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Efficacy of Different Insecticides Against Mushroom Sciarid Fly (*Lycoriella auripila*) in Punjab, Pakistan

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Abstract: Sciarid fly, *Lycoriella auripila* is the most destructive insect pest of mushroom causing serious threat to mushroom production and cultivation in Pakistan. Chemical control is the most effective easier and quicker method to control this insect pest which is commonly 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 sciarid fly for three consecutive years (2008 to 2010). During present study the insecticides evaluation was done on the bases of three parameters viz. percent reduction in adult emergence, mushroom damage rate by sciarid 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 for three years, the data revealed that maximum reduction of adult emergence (84.61, 86.32 and 83.42%) and minimum damage rate by sciarid flies (10.60, 9.53 and 13.73%) as well as maximum yield per plot (8.30, 8.02 and 8.12 kg/m²) 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 very effective insecticides to control mushroom sciarid fly in Pakistan.

Key words: Efficacy, insecticides, *Agaricus bisporus*, sciarid 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 sciarid 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 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 hesitate while growing mushrooms due to the severe attack of In Pakistan, 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.

Commercial cultivation of mushrooms in Pakistan 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 effectiveness of some commercially available insecticides against sciarid 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

Three hundred kilo gram 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
20th 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 sciarid flies: The insects used in the present study were obtained from laboratory cultures of sciarid 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 L) 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; White, 1985) therefore, the adults were introduced in a rearing chamber (380x280x150 mm³) 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 5 cm thick covering of moss peat, a homogeneous mixture of black peat (90%) and calcium carbonate (10%). After casing, forty pairs (40:40) of sciarid 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 7 days 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

Table 1: Chemical insecticides to control the mushroom sciarid fly (*Lycoriella auripila*)

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	-	-	-

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 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 (Erlor *et al.*, 2009):

$$\text{Reduction (\%)} = [(B-A)/B] \times 100$$

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 (Erlor *et al.*, 2009):

$$\text{Damage mushroom (\%)} = (\text{No. of mushroom damaged} / \text{total no. of mushroom}) \times 100$$

The mushroom yield data was expressed as Kg / M2.

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 between the treatments. Spinosad showed the highest results (84.61%±1.02) in MDR which was statistically at par with deltamethrin, spintoram and trichlorfon. In the second period of study, almost similar significant (86.32%±0.93) results were obtained and also in the 3rd study period significant (83.42%±0.82) results were obtained which showed that the four products as mentioned above were good in

causing death of sciarid 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>spintoram>permethrin>malathion, respectively.

Effects on mushroom damage rate by sciarid fly larvae:

All the chemical insecticides reduced the mushroom damage rate by the larvae of sciarid 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 (10.60%±1.15, 9.53%±0.49 and 13.73%±1.18) in spinosad treatment during three growing periods successively.

During the 1st growing period there was a significant difference among the treatments with spinosad showing very less damage rate by the larvae (10.60%±1.15) but again this was statistically at par with other three insecticide results viz. deltamethrin (11.50%±1.10), trichlorfon (11.63%±1.48) and spintoram (12.87%±1.41). When we compare results during 2nd year of study we see almost similar results as spinosad (9.53%±0.49) showing less damage rate as compared to the other three insecticides statistically at par namely trichlorfon (10.27%±0.60), deltamethrin (10.33%±0.63), spintoram (11.43%±0.66) and During 3rd year study the results were similar like spinosad (13.73%±1.18) showing less damage rate as compared to the other three insecticides statistically at par namely trichlorfon (14.43%±0.98), deltamethrin (14.63%±1.01) and spintoram (15.67±1.01) respectively. 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

