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Integrated management of oat diseases in north-western Himalaya

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Abstract
Oat (*Avena sativa*), one of the major *rabi* fodder crops in north-western Himalaya is severely affected by powdery mildew (*Blumeria graminis* f. sp. *avena*), leaf blight (*Helminthosporium* sp.) and loose smut (*Ustilago avenae*) and causes a serious qualitative as well as quantitative losses to fodder and seed yield of oat. Keeping in view, the importance of diseases 77 oat genotypes were evaluated under *in vitro* conditions for their resistance against powdery mildew. The line OS-9 was found highly resistant whereas, 17 lines were found resistant. A field trial to find effective control measures of oat diseases was conducted (2008-2010) in Randomized block design replicated thrice with 8 treatments comprising of seed treatment with carboxin @ 2.5 g/kg seed, seed treatment with Ecoderma (*Trichoderma viride*) @ 5 g/kg seed and two sprays of propiconazole @ 0.1per cent individually and in combinations. In general, the foliar spray of propiconazole was found effective against powdery mildew and leaf blight whereas, seed treatment with carboxin was found to be effective against loose smut. The study concluded that the diseases of oat can be effectively controlled by seed treatment with carboxin @ 2.5 g/ kg seed or carboxin @ 2.5 g + *Trichoderma viride* @ 5 g/kg seed followed by two sprays of propiconazole @ 0.1per cent at 15 days intervals.

Keywords: Integrated disease management, Leaf blight, Loose smut, Oat, Powdery mildew

Introduction

Oat (*Avena sativa*) is one of the major fodder crops grown in foot and mid hills and dry temperate zone of north-western Himalaya. In Himachal Pradesh, oat is severely affected by powdery mildew (*Blumeria graminis* f. sp. *avena*), leaf blight (*Helminthosporium avenae*) and loose smut (*Ustilago avenae*). These diseases cause serious qualitative as well as quantitative losses to fodder and seed yield of oat. The management of these diseases is of paramount importance when oat is grown for green fodder or seed purpose. Chemical management of powdery mildew through seed treatment has been suggested (Martinelli, 2001) but use of resistant cultivars is the best and most effective approach. Several good resistant sources against powdery mildew have been reported from Britain and Europe (Roderick *et al*., 2000). Keeping in view, the importance of crop, the present study was conducted for generating information on resistant sources, effective chemicals and role of bio-agents to develop an effective integrated disease management strategy for oat diseases.

Materials and Methods

Survey: Periodic surveys were conducted during 2006 to 2011 to record the incidence/severity of powdery mildew, leaf blight and loose smut of oat at Palampur, Himachal Pradesh**.** Data on disease severity were recorded for powdery mildew and leaf blight before maturity and incidence for loose smut at the time of harvest. Data were taken as an average of five fields selected at random.

Evaluation of genotypes: Powdery mildew was observed as major disease among all the diseases of oat in north-western Himalayas. Seventy seven oat genotypes obtained from various sources (local, NBPGR, abroad etc.) were evaluated under *in vitro* for their resistance against powdery mildew during 2010-2011.The inoculum of pathogen for the *in vitro* evaluation was multiplied on the susceptible oat plants grown in plastic pots under control conditions in green house at 23 ± 2^{o}C. For evaluation of powdery mildew resistance the plants of each genotype were raised in five plastic pots and kept for two month in green house. These two months old plants were inoculated with powdery mildew pathogen by dusting conidial inoculum on to them by using a camel hair brush. These inoculated plants were kept in green house for incubation (22 ± 2^{o}C and 66±10% RH). The data on powdery mildew severity was recorded

after 15-30 days of inoculation as per the 0-9 disease scale (Mayee and Datar, 1986) of powdery mildew of wheat.

Management of disease: Field experiment for the management of powdery mildew, leaf blights and loose smut of oat was conducted during 2008, 2009 & 2010 by using fungicides and biocontrol agents. The experiment was conducted in RBD with 8 treatments consisting of seed treatments with carboxin @ 2.5 g/kg seed, Ecoderma (*Trichoderma viride*) @ 5 g/kg seed and two foliar spray of propiconazole @ 0.1 per cent individually and in their different combinations having three replications each. The crop was raised as per recommended package and practices. The data on disease severity of powdery mildew and leaf blight were recorded till maximum disease reached, whereas, data on incidence of loose smut were recorded at maturity/ harvest.

Results and Discussion

Survey: The survey conducted to record the occurrence of powdery mildew, leaf blight and loose smut of oats at Palampur showed that powdery mildew was most prevalent and important disease of oat (Table 1). The average severity of powdery mildew of oat was 83.5 per cent ranging from 65.3 to 91.5 per cent. Leaf blight was also observed during all the years ranging from 17.6 to 31.5 per cent with an average disease severity of 24.5 per cent. The average incidence of loose smut was 3.0 per cent. Several diseases like powdery mildew, leaf blight, smut and rust have been found widely prevalent throughout the world and causing serious damage to oat (Martinelli, 2004).

