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# Effect of *Azolla*-urea Application on Yield and NPS Uptake by BRRI Dhan 29 in Boro Season

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**Abstract:** A field experiment was carried out at the Bangladesh Agricultural University Farm, Mymensingh, Bangladesh during Boro season of 2000 to evaluate the comparative effect between one or two layers of incorporated *Azolla* biomass from 0.2 and 0.1 kg $m^{-2}$ inoculum with 50 kg N $ha^{-1}$ as urea and the recommended dose of N (100 kg $ha^{-1}$) on the yield and NPS uptake of BRRI Dhan 29. All the treatments were tried in two different plant spacings i.e., $S_1$: 25-25×15 cm and $S_2$: 35-15×15 cm. The highest grain yield of 4.43 t $ha^{-1}$ produced by two incorporations of *Azolla* @ 0.2 kg $m^{-2}$ inoculum with 50 kg N $ha^{-1}$ as urea, which differed significantly from 4.06 t $ha^{-1}$ yield produced by 100 kg N $ha^{-1}$ as urea (the recommended dose). But the yield of 3.88 t $ha^{-1}$ produced by twice incorporation of *Azolla* @ 0.1 kg $m^{-2}$ inoculum with 50 kg N $ha^{-1}$ as urea and the yield from one incorporation of *Azolla* @ 0.1 and 0.2 kg $m^{-2}$ inoculum plus 50 kg N $ha^{-1}$ as urea (3.65 and 3.91 t $ha^{-1}$, respectively) did not differ statistically with that of 100 kg N $ha^{-1}$ as urea. The lowest grain yield of 2.26 t $ha^{-1}$ was recorded from the control. The nitrogen, phosphorus and sulfur (NPS) uptake in grain and straw increased significantly by about 40-84, 45.3-109 and 41-87%, respectively, due to incorporation of *Azolla* over control. The difference between two plant spacings was not significant. Interaction effect between plant spacing and *Azolla*-urea treatments also did not exhibit any significant variation.

**Key words:** *Azolla*, NPS uptake, yield of rice

## Introduction

Long term experiment showed that yield potentialities of rice declined due to continuous use of chemical fertilizers. This depleted soil fertility is a major constraint for higher crop production in Bangladesh which has further inbred yield stagnancy and even declines yield ( Bhuiyan,1991). But use of green manure maintains a good soil fertility level. So, it is important that green manuring or use of organic fertilizers in the crop field have now become essential to maintain soil fertility. The *Azolla-Anabaena* symbiosis has already become a potential biofertilizers for rice production due to its high N fixing abilities, rapid growth and easy decomposable characteristics (Khan, 1988 and Mian, 1993). It also acts as a recycling source of P, S and other essential nutrients to the rice plants (Mian and Azmal, 1989). Arvadia *et al.* (1989) reported that the use of *Azolla* as green manure and as multiple crop with rice can meet the entire N requirement of rice. In addition, *Azolla* also can supply substantial amounts of P, K, S, Zn and other nutrient elements for rice plants (Lumpkin and Plucknett, 1982; Mian, 1991).

There is a good deal of evidence that *Azolla* increases the yield of rice (Khan, 1988; Mian and Kashem, 1996). But information on the relative contribution of *Azolla* in combination with chemical fertilizers for rice production are still scanty. Therefore, the present study was designed and conducted to evaluate the effect of incorporated *Azolla* biomass along with urea on the yield of BRRI Dhan 29 and to asses N, P and S uptake by the rice plant.

