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Influence of nitrogen fertilizer dose on false smut of rice *(Oryza sativa)* caused by *Ustilaginoidea virens*

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ABSTRACT

The effects of five nitrogen fertilizer doses on the development of false smut disease of rice (*Oryza sativa* L.) were studied under field conditions at experimental area of Department of Plant Pathology, Punjab Agricultural University, Ludhiana during *kharif* 2013 and 2014. Five levels of nitrogen (40, 50, 60, 80 and 100 kg/acre) were tested for their effect on incidence and severity of false smut over two years at the same location. The results indicated that the disease incidence, infected panicle and number of balls/plant were increased with increased nitrogen levels in tested rice cultivars viz PR114 and PR116. Disease severity (%) and unfilled grains (%) were also observed maximum at 100 kg nitrogen level in tested cultivars during both years.

Key words: Disease severity, False smut, Fertilizer, Nitrogen, Rice

Out of several biotic stresses like blast, false smut, sheath blight, stem rot and bacterial blight, false smut of rice has emerged as an increasing concern for rice (*Oryza sativa* L production and pathologists since the change of weather conditions, large application of nitrogen fertilizer and large-scale planting of hybrid rice (Zhou *et al.* 2008, Haiyong 2012). In India, the disease has been observed in severe form since 2001 in major rice-growing states, viz Haryana, Punjab, Uttar Pradesh, Uttarakhand, Tamil Nadu, Karnataka, Andhra Pradesh, Bihar,

Jharkhand, Gujarat, Maharashtra, Jammu & Kashmir and Puducherry (Dodan and Singh 1996, Mandhare *et al.* 2008). In northern Indian states as a whole, disease incidence (percentage of false smut-infected tillers) varied from 2 to 75%. In Haryana, maximum infection was recorded on hybrids like PA 6444 and PA 6129 while in Punjab, 10 to 20% disease incidence was recorded on popular inbred rice varieties like PR 114, PR 116 and PAU 201. However, in the southern state of Tamil Nadu, the disease incidence varied from 5 to 85% (Ladhalakshmi *et al.* 2012). Pannu *et al.* (2010) also reported losses up to 44% in Punjab. Higher incidence of false smut has been reported by several workers (Singh *et al.* 1987, Dhindsa and Aulakh 1992, Patel *et al.* 1992 and Atia 2004) due to application of higher doses of nitrogenous fertilizers in soil. Present studies were undertaken to examine the effects of the form of nitrogenous fertilizers on false smut and an attempt has been made to identify optimum dose of N fertilizer for suppressing false smut disease of rice under Punjab conditions as an IDM component.

MATERIALS AND METHODS

The experiment was conducted at experimental area of Department of Plant Pathology, Punjab Agricultural University, Ludhiana during *kharif* 2013 and 2014. Five levels of nitrogen, i.e. 40, 50, 60, 80 and 100 kg/acre were tested for their effect on incidence and severity of false smut using two rice genotypes, viz PR 116 (susceptible cultivar) and PR 114 (tolerant cultivar) in replicated randomized block design. The experimental plots of 2×2 m^2 size were planted on 18 June 2013 and 25 June 2014. The fertilizer application and other standard cultural operations were practiced as per the recommendations of the Punjab Agricultural University, Ludhiana for rice. Different disease variables such as disease incidence, number of smut balls / panicle/plant, per cent infected panicles were calculated as per Standard Evaluation System for rice (IRRI 2002). Per cent unfilled grains were also calculated by counting sterile grains/healthy grains.

The disease severity on each genotype inoculated with each *U. virens* isolate was recorded as per following formula:

$$\text{Disease severity} = \frac{\text{No. of infected florets}}{\text{Total no. of florets}} \times 100$$

The data were statistically analysed by ANOVA (Cochran and Cox 1957) and the differences among means were tested by using critical difference (CD) values at 5%

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level of probability.

RESULTS AND DISCUSSION

Nitrogen fertilizers play an important role in the infection and development of false smut in rice. During the year 2013, on cv. PR 114 the highest disease incidence (32.00%) was observed in plots applied with nitrogen @ 100 kg/acre followed by 28.00% at 80 kg nitrogen/acre and the results were statistically at par. Minimum disease incidence (3.67%) was observed in 40 kg nitrogen level. Infected panicle (%) and number of smut balls/panicle were increased with increased nitrogen levels and observed maximum at 100 kg nitrogen level, i.e. 6.23% and 0.07, respectively (Table 1). Highest number of smut balls/plant (0.90) was observed in 80 kg nitrogen level. Maximum disease severity (0.43%) and unfilled grains (21.48%) were observed at 100 kg level (Table 2). The pooled data of the two years on grain yield revealed that there was non-significant difference in yield in all the treatments and maximum yield (25.33 q/acre) was recorded in cultivar PR114 at 50 kg nitrogen level.

