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Studies on damaging potential of *Cyllodes indicus* population on *Pleurotus sajor caju*

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Abstract
Relative susceptibility of six species of *Pleurotus* viz; *P. eryngii, P. flabellatus, P. florida, P. ostreatus, P. sajor caju* and *P. sapidus* was evaluated against the adults of *C. indicus*. On this basis, susceptibility of various oyster species was visualized in order of most susceptible to the less susceptible as follows:
P. sapidus = P. florida > P. eryngii > P. flabellatus > P. ostreatus = P. sajor caju
Yield losses to the extent of 16.2, 45.4 and 60.7 percent were recorded at the respective initial release levels of five, ten and twenty grubs. Adults caused more destruction with 26.2, 53.6 and 66.0 percent losses in mushroom yield at respective initial release levels of five, ten and twenty adults.

Keywords: Susceptibility, *Pleurotus* spp. and *Cyllodes indicus*

Introduction

Among the commercially cultivated mushrooms, oyster mushrooms (*Pleurotus* spp.) with contribution of 24.1 percent of the total world production rank second, next only to white button mushrooms (*Agaricus* spp.). The factors that go in favour of this mushroom are its desirable traits like scrumptious taste, unique flavour, high nutritional status, medicinal values, biotechnological applications and overall, its simple and economical cultivation techniques that enables even an uneducated farmer to grow it just after a training of two to three days (Rusuku, 1989; Bahl, 1995; Balakrishnan and Nair, 1997; Cohen *et al.,* 2002 and Khare *et al.*, 2007) [13, 2, 3, 6, 11]. In addition, possibility of growing this mushroom under semi controlled conditions at comparatively higher temperature, when button mushroom production is not feasible, makes it a 'mushroom of choice' for cultivation during lean summer season. Despite, the tremendous efforts of Government and interest of growers to boost mushroom production as a developed cottage industry, its pace of growth is slow in India as compared to other mushroom growing nations. The reason behind is, high susceptibility of *Pleurotus* spp. (Dhingri) to various pests and pathogens, which infest the crop in enormous counts due to the unhygienic conditions of improvised mushroom units in which this crop is grown (Chandran, 2000; Khanna and Kumar, 2005 and Kumar *et al*., 2007) [4, 10, 12]. Of these, the most prevalent and highly destructive to the crop, are the insect pests belonging to order diptera and coleoptera (Austin and Jerry, 1934; Johal *et al.*, 1992; Khanna and Chandran, 2002; Deepthi *et al.*, 2004 and Cline and Leschen, 2005) [1, 8, 9, 7, 5].

Looking into the high incidence of beetles belonging to different families of coleopteran in the commercial oyster farms, it was thought pertinent to generate basic information on their occurrence and infestation levels. Among coleopterans, *Cyllodes indicus* was reported for the first time in Solan district of Himachal Pradesh (Sharma, 2010) [14]. The beetle *Cyllodes indicus* Grouvelle (Coleoptera: Nitidulidae), that was found to be the most prevalent in dhingri farms during earlier investigations was selected for the present studies.

Material and Methods

Relative susceptibility of six *Pleurotus* species *viz., P. eryngii, P. flabellatus, P. florida, P. ostreatus, P. sajor caju.* and *P. sapidus* were tested against *C. indicus*. The insects were released @ one, two and four adults separately in Petri plates with fully impregnated mycelia of respective mushrooms. All the Petri plates were maintained at 25 ± 1 °C. Each treatment was replicated three times. The experiment was laid under Completely Randomized Design (CRD). Percent mycelial depletion was recorded at 2, 4, 6, 8, 10, 12, 14 and 16 days of inoculation. Squares of 9 x 9 mm were made on the cover of all the Petri plates released with adults to assess the mycelial depletion. Percent mycelial depletion was calculated using the following formula:

$$\text{Percent mycelium depletion} = \frac{\text{Damaged squares}}{\text{Total number of squares}} \times 100$$

Polypropylene bags (16" x 12") of 125 gauge, each containing 3 kg substrate medium were used for the experiment. Grubs as well as adults of *C. indicus* were released separately @ 5, 10 and 20 in these bags at pin head formation stage. Bags free of test insect were maintained as control. Each treatment was replicated five times. The experiment was laid out under Completely Randomized Design (CRD). Sporocarp yields were assimilated at weekly intervals to calculate the total sporocarp production. The population of test insect per 100 gm of sporocarps (grubs and adults) were also counted at termination stage (3^{rd} week).

