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Research Article

Relative susceptibility of advanced breeding lines against major insect pests of wheat (*Triticum aestivum* L.)

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Abstract

The food security of India primarily depends upon the rice-wheat cropping system. Wheat production is constantly threatened by different biotic and abiotic factors in India. Among the biotic stresses, foliar aphids, *Rhopalosiphum maidis* Fitch., *Rhopalosiphum padi* L., *Schizaphis graminum* Rondani, *Sitobion avenae* Takahashi, brown wheat mite (BWM), *Petrobia latens* (Muller) and shoot fly, *Atherigona naqvii* (Steyskal) causes serious damage to wheat crop. Advanced breeding lines were screened during 2020-21 and 2021-22 to determine the promising resistant genotypes against shoot fly, BWM and foliar aphids. It was found that the shoot fly infestation index of MACS 6774 and PBW 873 varied from 5.85 - 6.11 per cent during 2020-21 and these lines were also found to be moderately resistant to foliar aphids. In 2021-22, the four genotypes HI 1628, PBW 872, VL 3030 and UAS 310 recorded lowest number of BWM (7.7 mites/10cm^2) along with relatively low shoot fly infestation index (5.51-7.43%). HD 3386 and UAS 310 were found to be moderately resistant to foliar aphids along with low shoot fly infestation (6.67-7.43%) during 2021-22. These lines can be used as source of multiple insect-pest resistance in wheat breeding programme.

Keywords: Breeding lines, relative susceptibility, wheat, insect-pest, multiple resistance

1. Introduction

Wheat (*Triticum aestivum* L.) is most widely cultivated cereal crop in the world and it plays a crucial role in ensuring global food security (Erenstein et al., 2022). In India, wheat is grown on 30.54 million hectares area with a production of 106.41 million tonnes during 2021-22 (Anonymous, 2022). The food security of India primarily depends upon the rice-wheat cropping system. However, in recent past, the pace of increase in productivity does not match with the increase in population. A number of factors such as insect pest and diseases, declining soil fertility and climate change pose serious challenges in the successful cultivation of wheat in Indo-Gangetic plains of India. Among the biotic stresses, foliar aphids *Rhopalosiphum maidis* Fitch., *Rhopalosiphum padi* L., *Schizaphis graminum* Rondani, *Sitobion avenae* Takahashi, brown wheat mite (BWM), *Petrobia latens* (Muller) and shoot fly, *Atherigona naqvii* (Steyskal) inflicts serious damage to wheat crop (Deol et al., 1987; Jasrotia et al., 2022). An annual monetary loss of 413.68 billion rupees has been reported due to insect pest in wheat crop in India (Dhaliwal et al., 2010).

Foliar aphid sucks sap from the leaves and developing earheads of wheat and results in loss of chlorophyll content (Singh, 2009; Singh and Kaur 2017). Aphids secrete "honey dew" on which black sooty mould develops which again results in decrease in photosynthetic activity of the plant. Shoot fly turn out to be a serious pest in Southern India and occasionally cause damage to very late sown wheat crop in North-western plains of India (Jambagi et al., 2021). It damages young seedlings as freshly hatched maggots bore into the leaf sheaths and cut the central growing shoots causing dead hearts. Heavily infested plants give bushy appearance with large number of tillers. Brown wheat mite feeds on leaf tips and damages the plant cells while feeding and cause stippling (brown spots) of the leaves which leads to drying-out and death of plants. Heavy infestation of mites presents a scorched and withered appearance of field (Nogia and Sharma, 2003; Singh et al., 2006).

Incorporating insect pest resistant into elite wheat germplasm is a cost effective and environment friendly insect-pest management strategy. It will reduce the problems of pesticide residue, conserve natural enemies and reduce the chances of development of insecticide resistance. A lot of information is available in literature regarding the response of wheat germplasm against individual insect-pest in wheat (Vyas et al., 1973; Kumar et al., 2010; Aradottir et al., 2016; Singh et al., 2018; Sharma and Singh, 2022) However, only little information is available in literature regarding the simultaneous response of wheat germplasm against multiple insect-pests viz. foliar aphids, brown mite and shoot fly. Keeping all these factors in mind, the present study was conducted to evaluate the response of major insect-pests of wheat in advanced wheat germplasm to facilitate plant breeder for the development of insect resistance wheat varieties.

