Soil Chemistry and Yield of Maize as Influenced by Different Levels of Fertilizer in Ex-Tin Land Central Bangka, Kepulauan Bangka Belitung

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ABSTRACT. Kepulauan Bangka Belitung is one of the world's main tin-producing centers. Ex-tin lands have low soil fertility status, but these lands have a potency to be used as agricultural lands through fertilizing. The aim of this study was to study the influence of fertilizer application on soil chemistry and yield of maize in ex-tins mining lands Central Bangka, Kepulauan Bangka Belitung. The study was done in ex-tin mining land in Perlang Village Central Bangka, Kepulauan Bangka Belitung and was arranged in randomized block design with 3 (three) treatments and replicated 3 (three) times. The treatments were (1) urea: 200, SP-36: 150, KCl: 100 kg/ha; (2) urea: 250, SP-36: 150, KCl: 100 kg/ha, and (3) urea: 300, SP-36: 200, KCl: 150 kg/ha. The maize variety used was Lagaligo. The results showed that the application of fertlizer increased the soil chemistry properties of ex-tin mining land, namely total-N, soil P, and soil K. The increasing of fertilizer rate significantly increased the growth and yield of maize. The application of urea: 300, SP-36: 200, KCl: 150 kg/ha gave the highest yield of maize (4.43 t/ha).

Key words: ex-tin land, maize, fertilizer, soil chemistry

Introduction

Kepulauan Bangka Belitung is one of the world's main tin-producing centers. It is reported that total areas of tin-mining in Bangka Island is around 532.364 ha (Kepulauan Bangka Belitung Government 2010). Lands abandoned after tin-mining activity are degraded lands with undulating landscap and low soil fertility status. According to Setiadi (2002), soil texture of tailings generated due to ex-tin mining activities are dominated by sand texture and it caused soil properties of the tailings are very bad for the plant media. Tailings have a high portion of sand, low clay content, low soil pH, low organic matter content, low cation exchange capacity (CEC), low water-holding capacity, and very low essential macro elements (Saptaningrum 2001). As reported by previous researches, ex-tin mining lands have poor physical and chemical properties. Inonu (2011) stated that ex-tin mining areas were dominated by sandy texture and low nutrient content. These soil properties do not support the growth of food crops, such as maize.

Until present, the need of maize for food and feed in Kepulauan Bangka Belitung still have to be supplied from other province. This situation is caused the maize production in Kepulauan Bangka Belitung is still relatively low. Maize production is categorized low since both limited planting areas and low productivity of maize. According to BPS Kepulauan Bangka Belitung (2011), the production of maize in Kepulauan Bangka Belitung is only 850 tons, with 277 ha harvested area and productivity of 3.07 t/ha. Therefore, efforts to increase maize production in Kepulauan Bangka Belitung are an important thing to be done.

Efforts that can be executed to increase maize production are through increasing the productivity and harvested area of maize crop. One of potential lands to be used to develop maize is ex-tin mining lands that have low soil physical, chemical, and biolgical properties.. Utilization of ex-tin mining lands as productive agricultural activities can be done through improving the quality of ex-tin mining lands. Efforts to improve land quality are through fertilizer application, both organic and inorganic fertilizers. Improving the quality of ex-tin mining land is aimed to get the ideal conditions for the growth and yield of maize plants. In order to develop maize and usage of ex-tin mining land in Kepulauan Bangka Belitung, the fertilizing research to get the maize crop fertilizer recommendations is really needed.

The purpose of this research was to study the effect of fertilizer level on soil properties, growth and yield of maize of Lagaligo variety in ex-tin mining lands in Central Bangka, Kepulauan Bangka Belitung.

Materials and Methods

Study Site

This research was carried out in Perlang Village, Lubuk Besar Sub District, Central Bangka from September-December 2011. The site used was the ex-tin mining land that has been converted as paddy-lowland in 2009. During converting processes, top soil and organic fertilizer were applied.

