



Official publication of Pakistan Phytopathological Society
Pakistan Journal of Phytopathology

ISSN: 1019-763X (Print), 2305-0284 (Online)

<http://www.pakps.com>



AGRONOMIC MANAGEMENT OF BACTERIAL LEAF BLIGHT OF RICE (*ORYZA SATIVA* L.) DISEASE AND YIELD ENHANCEMENT THROUGH DIFFERENT COMBINATIONS OF NITROGEN AND POTASH DOSES

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ABSTRACT

This research trial was conducted at Rice Research Institute, Kala Shah Kaku, during kharif 2010, to assess the influence of nitrogen (N) and potash (K) on the incidence and severity of Bacterial leaf blight of rice (BLB) (*Oryza sativa* L.). The experiment was laid out in a Randomized Complete Block Design in factorial arrangement with three replications using net plot size of 2.25 m × 6.0 m. The experiment was comprised of 0, 75, 100, 125 kg N ha⁻¹ and 0, 50, 75, 100 kg K ha⁻¹. Thirty days old nursery of Super Basmati was transplanted manually in puddle field. Data on disease severity and yield parameters of rice were recorded using standard procedures. Yield parameters were affected significantly by various combinations of N & K. In case of BLB, minimum diseased leaf area (15.76 % DLA) was observed where N alone was applied @ 75 kg ha⁻¹ in contrast to 125 kg N + 50 kg K ha⁻¹ which showed maximum DLA (43.17 %). Highest paddy yield of 4.32 t ha⁻¹ was recorded where rice was fertilized @ 75 kg N + 100 kg K ha⁻¹, while the minimum paddy yield of 2.40 t ha⁻¹ was obtained where only 75 kg K ha⁻¹ was applied. Optimum fertilization @ 75 kg N + 100 kg K ha⁻¹ improved the harvest index value up to 20.32 %. Minimum harvest index of 15.61 % was obtained where K alone was applied at the rate of 100 kg ha⁻¹. Maximum gross income (Rs.154652 ha⁻¹), net return (Rs.154652 ha⁻¹), and BCR (1.32) were obtained where rice crop was fertilized @ 75 kg N and 100 kg K ha⁻¹.

Keywords: Rice BLB, Potash, Nitrogen, yield attributes.

INTRODUCTION

Rice is an important cereal crop and nearly more than half population of the world subsists on it. It is the third largest crop in Pakistan after wheat and cotton. Rice is grown on an area of 2.88 million hectares with a total production of 6.88 million tons an average yield of 2.38 t ha⁻¹. It accounts for 4.4 % of value contributed in agriculture and 0.9 % in GDP (GOP, 2010).

Despite higher potential, average yield of rice in Pakistan is 2.38 t ha⁻¹ which is lower than most of the countries of world. This low production is attributed to delayed

Submitted: February 24, 2017

Revised: June 07, 2018

Accepted for Publication: June 20, 2018

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sowing, low plant population, imbalance fertilizer use and disease attack especially Rice blast and Bacterial leaf blight (Chaudhary *et al.*, 2009, Ou, 1985). The bacterial leaf blight causes great losses wherever rice is grown. The disease is reported to induce 50% or even greater losses in severe cases. Losses in the tropical Asia varied 2-74% depending upon location, weather conditions, crop stage and cultivar (Davierwala *et al.*, 2001).

Much work has been done to control the diseases through chemicals and antibiotics (Mary and Mathew, 1983). Effective control of the disease had not been achieved by chemical methods (Reissing *et al.*, 1986). Under prevailing conditions commercial resistant varieties are generally scarce and current varieties are susceptible to these diseases thus reducing their potential due to disease attack. Cultural practices such as fertilizer rate, sowing time and irrigation etc. played an

important role for the management of these diseases (Kurschner *et al.*, 1992, Long *et al.*, 2000 and Myint *et al.*, 2007). So, there is a need to emphasize over the cultural techniques for the effective management of these diseases.

The plant diseases are influenced by specific genotype, fertilizer input and climatic conditions, which vary yearly (Krupinsky *et al.*, 2007). Different plant nutrients and their balanced use play a significant role in reducing pest and disease infestation, which results in higher returns through enhanced yields and better quality (Magnen, 2008). The cultural control may include the alteration of N and K levels, and investigating the appropriate levels for the control of these diseases. Optimum fertilization of N and K induces tolerance in plants and minimize the disease incidence.

It is a fact that excessive N application predispose plants to disease caused by obligatory parasitic pathogens (Gothoskar *et al.*, 1995). Sharma (2007) reported that excessive use of N fertilizers could result in more leaf growth that was over succulent and more susceptible to certain diseases. It was found that BLB incidence considerably increased by enhancing the rate of N fertilizer (Matho and Ganguly, 2001).

