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Website: www.aarf.asia Email : editor@aarf.asia , editoraarf@gmail.com

RELATIVE SUSCEPTIBILITY OF SOME MUSHROOM STRAINS TO *APHELENCHOIDES SWARUPI* AND NEMATODE REPRODUCTION ON THEM

Madhuri and R.S.Kanwar

Department of nematology CCS Haryana Agricultural University, Hisar-125004

Ten strains of A*garicus bisporus viz*., ABL2, ABL3, ABL4, ABL5, ABL6, B10, B13, DMR3, DMR7 and U3, and two strains of *Pleurotus eous* (A1 and A6) were evaluated against *A. swarupi*. Nematode multiplied on all the strains of *A. bisporus* and caused mycelial damage to them. ABL2 and DMR7 were found to be resistant and tolerant, respectively while remaining were susceptible. On these strains, nematode population and reproduction factor were higher after 30 days than after 15 days of nematode inoculation. Both the strains of *P.eous* were found immune to this nematode.

Key words: Mushroom, A*garicus bisporus*, *Pleurotus eous*, mycophagus nematode, *Aphelenchoides swarupi*

Mushroom, the fleshy fungi are cultivated for food and medicinal purposes. Its production is affected by a number of biotic and abiotic factors. Mycophagous nematodes are one of the important biotic factors threatening mushroom cultivation (Arrold and Blake, 1968). They are noxious pests which once introduced in the mushroom house are difficult to eliminate. *Aphelenchus avenae*, A*phelenchoides* spp., and *Ditylenchus* spp. are commonly found nematode pests in mushroom houses (Bajaj and Kanwar, 2011). They may cause patchy to no growth of mycelium, sinking of compost and foul smell of spawn run in mushroom beds leading to severe yield reduction (Kumar *et al*., 2008). Due to residual problem in sporophores, chemicals can not be used for controlling nematodes in mushroom. Under such conditions, resistance and tolerance

to nematodes in mushroom can be very effective in nematode management. There are evidences of resistance in *Pleurotus sajor- caju* against *A.agarici* (Khanna and Sharma, (1989), *Paraphelenchus* sp. (Vats *et al*., 2006), *A. avenae* and *A. swarupi* (Kumar *et al*., 2007). Multiplication of *A. sacchari*, was less on *A. bitorquis* than on *A. bisporus* (Chandel and Sharma, 1991).

Kumar *et al*. (2007) reported that adverse effect of *A. avenae* and *A. swarupi* on mycelial growth of *C. indica* was less than *A. bisporus*. This study reports the reaction of A*garicus bisporus,*and *Pleurotus eous* to mycophagus nematode, *Aphelenchoides swarupi*

MATERIALS AND METHODS

This experiment was conducted in pre-sterilized Petri plates of 9 cm diameter. Ten strains of A*garicus bisporus viz*., ABL2, ABL3, ABL4, ABL5, ABL6, B10, B13, DMR3, DMR7 and U3, and two strains (A1 and A6) of *Pleurotus eous* were tested against *A. swarupi*. All the strains of mushroom were cultured on freshly prepared PDA. Twenty five surface sterilized nematodes (Kanwar, 2011) per plate were inoculated. The plates were incubated in a BOD at 25 ºC. The treatments were replicated three times and observations on mycelial damage and nematode population were recorded on 15^{th} and 30^{th} day of inoculation. Mycelial damage was calculated as given by Kumar *et al*. (2007). For extracting nematode from Petri plates, each plate was divided into four equal sectors and one cm diameter bit was taken from each sector. The agar bits were placed in Petri dish having water until all the vermiform nematodes came in water. Eggs present in the bit were counted by dispersing the agar with dissecting needles.

