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Evaluation of the Effects of Various Insecticides on Edible Fungi and Sciarid (*Bradysia* spp.) Larvae

Satish Kumar and Shweta Sharma

ICAR, Directorate of Mushroom Research, Chambaghat Solan- 173212, Himachal Pradesh
Corresponding author, E-mail: Satish132@gmail.com

ABSTRACT

Effect of six insecticides has been studied on seven edible fungi under *in vitro* conditions by food poisoned technique and also on sciarid larvae under *in vivo* conditions during *Agaricus bisporus* cultivation by giving 4 sprays stating at casing. Under *in vitro* studies dichlorvos (0.1%) and chlorpyriphos (0.1%) completely inhibited the growth of all edible fungi and cyromazin was found highly toxic to *Lentinula edodes* and *Pleurotus ostreatus*. Deacamethrin was found nontoxic to *Lentinula edodes* and *Pleurotus ostreatus*. Malathion for *A. bisporus* and Neemax (1.0%) was observed least toxic to all the edible fungi except *L. edodes*. Tunnelling index was found nil in mushroom fruit bodies when malathion was sprayed and yield was also marginally reduced over control. Highest yield (14.78kg) was recorded in case of decamethrin. Highest tunnelling index (4) was recorded in case of Neemax and lowest yield in chlorpyriphos.

Key words: Edible fungi, insecticides inhibition, sciarids, tunnelling, yield

Mushroom production in India remained considerably lower than in developed countries, despite the country's diverse agro-climatic conditions. This shortfall is primarily due to the reliance on seasonal cultivation methods that utilize unpasteurized compost. When combined with inadequate hygiene and sanitation practices, these methods create a conducive environment for the proliferation of insect pests in mushroom farms. Sciarid flies (*Bradysia* spp.), phorid flies (*Megaselia* spp.), and springtails have been consistently reported as major threats to mushroom production, as these pests can cause significant damage by feeding on mycelium, reducing yields, and introducing fungal pathogens (Rambelli and Menini 1983; Brar and Sandhu 1987; Gea *et al*., 2021and Navarro *et al*., 2020). The larvae of sciarid flies are known to cause severe damage by burrowing into the growing media and feeding on the fungal mycelium, leading to stunted growth and crop failure.

Effective insect pest management is crucial for successful mushroom cultivation, as these pests not only diminish yields but also facilitate the transmission of fungal diseases that can devastate crops (Kumar and Sharma, 1998; Rinker, 2017; Shamshad, 2010). The persistence of such pests can lead to secondary infestations by pathogenic fungi such as *Verticillium* sp., *Cladobotryum* sp, and *Mycogone* sp., which further complicates the management of mushroom farms (Geels and Rutjens, 1997; Fletcher and Gaze, 2008). Historically, chemical insecticides such as Endosulfan and Dichlorvos at 0.05% have been recommended for controlling these pests, although concerns about their environmental impact and

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potential residues have led to increased interest in safer alternatives (Sharmad *et al*., 2009; Ramos *et al*., 2018). In the present investigation, efforts have been made to evaluate safe and effective insecticides for the management of mushroom sciarids, with a focus on minimizing harm to non-target organisms and reducing the risk of resistance development in pest populations.

MATERIAL AND METHODS

Different insecticides namely, decamethrin, cyromazin, dichlorvos, chlorpyriphos, malathion (0.01%) and one bio-pesticide neemax (neem product) (1%) were evaluated against various edible fungi namely, *Agaricus bisporus*, *A. bitorquis*, *Calocybe indica*, *Pleurotus sajor-caju*, *P. ostreatus, Auricularia polytricha* and *Lentinula edodes* under *in vitro* conditions on malt extract agar medium. Different insecticides were added to the MEA medium at the rate of 0.01% and bio-pesticide at the rate of 1% after sterilization of the medium. After mixing thoroughly the medium was poured into the Petri plates @ 20 ml per plate and after solidification, inoculations were done with 8 mm diameter mycelial discs cut from 10 days old culture of different edible fungi and incubated at 25°C. Five replications were maintained for each treatment. Medium with sterile distilled water served as control. The inhibition of mycelial growth was calculated after 10 days of inoculation.

To evaluate the effect of different insecticide, experiment was conducted by cultivating *A. bisporus* (strain U-3) on short method compost following standard package of practices in 10 Kg compost bags. Five insecticides namely decamethrin, cyromazin, dichlorvos, chlorpyriphos, malathion (0.01%) and one bio-pesticide neemax (1%) were applied during casing, casing + pinning, casing+ pinning + 7 days after casing and casing+ pinning + 15 days after pinning. Each treatment was replicated five times.

Sciarid flies were introduced by placing 15 bags of spent compost containing very high population of flies in the cropping room. In addition, flies were also introduced by capturing them with the help of aspirator from other cropping rooms. Tunnelling index was worked out using the following key:

S. No.	Number of tunnels/ sporophore	Ranks
1.	More than 5 tunnels	5
2.	3-4 tunnels	4
3.	2-3 tunnels	3
4.	1-2 tunnels	2
5.	Tunnelling just started	1
6.	No tunnels	0

RESULTS AND DISCUSSION

Perusal of data in Table 1 revealed that dichlorvos and chlorpyriphos proved highly inhibitory to mycelial growth of all the edible fungi tested. Neemax on the other hand caused minimum inhibition of mycelial growth and proved safe to *P. ostreatus*. Similarly, decamethrin proved safe to *P. sajor-caju*, *P. ostreatus* and *L. edodes*, although 46.44% inhibition of mycelial growth was recorded in case of *A. bisporus*. Considerable variation in the effect of different insecticides on tunnelling by larvae in mushroom stipe was observed depending upon the time of application. Perusal of data in Table 2 indicates that among the different insecticides, bio-pesticide neemax proved least effective wherein maximum number of stipes were observed tunnelled. The tunnelling index in this case ranked 4. Maximum reduction in yield (23.20%) was observed in case of chlorpyriphos treatment although tunnelling index ranked, only 2. The reduction in yield may be due to the inhibitory effect of chlorpyriphos on mushroom mycelium.