The role of K is very important regarding the disease control. The potassium aggregate increases the vigor and the resistance of the plant to stress. It fortifies the straw, enhances the quality of grains and helps the transfer of starch, sugars and oils. K strengthens the plant leaf cells and K deficiency in leaf cells makes them weak and susceptible to secondary fungal infection (Harris, 1997). Sufficient K nutrition increases cell cuticle thickness, cell

wall strength and production of phenols that ultimately implant resistance in crops (Jayasena and Brennan, 2007). Potassium fertilization greatly affected panicle blast development, the response being significantly linear and negative with increasing levels of K₂O (Prabhu *et al.*, 1999). Thus disease incidence can be lowered by high K levels (Tajani *et al.*, 1993; William *et al.*, 2001). However, in Pakistan K use is only about 2 kg ha⁻¹ (GOP, 2010).

MATERIALS AND METHODS

The research trial was conducted to study the influence of N and K levels on the severity of BLB at Rice Research Institute (RRI), Kala Shah Kaku, Lahore during the year 2010. The experiment was laid out in a Randomized Complete Block Design in factorial arrangement with three replications using net plot size of 2.25 m × 6.0 m. The experiment was comprised of 0, 75, 100, 125 kg N ha⁻¹ and 0, 50, 75, 100 kg K ha⁻¹. Thirty days old nursery of Super Basmati was transplanted manually in puddle field on 16th July 2010. Whole of the phosphorus @ 75 kg P ha⁻¹ and Zinc was applied at the time of soil preparation. Whole of the K was added to the plots just before transplanting of nursery according to respective treatments. N was added in two splits i.e. 1/2 was applied just after transplantation of nursery and 1/2 half dose was applied 30 DAT. Machete 60EC was applied (2 t/ha) to control weeds just after four days of transplanting. The remaining (fallow) weeds were controlled manually. ZnSO₄ (35%) was applied @ 12.5 kg/ha at 12 DAT. Rice was inoculated with *Xanthomonas oryzae* pv. *oryzae* following clipping method at tillering and heading stage. Data regarding BLB incidence was analyzed according to the following disease rating scales developed by IRRI (IRRI system, 1996) Table 1.

Table 1. Disease rating scale for BLB of rice.

Percent area	Response	Ranking
0%	Highly resistant	0
0-1%	Resistant	1
1-5%	Moderately resistant	3
6-25%	Moderately susceptible	5
26-50%	Susceptible	7
51-100%	Highly susceptible	9

Percent disease incidence will be calculated according to the formula as follows:

$$\text{Disease Incidence (\%)} = \frac{\text{Total lesion area}}{\text{Total leaf length}} \times 100$$

The data obtained were analyzed statistically by using Fisher

analysis of variance technique and difference among treatment means was compared by using least significant difference test (LSD) at 5% probability level. The differences were only considered when significant at p<0.05.

RESULTS AND DISCUSSION

Disease incidence (%): Data regarding the appearance of

BLB of rice is presented in Table 2. Data revealed that interaction of N and K regarding the incidence of BLB of rice

was statistically significant. The N and K also had significant effect on incidence of BLB.

Table 2. Effect of N and K levels on BLB percentage leaf infection.

Treatment	N0 0 kg/ha	N1 75 kg/ha	N2 100 kg/ha	N3 125 kg/ha	Mean
K0, 0 kg/ha	35.27a	15.76c	25.89b	31.06ab	26.99b
K1, 50 kg/ha	30.20b	24.13b	27.82b	43.17a	31.33a
K2, 75 kg/ha	27.17a	23.07a	26.33a	27.00a	25.89b
K3, 100 kg/ha	28.10a	21.22b	22.33b	33.73a	26.35b
Mean	30.18b	21.05d	25.59c	33.74a	

LSD value for N = 3.41

LSD value for interaction= 6.837

LSD value for K = 3.41

Percent diseased leaf area (% DLA) increased significantly when assessed in the interaction of N and K. At zero kg K level, the zero kg N ha⁻¹ and 125 kg N ha⁻¹ produced statistically similar percent diseased leaf area (% DLA) i.e. 35.27 and 31.06 % respectively, followed by 25.89 % at 100 kg N ha⁻¹, and the minimum percent diseased leaf area (% DLA) of 15.76 % was obtained at 75 kg N ha⁻¹. The maximum percent diseased leaf area (DLA) of 43.17 % was attained at 125 kg N ha⁻¹ at 50 kg K level, whereas 0, 75 and 100 kg N ha⁻¹ produced statistically at par percent diseased leaf area (% DLA) i.e. 30.20, 24.13 and 27.28 % respectively. Percent diseased leaf area (% DLA) showed no response to N fertilization from 0-125 kg N ha⁻¹ at 75 kg K ha⁻¹. On the other hand, at 100 kg K level, the zero and 125 kg N ha⁻¹ gave highest percent diseased leaf area (% DLA) of 28.10 and 33.73 %, followed by 75 kg N ha⁻¹ and 100 kg N ha⁻¹ which gave 21.22 and 22.33 % DLA respectively.