## Materials and Methods

The experiment was conducted in the Non-calcareous Dark Grey Flood plain soil (Sonatola Series) of the Bangladesh Agricultural University farm, Mymensingh in Boro season of 2000 in a field with characteristics indicated in Table 1. There were altogether six treatments:

$T_0$ No *Azolla*, no N
$T_1$ Twice incorporation of *Azolla* @ 0.1kg $m^{-2}$ inoculum (28 and 45 DAT) with $N_{50}$ (15 and 60 DAT)
$T_2$ Twice incorporation of *Azolla* @ 0.2kg $m^{-2}$ inoculum (28 and 45 DAT) with $N_{50}$ (15 and 60 DAT)
$T_3$ Once incorporation of *Azolla* @ 0.1kg $m^{-2}$ inoculum (45 DAT) with $N_{50}$ (15 and 60 DAT)
$T_4$ Once incorporation of *Azolla* @ 0.1kg $m^{-2}$ inoculum (45 DAT) with $N_{50}$ (15 and 60 DAT)
$T_5$ Recommended dose of urea (100 kg N $ha^{-1}$ as urea applied at 15,45 and 60 DAT)

Table 1: Soil properties of the experimental field

| Properties | Observed value |
|---|---|
| Sand (%) | 23.2 |
| Silt (%) | 66.0 |
| Clay (%) | 10.8 |
| Texture | Silty loam |
| pH | 6.9 |
| % Organic matter | 1.892 |
| Total Nitrogen (%) | 0.093 |
| Available Phosphorus (ppm) | 13.0 |
| Exchangeable Potassium (me/100 g soil) | 0.31 |
| Available Sulfur (ppm) | 12.0 |

The above treatments were tried in two plant spacing: 25-25x15 cm ($S_1$) and 35-15x15 cm ($S_2$).

In case of treatment $T_1$ and $T_2$ *Azolla* was inoculated at 3 DAT (days after transplanting) and the layer formed was incorporated at 28 DAT. The second inoculation was done at 29 DAT and layer formed was incorporated at 45 DAT. In treatment $T_3$ and $T_4$ *Azolla* was first inoculated at 3 DAT and incorporated the layer formed at 45 DAT. Recommended dose of P was applied as basal in case of $T_0$ and $T_5$ but in case of other treatments half of the P as basal and the rest half of P was used in 4 equal splits within 40 DAT for the better growth of *Azolla*. All treatments also received the recommended dose of K, S and Zn.

The experiment was laid out in a split- plot design having three replications. Plant spacing was assigned to the main plot and *Azolla*-urea treatments to the sub plot. 50 days old seedlings were transplanted in the experimental plots. *Azolla* mass was maintained and multiplied in the nursery for use in the experimental plots. Necessary irrigation was done to maintain desired water layer during the growth of *Azolla*. Insecticide was applied to prevent the *Azolla* from insect attack. After harvesting the whole plot, the grain and straw yield were separated by hand threshing. From each plot 100 g grain and 100 g straw were taken for oven drying. Grain and straw were analyzed for total N, available P and available S content following some standard methods (Olsen *et al.*, 1954 and Black, 1965). The data were analyzed statistically following ANOVA and the means differences were adjusted using DMRT.

## Results and Discussion

**Grain and straw yield:** Inoculation of one ($T_3$ and $T_4$) and two ($T_1$ and $T_2$) layers of *Azolla* along with 50 kg N $ha^{-1}$ in two equal splits and use of 100 kg N $ha^{-1}$($T_5$) in three equal splits significantly increased the grain and straw yield of BRRI Dhan 29 (Table 2.1) over control ($T_0$). The trend of increasing yield was the positive effect of incorporated *Azolla* biomass on soil fertility status of the rice field. Several research workers have reported the beneficial effects of incorporated *Azolla* biomass on soil fertility (Solaiman *et al.* ,1994; Banik, 1996; Ahmmad, 1992). Incorporation of two layers of *Azolla* @ 0.2 kg $m^{-2}$ inoculum with 50 kg N $ha^{-1}$ ($T_2$) produced the highest grain yield (4.43 t $ha^{-1}$) which differ significantly from all other treatments. Application of 100 kg N $ha^{-1}$($T_5$) in three equal splits produced 4.06 t $ha^{-1}$ rice grain. The lowest grain yield (2.26 t $ha^{-1}$) was recorded from the control ($T_0$). Similar finding was stated by Singh and Singh (1987) and Mian and Kashem (1996). Incorporation of one layer of *Azolla* @ 0.2 kg $m^{-2}$ inoculum at 45 days after transplanting ($T_4$) produced the grain yield of 3.91 t $ha^{-1}$ which did not differ significantly with the yield of $T_5$ indicating that even use of one layer of *Azolla* @ 0.2 kg $m^{-2}$ inoculum with 50 kg N $ha^{-1}$ as urea could be an alternative practice for the use of recommended dose of urea (100 kg N $ha^{-1}$). The straw yield showed the similar pattern as grain yield. All the *Azolla*-urea treatments ($T_1$ to $T_4$) and also $T_5$ (recommended dose of N fertilizer) differed significantly in straw yield from the control.

