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# Grain yield and protein content of transplant *aman* rice as influenced by variety and rate of nitrogen

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**Abstract**: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from June to December 2006 with a view to studying grain yield and protein content of transplant *aman* rice as influenced by variety and rate of nitrogen. The experiment consisted of five varieties viz. BRRI dhan30, BRRI dhan32, BRRI dhan34, BRRI dhan39 and Nizersail and four rates of nitrogen viz. 0, 40, 80 and 120 kg $ha^{-1}$. The longest plant was found in Nizersail (146.9 cm) and BRRI dhan34 (145.2 cm) and the shortest in BRRI dhan39 (107.2 cm). As for nitrogen, the longest plant (131.7 cm) was obtained from 80 kg N $ha^{-1}$, which was identical with 120 kg N $ha^{-1}$. Variety showed significant effect on all the yield contributing characters and yield except panicle length. Results revealed that BRRI dhan39 produced the highest grain yield (4.18 t $ha^{-1}$) from BRRI Dhan34; whereas BRRI dhan30 produced the lowest grain yield (3.85 t $ha^{-1}$). BRRI dhan34 had the highest grain protein content (9.18%), identically followed by BRRI dhan39 (8.53%). All the characters were significantly influenced by rate of nitrogen except panicle length and weight of 1000 grains. Grain protein content was highest from 80 kg N $ha^{-1}$. The effect of interaction between variety and rate of nitrogen showed that the highest grain yield was obtained from BRRI dhan39 (4.90 t $ha^{-1}$) with 120 kg N $ha^{-1}$. Results showed that the variety BRRI dhan39 produced the highest grain yield and 80 kg N $ha^{-1}$ appeared to be the best nitrogen rate in respect of yield and grain protein content of rice.

**Key words:** Grain yield, protein content, T *aman* rice, variety, nitrogen

## Introduction

Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population and grows in more than 100 countries. China, India, Indonesia, Bangladesh, Thailand and Vietnam produce about 80% of the world's rice production. Among the leading rice growing countries of the world, Bangladesh ranked fourth in both rice area and production following China, India and Indonesia (Ange, 1994). The population of the country is increasing at an alarming rate. As a result the demand for food is increasing day by day. But the cultivable area is not increasing. Horizontal expansion of rice area is not possible due to limited arable land. Therefore, it is need of time to increase rice production through increasing the yield per unit area. For this reason special emphasis should be given towards the development of new varieties and their management, especially nitrogenous fertilizer, to increase the yield per unit area and meet various requirements.

Nitrogen is a key element which plays a vital role in vegetative growth, development of yield components and yield of rice (BRRI, 1990). The important role of nitrogen fertilizers in increasing rice yields has been widely recognized, particularly after the development of modern varieties. An increase in the yield of rice by 70-80% may be obtained by proper application of nitrogenous fertilizers (IFC, 1982). Nitrogen plays a vital role in increasing protein content in the grains. Proper timing and rate of nitrogenous fertilizers have been reported to influence protein content in the grains (Petibskaya and Mikkelen, 1984). This experiment was undertaken to study the yield and protein content of transplant *aman* rice as influenced by variety and rate of nitrogen at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh.

## Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the period of June to December 2006 to studying grain yield and protein content of transplant *aman* rice as influenced by variety and rate of nitrogen. The experiment consisted of five varieties viz. BRRI dhan30, BRRI dhan32, BRRI dhan34, BRRI dhan39 and Nizersail and four rates of nitrogen viz. 0, 40, 80 and 120 kg $ha^{-1}$. The experiment was laid out in a split-plot design with three replications. The size of unit plot was 4.0 m × 2.5 m. There were 60 plots in the experiment. The land was fertilized with triple superphosphate, muriate of potash, gypsum and zinc sulphate at the rate of 80, 60, 50, and 10 kg $ha^{-1}$, respectively. Intercultural operations and proper management practices were done. Data were recorded on plant height, no. of total tillers $hill^{-1}$, no. of effective tillers $hill^{-1}$, no. of total spikelets $panicle^{-1}$, no. of grains $panicle^{-1}$, wt. of 1000 grains, grain yield, biological yield and grain protein content. The analysis of variance was done with the help of computer package program MSTAT-C and the mean differences were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984).