Table 1. Occurrence of oat diseases at Palampur

Year	Disease severity/ incidence (%)		
	Powder mildew	Leaf blight	Loose smut
2010-11	91.5	23.6	2.5
2009-10	79.6	31.5	3.2
2008-09	82.6	28.5	2.5
2007-08	65.3	17.6	3.5
2006-07	93.2	25.3	2.9
2005-06	90.5	20.4	3.2
Average	83.8	24.5	3.0

Evaluation of genotype: Seventy seven genotypes of oat were evaluated against powdery mildew *in vitro* conditions and data on disease reaction presented in table-2 revealed that only one genotype i.e. OS-9 gives a highly resistant reaction against powdery mildew pathogen. Seventeen lines *viz.,* OT-9, IG-03-251, IG-03-213, PLP-1, IG-03-246, IG-03-248, TRSRKL-106, IG-03-250, EC-605832, KRR-AK-36, IG-03-214, IG-03-208, IG-03-211, EC-605834, IG-03-212, JHO-862 and OS-92 give a resistant reaction with a disease severity between 1-10 per cent, however, 11 oat genotypes were found moderately resistant with 11-25 percent disease severity. The remaining genotypes were either found susceptible (19 genotypes with disease severity 26 – 50 per cent) or highly susceptible (29 genotypes with disease severity above 50 per cent). Powdery mildew is a deleterious foliar disease of cereals, including oats (Hsam *et al*., 1997; Dreiseitl and Wang, 2007; Kaur *et al*., 2008; Silvar *et al*., 2013). Hsam *et al*. (1998) have reported that about 5 per cent from a total of 207 accessions possessed resistance against oat powdery mildew in northern and eastern European countries. Several good resistant sources against powdery mildew have been also reported from Britain and Europe (Roderick *et al*., 2000). Sanchez-Maetin *et al*. (2011) found 10 resistant and moderately resistant accessions against oat powdery mildew from 165 *Avena sativa* and *A. byzantine* accession. Okon *et al*. (2014) studied 67 oat genotypes belonging to five different species of *Avena* and found high level of resistance against powdery mildew with *A. murphy.*

Management of disease: Results revealed that all the treatments in which propiconazole was used as foliar spray individually or in combination with seed treatments were highly effective and provided 77.9 to 84.7 per cent control of powdery mildew over unsprayed check (Table 3). The treatment having combination of carboxin, Ecoderma as seed treatment and two foliar sprays of propiconazole provided maximum disease control (84.7 per cent) followed with non-significant differences by treatments *i.e.* two sprays of propiconazole and seed treatment with carboxin + two spray of propiconazole. Martinelli (2001) suggested that oat powdery mildew can be effectively managed by different fungicides. Further it was observed that like powdery mildew of oat, the treatments of foliar sprays of propiconazole were also effective in controlling leaf blights and provided maximum (77.1 per cent) disease controls with seed treatment of carboxin and Ecoderma followed by the foliar sprays of propiconazole (Table 4). In case of loose smut seed treatment with carboxin was most effective against the disease. Seed treatment in combination with carboxin and Ecoderma proved more effective and provided 97.2 per cent disease control than seed treatment as alone with carboxin (94.4%) and Ecoderma (55.5%). Maximum increase (Table 5) in the grain as well as straw yield

Table 2. *In vitro* evaluation of oat germplam for powdery mildew resistance

Disease Reaction	Severity (%)	No. of lines	Lines
Highly Resistant	<1	1	OS-9
Resistant	1-10	17	OT-9, IG-03-251, IG-03-213, PLP-1, 1G-03-246, IG-03-248, TRSRKL-106, IG-03-250, EC-605832, KRR-AK-36, IG-03-214, IG-03-208, IG-03-211, EC-605834, IG-03-212, JHO-862 and OS-92.
Moderate	11-25	11	Oats-8655, EC-605836, IG-03-262, Oats-902, UPO-114, H-3-8, KRR-AK-15, EC-605831, IG-03-254, K-353 and IG-03-251.
Susceptible	26-50	19	KRR-AK-26, 19-03-203, PO-113, EC-605830, Oats-13, 99-1, HFO-52, EC-605833, JHO-813, IG-03-216, KRR-AK-8, KRR-AK-15, EC-605837, No-77, IG-03-257, Oats-17, HFO-114, IG-03-271and JHO-99-2.
Highly Susceptible	>50	29	KRR-AK-15, OS-121, UPO-102, Oats-3018, OS-10, IG-03-240, Oats-80, Oats-19, AOG-124, K-10,ADG-96, PO-1, HFO-288-B, KRR-AK-42,OL-822, EC-605838,OS-1,PO-160,190-14, UPO-119, OS-317, TRS-RKC-1180, SNTM-90, OS-6,KRR-AK-15, IG-03-205, KRR-AK-6, OL-125 and HFO-114.