Spacing produced insignificant influence on grain and straw yield of rice but $S_1$ showed some superiority over $S_2$

Table 2.1: Effect of *Azolla*- urea application on the grain and straw yield of BRRI Dhan 29

| | Yield (t $ha^{-1}$) | | | |
|---|---|---|---|---|
| Treatment | Grain | % Increase over $T_0$ | Straw | Total |
| a)Plant spacing | | | | |
| $S_1$ | 3.84 | - | 4.00 | 7.85 |
| $S_2$ | 3.67 | - | 3.85 | 7.53 |
| b)*Azolla* -urea treatments | | | | |
| $T_0$ | 2.62d | - | 3.50b | 6.12c |
| $T_1$ | 3.88bc | 48.1 | 3.89a | 7.77b |
| $T_2$ | 4.43a | 69.1 | 4014.0a | 8.57a |
| $T_3$ | 3.65c | 39.3 | 3.92a | 7.57b |
| $T_4$ | 3.91bc | 49.2 | 4.02a | 7.94ab |
| $T_5$ | 4.06b | 55.0 | 4.09a | 8.16ab |
| Sx | 0.104 | | 0.099 | 0.151 |
| CV% | 6.78 | | 6.15 | 4.80 |

In a column, the figures having similar letter (s) do not differ significantly at 5% level

Table 2.2: Interaction effect between plant spacing and *Azolla*-urea treatment on the grain and straw yield of BRRI Dhan 29

| | | Yield (t $ha^{-1}$) | | | |
|---|---|---|---|---|---|
| Plant spacing × *Azolla*-Urea treatments | | Grain | % increase over $T_0$ | Straw | Total |
| $S_1$ | $T_0$ | 2.90 | - | 3.54 | 6.44 |
| | $T_1$ | 3.97 | 36.8 | 4.02 | 7.99 |
| | $T_2$ | 4.47 | 54.1 | 4.15 | 8.62 |
| | $T_3$ | 3.67 | 26.6 | 4.02 | 7.69 |
| | $T_4$ | 3.96 | 36.6 | 4.10 | 8.07 |
| | $T_5$ | 4.07 | 40.3 | 4.19 | 8.26 |
| $S_2$ | $T_0$ | 2.35 | - | 3.47 | 5.82 |
| | $T_1$ | 3.79 | 61.3 | 3.76 | 7.55 |
| | $T_2$ | 4.39 | 86.8 | 4.12 | 8.51 |
| | $T_3$ | 3.62 | 54.0 | 3.85 | 7.45 |
| | $T_4$ | 3.85 | 63.8 | 3.95 | 7.80 |
| | $T_5$ | 4.05 | 72.3 | 4.00 | 8.05 |
| | CV(%) | 6.77 | | 6.15 | 4.80 |