For the determination of grain protein content, the grain samples were collected from each plot and dried in an oven at $65^0$C for 24 hours after which they were ground by a grinding mill. The ground samples were sieved through a 20 mesh sieve. Approximately 10 g grain samples were preserved in polythene bags for chemical analysis to determine total nitrogen content. Chemical analysis was done by Micro-kjeldahl method (AOAC, 1984) at the Laboratory of Biochemistry Department in Bangladesh Agricultural University, Mymensingh. One gram sample was digested in 25 ml concentrated $H_2SO_4$ in presence of 12-15 g of mixture ($CuSO_4$: $K_2SO_4$=1:5) in a Kjeldahl flask. After the completion of digestion, the flask was cooled, 150 ml distilled water was added, followed by the addition of some glass beads and zinc granules to avoid bumping. One hundred ml of 40% NaOH solution was then introduced into the flask along the side of the flask carefully avoiding mixing and was immediately distilled. The distillate was collected in 2% boric acid solution in presence of mixed indicator in an Erlenmeyer flask. The distillate was titrated with0.2 N HCl solution and the

amount of nitrogen was found in the sample was multiplied by 5.95 to obtain total protein present in the sample. The result was expressed in percentage of grain protein content calculated by the following formula.

$$\text{Protein (\%)} = \frac{\text{(Reading-blank value)} \times \text{Strength of HCl} \times 1.4 \times 5.95}{\text{Weight of the sample}}$$

## Results and Discussion

Results obtained from the present study regarding the yield and its components and grain protein content of T. *aman* rice as influenced by variety and rate of nitrogen are presented and discussed below.

Plant height was significantly influenced by variety. The highest plant heights were recorded in Nizersail (146.9 cm) and BRRI dhan34 (145.2 cm), and the lowest plant height was recorded in BRRI dhan39 (107.2 cm) (Table 1). In effect of nitrogen rate, the highest plant height (131.7 cm) was recorded in 80 kg N $ha^{-1}$ ($N_2$) and 120 kg N $ha^{-1}$ ($N_3$) and the lowest plant height (121.4 cm) was observed in 0 kg N $ha^{-1}$ ($N_0$) (Table 2). Plant height increased due to increasing levels of nitrogen as reported by Reddy *et al*. (1985). The interaction effect of variety and rate of nitrogen, the highest plant height was obtained from Nizersail with 120 kg N $ha^{-1}$ treatment combination which was statistically similar to BRRI dhan34 with 120 kg N $ha^{-1}$ and 80 kg N $ha^{-1}$ and Nizersail with 80 kg N $ha^{-1}$ and 40 kg N $ha^{-1}$. (Table 3).

The number total tillers $hill^{-1}$ ranged from 9.45 to 13.20. The highest number of total tillers $hill^{-1}$ (13.20) was recorded in BRRI dhan39 and the lowest number (9.45) was recorded in Nizersail (Table 1). The number of total tillers $hill^{-1}$ varied due to varietal differences (Kabir *et al*., 2004). In effect of nitrogen rate, the highest number of total tillers $hill^{-1}$ (11.83) was recorded from when nitrogen applied at 120 kg $ha^{-1}$ ($N_2$) and the lowest (8.78) one from the control treatment ($N_0$) (Table 2). Variety and rate of nitrogen interacted significantly with each other in respect of number of total tillers $hill^{-1}$. The highest number of total tillers $hill^{-1}$ (15.80) was recorded in the interaction of BRRI dhan39 × $N_3$ and the lowest (8.20) one in Nizersail × $N_0$ which was statistically similar to BRRI dhan30, BRRI dhan32 and BRRI dhan34 with control treatment (Table 3).

