a cosmetic damage to the fruiting bodies of the mushrooms (Rinker and Snetsinger, 1984). This pest must be controlled during early stages of mushroom production as to avoid a significant damage and yield losses (Jess and Bingham, 2004).

Pakistan enjoys diverse climate enabling great potential to grow different kinds of mushrooms but most of the growers feel reluctant while growing mushrooms due to the severe infestation of phorid flies each year at different farms which sometimes results into total failure of the crop. Due to these reasons mushrooms sometimes need to be imported from China, Korea, India and Australia.

In Pakistan, commercial cultivation of mushrooms exists on a small scale with a few private farms and no pesticide has yet been registered against this pest. The present study was therefore, designed to find out the efficacy of some commercially available pesticides against phorid fly of mushroom. It is the first study in Pakistan regarding the mushroom insect-pests control.

MATERIALS AND METHODS

The research work was carried out in the Department of Agriculture Entomology, Mushroom Culture Laboratory, Institute of Horticultural Sciences University of Agriculture, Faisalabad, Pakistan and Mushroom houses of different mushroom growers of Punjab.

Preparation of mushroom compost

Mushrooms compost was prepared, by following the method (Babar et al., 2005).

Compost material

Chicken manure = 120 kg,
Wheat straw = 300 kg
Gypsum = 10.50 kg,

300 kg of wheat straw was moisturized daily up to three days to make it soft for the microbial activity. Later on, 120 kg chicken-manure was added to the moistened wheat straw and heaped up, one meter and given 6 turnings, according to the pre-planned time schedule.

Turning schedule of the compost

0 day = making heap.
4th day = first turning.
8th day = second turning.
11th day = third turning
14th day = fourth turning + 1/2 gypsum.
17th day = fifth turning. + next 1/2 gypsum.
20^{th} day = sixth turning (last turning).

Pasteurization

The compost was pasteurized, at 60°C, for 6 h (Noble and Gaze, 1994), in a controlled temperature chamber and cooled to ambient temperature and aerated, in order to reduce the ammonia contents.

Collection and rearing of phorid flies

The insects used in the present study were obtained from laboratory cultures of phorid flies maintained by the method reported by Richardson and Hesling (1978). The adults were collected from different mushroom farms of Punjab with the help of an aspirator which were subsequently shifted into transparent plastic pots (ca.3 litre) and transferred to the insect culture lab of Agri. Entomology Department, University of Agriculture Faisalabad. As the larvae directly feed on button mushroom (*Agaricus bisporus*) mycelium (Hussey, 1959 and White 1985) therefore, the adults were introduced in a rearing chamber (380 × 280 × 150 mm^3) containing a jar of 200 gm compost, fully colonized with mushroom-mycelia placed on a moist towel. Saccharide syrup was also provided as a carbohydrate source for flies. The flies were allowed to lay eggs for 72 h at 25 ± 1°C. After three days, the flies were expelled out from the rearing chamber. Within 21 to 30 days, a new generation was emerged under same temperature regimes. Six commercial insecticides were used in this study are tabulated as follows in table 1.

Experimental design

The experiments were carried out in RCBD (Randomized Complete Block design), at the farmer's field (mushroom houses) in three consecutive growing years during 2008 and 2010. The growth cell was used in designed to those which are employed commercially, but smaller in size (dimensions 1 m × 1 m). Each growing cellar was considered as a replication, and three replicates were used for each treatment. The experiments were repeated in three separate growing periods.

Biological assays

Pasteurized and colonized compost growing cellar were kept in the growth room. When spawn running completed then kept for 14 days at 26 ◦C and 80 to 90% relative humidity, the compost was amply spawned and then covered with 5cm thick covering of moss peat, a homogeneous mixture of black peat (90%) and calcium carbonate (10%). After casing, forty pairs (40:40) of phorid fly were introduced over the casing layer in each growing cellar covered with transparent nylon gauze dome-shaped cages and was allowed to lay eggs for 3 to 4 days. All the adult flies were subsequently removed, and when tiny larvae started to hatch then hatching date was determined by microscopic examination of small amounts of growing substrate taken randomly from growing cellars and then every plot was treated with insecticide to control the insect pest at early stage.

