Exploring the Hidden Threats: A Comprehensive Study on Incidence and Insect Pest Diversity on Button Mushroom (*Agaricus bisporus*) in Kashmir, India

ABSTRACT

In recent years, mushroom farming has gained popularity across the globe as the enterprise assists in transforming agricultural wastes into highly healthy nutritional foods. However, mushrooms are affected adversely by a large number of biotic and abiotic agents. Among the biotic agents, fungi, bacteria, viruses, nematodes, insects and mites cause damage to mushrooms directly or indirectly posing serious threats to their cultivation. Kashmir valley is one of the most promising regions for the cultivation of mushrooms, therefore, a study was carried out to document the insect pest complex infesting button mushroom and to quantify the pest incidence at different locations (SKUAST-K, Shalimar, Budgam, Baramulla and Pulwama) of the Kashmir valley. The study revealed that various insect pests *viz*., sciarid fly (*Lycoriella castanescens*), picture winged fly (*Physiphora sericea*), springtail (*Achorutes armatus*), mould mite (*Tyrophagus putrescentiae*) and flour mite (*Acarus siro*) were found infesting button mushroom in different months of the year. Further, the study also witnessed the overall incidence of different pests was highest (75 per cent) at Budgam, followed by an incidence of 70 per cent at Baramulla, 68 per cent at Pulwama, while the lowest incidence of 63.80 per cent at SKUAST-K, Shalimar; besides, the pest incidence was maximum in the months of July and August with highest and lowest incidence of sciarid flies and mites, respectively.

Keywords: Abiotic agents; button mushroom; pest complex; per cent incidence.

1. INTRODUCTION

Mushroom cultivation represents one of the commercially important microbial technologies for large-scale recycling of agro wastes into highly nutritious food. Mushrooms, also known as "white vegetables" or "boneless vegetarian meat," are rich in proteins, minerals, vitamins and fibre. Additionally, they exhibit low levels of saturated fats and have potential health benefits such as reducing harmful blood cholesterol and acting as an appetite suppressant [1]. Over 200 species of mushrooms are being consumed as functional foods in different parts of the world, but only 35 species have been raised commercially [2,3,4]. Among them, the white button mushroom (*Agaricus bisporus*) accounts for around 70 per cent of all mushroom production, and is reported to lower the chance of developing breast and prostate cancer, in accordance to research [5]. In fact, it has been discovered that white button mushroom extract can reduce tumour growth and cell multiplication [6]. China became the leading producer of mushroom in the world, which alone accounts for more than 30 per cent [7]. Presently the total white button mushroom produced in India from both seasonal and high-tech cultivation units is estimated at 94,676 metric tons and it contributes around 73 per cent of mushroom production in India [8].

Despite nutritional and medicinal importance of mushrooms, they are susceptible to variety of pests and diseases throughout their growth cycle from spawning to harvest. Among these challenges sciarid flies, phorid flies, physiphora flies, springtails, mites, and nematodes are significant pests, resulting in heavy crop losses [9,10,11] reported that the yield of mushrooms is reduced by about 49 per cent due to the pest attack. Joshi *et al*. [12] reported the dipteran sciarid fly (*Bradysia tritici*) and phorid fly (*Megaselia sandhui*) infestation on cultivated mushroom. Kumar *et al.* [13] studied insect fauna associated with cultivated edible mushrooms in

Himachal Pradesh and observed the infestation of sciarid fly, along with some species of springtails and mites on mushroom. Nongkynrih *et al.* [14] studied the detailed pest complex of cultivated mushroom and role of microclimate in pest multiplication.

Furthermore, mushrooms are grown mostly in enclosed environment, the risk of insect pests and diseases spreading rapidly within the crop are high, find very suitable and protected environment for their unhindered multiplication. Therefore, it is crucial to manage these pests for the best possible mushroom output. Thus, to know the diversity and incidence of insect pests and mites in mushroom, survey was conducted in different mushroom growing districts of Kashmir valley.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment on the diversity and incidence of pests on button mushroom was conducted during the year 2022 at Division of Entomology, Faculty of Horticulture, SKUAST-K, Shalimar. Mushroom samples were collected from Mushroom research and training centre, Division of Plant Pathology and at three districts of Kashmir valley namely, Budgam (Mohammadpora,Rishipora), Baramulla **(**Pattan, Khawnchipora) and Pulwama (Barapora, Pakharpora).