The highest number of effective tillers $hill^{-1}$ (11.35) was found in BRRI dhan39 and the lowest (7.07) one was found in Nizersail (Table 1). In effect of nitrogen rate, the highest number of effective tillers $hill^{-1}$ (10.34) was obtained with 80 kg N $ha^{-1}$ ($N_2$). The second highest number of effective tillers $hill^{-1}$ (9.75) was found from 120 kg N $ha^{-1}$ ($N_3$) which was statistically similar to $N_2$ treatment. The lowest number of effective tillers $hill^{-1}$ (5.72) was obtained from control treatment (Table 2). Number of effective tillers $hill^{-1}$ was increased due to increases in the rates of nitrogen as was observed by Mendhe *et al.* (2002). The effect of interaction between variety and rate of nitrogen on number of effective tillers $hill^{-1}$ was found significant. The highest number (14.77) of effective tillers $hill^{-1}$ was obtained from BRRI dhan39 with application of 120 kg N $ha^{-1}$ ($N_3$) and the lowest number (4.67) was obtained from Nizersail with control treatment (Table 3).

The number of total spikelets $panicle^{-1}$ was significantly influenced by variety. Results from Table 1 showed that BRRI dhan34 produced highest number of total spikelets $panicle^{-1}$ (260.2) followed by BRRI dhan39 (151.5). The lowest number of total spikelets $panicle^{-1}$ (125.4) was counted from Nizersail. In effect of nitrogen rate, the highest number (169.8) of total spikelets $panicle^{-1}$ was produced when N applied at 120 kg $ha^{-1}$ which was statistically identical with 40 and 80 kg N $ha^{-1}$. The lowest number (157.5) of total spikelets $panicle^{-1}$ was found in control treatment (Table 2). Mendhe *et al*. (2002) also reported that the increased total spikelets $panicle^{-1}$ with increasing the rate of nitrogen. The interaction effect of variety and rate of nitrogen, the highest number of total spikelets $panicle^{-1}$ (272.6) were counted in BRRI dhan34 and the lowest number (122.9) was found in Nizersail with control treatment (0 kg N $ha^{-1}$ ) (Table 3).

BRRI dhan34 produced the highest number (238.8) of grains $panicle^{-1}$ and the lowest number (112.4) in Nizersail (Table 1). In effect of nitrogen rate, the highest (155.5) number of grains $panicle^{-1}$ was produced when N applied at 80 kg $ha^{-1}$ ($N_2$) and the lowest number (136.3) was obtained from control treatment ($N_0$) (Table 2). Number of grains $panicle^{-1}$ was significantly affected by the interaction between variety and rate of nitrogen. The highest number of grains $panicle^{-1}$ (254.9) was found in BRRI dhan34 with 80 kg N $ha^{-1}$ which was statistically similar to 120 kg N $ha^{-1}$ with same variety. The lowest (108.0) was obtained from Nizersail with control ($N_0$) treatment followed by other treatments (Table 3).

The highest weight of 1000 grains (22.84 g) was produced by BRRI dhan30 which was statistically identical with BRRI dhan39 and BRRI dhan32, and the lowest weight (11.51 g) was recorded in BRRI dhan34 (Table 1). Chowdury *et al.* (1996) and Bhowmick and Nayak (2000) also reported similar results. There was no significant effect on weight of 1000 grains by rate of nitrogen. The highest weight of 1000 grains (19.28 g) was obtained from 120 kg N $ha^{-1}$ ($N_3$) and the lowest (19.03 g) from control (0 kg N $ha^{-1}$) which were numerically different but statistically similar (Table 2). The effect of interaction of variety and rate of

nitrogen was found to be non-significant in respect weight of 1000 grains. The highest weight of 1000 grains (23.26 g) was recorded from BRRI dhan30 with 120 kg N $ha^{-1}$ and the lowest (11.31 g) one was found in BRRI dhan34` with control treatment combination (Table 3).

BRRI dhan39 gave the highest grain yield (4.18 t $ha^{-1}$) followed by BRRI dhan32 (3.61 t $ha^{-1}$). The lowest grain yield (2.92 t $ha^{-1}$) was recorded from BRRI dhan34 (Table