2. Materials and Methods

The present investigations were undertaken during 2020-21 and 2021-22 at Experimental area of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. One hundred seventy-six and one hundred fifty-three wheat lines received from ICAR-Indian Institute of wheat and barley research (IIWBR) Karnal under advanced varietal trial (AVT) nursery during 2020-21 and 2021-22 crop seasons, respectively, were screened against major insect-pests of wheat. In all, 68 lines were common during two years of screening for which a mean score was calculated for incidence of insect-pests. For foliar aphid screening, the seed were sown in one metre row length with 22.5 cm of space between rows in alpha lattice design and each line was replicated thrice. The susceptible check (A-9-30-1) was sown after every 20 lines. The crop was grown by following the recommendations of PAU, Ludhiana (Anonymous, 2021), except for the usage of insecticide. Observations on incidence of foliar aphids from each line were recorded by counting the number of aphids/tiller at peak period of their activity in the months of February-March. Three observations were recorded from each line at weekly intervals and all lines were assigned grades as per the 5-point system (Anonymous, 2020) approved by All India co-ordinated wheat and barley improvement project (Table 1).

Table 1. Grading and rating of foliar aphid on the basis of population in wheat

Grade Approx.	Numbers of aphids/shoot	Rating
1	0	Immune
2	1-5	Resistant
3	6-10	Moderately resistant
4	11-20	Susceptible
5	21 and above	Highly susceptible

For BWM screening, each accession was sown in one-meter row length under rainfed conditions and after every 20 line a susceptible check IWP 72 was sown. The population of BWM was recorded by tapping the mites on glycerine smeared slides and counting their number in 10 cm^2. The observations were recorded from randomly selected five spots in each line at peak period of their activity starting from first week of March. The shoot fly screening nursery was sown very late in the first fortnight of January and each line was sown in one meter row length and a susceptible check *Sonalika* was sown after every 20 lines. To attract the adults of shoot fly, fish meal @ 50 g/m^2 was applied one week after the emergence of seedlings. The shoot fly damaged tillers per meter row length were recorded 20, 40 and 60 days after germination and average infestation index was calculated for each entry as under:

$$\text{Average infestation index} = \frac{\text{Number of damaged tillers}}{\text{Total tillers}} \times 100$$

The data from all three observations were pooled to calculate average infestation index of each accession.

Table 2. Response of AVT entries against foliar aphid, shoot fly and brown wheat mite during 2020-21 and 2021-22