2.2 Mushroom Collection

Mushrooms were collected using a shovel for obtaining part of the substratum (wood) on which mushroom were growing. The samples were collected from each sampling site at fortnightly intervals, collections were usually done in the morning. 20 fruiting bodies were randomly selected at each sampling date and kept in fresh polythene bags, sealed properly with rubber bands to avoid moisture losses and labelled with sampling site, cropping time and date of collection.

2.3 Insect Collection and Identification

Insect pests were removed from the mushroom samples by hand picking method and kept in specimen bottles. The flying insects were collected with the help of an aspirator which were then, subsequently shifted into transparent plastic vials. The samples were also examined for the presence of pests in their developmental stages *i.e.*, egg, larval, pupal or adult stages. The specimens of all insect pests collected were preserved in 90 per cent ethanol, however, mites were preserved in Oudmans fluid. The specimens were identified with the help of taxonomic keys and later, confirmed by extracting genitalia in the Taxonomy laboratory of the Division of Entomology, SKUAST-K,Shalimar.

Per cent incidence to fruit bodies of button mushroom was calculated by the following formula;

> Percent incidence = No. of infested fruiting bodies / Total no. of fruiting bodies. × 100

Statistical analysis was carried out as per standard procedures given by Gomez and Gomez [15]. The incidence data was analysed with OPSTAT software.

3. RESULTS AND DISCUSSION

3.1 Diversity and Status of Pests Infesting Button Mushroom

In the year 2022, a total of five pests (05) were found associated with button mushrooms *viz*. sciarid fly (*Lycoriella castanescens*), picture winged fly (*Physiphora sericea*), springtail (*Achorutes armatus*), mould mite (*Tyrophagus putrescentiae*) and flour mite (*Acarus sir*o). The period of major activity of sciarid fly, mould mite and flour mite were observed during the 26th to 32nd Standard Meteorological Week (SMW). In contrast, the picture winged fly and springtail exhibited their highest activity during the 26th - 30th SMW and 26th -34th SMW, respectively. The infestation of all the pests was observed on the mushroom fruiting body and its substrate. During the study, sciarid fly was identified as a major pest, as also reported by Chakravarty *et al.* [16] and Erler *et al.* [17]. Besides the picture winged flies and spring tails were also observed as major pests while both mites were observed as minor pests. Among the pests encountered mould mites, flour mites and picture-winged flies have been reported for the first time from Kashmir Valley (Table 1). These results are in conformity with Joshi *et al.* [12] Kumar *et al.* [13] and Nongkynrih *et al.* [14] who similarly reported the infestation of sciarid fly, *Bradysia* spp., *Scaphisoma* spp*., Staphylinus* spp., phorid fly*, Megaselia sandhu*, along with some species of springtails and mites on mushroom.

Per cent Incidence of different pests recorded on button mushrooms at various locations of Kashmir valley during the different meteorological weeks of the year 2022.

3.2 Incidence of Sciarid Fly (*Lycoriella castanescens*)

The data pertaining to per cent incidence of sciarid fly at SKUAST-K, Shalimar is depicted in Table 2 and Fig. 1. It revealed the per cent incidence of sciarid fly initiated from the last week of April (17th SMW) as 35 per cent, gradually increasing in subsequent weeks and attaining a peak of 78 per cent in the 28th SMW corresponding to the 2nd week of July Afterwards, the declining trend in population was observed with the lowest incidence of 20 per cent recorded in 2nd week of October (41st SMW). In district Budgam, the population of sciarid flies commenced from the 2nd week of June (24th SMW) at 75 per cent. Thereafter, showed an inclining trend with a peak of 95 per cent recorded during the 31st SMW (Table 3 and Fig. 2). Data present in Table 4 and Table 5 revealed the first appearance of sciarid fly in the districts Baramulla and Pulwama during the 25th SMW and 26th SMW with incidence of 80 and 85 per cent, respectively. However, the peak incidence of 90 and 95 per cent was recorded during 3rd week of July and Ist week of August, respectively (Fig. 3 and 4).

3.3 Incidence of Mould Mite (*Tyrophagus putrescentiae*)

At SKUAST-K, Shalimar the incidence began during the 17th SMW as 31 per cent with a peak of 56 per cent observed during the 2nd week of July (Table 2 and Fig.1). However, the first occurrence of mould mites was observed during the 24th SMW at district Budgam reaching its peak at 65 per cent during the Ist week of August corresponding to the 31st SMW (Table 3 and Fig. 2). In district Baramulla, the peak infestation of mould mites was observed during 3rd week of July at 60 per cent, while a peak incidence of 50 per cent was observed during both 28th and 31st SMW corresponding to the month of July and August at district Pulwama (Table 4 and 5, Fig. 3 and 4). Thereafter a declining trend in incidence was observed.