Table 2: Mean percentage reductions in sciarid fly (*Lycoriella auripila*) 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	82.90(±1.04) ^{ab}	11.50 (±1.10) ^c	84.61 (±0.98) ^{ab}	10.33 (±0.63) ^c	81.82 (±0.88) ^{ab}	14.63 (±1.01) ^c
T2= Spinosad	84.61 (±1.02) ^a	10.60 (±1.15) ^c	86.32 (±0.93) ^a	9.53 (±0.49) ^c	83.42 (±0.82) ^a	13.73 (±1.18) ^c
T3= Spintoram	81.64 (±0.95) ^b	12.87 (±1.41) ^c	83.44 (±0.98) ^b	11.43 (±0.66) ^c	80.67 (±0.85) ^b	15.67 (±1.01) ^c
T4= Trichlorphon	83.72 (±0.96) ^{ab}	11.63 (±1.48) ^c	85.40 (±1.00) ^{ab}	10.27 (±0.60) ^c	82.43 (±0.85) ^{ab}	14.43 (±0.98) ^c
T5= Malathion	73.83 (±1.01) ^d	17.93 (±0.77) ^b	75.56 (±0.98) ^d	15.83(±0.84) ^b	72.44 (±1.12) ^d	20.77(±1.09) ^b
T6= Permethrin	77.62 (±0.91) ^c	16.43 (±0.62) ^b	79.48 (±1.04) ^c	14.97 (±0.66) ^b	76.41 (±0.84) ^c	19.50 (±1.15) ^b
T7= Control	0.00 ^e	49.97(±0.64) ^a	0.00 ^e	49.10 (±1.26) ^a	0.00 ^e	52.50 (±1.05) ^a

Means sharing similar letters in each column are not different significantly (Tukey's HSD)

RAE: Reduction in adult emergence

MDR: mushroom damage rate

Table 3: Average yield of mushroom (*A. bisporus*) obtained during three growing periods by using chemical insecticides against sciarid fly (*Lycoriella auripila*)

Treatments	Yield (kgM ²)		
	Period I	Period II	Period III
T1= Deltamethrin	7.85 (±0.07) ^a	8.10 (±0.10) ^a	7.46 (±0.04) ^a
T2= Spinosad	7.95 (±0.10) ^a	8.00 (±0.09) ^a	6.77 (±0.98) ^a
T3= Spintoram	7.66 (±0.09) ^b	7.95 (±0.10) ^a	7.40 (±0.07) ^a
T4= Trichlorphon	7.70 (±0.07) ^b	7.90 (±0.11) ^a	7.49 (±0.83) ^a
T5= Malathion	7.20 (±0.07) ^c	7.50 (±0.06) ^b	6.93 (±0.03) ^a
T6= Permethrin	7.35 (±0.08) ^c	7.40 (±0.06) ^b	7.08 (±0.02) ^a
T7= Control	4.56 (±0.04) ^d	4.59 (±0.03) ^c	4.28 (±0.04) ^b

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

Effect on mushroom yield: The yield in kg/m² for cumulative flushes for each individual treatment is shown in Table 3. In the 1st period of study significant differences in yield were obtained between the treatments. Maximum yield (7.95±0.10 kg/m²) was observed where spinosad was applied followed by deltamethrin, trichlorphon, spintoram, permethrin, malathion and control (7.85±0.07, 7.70±0.07, 7.66±0.09, 7.35±0.08, 7.20±0.07 and 4.56±0.04) kg/m², respectively). During 2nd growing period again significant differences were observed between the treatments. Maximum yield (8.10±0.10 kg/m²) was observed in deltamethrin treatment followed by, spinosad, spintoram, trichlorphon malathion permethrin and control (8.00±0.09, 7.95±0.10, 7.90±0.11, 7.50±0.06, 7.40±0.06 and 4.59±0.03 kg/m², respectively). Similarly, during 3rd growing period significant differences in yield were observed. Maximum yield (7.49±0.83 kg/m²) was observed in trichlorphon treatment followed by deltamethrin, spintoram, permethrin, malathion spinosad and control (7.46±0.04, 7.40±0.07, 7.40±0.07, 7.08±0.02, 6.93±0.03, 6.77±0.98 and 4.28±0.04 kg/m², respectively).

DISCUSSION

Spinosad is a new chemistry insecticide with novel mode of action. It was first registered 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 (84.61%±1.02, 86.32%±0.93 and 83.42%±0.82) 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 sciarid and

phorid fly of mushroom. They reduced the population more than 80% which is also confirmed by the previous studies (Chihya *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) 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 ineffectiveness was the heavy use of malathion and permethrin which 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 sciarid 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 deltamethrin 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 sciarid fly by reducing adult emergence and have potential to control this 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).

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