		2020-21			2021-22				Mean		
S. No.	**Entry**	**Foliar aphid score (1-5 scale)**	**No. of brown wheat mites/10 cm²**	**Shoot fly incidence (%)**	**Entry**	**Foliar aphid score (1-5 scale)**	**No. of brown wheat mites/10 cm²**	**Shoot fly incidence (%)**	**Foliar aphid score (1-5 scale)**	**No. of brown wheat mites/10 cm²**	**Shoot fly incidence (%)**
1	VL2041	5	9.00	5.94	VL2041	5	13.00	4.90	5.0	11.00	5.42
2	HS562	5	10.70	5.68	HS562	5	13.70	6.43	5.0	12.20	6.06
3	HPW349	5	8.00	6.43	HPW349	5	12.70	5.65	5.0	10.35	6.04
4	HS507	5	6.70	7.40	HS507	5	13.70	6.28	5.0	10.20	6.84
5	VL907	5	4.70	5.87	VL907	5	11.70	7.10	5.0	8.20	6.49
6	HD3406	5	11.70	6.42	HD3406	5	12.70	6.98	5.0	12.20	6.70
7	HD2967	5	9.70	6.30	HD2967	5	13.30	5.98	5.0	11.50	6.14
8	PBW826	5	10.30	6.34	PBW826	5	13.70	6.84	5.0	12.00	6.59
9	JKW261	5	8.30	5.17	JKW261	4	14.00	7.94	4.5	11.15	6.56
10	WH1124	5	12.00	5.42	WH1124	4	14.00	5.77	4.5	13.00	5.60
11	PBW771	5	9.00	5.66	PBW771	4	13.70	7.43	4.5	11.35	6.55
12	HUW838	5	10.70	6.00	HUW838	5	14.70	5.07	5.0	12.70	5.54
13	HI1628	5	12.00	6.90	HI1628	5	7.70	5.76	5.0	9.85	6.33
14	NIAW3170	4	11.70	6.45	NIAW3170	5	14.30	5.47	4.5	13.00	5.96
15	HD3369	5	11.30	6.85	HD3369	5	14.00	5.14	5.0	12.65	6.00
16	HD3043	5	9.30	5.01	HD3043	5	14.30	5.53	5.0	11.80	5.27
17	HI1653	5	12.30	6.11	HI1653	5	11.30	4.72	5.0	11.80	5.42
18	HD2733	5	11.70	5.52	HD2733	4	13.70	6.22	4.5	12.70	5.87
19	HD3249	5	12.30	3.95	HD3249	4	14.00	6.01	4.5	13.15	4.98
20	HD3411	5	10.30	5.51	HD3411	5	14.30	6.32	5.0	12.30	5.92
20A	Susceptible checks	5	15.00	9.62	Susceptible checks	5	22.00	8.60	5.0	18.50	9.11
21	PBW835	5	12.30	6.67	PBW835	4	13.30	6.93	4.5	12.80	6.80

S. No.	Entry	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)	Entry	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)
22	HD3118	5	8.70	6.44	HD3118	5	14.00	6.24	5.0	11.35	6.34
23	HI1621	5	12.70	7.53	HI1621	5	12.70	6.59	5.0	12.70	7.06
24	DBW316	5	11.70	7.69	DBW316	5	12.30	6.49	5.0	12.00	7.09
25	PBW833	5	10.00	7.30	PBW833	5	13.70	6.10	5.0	11.85	6.70
26	DBW252	5	10.00	6.40	DBW252	5	13.30	6.77	5.0	11.65	6.59
27	HI1654	5	10.00	6.50	HI1654	4	13.70	5.14	4.5	11.85	5.82
28	HD3293	5	10.70	6.49	HD3293	5	12.70	6.38	5.0	11.70	6.44
29	HD3171	5	8.70	5.77	HD3171	5	14.30	7.33	5.0	11.50	6.55
30	MP3535	5	13.30	5.28	MP3535	5	11.30	5.90	5.0	12.30	5.59
31	GW513	5	12.00	5.82	GW513	5	8.30	6.40	5.0	10.15	6.11
32	HI1636	5	10.70	5.86	HI1636	5	14.30	6.13	5.0	12.50	6.00
33	MACS6768	4	10.70	7.26	MACS6768	5	14.30	6.49	4.5	12.50	6.88
34	HI1650	5	9.70	6.49	HI1650	5	13.30	6.50	5.0	11.50	6.50
35	MP3336	5	12.30	6.59	MP3336	5	14.30	7.07	5.0	13.30	6.83
36	HI1634	5	11.00	6.93	HI1634	5	12.70	5.14	5.0	11.85	6.04
37	HD3407	5	13.30	6.01	HD3407	4	13.30	5.53	4.5	13.30	5.77
38	CG1029	5	6.70	6.84	CG1029	5	8.30	5.47	5.0	7.50	6.16
39	DDW47(d)	4	9.70	6.77	DDW47(d)	5	13.30	4.82	4.5	11.50	5.80
40	HI8823(d)	3	10.30	7.43	HI8823(d)	5	10.70	7.05	4.0	10.50	7.24
40A	Susceptible checks	5	17.00	10.27	Susceptible checks	5	17.70	6.35	5.0	17.35	8.31
41	CG1036	4	11.70	5.77	CG1036	5	8.00	4.34	4.5	9.85	5.06
42	HI1655	4	10.70	5.98	HI1655	5	12.00	6.41	4.5	11.35	6.20
43	MP3288	5	11.00	6.30	MP3288	5	11.00	5.33	5.0	11.00	5.82
44	DDW55 (d)	5	12.00	7.14	DDW55(d)	5	14.30	6.95	5.0	13.15	7.05

