INFLUENCE OF UREA ON THE CHANGE OF SOIL pH AND SEEDLING HEIGHT OF RICE

Md. Shahidul Haque[1], Md. Kamrul Hasan[1], N. M. Rahmatullah[2], Bikash C. Sarker[3] and B. S. Sultana[4]

[1]Department of Biochemistry and Molecular Biology, University of Rajshahi, Rajshahi-6205, [2]Department of Agricultural Statistics, Sher-e-Bangla Agricultural University, Dhaka, [3]Department of Agricultural Chemistry and Biochemistry, Hajee Mohammad Danesh Science and Technology University, Dinajpur, [4]SSO, SRDI, Dinajpur, Bangladesh

Accepted for publication: November 29, 2008

ABSTRACT

Haque M. Shahidul, Hasan M. Kamrul, Rahmatullah N. M., Sarker Bikash C. and Sultana B. S. 2008. ***Influence of Urea on the Change of Soil pH and Seedling Height of Rice.*** **J .Soil .Nature. 2(3)**: **46-49**

The experiment was conducted to observe the effect of urea on the changes of pH in the soil and growth of rice (BRRI Dhan-27). Urea (80 kg ha^{-1}) was applied to one of the seedlings after 20 days of germination and the soil pH and length of rice were determined after 25 days of urea application. Soil pH was gradually decreased with increase rice grown in the control seedling. However, no changes of pH were found in the urea treated seedling up to 20 days of germination and were similar to the control. The pH of soil compared to the control falls gradually with increase rice growth. Seedling height was gradually increased in both the control and urea treated seedlings from the germination. However, higher length was found in the urea treated seedling. Up to 20 days of germination of rice, no differences of seedling height in the two seedlings were observed. This findings suggests that urea is the potent compound inducing growth of rice and pH measurements indicate the period where optimum uptake of urea is happened.

Key words: Soil pH, BRRI-27, urea, plant growth

INTRODUCTION

Plant growth and development is an important feature of plant. Various factors are involved in the development of plant growth. Soil fertility because of the higher activity of soil microorganisms is also an important factor for plant growth and development. Most plants utilize urea and amino acids as N substrates and responses to these compounds vary among species. Some have evolved strategies that favor one specific substrate or a combination of substrates. Most crop species grow optimally with a mixture of ammonium and nitrate, the latter generally being the most abundant N form in freely drained aerobic soil environments (Crawford and Glass, 1998) becomes an increasingly important substrate on ammonia-fertilized soils or on poorly drained, acidic soils where nitrification by micro-organisms is limited (Rice and Pancholy, 1972). Urea has been recently used as a potent fertilizer inducing fertility and plant growth. Nitrification is the oxidation of ammonium to nitrate. In soils, the process is mediated by autotrophic and heterotrophic bacteria. The nitrification process is controlled primarily by ammonium and oxygen concentrations. The transport of ammonium by diffusion is influenced by the organic matter status and cation exchange capacity of the soil, the presence of reduced iron and manganese, the bulk density, and the rate of nitrification in the oxidized soil layer and rice rhizosphere. Biological denitrification is the dissimilatory reduction of nitrate and nitrite to produce NO, N_2O and N_2. Soil factors that strongly influence denitrification are oxygen (which is controlled primarily by soil water content), nitrate concentration, pH, temperature, and organic carbon (Peoples *et al*. 1995). The loss of soil nitrogen in various ways is compensated by the addition of urea. Recent investigation reveals that growth in response to urea is characterized by the enhanced cellular function, increased protein and carbohydrate synthesis (Nishi *et al*. 2001) as well as increased cell proliferation and differentiation. To clarify the urea induced plant growth, we measured soil pH before and after application of urea in the soil and also measured the length of rice.

MATERIALS AND METHODS

Plant Materials

In this study, we prepared seed beds grown with BRRI Dhan-27 seeds. The seeds were collected from the near by Bangladesh Rice Research Institute (BRRI), Sympur, Rajshahi, Bangladesh. For germination of seed, light, watering and other essential requirements were implied. The efficiency of germination of seeds was 99 % from the observation. Plants in the control seedling were not treated with urea while the other seedling was treated with urea (80 Kg ha^{-1}). The plants grown in the seedlings were taken care of weed control.

Determination of soil pH

20 g soil was taken in a 250 ml beaker and 50 ml distilled water was added with the soil. The contents were thoroughly stirred with magnetic stirrer for half an hour. pH of the suspension was measured with a digital pH meter. Soil pH was determined before germination of seed, 20 days after application of urea. In the control seedling, pH was determined similarly before and after germination of seeds.

Determination of seedling height

Seedling height was determined after germination and before and after 20 days of urea application. Seedling height was determined by using measuring scale in different stages of growth both in the control and urea exposed seedlings.

RESULTS AND DISCUSSION

Determination of soil pH in the seedlings before germination of seeds

Soil pH determination is an indication of the acidic or basic phase of soil. The higher pH of soil is because of the lower utilization of amino nitrogen in the plant. The optimum pH for the growth of rice is 5- 9. To examine whether the soil is suitable for the growth of rice, we determined the soil pH in the seedlings. The pH was 7.8 in the control and urea-treated seedlings which were within the normal range. The pH indicates that the amino nitrogen in the soil is suitable for growing of rice.