Data were analysed using two factorial Completely Randomised Design (CRD), with the help of OPSTAT software available on www.hau.ernet.in. Population data were log transformed, and arc sine transformation was used for % mycelial damage. Treatment means were compared with critical difference (CD) at P= 0.05 level of significance. Data on strains of *P. eous* not included in analysis as there was no mycelial damage or nematode reproduction. Population growth rate (PGR) for nematode population was calculated by the formula: $P_f = P_i (1+GR/100)^t$

Where, P_f = Final population, P_i = Initial population, t = No. of life cycles (taking two life cycles in 15 days). On the basis of nematode multiplication and mycelial damage, the strains were categorized as immune, tolerant, resistant and susceptible.

RESULTS

Mycelial damage

The data on mycelial damage caused by *Aphelenchoides swarupi* in different strains after 15 and 30 days (Table 1) show that % mycelial damage was minimum (52.3) in ABL2 followed by DMR7 (57.4). The damage in these strains was significantly lower than all other strains of *A. bisporus*. Maximum damage occurred in U3 strain (75.2 %) followed by B13 (73.4 %). Mycelial damage in U3 was significantly higher than all other strains. Strains B10 and B13 did not differ significantly in respect of mycelial damage and damage was more in DMR3 (73.0 %) than DMR7 (57.4 %). Mycelial damage after 15 days was significantly less than the damage after 30 days in all the strains. After 15 days, minimum damage (25.3 %) was recorded in ABL2 which was significantly less than all other strains, whereas maximum damage (50.6 %) after 15 days was recorded in U3 strain. At 30 days, minimum damage was found in DMR7 (77.3 %) followed by ABL2 (79.3 %) which was significantly less than the damage in all the remaining strains of *A. bisporus*. In all other strains of *A. bisporus*, damage was 100 % after 30 days. Between strains DMR3 and DMR7, the later showed significantly less mycelial damage both at 15 days (37.6 %) and 30 days (77.3 %). Among ABL group, all the strains except ABL2 suffered similar damage at both periods of observations. Depletion of mycelia, as indicated by change in colour of fungal colony, occurred in all strains (Fig 1). A1 and A6 strains of oyster mushroom showed no mycelial damage after 15 or 30 days of nematode inoculation.

Nematode Population

Nematode fed and multiplied on all strains and numerous nematodes of all stages were observed in plates of *A. bisporus* at both periods of observations. Maximum population was obtained in U3 (284602) followed by ABL5 (207330), whereas it was minimum in ABL2 (109869) which was significantly lesser than other strains (Table 2). Mean population after 15 days was significantly less than the final population after 30 days. After 15 days, maximum population was obtained in U3 and minimum in ABL2. Considering ABL group, ABL5 had significantly higher population as compared to ABL2, ABL3, ABL4 and ABL6. Between B10 and B13, B13 supported significantly higher population. Similarly, DMR3 had significantly higher population than DMR7 at this period. After 30 days, among all the strains, maximum population was obtained in U3 (365650) followed by ABL6 (280590) and it was minimum in ABL2. DMR3 had

significantly higher population than DMR7 whereas populations in B10 and B13 were statistically similar at this period. No nematode population was recorded in any of the two strains of oyster mushroom.

Reproduction factor and population growth rate

Data on reproduction factor of nematode on different strains (Table 3) indicate that it was significantly higher after 30 days as compared to 15 days. Among all the strains of *A. bisporus*, maximum nematode multiplication occurred in U3 (11384) and minimum in ABL2 (4395). Among the ABL strains, reproduction factor was maximum (8293) in ABL5 which was significantly higher than other strains of ABL series; it was higher in B13 (7230) than B10 (6731). Similarly, reproduction factor was significantly more in DMR3 (8417) than DMR7 (6449). While considering the reproduction factor at 15 and 30 days, it was found maximum in U3 and minimum in ABL2 at both intervals. The reproduction factor was significantly higher in DMR3 over DMR7 at both intervals. In B13 it was significantly higher than B10 at 15 days but statistically at par after 30 days (Table 3). In strains of oyster mushroom, reproduction factor was zero since there was no multiplication of *A. swarupi* on these strains. As is evident from Fig. 2, population growth rate after 30 days was quite high (>800) in all strains of *A. bisporus* except ABL2, where it was 775. Maximum growth rate (999) was recorded in U3. In ABL group, order of growth rate was ABL6 > ABL5 > ABL4 > ABL3 > ABL2. It was similar in B10 and B13 whereas it was greater in DMR3 than DMR7.

