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Effect of Different Levels of Phosphorus (P_2O_5) and Potash (K_2O) Applications on Rice Sheath blight (*Thanatephorus cucumeris*) under Temperate Conditions of Kashmir, India

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A B S T R A C T

Fertilizer doses of phosphorus (P_2O_5) and potash (K_2O) are known to influence the rice sheath blight disease. Two years of experimentation at Mountain Research Centre for Field Crops, conclusively proved that irrespective of K_2O levels, increase in P_2O_5 from 40 to 80 kg ha^{-1}, increases the disease incidence from 38.50 to 44.00 per cent, disease intensity from 16.93 to 18.60 per cent and decreases the yield from 4.95 to 4.75 t ha^{-1} while irrespective of P_2O_5 levels, increase in K_2O level from 20 to 40 kg ha^{-1} decreases the disease incidence from 38.50 to 29.25 per cent, disease intensity from 16.93 to 11.60 per cent and increases the grain yield from 4.95 to 5.25 t ha^{-1}. The highest disease incidence (44.00%) and intensity (18.60%) was recorded at P3K1 (P_2O_5=80 kg ha-^{1} and K_2O=20 kg $ha^{-1)}$ with a lowest grain yield of 4.75 t ha-^{1} while lowest disease incidence (29.25%) and intensity (11.60%) was recorded at P_1K_3 (P_2O_5=80 kg ha-^{1} and K_2O=60 kg $ha^{-1)}$ with the highest grain yield of 5.25 t ha^{-1}.The recommended doses of P_2O_5 and K_2O (P2K2) resulted in 36.50 per cent disease incidence while disease intensity and yield were 15.20 per cent and 4.95 t ha^{-1}, respectively.

Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop of India. It is staple food crop of Jammu and Kashmir where it occupies 261.35 thousand hectare area with an annual production of 5001 thousand tones (Kaloo *et al.*, 2014). The crop is attacked by a number of fungal, bacterial and viral diseases, which inflict heavy yield losses every year. Sheath blight of rice has attained the status of a major described as a minor disease by Ramakrishna (1971). The disease has wide geographic distribution and now occurs throughout the temperate and tropical rice production areas, being most prominent where rice is grown under intense, high fertility production system (Eizenga *et al.*, 2002). Sheath blight of rice was first reported in India by Paracer and

Chahal (1963), while Mir (1986) reported it from Kashmir.

The sheath blight of rice caused by *Thanatephorus cucumeris* [Anamorph: *Rhizoctonia solani* Kuhn] is one of the important biological constraints in achieving the stable rice production. The disease can result in yield losses ranging from 20 to 50 per cent (Rajan, 1987). However, under conditions of heavy severity, yield loss of more than 70 per cent has been reported from Chennai, India (Baby, 1992), and even complete crop failure has also been reported in Vietnam (Ou, 1992).

Mineral nutrition of the host plants form one of the important factors effecting the development of any disease. Management of the disease by manipulation in the chemical fertilizer applications to keep the disease at its lowest ebb is an important aspect of disease management. It is already established that an increase in nitrogen increases the susceptibility of rice plants (Fan *et al.*, 1993; Sarvary *et al.*, 1995; Zhang *et al.*, 1995), while lower levels of P and higher levels of K are also known to influence the disease (Kannaiyan and Prasad (1983; Sujata *et al.*, (1986). Therefore, different levels of P_2O_5 and K_2O were evaluated for their effects on the disease incidence, intensity and grain yield were investigated in present investigations..