In cultivar PR116, the highest disease incidence (55.33%) was observed in plots with nitrogen @ 100 kg/acre followed by 52.33% in plots with nitrogen @ 80 kg/acre and the findings were statistically at par during 2013. Minimum disease incidence (14.33%) was observed in 40 kg nitrogen level. Infected panicle (%), number of smut balls/panicle and number of smut balls/plant were increased with increased nitrogen levels and observed maximum at 100 kg nitrogen level, i.e. 30.59%, 0.60 and 8.47, respectively (Table 3). Disease severity (%) and unfilled grains (%) were also observed maximum at 100 kg level, i.e. 1.45 and 43.23%, respectively. (Table 4). Also during

Table 1 Effect of nitrogen doses on false smut of rice on cv. PR 114

Nitrogen level	Disease incidence (%)			Infected panicles (%)			No. of balls/panicle			No. of balls/plant		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
T_1 (40 kg)	3.67 (10.76)	5.33 (12.83)	4.50 (11.80)	1.36 (6.69)	0.84 (5.13)	1.10 (5.91)	0.01	0.03	0.02	0.2	0.13	0.17
T_2 (50 kg)	10.67 (19.00)	15.67 (23.16)	13.17 (21.08)	2.68 (9.40)	3.14 (9.69)	2.91 (9.54)	0.04	0.05	0.04	0.57	0.60	0.58
T_3 (60 kg)	20.33 (26.70)	24.00 (29.23)	22.17 (27.97)	3.40 (10.55)	3.66 (10.97)	3.53 (10.76)	0.06	0.07	0.06	0.87	0.67	0.77
T_4 (80 kg)	28.00 (31.85)	36.00 (36.77)	32.00 (34.31)	4.60 (12.27)	5.57 (13.62)	5.09 (12.94)	0.06	0.09	0.07	0.90	1.07	0.98
T_5 (100 kg)	32.00 (34.34)	37.00 (37.40)	34.50 (35.87)	6.23 (14.19)	5.75 (13.70)	5.99 (13.95)	0.07	0.10	0.08	0.83	1.53	1.18
CD (pe>0.05)	6.22	7.27	Y 2.78 T 4.40 Y×T 6.22	3.93	5.03	Y NS T 2.93 Y×T 4.15	0.34	0.30	Y 0.13 T 0.21 Y×T 0.30	0.42	0.30	Y NS T 0.24 Y×T 0.33

Y = Year, T = Nitrogen levels.*Figures in parenthesis are arc sine transformation

Table 2 Yield losses due to false smut of rice on cv. PR 114

Nitrogen level	Disease severity (%)			Unfilled grains/panicle (%)			Yield		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
T_1 (40 kg)	0.10 (1.83)	0.08 (1.63)	0.09 (1.73)	11.94 (19.85)	16.05 (23.38)	14.00 (21.61)	23.33	24.00	23.67
T_2 (50 kg)	0.25 (2.84)	0.32 (3.03)	0.29 (2.94)	10.69 (19.04)	13.37 (21.15)	12.03 (20.10)	25.00	25.67	25.33
T_3 (60 kg)	0.30 (3.11)	0.35 (3.33)	0.33 (3.22)	10.11 (18.44)	13.90 (21.83)	12.01 (20.13)	25.33	25.33	25.33
T_4 (80 kg)	0.38 (3.48)	0.42 (3.69)	0.40 (3.58)	19.97 (25.79)	21.82 (27.13)	20.90 (26.46)	24.67	24.67	24.67
T_5 (100 kg)	0.43 (3.72)	0.41 (3.50)	0.42 (3.65)	21.48 (27.18)	21.59 (27.18)	21.54 (27.23)	23.67	24.00	23.83
CD (P>0.05)	0.82	NS	Y NS T 0.76 Y×T 1.07	NS	NS T NS Y×T 11.04	Y NS	NS	NS	Y NS T NS Y×T 14.81