DISCUSSION

On all the strains, except ABL2 and DMR7, nematode caused 100 % damage after 30 days of inoculation. In ABL2 and DMR7, mycelial damage was less than 80 % and it was significantly less than the damage in all other strains of *A. bisporus*. The mycelial damage was higher in all the strains of *A. bisporus* after 30 days than 15 days. It was so because nematode multiplied rapidly and its population became very high on all the strains. Mean mycelial damage in white button mushroom ranged from 69.9% in ABL4 to 75.2 % in U3 while it was 52.3 and 57.4 % in ABL2 and DMR7, respectively. This showed the variation in their susceptibility to *A. swarupi*.
Mean as well as at both durations nematode population was quite high in all the strains as indicated by nematode reproduction factor (Tables2,3). In ABL2, mycelial damage and reproduction factor were comparatively low while in DMR7 population and reproduction factor

were high in spite of lower mycelial damage. This strain was therefore, categorized as tolerant. In this strain, initial mycelial growth in plates was more than the growth in all other strains. U3 strain showed maximum susceptibility to *A. swarupi* as population build up and damage was maximum on it. On ABL2, populatin build up of nematode as well as mycelial damage was less than all other strains of *A. bisporus* so, it was considered resistant.

S-11, W-3, MC-378, Pant-52, S-649, MS-39, NCS-100, NCS-101 and NCS-102 strains of *A. bisporus* were found susceptible to *A. avenae* and *Ditylenchus myceliphagus* (Anon., 2003). Devi (1999) reported that all the 11 strains of *A. bisporus viz*. 31, 39, 44, 53, 56, U3, 100, 101, 102, 649 and 1927 tested under laboratory and field conditions were susceptible to *A. composticola*. However, Tan *et al*. (1992) showed that the best host for *A. composticola* was strain 176 than strains 102 and 101 of *A. bisporus.*Thus the reaction of various strains may differ to different or even single nematode species according to their inherent capabilities.

In present work, no damage or nematode multiplication occurred in *Pleurotus eous* and hence it was rated as immune. There is no report of resistance to nematode in *P. eous*, although another species of oyster mushroom, *Pleurotus sajor-caju* has been reported resistant to *Aphelenchoides* species (Khanna and Sharma, 1989; Kumar *et al*., 2007). This species however, was found resistant to *Aphelenchoides* species but showed susceptibility to *D. myceliphagus* (Anon., 2003). This indicates that a mushroom species or strain resistant to a nematode may not necessarily be resistant to another nematode species.

Further studies are required to work out the resistance and or tolerance in various cultivated mushrooms against different species of myceliophagous nematodes prevalent in mushroom houses.

In present investigation, *A. swarupi* was cultured successfully on *Fusarium solani*, a plant pathogenic fungus. Other species of mycophagous nematodes such as *D. myceliophagous*, *A. agarici* and *Paraphelenchus* sp. have been reported to feed on a wide variety of fungi including plant pathogenic species (Christie and Arndt, 1936; Khanna and Sharma, 1989; Anon., 2003; Vats *et al*., 2006). Hence, the potential of these nematodes may also be explored for the control of soil borne plant pathogenic fungi.

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Table 1. Effect of *Aphelenchoides swarupi* on the mycelial damage of different strains of *Agaricus bisporus*

S. No.	Strains	% mycelial damage after		Mean
		15 days	30 days	
1	ABL 2	25.3 (30.2)	79.3 (62.9)	52.3 (46.6)
2	ABL 3	43.6 (41.4)	100 (88.1)	71.7 (64.7)
3	ABL 4	40.0 (39.2)	100 (88.1)	69.9 (63.7)
4	ABL 5	43.0 (40.9)	100 (88.1)	71.4 (64.5)
5	ABL 6	44.0 (41.5)	100 (88.1)	71.9 (64.8)
6	B 10	45.0 (42.1)	100 (88.1)	72.4 (65.1)
7	B13	47.0 (43.3)	100 (88.1)	73.4 (65.7)
8	DMR 3	46.0 (42.7)	100 (88.1)	73.0 (65.4)
9	DMR 7	37.6 (37.7)	77.3 (61.6)	57.4 (49.7)
10	U 3	50.6 (45.4)	100 (88.1)	75.2 (66.7)
Mean		42.2 (40.4)	95.5 (82.9)	

