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Recommendation of Phosphate and Potassium Fertilizers for Maize at Five Locations in Lampung

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ABSTRACT

Recommendation of Phosphate and Potassium Ferlilizers for Maize at Five Location in Lampung (J Barus and AM Murni):. Fertilizer recommendation in specific location will be related to fertilizers efficiency. The study was conducted at five locations which were planted with corn minimal once a year, namely: (1) Sidowaras village, Bumi Ratu Nuban Subdistrict, Lampung Tengah Regency; (2) Binjai Ngagung, Bekri Subdistrict, Lampung Selatan Regency; (3) Watu Agung, Kalirejo Subdistrict, Lampung Tengah Regency, (4) Balai Rejo, Kalirejo Subdistrict, Lampung Tengah Regency, and (5) Trimulyo, Tegineneng Subdistrict, Lampung Selatan Regency. The soil samples were analyzed in the Research and Development Centre for Soil and Agroclimate Laboratory in Bogor. The value of P and K in soil were compared to the results of correlation study using several extraction of P and K in Lampung. Results of the study showed that the status of P was high for three location, medium for one location and low for one location. K status was low for five locations. Phosphorus fertilizer recommendation on the three locations with high level of P (Sidowaras, Binjai Ngagung, and Balai Rejo) was 75 kg ha^{-1} SP-36, on the middle P levels (Trimulyo) was 150 kg and on the low level of P (Watu Agung) was 300 kg. On the other hand, the recommendation for K fertilizer for all locations were 150 kg ha^{-1} KCl.

Keywords: Fertilizers recommendation, nutrient status, phosphorus (P), potassium (K)

INTRODUCTION

Nitrogen (N), phosphorus (P), and potassium (K) are the major nutrients needed for maize growth and production. To produce a thousand kilogram of maize seed yield required 27.4 kg N, 4.8 kg P, and 18.4 kg K (Cooke 1985). Nitrogen is the most dominant limiting factor influencing the plant growth, seed yield, and nutrient uptakes. On the other hand, Syafruddin *et al.* (2009) reported that in the Inceptisol Haplustepts of Wolangi village, Bone, South Sulawesi, applications of P and K fertilizer were absolutely important to improve maize yield.

Some of nutrients required were came from soil (indigenous nutrient supply), however, to obtain high yield, the nutrient supply usually insufficient. Consequently, the addition of nutrient (fertilizer) was required in order to reach optimal of growth and yield (Dobbermann *et al*. 2003). Amount of fertilizers added should be suitable to soil nutrient status. So that the fertilizer can be used by crops efficiently. It is supported by the research of Hermawan (2005) that at soil with high P status, addition of P fertilizer (SP-36) up to 75 kg ha^{-1} increased yield of paddy, more dosages will reduce the yield.

Nutrient status of P and K in soil is determined from soil test with best extraction methods. This method is easy, quickly, simple, reproducible, and has high correlation with soil–plant nutrients test. For Oxisol Lampung, extraction of P with Bray-1 and K with NH_4OAC pH 4.8 have positive correlation to maize yields (Setyorini *et al.* 2007). Nutrient status of P and K in soil needs to be specified so that fertilizers added are more efficient. Barus (2007) reported that the yield of paddy in East Lampung still increased with application of P fertilizer at low and medium status of soil P, while at high soil P status it had no response.

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The research was aimed to determine nutrient status of P and K in soil, and to determine fertilizers recommendation of maize at five maize plantations in Lampung.

MATERIALS AND METHODS

Research Site

The research was conducted at March 2005 at five maize cropping locations, namely Sidowaras Village, District of Bumi Ratu Nuban; Binjai Ngagung Village, District of Bekri; Watu Agung Village and Balai Rejo, District of Kalirejo; and Trimulyo Village, District of Tegineneng. Soil types of locations are Kandiudult in Sidowaras, Binjai Ngagung and Trimulyo and Kanhapludult in Watu Agung and Balai Rejo (Isa *et al.* 2005).

Sampling and Soil Analysis

Soil sampling was conducted before planting maize at five locations. Composite soil samples were taken at tillage layer and analyzed for physical and chemical soil properties, especially rate of soil P_2O_5 using different extractions methods, namely HCl 25%, Bray 1 and Olsen, and rate of K_2O using extraction of NH_4OAC pH 4.8. Soil physical and chemical properties were analyzed in the Soil Laboratory of Bogor Soil Research.