Results and Discussion

The adults of *C. indicus* voraciously fed upon the mycelium of all the species of *Pleurotus;* the degree of feeding being different for different species. Progressive mycelium decline was recorded with increase in number of beetles and passage of time. Mean mycelial depletion of 12.4 percent at two days of inoculation increased to the tune of 61.2 percent at sixteen days. When compared the levels of susceptibility in various test species, *P. florida* and *P. sapidus* were found to be most susceptible showing respective mean depletions of 29.0 and 30.0 percent at initial release level of just one adult. The highly damaged mycelium was observed at the initial release level of four adults wherein depletion to the tune of 87.6 and 87.0 percent respectively was recorded in these species of mushrooms. Mycelium vanished completely by 8^{th} day in both the species at this level of insect inoculum. Other species of oyster mushrooms were comparatively less susceptible. In species like *P. sajor caju* and *P. ostreatus*, though the damage increased significantly with increase in release levels during all intervals of observations, the variations in mycelium depletion were significant at two days interval up to six days of observations. *Pleurotus sajor caju* suffered mycelial loss to the tune of 25.6, 30.7 and 67.1 percent at the respective release levels of one, two and four adults at the termination (Day 16). The damage suffered at this time by *P. ostreatus* was 26.1, 34.5 and 76.3 percent and by *P. eryngii* was 38.9, 70.0 and 96.5 percent at respective levels of one, two and four adults. The information extracted out of this data indicated of high susceptibility of oyster mushrooms even to the minimum release of one adult that voraciously fed upon the mycelium and devitalized it (Table 1).

Data assembled in Fig 1 indicated that both grubs and adults of *C. indicus* were destructive for oyster mushrooms; adults being more damaging than grubs. The total sporocarp production declined to 1287.0 and 1156.0 g in the treatments receiving five grubs and five adults respectively. Compared to this, yields were as high as 1535.4 and 1567.0 g in insect free bags. Whereas, the release of twenty grubs brought down the sporocarps yield to just 603.4 g, it was further reduced to 532.2 g when twenty adults were released initially. Yield losses to the extent of 16.2, 45.4 and 60.7 percent were recorded at the respective initial release levels of five, ten and twenty grubs. Adults caused more destruction with 26.2, 53.6 and 66.0 percent losses in mushroom yield at respective initial release levels of five, ten and twenty adults (Fig 2).

Significantly higher populations (Table 2) of 46.8, 150.8 and 210.8 grubs were recovered from the fruiting bodies produced in bags receiving respective initial release of five, ten and twenty grubs. Adult population also remained significantly different at every level of release with recovery of 5.8, 25.2 and 40.4 adults from the sporocarps produced in the bags initially receiving five, ten and twenty grubs respectively.

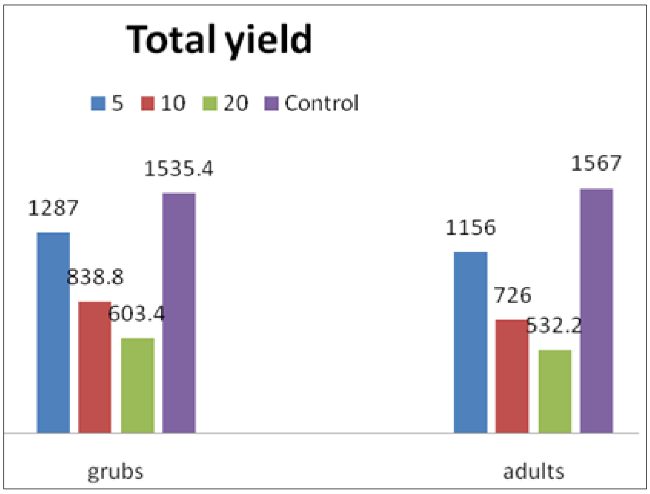

Fig 1 Effect of different populations of grubs and adults of *C. indicus* on total yield of *P. sajor caju*