After casing, the bags were kept at 24 to 26°C for 6 to 7days, and then fresh air was introduced until a temperature of 16.5 ± 0.5°C and a relative humidity of 80 to 85% were maintained throughout cropping. Light trap was installed to assess the emerging adult's population. Treatments were assessed by calculating the emergent flies of the mushroom. At weekly intervals for 5 weeks, emerging flies were counted in each treatment including control. The number of mushroom damaged by the larvae was also recorded separately for each treatment.

Data analysis

All data collected were analyzed statistically for calculation of ANOVA. The means were separated by Tukey's HSD test by using

Table 1. Chemical insecticides to control the mushroom phorid.

Treatment	Common name	Trade name	Manufacturer	Dose (ml/L)
T1	Deltamethrin	Decis® 2.5EC	Bayer Crop Sciences, Germany	0.4
T2	Spinosad	Tracer® 240SC	Dow Agro Sciences, USA	0.4
T3	Spintoram	Radiant® 120SC	Ali Akbar Enterprises, Pakistan	0.2
T4	Trichlorphon	Dipterex® 80WP	Bayer Crop Sciences, Germany	6.8
T5	Malathion	Fyfanon® 57EC	Ali Akbar Enterprises, Pakistan	7.5
T6	Permethrin	Coopex® 0.5%	Ali Akbar Enterprises, Pakistan	0.25
T7	Control	-		-

Table 2. Mean percentage reductions in phorid fly (*Megaselia halterata*) population and mean percentage damaged of mushroom (*Agaricus bisporus*) caused by the larvae during three growing periods by using chemical insecticides.

Treatment	Period I		Period II		Period III	
	RAE	MDR	RAE	MDR	RAE	MDR
T1=Deltamethrin	84.75 (± 0.90)[a]	10.50 (± 0.69)[c]	86.01 (± 0.83)[a]	9.40 (± 0.44)[c]	84.59 (± 1.14)[a]	10.37 (± 0.58)[c]
T2= Spinosad	86.43 (± 0.85)[a]	9.70 (± 0.67)[c]	88.02 (± 1.07)[a]	9.07 (± 0.33)[c]	86.25 (± 1.13)[a]	9.17 (± 0.30)[c]
T3= Spintoram	83.58 (± 0.87)[a]	11.43 (± 0.70)[c]	84.97(± 0.93)[ab]	10.80 (± 0.32) [c]	83.33 (± 1.10)[ab]	11.07 (± 0.39)[c]
T4= Trichlorphon	85.60 (± 0.84)[a]	10.33 (± 0.68)[c]	87.14 (± 1.03)[a]	9.70 (± 0.33)[c]	85.35 (±1.12)[a]	9.83 (±0.33)[c]
T5= Malathion	75.69 (± 0.89)[c]	16.47 (± 1.03)[b]	77.03 (± 0.85)[c]	14.67 (±0.50)[b]	75.50 (± 1.14)[c]	16.47 (± 1.16)[b]
T6= Permethrin	79.58 (± 0.88)[b]	15.00 (± 0.67)[b]	81.02 (± 0.74) [c]	13.63 (±0.76)[b]	79.29 (±1.12)[bc]	15.33 (± 0.87)[b]
T7= Control	0.00[d]	50.10 (± 0.21)[a]	0.00[d]	48.70 (±0.87)[a]	0.00[d]	48.57 (± 0.63)[a]

Means sharing similar letters in each column are not different significantly (Tukey's HSD). RAE= Reduction in adult emergence and MDR= mushroom damage rate.

computerized statistical software SPSS® ver. 16.

The percentage reduction in adult emergence for each treatment in each of the three growing periods was calculated by using the formula (Erler et al., 2009):

% Reduction = [(B-A)/B] × 100

Where A = total number of emerging adults in the each treatments and B= total number of emerging adults in the control. Whereas the percentage damage of mushroom was determined by using the formula (Erler et al., 2009).

% Damage mushroom = (number of mushroom damaged/total number of mushroom) × 100

The mushroom yield data was expressed as Kg / M^2.