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45	HI8826(d)	5	12.70	5.14	HI8826(d)	5	13.70	6.44	5.0	13.20	5.79
46	MACS4100(d)	5	10.30	7.07	MACS4100(d)	5	10.00	6.35	5.0	10.15	6.71
47	DDW48(d)	5	15.30	5.14	DDW48(d)	5	8.00	6.43	5.0	11.65	5.79
48	HD3090	5	12.30	5.32	HD3090	4	12.70	6.60	4.5	12.50	5.96
49	HI1633	5	14.00	6.04	HI1633	4	13.00	5.93	4.5	13.50	5.99
50	RAJ4083	4	11.00	5.32	RAJ4083	5	13.70	5.40	4.5	12.35	5.36
51	DBW320	5	10.70	4.44	DBW320	5	13.00	6.12	5.0	11.85	5.28
52	MP1358	5	8.70	5.26	MP1358	4	12.70	7.30	4.5	10.70	6.28
53	NIDW1149 (d)	5	9.00	5.31	NIDW1149(d)	5	13.70	6.21	5.0	11.35	5.76
54	DBW372	5	8.70	6.76	DBW372	5	12.30	5.49	5.0	10.50	6.13
55	DBW370	5	11.30	6.92	DBW370	5	13.70	6.20	5.0	12.50	6.56
56	DBW327	5	12.30	6.28	DBW327	5	14.00	6.43	5.0	13.15	6.36
57	DBW332	4	9.30	6.13	DBW332	5	12.00	6.44	4.5	10.65	6.29
58	DBW371	4	9.30	5.58	DBW371	5	9.00	6.05	4.5	9.15	5.82
59	PBW872	5	13.00	5.20	PBW872	4	7.70	5.51	4.5	10.35	5.36
60	PBW868	4	12.00	6.34	PBW868	4	12.30	7.87	4.0	12.15	7.11
60A	Susceptible checks	5	17.70	8.60	Susceptible checks	5	19.00	8.60	5.0	18.35	8.60
61	DBW377	5	12.70	5.44	DBW377	5	12.30	5.11	5.0	12.50	5.28
62	PBW871	5	11.70	6.80	PBW871	5	10.30	4.85	5.0	11.00	5.83
63	DBW373	5	7.70	5.97	DBW373	5	10.00	6.48	5.0	8.85	6.23
64	PBW870	5	13.30	5.88	PBW870	5	11.30	5.40	5.0	12.30	5.64
65	DBW366	5	13.30	5.35	DBW366	5	12.30	5.14	5.0	12.80	5.25
66	KRL210	5	10.70	6.38	KRL210	4	13.30	5.98	4.5	12.00	6.18
67	DBW365	5	12.00	6.03	DBW365	5	13.70	5.53	5.0	12.85	5.78