The % DLA showed a parabolic trend to various N fertilization levels at zero kg K ha⁻¹ i.e. more where no N was applied, decreased by 55 % when N application was made at the rate of 75 kg N ha⁻¹ and again increased by 11.9-26.6 % at 100-125 kg N ha⁻¹ against control (0 kg N ha⁻¹). At 50 kg K level, the percent diseased leaf area remained unaffected with N fertilization from zero to 100 kg N ha⁻¹, however percent diseased leaf area (% DLA) reaches at its maximum at 125 kg N/ ha. On the other hand, percent diseased leaf area (% DLA) remained unaffected with any rate of N at 75 kg K level. The percent diseased leaf area (% DLA) once again showed a parabolic trend at 100 kg K level where comparatively high percent diseased leaf area (% DLA) was recorded in

treatment with out N fertilization and it decreased by 24.48 % at 75 kg N level. A further increase of N fertilization by 25 kg N ha⁻¹ (i.e. 100 kg N ha⁻¹) did not contributed any way to percent diseased leaf area (% DLA). However when N fertilization was increased upto 125 kg N ha⁻¹ the percent diseased leaf area (% DLA) again increased by 33 %. Percent diseased leaf area (% DLA) varied differently in relation to N fertilization at different K rates. Irregular trend was seen at different K levels however 75-100 kg N ha⁻¹ gave lower percent diseased leaf area (% DLA) as compared to control and 125 kg N ha⁻¹. Based on results it was deduced that BLB could be minimized by a better combination of N and K rather to apply these nutrients in a haphazard manner. So for better management of disease a balanced combination of N and K should be applied. Prabhu *et al.*, (1999) also suggested that K:N ratio is more important then the effect of each nutrient in blast development.

Paddy yield (t ha⁻¹): Paddy yield enhanced significantly when assessed by the interaction of N and K. Results showed (Table 3) that at zero to 50 kg K ha⁻¹ the yield depicted similar trend to N fertilization. The minimum yield was recorded at zero kg N ha⁻¹ and an increase of 32-36 % was recorded at 75 kg N ha⁻¹. A further increase of 25 kg N ha⁻¹ did not contribute to yield, whereas increase in N fertilization up to 125 kg N resulted in decline of yield.

Treatments with 75 and 100 kg K ha⁻¹ showed similar trend to N fertilization where the minimum yield was recorded in treatment with zero kg N ha⁻¹, and an increase of 41-44 % was recorded when applied with 75 kg N ha⁻¹. After 75 kg N ha⁻¹ every increase in 25 kg N resulted in decline of yield and this decline was recorded 7-12 % at 100 kg N and 18-19 % at 125 kg N as compared with 75 kg N ha⁻¹.

Table 3. Effect of N and K levels on paddy yield (t ha⁻¹)

Treatment	N0 (0 kg/ha)	N1 (75 kg/ha)	N2 (100 kg/ha)	N3 (125 kg/ha)	Mean
K0, 0 kg/ha	2.44c	3.62a	3.68a	3.14b	3.22c
K1, 50 kg/ha	2.47c	3.89a	3.83a	3.25b	3.36bc
K2, 75 kg/ha	2.40d	4.09a	3.79b	3.34c	3.40ab
K3, 100 kg/ha	2.51d	4.32a	3.80b	3.48c	3.53a
Mean	2.46d	3.98a	3.78b	3.30c	

LSD value for N = 0.14

LSD value for interaction= 0.281

LSD value for K = 0.14

Results indicated a marked increase in yield from zero kg N ha⁻¹ to 100 kg N ha⁻¹. This increase in yield was attributed to more number of panicle bearing tillers, more 1000 kernel weight and more number of kernels per panicle at 75 and 100 kg N ha⁻¹. This increase in yield was supported by

Chaurasia and Duvellier (2006), they found an increase in yield with increased N rates. Tajani *et al.* (1993) and Myint *et al.* (2007) also observed an increase in yield with increasing N fertilization. However, there was a significant decrease in yield at 125 kg N ha⁻¹ irrespective of different K levels. This decrease in yield may be due to high disease percentage. However, it was found no correlation between N uptake and yield of rice. Similarly,

Chaudhary *et al.* (2009) showed an increase in yield up to 85 kg N ha⁻¹ beyond this level decrease in yield was attributed to accumulative effect of N toxicity and disease severity. The yield also displayed a positive increase with increase in K fertilization. These results were advocated by Jayasena and Brennan (2007) and Adejumo (2010) they explained that potassium fertilization increased the yield over the control.

