



The Effect of Fertilizer Urea and KCl on Ultisol and Inceptisol toward Soil Chemical Properties on Corn (*Zea Mays* L.) Growth

AUTHORS INFO

Wira Okriadi Lubis
Badan Perencanaan Pembangunan Daerah
Panyabungan
Wiraokriadi@gmail.com
+628116191883

ARTICLE INFO

ISSN: 2548-5121
Vol. 1, No. 1, December 2016
URL: <http://usnsj.com/index.php/ATJ/article/view/ATJ009>

© 2016 ATJ All rights reserved

Abstract

The research was conducted at green house of Agriculture Faculty, North Sumatera University. The research was done to study on the Urea and KCl fertilizer of chemical effect characteristic and growth of corn plant at Ultisols and Inceptisols. The research designed by randomized block factorial with two factors and four dosage replications. The first factors were kind of soils (Ultisols and Inceptisols). The second factor was Urea and KCl fertilizer, each others at 0 ppm, 100 ppm, 200 ppm, 300 ppm N and 0 ppm, 100 ppm, 200 ppm, 300 ppm K₂O. The result showed that application of Urea and KCl fertilizers increased height and dry weight of corn plants, soil acidity, nitrogen content and exchangeable Kalium at Inceptisols. Dosage excess of Urea was more at 100 ppm N responsible on height and weight of corn plant.

Keywords: corn (*Zea mays* L.), urea, KCl, ultisol, inceptisol

A. Introduction

The growth and production of crops is influenced by factors of soil, climate and plant itself, all of which interact with each other. Soil or land as a place to grow plants do not always contain sufficient nutrients and in a state ready to be absorbed by plants. This situation often creates problems in increasing crop production. In poor soil nutrient should be a provision of nutrients known as fertilization. Most nitrogen in the soil combined with organic material. In this form of nitrogen is protected from the liberation by microbes, a year only 2-3% mineralization in alkaline state. Approximately, half the known organic nitrogen is in the form of amino compound.

Provision of ammonium nitrogen in large quantities in the soil is very alkaline pressing the second stage from the nitrification. It turned out that ammonium is toxic to nitrobacter but not harm nitrosomonas. As a result, accumulation of nitrite can occur until the amount of toxins that cause ammonium-containing compound is added to the soil with a high pH. Similarly, in the land which the urea donate NH₄⁺ ions in the soil due to hydrolysis, the result is also detrimental. Fertilizer N and K are the main macro nutrients that are awarded to the soil in the form of fertilizers such as urea and KCl. With fertilizer application Ultisol and Inceptisol will respond differently to different fertilizer.

Results of Agustina's research (2006), was the benefits of Natural Phosphate fertilizer C.I.R.P significant effect in improving P-Inceptisol available on the ground. While the TSP fertilizer application significantly in improving P-available on Ultisol. Benefits of TSP fertilizer application

and Phosphate C.I.R.P significant effect in increasing soil pH, plant height and plant dry weight. Phosphate treatment is best for giving a response on the ground is 300 ppm TSP.

Dewani's research results (2004), shows that there is interaction between the soil treatment and dosage of NPK fertilizer on leaf area, leaf area index, total dry weight of the plant, and the relative growth rate of plants, while the treated soil and NPK fertilizer significantly affected plant height. Ultisol and Inceptisol the soil is acidic. In Indonesia is the widest part of about 51 million hectares or 29.7% of the broad plains in Indonesia. While widest Inceptisol throughout Indonesia is particularly in Java. This land is potentially the first few years. Many planted with reeds, especially Ultisol.

B. Methodology

This study used Random Design Group (RAK) Factorial. By using two types of soil and Inceptisol Ultisol with 2 factors and 4 doses of fertilizer fertilizing with three replications, thus forming 48 treatment

Using formula : $Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$

Where:

Y_{ijk} = observations to factors A level ke-I, factor B level to-j and at the repetition to-k.

μ = common intermediate result

α_i = influence actor A to-i, level B to-j

β_j = influence factor B level j

$(\alpha\beta)_{ij}$ = interaction AB at level A to-i level B to-j

ε_{ijk} = error experiments to level to-i (A), level to-j (B) ulangan to-k for Ultisol

a. Research procedure

Soil Sampling

Ultisol used came from the District Mancang, Langkat, while the soil from the land Inceptisol came from tanah Enam Ratus Kecamatan Hamparan Perak. Soil was taken at a depth of 0-20 cm in composites with cleaning the weeds that are above the soil surface beforehand. The land wind dried and sieved to 10 mesh sieves, then calculated percent water content of air-dry soil. Then preliminary analyses include soil pH and total-N and K-exchange. Furthermore, soil put in a plastic bucket equivalent of 4 kg weight of oven dry soil.