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68	KRL19	5	13.30	6.06	KRL19	5	13.30	3.60	5.0	13.30	4.83
69	WH1105	5	9.00	6.81	VL2043	5	13.7	5.14			
70	DBW187	5	9.00	5.92	VL2044	5	13.3	5.9			
71	HD3349	5	10.00	6.71	HD3402	5	13.7	6			
72	PBW876	5	11.30	8.09	HPW481	5	12.7	5.28			
73	DBW222	5	10.70	5.44	HPW487	5	13	5.99			
74	DBW313	4	9.30	6.70	HPW488	4	13.7	5.6			
75	RAJ4548	5	8.70	6.71	HS692	5	14	5.68			
76	HD3354	5	10.30	6.63	HS693	5	13.7	7.32			
77	WH1283	5	13.00	6.77	HS694	5	13.3	6.43			
78	HD3086	5	7.30	5.78	UP3114	5	14.3	6.44			
79	HD3059	5	11.30	6.79	VL3028	5	13.3	6.35			
80	PBW834	5	9.30	5.91	VL3029	5	13.7	6.2			
80A	Susceptible checks	5	17.70	8.41	Susceptible checks	5	20.70	7.69			
81	DBW173	5	10.30	6.63	VL3030	5	7.7	6.05			
82	NW7096	5	13.00	4.88	HPW483	5	13.7	6.48			
83	DBW296	4	12.30	5.75	HPW484	5	12.7	6.81			
84	K1910	5	11.70	6.02	HPW485	5	14	6.78			
85	PBW838	5	13.30	6.54	HPW486	5	10.7	5.52			
86	WH1142	4	12.00	4.54	HS688	5	12.3	4.57			
87	UP3062	5	11.00	6.13	HS689	5	14	5.51			
88	HD3368	5	11.70	6.26	HS690	5	14.3	5.2			
89	PBW644	5	11.00	7.14	HS691	5	14.3	6.27			
90	PBW848	5	9.70	5.61	SKW362	5	10	6.06			

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91	DBW39	4	11.70	5.60	UP3113	5	13.7	6.8			
92	DBW317	3	11.00	6.84	VL2047	4	14.7	5.81			
93	DBW318	4	11.70	5.60	VL2048	4	14	5.07			
94	HI1563	5	14.70	6.52	VL2049	5	9.3	4.81			
95	DBW107	5	11.30	6.38	VL2050	5	14	6.3			
96	UP3060	5	9.00	6.37	HS490	5	14.3	5.92			
97	HD3360	5	9.70	6.07	VL892	5	12.7	6.56			
98	DBW322	4	9.00	5.91	DBW318	5	13.3	5.01			
99	HI1612	5	11.00	5.80	MP1380	4	8.3	5.49			
100	DBW321	5	7.00	6.04	DBW407^B	5	13.7	5.01			
100A	Susceptible checks	5	15.70	9.34	Susceptible checks	5	21.00	9.34			
101	WH1281	4	10.70	5.90	MP1378	5	14.3	6.2			
102	K1317	5	7.00	4.34	MP3552	4	12	6.05			
103	HI8833 (d)	5	5.00	4.82	UAS3015	4	11.7	6.48			
104	GW322	5	11.30	6.95	HI8839(d)	5	12.7	7.87			
105	GW523	5	10.30	5.80	HI8840(d)	4	9	7.69			
106	HI8832	5	11.30	5.48	NIAW3922	5	14	6.07			
107	HI1544	5	11.00	5.21	UAS478(d)	5	12.70	5.91			
108	HI1667	5	11.00	5.51	DBW352	5	14.00	5.80			
109	HI8498 (d)	4	12.30	6.18	GW547	5	14.00	6.04			
110	HI8713 (d)	5	10.00	6.59	NWS2194	5	9.00	7.90			
111	MP4010	5	12.00	6.24	HI1665	5	12.30	5.77			
112	HD2864	5	10.00	5.63	NIAW4028	5	8.70	5.55			
113	HD2932	5	10.30	6.10	CG1040	5	9.00	6.61			