Table 3.1: Effect of *Azolla*- urea application on N P S uptake by the BRRI Dhan 29

| | N uptake (kg ha$^{-1}$) | | | | P uptake (kg ha$^{-1}$) | | | | S uptake (kg ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | Grain | Straw | Total | % increase over $T_0$ | Grain | Straw | Total | % increase over $T_0$ | Grain | Straw | Total | % increase over $T_0$ |
| Plant spacing | | | | | | | | | | | | |
| $S_1$ | 38.0 | 23.2 | 61.2 | - | 11.15 | 8.42 | 19.9 | - | 3.54 | 3.31 | 6.81 | - |
| $S_2$ | 34.8 | 22.4 | 57.1 | - | 11.00 | 7.97 | 18.9 | - | 3.31 | 3.16 | 6.47 | - |
| *Azolla* –Urea treatments | | | | | | | | | | | | |
| $T_0$ | 22.2c | 18.9b | 41.1c | - | 6.1e | 6.0d | 12.1d | - | 2.27d | 2.18b | 4.45d | - |
| $T_1$ | 38.2b | 23.1a | 61.3b | 49.1 | 11.7c | 8.3bc | 20.6bc | 67.0 | 3.42c | 3.34a | 6.76bc | 51.9 |
| $T_2$ | 44.1a | 25.2a | 69.3a | 68.6 | 14.4a | 9.3a | 23.7a | 97.5 | 4.16a | 3.59a | 7.75a | 74.2 |
| $T_3$ | 36.3b | 24.0a | 60.3b | 46.7 | 10.3d | 8.1c | 18.4c | 53.3 | 3.28c | 3.35a | 6.63c | 49.0 |
| $T_4$ | 37.9b | 22.6a | 60.6b | 49.2 | 11.8c | 8.6bc | 20.4bc | 70.0 | 3.54bc | 3.39a | 6.93bc | 55.7 |
| $T_5$ | 39.7ab | 22.8a | 62.5b | 55.0 | 13.1b | 8.9ab | 22.0ab | 83.3 | 3.88ab | 3.55a | 7.43ab | 67.0 |
| Sx | 1.774 | 0.523 | 1.992 | | 0.38 | 0.219 | 0.468 | | | 0.058 | 0.107 | 0.162 |
| CV% | 11.94 | 9.29 | 8.25 | | 8.3 | 6.53 | 5.91 | | | 7.54 | 8.13 | 5.99 |

In a column, the figures having similar letter (s) do not differ significantly at 5% level

Table 3.2: Interaction effect between plant spacing and *Azolla*-urea treatment on N P S uptake by BRRI Dhan 29

| | | N uptake (kg ha$^{-1}$) | | | | P uptake (kg ha$^{-1}$) | | | | S uptake (kg ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant spacing × *Azolla*-Urea treatments | | Grain | Straw | Total | % increase over $T_0$ | Grain | Straw | Total | % incr-ease over $T_0$ | Grain | Straw | Total | % incr-ease over $T_0$ |
| | $T_0$ | 24.8 | 19.1 | 43.9 | - | 6.73 | 6.06 | 12.8 | - | 2.61 | 2.20 | 4.81 | - |
| | $T_1$ | 39.9 | 24.9 | 64.8 | 47.6 | 12.0 | 8.90 | 20.9 | 63.3 | 3.52 | 3.47 | 6.99 | 45.3 |
| $S_1$ | $T_2$ | 44.2 | 23.6 | 67.8 | 54.4 | 14.4 | 9.29 | 23.7 | 85.2 | 4.26 | 3.59 | 7.85 | 63.2 |
| | $T_3$ | 36.7 | 24.8 | 61.5 | 40.0 | 10.3 | 8.31 | 18.6 | 45.3 | 3.33 | 3.44 | 6.77 | 40.7 |
| | $T_4$ | 38.3 | 23.1 | 61.4 | 39.9 | 12.3 | 8.97 | 21.3 | 66.4 | 3.61 | 3.47 | 7.08 | 47.2 |
| | $T_5$ | 44.1 | 23.6 | 67.7 | 54.2 | 13.2 | 9.01 | 22.2 | 73.4 | 3.91 | 3.68 | 7.59 | 57.8 |
| | $T_0$ | 19.7 | 18.7 | 38.4 | - | 5.4 | 5.92 | 11.3 | - | 1.94 | 2.15 | 4.09 | - |
| | $T_1$ | 36.5 | 21.2 | 57.7 | 50.3 | 11.4 | 7.79 | 19.2 | 70.0 | 3.32 | 3.22 | 6.54 | 59.9 |
| | $T_2$ | 43.9 | 26.7 | 70.6 | 83.9 | 14.3 | 9.24 | 23.6 | 108.8 | 4.05 | 3.59 | 7.64 | 86.8 |
| $S_2$ | $T_3$ | 35.8 | 23.2 | 59.0 | 53.6 | 10.3 | 7.93 | 18.2 | 61.1 | 3.24 | 3.27 | 6.51 | 59.2 |
| | $T_4$ | 37.5 | 22.2 | 59.7 | 55.5 | 11.3 | 8.16 | 19.5 | 72.6 | 3.48 | 3.31 | 6.79 | 66.0 |
| | $T_5$ | 35.2 | 20.2 | 57.2 | 49.0 | 13.0 | 8.84 | 21.8 | 92.9 | 3.84 | 3.42 | 7.26 | 77.5 |
| CV (%) | | 11.94 | 9.29 | 8.25 | | 8.3 | 6.53 | 5.91 | | 7.54 | 8.13 | 5.99 | |