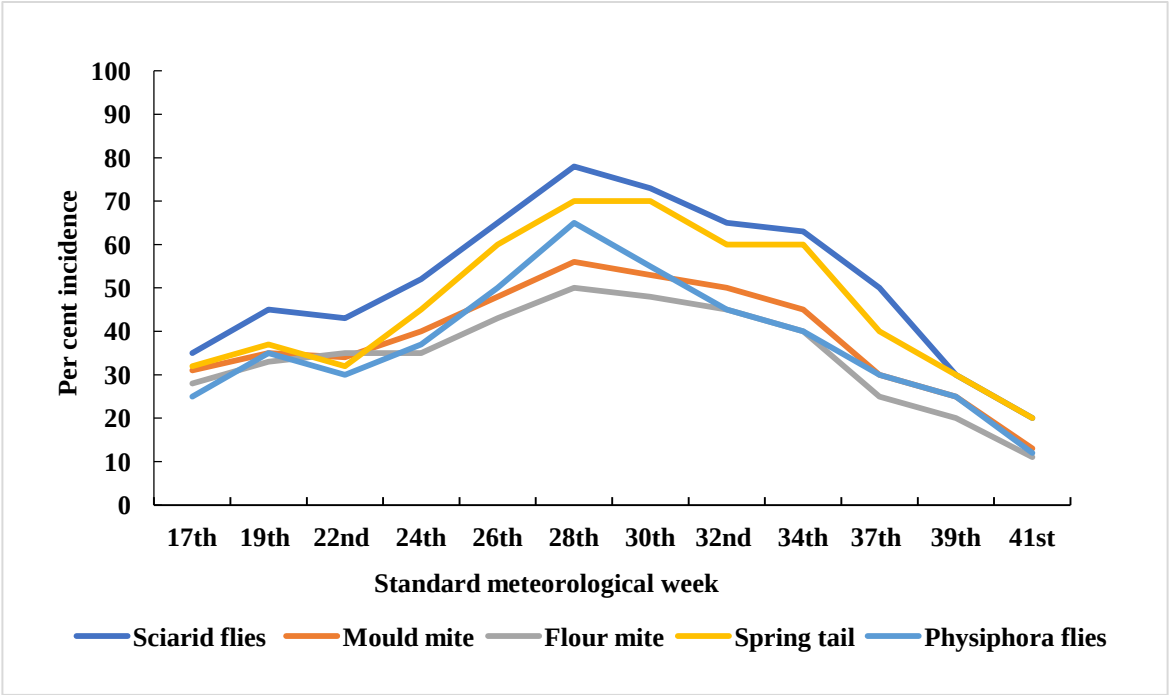

Fig. 1. Per cent incidence of different pests on button mushroom at SKUAST-K, Shalimar