Labelling

After the soil is inserted into the bucket and fertilizer N and K incorporated in accordance with each dose and incubated for 1 day. Planting of maize seeds 2-3 seeds by soaking them first for 10 minutes with water. Provision of basic fertilizer that is SP-36 (36% P_2O_5) at a dose of 200 ppm P_2O_5 fertilizer, provided treatment dose given. After 2 weeks of planting thinning by choosing healthy plants.

Plant maintenance

Maintenance was done by keeping the field conditions. Do weeding in each bucket.

Harvesting

Harvesting was done when the plant has flowered 75% or until the end of the vegetative.

b. Measured parameter

At the beginning of the study in the analysis of soil samples with the following parameters:

1. pH H_2O and KCl by using a pH meter method
2. N- total soil with Kjeldahl Method
3. K- exchange me/100 g by the method of Ammonium Acetate (CH_3COONH_4) 1 M pH : 7

c. Final Soil Analysis

At the beginning of the study in the analysis of soil samples with the following parameters:

1. pH H_2O and KCl by using a pH meter method
2. N- total soil with Kjeldahl Method
3. K- exchange me/100 g by the method of Ammonium Acetate (CH_3COONH_4) 1 M pH : 7

d. Plant growth

At the end of the study measured plant parameters as follows:

1. Total plant dry weight (g)

Separated parts of the plant next to the top and the roots of plants diovenkan at a temperature of 800 C and then weighed and summed entirely.

2. Plant height (cm)

Metered after the end of the vegetative period ranging from above ground to the highest leaf.

C. Findings and Discussion

1. Plant growth

Plant height (cm)

From the research and list Fingerprint Variety, indicated that the administration of urea and KCl significantly raise the height of the plant. To determine the mean treatment difference test Urea and KCl can be seen in Table 1.

Table 1. Response of urea and KCl on plant height (cm) at Land Ultisol and Inceptisol

Treatment	Plant height (cm)	
Ultisol 0 ppm N	77.8	g
Ultisol 100 ppm N	104.6	f
Ultisol 200 ppm N	106	f
Ultisol 300 ppm N	89.8	g
Ultisol 0 ppm K ₂ O	79	g
Ultisol 100 ppm K ₂ O	104.8	f
Ultisol 200 ppm K ₂ O	116.1	ef
Ultisol 300 ppm K ₂ O	125.6	cde
Inceptisol 0 ppm N	123.6	de
Inceptisol 100 ppm N	137.6	abc
Inceptisol 200 ppm N	141.5	ab
Inceptisol 300 ppm N	139.1	abc
Inceptisol 0 ppm K ₂ O	130.5	bcd
Inceptisol 100 ppm K ₂ O	131.5	abcd
Inceptisol 200 ppm K ₂ O	141.5	ab
Inceptisol 300 ppm K ₂ O	144.8	a

Description: Figures followed by the same notation is not significantly different according to Duncan test (DMRT) 0,05

From Table 2 it can be seen that the highest value in the treatment Inceptisol 300 ppm K₂O amounting to 144.8 cm were significantly different with Ultisol Urea 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm, and KCl 0 ppm K₂O, 100 ppm K₂O, 200 ppm K₂O, 300 ppm K₂O, and Urea Inceptisol 0 ppm N, and no significant difference in the other treatments on soil Inceptisol.

The dry weight of the plant (g)

From the research and list Fingerprint Variety, indicated that the administration of urea and KCl significantly increase plant dry weight. To determine the mean treatment difference test Urea and KCl can be seen in Table 2.