Table 3. Integrated disease management of powdery mildew in oat

Treatment	Powdery mildew severity (%)			
	2007-08	08-09	09-10	Mean
T_1 - Seed treatment with Vitavax @ 2.5 g /kg seed	44.0	60.7	54.0	52.9
T_2 - Seed treatment with Ecoderma @ 5g/kg seed	50.0	70.0	60.7	60.2
T_3 -Foliar spray of Tilt @ 0.01%	10.3	15.3	11.0	12.2
T_4 - T_1+T_2	41.7	55.7	44.7	47.4
T_5 - T_1+T_3	9.7	15.7	11.3	12.2
T_6 - T_2+T_3	8.0	15.7	17.7	13.8
T_7 - T_1+T_2+ T_3	7.0	12.0	9.7	9.6
T_8 - Control	51.7	71.0	65.3	62.7
CD (P<0.05)	1.3	3.53	2.58	-

Table 4. Integrated disease management of leaf blights in oat

Treatment	Powdery mildew severity (%)			
	2007-08	08-09	09-10	Mean
T_1 - Seed treatment with Vitavax @ 2.5 g /kg seed	14.0	26.0	17.5	19.2
T_2 - Seed treatment with Ecoderma @ 5g/kg seed	16.0	24.0	15.9	18.6
T_3 -Foliar spray of Tilt @ 0.01%	5.0	7.3	7.0	6.4
T_4 - T_1+T_2	15.3	21.0	12.2	16.2
T_5 - T_1+T_3	4.0	7.3	6.0	5.8
T_6 - T_2+T_3	4.7	6.0	6.7	5.8
T_7 - T_1+T_2+ T_3	3.0	5.3	6.4	4.9
T_8 - Control	17.3	26.7	20.2	21.4
CD (P<0.05)	2.2	4.15	1.35	

(15.4 & 16.6 per cent, respectively) was observed in the treatment having the combination of seed treatment with carboxin and Ecoderma with two sprays of propiconazole.

Conclusion

It was concluded that powdery mildew and leaf blight are the most important diseases of oats. In general, the foliar sprays of propiconazole were found effective against powdery mildew and leaf blight whereas, seed treatment with carboxin was found to be highly effective against loose smut. For the management of powdery mildew and leaf blights, two spray of propiconazole @ 0.1percent and in case of loose smut management seed treatment with carboxin @ 25 g/kg seed were found effective. In case of integrated management of oat diseases (powdery mildew, leaf blight and loose smut), seed treatment with carboxin @ 2.5 g/ kg/seed or carboxin @

Table 5. Effect of powdery mildew, leaf blights and loose smut on oat seed and straw yield

Treatment	Grain Yield (q/ha)				
	2007-08	08-09	09-10	Mean	Increase (%)
T_1 - Seed treatment with Vitavax @ 2.5 g /kg seed	16.3	16.1	14.8	15.7	5.3
T_2 - Seed treatment with Ecoderma @ 5 g/kg seed	16.1	15.9	14.9	15.6	4.7
T_3 -Foliar spray of Tilt @ 0.01%	17.0	17.8	16.1	17.0	14.1
T_4 - T_1+T_2	15.9	15.9	15.6	15.8	6.0
T_5 - T_1+T_3	17.4	17.7	16.3	17.1	14.8
T_6 - T_2+T_3	17.1	17.6	16.0	16.9	13.4
T_7 - T_1+T_2+ T_3	17.5	17.1	16.3	17.2	15.4
T_8 - Control	15.2	15.4	14.1	14.9	
CD (P<0.05)	0.9	0.77	0.25		

Treatment	Straw Yield (q/ha)				
	2007-08	08-09	09-10	Mean	Increase (%)
T_1 - Seed treatment with Vitavax @ 2.5 g/kg seed	59.5	58.9	52.2	56.9	7.4
T_2 - Seed treatment with Ecoderma @ 5 g/kg seed	58.9	55.9	51.2	55.3	4.3
T_3 -Foliar spray of Tilt @ 0.01%	61.4	62.0	58.4	60.6	14.3
T_4 - T_1+T_2	58.6	57.7	54.4	56.9	7.3
T_5 - T_1+T_3	62.2	62.3	59.9	61.5	16.0
T_6 - T_2+T_3	62.0	61.2	60.2	61.1	15.3
T_7 - T_1+T_2+ T_3	62.3	62.1	61.1	61.8	16.6
T_8 - Control	53.7	54.7	50.6	53.0	
CD (P<0.05)	2.1	2.87	2.99		

2.5 g + Ecoderma (*T. viride*) @ 5 g/kg seed followed by two sprays of propiconazole @ 0.1per cent at 15 days intervals was most effective.

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