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## The effect of nitrogen fertilizer, zeolite and fresh straw to increase total-N, cation exchange capacity (CEC) of rice crop

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# The effect of nitrogen fertilizer, zeolite and fresh straw to increase total-N, cation exchange capacity (CEC) of rice crop

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**Abstract.** The use of nitrogen fertilizer accompanied by zeolite and fresh straw is expected to increase rice plant growth and the chemical properties of rice fields. The objectives of this research were to compare the effect of nitrogen fertilizer, zeolite, and fresh straw on the *total-N*, Cation Exchange Capacity (CEC) and the growth of paddy rice plants. This study used a factorial randomized block design method with 3 Factors: Nitrogen (Urea) : 0, 100, 200 and 300 kg/ha; Zeolite : 0 and 300 kg/ha; and fresh straw treatment are without fresh straw and with the provision of 2 kg of fresh straw/plot equal to 5 ton/ha. Results showed that there was an increase in the combination of urea, zeolite and fresh straw with low to high nutrient status but there were no significant differences. While there was a significant effect on plant height, number of tillers at 4 MST and dry weight of rice canopy. The combination of urea and zeolite fertilizers showed higher results than the treatment of urea fertilizer without zeolite. A combination of fertilizer urea and the zeolites show results higher than treatment fertilizer urea without zeolite.

## 1. Introduction

Nitrogen is one of the plant nutrients which are most important for plant growth. However, nitrogen is easy leaching from the soil as nitrate, volatilizing as ammonia gas, or change to other forms which cannot be absorbed by crops. The efficiency of using N fertilizer in land rice can be maximized by timely fertilizing, and by placing fertilizer or organic matter into the soil [1].

The availability of organic matter in the soil makes an important role in increasing land productivity. According to his research [2], if the soil contains some non-fixed charged minerals, then ammonium ( $\text{NH}_4^+$ ) and nitrate ( $\text{NO}_3^-$ ) can be adsorbed by cation and anion exchange complexes. However, this form of nitrate has the weakest bond compared to phosphate and sulphate so that nitrate is more easily released from the anion and washed exchange complexes. With the presence of organic materials that can increase soil CEC and maintain soil moisture, the form of ammonium is expected to last longer in the soil. However, organic material such as rice straw is very much needed, which is around 10 tons/ha/year.

To reduce the straw input, the material used is the zeolite. Zeolites have the advantage of a stable structure in the soil and also affect over a long period. Zeolites can be a fixation nutrient provided through fertilizer to prevent nutrient leaching. The bound nutrients will be rereleased slowly and immediately absorbed by the roots. Zeolites can be directly mixed with the fertilizer especially urea before being spread or given to agricultural land. Based on the results of research from the Soil Research Institute [3] input of zeolite had the highest yield on dry milled grain (GKG) (6.52 ton/ha) obtained on



zeolite 2 ton/ha. This research aims to determine the effect of urea, zeolite and fresh straw on increasing the total-N, CEC and rice crop growth.

## 2. Materials and methods

This research was carried out in the paddy fields of CengkehTuri, North Binjai Sub district, Binjai City with an altitude of  $\pm 32$  m above sea level. Soil analysis was carried out by the Research and Technology Laboratory of the Faculty of Agriculture, Universitas Sumatera Utara from March 2018 to July 2018.

The materials used in this study were Inpari Sidenuk variety rice seeds, Nitrogen in the form of Urea fertilizer (45% N), Zeolite, Potassium in the form of KCL fertilizer (100% K), phosphate in the form of TSP fertilizer (45% P<sub>2</sub>O<sub>5</sub>) and fresh straw. The tools that will be used in this research are pH Meter, Burst Titration, hoe, meter, trace sample, leaf colour chart, scale, camera and stationery.

This study used factorial randomized block design method with 3 Factors namely Potassium (KCL) with 0 kg/ha, 25 kg/ha, 50 kg/ ha and 75 kg/ha; dosage of Nitrogen (Urea) dosage for farmers (250 kg/ha) and LCC recommendations (315 kg/ha); No compost (control) and Straw compost (5 tons/ha). The area of the research plot is 2 x 2 m, the spacing is 20 x 20 cm and the distance between the plots of each sample is 20 cm.

Variance Analysis analysed data for each parameter measured and further test using Duncan Distance Test (Duncan's Multiple Range Test) levels of 5%.

