

Effect on Rice Growth and Change of Inorganic Nitrogen Content in Soil by Application with Rice Bran and Mixed Expeller Cake Fertilizer on Machine Transplanting Rice Paddy Field

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Abstract

This study was conducted to find a method using the application of rice bran and mixed expeller cake at machine transplanting rice paddy field. Different ratios of rice bran and mixed expeller cake were sprayed as substitute of chemical fertilizer (nitrogen 90kg ha⁻¹) before transplanting. Nitrogen content was highest in 30th day after transplantation, and in relation to treatments the order was the following: Rice bran 1,000kg ha⁻¹ + Mixed expeller cake 1,374kg ha⁻¹ > rice bran 2,000kg ha⁻¹ + Mixed expeller cake 948kg ha⁻¹ > rice bran 3,000kg ha⁻¹ + Mixed expeller cake 522kg ha⁻¹. Number of panicle and spikelets per m² was higher in rice bran 1,000kg ha⁻¹ + Mixed expeller cake 1,374kg ha⁻¹ and rice bran 2,000kg ha⁻¹ + Mixed expeller cake 948kg ha⁻¹ than in rice bran 3,000kg ha⁻¹ + Mixed expeller cake 522kg ha⁻¹ and the yields was the highest in rice bran 1,000kg ha⁻¹ + Mixed expeller cake 1,374kg ha⁻¹.

Introduction

Korean organic rice producers often use rice bran as a source of nutrients. The singular use of rice bran, however, results in lower plant height, number of tillers, and number of spikelets even when the same amount of nitrogen is supplied through rice bran as through chemical fertilizer (Kim et al., 2009). One of the reasons is because the efficiency of nitrogen fertilizer contained in rice bran is low. Also, nitrogen content contained in mixed expeller cake, another organic fertilizer, is more efficient and results in higher yield compared to the use of chemical fertilizer in an amount that can supply the same amount of nitrogen content (100%) (An et al., 2008). Therefore, it is believed that the combined use of rice bran and mixed expeller cake could improve the effectiveness of fertilization. This study tested the effectiveness of the combined fertilize at varying ratios.

Materials and methods

The test was carried out in 2008 in the experiment field of the Department of Rice and Winter Cereal Crop, National Institute of Crop Science located in Songhak-dong, Iksan-si, Jeollabuk-do using the Dongjin-1 rice variety. Considering the conventional application method (chemical fertilizer 90kg ha⁻¹), the amounts of rice bran and mixed expeller cake were decided at the level that supplies the same nitrogen content contained in chemical fertilizer 90kg ha⁻¹: rice bran (N: 2.16%, P: 3.78%, K: 1.43%) and mixed expeller cake (T-N Ratio 5.22%, N : 5%, P : 1%, K : 1%, KG Chemical).

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The tested mixing ratios of rice bran and mixed expeller cake are rice bran 1,000kg (nitrogen 21.3kg) ha⁻¹ + mixed expeller cake 1,374kg (nitrogen 68.7kg) ha⁻¹; rice bran 2,000kg (nitrogen 42.6kg) ha⁻¹ + mixed expeller cake 948kg (nitrogen 47.4kg) ha⁻¹; and rice bran 3,000kg (nitrogen 63.9kg) ha⁻¹ + mixed expeller cake 522kg (nitrogen 26.1kg) ha⁻¹. As for the split application of fertilizer, the standard application method was used for chemical fertilizer. Fertilization using organic fertilizers followed the method used in the mixed expeller cake substation test (Yang et al., 2008) at the base to top dressing ration of 7:3. The base dressing was applied right before rotary tillage and the top dressing was applied 20 days prior to earing.

For this study, a single test field was created and the analysis was conducted on the test field three times with a 10-day interval with the first on the 20th day since transplantation of rice seedlings and the last on the 40th day. Wet soil collected in the depth of 10-15cm was analyzed to measure NH₄-N and NO₃-N contents. On August 9, which was before earing, the number of tillers and plant length were surveyed, and on October 10, which was during the ripening period, the yield and related properties were surveyed.

Results

The analysis of soil where three different ratios of rice bran and mixed expeller cake were applied showed that nitrogen content in soil was higher in the case of rice bran 1,000kg + mixed expeller cake 1,374kg ha⁻¹ until the 30th day after transplantation than in the case of chemical fertilizer. In the two other combinations in which the ratio of rice bran is higher, nitrogen content in the organically fertilized soil was lower than in the chemically fertilized soil throughout the study period (Tab. 1).