Nutrient Status Analysis

To determine nutrient status class of soil P and K at five locations, the values from result of P and K analysis were compared to each correlation test of P and K using some extraction in Lampung and its nutrient status criterion (Setyorini *et al*. 2007). The results are shown at Table 1. After nutrient status class of P and K were determined, recommendations of fertilization of P and K at five locations center cultivation of maize in Lampung were calculated.

RESULT AND DISCUSSION

Soils Physical and Chemical Properties at Five Locations

The values of soil properties before planting are presented at Table 2. The soil texture in Sidowaras, Binjai Ngagung and Trimulyo were clay loam and in Watu Agung and Balai Rejo were sandy clay. The soil pH at five locations was low especially in Sidowaras Village and in Bali Rejo Village (<5.0). The level of organic matter was very low (especially in Watu Agung and in Balai Rejo (0.49 and 0.61%), total-N was also low (0.04-0.11%) at five locations.

Soil P potentials (extracted with 25% HCl) was high (>400 mg kg^{-1}) at three locations (Sidowaras, Binjai Ngagung and Trimulyo), medium (200 - 400 mg kg^{-1}) at one location (Watu Agung), and low (<400 mg kg^{-1}) at one location (Balai Rejo). Soil K potential (extraction with 25% HCl) was low (<200 mg kg^{-1}) for three locations (Watu Agung, Balai Rejo and Trimulyo), medium (100-200 mg kg^{-1}) for one location (Binjai Ngagung) and high (>200 mg kg^{-1}) for one location (Sidowaras).

Status of Soil P

The value of soil P available analysis using Olsen and Bray-I extraction methods at five cropping locations of maize in Lampung are presented at Table 4. According to Setyorini *et al.* (2007), extraction of P with Bray-I which had significant correlation with maize crop at Oxisol Lampung was able to determine nutrient status class of soil P at five locations.

Based on criteria of soil P nutrient status for maize in Oxisol Lampung (Table 1), then the nutrient status class of soil P for five locations of maize in Lampung were compiled (Table 4). Rate of soil P was hight at three locations, namely Sidowaras, Binjai Ngagung and Balai Rejo, one location was medium

Table 1. Criteria of soil P and K as a nutrient status for maize in Oxisol Lampung*.

Soil Analysis	Extraction	Creteria		
		Low	Medium	High
Soil-P (mg kg^{-1} P_2O_5)	Bray 1	< 20	20-35	>35
Soil-K (mg kg^{-1} K_2O)	NH_4OAC pH 4.8	< 5	5-15	>15

* (Setyorini *et al.* 2007).

Table 2. The values of soil properties before planting at five locations.

Soil properties	Locations				
	1	2	3	4	5
Textur :					
- Sand (%)	16	7	68	58	11
- Silt (%)	14	43	15	15	16
- Clay (%)	70	50	17	27	73
pH :					
- H_2O	4.4	5.1	5.3	4.9	5.1
- KCl	4.2	4.7	5.0	4.6	4.8
Total-N (%)	0.10	0.11	0.04	0.07	0.11
Organic-C(%)	1.23	1.46	0.49	0.61	1.41
C/N	12.3	13.25	12.3	10.5	12.8
NH_4-Acetat 1*N* pH 7.0					
- K	0.45	0.27	0.08	0.14	0.09
- Ca	3.38	6.84	2.48	3.19	6.31
- Mg	0.88	1.41	0.53	0.62	1.76
- Na	0.17	0.16	0.07	0.4	0.09
CEC	13.39	15.01	6.24	7.25	12.84
Base sat. (%)	40	58	51	56	64
Morgan					
- NH_4^-	1.05	1.56	0.90	1.57	1.29
- $NO3^-$	12.48	14.66	12.03	10.58	12.78

Notes: 1) Sidowaras Village, 2) Binjai Ngagung Village, 3) Watu Agung Village, 4) Balai Rejo Village, 5) Trimulyo Village.

Table 3. Soil P and K analysis at five cropping locations of maize in Lampung.

Type of analysis	Location				
	1	2	3	4	5
K_2O (mg kg^{-1})					
HCl 25 %	220	150	70	60	90
P_2O_5 (mg kg^{-1})					
HCl 25 %	510	820	170	240	400
Olsen	77	107	17	24	18
Bray-1	37.1	81.8	19.8	72.3	22.2

Notes: 1) Sidowaras Village, 2) Binjai Ngagung Village, 3) Watu Agung Village, 4) Balai Rejo Village, 5) Trimulyo Village.