RESULTS

Effect of chemical insecticides on adult emergence

There were significant differences in RAE (Reduction in Adult Emergence) in all the three years of study (Table 2). In the first period of study there were significant differences (F = 1519.61, df 6, 14, prob. 0.000) between the treatments. Spinosad showed the highest results (86.43% ± 0.85) in RAE which was statistically at par with deltamethrin, spintoram and trichlorfon. In the second period of study, almost similar significant (F = 1424.45, df6, 14, prob. 0.000) results were obtained and also in the 3rd study period significant (F = 903.28, df 6, 14, prob. 0.000) results were obtained which showed that the four products as mentioned above were good in causing death of phorid flies. In all the three study periods two of the insecticides remained less effective viz. malathion and permethrin.

When all the treatments are compared with respect to the mean percentage reduction in adult emergence, the order of effectiveness is generally as follows: spinosad > trichlorphon > deltamethrin

Table 3. Average yield of mushroom (*A. bisporus*) obtained during three growing periods by using chemical insecticides against phorid fly (*M. halterata*).

Treatments	Yield (kg/M^2)		
	Period I	Period II	Period III
T1=Deltamethrin	7.95 (± 0.08) ab	8.10 (± 0.13) a	7.84 (± 0.08) ab
T2= Spinosad	8.30 (± 0.05) a	8.02 (± 0.08) ab	8.12 (± 0.15) a
T3= Spintoram	7.81 (± 0.09) bc	7.95 (± 0.10) ab	7.64 (± 0.07) bc
T4= Trichlorphon	8.00 (± 0.08) ab	8.12 (± 0.15) a	8.25 (± 0.09) a
T5= Malathion	7.35 (± 0.13) d	7.55 (± 0.18) c	7.20 (± 0.08) d
T6= Permethrin	7.50 (± 0.04) cd	7.65 (± 0.16) bc	7.42 (± 0.05) cd
T7= Control	4.35 (± 0.03) e	4.47 (± 0.04) d	4.54 (± 0.04) e

Means sharing similar letters in a column are not different from each other (Tukey's HSD test).

> spintoram > permethrin > malathion respectively.

Effects on mushroom damage rate by phorid fly larvae

All the chemical insecticides reduced the mushroom damage rate by the larvae of phorid fly and had significantly less mushroom damage rate compared with the control (Table 2). In terms of mean percentage damage of mushroom by the larvae, the lowest damage rates were observed (9.70%, 9.07% and 9.17%) in spinosad treatment during three growing periods successively.

During the 1st growing period there was a significant difference (F = 429.18, df 6, 14, prob. 0.000) among the treatments with spinosad showing very less damage rate by the larvae (9.70% ± 0.67) but again this was statistically at par with other three insecticide results viz. deltamethrin (10.50% ± 0.69), spintoram (11.43% ± 0.70) and trichlorfon (10.33% ± 0.70). When we compare results during 2nd year of study we see almost similar results as spinosad (9.07% ± 0.33) showing less damage rate as compared to the other three insecticides statistically at par namely deltamethrin (9.40% ± 0.44), spintoram (10.80% ± 0.32) and trichlorfon (9.70% ± 0.32). During 3rd year study the results were similar like spinosad (9.17% ± 0.30) showing less damage rate as compared to the other three insecticides statistically at par namely deltamethrin (10.37% ± 0.58), spintoram (11.07% ± 0.39) and trichlorfon (9.83% ± 0.33). The other two products showed higher damage rate by the larvae showing their less control during the three consecutive periods. Based on the mushroom damage rates, the order of efficacy of the treatments was as follows: spinosad > trichlorphon > deltamethrin > spintoram > permethrin > malathion > control.