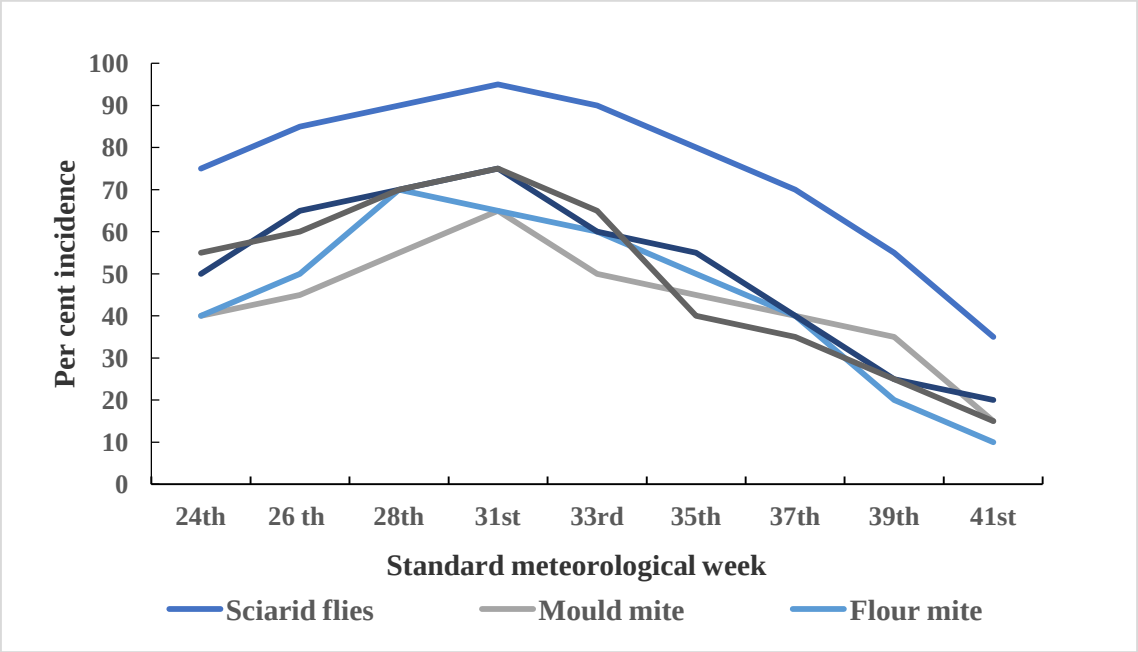

Fig. 2. Per cent incidence of different pests on button mushroom at Budgam

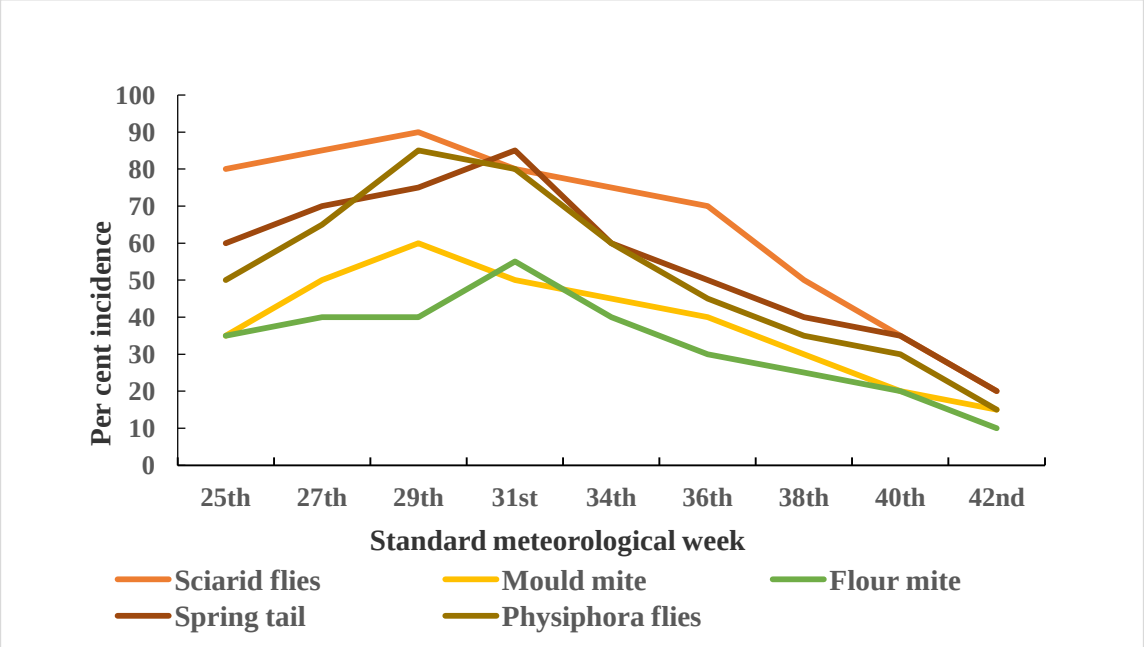

Fig. 3. Per cent incidence of different pests on button mushroom at Baramulla

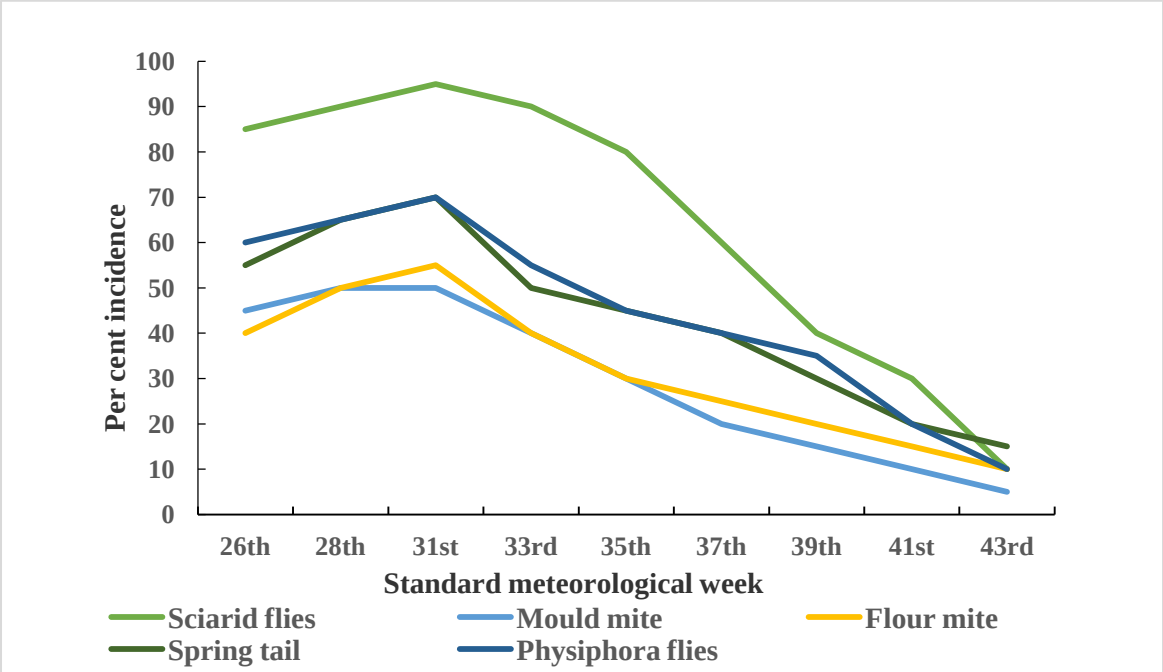

Fig. 4. Per cent incidence of different pests on button mushroom at Pulwama

3.4 Incidence of Flour Mite (*Acarus siro*)

The flour mite population began around the last week of April (17th SMW) with an incidence of 28 per cent at SKUAST-K, Shalimar. In the subsequent weeks, incidence inclined and reached to peak value of 50 per cent in the 28th SMW (Table 2 and Fig.1). However, district Budgam recorded a peak infestation of 70 per cent during the 28th SMW corresponding to the 2nd week of July (Table 3 and Fig. 2). On the other hand, the highest infestation of 55 per cent was recorded during the 31st SMW at both districts Baramulla and Pulwama,with declining trend in incidence observed thereafter (Table 4 and 5, Fig. 3 and 4).

Table 1. Diversity and status of pest complex of button mushroom during the year 2022

S. No.	Common name	Scientific name	Order	Family	Period of major activity	Status	Infestation observed on	Status in Kashmir
1	Sciarid fly	*Lycoriella castanescens*	Diptera	Sciaridae	26^{th} -32^{nd} SMW	Major pest	The fruiting body, substrate	
2	Mould mite	*Tyrophagus putrescentiae*	Sarcoptiformes	Acaridae	26^{th}-32^{nd} SMW	Minor pest	The fruiting body, substrate	The first record from Kashmir
3	Flour mite	*Acarus siro*	Sarcoptiformes	Acaridae	26^{th}-32^{nd} SMW	Minor pest	The fruiting body, substrate	The first record from Kashmir
4	Picture winged fly	*Physiphora sericea*	Diptera	Ulididae	26^{th}-30^{th} SMW	Major pest	The fruiting body, substrate	The first record from Kashmir