(Trimulyo), and one was low (Watu Agung) although the value (19.80) was closed to medium criterion. The soil texture at Watu Agung Village was dominantly by sand (68%, Table 2) that had smaller surface area. Consecquenly the soil had smaller ability to adsorb nutrient and water compared to soil dominantly by clay (Buckman and Brady 1982). For paddy cultivated soil in Lampung Tengah Regency, Barus and Andarias (2007) reported that the soil was predominated by high status of soil P (61.5%), followed by medium status (35.84%), and low status 2.6%.

Table 4. Soil P content and their class status at five locations in maize plantation.

Locations	Soil P content and status (Bray-1) (mg kg^{-1} P_2O_5)		
	Low <20	Medium 20-35	High >35
1. Sidowaras	-	-	37.1
2. Binjai Ngagung	-	-	81.8
3. Watu Agung	19.8	-	-
4. Balai Rejo	-	-	72.3
5. Trimulyo	-	22.2	-

Table 5. Soil K content and their class status at five locations of maize plantation.

Locations	Soil K content and status (NH_4OAC pH 4.8) (mg kg^{-1} K_2O)		
	Low <5	Medium 5 - 15	High >15
1. Sidowaras	0.40	-	-
2. Binjai Ngagung	0.25	-	-
3. Watu Agung	0.07	-	-
4. Balai Rejo	0.14	-	-
5. Trimulyo	0.16	-	-

Table 6. Nutrient satus of soil P and fertilizer recommendation at five locations of maize plantation.

Locations	Soil P status and fertilizers recommendation		
	P Status	P_2O_5 (kg ha^{-1})	SP-36 (kg ha^{-1})
1. Sidowaras	High	27	75
2. Binjai Ngagung	High	27	75
3. Watu Agung	Low	108	300
4. Balai Rejo	High	27	75
5. Trimulyo	Medium	54	150

Tabel 7. Nutrient satus of soil K and fertilizer recommendation at five locations of maize plantation.

Locations	Soil K status and fertilizers recommendation		
	K status	K_2O (kg ha^{-1})	KCl (kg ha^{-1})
1. Sidowaras	Low	90	150
2. Binjai Ngagung	Low	90	150
3. Watu Agung	Low	90	150
4. Balai Rejo	Low	90	150
5. Trimulyo	Low	90	150

Status of Soil K

The value of soil K extracted by NH_4OAC pH 4.8 at five cropping locations of maize in Lampung were low (Table 5). According to research presented by Setyorini *et al*. (2007), the extraction of K that has high correlation with maize at Oxisol Lampung was NH_4OAC with pH 4.8. Based on criterion of soil K nutrient status (Table 1), it was compiled that the nutrient status class of soil K at five location of maize in Lampung (Table 4). The rate of K soil at five cropping locations of maize in Lampung was belong to low (0.8-4.5 mg kg^{-1} K_2O), consequently the soil K status was low at five locations.

Fertilizers Recommendation of P and K

After the P and K class status was determined, the fertilizers recommendation based on the calibration test that was carried out by Setyorini *et al*. (2007) was compiled. The P and K fertilizer recommendation at five locations are presented in Table 6 and 7. There were three locations with the high P status (Sidowaras, Binjai Ngagung, and Balai Rejo), so that the fertilizer recommendation was 27 kg ha^{-1} P_2O_5 or 75 kg ha^{-1} SP-36; on location that have medium status (Trimulyo), the fertilizer recommendation was 54 kg P_2O_5 or 150 kg SP-36; and on location with low status, the fertilizer recommendation was 108 kg P_2O_5 or 300 kg SP-36.

The fertilizer recommendation of potassium was similar at five locations, that was 90 kg K_2O or 150 kg KCl because all the locations have low status of soil K.