Interaction effect between plant spacing and *Azolla*-urea treatments also did not showed any significant variation in grain and straw yield (Table 2.2).

**N uptake:** The highest amount of N uptake was recorded for both grain and straw due to incorporation of two layers *Azolla* @ 0.2 kg m$^{-2}$ inoculum with 50 kg N ha$^{-1}$ as Urea ($T_2$) which was followed by the application of 100 kg N ha$^{-1}$ as Urea ($T_5$). It is revealed that the N uptake in grain for $T_2$ significantly differed with all other treatments except $T_5$ (Table 3.1). However, N uptake in straw due to different *Azolla*-urea treatments did not differ significantly. The higher amount of total N uptake (grain and straw) was 69.3 kg ha$^{-1}$ in the treatment $T_2$ that significantly differed from other treatments including $T_5$ (62.5 kg ha$^{-1}$). The total N uptake increased by 40-84% due to different treatments over the control. Several others researchers (Latha and Subranian, 1988 and Mian, 1991) have also been reported that incorporated *Azolla* biomass increased N uptake by rice plant. Plant spacing did not exhibit any significant variation to N uptake by grain and straw. Interaction effect regarding N uptake both in grain and straw were also insignificant (Table 3.2).

**P uptake:** The P uptake in grain and straw differed significantly due to different *Azolla*-urea combinations but there was no significant difference between two plant spacings. The highest amount of total P uptake of 23.7 kg ha$^{-1}$ (grain and straw) was observed for the treatment $T_2$ which differed significantly with that of all others treatments except the second highest amount of 22.0 kg ha$^{-1}$ shown by $T_5$. Total P uptake increased by 45.3-108% over the control due to treatment differences (Table 3.1). The interaction effect was not significant (Table 3.2). Beneficial effect of incorporated *Azolla* biomass on P uptake by rice plant also has been reported by Manjappa *et al.* (1989) and Mian (1991).

**S uptake:** The highest amount of total S uptake of 7.75 kg ha$^{-1}$ was observed for the treatment $T_2$ which differed significantly with that of all other treatments except $T_5$ (Table 3.1). Total S uptake increased by 40.7-86.8% over control (Table 2). S uptake due to different spacing did not showed any marked effect. Variation of S uptake due

to interaction effect was insignificant (Table 3.2). Shamsuddoha (1990) also supported the similar findings. The overall results indicate that the application of *Azolla* increased grain and straw yield of rice. N P S uptake by rice plant was also increased by *Azolla* application. The treatment $T_2$ i.e., twice incorporation of *Azolla* from 0.2 kg $m^{-2}$ inoculum along with 50 kg N $ha^{-1}$ as urea was superior to all other treatments in increasing yield of rice and N P S uptake by rice plant.

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