5	Spring tail	*Achorutes armatus*	Collembola	Hypogastruridae	26^{th}-34^{th} SMW	Major pest	The fruiting body, substrate	

** SMW= Standard meteorological week*

Table 2. Percent incidence of different pests recorded on button mushroom at, mushroom research and training centre, SKUAST-K, Shalimar during different meteorological weeks of the year 2022

Standard meteorological week	Per cent incidence of different pests					Overall incidence of pests
	Sciarid flies	Mould mite	Flour mite	Spring tail	Physiphora flies	
17th (23 April-29 April)	35.00 (36.25)*	31.00 (5.65)	28.00 (5.56)	32.00 (34.42)	25.00 (5.09)	30.20
19th (07 May-13May)	45.00 (42.11)	35.00 (5.99)	33.00 (5.82)	37.00 (37.44)	35.00 (5.99)	37.00
22nd (28 May-03 June)	43.00 (40.95)	34.00 (5.91)	32.00 (5.74)	35.00 (36.25)	30.00 (5.56)	34.80
24th (11 June-17 June)	52.00 (44.98)	40.00 (6.40)	35.00 (5.99)	45.00 (42.11)	37.00 (6.16)	41.80
26th(25 June-01July)	65.00 (53.71)	48.00 (6.99)	43.00 (6.63)	60.00 (50.75)	50.00 (7.14)	53.20
28th(09 July-15July)	78.00 (62.01)	56.00 (7.54)	50.00 (7.14)	70.00 (56.77)	65.00 (8.12)	63.80
30th(23 July-29July)	73.00 (58.68)	53.00 (7.34)	48.00 (6.99)	70.00 (56.77)	55.00 (7.48)	59.8
32nd(06 August -12 August)	65.00 (53.71)	50.00 (7.14)	45.00 (6.78)	60.00 (50.75)	45.00 (6.78)	53.00
34th(20 August-26 August)	63.00 (52.51)	45.00 (6.78)	40.00 (6.40)	60.00 (50.75)	40.00 (6.40)	49.60
37th(10 September-16 September)	50.00 (44.98)	30.00 (5.56)	25.00 (5.09)	40.00 (39.21)	30.00 (5.56)	35.00
39th(24September-30 September)	30.00 (33.19)	25.00 (5.09)	20.00 (4.57)	30.00 (33.19)	25.00 (5.09)	26.00
41st(08 October-14 October)	20.00 (26.53)	13.00 (3.73)	11.00 (3.45)	20.00 (26.53)	12.00 (3.59)	15.20
SE(d)	1.00	0.14	0.14	0.99	0.14	
C.D.	2.08	0.29	0.30	2.07	0.29	