## 3. Results and Discussion

The combination of urea fertilization, zeolite and fresh straw to the total-N (%) and CEC (me/100g) do not show a significantly different effect. However, in general, the data shows the difference in the value of each treatment given to each parameter (Table 1).

In the total N-parameter (%) the data shows the nutrient status conditions included in the criteria of low (L), medium (M) to high (H). N-total with criteria being shown by combination treatment without fresh straw, 0 kg/ha urea, 0 kg/ha zeolite by 0.159% while N-total with high criteria is indicated by the combination treatment of fresh straw, 300 kg/ha urea and 300 kg/ha zeolite is 0.467% (Table 1).

**Table 1.** Total-N levels (%) and CEC (me/100g) in various combinations of Urea, Zeolite and Fresh Straw Fertilizers

Treatment		Total-N (%)	CEC (me/100 g)
Without Fresh Straw	0 kg/ha Urea	0.159 <sup>L</sup>	14.057 <sup>L</sup>
	100 kg/ha Urea	0.187 <sup>L</sup>	14.359 <sup>L</sup>
	200 kg/ha Urea	0.203 <sup>L</sup>	14.368 <sup>L</sup>
	300 kg/ha Urea	0.231 <sup>M</sup>	14.623 <sup>L</sup>
	0 kg/ha Urea	0.209 <sup>L</sup>	15.001 <sup>L</sup>
	100 kg/ha Urea	0.218 <sup>L</sup>	15.471 <sup>L</sup>
	200 kg/ha Urea	0.240 <sup>M</sup>	17.130 <sup>M</sup>
	300 kg/ha Urea	0.221 <sup>L</sup>	17.147 <sup>M</sup>
Fresh Straw	0 kg/ha Urea	0.238 <sup>M</sup>	15.989 <sup>L</sup>
	100 kg/ha Urea	0.268 <sup>M</sup>	16.255 <sup>L</sup>
	200 kg/ha Urea	0.281 <sup>M</sup>	19.438 <sup>M</sup>
	300 kg/ha Urea	0.402 <sup>M</sup>	20.150 <sup>M</sup>
	0 kg/ha Urea	0.309 <sup>M</sup>	16.211 <sup>L</sup>
	100 kg/ha Urea	0.320 <sup>H</sup>	20.196 <sup>M</sup>
	200 kg/ha Urea	0.434 <sup>H</sup>	24.098 <sup>M</sup>
	300 kg/ha Urea	0.467 <sup>H</sup>	25.161 <sup>H</sup>

Note: L=Low, M=Medium, H=High

Source: Soil Research Center [4] Hardjowigeno [5]

Although based on the analysis of various N-total parameters there was no significant effect, but the combination of the three treatments showed an increase. Combination of fresh straw with 300 kg/ha urea and 300 kg/ha zeolite and the combination of fresh straw with 300 kg/ha urea and 0 kg/ha zeolite increased by 0.065% (Table 1). Likewise, with a combination of urea fertilizer, N-total will increase with increasing doses. This can be seen in the combination of fresh straw, zeolite, and urea.

In the CEC soil (me/100 g) parameter, the higher dose of zeolite given, the CEC will increase. This can be seen in Table 1 with a combination of fresh straw treatment, 300 kg/ha urea and 300 kg/ha zeolite and a combination of fresh straw treatment, 300 kg/ha urea and 0 kg ha zeolite of 5.011%.

Suwardi [6] said one of the increased fertilizer efficiency is mixing fertilizer and zeolite. Zeolite is one of the ingredients that can temporarily bind nitrogen. Zeolite-mixed fertilizers are expected to optimize nitrogen absorption by plants because the fertilizer can control the release of nitrogen in accordance with the time and amount needed by plants, so the fertilizer dosage given is smaller than the dose of conventional fertilizer.

The results of the research by Roechan et al. [7] show that the administration of straw in rice fields can increase organic C, N-total, K-dd, Cadd, and land CEC even though their presence in the first season has not significantly increased yield. Sitepu et al. [8] also stated that the addition of organic fertilizer is thought to contribute mainly N nutrients needed by plants, also able to increase the efficiency of N and K nutrients inorganic fertilizers (50%) caused by improvements in soil chemical properties, especially CEC, so that growth plants become better than without organic fertilizer.

The combination treatment between urea and zeolite showed a different effect on the height of rice plants at the age of 4 MST. The results of the research have shown that the administration of urea accompanied by zeolite gives a higher average yield of 50.32 cm compared to urea fertilization without accompanied by zeolite of 45.83 cm (Table 2).