Y = Year, T = Nitrogen levels. *Figures in parenthesis are arc sine transformation

Table 3 Effect of nitrogen doses on false smut of rice on cv. PR 116

Nitrogen level	Disease incidence (%)			Infected panicles (%)			No. of balls/panicle			No. of balls/plant		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
T_1 (40 kg)	14.33	22.00	18.17 (22.11)	6.62 (27.79)	3.83 (24.95)	5.23 (14.74)	0.08 (11.17)	0.12 (12.96)	0.01	1.03	3.10	2.07
T_2 (50 kg)	37.33	44.33	40.83 (37.45)	17.32 (41.62)	20.90 (39.54)	19.11 (24.49)	0.21 (27.19)	0.51 (25.84)	0.36	2.87	12.47	7.67
T_3 (60 kg)	39.00	48.33	43.67 (38.36)	16.74 (43.99)	31.85 (41.18)	24.30 (24.14)	0.22 (34.31)	0.80 (29.23)	0.51	3.0	13.37	8.18
T_4 (80 kg)	52.33	67.33	59.83 (46.37)	25.75 (55.62)	39.50 (51.00)	32.63 (30.48)	0.44 (38.92)	0.97 (34.70)	0.70	5.5	13.13	9.32
T_5 (100 kg)	55.33	67.00	61.17 (48.21)	30.59 (55.61)	40.08 (51.69)	35.34 (33.49)	0.60 (39.25)	0.95 (36.37)	0.77	8.47	16.47	12.47
CD (P≥0.05)	14.43	15.73	Y 6.20	5.29	3.41	Y 1.82	0.73	0.12	Y 0.42	1.09	3.77	Y 1.13
			T 9.80			T 2.89			T 0.66			T 1.80
			Y×T			Y×T			Y×T			Y×T
			13.86			4.09			0.94			2.55

Y = Year, T = Nitrogen levels. *Figures in parenthesis are arc sine transformation

Table 4 Yield losses due to false smut of rice on cv. PR 116

Nitrogen level	Disease severity (%)			Unfilled grains/panicle (%)			Yield		
	2013	2014	Pooled	2013	2014	Pooled	2013	2014	Pooled
T_1 (40 kg)	0.46 (3.85)	0.30 (3.05)	0.38 (3.45)	18.42 (24.25)	22.23 (27.79)	20.33 (26.01)	23.67	24.00	23.83
T_2 (50 kg)	0.69 (4.77)	1.61 (7.26)	1.15 (6.01)	30.22 (33.04)	36.05 (36.83)	33.14 (34.94)	26.67	25.33	25.83
T_3 (60 kg)	0.73 (4.90)	1.85 (7.77)	1.29 (6.34)	33.89 (35.40)	33.89 (40.55)	38.23 (37.98)	25.67	26.00	26.33
T_4 (80 kg)	1.15 (6.10)	2.40 (8.88)	1.78 (7.49)	42.45 (40.12)	45.01 (42.08)	43.73 (41.10)	25.00	25.00	25.33
T_5 (100 kg)	1.45 (6.87)	2.00 (8.12)	1.73 (7.50)	43.23 (41.01)	46.15 (42.49)	44.69 (41.75)	24.33	23.67	24.00
CD (P≥0.05)	1.12	1.36	Y 0.51	NS	NS	Y NS	NS	NS	Y NS
			T 0.81			T 10.78			T NS
			Y×T 1.15			Y×T 15.25			Y×T 8.66

Y = Year, T = Nitrogen levels. *Figures in parenthesis are arc sine transformation

2014, disease incidence (%), infected panicle (%) and number of balls/plant were increased with increased nitrogen levels.

The pooled data of the two years (2013 and 2014) on grain yield revealed that there was nonsignificant difference in yield in all the treatments and maximum yield of 26.33 q/acre was recorded @ 60kg nitrogen level. The incidence of disease was comparatively more during 2014 in both the cultivars. These results were in accordance with the data obtained by Singh and Kang (1987), Narinder and Singh (1989), Dhindsa and Aulakh (1992), Atia (2004) and Barnwal *et al.* (2009) who reported that the incidence of disease increased with every increase of nitrogen level. Excess dose of N causes a thinner wall of the host and easy to be penetrated by the pathogen (Patel *et al.* 1992; Cartwright *et al.* 1999).

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