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EFFECT OF NITRIFICATION INHIBITORS ON RICE PROTEIN[1]

KEY WORDS: Karanjin, Nitrapyrin, nitrification inhibitors, inhibition of nitrification, rice protein

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ABSTRACT

The effects of ammonium sulfate and urea nitrogen (150 kg N/ha) applied with three levels (5, 10 and 15% of N) of the nitrification inhibitors karanjin and nitrapyrin on grain protein of rice (Oryza sativa L. cv. Bala) were studied in pot experiment. Karanjin at the 10 and 15 per cent levels and nitrapyrin at the 10 per cent level significantly increased grain protein. Rice protein levels were highest at the 15 per cent karanjin level.

INTRODUCTION

Nitrification inhibitors have been used for increasing the efficiency of fertilizer nitrogen for various crops under situations where losses of applied nitrogen by denitrification and leaching are high[3,4]. These chemicals, when applied with ammoniacal fertilizer, partially check nitrification and help in minimizing the subsequent loss.

The effectiveness of nitrogen fertilizers in increasing rice protein has been recognized[5-7]. However, little has been reported about the effects of nitrification inhibitors on rice protein. In an earlier communication[8], we reported that karanjin, a nitrification inhibitor developed in our laboratory, significantly increased yield and nitrogen uptake by rice when used in conjunction with ammonium sulfate and urea nitrogen. The effectiveness of karanjin and nitrapyrin were equal in both laboratory and greenhouse experiments with rice crops[8]. This paper reports the influence of fertilizers amended with karanjin and nitrapyrin on the protein content of rice grains.

MATERIALS AND METHODS

The nitrification inhibitors used in this study were karanjin (3-methoxy flavono- (7:8-2':3') furan), the major furanoflavonoid from the Pongamia glabra seeds and nitrapyrin (2-chloro-6-(trichloromethyl)pyridine), a product of Dow Chemical Co., U.S.A.

Rice plants were grown in 16 l glazed pots (35 cm height, 25 cm dia) in a sandy loam soil (pH 7.7, total N 0.07%), air dried and passed through a 5 mm sieve, under greenhouse conditions. The other physicochemical properties of the soil are reported elsewhere[8] Ammonium sulfate and urea were applied at a rate of 150 kg N/ha. Karanjin and nitrapyrin were added to each fertilizer at three rates of 5, 10 and 15 per cent of the nitrogen rate. Nitrogen was applied with 60 kg P and 60 kg K/ha to the soil as basal application. Controls without the inhibitors were included giving total 16 treatments replicated three times in a randomized complete block design.

Each respective fertilizer treatment and inhibitor level were mixed with 10 kg of soil and placed in pots, submerged, and soil manually puddled. Five three-week old seedlings of rice ('Bala' variety) were transplanted in each pot. The pots were maintained under submerged conditions (5-6 cm standing water) throughout the growing season, then plants harvested at maturity and dried at 60°C. The protein content of rice grains were obtained by multiplying the total nitrogen, determined by the Kjeldahl method[9] by a factor of 6.25. The protein content is expressed on a 12 per cent moisture basis.

Soil samples were collected from each pot after harvest. The samples were air dried, screened and analyzed for NH_4^+, NO_2^- - and NO_3^- nitrogen by the procedure described by Sahrawat and Prasad[10].

RESULTS AND DISCUSSION

The results (Table 1) show that the protein content varied from 7.41 to 8.84 per cent. The highest protein was realized with 15 per cent karanjin and the lowest with 5 per cent nitrapyrin when ammonium sulfate supplied the nitrogen source. Ammonium sulfate and urea nitrogen had similar effects on the rice grain protein content.

The 10 and 15 per cent levels of karanjin and the 10 per cent level of nitrapyrin significantly improved the rice protein content with both ammonium sulfate and urea. With increases in the karanjin level from 5 to 15 per cent, the grain protein was also increased with both ammonium sulfate and urea. However, no such trend was observed with nitrapyrin, with the only effect being realized at the 10 per cent level. The results further indicate that the

TABLE 1

Effect of karanjin and nitrapyrin treatments on rice grain protein.