Fertilizers recommendation at specific location are useful for the allocation of fertilizer so that the farmers can fertilize their maize in accordance with the requirement of the soil nutrient status. Murni *et al*. (2006) reported that the results of the agronomy

Table 8. Amount of urea fertilizer, SP-36, KCl and NPK (15:15:15) resulted from agronomic survey at five locations of maize plantation

Location	Kind and amount of fertilizers applied (kg ha^{-1})			
	Urea	SP-36	KCl	NPK
1. Sidowaras	320	103	104	-
2. Binjai Ngagung	312	30	61	42
3. Watu Agung	428	71	71	-
4. Balai Rejo	288	142	56	-
5. Trimulyo	329	103	95	-

*) Murni (2007)

survey at five locations covered the planting method, the amount of fertilizer given, farming cost, etc. The amount of fertilizers used (urea, SP-36, KCl, and NPK) can be seen in the Table 8 (Murni 2007). P fertilizer applied was abundant (based on the P fertilizer recommendation to the Table 7) at Sidowaras Village and Balai Rejo Village. Application of SP-36 fertilizer under the recommendation dosage was occurred in two villages *i.e.* the Watu Agung Village and Trimulyo Village. At Binjai Ngagung village, the use of SP-36 was low (30 kg ha^{-1}), but generally the local farmer added their maize plantation with 42 kg ha^{-1} of NPK.

For the use of potassium fertilizer, the amount that was given (56 - 104 kg ha^{-1}) was really lower compared to the recommendation to all the locations (150 kg ha^{-1}). The low level input of fertilizer especially potassium was due to the expensive price and it was not readily available in the agricultural kiosk.

CONCLUSIONS

By determining the nutrient class status of P and K in soil, there were three locations with the high P status (Sidowaras, Binjai Ngagung, and Balai Rejo), so that the fertilizer recommendation was 27 kg ha^{-1} P_2O_5 or 75 kg ha^{-1} SP-36; one location medium status (Trimulyo), so the fertilizer recommendation was 54 kg P_2O_5 or 150 kg SP-36; and one location was low status, so the fertilizer recommendation was 108 kg P_2O_5 or 300 kg SP-36. The fertilizer recommendation of potassium was similar at five locations that was 90 kg K_2O or 150 kg KCl because all locations had low status of potassium.

REFERENCES

Barus J. 2007. Penghitungan dosis optimum pemupukan pada berbagai status P tanah dengan fungsi Mitcherlich-Bray. *J Tanah Trop* 12 (2): 99-104 (in Indonesian).

Barus J and AM Murni. 2007. Status hara fosfor dan kalium tanah sawah Kabupaten Lampung Tengah. *J Tanah Lingk* 9 (1): 16 -19 (in Indonesian).

Buckman HO and NC Brady. 1982. The Nature and Properties of Soils 7th Ed. The Macmillan Company, New York.

Cooke GW. 1985. Fertilizing for Maximum Yield. Granada Publ., London. p. 75-87.

Dobermann A, CWitt, S Abdulrahman, HC Gines, R Nagarajan, TT Son, PSTan, GH Wang, NV Chien, VTK Thoa, CV Phung, P Stalin, P Muthukrishnan, V Ravi, M Babu, GC Simbahan, MAA Adviento and V Bartolome. 2003. Estimating indigenous nutrient supplies for site-spesific nutrient management in irrigated rice. *Agron J* 95: 924-935.

Hermawan B. 2005. Penetapan status fosfor dan rekomendasi spesifik lokasi pada tanaman padi. *J Penel Unib* XI (1): 1-8 (in Indonesian).

Isa AF, K Nugroho, Subarma, and F Agus. 2005. Soil profile description: Site-spesific nutrient management for maize in experimental site in North Sumatera, Lampung, Central Java, East Java and South Sulawesi. Indonesian Soil Research Institute in collaboration with PPI/PPIC and IP Southeast Asia Program. 54 p.

Murni AM, J Barus, Slameto, and Kiswanto. 2006. Progres Report Hasil Survei Agronomik Pertanaman Jagung di Lampung. Disampaikan pada Lokakarya Site Spesifik Nutrient Manajement (SSNM) Jagung di Pusat Penelitian Tanaman Pangan Bogor (in Indonesian).

Murni AM. 2007. Effect of omission plot on agronomic performance of maize. *J Akta Agrosia* 10 (1): 87-93.

.

Syafruddin, M Rauf, Y Rahmi, Arvan and M Akil. 2009. Requirements for N, P, and K fertilizers on Inceptisol Haplustets Soil. *Indon J Agric* 2 (1): 77-84.

Setyorini D, MT Sutriadi and AM Murni. 2007. Penentuan kebutuhan pupuk P dengan uji P-tanah untuk tanaman jagung di Typic Kandiudox. Balai Penelitian Tanah, Bogor. Belum diterbitkan. 17 p. (in Indonesian).