Determination of soil pH after germination and before urea application

Soil pH was determined in the seedlings up to twenty days from germination of seeds before urea application. Soil pH was determined by the procedure mentioned before. The results are compared with the control seedling and illustrated in Table 1. There were no differences in soil pH between two groups. However, pH was gradually decreasing from the germination of rice in the two seedlings because of their increasing growth. The results indicate that the higher utilization of amino nitrogen by rice has been taken place.

Determination of soil pH after first dose of urea application

To check whether urea changes the soil pH, we determined soil pH in the control and urea treated seedlings from 20 to 40 days after application of the first dose of urea. The results are illustrated in Table 2. The initial pH determined at 25 days was 7.1 and 7.25 for the control and urea-treated seedlings respectively. Soil pH was gradually decreasing up to 40 days of the measurement for both groups. Application of urea enhanced soil pH because of the increased production of NH_4^+ from urea.

Determination of seedling height after germination and before urea application

Seedling height gradually increased in urea treated and non-urea treated (control) seedlings. The length of rice in both, the seedlings were same. Table 3 indicates the length of rice plant in urea treated and without urea treated (control) seedlings. Measurement was taken from 5 to 20 days after germination of seeds. 15 cm, 24 cm, 28 cm and 30 cm seedling height were observed in both the seedlings. Increased seedling height in both seedlings is caused by the utilization of soil nitrogen and other nutrients. The soil nitrogen might be from the degradation of soil urea.

Determination of seedling height after first dose of urea application

Urea was applied after 20 days of germination of seeds. Seedling height was measured at 25, 30, 35 and 40 days. As shown in Table 4, seedling height gradually increased in urea treated and without urea treated (control) seedlings. However, seedling height in urea treated seedling was higher than without urea treated (control) seedling. The changes of increase in seedling height up to 40 days of observation were stimulated by urea application compared to the control. The results show that urea is the most potent fertilizer utilized in enhancing plant cellular growth.

Urease which is involved in the degradation of urea in the soil results in the release of NH_4^+ and CO_2. The higher activity of urease enhances the higher production of NH_4^+ and stimulates the increased pH of soil. The changes of soil pH are an index of utilization of soil urea to the plant cells. In our study, after application of urea, the soil pH was abruptly increased and was gradually decreasing with the increasing seedling height because of the higher utilization of NH_4^+ by the cells. In the urea induced rice seedling, growth of rice is stimulated as observed by the higher seedling height. At 25th day after application of urea, soil pH 7.25 was observed while for the control seedling, the pH was changed to 7.1. The seedling height was co-related with the pH and was 30 cm and 33 cm respectively for the control and urea induced rice (Figure 1)

Table 1. Soil pH in the control and urea-treated seedlings after germination of rice

Days after germination of rice	Soil pH in the control seedling treated without urea	Soil pH in the urea-treated seedling
Five days	7.8	7.8
Ten days	7.5	7.5
Fifteen days	7.33	7.33
Twenty days	7.15	7.15

Table 2. Soil pH after first application of urea in the seedlings

Days after germination of rice	Soil pH in the control seedling treated without urea	Soil pH in the urea-treated seedling
Twenty five days	7.10	7.25
Thirty days	7.05	7.15
Thirty five days	6.85	7.10
Forty days	6.75	7.05

Table 3. Seedling height in the control and urea-treated seedlings after germination of rice

Days after germination of rice	Length of rice(cm) in the control seedling	Length of rice(cm) in the urea-treated seedling
Five days	15	15
Ten days	24	24
Fifteen days	28	28
Twenty days	30	30

Table 4. Seedling height after application of urea in the seedlings

Days after germination of rice	Height (cm) in the control seedling	Height (cm) in the urea-treated seedling
Twenty five days	30	33
Thirty days	30.5	42
Thirty five days	33	50
Forty days	35	56