1). BRRI (1995) reported that variable grain yields were obtained from different varieties. In effect of nitrogen rate, the highest grain yield (3.91 t $ha^{-1}$) was produced when N applied at 80 kg $ha^{-1}$ ($N_2$) which was statistically identical with $N_3$ treatment (120 kg N $ha^{-1}$), and the lowest yield (2.74 t $ha^{-1}$) was obtained from the control treatment (Table 2). Lawal and Lawal (2002) reported that application of N fertilizer up to 80 kg $ha^{-1}$ significantly increased number of grains $panicle^{-1}$ and highest at 120 kg N $ha^{-1}$. Grain yield was significantly affected by the interaction between variety and rate of nitrogen application. The highest grain yield (4.90 t $ha^{-1}$) was obtained from BRRI dhan39 with 120 kg N $ha^{-1}$ and the second highest (4.50 t $ha^{-1}$) was obtained from the same variety with 80 kg N $ha^{-1}$. The lowest grain yield (2.01 t $ha^{-1}$) was obtained from Nizersail with the control treatment (Table 3).

**Table 1.** Effect of variety on yield, yield contributing characters and grain protein content of transplant *aman* rice

| Variety | Plant height (cm) | Total tillers $hill^{-1}$ | Effective tillers $hill^{-1}$ | Total spikelets $panicle^{-1}$ | Grains $panicle^{-1}$ | Wt. of 1000 grains (g) | Grain yield (t $ha^{-1}$) | Biological yield (t $ha^{-1}$) | Grain protein content (%) |
|---|---|---|---|---|---|---|---|---|---|
| ($V_1$) | 113.8 c | 9.50 c | 7.52 c | 140.7 c | 122.4 d | 22.84 a | 3.46 c | 7.40 d | 8.21 bc |
| ($V_2$) | 127.5 b | 10.08 c | 7.65 c | 149.7 b | 131.7 c | 21.79 a | 3.61 b | 7.76 c | 7.90 bc |
| ($V_3$) | 145.2 a | 10.85 b | 8.87 b | 260.2 a | 238.8 a | 11.51 c | 2.92 e | 8.34 b | 9.18 a |
| ($V_4$) | 107.2 d | 13.20 a | 11.35 a | 151.5 b | 137.6 b | 22.11 a | 4.16 a | 8.65 a | 8.53 ab |
| ($V_5$) | 146.9 a | 9.45 c | 7.07 d | 125.4 d | 112.4 e | 17.65 b | 3.20 d | 8.44 ab | 7.41 c |
| $S_x$ | 0.9668 | 0.0880 | 0.2536 | 1.510 | 1.490 | 0.4797 | 0.0303 | 0.0707 | 0.2958 |
| CV (%) | 2.61 | 5.87 | 5.88 | 3.16 | 3.49 | 8.59 | 2.98 | 3.02 | 12.43 |
| Level of significance | ** | ** | ** | ** | ** | ** | ** | ** | ** |

In a column, figures with common letter (s) do not differ significantly, whereas figures with dissimilar letters differ significantly as per DMRT, ** = Significant at 1% level of probability, NS = Not significant, $V_1$ =BRRI dhan30; $V_2$ =BRRI dhan32; $V_3$ =BRRI dhan34; $V_4$=BRRI dhan39; $V_5$=Nijersail

**Table 2.** Effect of rate of nitrogen on yield yield contributing characters and grain protein content of transplant *aman* rice

| Rate of nitrogen (Kg $ha^{-1}$) | Plant height (cm) | Total tillers $hill^{-1}$ | Effective tillers $hill^{-1}$ | Total spikelets $panicle^{-1}$ | Grains $panicle^{-1}$ | Wt. of 1000 grains (g) | Grain yield (t $ha^{-1}$) | Biolog-ical yield (t $ha^{-1}$) | Grain protei content (%) |
|---|---|---|---|---|---|---|---|---|---|
| $N_0$ | 121.4c | 8.78 c | 5.72 c | 157.5 b | 136.3 b | 19.03 | 2.74 c | 6.46 c | 6.65 d |
| $N_1$ | 127.6b | 10.32b | 8.17 b | 165.2 ab | 147.4 a | 19.16 | 3.34 b | 7.84 b | 7.94 c |
| $N_2$ | 131.7a | 11.83a | 10.34a | 169.7 a | 155.5 a | 19.25 | 3.91 a | 9.00 a | 9.58 a |
| $N_3$ | 131.7a | 11.55a | 9.75 a | 169.8 a | 155.2 a | 19.25 | 3.89 a | 9.16 a | 8.81 b |
| $S_x$ | 0.1929 | 0.1929 | 0.2013 | 2.560 | 2.286 | 0.0835 | 0.0163 | 0.0721 | 0.1454 |
| CV (%) | 2.61 | 5.87 | 5.88 | 3.16 | 3.49 | 8.59 | 2.89 | 3.02 | 12.43 |
| Level of significance | ** | ** | ** | * | ** | NS | ** | ** | ** |