Effect on mushroom yield

The yield in kg/m^2 for cumulative flushes for each individual treatment is shown in table 3. In the 1st period of study significant (F = 304.61, df 6, 14, prob. 0.000) differences in yield were obtained between the treatments. Maximum yield (8.30 ± 0.05 kg/m^2) was observed where spinosad was applied followed by trichlorphon, deltamethrin, spintoram, permethrin, malathion and control (8.00, 7.95, 7.81, 7.50, 7.35 and 4.35 kg/m^2 respectively). During 2nd growing period again significant (F = 105.15, df 6, 14, prob. 0.000) differences were observed between the treatments. Maximum yield (8.12 kg/m^2) was observed in trichlorphon treatment followed by deltamethrin, spinosad, spintoram, permethrin, malathion and control (8.10, 8.02, 7.95, 7.65, 7.55 and 4.47 kg/m^2 respectively). Similarly, during 3rd growing period significant (F = 215.40, df 6, 14, prob. 0.000) differences in yield were observed. Maximum yield (8.25 kg/m^2) was observed in trichlorphon treatment followed by spinosad, deltamethrin, spintoram, permethrin, malathion and control (8.12, 7.84, 7.64, 7.42, 7.20 and 4.54 kg/m^2, respectively).

DISCUSSION

Spinosad is a new chemistry insecticide with novel mode of action. It was first registred against dipterous insects in the United States in 2005 (Juliane et al., 2006). Spinosad, an environment friendly alternative to malathion (Peck and McQuate, 2000; Vargas et al. 2001).

The present study showed that in mushroom house condition spinosad was found to be most effective insecticide which had significantly reduced the adult emergence (86.43, 88.02 and 86.25%) than any of the others insecticides during three successive growing period. Similar conclusion was obtained by Sameh et al. (2009) who indicated that spinosad can reduce the olive fruit fly infestation up to 86.3%. The results of present study also match with previous studies (Kirsten et al., 2005; Braham et al., 2007; El-Aw et al., 2008; Gabriele et al., 2011). While trichlorphon deltamethrin and spintoram was also found most effective chemicals to control the phorid fly of mushroom. They reduced the phorid fly population more than 80% which is also confirmed by the previous studies (Chihiya et al., 2006; Yee et al., 2007; Palumbo and Richardson, 2008; Mahmoud et al., 2009; Ahmad et al., 2010; Raga and Sato, 2011; Saeidi et al., 2011) but they used these chemicals against fruit fly which is also a dipterous insect. Malathion and permethrin were proved effective but their efficacy was less as compared with other insecticides. Similar results were obtained by Braham et al. (2007) (in Tunisia) and El-Aw et al. (2008) who reported that spinosad was most effective insecticide than malathion in controlling dipterous insect pests. The main reason of ineffective of heavy use of malathion and permethrin was created the resistance problems, previous studies (Kaufman and Rutz, 2001; Hussain et al., 2005; Fourie et al., 2006; Braham et al., 2007; Roger et al., 2009; Saeidi et al., 2011) confirmed the results.

The results of present study indicate that all the insecticides reduce the phorid fly emergence and mushroom damage rate. When taking into consideration yield values from the treatments, the lowest values were obtained from the control. The yield values also show that all treatments gave good yield but spinosad and trichlorphon were proved most effective against this pest and gave maximum yield as compared with other treatments.

Results from this study suggest that commercial insecticides suppress the populations of mushroom flies by reducing adult emergence and have potential to control phorid fly of mushroom by the chemicals. Mushroom growers are not using insecticides against this pest in Pakistan, so resistance problem is not present here. While in some mushroom growing European countries, America, Canada and Australia where maximum farmers use insecticides to control this pest have created the resistance problems against diazinon, organophosphate and pyrethroids (Smith and White, 1996; Smith, 2002; Hsu et al., 2004; Magana et al., 2007; Ahmad et al., 2010; Jamal et al., 2011; Raga and Sato, 2011).

ACKNOWLEDGEMENT

This study was supported by the Higher Education Commission (HEC) of Pakistan in the form of Indigenous Ph. D fellowship for which the author is highly thankful.

REFERENCES

Agrahar-Murugkar D, Subbulakshmi G (2005). Nutritional value of edible wild mushrooms collected from the Khasi Hills of Meghalaya. J. Food Chem., 89: 599-603.

Ahmad S, Ahmed FS, Khan RR, Nadeem MK (2010). Evaluation of insecticide resistance in two strains of fruit fly, *Bactrocera zonata* (*Tephritidae*: Diptera), with fruit dip method, Pak. Entomol. 32 (2): 163-167.