Tab. 1: Inorganic nitrogen in soil under different application rate of rice bran and mixed expeller cake

(Units: mg/kg)

Treatment	After 20DAT (July 1)	After 30DAT (July 11)	After 40DAT (July 21)	Heading stage (Aug 22)
Control	8.9	15.5	16.2	11.3
RB1,000kg+MEC1374kg ha ⁻¹	14.9	19.0	12.4	11.7
RB2,000kg+MEC948kg ha ⁻¹	11.8	12.0	9.5	11.9
RB3,000kg+MEC522kg ha ⁻¹	8.9	12.2	9.2	13.4

RB: Rice bran; MEC: Mixed expeller cake; DAT: Days after treatment

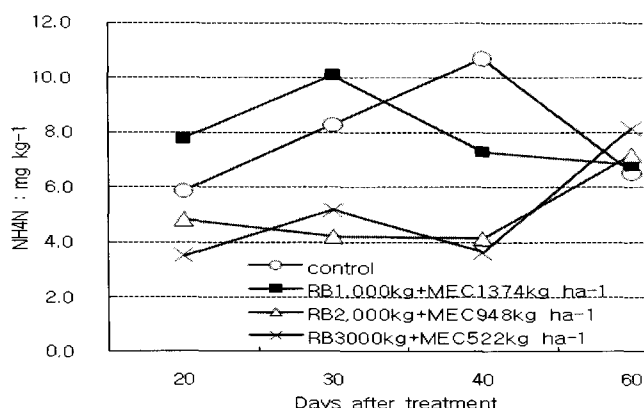


Figure 1: NH₄-N content in soil under different application rate of rice bran and mixed expeller cake

The analysis of NH₄-N content in soil showed a similar trend as that of nitrogen content. NH₄-N content in soil fertilized with the combination of rice bran and mixed expeller cake increased as the proportion of mixed expeller cake increased in the organic fertilizer (in the order of rice 1,000kg + mixed expeller cake 1374kg ha⁻¹ > rice bran 2,000kg + mixed expeller cake 948kg ha⁻¹ > rice bran 3,000kg + mixed expeller cake 522kg ha⁻¹) (Fig 1). No difference was observed in NO₃-N content between the different combinations analyzed.

Tab. 2: Rice yield and yield component under different application rate of rice bran and mixed expeller cak.

Treatments	No. of panicle per m ²	No. of spikelets per m ²	Percent ripened grain	1,000 grains weight	Milled rice yield	Yield index
	ea	×1,000	%	g	t/ha	
Control	304.4	38.0	74.6	20.8	6.23a	100
RB1,000kg+MEC1374kg ha ⁻¹	317.2	40.3	73.2	20.8	6.26a	100
RB2,000kg+MEC948kg ha ⁻¹	315.2	38,5	71.4	20.6	5.87b	94
RB3,000kg+MEC522kg ha ⁻¹	284.2	35,1	79.4	20.3	5.75b	92

RB: Rice bran; MEC: Mixed expeller cake

The data was analyzed using SAS program(VER 9.2). Analysis of variance(ANOVA) was used to test the statistical significance, and Duncan's multiple range test was used to carry out significance of difference among means at P=0.05 probability level.

In terms of growth and development associated with the mixing ratios of rice bran and mixed expeller cake, the higher the proportion of mixed expeller cake, the greater the

number of spikes per plant and the number of grains per m². The growth of rice was better in the soil fertilized by the mixture of rice bran 1,000kg + mixed expeller cake 1,374kg ha⁻¹ and the mixture of rice bran 2,000kg + mixed expeller cake 948kg ha⁻¹ than the soil fertilized by the mixture of rice bran 3,000kg + mixed expeller cake 522kg ha⁻¹ and chemical fertilizer. The analysis of yield also showed a similar trend with the yield from the soil fertilized by the combination of rice bran 1,000kg + mixed expeller cake 1374kg ha⁻¹ being the highest at 6.26MT ha⁻¹ (Tab. 2).

Discussion

This study confirmed that the proportion of mixed expeller cake in the organic fertilizer consisting of rice bran and mixed expeller cake affects the growth, development, and yield of rice. The influence is believed to be due to the leaching characteristics of nitrogen fertilizer which differ from one organic fertilizer to another. Nitrogen content in the soil treated with the organic fertilizer where the proportion of mixed expeller cake is higher tends to be stable throughout the entire development period of rice, and accordingly nutrients were consistently supplied to the rice plants resulting in more tillers and grains. In the meantime, a number of different raw materials are used to make mixed expeller cake. Therefore, further analysis is advised to examine the speed of nutrient elution and effectiveness depending on the ratio of primary materials.

Conclusions

When the mixture of rice bran and mixed expeller cake is used as organic fertilizers for rice farming, nitrogen content in soil tends to remain stable when the proportion of mixed expeller cake is higher, and rice yield was the highest when the soil was fertilized with the mixture of rice bran 1,000kg + mixed expeller cake 1,374kg ha⁻¹.

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