Treatment	With ammonium sulfate *Protein content (%)	With Urea
No inhibitor	7.76 ab	7.67 a
5% karanjin	7.99 bc	7.81 a
5% nitrapyrin	7.41 a	7.52 a
10% karanjin	8.28 c	8.34 b
10% nitrapyrin	8.22 c	8.60 b
15% karanjin	8.84 d	8.54 b
15% nitrapyrin	8.05 bc	7.56 a

*Means followed by a common letter within a column are not significantly different at the 5% level based on Duncan's New Multiple Range Test.

performance of karanjin in increasing the grain protein was either better or at least equal to that of nitrapyrin at all levels.

The results of this study support our earlier report in which we observed that karanjin and nitrapyrin effectively inhibited the nitrification of ammonium sulfate and urea nitrogen (laboratory experiments) with a concurrent increase in grain yield and nitrogen uptake of rice plants (pot-culture experiment)[8]. This increase in grain protein observed may be due to conservation of ammonium nitrogen by these inhibitors, resulting in increased nitrogen uptake by plants due to the greater availability of the nitrogen. Increased nitrogen

uptake by rice crop due to incorporation of nitrapyrin with ammoniacal fertilizers has been reported[8,11,12]. Sahrawat and Mukerjee[8] made similar observations with karanjin. An increase in the grain protein of corn, when nitrapyrin was applied with ammonia has been reported by Warren et al.[13] and is supportive of the present finding for rice. The conservation of ammonium nitrogen in the soil due to application of the nitrification inhibitors is further indicated by analysis of the soil samples (Table 2). A perusal of data would bring out that there were no differential effect due to ammonium sulfate and

TABLE 2

Effect of karanjin and nitrapyrin on ammoniacal and nitrate nitrogen in soil after harvest of rice crop.

Treatment	Inorganic N in soil* (ppm)			
	With ammonium sulfate		With urea	
	NH_4^+-N	NO_3^- - N	NH_4^+-N	NO_3^- - N
No inhibitor	6.60 c	7.90 a	6.50 c	7.45 a
5% karanjin	9.45 b	7.00 b	9.35 b	6.90 b
5% nitrapyrin	9.55 ab	6.20 c	9.40 b	6.70 b
10% karanjin	9.50 b	7.00 b	9.66 b	5.90 c
10% nitrapyrin	9.87 ab	6.12 c	9.80 ab	6.00 c
15% karanjin	10.10 a	6.32 c	10.30 a	6.00 c
15% nitrapyrin	10.00 ab	6.12 c	10.25 a	5.75 c

*In each column means followed by a common letter are not significantly different at 5% level.

urea on residual inorganic nitrogen. Nitrite could not be detected other than in minute traces in any soil sample. The soils with fertilizer plus inhibitor treatments revealed significantly higher amounts of ammoniacal nitrogen than those treated with fertilizers alone (Table 2). The highest amounts of ammonium nitrogen was recovered from 15 per cent karanjin and nitrapyrin treatments with both urea and ammonium sulfate. There was no significant difference in the residual ammonium nitrogen either due to the fertilizers or their combinations with the corresponding levels of karanjin and nitrapyrin.

The nitrate contents of the soil samples receiving the inhibitors were found to be significantly lower than the untreated fertilizer treatments as is evident from the results shown in Table 2. The lowest amount of nitrate was observed with 15 per cent karanjin and nitrapyrin treatments. With urea, there was no significant difference between karanjin and nitrapyrin treatments but with ammonium sulfate, nitrapyrin showed significantly lower amounts of nitrates at 5 and 10 per cent levels than the corresponding karanjin treatments however, there was no difference at 15 per cent levels of the inhibitors.

These results show that there was conservation of the fertilizer nitrogen when this was treated with the nitrification inhibitors karanjin and nitrapyrin, which resulted not only in the better protein content in rice grains but also left the soil with higher amounts of inorganic nitrogen after harvest of the crop. The findings of this study also further tend to suggest that the use of nitrification inhibitors like karanjin and nitrapyrin may help in improving the grain quality of rice and this aspect mertis further research.

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