**Values in parenthesis represent square root/arc sin transformation*

3.5 Incidence of Spring Tail (*Achorutes armatus*)

At SKUAST-K, Shalimar the incidence of springtail commenced from 17th SMW as 32 per cent which in subsequent weeks more or less gradually increased with a peak value of 70 per cent recorded during 28th and 30th SMW corresponding to the month of July (Table 2 and Fig.1). However, in other districts (Budgam, Baramulla and Pulwama) the peak in the incidence of springtail was recorded in the Ist week of August (31st SMW) as 75,85 and 70 per cent respectively (Table 3,4 and 5, Fig. 3and 4).

3.6 Incidence of Physiphora Fly (*Physiphora sericea*)

It is obvious from the data presented in Table 2 and Fig. 1 that the incidence of *Physiphora* flies at SKUAST-K, Shalimar attained its peak of 65 per cent in 28th SMW. In districts, Budgam and Pulwama the population of physiphora fly commenced 24th and 26th SMW, respectively The peak incidence of 75 per cent and 70 per cent was observed during the 31st SMW (Table 3 and 5, Fig. 2 and 4). In contrast, district Baramulla recorded its peak incidence of 85 per cent during 3rd week of July (29th SMW). Afterwards, incidence declined and reached to lowest of 15 per cent during the 42nd SMW.

Among the various locations surveyed district Budgam recorded the highest overall incidence of pests (75 per cent) followed by Baramulla (70 per cent) and Pulwama (68 per cent); while the lowest incidence of 63.80 per cent was recorded at SKUAST -K, Shalimar.

The present investigation revealed the highest incidence of all the associated pests in the month of July while the lowest infestation was recorded in the month of October. These observations are in similar lines with the findings of Navarro *et al.*

[18] and Nongkynrih *et al*., [14] who also reported the highest and lowest infestation of mushroom pests in May-July and October respectively. Gill *et al.* [19] studied the pest and predatory status of mite *Parasitus consanguineous* in Punjab and reported the infestation of mites on mushrooms from April to October., further corroborating our findings.

Table 3. Percent incidence of different pests recorded on button mushroom at Budgam (Mohammadpora,Rishipora)during different meteorological weeks of the year 2022

Standard meteorological week	Per cent incidence of different pests					Overall incidence of pests
	Sciarid flies	Mould mite	Flour mite	Spring tail	Physiphora flies	
24th (11 June -17 June)	75.00 (8.71)*	40.00 (6.40)	40.00 (39.20)	50.00 (44.98)	55.00 (47.85)	52.00
26th (25 June -01 July)	85.00 (9.27)	45.00 (6.78)	50.00 (44.98)	65.00 (53.70)	60.00 (50.75)	61.00
28th (09 July -15 July)	90.00 (9.59)	55.00 (7.48)	70.00 (56.77)	70.00 (56.77)	70.00 (56.76)	71.00
31st (30 July-05 August)	95.00 (9.79)	65.00 (8.12)	65.00 (53.70)	75.00 (59.98)	75.00 (59.97)	**75.00**
33rd (13 August-19 August)	90.00 (9.53)	50.00 (7.13)	60.00 (50.74)	60.00 (50.75)	65.00 (53.70)	65.00
35th (27 August-02 September)	80.00 (8.99)	45.00 (6.78)	50.00 (44.98)	55.00 (47.85)	40.00 (39.21)	54.00
37th (10 September-16 September)	70.00 (8.42)	40.00 (6.40)	40.00 (39.21)	40.00 (39.20)	35.00 (36.21)	45.00
39th (24 September -30 September)	55.00 (7.48)	35.00 (5.99)	20.00 (26.53)	25.00 (29.97)	25.00 (29.98)	32.00
41st (08 October-14October)	35.00 (5.97)	15.00 (3.99)	10.00 (18.41)	20.00 (26.55)	15.00 (22.74)	19.00
SE(d)	0.09	0.12	0.97	0.99	0.92	
C.D.	0.21	0.25	2.07	2.11	1.94	