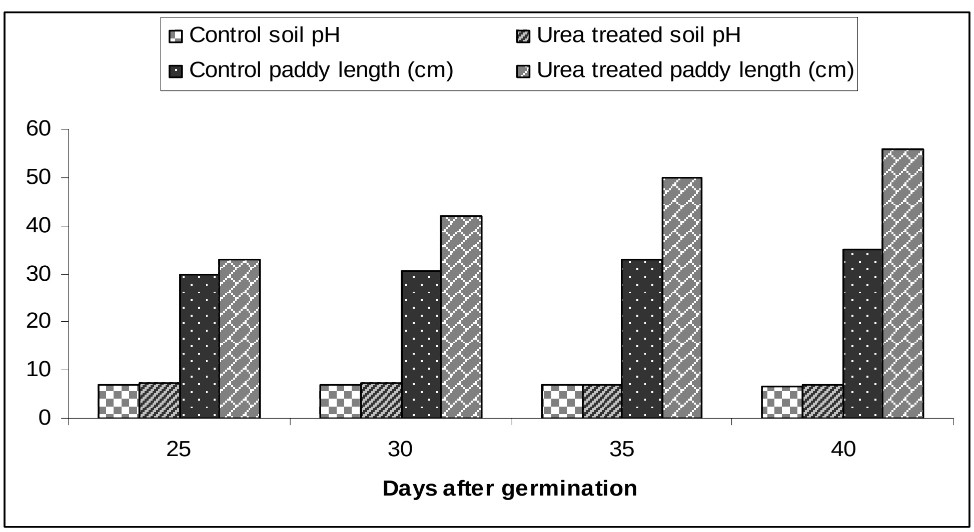

Figure1. Different DAS with control of soil pH, urea treated soil pH, control seedling height/paddy length (cm) and urea treated seedling height

Ammonium ions in the soil solution enter into an equilibrium reaction with NH_3 in the soil solution. The soil solution NH_3 is, in turn, subject to gaseous loss to the atmosphere. Soil pH and concentration of NH_4^+ in the soil solution are important factors affecting amount of NH_3 loss to the atmosphere. As soil pH increases, the fraction of soil-solution NH_4^+ plus soil-solution NH_3 in the NH_3 form also increases by an order of magnitude for every unit of pH above 6.0, thus increasing losses of soil-solution NH_3 to the atmosphere. Collectively, NH_3 volatilization: 1) is of most importance on calcareous soils, especially as soil pH exceeds 7; 2) losses increase with temperature and can be appreciable for neutral or alkaline soils as they dry out; 3) is greater in soils of low CEC, such as sands; 4) losses can be high when high-N organic wastes, such as manure, are permitted to decompose on the soil surface; 5) losses are high from urea applied to grass or pasture, as a result of hydrolysis of the urea to NH_3 by indigenous urease enzyme; 6) losses from soil and fertilizer N are decreased by growing plants (Stevenson 1986). It is assumed that if higher NH_3 loss is prevented, the utilization of amino nitrogen in plant will be enhanced. However, atmospheric NH_3 and the utilization of soil N_2 from NH_3 should be balanced.

As ammonia formed from urea is oxidized to nitrite by *nitrosomonas* bacteria, the nitrite is again oxidized to nitrate by nitrification process and caused by *nitrobacter*. The nitrate which is the plant food is utilized by the cells in the form of protein. Therefore, nitrification causes the enhancement of total growth of rice. It is reported that urea enhances the synthesis of proteins, enzymes (Claus-Peter *et al.* 2002; El-Shora 2001) and other cellular functions (Nishi *et al.* 2001). Cell proliferation and differentiation in response to urea has been observed. Urea is utilized by the cells by interaction with nitrate-induced nitrate transporter. Recent investigation reveals that Nrt1 and Nrt2 have been cloned in the plant (Crawford and Glass, 1998). Therefore, uptake pathways of urea in the plant are not properly clarified. It is probable that urea is taken by the cells through urea transporter. Therefore, further studies are needed to clarify the mechanism of urea-induced growth of rice. Collectively, our study indicates that urea has stimulatory effect on growth of rice which is reciprocally related to the soil pH caused by the applied urea. The rate of uptake of amino nitrogen in the plant is also related to the availability of urea in the soil as well as with the disappearance of soil urea.

ACKNOWLEDGEMENT

We thank Dr. Md. Ansar Ali, Chief Scientific Officer and Head, Bangladesh Rice Research Institute, Regional Station, Sympur, Rajshahi for providing us seeds of BRRI-27. The work was supported by the University Grant Commission (U.G.C), Bangladesh.

REFERENCES

Crawford N. M and Glass, A. D. M. 1998. Molecular and physiological aspects of nitrate uptake in plants. Trends in Plant Science 3: 389-395

Claus-Peter W., Tiller S. A., Taylor, M. A and Davies H. V. 2002. Leaf Urea Metabolism in Potato. Urease Activity Profile and Patterns of Recovery and Distribution of ^{15}N after Foliar Urea Application in Wild-Type and Urease-Antisense Transgenics. *Plant Physiol.* 128: 1129-1136

El-Shora H. M. 2001. Properties and immobilization of urease from leaves of *Chenopodium album* (C_3). *Bot. Bull. Acad. Sin.* 42: 251-258

Nishi A., Nakamura Y., Tanaka N. and Satoh H. 2001 Biochemical and Genetic Analysis of the Effects of *Amylose-Extender* Mutation in Rice Endosperm. *Plant Physiol.* 127: 459-472

Peoples, M. B., Freney, J. R and Mosier, A. R .1995. Minimizing gaseous losses of nitrogen. In: *Nitrogen Fertilization in the Environment*, P.E. Bacon (ed.). Marcel Dekker, Inc., New York, pp. 565-602

Rice E. L and Pancholy S. K. 1972. Inhibition of nitrification by climax ecosystems. *American Journal of Botany* 59: pp.1033-1040

Stevenson F. J. 1986. *Cycles of Soil*: Carbon, Nitrogen, Phosphorus, Sulfur, Micronutrients. John Wiley & Sons, NY. p380