Table 4 Economic analysis of different application rates of N and K

	Yield t ha-1	Value Rs. ha-1	Straw yield t ha-1	Value Rs. ha-1	Gross income Rs. ha-1	Variable cost Rs. ha-1	Total Cost Rs.ha-1	Net Return. Rs. ha-1	Benefit cost ratio
T1:N1×K1	2.44	79408	13.0	11011	90420	7941	93252	-2832	0.97
T2:N1×K2	2.47	80167	13.1	11138	91305	15667	100978	-9673	0.90
T3:N1×K3	2.40	78000	12.9	10956	88956	19275	104586	-15630	0.85
T4:N1×K4	2.51	81683	13.6	11530	93214	23468	108779	-15566	0.86
T5:N2×K1	3.62	117758	16.8	14312	132071	14628	99939	32131	1.32
T6:N2×K2	3.89	126533	17.2	14643	141176	23156	108467	32709	1.30
T7:N2×K3	4.09	132925	16.8	14287	147212	27620	112931	34281	1.30
T8:N2×K4	4.32	140292	16.9	14360	154652	32182	117493	37159	1.32
T9:N3×K1	3.68	119600	16.4	13926	133526	15766	101077	32449	1.32
T10:N3×K2	3.83	124583	16.7	14226	138810	23915	109226	29584	1.27
T11:N3×K3	3.79	123067	17.2	14653	137719	27588	112899	24820	1.22
T12:N3×K4	3.80	123608	16.8	14295	137904	31467	116778	21126	1.18
T13:N4×K1	3.14	102158	15.9	13528	115686	14967	100278	15408	1.15
T14:N4×K2	3.25	105733	15.8	13431	119164	22975	108286	10878	1.10
T15:N4×K3	3.34	108550	16.2	13749	122299	27081	112392	9907	1.09
T16:N4×K4	3.48	113100	16.9	14339	127439	31361	116672	10767	1.09

Fixed cost Rs. per ha⁻¹ = 85311.0

Paddy price Rs. per 40 kg= 1300.0

N₁: 0 kg N ha⁻¹ = 0 bags of Urea

N₂: 75 kg N ha⁻¹ = 3.26 bags of Urea

N₃: 100 kg N ha⁻¹= 4.35 bags of Urea

N₄: 125 kg N ha⁻¹= 5.43 bags of Urea

Straw price Rs. per ton = 850.0

Paddy price per kg = 32.5

K₁: 0 kg K ha⁻¹ = 0 bags of K-Sulphate

K₂: 50 kg K ha⁻¹ = 2 bags of K-Sulphate

K₃: 75 kg K ha⁻¹ = 3 bags of K-Sulphate

K₄: 100 kg K ha⁻¹= 4 bags of K-Sulphate

ECONOMIC ANALYSIS

The effectiveness of any production system is ultimately evaluated on the basis of its economics. Economic analysis is criteria for basic determination of net benefits. The economic analysis for different N and K rates is essential to evaluate results from farmer point of view as they are more interested in net return or benefit. In the economic analysis of present study price of inputs and outputs prevailing in the local market of Faisalabad (Pakistan) was used to calculate the budget of treatments (Table 4).

The gross income was calculated by adding paddy and straw yield values per hectare. Paddy price was Rs. 32500 ton⁻¹ and straw price of Rs. 700 ton⁻¹. The complete budget (2010) presented in Table 4.16 revealed that application of 75 kg N and 100 kg K ha⁻¹ gave maximum net returns amounting Rs. 37159, whereas the highest cost benefit ratio (BCR) of 1.32 was obtained in treatments T8 (75 kg N and 100 kg K ha⁻¹) and T9 (100 kg N and 0 kg K ha⁻¹). The production level at T 8 is favored for lower disease severity.

CONCLUSION

BLB responded significantly to different levels of N and K fertilizers. Both deficiency and excessive use of N promoted disease severity. Lower diseased leaf area (% DLA) was observed where N was applied at the rate of 75-100 kg ha⁻¹. Results revealed that balanced nutrition is required to manage the BLB problem. As the rate of N fertilizer was increased the demand for potassium also increased. Super Basmati gave best paddy yield, highest harvest index value, higher gross income, maximum net returns, higher benefit cost ratio and provide more protection against BLB when fertilized @ 75 kg N & 100 kg K ha⁻¹.