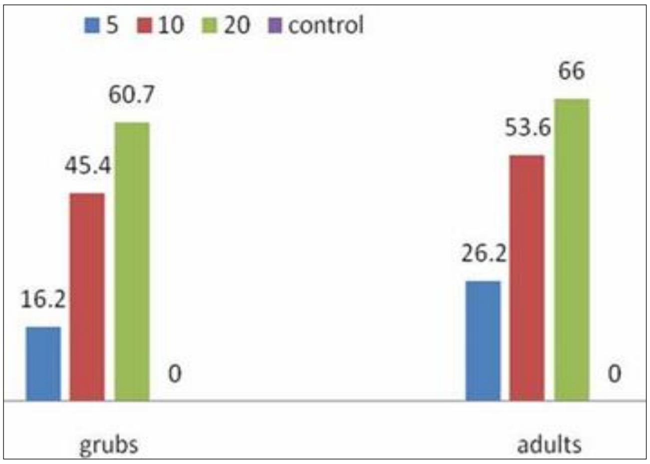

Fig 2 Percent yield loss caused by different populations of grubs and adults of *C. indicus* on *P. sajor caju*

Table 1 Effect of various adult populations of *C. indicus* on mycelium of different species of *Pleurotus*

Treatments	Percent mycelium depletion in the indicated days								Mean
	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12	Day 14	Day 16	
T_1 : *P. eryngii* + 1 adult	7.05 (15.39)	12.58 (20.77)	18.34 (25.36)	21.23 (27.43)	27.02 (31.32)	29.08 (32.63)	33.97 (35.65)	38.86 (38.56)	23.50 (28.38)
T_2 : *P. eryngii* + 2 adults	13.70 (21.68)	18.27 (25.10)	33.01 (35.02)	40.78 (38.47)	48.63 (44.22)	54.32 (47.62)	59.05 (50.44)	66.90 (55.66)	41.83 (39.93)
T_3: *P. eryngii* + 4 adults	16.10 (23.66)	41.10 (39.87)	67.62 (55.32)	75.96 (60.64)	76.60 (61.07)	81.00 (64.16)	85.57 (67.68)	96.50 (81.23)	67.56 (56.71)
T_4: *P. flabellatus* + 1 adult	3.20 (10.28)	13.62 (21.66)	20.99 (27.27)	24.59 (29.72)	26.04 (30.67)	27.16 (31.41)	27.80 (31.82)	28.20 (32.08)	21.45 (26.86)
T_5: *P. flabellatus* + 2 adults	8.41 (16.86)	14.26 (22.18)	22.51 (28.32)	29.19 (32.70)	33.81 (35.55)	39.10 (38.70)	46.07 (42.75)	47.27 (43.44)	29.99 (32.51)
T_6: *P. flabellatus* + 4 adults	20.91 (27.21)	28.52 (32.28)	35.81 (36.76)	43.50 (41.27)	44.63 (41.92)	50.48 (45.27)	74.11 (59.42)	81.87 (64.81)	47.48 (43.62)
T_7 : *P. florida* + 1 adult	5.84 (13.98)	11.85 (20.13)	17.70 (24.88)	23.47 (28.98)	34.29 (35.84)	40.22 (39.36)	45.99 (42.70)	52.40 (46.38)	28.97 (31.53)
T_8 : *P. florida* + 2 adults	10.41 (18.82)	37.09 (38.11)	50.64 (45.37)	56.97 (49.01)	66.02 (54.35)	76.04 (60.70)	85.18 (67.41)	97.19 (82.30)	59.94 (51.93)
T_9 : *P. florida* + 4 adults	32.85 (34.97)	68.50 (55.86)	99.19 (85.88)	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	87.57 (78.34)
$T_{13}0$: *P. ostreatus* + 1 adult	3.68 (11.06)	6.33 (14.57)	12.41 (20.63)	17.95 (25.06)	21.00 (27.27)	23.23 (28.82)	25.80 (30.53)	26.04 (30.68)	17.05 (23.58)
T_{11} : *P. ostreatus* + 2 adults	8.89 (17.34)	14.66 (22.51)	25.56 (30.05)	28.20 (31.74)	30.05 (32.84)	31.72 (33.87)	33.25 (34.84)	34.45 (35.59)	25.85 (29.85)
T_{12}: *P. ostreatus* + 4 adults	17.47 (24.60)	22.91 (28.39)	27.08 (31.36)	31.89 (34.38)	38.68 (38.46)	39.98 (39.22)	61.21 (51.48)	76.27 (60.86)	39.44 (38.59)