Table 2. Response Urea and KCl to plant dry weight (g) on Land Ultisol and Inceptisol

Treatment	The dry weight of the plant (g)	
Ultisol 0 ppm N	3.033	k
Ultisol 100 ppm N	9.533	hi
Ultisol 200 ppm N	9.166	ij
Ultisol 300 ppm N	4.466	jk
Ultisol 0 ppm K ₂ O	3.333	k
Ultisol 100 ppm K ₂ O	11.26	ghi
Ultisol 200 ppm K ₂ O	14.3	fgh
Ultisol 300 ppm K ₂ O	15.7	efg
Inceptisol 0 ppm N	19.36	de
Inceptisol 100 ppm N	22.36	bcd
Inceptisol 200 ppm N	25.23	bc
Inceptisol 300 ppm N	21.03	cd
Inceptisol 0 ppm K ₂ O	17.86	def
Inceptisol 100 ppm K ₂ O	27.36	b
Inceptisol 200 ppm K ₂ O	38.1	a
Inceptisol 300 ppm K ₂ O	37.43	a

Description: Figures followed by the same notation is not significantly different according to Duncan test (DMRT) 0,05

From Table 2 it can be seen that the highest value in the treatment Inceptisol 200 ppm K₂O of 38.1 grams were significantly different with Ultisol Urea 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm N, and KCl 0 ppm K₂O, 100 ppm K₂O, K₂O 200 ppm, 300 ppm K₂O, and Urea Inceptisol 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm N and K₂O KCl 0 ppm and 100 ppm K₂O, and no significant difference in treatment on soil of 300 ppm K₂O Inceptisol.

2. Soil Chemical

Properties Soil acidity

From the research and list Fingerprint Variety, indicated that the administration of urea and KCl significantly raise the soil pH. To determine the mean treatment difference test Urea and KCl can be seen in Table 3.

Table 3. Response of urea and KCl to soil pH on Land Ultisol and Inceptisol

Treatment	Soil acidity	
Ultisol 0 ppm N	5.77	b
Ultisol 100 ppm N	5.69	b
Ultisol 200 ppm N	5.61	b
Ultisol 300 ppm N	5.07	bc
Ultisol 0 ppm K ₂ O	5.66	b
Ultisol 100 ppm K ₂ O	5.75	b
Ultisol 200 ppm K ₂ O	5.77	b
Ultisol 300 ppm K ₂ O	5.50	bc
Inceptisol 0 ppm N	6.34	a
Inceptisol 100 ppm N	6.40	a
Inceptisol 200 ppm N	6.63	a
Inceptisol 300 ppm N	6.62	a
Inceptisol 0 ppm K ₂ O	6.52	a
Inceptisol 100 ppm K ₂ O	6.46	a
Inceptisol 200 ppm K ₂ O	6.84	a
Inceptisol 300 ppm K ₂ O	6.67	a

Description: Figures followed by the same notation is not significantly different according to DMRT F 0:05

From Table 3 it can be seen that the highest value in the treatment Inceptisol 200 ppm K₂O of 6.84 which is significantly different from the Ultisol Urea 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm N, and KCl 0 ppm K₂O, 100 ppm K₂O, 200 K₂O ppm, 300 ppm K₂O and not significantly different to Inceptisol Urea 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm N and K₂O KCl 0 ppm, 100 ppm, 300 ppm K₂O.

Nitrogen – Total (%)

Table 4. Response Urea and KCl against N - Total (%) in the Land Ultisol and Inceptisol

Treatment	N – Total (%)	
Ultisol 0 ppm N	0.010	c
Ultisol 100 ppm N	0.020	bc
Ultisol 200 ppm N	0.025	b
Ultisol 300 ppm N	0.025	b
Ultisol 0 ppm K ₂ O	0.015	bc
Ultisol 100 ppm K ₂ O	0.015	bc
Ultisol 200 ppm K ₂ O	0.020	bc
Ultisol 300 ppm K ₂ O	0.020	bc
Inceptisol 0 ppm N	0.085	a
Inceptisol 100 ppm N	0.085	a
Inceptisol 200 ppm N	0.090	bc
Inceptisol 300 ppm N	0.095	a
Inceptisol 0 ppm K ₂ O	0.085	a
Inceptisol 100 ppm K ₂ O	0.095	a
Inceptisol 200 ppm K ₂ O	0.090	bc
Inceptisol 300 ppm K ₂ O	0.090	bc

Description: Figures followed by the same notation is not significantly different according to Duncan test (DMRT) F 0:05

From the research and list Fingerprint Variety, indicated that the administration of urea and KCl significantly increase N - total (%). To determine the mean treatment difference test Urea and KCl can be seen in Table 4.