CD at 5% for:

Strains = (1.5), Duration = (0.7), Strains × Duration = (2.2)

Values in parentheses are arc sine transformation

Table 2. Population of *Aphelenchoides swarupi* on different strains of *Agaricus bisporus*

S. No.	Strains	Population per plate after		Mean
		15 days	30 days	
1	ABL2	72648 (4.86)	147090 (5.16)	109869 (5.01)
2	ABL3	83264 (4.92)	165388 (5.22)	124326 (5.06)
3	ABL 4	90285 (4.95)	196144 (5.29)	143214 (5.11)
4	ABL 5	162955 (5.21)	251705 (5.40)	207330 (5.30)
5	ABL 6	116535 (5.06)	280590 (5.45)	198562 (5.12)
6	B 10	110824 (5.04)	225751 (5.35)	168287 (5.19)
7	B13	138006 (5.14)	223500 (5.35)	180753 (5.24)
8	DMR 3	164510 (5.21)	256352 (5.41)	210431 (5.31)
9	DMR 7	102880 (5.01)	219603 (5.34)	161241 (5.17)
10	U 3	203554 (5.31)	365650 (5.56)	284602 (5.43)
Mean		124546 (5.04)	233177 (5.35)	

CD at 5% for: Strains = (0.02), Duration = (0.01), Strains × Duration = (0.03)

Values in parentheses are log transformations.

Table 3. Reproduction factor of *Aphelenchoides swarupi* on different strains of *Agaricus bisporus* and their status

S. No.	Strains	Reproduction factor after		Mean	Status *
		15 days	30 days		

1	ABL 2	2906	5884	4395	Resistant
2	ABL 3	3330	6615	4972	Susceptible
3	ABL 4	3611	7846	5728	Susceptible
4	ABL 5	6518	10068	8293	Susceptible
5	ABL 6	4697	11223	7960	Susceptible
6	B 10	4433	9030	6731	Susceptible
7	B13	5520	8940	7230	Susceptible
8	DMR 3	6580	10254	8417	Susceptible
9	DMR 7	4115	8784	6449	Tolerant
10	U 3	8142	14626	11384	Susceptible
Mean		4985	9327		

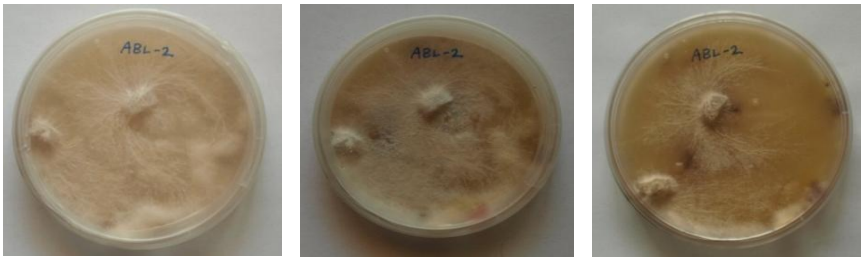
CD at 5% for:

Strains = 387.22, Duration = 173.17, Strains × duration = 547.61

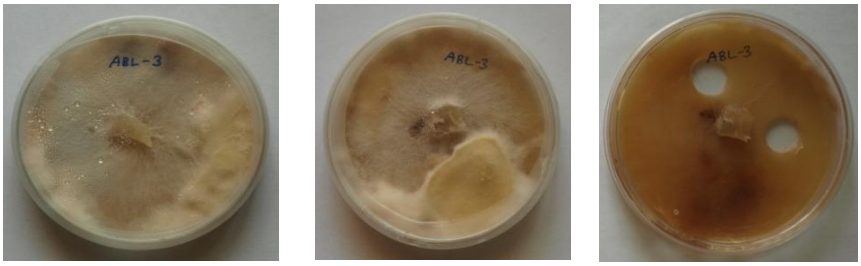
*both strains of pink oyster mushroom (*P. eous*) were immune and not included in table