Experiment Design

The experiment was arranged in a randimozed block design with 3 replications. The treatments were fertilizer levels, namely (1) urea-SP36-KCl: 200-150-100 kg/ha; (2) urea-SP36-KCl: 250-150-100 kg/ha, and (3) urea-SP36-KCl: 300-200-150 kg/ha. The maize variety used was Lagaligo. Lime applied was 1 t/ha and organic fertilizer was 2 t/ha.

The planting of maize was done throught drill as deep as 5 cm at a spacing of 40 cm x 80 cm, with 2 seeds per hole. Urea was applicated three times, as many as 1/3 level was applied at planting time, 1/3 level given at the age of 21 days after planting and 1/3 was given at the age of 42 days after planting. As for the SP-36, KCl, and organic fertilizer were applied once at the time of planting. Lime was applied during plowing the land.

Soil Analysis

Parameters observed were soil chemical properties before planting and after harvesting, growth and crop yield. The variable of soil chemical properties were soil pH, pH (H_2O), organic C, total N, P_2O_5, K_2O, exchangeable Ca, Mg, K, and Na, cation exchange capacity (CEC), and soil texture.

Table 1. Physical and chemical properties of ex-tin mining lands Perlang Village, Central Bangka before planting of maize.

No.	Parameters	Value	Criteria
1	pH (H_2O)	6,6	Neutral
2	Organic-C (%)	0,62	Very low
3	Total-N (%)	0,05	Very low
4	P_2O_5 HCl 25% (mg/100g)	11	Very low
5	K_2O HCl 25% (mg/100g)	10	Low
6	Exchangeable-Ca (cmol(+)/kg)	2,21	Low
7	Exchangeable-Mg (cmol(+)/kg)	1,39	Moderate
8	Exchangeable-K (cmol(+)/kg)	0,19	Low
9	Exchangeable-Na (cmol(+)/kg)	0,10	Low
10	CEC (cmol(+)/kg)	3,24	Very low
11	Texture		
	Sand (%)	58	Sandy loam
	Silt (%)	9	
	Clay (%)	33	

Statistical Analysis

Soil data's were analyzed descriptively while the crop data's were analyzed using the SAS system for linier models (Ramons *et al.* 1992). Data were analyzed by analysis of variance and followed by Least Significant Different (LSD) at 5% significance level.

Results and Discussion

Soil Properties Before Experiment

Soil used in this study was ex-tin mining land that has been converted into paddy-lowland. Before planting maize, the soil was planted with rice for two planting seasons. The soil chemical properties before the application of fertilizer can be seen in Table 1.

Based on these results of soil analysis, it is informed that the soil has the proportion of particles of 58% sand, 9% silt, and 33% clay, so the soil has sandy loam soil texture class. The soil used has a neutral soil pH value. The content of organic-C, total-N, P_2O_5, and CEC were classified as very low; K_2O, exchangeable-Ca, K, and Na were classified as low; and Mg-dd was classified as moderate. Based on these physical and chemical properties, it is important to apply external input in form of organic fertilizer, organic fertilizer, and lime in order to meet the nutrient requirements of maize.

Effects of N Fertilizer Level on Soil Chemical Properties

Effects of application of fertilizer urea, SP36, and KCl on soil total N-content, P and K in the soil were presented in Table 2. Application of fertilizer urea, SP36, and KCl generally increased the content of soil N, P, and K. The increasing level of fertilizer improved the soil chemical properties. The increasing varied from 0.04 to 0.08% of total-N; 2 to 5 mg/100g of P_2O_5; and 1 to 4 mg/100 g of K_2O.

Table 2. Effect of fertilizer urea, SP-36, and KCl on total-N, P_2O_5 and K_2O after harvesting of maize.