From Table 4 it can be seen that the highest value in the treatment Inceptisol 300 ppm N and 100 ppm K₂O of 0095 were significantly different from the Ultisol Urea 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm N and KCl 0 ppm K₂O, 100 ppm K₂O, K₂O 200 ppm, 300 ppm K₂O and Inceptisol Urea 200 ppm N and Inceptisol KCl K₂O 200 ppm, 300 ppm K₂O. While the treatment of Urea Inceptisol 0 ppm N, 100 ppm N and 100 ppm KCl K₂O was not significantly different.

Potassium - Exchange (me/100 g)

From the research and list Fingerprint Variety, indicated that the administration of urea and KCl significantly improve K - Swap (me / 100 g). To determine the mean treatment difference test Urea and KCl can be seen in Table 5.

Table 5. Response Urea and KCl to the K - Exchange (me / 100 g) at Land Ultisol and Inceptisol

Treatment	K - Exchange (me/100)	
Ultisol 0 ppm N	0.08	c
Ultisol 100 ppm N	0.08	c
Ultisol 200 ppm N	0.11	bc
Ultisol 300 ppm N	0.09	c
Ultisol 0 ppm K ₂ O	0.09	c
Ultisol 100 ppm K ₂ O	0.09	c
Ultisol 200 ppm K ₂ O	0.12	abc
Ultisol 300 ppm K ₂ O	0.15	abc
Inceptisol 0 ppm N	0.11	bc
Inceptisol 100 ppm N	0.14	abc
Inceptisol 200 ppm N	0.27	ab
Inceptisol 300 ppm N	0.14	abc
Inceptisol 0 ppm K ₂ O	0.16	abc
Inceptisol 100 ppm K ₂ O	0.24	abc
Inceptisol 200 ppm K ₂ O	0.36	a
Inceptisol 300 ppm K ₂ O	0.25	abc

Description: Figures followed by the same notation is not significantly different according to Duncan test (DMRT) F 0:05

From Table 5 it can be seen that the highest value in the treatment Inceptisol 200 ppm K₂O with a value of 0:36 is significantly different from the treatment Ultisol Urea 0 ppm N, 100 ppm N, 200 ppm N, 300 ppm N and KCl 0 ppm K₂O, 100 ppm K₂O and to treatment of Urea Inceptisol 0 ppm N. While on treatment Ultisol KCl K₂O 200 ppm, 300 ppm K₂O and Inceptisol Urea 100 ppm N, 200 ppm N, 300 ppm N and K₂O KCl 0 ppm, 200 ppm K₂O, 300 ppm K₂O no different real.

Based on the research results, visually 4 MST on maize visible difference is striking between the growths of corn plants grown in Ultisol with corn plants grown in soil Inceptisol, the whole treatment of fertilizers applied to the soil Inceptisol very good compared to Ultisol. Clearly, Ultisol responded to K, the more the K the better plant growth. In contrast to N application on the same ground, the high-dose N stunted growth and dwarf but best at 100 ppm N. Means Ultisol dose of 100 ppm N in Ultisol promote plant growth further with increase dose of 200-300 ppm N decrease the growth of plants. Where it is consistent with the results of Sanchez (1992) showed that administration of high doses of N, during the first 4 weeks are not contained in the root area of 10 cm around the track urea or ammonium sulfate. After that, the roots into the path of ammonium sulphate and began to absorb nitrogen. Urea root development round was delayed for 4 weeks until nitrite is converted to nitrate

The highest growth at treatment plants Inceptisol 300 ppm K₂O of 144.8 cm and 77.8 cm in the treatment room Ultisol 0 ppm N. Where in this case, the provision of urea and KCl significantly affect in increasing plant height. This is because the nutrients nitrogen is an element that is very important role in the growth of plants that generally serve to fix nitrogen plant vegetative growth and the formation of proteins. This is consistent with the literature Boswel et al. (1997) Nitrogen is responsible for vegetative growth of dense and dark green leaf color and researches Muhammad (2001) showed that administration of urea provide significant effect on the increase in plant height. While nutrient potassium increasingly being granted to the ground, the better plant growth, since potassium is not toxic to plants. This is consistent

with the literature Hasibuan (2004) which states the actual content of K in the soil there in large numbers, but only a few of the K that can be used by plants.