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114	GW528	5	9.00	5.12	GW532	5	13.70	5.28			
115	DBW326	5	10.00	7.33	HD3401	5	12.00	5.80			
116	UAS475(d)	5	10.00	6.38	HI1666	5	11.30	6.29			
117	HI8627 (d)	5	8.00	6.07	HI8830(d)	5	11.00	5.24			
118	NIAW3851	5	9.70	7.94	MACS6795	4	12.00	4.37			
119	DBW110	5	9.00	6.67	MP1377	4	8.00	6.37			
120	WHD965(d)	5	10.30	5.47	UAS3019	5	13.30	6.59			
120A	Susceptible checks	5	18.30	7.64	Susceptible checks	5	24	7.64			
121	UAS428(d)	5	11.70	5.53	HD3392	5	14.00	5.63			
122	MACS3949(d)	5	13.30	4.65	HD3388	5	12.00	5.38			
123	DDW53(d)	4	11.70	6.22	PBW852	5	12.30	5.12			
124	NIDW1345(d)	5	10.30	5.76	DBW353	5	14.00	6.07			
125	MACS6222	5	10.70	4.72	HD3386	3	13.30	6.67			
126	MACS4106(d)	4	9.00	5.14	DBW359	4	15.70	6.30			
127	NIDW1348(d)	5	12.70	5.07	DBW358	4	11.70	7.14			
128	HI8828(d)	5	11.70	4.56	HD3397	4	14.00	7.07			
129	HI8827	5	10.30	4.77	HD3400	5	13.30	4.65			
130	MACS6774	3	9.30	6.11	HD3418	4	9.30	6.22			
131	NWS2180	5	11.30	6.67	UP3090	5	14.00	4.56			
132	HI1651	5	10.70	4.69	WH1402	5	13.70	6.71			
133	MACS6755	5	9.70	5.41	WH1403	5	14.00	5.47			
134	HI1605	5	9.30	7.03	DBW402	4	11.30	7.07			
135	MACS6753	4	11.30	6.04	HD3415	4	12.70	4.65			

S. No.	Entry	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)	Entry	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)
136	AKDW2997-16(d)	4	11.30	5.65	Kharchia65	5	12.30	6.22			
137	UAS446(d)	5	7.00	5.44	KRL2006	5	9.30	7.94			
138	DBW325	5	8.30	6.41	UAS310	3	7.70	7.43			
139	MACS5058	5	11.00	5.29	KRL2021	4	14.00	5.77			
140	DDK1029	5	9.30	6.22	Susceptible checks	5	21.3	9.02			
140A	Susceptible checks	5	16.30	9.02	RAJ4565	4	13.00	6.67			
141	DDK1061	5	9.70	6.32	HD3438	5	9.30	6.30			
142	HW1098	4	7.70	7.09	HD3439	5	11.70	7.14			
143	MACS5057	4	6.00	6.98	HI8498	5	12.70	4.65			
144	DDK1060	5	9.30	6.96	HI8759	5	12.70	7.95			
145	DBW328	5	9.30	6.40	HI8846	4	14.30	5.29			
146	WH1252	5	9.70	6.13	HI8847	4	9.30	5.98			
147	PBW874	5	11.30	5.23	HD3440	5	14.70	7.09			
148	HD3410	4	9.00	5.40	HD3436	5	12.00	6.96			
149	PBW873	3	10.00	5.85	HD3437	5	11.70	6.40			
150	DBW333	5	10.70	7.01	PBW175	5	10.70	6.76			
151	WH1270	4	11.30	5.99	PBW677	5	13.30	6.92			
152	DBW303	5	10.00	5.14	PBW901	5	12.70	6.28			
153	HD3412	5	11.30	6.78	PBW902	5	13.30	6.13			
154	DBW375	5	6.70	7.17	Susceptible checks	5	24	5.23			
155	DBW374	5	8.00	8.46							
156	HD3403	5	13.30	8.53							

S. No.	Entry	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)	Entry	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)	Foliar aphid score (1-5 scale)	No. of brown wheat mites/10 cm^2	Shoot fly incidence (%)
157	WH1406	5	4.70	6.69							
158	HD3413	5	12.00	6.32							
159	PBW867	5	11.00	7.40							
160	UP3096	5	12.00	6.38							
160A	Susceptible checks	5	17.00	8.35							
161	WH1404	5	11.30	6.90							
162	DBW378	3	10.70	7.40							
163	WH1405	4	14.00	5.93							
164	HD3405	5	10.30	4.90							
165	PBW869	5	7.70	7.40							
166	DBW376	5	11.70	5.29							
167	HD3404	5	8.00	6.46							
168	WH1407	5	12.00	6.46							
169	UP3095	5	12.30	6.54							
170	DBW368	4	10.30	7.75							
171	DBW363	4	12.30	6.05							
172	DBW369	5	10.00	5.48							
173	DBW367	5	8.70	6.47							
174	DBW364	5	9.70	8.10							
175	Kharchia 65	5	11.70	5.93							
176	K1805	5	11.70	5.96							

* A-9-30-1, GW 173, Sonalika and IWP 72 are susceptible check for foliar aphid, , Shoot fly and Brown mite, respectively.