Materials and Methods

Thirty-days old seedlings of rice variety 'Jhelum' (K-448) were transplanted in 5 x 2 m plots in randomized block design replicating the treatments thrice. Three levels of P_2O_5 *viz*., 40, 60 and 80 kg ha^{-1} and three levels of K_2O *viz*., 20, 30 and 40 kg ha^{-1} and a uniform recommended dose viz., 80 kg ha^{-1} of nitrogenous fertilizer were evaluated in all possible combinations for their effect on sheath blight incidence, intensity and grain yield**.** The sheath blight incidence was calculated by following formula:

$$\text{Per cent disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

For recording sheath blight intensity, the plants were scored on 0-9 scale (Anonymous, 2002) and the per cent disease intensity calculated using the following formula:

$$\text{Per cent disease intensity} = \frac{\text{Sum of all numerical ratings}}{\text{Total No. of plants observed x Maximum score value}} \times 100$$

Observations on disease incidence and intensity were recorded ten days after the last spray (Vihol *et al.*, 2009), whereas the observation on grain yield were recorded at harvest and expressed in tonnes per hectare.

Results and Discussion

The results are discussed under following headings;

Effect of disease incidence

The data presented in Table 1, depicts the mean per cent sheath blight incidence of rice during two years of experimentation, as influenced by different levels of P_2O_5 and K_2O and their combinations in field. Perusal of the data revealed that irrespective of K_2O level, lower level (40 kg ha^{-1}) of P_2O_5 resulted in reduced mean sheath blight incidence of 32.25 per cent whereas the higher level (80 kg ha^{-1}) of P_2O_5 showed higher mean sheath blight incidence of 38.91 per cent as compared to 36.41 per cent obtained at standard recommended P_2O_5 level of 60 kg ha^{-1}. While irrespective of P_2O_5 levels, higher level (40 kg ha^{-1}) of K_2O resulted in reduced mean sheath blight incidence of 31.75 per cent whereas lower level (20 kg ha^{-1}) showed

higher mean sheath blight incidence of 41.25 per cent as compared to 35.58 per cent obtained at standard recommended K_2O level of 30 kg ha^{-1}. The data further revealed that the combined application of 40 kg P_2O_5 and 40 kg of K_2O ha^{-1} resulted in the minimum mean sheath blight incidence of 29.25 per cent. Application levels of 40 kg P_2O_5 together with 60 and 80 kg P_2O_5 were next best resulting in mean sheath blight incidence of only 31.50 and 34.50 per cent, respectively. Maximum mean sheath blight incidence of 44.00 per cent was obtained in plot receiving 80 kg P_2O_5 and 20 kg of K_2O ha^{-1}.

Effect on disease intensity

The data generated after two years of experimentation presented in table 2, depicts that irrespective of K_2O level, lower level (40 kg ha^{-1}) of P_2O_5 resulted in reduced mean sheath blight intensity of 13.63 per cent whereas the higher level (80 kg ha^{-1}) of P_2O_5 showed higher mean sheath blight intensity of 16.09 per cent as compared to 15.14 per cent obtained at standard recommended P_2O_5 level of 60 kg ha^{-1}.

Table.1 Effect of different levels of P_2O_5 and K2O on sheath blight (*Thanatephorus cucumeris*) incidence on rice cv. Jhelum

Phosphorus (P_2O_5) level (kg ha^{-1})	Sheath blight incidence (%)			Mean
	Potassium (K_2O) level (kg ha^{-1})			
	K1 = 20	K2 = 30	K3 = 40	
P1 = 40	38.50 (38.35)*	32.00 (34.44)	29.25 (32.74)	**33.25**
P2 = 60	41.25 (39.96)	36.50 (37.16)	31.50 (34.14)	**36.41**
P3 = 80	44.00 (41.55)	38.25 (38.20)	34.50 (35.97)	**38.91**
Mean	**41.25**	**35.58**	**31.75**	
CD(P=0.05)				
Phosphorus	=	**0.50**		
Potassium	=	**0.41**		
Phosphorus x Potassium	=	**0.48**		

P1, P2, P3= levels of P_2O_5; K1, K2, K3 = levels of K_2O
*figures in parenthesis are arc sin transformed values

Table.2 Effect of different levels of P_2O_5 and K_2O on sheath blight (*Rhizoctonia solani* Kühn) intensity on rice cv. Jhelum