Based on the observation of the dry weight of the plant is the highest value in the treatment Inceptisol 200 ppm K₂O of 38.1 grams and the lowest at 0 ppm N Ultisol treatment amounted to 3.033 grams. This suggests the provision of urea and KCl significant effect in increasing plant dry weight. The higher the dose given to the treatment of 300 ppm N Ultisol plant growth by nearly approached without fertilizer N. While on treatment Ultisol K and Inceptisol K are better plant in dry weight. With the provision of urea fertilizer and KCl significant effect in raising the pH of soil. The highest soil pH that is in the treatment Inceptisol 200 ppm K₂O of 6.84 while terendah 5.07 on Ultisol 300 ppm N. This is because the concentration of H⁺ ions in the soil after being treated to be reduced and replaced by the OH⁻ ions. Where this is in accordance with the literature Hasibuan (2004) that urea is organic clam compound fertilizers from CO (NH₂)₂, solid fertilizers granulated little rounded. This fertilizer has the N content 45-46%. Urea can be completely soluble in water and does not acidify soil.

With the provision of urea fertilizer and KCl significant effect in increasing N - total (%). Nitrogen - the highest total in the treatment Inceptisol 100 ppm N and 300 ppm K₂O by 0095 while lowest 0010 on Ultisol 0 ppm N. This shows the low availability of nutrients N on Ultisol than Inceptisol. Although a statistically significant increase in N-total on every additional dose of the same on both soil types, but nonetheless the availability of N in Ultisol much lower than Inceptisol, this is because the chemical properties of acid soils. According to Munir (1996) that Ultisol is poor soil chemical and physical properties, besides having a constraint Ultisol soil acidity, high Al-dd saturation, low cation exchange capacity, low nitrogen content, phosphorus and potassium and highly susceptible to erosion.

With the provision of urea fertilizer and KCl significant effect in raising K - exchange (me / 100 g). K - Exchange (me / 100 g) as the highest, at 200 ppm K₂O Inceptisol treatment for 0:36 while lowest 0:08 on Ultisol 0 and 100 ppm N. This shows the low availability of nutrients K on Ultisol than Inceptisol. Although a statistically significant increase in K - Rates on every additional dose of the same in the two types of land, but still nutrient availability K on Ultisol much lower than Inceptisol, this is because the chemical properties of acid soils. According to Munir (1996) that Ultisol is poor soil chemical and physical properties, besides having a constraint Ultisol soil acidity, high Al-dd saturation, low cation exchange capacity, low nitrogen content, phosphorus and potassium and highly susceptible to erosion.

D. Conclusion

1. Provision of Urea and KCl increased plant height and dry weight of plants on soil Inceptisol.
2. Provision of urea and KCl increase the soil pH, Nitrogen - Total and Potassium - Exchange Inceptisol soil.
3. Provision of urea and KCl best shows the response as follows: at a dose of Urea excessive growth of corn plants decreased in Ultisol. At excessive doses of urea increased growth of corn plants on soil Inceptisol. At doses of KCl excessive plant growth of maize increased ground Ultisol and Inceptisol.

E. References

- Agustina, S. (2006). Respon Pupuk Fosfat Pada Tanah Ultisol dan Inceptisol Terhadap Pertumbuhan Tanaman Jagung (*Zea mays* L.). Thesis Department of Soil Science FP-USU, Medan. P. 21.33. Unpublished Thesis.
- Boswell, C.F., J.J Meisinger & N.J., Case. (1997). *Produksi, Pemasaran dan Penggunaan Pupuk-pupuk Nitrogen*. In O.P. Engelstad. Technology and the use of fertilizers, Yogyakarta: Gadjah Mada University Press.
- Dewani, M. (2004). Pengaruh Pemberian Dosis Pupuk N, P dan K Terhadap Pertumbuhan dan Hasil Tanaman Jagung Manis. *Journal of Habitat*, 15(1), 31.
- Hasibuan, B.E. (2004). *Pupuk dan Pemupukan*. Medan: USU Press.
- Muhammad, A. (2001). Pengaruh Pemberian Beberapa Jenis Pupuk Nitrogen Terhadap Pertumbuhan Tanaman Sawi (*Brassica juncea* L.). Thesis Department of Soil Science, North Sumatera University. Unpublished Thesis.
- Munir, M. (1996). Tanah-Tanah Utama Indonesia. Karakteristik, Klasifikasi dan Pemanfaatannya. Jakarta: Dunia Pustaka Jaya.
- Sanchez, P.A. (1992). Sifat dan pengelolaan tanah tropika. Translation Properties and Management in the Tropics. Bandung: ITB.