Treatment (kg/ha)	Total-N (%)	P_2O_5 HCl 25%	K_2O (mg/100g)
Before Treatment	0,05	11	10
After Treatment			
Urea-SP36-KCl: 200-150-100	0,09	13	11
Urea-SP36-KCl: 250-150-100	0,11	14	
Urea-SP36-KCl: 300-200-150	0,13	16	14

The increase in total N content, P, and K in the soil allegedly associated with the direct effects of fertilizer application of urea, SP36, and KCl themself. Application of urea fertilizer at higher level increased N-total in the soil. Increasing the levels of N-total in the soil is directly influence of urea as the source of N, so that the levels of N-total in the soil increased. Application of urea fertilizer in the soil will affect the chemical and biological soil properties, such as ion exchange and chemical buffer, as a repository of N, P, and S, with the dissolution of phosphate ion complexation of Fe and Al in the soil and soil microorganisms as an energy source (Notohadiprawiro 1998).

Potassium can increased levels of soil K since the fertilizer of KCl given saturated the adsorption complex in order to reach equilibrium with the K in the soil solution. Tan (2001) reported that the amount of potassium that can be adsorbed by the soil depends on the level of saturation. Potassium adsorbed most of these are in equilibrium with the potassium in the soil solution are the primary source for plants, so K fertilization increased K in the soil.

P nutrient is the primary limiting nutrient productivity in acid soils (Mutert and Sri Adiningsih, 1996; Santoso, 1996), so the use of fertilizers to improve nutrient P and reduce soil acidity. Besides, the increasing of soil N, P, and K was predicted as the effect of the residue of fertilizer applied during planting of rice crops.

Effects of Fertilizer Level on Growth and Yield of Maize

The results of analysis of variance of fertilization effects on growth and yield parameters of maize (plant height and stem diameter, weight of 1,000 seeds, and yield) were presented in Table 3.

Table 3 showed that the growth parameter of plant height of maize at level of urea-SP36-KCl: 300-200-150 (202.6 cm) was significantly different compared to level of urea-SP36-KCl: 250-150-100 (197.0 cm) and level of urea-SP36-KCl: 200-150-100 (191.1 cm) and the stem diameter of level of urea-SP36-KCl: 300-200-150 (1.4 cm was not significantly different compared to level of urea-SP36-KCl: 250-150-100 (1.1 cm), but significantly different compared to level of urea-SP36-KCl: 200-150-100 (1.0 cm).

The yield of maize of level of urea-SP36-KCl: 300-200-150 (4,43 t/ha) was significantly different compared to levels of urea-SP36-KCl: 250-150-100 (4,13 t/ha) and level of urea-SP36-KCl: 200-150-100 (3,98 t/ha), while the weight 1,000 seed of level of urea-SP36-KCl: 300-200-150 (266,3 g) was significantly different compared to level of urea-SP36-KCl: 250-150-100 (263,5 g) and level of urea-SP36-KCl: 200-150-100 (239,7 g)

These data indicated that the ex-tin mining lands that previously converted as paddy filed requires a larger number of elements of N, P, K to get higher growth and yield of maize. This is understood since the high level of fertilizer nutrients were able to provide more nutrient needed by plants than low levels. This is in line with the results of the study (Marscher 1995) which states that N as forming compounds of amino acids and proteins for plant growth. Phosphate (P) is necessary for the growth of energy (ATP) including seed formation, while K stimulate translocation of photosynthesis from the leaves to other parts of the plant and contribute to the formation of plant carbohydrates.

In addition, the nutrient content of the soil in this study is low, so the application of fertilizer is important to fullfill the nutrient needs of maize crop. This proved the improvement of the quality of ex-tin mining lands through application of NPK fertilizer with a higher level could give a higher yield of maize. Jumin (2005) *in* Maruapey and Faesal (2010) reported that the production of a crop is resultanste of the process of photosynthesis, respiration, and decreasing the asimilat due to the translocation of dry matter yield. Meanwhile, Kasniari and Supadma (2007) *in* Maruapey and Faesal (2010) states that the elements of K has an important role in increasing the size and weight of seeds.

Table 3. Effect of fertilizer urea, SP-36, and KCl on plant height, stem diameter, weight of 1000 seeds, and maize yield.