REFERENCES

Adejumo, C. O. 2010. Promoting artistic and cultural development through service learning and critical pedagogy in a low-income community art program. *Visual arts research*, 36: 23-34.

Chaudhary, S. U., M. Hussain, J. Iqbal and M. A. Ali. 2009. Effect of nitrogen doses on incidence of bacterial

leaf blight in rice. *Journal of Agricultural Research*, 47.

Davierwala, A., A. Reddy, M. Lagu, P. Ranjekar and V. Gupta. 2001. Marker assisted selection of bacterial blight resistance genes in rice. *Biochemical genetics*, 39: 261-278.

GOP. 2010. Economic survey of Pakistan, 2010. Ministry of Food, Agriculture and Livestock Division (Economic Wing). Islamabad, pp. 22-23.

Gothoskar, S. S., R. P. Scheffer, J. C. Walker and M. A. Stahmann. 1995. The role of enzymes in the development of Fusarium wilt of tomato. *Indian Phytopathology*: 381-387.

Harris, G. 1997. Potassium deficiency in cotton linked to leafspot disease. *Better Crops*, 81: 10-11.

IRRI. 2004. International Rice Research Institute "Rice", Almanac. 3rd Edition ed. Int. Rice Res. Inst, Los, Banos, Philippines, pp. 59-235.

Jayasena, K. and R. Brennan. 2007. Potassium deficient barley is more susceptible to powdery mildew disease.

Krupinsky, J. M., D. L. Tanaka, S. D. Merrill, M. A. Liebig, M. T. Lares and J. D. Hanson. 2007. Crop Sequence Effects on Leaf Spot Diseases of No-Till Spring Wheat. *Agronomy Journal*, 99: 912.

Kürschner, E. 1992. Effects of Nitrogen Timing and Split Application on Blast Disease in Upland Rice. *Plant Disease*, 76: 384.

Long, D. H., F. N. Lee and D. O. TeBeest. 2000. Effect of Nitrogen Fertilization on Disease Progress of Rice Blast on Susceptible and Resistant Cultivars. *Plant Disease*, 84: 403-409.

Magen, H. 2008. Balanced crop nutrition: fertilizing for crop and food quality. *Turkish Journal of Agriculture and Forestry*, 32: 183-193.

Mary, C. and J. Mathew. 1983. Chemical control of bacterial leaf blight of rice using antibiotics. *Agricultural Research Journal of Kerala*, 21: 17-20.

Matho, R. and D. Ganguly. 2001. Heterosis and combining ability studies in maize. *Journal of Research*, 13: 197-199.

- Myint, S. S., K. M. Nyunt, H. K. Ko and M. M. Thein. 2007. Study on the Effect of Different Urea Fertilizer Rates and Plant Populations on the Severity of Bacterial Blight (BB) of Rice. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS)*, 108: 161-167.
- Prabhu, A. S., M. P. Barbosa Filho, M. C. Filippi and F. J. P. Zimmermann. 1999. Relationship between potassium fertilization and panicle blast severity in upland rice. *Pesquisa Agropecuária Brasileira*, 34: 1729-1732.
- Reissing, W., E. Heinrich, I. Listinger and A. Barrian. 1986. *Illustrated Guide to Integrated Pest Management in Rice*. Tropical Asia IRRI, Manila Philippines.
- Sharma, P. 2007. *Vegetables: Disease, Diagnosis and Biomanagement*. Aavishkar Publishers, Distributors.
- Steel, R., J. Torrie and D. Dickey. 1997. *Principles and Procedures of Statistics. A Biometrical Approach*. 3rd Ed ed. McGraw Hill Book Co, New York.
- Tajani, M., A. Douira, N. Haloui and R. Benkirane. 1993. Impact of fertilization on disease development and yield components. *Cahiers Options Mediterraneennes*, 3: 95-99.
- Waller, J. M. 1987. *Rice Diseases*. By S. H. Ou Slough, UK: Commonwealth Agricultural Bureaux (1985) 2nd ed., pp. 380, UK £38.00, USA \$70, elsewhere £41.00. *Experimental Agriculture*, 23: 357.
- Williams, J. and S. G. Smith. 2001. Correcting potassium deficiency can reduce rice stem diseases. *Better crops*, 85: 7-9.
- Wu, J. R. X. and R. Härdter. 2000. Balanced plant nutrition may help reduce pesticide use by improving tea plants' resistance to fungal diseases.