3. Results and Discussion

The damage of shoot fly ranges from 3.95-8.53 and 3.60-7.95 per cent during 2020-21 and 2021-22 *rabi* season, respectively. In 2020-21, maximum infestation index was reported on HD 3403 (8.53%) and minimum infestation index on HD 3249 (3.95%) (Table 2). In 2021-22 *rabi* season, maximum infestation index was recorded on HI 8759 (7.95%), and minimum on KRL 19 (3.60%) (Table 2). Jambagi et al. (2021) reported that shoot fly is becoming a major threat to wheat production in irrigated belt of North Karnataka and caused 12.41-26.62 per cent damage in Karnataka. During *rabi* 2020-21, five entries *viz.* HI 8823(d), DBW 317, MACS 6774, PBW 873 and DBW 378 were found to be moderately resistant (grade 3) to foliar wheat aphid whereas in *rabi* 2021-22, HD 3386 and UAS 310 were moderately resistant (grade 3) and rest of the entries were categorized either susceptible (grade 4) or highly susceptible (grade 5) against foliar wheat aphid (Table 2). Brown wheat mite infestation recorded during 2020-21 revealed highest damage of BWM on DDW48 (d) (15.3 mites/10 cm^2) whereas WH 1406, VL 907 (4.7 mites/10cm^2) recorded lowest mite infestation. Similarly, DBW 359 (15.7 mites/10 cm^2) recorded highest BWM and HI 1628, PBW 872, VL 3030 and UAS 310 (7.7 mites/10cm^2) were least infested with BWM during 2021-22 (Table 2). On the basis of mean of 68 common lines screened during 2020-21 and 2021-22, no entry was found resistant to foliar aphid, CG 1029 (7.5 mites/10 cm^2) has lowest number of brown wheat mite and KRL 19 (4.83 %) has lowest shoot fly dead-hearts.

The results of 2020-21 indicated that VL 907 (4.7 mites/10cm^2) recorded least number of BWM along with fairly low shoot fly infestation (5.87%). At the same time, shoot fly infestation index of MACS 6774 and PBW 873 varied from 5.85 - 6.11 per cent and these lines also gave moderately resistant reaction to foliar aphids. In 2021-22, HI 1628, PBW 872, VL 3030 and UAS 310 recorded lowest number of BWM (7.7 mites/10cm^2) along with relatively low shoot fly infestation index (5.51-7.43%). HD 3386 and UAS 310 which were moderately resistant to foliar aphids also recorded low shoot fly infestation (6.67-7.43%). These lines can be used as source of multiple insect-pest resistance in wheat breeding programme.

Resistance to individual insect-pest in wheat is reported in literature viz. shoot fly (Kumar et al., 2010; Lutfallah et al., 2014; Singh et al., 2019), foliar wheat aphid (Dunn et al., 2011; Crespo-Herrera et al., 2013; Singh et al., 2018; Singh et al., 2022) and brown wheat mite (Vyas et al., 1973; Ibraheem et al., 2007). However, this study reports the sources of resistance to multiple pests in wheat. Smith et al., (2004) has reported resistance in *Aegilops neglecta* accession 8052 against multiple aphid species viz. *Schizaphis graminum* (Rondani), *Diuraphis noxia* (Mordvilko), and *Rhopalosiphum padi* (L.). Resistance to multiple insect-pests is already reported in rice, however, this is one of the early report on multiple insect-pest resistance in wheat in India (Singh and Shukla, 2007; Sarao et al., 2009).

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Authors Contribution:

BS: Conceptualization of research work, designing of experiments, data interpretation and preparation of manuscript

HS: Execution of field/lab experiments, data collection, interpretation of results and preparation of manuscript

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