Alam N, Hossain MS, Khair A, Amin SMR, Khan A (2007). Comparative Study of Oyster mushrooms on Plasma Lipid Profile of Hypercholesterolemic Rats. Bangl. J. Mushr., 1(1): 15-22.

Babar MH, Afzal M, Bashir MH, Ali MA (2005). Relative efficacy of different acaricides (Dicofol, Abamectin and Hexythiazox) against mushroom mites (Pygmephoroidae). Pak. J. Agri. Sci., 42 (3-4): 45-47.

Braham M, Pasqualini E, Ncira N (2007). Efficacy of kaolin, spinosad and malathion against *Ceratitis capitata* in *Citrus* orchards. Bull. Insectol., 60(1): 39-47.

Chang ST, Miles PG (1991). Recent trends in World Production of Cultivated Edible Mushrooms. Mushr. J., 503: 15-18.

Chihiya J, Gadzirayi CT, Mutandwa E (2006). Effect of three different treatment levels of deltamethrin on the numbers of dung beetles in dung pats, Afr. J. Agric. Res., 1(3): 74-77.

El-Aw MAM, Draz KAA, Hashem AG, El-Gendy IR (2008). Mortality comparison among spinosad, actara, malathion and methomyl-containing baits against peach fruit fly, *Bactrocera zonata* Saunders (Diptera: Tephtitidae) under laboratory conditions. J. Appl. Sci. Res., 4(2): 216-223.

Erler F, Polat E, Demir H, Cetin H, Erdemir T (2009). Control of the mushroom phorid fly, *Megaselia halterat* (Wood), with plant extracts. Pest Manag. Sci., 65: 144-149.

Fourie LJ, Stanneck D, Horak IG (2006). Efficacy of a topically applied combination of imidacloprid and permethrin against *Stomoxys calcitrans* on dogs, Intern. J. Appl. Res. Vet. Med., 4(1): 29-33.

Gabriele L, Hack R, Smid G (2011). Efficacy of spinosad against the poultry red mite, *Dermanyssus gallinae* (Mesostigmata: Dermanyssidae), in laboratory and field trials. Zoosymposia, 6: 282-287.

Greenslade P, Clift AD (2004). Review of pest arthropods recorded from commercial mushroom farms in Australia. Austr. Mycol. 23: 77-93.

Halpern GM, Miller AH (2002). Medicinal Mushrooms. M. Evans and Company, Inc, New York.

Hsu JC, Wu WJ, Feng HT (2004). Biochemical mechanisms of malathion resistance in oriental fruit fly, *Bactrocera dorsalis* (Hendel). Pl. Protect. Bull., 46: 255-266.

Hussain R, Ashfaq M, Saleem MA, Ahmed S (2005). Toxicity of some insecticides with novel modes of action against malathion–resistant and organophosphate susceptible strains of *Tribolium castaneum* larvae, Int. J. Agri. Biol., 7(5): 768-772.

Jamal AE, Nugud AD, Abdalmagid MA, Bashir AI, Brair M, Elnaeim IH (2011). Susceptibility of *Culex quinquefasciatus* (Diptera: Culicidae) in Khartoum locality (Sudan) to malathion, temephos, lambda-cyhalothrin and permethrin insecticides, Sudanese J. Public health. 6(2): 56-62.

Jess S, Bingham JFW (2004). Biological control of sciarid and phorid pests of mushroom with predatory mites from the genus *Hypoapsis* (Acari: Hypoaspidae) and the entomopathogenic nematode *Steinernema feltiae*, Bull. Entomol. Res., 94: 159-167.

Kaufman PE, Rutz DA (2001). Susceptibility of house flies (Diptera: Muscidae) exposed to commercial insecticides on painted and unpainted plywood panels. Pest manag. Sci., 128: 174-178.

Kirsten SP, Isaacs R, Wise JC, Gut LJ (2005). Protection of fruit against infestation by apple maggot and blueberry maggot (Diptera: Tephritidae) using compounds containing spinosad. J. Econ. Entomol., 98 (2): 432-437.