In a column, figures with common letter (s) do not differ significantly, whereas figures with dissimilar letters differ significantly as per DMRT, * = Significant at 5% level of probability, ** = Significant at 1% level of probability, NS = Not significant, $N_0$ = 0; $N_1$= 40; $N_2$ = 80; $N_3$ = 120

The biological yields of the varieties ranged from 7.40 to 8.65 t $ha^{-1}$ . The highest biological yield (8.65 t $ha^{-1}$) recorded in BRRI dhan34 which statistically identical to Nizersail and lowest (7.40 t $ha^{-1}$) was observed in BRRI dhan30 (Table 1). In effect of nitrogen rate, the highest biological yield (9.16 t $ha^{-1}$) was obtained with 120 kg N $ha^{-1}$ which was similar to 80 kg N $ha^{-1}$ ($N_2$) and lowest (6.46 t $ha^{-1}$) was recorded in control treatment (Table 2). Biological yield was significantly affected by the interaction between variety and rate of nitrogen application. The highest biological yield (10.10 t $ha^{-1}$) was produced by BRRI dhan39 with 120 kg N $ha^{-1}$ ($N_3$) and lowest (5.98 t $ha^{-1}$) was observed in BRRI dhan30 with control treatment which was statistically similar to BRRI dhan32 and BRRI dhan34 with the same treatments (Table 3).

The highest grain protein content (9.18%) was observed in BRRI dhan34, which was statistically identical with BRRI dhan39 (8.53%). The lowest grain protein content (7.41%) was observed in Nizersail, which was similar to BRRI dhan32 (7.90%) and BRRI dhan30 (8.21%) (Table1). In effect of nitrogen rate, the highest grain protein content (9.58%) was recorded with 80 kg N $ha^{-1}$ ($N_2$) and the lowest grain protein content (6.65%) was observed in the control treatment. Jiang *et al*. (2004) reported that grain protein content of rice increased with increased rate of nitrogen application. The effect of interaction between variety and rates of nitrogen application was not significant in respect of grain protein content of rice. Numerically, the highest grain protein content (10.98%) was recorded in BRRI dhan34 with 80 kg N $ha^{-1}$ and the lowest (6.05%) was observed in Nizersail with control (Table 3).

BRRI dhan39 was the highest yielding variety followed by BRRI dhan32, BRRI dhan30, BRRI dhan34 and Nizersail. Nitrogen fertilization of all the varieties with 80 kg N $ha^{-1}$ appeared to be the best nitrogen rate for grain yield, straw yield and grain protein content, which were statistically similar to 120 kg N $ha^{-1}$. The highest grain yield and straw yield were produced by the combination of BRRI dhan39 with 120 kg N $ha^{-1}$.

**Table 3.** Effect of interaction between variety and rate of nitrogen on yield contributing characters, yield and grain protein content of transplant *aman* rice