Phosphorus (P_2O_5) level (kg ha^{-1})	Sheath blight intensity (%)			Mean
	Potassium (K_2O) level (kg ha^{-1})			
	K1 = 20	K2 = 30	K3 = 40	
P1 = 40	16.93	12.38	11.60	**13.63**
P2 = 60	17.87	15.20	12.36	**15.14**
P3 = 80	18.60	15.82	13.85	**16.09**
Mean	**17.80**	**14.28**	**12.60**	
CD(P=0.05)				
Phosphorus	=	**0.50**		
Potassium	=	**0.41**		
Phosphorus x Potassium	=	**0.48**		

P1, P2, P3= levels of P_2O_5; K1, K2, K3 = levels of K_2O

Table.3 Effect of different levels of P_2O_5 and K_2O on grain yield of rice cv. Jhelum

Phosphorus (P_2O_5) level (kg ha^{-1})	Grain Yield (t ha^{-1})			Mean
	Potassium (K_2O) level (kg ha^{-1})			
	K1 = 20	K2 = 30	K3 = 40	
P1 = 40	4.95	5.10	5.25	**5.10**
P2 = 60	4.85	4.95	5.15	**4.98**
P3 = 80	4.75	4.90	5.05	**4.91**
Mean	**4.85**	**5.0**	**5.15**	
CD(P=0.05)				
Phosphorus		=	**0.02**	
Potassium		=	**0.01**	
Phosphorus x Potassium		=	**0.01**	

P1, P2, P3= levels of P_2O_5; K1, K2, K3 = levels of K_2O

While irrespective of P_2O_5 levels, higher level (40 kg ha^{-1}) of K_2O resulted in reduced mean sheath blight intensity of 12.60 per cent whereas lower level (20 kg ha^{-1}) showed higher mean sheath blight intensity of 17.80 per cent as compared to 14.28 per cent obtained at standard recommended K_2O level of 30 kg ha^{-1}. The data further revealed that the combined application of 40 kg P_2O_5 and 40 kg of K_2O ha^{-1} resulted in the minimum mean sheath blight intensity of 11.60 per cent. Application levels of 40 kg K_2O together with 60 kg of P_2O_5 was next best combination resulting in mean sheath blight intensity of only 12.36 per cent. However, Maximum mean sheath blight intensity of 18.60 per cent was obtained in plot receiving 80 kg P_2O_5 and 20 kg of K_2O ha^{-1}.

Effect on grain yield

The data recorded over two years of experimentation and presented in Table 3, revealed that irrespective of K_2O level, lower level (40 kg ha^{-1}) of P_2O_5 resulted in maximum mean grain yield of 5.10 t ha^{-1} whereas the higher level (80 kg ha^{-1}) of P_2O_5 showed minimum grain yield of 4.91 t ha^{-1} as compared to 4.98 t ha^{-1} obtained at standard recommended P_2O_5 level of 60 kg ha^{-1}. While irrespective of P_2O_5 levels, higher level (40 kg ha^{-1}) of K_2O resulted in higher grain yield of 5.15 t ha^{-1} whereas lower level (20 kg ha^{-1}) resulted in minimum of 4.85 t ha^{-1} as compared to 5.00 t ha^{-1} obtained at standard recommended K_2O level of 30 kg ha^{-1}. The data further revealed that the combined application of 40 kg P_2O_5 and 40 kg of K_2O ha^{-1} resulted in the maximum grain yield of 5.25 t ha^{-1}. Application levels of 40 kg K_2O together with 60 kg P_2O_5 provided next best grain yield of 5.15 t ha^{-1}. Minimum grain yield 4.75 t ha^{-1} was obtained in plot receiving 80 kg P_2O_5 and 20 kg of K_2O ha^{-1}.

A number of plant diseases have been successfully managed by manipulating different fertilizer levels (Nandi and Chakarbarti, 1986; Singh *et al.*, 1989, Dwivedi *et al.*, 1990). The present findings that lower doses of P_2O_5 and higher doses of K_2O decreases the sheath blight disease are in conformity with the findings of Kannaiyan and Prasad (1983), Sujata *et al.*, (1986) and Sarkar *et al.*, (1991).

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