**Values in parenthesis represent square root/arc sin transformation.*

Table 4. Percent incidence of different pests recorded on button mushroom at Baramulla (Pattan, Khawnchipora) during different meteorological weeks of the year 2022

Standard meteorological week	Per cent incidence of different pests					Overall incidence of pests
	Sciarid flies	Mould mite	Flour mite	Spring tail	Physiphora flies	
25th (18 June -24 June)	80.00 (63.45)*	35.00 (6.00)	35.00 (5.99)	60.00 (50.75)	50.00 (44.98)	52.00
27th (02 July – 8 July)	85.00 (67.19)	50.00 (7.14)	40.00 (6.39)	70.00 (56.77)	65.00 (53.71)	62.00
29th (16 July – 22 July)	90.00 (71.59)	60.00 (7.80)	40.00 (6.40)	75.00 (59.97)	85.00 (60.66)	**70.00**
31st (30 July – 5 August)	80.00 (63.48)	50.00 (7.14)	55.00 (7.48)	85.00 (67.25)	80.00 (63.42)	**70.00**
34th (20 August – 26 August)	75.00 (59.98)	45.00 (6.78)	40.00 (6.40)	60.00 (50.75)	60.00 (50.76)	56.00
36th (3 September – 9	70.00 (56.76)	40.00 (6.40)	30.00 (5.56)	50.00 (44.98)	45.00 (42.11)	47.00

Standard meteorological week	Per cent incidence of different pests					Overall incidence of pests
	Sciarid flies	Mould mite	Flour mite	Spring tail	Physiphora flies	
September)						
38th (17 September – 23 September)	50.00 (44.98)	30.00 (5.56)	25.00 (5.09)	40.00 (39.21)	35.00 (36.25)	36.00
40th (1 October – 7 October)	35.00 (36.25)	20.00 (4.57)	20.00 (4.58)	35.00 (36.25)	30.00 (33.19)	28.00
42nd (15 October – 21 October)	20.00 (26.51)	15.00 (3.99)	10.00 3.30)	20.00 (26.48)	15.00 (22.77)	16.00
SE(d)	1.35	0.15	0.16	1.37	3.14	
C.D.	2.86	0.32	0.35	2.90	6.66	

**Values in parenthesis represent square root/arc sin transformation.*

Table 5. Percent incidence of different pests recorded on button mushroom at Pulwama (Barapora, Pakharpora) during different meteorological weeks of the year 2022

Standard meteorological week	Per cent incidence of different pests					Overall incidence of pests
	Sciarid flies	Mould mite	Flour mite	Spring tail	Physiphora flies	
26th (25 June – 1 July)	85.00 (67.19)*	45.00 (6.78)	40.00 (6.40)	55.00 (47.85)	60.00 (50.75)	57.00
28th (9 July – 15 July)	90.00 (71.66)	50.00 (7.13)	50.00 (7.13)	65.00 (53.71)	65.00 (53.70)	64.00
31st (30 July – 5 August)	95.00 (77.22)	50.00 (7.13)	55.00 (7.48)	70.00 (56.76)	70.00 (56.79)	**68.00**
33rd (13 August – 19 August)	90.00 (71.59)	40.00 (6.40)	40.00 (6.40)	50.00 (44.98)	55.00 (47.85)	55.00
35th (27 August – 2 September)	80.00 (63.41)	30.00 (5.56)	30.00 (5.56)	45.00 (42.11)	45.00 (42.11)	46.00
37th (10 September – 16 September)	60.00 (50.76)	20.00 (4.58)	25.00 (5.09)	40.00 (39.21)	40.00 (39.21)	37.00
39th (24 September – 30 September)	40.00 (39.20)	15.00 (3.99)	20.00 (4.56)	30.00 (33.18)	35.00 (36.25)	28.00
41st (8 October – 14 October)	30.00 (33.18)	10.00 (3.31)	15.00 (3.99)	20.00 (26.53)	20.00 (26.53)	19.00
43rd (22 October – 28 October)	10.00 (18.29)	5.00 (2.42)	10.00 (3.31)	15.00 (22.77)	10.00 (18.29)	10.00
SE(d)	1.74	0.18	0.18	1.01	1.36	
C.D.	3.68	0.38	0.39	2.14	2.89	

