Indian J. Plant Physiol., Vol. 10, No. 2, (N.S.) pp. 196-198 (April-June, 2005)

SHORT COMMUNICATION

NITROGEN ASSIMILATION POTENTIAL, PERIODIC NITRATE REDUCTASE ACTIVITY AND ITS RELATIONSHIP TO GRAIN PROTEIN IN FIELD GROWN RICE IN PRESENCE OF BUTACHLOR

NEELAM SHARMA* AND RUCHI

Department of Agronomy, CSK – Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176062

Received on 18 Nov., 2004, Revised on 15 July, 2005

Effect of butachlor on nitrate reductase activity, nitrogen and protein content in the leaves at different stages of growth and protein content in grains was examined in rice variety RP-2421. The butachlor was applied at three concentrations, viz. 1.5 kg ha^{-1}, 2.0 kg ha^{-1} and 2.5 kg ha^{-1} four days after transplanting (4 DAT) alongwith hand weeding (30 DAT and 60 DAT) and weedy check. At all the stages of development, hand weeding twice (30 DAT and 60 DAT) and butachlor 1.5 kg ha^{-1} being statistically at par maintained their superiority in increasing nitrate reductase activity, nitrogen content and protein content in rice leaves over all other treatments. Irrespective of the treatments nitrate reductase activity, nitrogen content and protein content in rice leaves increased up to 30 days and declined thereafter to minimal level up to 90 days. A positive correlation was observed in nitrate reductase activity and grain protein and in leaf protein and grain protein.

***Key words:*Butachlor, nitrate reductase activity, protein content, rice**

Nitrate reductase activity is closely related to the protein producing potential of a plant. Hageman and Flesher (1960) observed a positive correlation between nitrate reductase activity, growth and protein content of different cultivars of corn. Herbicides are commonly used for weed control in various crops. There are some reports that herbicide stimulate plant enzymes and other metabolic functions including the activity of nitrate reductase enzyme (Tweedy and Ries 1967, Mohan Dass *et al.* 1978, Lablova *et al.* 1981). Information on this aspect in crop plants under field conditions is rather meagre. In light of above facts, the present study was undertaken to find out effect of butachlor on nitrate reductase activity and nitrogen content in rice leaves and grain protein.

An experiment consisted of five treatments, i.e. butachlor 1.5 kg ha^{-1}, 2.0 kg ha^{-1}, 2.5 kg ha^{-1}, handweeding twice (30 DAS and 60 DAS) and weedy check was conducted in *Kharif* season (July-Oct) of 2002 at the Agronomy Farm of CSK HPKV, Palampur. Thirty days old rice (var. RP-2421) seedlings were transplanted at a spacing of 20cm x15cm . Fertilisers (N, Pand K) were applied as per standard recommended doses. The treatments were replicated four times. Just as the standing water receded down after 4 days of transplanting of rice, butachlor was sprayed at rate of 1.5 kg ha^{-1}, 2.0 kg ha^{-1} and 2.5 kg ha^{-1}. Fresh leaves were collected immediately after spray and thereafter at monthly interval after herbicide application. Grains were harvested at maturity. Collected fresh leaves were used for estimating nitrate reductase activity just after picking. Nitrogen content in leaves and protein content in grains were estimated in oven-dried samples. Nitrate reductase activity was assayed *in vivo* according to method of Nicolas and Nason (1957). Nitrogen in dried crop material and in rice grains was estimated by Snell and Snell (1955) method.

* Corresponding author.

The data presented in Table 1 revealed that the nitrate reductase activity, nitrogen content and protein content were affected significantly by different treatments at all the stages of observation except on the day of herbicide application. At all the stages of development, hand weeding twice (30 DAT and 60 DAT) and butachlor 1.5 kg ha^{-1} being statistically at par maintained their superiority in increasing nitrate reductase activity, nitrogen content and protein content in rice leaves over all other treatments. Irrespective of treatments, nitrate reductase activity, nitrogen and protein content in leaves increased up to 30 and decreased thereafter up to 90 days. Butachlor 1.5 kg ha^{-1} (4 DAT) increased NRA, nitrogen content and in turn protein content in leaves of rice significantly over other butachlor treatments. Enhanced nitrate reductase activity in butachlor (1.5 kg ha^{-1}) treated plants might be due to less crop weed competition and moderate condition of stress for crop plants, which led to the increase in enzyme levels (Mengel and Kirkby 1987) and ultimately increase in protein synthesis. A similar behaviour of enhancement in nitrate reductase activity has also been reported in rice leaves by butachlor application at the rate of 1.0 kg ha^{-1} (Deka *et al.* 1996). Butachlor 2.5 kg ha^{-1} resulted in minimum nitrate reductase activity, nitrogen content and protein content both at 30 and 60 days after herbicide application. Decrease can be well explained by several reports indicating toxicity at higher doses of butachlor (Zhang and Tang 1991 and Singh *et al.* 1996) and inhibition of protein synthesis by chloroacetamide herbicide to which butachlor belongs has also been reported by other workers (Noreil 1981, Omokaro and Ajakaiye 1989, Ndahi and Bendixen 1992, Wang *et al.* 1995). At 90 days after herbicide application an increase in NRA value, higher nitrogen and protein content in butachlor 2.5 kg ha^{-1} over weedy check might be due to recovery of crop plant from initial state of stress. So, it can be inferred from above behaviour that effect of higher dose of butachlor on nitrate reductase activity, nitrogen and protein content was temporary and recovered with passage of time and thus suggesting that higher dose of butachlor caused slight suppression in synthesis of NRA, nitrogen and protein content.