T_{13}: *P. sajor caju* + 1 adult	3.36 (10.56)	5.68 (13.78)	11.93 (19.91)	17.46 (24.70)	20.51 (26.93)	22.67 (28.43)	25.48 (30.32)	25.64 (30.42)	16.59 (23.17)
T_{14}: *P. sajor caju* + 2 adults	8.33 (16.76)	12.66 (20.83)	18.66 (25.48)	22.19 (28.04)	24.63 (29.72)	27.32 (31.49)	28.92 (32.52)	30.69 (33.62)	21.68 (27.31)
T_{15} : *P. sajor caju* + 4 adults	10.41 (18.82)	14.58 (22.45)	28.44 (32.23)	31.00 (33.84)	32.05 (34.48)	34.29 (35.84)	50.72 (45.41)	67.10 (55.00)	33.57 (34.76)
T_{16} : *P. sapidus* + 1 adult	6.89 (15.22)	12.90 (21.05)	23.79 (29.19)	26.68 (31.10)	32.69 (34.87)	38.80 (39.13)	46.87 (43.21)	49.75 (44.86)	29.80 (32.25)
T_{17} : *P. sapidus* + 2 adults	14.42 (22.32)	37.49 (37.76)	61.61 (51.72)	66.34 (54.54)	69.46 (56.46)	75.15 (60.11)	80.04 (63.48)	81.49 (64.52)	60.75 (51.36)
T_{18} : *P. sapidus* + 4 adults	31.49 (34.13)	67.46 (55.22)	95.83 (80.35)	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	100.0 (90.00)	86.85 (77.46)
Mean	12.41 (19.65)	24.47 (28.44)	37.29 (38.08)	42.04 (41.80)	45.89 (44.22)	49.48 (46.45)	56.11 (50.54)	61.15 (54.45)	

Figure in parentheses are arc sine transformed values

$CD_{0.05}$

Treatments (T) 1.59

Days (D) 1.06

T x D 4.51SS

Table 2 Multiplication potential of *C. indicus* on *P. sajor caju* at termination

Treatments	Population in 100 g sporocarps		Mean
	Grubs	Adults	
3 kg substrate + 5 grubs	46.80	5.8	26.3
3 kg substrate + 10 grubs	150.8	25.2	88
3 kg substrate + 20 grubs	210.8	40.4	125.6
Mean	136.1	23.8	

$CD_{0.05}$

Treatments (T) 1.5

Population (P) 1.3

T x P 2.2

Conclusion

Yield losses to the tune of 16.2, 45.4 and 60.7 percent were assessed in the treatments receiving five, ten and twenty grubs respectively at pin initiation stage, as compared to insect free control. The losses caused by adults at these release levels were estimated at 26.2, 53.6 and 66.0 percent respectively. The extent of damage varied in different species and on this basis, susceptibility of various oyster species was visualized in order of most susceptible to less susceptible as follows:

P. florida = *P. sapidus* > *P. eryngii* > *P. flabellatus* > *P. ostreatus* = *P. sajor caju*

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