| Treatments | Plant height (cm) | Total tillers hill$^{-1}$ | Effective tillers hill$^{-1}$ | Total spikelets panicle$^{-1}$ | Grains panicle$^{-1}$ | Weight of 1000 grains (g) | Grain yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) | Grain protein content (%) |
|---|---|---|---|---|---|---|---|---|---|
| $V_1 \times N_0$ | 110.3fgh | 8.30 l | 5.40 k | 136.4 g | 115.9 jkl | 22.48 | 2.78 m | 5.98 i | 6.42 |
| $V_2 \times N_0$ | 119.6 de | 8.73 kl | 5.70 jk | 140.5efg | 120.8 hk | 22.26 | 2.98 l | 6.18 i | 6.50 |
| $V_3 \times N_0$ | 133.8 bc | 8.87 jk | 6.00 j | 236.8 c | 210.8 c | 11.31 | 2.01 n | 6.37 i | 7.45 |
| $V_4 \times N_0$ | 104.0 i | 9.78 gh | 6.83 i | 145.8efg | 125.9ghi | 21.95 | 3.35 ij | 6.97 h | 6.45 |
| $V_5 \times N_0$ | 139.6 b | 8.20 l | 4.67 l | 122.9 h | 108.0 l | 17.16 | 2.60 m | 6.80 h | 6.05 |
| $V_1 \times N_1$ | 113.7efg | 9.20 ijk | 7.18 i | 138.9 g | 120.2 ijk | 22.71 | 3.35 ij | 7.03 h | 8.01 |
| $V_2 \times N_1$ | 124.1 d | 9.80 gh | 7.30 i | 149.5def | 130.0fgh | 21.58 | 3.56 gh | 7.75 g | 7.85 |
| $V_3 \times N_1$ | 147.5 a | 10.94 de | 8.93 fg | 260.3 b | 239.2 b | 11.57 | 2.71 m | 8.02 fg | 8.93 |
| $V_4 \times N_1$ | 106.0 hi | 12.30 c | 10.20 d | 150.4def | 134.8efg | 22.14 | 3.95 b | 8.15 efg | 7.81 |
| $V_5 \times N_1$ | 146.5 a | 9.36 hij | 7.23 i | 126.6 h | 112.7 kl | 17.82 | 3.15 kl | 8.25 def | 7.12 |
| $V_1 \times N_2$ | 115.3 ef | 10.10 ef | 8.50 gh | 142.0 fg | 124.4 hij | 22.91 | 3.65 fg | 8.08 efg | 9.65 |
| $V_2 \times N_2$ | 135.4 bc | 11.20 d | 9.40 ef | 152.8 de | 140.0 de | 21.64 | 4.17 c | 8.67 d | 9.01 |
| $V_3 \times N_2$ | 149.3 a | 12.40 c | 11.05 c | 272.6 a | 254.9 a | 11.58 | 3.45 hi | 9.30 bc | 10.98 |
| $V_4 \times N_2$ | 108.5ghi | 14.91 b | 13.60 b | 153.4 de | 142.5 de | 22.15 | 4.50 b | 9.35 bc | 9.35 |
| $V_5 \times N_2$ | 150.0 a | 10.53 ef | 9.13 ef | 127.4 h | 115.8 jkl | 17.98 | 3.80 ef | 9.61 b | 8.90 |
| $V_1 \times N_3$ | 115.8 ef | 10.41 ef | 9.01 efg | 145.3efg | 129.1 f-i | 23.26 | 4.07 cd | 8.50 de | 8.35 |
| $V_2 \times N_3$ | 130.9 c | 10.60 ef | 8.20 h | 151.1def | 136.1 ef | 21.67 | 3.75 f | 8.45 def | 8.25 |
| $V_3 \times N_3$ | 150.3 a | 11.20 d | 9.50 e | 271.1 a | 250.2 a | 11.58 | 3.50 ghi | 9.65 b | 9.35 |
| $V_4 \times N_3$ | 110.4fgh | 15.80 a | 14.77 a | 156.6 d | 147.1 d | 22.21 | 4.90 a | 10.10 a | 10.52 |
| $V_5 \times N_3$ | 151.3 a | 9.73 ghi | 7.26 i | 124.9 h | 113.3 kl | 17.65 | 3.25 jk | 9.12 c | 7.56 |
| $S_x$ | 1.934 | 0.176 1 | 0.1761 | 3.019 | 2.997 | 0.9514 | 0.0606 | 0.1414 | 0.5916 |
| CV (%) | 2.61 | 5.87 | 5.88 | 3.16 | 3.49 | 8.59 | 2.97 | 3.02 | 12.43 |
| Level of significnce | * | ** | ** | ** | ** | NS | ** | ** | NS |

In a column, figures with common letter (s) do not differ significantly, whereas figures with dissimilar letters differ significantly as per DMRT, * = Significant at 5% level of probability, ** = Significant at 1% level of probability, NS = Not significant, V1 = BRRI dhan30, V2 = BRRI dhan32, V3 = BRRI dhan34, V4 = BRRI dhan39, V5 = Nizersail

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