Treatment (kg/ha)	Plant height (cm)	Stem diameter (cm)	Weight 1,000 seeds (g)	Yield (t/ha)
Urea-SP36-KCl: 200-150-100	191,07c	0,99b	239,71c	3,98b
Urea-SP36-KCl: 250-150-100	196,96b	1,10ab	263,46b	4,13b
Urea-SP36-KCl: 300-200-150	202,60a	1,44a	266,31a	4,43a

Values in the same column followed by the same letter were not significantly different at the 5% level using LSD method

Conclusion

Based on the results obtained, it can be concluded as follow:

1. Ex-tin mining lands have poor soil physical and chemical properties indicated by sand soil texture and low nutrient content of soil N, P, and K.
2. Appplication of fertilizer at level urea-SP-36-KCl: 300-200-150 kg/ha improved soil chemical properties, such as nutrient content of soil N, P, and K
3. Application of fertilizer at a level urea-SP36-KCl of 300-200-150 kg/ha gave higher growth and production of maize than level of urea-SP36-KCl of 250-150-100 kg/ha and 200-150-100 kg/ha.

References

Badan Pusat Statistik Provinsi Kepulauan Bangka Belitung. 2011. Kepulauan Bangka Belitung dalam angka. Pangkalpinang.

Inonu, I. 2011. Toleransi tanaman karet (Hevea brasiliensis Muell. Arg.) di tailing pasir untuk revegetasi lahan pasca tambang timah di Pulau Bangka. Disertasi. Program Pascasarjana Universitas Sriwijaya. Palembang. 133 p.

Jumin, H.B. 2005. Dasar-dasar agronomi. Edisi Revisi. Raja Grafindo Perkasa. Jakarta. 250p.

Kasniari, D.N. dan A.N. Supadma. 2007. Pengaruh pemberian beberapa dosis pupuk (N, P, K) dan jenis pupuk alternatif terhadap hasil tanaman padi (*Oriza sativa L.*) dan kadar N, P, K Inceptisol Selemadep, Tabanan. Agri-sitp, 26(4): 168-176.

Kepulauan Bangka Belitung Government. 2010. Profile of mining aspect in Kepulauan Bangka Belitung Province. Board of Mining, Government of Kepulauan Bangka Belitung Pangkalpinang.

Maruapey, A. dan Faesal. 2010. Pengaruh pemberian pupuk KCl terhadap pertumbuhan dan hasil jagea mays ceratina.L). Prosiding Pekan Seralia Nasional 2010. Balai Penelitian Tanaman Serealia Maros. pp. 315-326

Mutert, E. W. and J. Sri Adiningsih. 1996. Tropical upland improvement: comparative performance of different phosphorus source. *p*. 97-108. *In* Nutrient Management for Sustainable Crop Production in Asia. Proc. Of an International Conference held in Bali, Indonesia, 9-12 December 1996.

Marschner, H. 1995. Mineral Nutrition of Higher Plants. Academic Press. London. p.596-680

Notohadiprawiro, T. 1998. Tanah dan Lingkungan. Dirjen Pendidikan Tinggi. Depdikbud. Jakarta.

Ramon, C., R.J. Freud, and P.C. Spector. 1992. SAS systems for linier models. Third Edition. SAS Series in Statistical Application. SAS Institute Inc., 1992. 329 p.

Santoso, D. 1996. Development of phosphorus fertilizer use on acid soils in Indonesia. *p*. 7584. *In* Nutrient Management for Sustainable Crop Production in Asia. Proc. Of an International Conference held in Bali, Indonesia, 9-12 December 1996,

Setiadi, Y. 2002. Effect of Bio-organic on Soil and Plant Productivity Improvement of Post Tin Mine Site at PT. Koba Tin Project Area Bangka. Report to Enviromental and Forest Biotehcnology Laboratory, Bogor Agricultural University (tidak dipublikasikan).

Tan, K.H. 1982. Principles of Soil Chemistry. Marcel Dekke.Inc. New York.