**Values in parenthesis represent square root/arc sin transformation.*

4. CONCLUSION

The present study on diversity and incidence revealed about five pests (05) *viz*. sciarid fly picture winged fly, springtail, mould mite and flour mite associated with button mushrooms from different regions of Kashmir valley. The incidence of all the encountered pests was found highest in the months of July and August with sciarid flies having the highest incidence and mites lowest incidence. Among all the locations surveyed district Budgam reported the highest overall incidence of pests followed by Baramulla and Pulwama while the lowest incidence was

reported from SKUAST-K, Shalimar. Further, these findings would be of immense importance for understanding the mushroom pest complex and designing effective management strategies against the major pest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kim K, Choi B, Lee I, Lee H, Kwon S, Oh K, Kim A, Y..Bioproduction of mushroom mycelium of Agaricus bisporus by commercial submerged fermentation for the production of meat. J.Sci. Food Agric. 2011;91:1561-1568.
2. Kalac P. A review of chemical composition and nutritional value of wild-growing and cultivated mushrooms. J.Sci.Food Agric. 2013;93:209-218.
3. Aida FMNA, Shuhaimi M, Yazid M, Maaruf AG. Mushroom as a potential source of prebiotics: a review. Trends Food Sci. 2009;20:567-575.
4. XU X, Yan H, Chen J, Zhang X. Bioactive proteins from mushrooms. Biotechnol. Adv. 2011;29: 667-674.
5. Chang ST, Miles PG. Edible mushrooms and their cultivation.CRC Press, Florida. 1989;345.
6. Singh B. Pest incidence in white button mushroom in Haryana. Mushroom Res. 2019;28(1):61-63.
7. Fletcher JT, Gaze RH. Mushroom pest and disease control: a colour handbook (1st ed.) CRC Press. 2007;5-16.
8. Sharma VP, Kumar S, Annepu SK. Technologies developed by ICAR-Directorate of mushroom research for commercial use.Tech. Bull. 2017;11-13.
9. Deepthi S, Suharban M, Geetha D, Sudharma K. Pests infesting oyster mushroom in Kerala and the seasonability of their occurrence. Mushroom Res. 2004;13:76-81.
10. Sandhu GS. Management of mushroom insect pests. in: advances in horticulture Mushroom (Chadha, K.L. and Sharma, S.R., Eds.). MPH, New Delhi. 1995;13:239-260.
11. Bhattacharyya PR, Adhikary RK, DN Bordoloi. Population dynamics of insect pests and damage of the white button mushroom in the environment of North East India. J Food Sci Technol. 1993;30:377-379.
12. Joshi G, Mrig KK, Singh R, Singh S. Screening of oyster mushroom (Pleurotus species) against mushroom flies. Res. Crop. 2011;12:222-225.
13. Kumar S, Khanna AS, Rana VK. Insect fauna associated with cultivated edible mushrooms in Himachal Pradesh. J. Insect Sci. 2012;25(1):29-38.
14. Nongkynrih B, Firake DM, Baiswar P, Behere GT, Chandra S, Ngachan SV. Pest complex of cultivated oyster mushroom in Northeast India: feeding losses and role of micro-climate in pest multiplication. Indian J. Hill Farming. 2017;30(2):259-267.
15. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research (2nd ed.). John Wiley and Sons, New York. 1984;680.
16. Chakravarty DK, Sarkar BB, Dattta S, Chatterjee ML. Bionomics and control of sciarid fly Lycoriella auripila Winn. in subtropical mushroom, Pleurotus sajor-caju (fr.) Sing, in India. Bull. Entomol.Res. 1987;71:509-12.
17. Erler F, Polat E, Demir H, Catal M, Tuna G. Control of mushroom sciarid flies Lycoriella ingenua populations with insect growth regulators applied by soil drench.J. Econ. Entomol. 2011;104:839-844.
18. Navarro MJ, Escudero A, Ferragut F, Gea FJ. Evolution and seasonal abundance of phorid and sciarid flies in Spanish mushroom crops. In: Mushroom. Biol. Mush. Prod. (Eds. Sánchez JE, Huerta G. and Montiel E). 2002;189-195.
19. Gill RS, Sandhu GS, Dhooria MS. Studies on the pest and predatory status of mite Parasitus consanguineus Oudemans & Voigts (Parasitidae: Mesostigmata: Acari) occurring in Punjab. Indian J. Mushrooms. 1988;14:32-36.