Control **15 days** **30 days**

ABL2



ABL3



ABL4

ABL5

ABL6

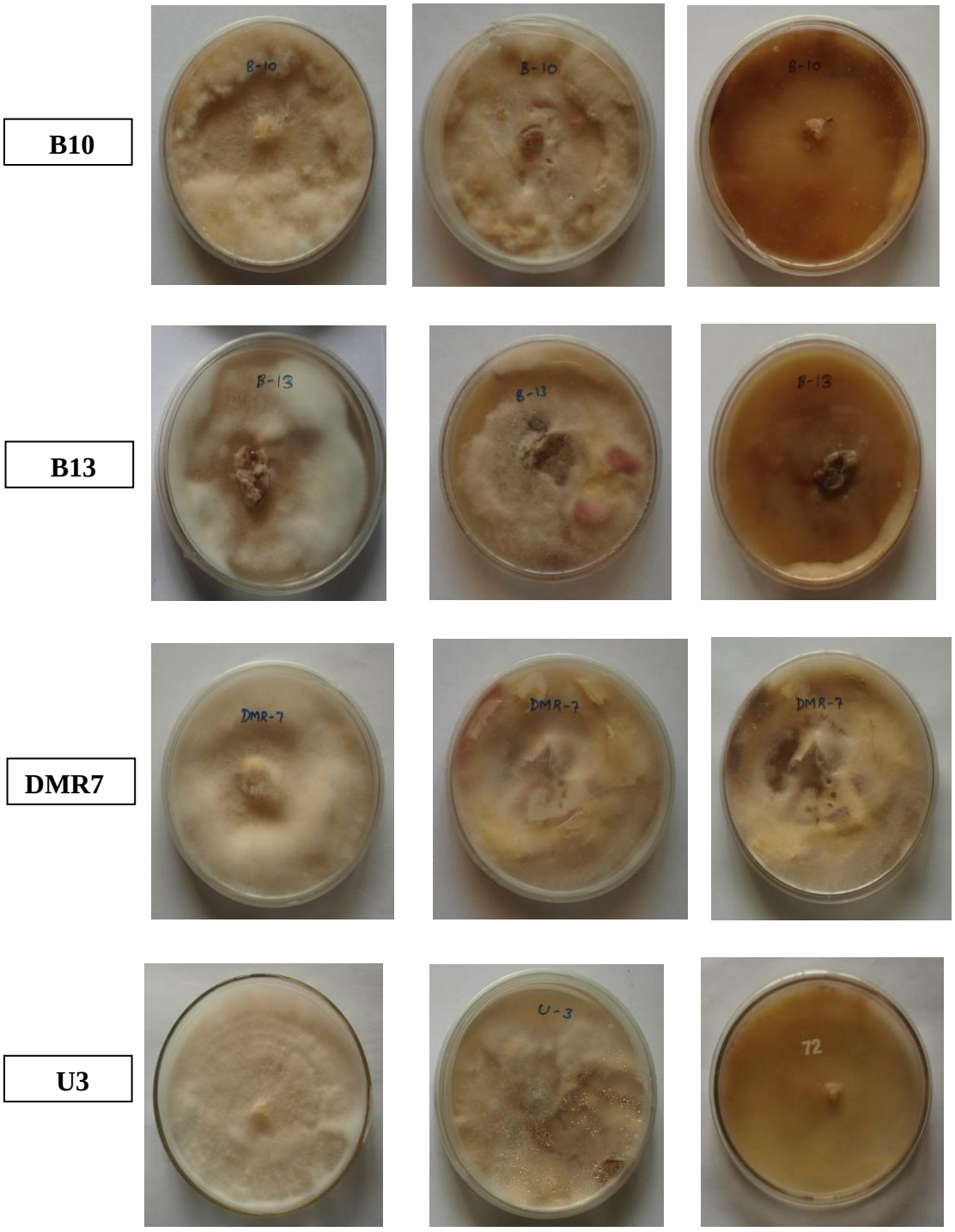


Fig. 1. Mycelial damage caused by *Aphelenchoides swarupi* after 15 and 30 days on different strains of button mushroom