The data on the effect of different treatments on grain protein showed the maximum increase by butachlor 1.5 kg/ha and handweeding twice (30DAT and 60 DAT). However, weedy check resulted in least protein content in grains. NRA has the biochemical characteristics which suggest that reaction is rate limiting step of nitrogen metabolism. This consideration forms the basis of hypothesis that plants with more nitrogen uptake and

Table 1. Effect of different treatments on nitrate reductase activity (µmol NO_2^- g^{-1} fw h^{-1}), nitrogen content (mg g^{-1} dry w), protein content (mg g^{-1} dry w) in leaves at different growth stages and protein content (%) in grains of rice var. RP-2421.

Treatments	Days after herbicide application												Protein content
	Nitrate reductase activity				Nitrogen content				Protein content				
	0	30	60	90	0	30	60	90	0	30	60	90	(%)
Butachlor 1.5 kg ha^{-1} (4 DAT)	3.056	3.158	2.170	1.857	29.32	47.33	13.56	7.27	183.24	295.83	84.75	45.46	9.34
Butachlor 2.0 kg ha^{-1} (4 DAT)	3.044	3.118	2.128	1.794	29.50	47.07	13.02	6.93	184.35	294.17	80.63	43.32	8.84
Butachlor 2.5 kg ha^{-1} (4 DAT)	3.044	3.060	2.109	1.778	29.10	43.65	12.44	6.80	181.85	272.80	77.72	42.47	8.22
Two handweeding (30 DAT and 60 DAT)	3.046	3.186	2.166	1.872	29.11	47.13	13.47	7.44	181.91	294.58	84.74	46.51	9.15
Unweeded	3.044	3.085	2.116	1.759	29.10	46.40	12.53	5.63	181.85	289.97	78.28	35.19	8.14
CD (5%)	NS	0.029	0.012	0.025	NS	0.40	0.40	0.18	NS	2.47	2.52	1.12	0.13

DAT=Days after transplanting.

higher NRA should possess a greater potential for accumulating nitrogen in the form of protein. Accumulation of protein in cereals grains involves translocation of nitrogen from vegetative parts particularly leaves. This relationship is quite evident from Table 1. As vegetative growth begins,total nitrogen content in leaves decreased with advancement of crop age and decrease was maximum from 30 to 60 days and this period corresponds to accumulation of protein in cereal grains. The behaviour of nitrogen content in leaves clearly supports this translocation of nitrogen from leaves to reproductive parts. From the above studies a positive association was observed in nitrate reductase activity and grain protein; and in leaf protein and grain protein.

REFERENCES

Deka, S.C., Gogoi, A.K. and Pathak, D. 1996. Effect of herbicides on chlorophyll content and nitrate reductase activity in relation to grain protein yield and grain yield of rice *(Oryza sativa* L.). *Ann. Agric. Bio. Res.* **1**: 107-111.

Hageman, R.H. and Flescher, D. (1960). Nitrate reductase activity in corn seedlings as affected by light and nitrate content of nutrient media. *Plant Physiol*. **35** : 700-708.

Lablova, S., Cerovska, N. and Cerna, V. (1981). The effect of herbicides on the activity of pea alcohol dehydrogenease *Biochem. Physiologic der Pflazen.* **176** : 283-285.

Mengel, K. and Kirkby, E.A. (1987). Principles of Plant Nutrition. Panima Publishing Corporation, New Delhi.

Mohandass, S. , Wallace, W. and Nicolos, D.J.D. (1978). Effect of atrazine on the assimilation of inorganic in cereals. *Phytochem.* **17** : 1021-1028.

Ndahi, W.B. and Bendixen, L.E. (1992). Effect of some selected chloroacetamide herbicides and herbicide antedates on protein content and ^{14}C-leucine incorporation in sorghum, maize and pearl millet seedlings. *Samarau J. Agric. Res.* **9** : 77-85.

Nicholas, D.J.D. and Nason, A. (1957). Determination of nitrate and nitrite. In: P.S. Colowick and O.N. Kaplan (eds.), Methods of Enzymology, Vol. III pp. 981-984. Academic Press Inc. Pub., New York.

Noreil, L.M. (1981). Effect of butachlor on protein content of C-168 and IR-36 rice cultivars at different growth. *Ann. Trop. Res*. **3**: 111-116.

Omokaro, D.N. and Ajakaiye, C.O. (1989). Effect of soil applied herbicides on leaf nitrate reductase and crude protein in leaf and seed of two cowpea cultivars. *Plant Soil* **116**: 141-146.

Pandey, M. and Srivastava, G.P. (1985). Nitrate reductase activity in wheat leaves as influenced by herbicide application and its relationship with grain protein content. *Indian J. Agric. Chem.* **18** : 239-245.

Snell, F.D. and Snell, C.T. (1955). Determination of Total Nitrogen in Plant Material. Colorimetric Methods of Analysis, Vol 2, pp. 813-816.Van Nostrand Reinhold Company, New York

Tweedy, J.A. and Ries, S.K. (1967). Effect of simazine on nitrate reductase activity in corn. *Plant Physiol.* **42** : 280-282.

Wang, Y.S., Chen, Y.D., Hsieh, Y.N. and Chen, Y.L. (1995). Effect of butachlor on the biosynthesis of lipid, protein and nucleic acid in three isolated plant cells. *J. Pest. Sci.* **20**: 257-264.