Snetsinger *et al*. (1978) observed slight inhibition in growth of *Pleurotus* spp due to the application of

Table 1. Inhibition of growth of different edible fungi by various insecticides

S.No	Insecticide	Av. Diametric growth (mm) of different mushrooms						
		A. bisporus	*A. bitorquis*	*C. indica*	*P. sajor-caju*	*P. ostreatus*	*A. polytricha*	*L. edodes*
1.	**Decamethrin**	48.2 0 (46.44)*	50.80 (43.55)	54.00 (40.0)	79.20 (12.0)	90.00 (0.0)	64.80 (28.0)	90.00 (0.0)
2.	**Cyromazin**	51.00 (43.33)	54.60 (39.33)	0.00 (100)	0.00 (100)	0.00 (100)	15.60 (82.66)	0.00 (100)
3.	**Dichlorvos**	0.00 (100)	0.00 (100)	0.00 (100)	0.00 (100)	0.00 (100)	0.00 (100)	23.60 (73.77)
4.	**Chlorpyriphos**	0.00 (100)	0.00 (100)	0.00 (100)	0.00 (100)	0.00 (100)	0.00 (100)	24.20 (73.11)
5.	**Malathion**	90.0 (0.00)	28.0 (68.88)	30.6 (66.0)	23.0 (74.44)	0.0 (100)	32.6 (63.77)	52.0 (42.22)
6.	**Neemax**	90.0 (0.00)	84.6 (6.00)	90.0 (0.00)	90.0 (0.00)	79.0 (12.22)	90.0 (0.00)	26.8 (70.22)
7.	**Control**	90.00	90.00	90.00	90.00	90.00	90.00	90.00

*Figures in parentheses are percent inhibition over control

Table 2. Sciarid fly damage and yield of button mushroom

S.no.	Insecticide	Stages of spray	Yield (kg/q)		Damage		Index
			No. of fruit bodies	Weight	% increase (+) or decrease (-) in yield	Av. number of tunnels	
1.	**Neemax**	Casing + pinning + 7 and 15 days after pinning	1040	12.33	-10.20	2.2	4
2.	**Decamethrin**	Casing + pinning + 7 and 15 days after pinning	1451	14.78	+7.10	0.2	2
3.	**Cyromazin**	Casing + pinning + 7 and 15 days after pinning	1272	13.19	-3.94	0.2	2
4.	**Dichlorvos**	Casing + pinning + 7 and 15 days after pinning	1269	13.46	-2.00	0.4	3
5.	**Chlorpyriphos**	Casing + pinning + 7 and 15 days after pinning	1158	10.54	-23.20	0.2	2
6.	**Malathion**	Casing + pinning + 7 and 15 days after pinning	1346	13.47	-1.89	-	-
7.	**Control**	No spray	1535	13.73	-	1.2	3

chlorpyriphos methyl and chlorpyriphos ethyl at 38 ppm concentration. Application of decamethrin at casing + pinning + 7 and 15 days after pinning resulted in 7.10% increase in yield over untreated control. Aerial application of synthetic pyrethroids like permethrin and fenvalerate (29.4 and 36g/ 1000m^3 air, respectively) has been found to give control of 85-95% of sciarids (Rinker *et al.*, 1989). However, in present study application of decamethrin as drench on casing surface proved quite effective. Malathion also proved quite effective wherein no tunnelling was observed when applied at casing + pinning + 7 and 15 days after pinning. Application of cyromazin at casing + pinning + 7 and 15 days resulted in 3.94% reduction in yield and the tunnelling index also ranked 2. According to Rinker *et al*. (1989) application of cyromazin (8.75g/ 100m^3) at casing was moderately effective against sciarids. Adequate control of sciarid, *Lycoriella* *auripila* was achieved by application of methoprene @ 100ml/ 100 dm^3 water and applied as surface drench (Eicker and Ludick, 1993).

The use of integrated pest management (IPM) strategies, combining biological controls with safer chemical options, has been recommended to sustainably manage these pests while minimizing the impact on non-target organisms and ensuring food safety (Helyer *et al*., 2003; Shamshad, 2010). Additionally, cultural practices such as maintaining optimal hygiene, using pasteurized compost, and implementing proper ventilation can significantly reduce pest incidence and improve overall crop health (Visscher, 1996; Williams and Wall, 2003). Insecticides like decamethrin, cyromazin, dichlorvos, chlorpyriphos, and malathion offer various levels of control against sciarid larvae, their impact on edible fungi varies. Bio-pesticides, such as neem products, provide a safer alternative with minimal adverse effects on fungal growth. Integrated pest management strategies, combining biological control, cultural practices, and judicious use of chemical products, are recommended for sustainable mushroom cultivation.

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