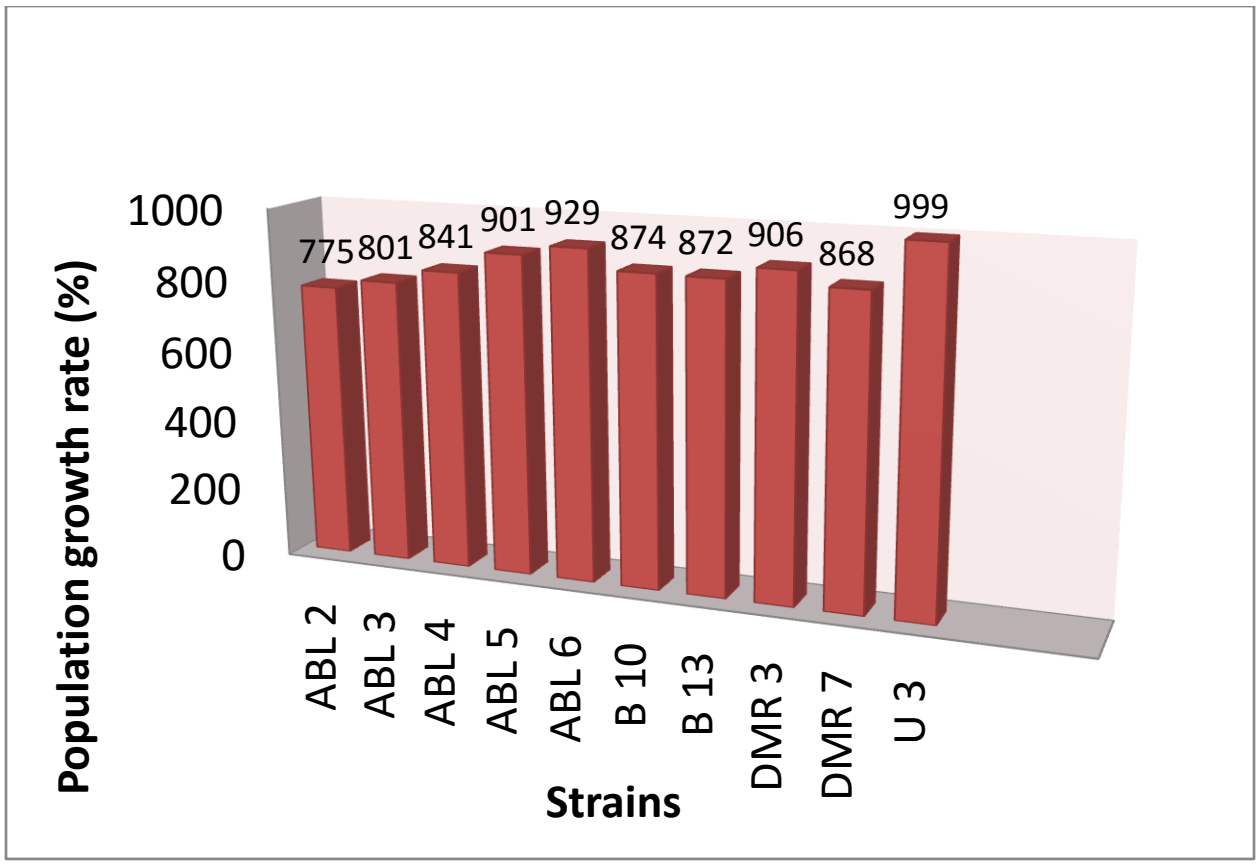


Fig 2. Population growth rate of *Aphelenchoides swarupi* on different strains of *Agaricus bisporus* after 30 days