**Table 2.** Rice crop height (cm) 4 weeks after planting on various combinations of urea fertilizer and zeolite

Treatment	Without Zeolite	Zeolite	Average
0 kg/ha Urea	41.50	45.32	43.41
100 kg/ha Urea	43.27	48.56	45.92
200 kg/ha Urea	50.55	52.92	51.74
300 kg/ha Urea	48.00	54.48	51.24
Average	45.83 <sup>a</sup>	50.32 <sup>b</sup>	48.08

Note: Numbers followed by unequal letters in the same column or row show significantly different levels of 5% based on Duncan's Distance Test.

Zeolite has a high CEC value which means it has a large number of exchange lattices and cavities in large quantities so that more and more ammonium ions from nitrogen fertilizers that have undergone hydrolysis are absorbed by zeolite. The application of ammonium ions in zeolite cavities/lattices is only temporary and will easily be given to plants when needed [6]. If the N level in the soil solution decreases, the N adsorbed by the zeolite will be slowly released into the soil solution. Nitrogen is an essential element of amino acids, nucleic acids, nucleotides and chlorophyll. Nitrogen serves to encourage plant growth quickly (increase plant height and number of tillers), increase the size of leaf area, number of grains per panicle, the percentage of grain content and protein content of grain.

The interaction of urea fertilizer with zeolite also showed a significant effect on the number of tillers per rice clump at the age of 4 MST. The results showed that the interaction of urea fertilizer with zeolite showed a higher value than urea without zeolite.

**Table 3.** Number of tillers per clump (stem/clump) of rice crops four weeks after planting on various combinations of Urea fertilizer and zeolite

Treatment	Without Zeolite	Zeolite	Average
0 kg/ha Urea	10.33	11.33	10.83
100 kg/ha Urea	10.53	12.28	11.41
200 kg/ha Urea	11.00	12.33	11.67
300 kg/ha Urea	11.67	11.83	11.75
Average	10.88 <sup>a</sup>	11.94 <sup>b</sup>	6.83

Note: Numbers followed by unequal letters in the same column or row show significantly different levels of 5% based on Duncan's Distance Test.

Based on Table 3, the average number of tillers per rice clump in the interaction of urea fertilizer with zeolite is 1.94 stems/clump. This average is higher than the interaction of urea fertilizer with zeolite which is 10.88 stems/clump. [9] States the higher number of tillers due to the combination of urea and zeolite caused by zeolites which have cation exchange lattices, can absorb  $\text{NH}_4^+$  cations which are then released slowly so that zeolite can be a slowly available fertilizer.

The interaction between urea fertilizer and zeolite also showed a significant effect on the dry weight of the canopy of rice plants. The average value of dry canopy weight was higher in the interaction between urea fertilizer and zeolite than without zeolite.

**Table 4.** Effect of Straw Compost on Dry Weight of Rice Plant Head (gram)

Treatment	Without Zeolite	Zeolite	Average
0 kg/ha Urea	19.54	24.80	22.17
100 kg/ha Urea	21.31	25.45	23.38
200 kg/ha Urea	21.78	25.53	23.66
300 kg/ha Urea	24.06	26.91	25.49
Average	21.67 <sup>b</sup>	25.67 <sup>a</sup>	23.67

Note: Numbers followed by unequal letters in the same column or row show significantly different levels of 5% based on Duncan's Distance Test.

From Table 4 it can be seen that the highest weight in the combination treatment of 300 kg/ha urea with zeolite is 25.67. This shows that zeolite administration can increase the value of plant canopy dry weight. In zeolite experiments can increase soil CEC. Increasing soil CEC affects the absorption of nutrients needed by plants in the formation of plant weights. According to [6], zeolites are good ion exchangers because zeolites are a class of tectosilicate minerals with oxygen atoms surrounding them, both Si and Al form three-dimensional networks. [10] Also stated that zeolite application significantly increases soil CEC, plant weight, and increases crop production.

#### 4. Conclusion

The combination treatment of urea, zeolite and fresh straw showed no significant effect on increasing the total N-soil content, but showed a significant effect on plant height (50.32 cm) and the number of

tillers per hill (11.94 stems/clump) at age 4 MST and the dry weight of the canopy of rice plants (25.67). A combination of urea and zeolite indicates the treatment with the highest value.

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