Magana C, Hernandez-Crespo P, Ortego F, Castanera P (2007). Resistance to malathion in field populations of *Ceratitis capitata*. J. Econ. Entomol., 100: 1836-1843.

Mahmoud MF, El-Kady G, Osman MAE (2009). Toxicity of spinetoram to onion thrips (*Thrips tabaci*) and to green peach aphid (*Myzus persicae*) under laboratory and field conditions. Tunisian J. Pl.

Prot., 4 (2): 221-227.
Manpreet K, Giridhar S, Khanna PK (2004). *In vitro* and *in vivo* antioxidant potentials of *Pleurotus florida* in experimental animals. Mushr. Res., 13(1): 21-26.
Nayana J, Janardhanan KK (2000). Antioxidant and antitumour activity of *Pleurotus florida*. Curr. Sci., 79(7): 941-943.
Noble R, Gaze RH (1994). Controlled environment composting for mushroom cultivation: substrates based on wheat and barley straw and deep litter poultry manure. J. Agri. Sci., 123(1): 71-79.
Palumbo J, Richardson YAJ (2008). Efficacy of radiant (spinetoram) against western flower thrips in romaine lettuce, Vegetable Report. 152: 96-103.
Peck SL, McQuate GT (2000). Field test of environmentally friendly malathion replacements to suppress wild Mediterranean fruit fly (Diptera: Tephritidae) populations. J. Econ. Entomol., 93: 280-289.
Raga A, Sato ME (2011). Toxicity of neonicotinoids to *Ceratitis capitata* and *Anastrepha fraterculus* (Diptera: Tephritidae). J. Pl. Prot Res., 51(4): 413-417.
Richardson PN, Hesling JJ (1978). Laboratory rearing of the mushroom phorid fly, *Megaselia halterata* (Diptera: Phoridae). Annu. Appl. Biol., 88: 211-217.
Rinker DL, Snetsinger RJ (1984). Damage threshold to a commercial mushroom by a mushroom-infesting phorid (Diptera: Phoridae). J. Econ. Entomol., 77: 449-453.
Roger I, Vargas RI, Pinero JC, Jacome I, Revis HC, Prokopy RJ (2009). Effectiveness of malathion against different ages of melon fly (Diptera: Tephritidae). Proc. Hawaiian Entomol. Soc., 41: 15-23
Saeidi K, Nur-Azura A, Omar D, Abood F (2011). Efficacy of various insecticides on safflower fly, *Acanthiophilus helianthi* Rossi (Diptera: Tephritidae) in Kohgiloyeh and Boyerahmad province (Iran) Austr. J. Bas. Appl. Sci., 5(12): 2660-2664.
Sameh AM, Ahmed E, Mostafa M, Metwally E, Nabil MG (2009). Efficacy of spinosad, lufenuron and malathion against olive fruit fly, *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) Egypt. Acad. J. biolog. Sci., 2(2): 171-178.
Smith JE (2002). Dimilin resistance in mushroom sciarids. Mushr. J., 656: 15-19.
Smith JE, White PF (1996). Diazinon resistance in mushroom pests. HDC Project News, 36: 12-15.
Vargas RI, Peck SL, McQuate GT, Jackson CG, Stark JD, Armstrong JW (2001). Potential for area wide integrated management of Mediterranean fruit fly (Diptera: Tephritidae) with a braconid parasitoid and a novel bait spray. J. Econ. Entomol., 94: 817-825.
Wasser SP (2002). Medicinal mushrooms as a source of antitumor and immunomodulating polysaccharides. Appl. Microbiol. Biotechnol., 60: 258-274.
White PF (1985). Pests and pesticides. In the Biology and Technology of the Cultivated Mushroom (Eds. Flegg PB, Spencer DM and Wood DA) Chichester: John Wiley and Sons Ltd. pp. 279-293
Yee WL, Jack O, Nash MJ (2007). Mortality of *Rhagoletis pomonella* (Diptera: Tephritidae) exposed to field-aged spinetoram and azinphos-methyl in Washington state. Florida Entomol., 90(2): 335-342.