IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals
HUMAN

Human Journals
Research Article
September 2017 Vol.:7, Issue:3

The Effect of Empty Bunch of Palm Oil and NPK on Corn (*Zea mays* L) and NPK Efficiency in Critical Inceptisol of North Sumatra

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Submission: 21 August 2017
Accepted: 30 August 2017
Published: 30 September 2017

HUMAN JOURNALS
www.ijsrm.humanjournals.com

Keywords: Inceptisol, TKS, NPK, Efficiency, Maize

ABSTRACT

A study aimed to study the response of TKS compost and NPK fertilizer to growth and yield of corn (*Zea mays*) and efficiency of TKS-NPK on critical Inceptisol soil have been conducted. This field research was conducted at Experimental Farm, Agriculture Faculty of North Sumatra Islamic University, Village of Gedung, Johor, District of Medan Johor, and Province of North Sumatera, Indonesia. The research site is located at an altitude of ± 45 meters above sea level with flat topography. The experiment is using Factorial Randomized Block Design consisting of two factors namely NPK (N) fertilizer and TKS (T). Factor of TKS (T) compost is consisted of 3 levels: T_0 = Control, T_1 = 2 kg/plot, T_2 = 4 kg/plot, while the NPK factor (N) consists of 3 levels, namely: N_0 = Control, N_1 = 30 g/plot, N_2 = 60 g/plot. The Inceptisol soil was considered as critical due to very low N content, low K-exchangeable (K-dd) and moderate P-Bray-2, low soil pH and low C-organic. Application of TKS and NPK, each significantly influences all variables (plant height, stem diameter, leaf chlorophyll, fresh weight, dry weight, cob weight/plant, cob diameter, and pipe weight). The interaction of TKS and NPK showed that TKS could increase the effect of NPK on stem diameter, leaf chlorophyll, cob weight/plant, cob diameter. Relative Efficiency (ER) of NPK is higher (2-5%) than TKS in improving growth and yield of crops. In other words, TKS is able to increase the efficiency of NPK on corn at critical Inceptisol soils.

INTRODUCTION

Corn (*Zea mays*) is one of the important crops as a source of carbohydrates. Some Indonesian people, for example, Madura and Nusa Tenggara, uses corn as staple food. Beside as source of carbohydrates, corn also is used as animal feed (the forage and cob), sources of corn oil (from seeds), corn flour (maize), and industrial raw materials (from seed and cob flour). Corn cobs are also rich with pentoses (AAK, 1993; Purwono and Hartono, 2005).

The critical soil is a soil that is physical, chemically and/or biologically damaged so that the soil quality and productivity are low. Such condition has a wide impact on various functions among others: agricultural production, hydrological functions, settlements and socio-economic life around the area affected. In Indonesia, the critical land is around 23.2 million ha and tends to increase due to various factors. Generally, the soil nutrient content, such as N, P, and K is low and as inhibiting factor to the growth and yield of plants (Setiawan, 1996; BPS, 2002; Wahono, 2002; Brady and Weil, 2002). Therefore, the addition of N, P, and K as a conservation effort becomes important to meet the needs of plant nutrients. But the use of synthetic fertilizer faces another problem because the price is expensive.

Palm Oil Bunches Compost (TKS) has great potential to improve the quality and productivity of the critical soil. This material can be utilized for critical land conservation due to the contribution as the source of organic fertilizer and contains a number of nutrients (N, P, K, Ca, Mg) needed by plants (Yani, 2010). The content of TKS compost consists of 2-3% N, 0.2-0.4% P_2O5, 4-6% K, 1-2% Ca, and 0.8-1.0% Mg, 5-10% C, 45-50% water, and 12.60% ash. In addition, TKS also contains several substances such as humic acid, antibiotics, and hormones that contribute to increasing plant growth (PPKS, 2008).

The effect of NPK fertilizer on crops has been studied and reported extensively (Agustina, 2004; Iskandar, 1998; Sania, 1998; Suprapto, 2000). But recently, the provision of fertilizer is always experiencing scarcity and expensive (Novizan, 2005) so that farmers have difficulty to get it at affordable prices. Such condition encourages researchers to find methods and agro-technology to overcome this problem. Based on the composition, utilization of TKS is expected to make efficient use of NPK fertilizer because the TKS contains organic materials, nutrients, and hormones that can substitute/reduce the need for NPK fertilizer.

However, research on the utilization of TKS to conserve critical soils and at the same time efficient efforts to use NPK for corn is still relatively limited in publications. Therefore, the purpose of this study was to study: (a) the effect of TKS compost application on corn at critical Inceptisol soil, (b) the effect of NPK application on corn at critical Inceptisol soil, (c) the effect of TKS and NPK interaction on corn at critical Inceptisol soil, and (d) the role of TKS compost on the efficiency of NPK on corn at critical Inceptisol soil.

EXPERIMENTAL

This research was conducted on critical Inceptisol soil, located in Experimental Farm, Agriculture Faculty of North Sumatra Islamic University, Village of Gedung Johor, District of Medan Johor, Province of North Sumatera which is at 45 m asl on flat topography. This soil is considered critical because the content of nutrient and organic matter is low. Some soil chemical properties were analyzed such as N (Kjeldahl), P (Bray 2), K (NH_4OAc pH 7.0), and C-organic (Walkley and Black), and pH-H_2O; while the TKS properties are N, P, K, Ca, Mg, C, water, ash, and organic matter.

Materials used in the study consisted of corn seed (Pioneer 12), NPK fertilizer, TKS compost, Reagent (insecticide), and Dithane (fungicide).

This experiment uses Factorial Randomized Block Design (RAK), consisting of two factors namely TKS and NPK. TKS treatment is consists of 3 levels (T_0 = 0 kg/plot, T_1 = 2 kg/plot, and T_2 = 4 kg/plot, while NPK consists of 3 levels (N_0 = 0 g/plot, N_1 = 30 g/plot (half of recommended dose), and N_2 = 60 g/plot (according to recommended dosage). Therefore, there are 9 treatments and each treatment repeated 3 times so that there are 27 treatment units. The plot is 200 x 200 cm, the planting space is 75 x 40 cm and the plant population is 15 plants/plot The cultivation is carried out according to generally accepted guidelines (AAK, 1993; Anonimus, 2003 and 2004) The observed variables include: plant height, stem diameter, amount of chlorophyll, fresh weight, dry weight, cob weight/plant, cob diameter, and pipe weight.

RESULTS AND DISCUSSION

1. Soil Analysis

The results of soil analysis conducted at the beginning of the study are presented in Table 1. The table shows that the N element is very low, K-exchangeable (K-dd) is low, P-Bray-2 is moderate, soil pH is moderate, and C-organic is low. The low nutrient content (N, P, and K) and organic matter prove that Inceptisol soil can be considered as critical/marginal soil. If fertilizer and organic material are not added as well as relevant agro-technology then the soil quality will tend to decrease so that the productivity is low and tend to decline.

Table 1: Analysis of Some *Inceptisol* soil properties

Sr. No	Soil Properties	Result	Criteria
1	pH (H_2O)	5,61	Moderate
2	N (%)	0,02	Very low
3	C-Organic (%)	1,02	Low
4	P Bray II(ppm)	24,04	Moderate
5	K – dd (me/100g)	0,17	Low

2. TKS Compost Analysis

The analysis results of TKS compost is presented in Table 2. The table shows that TKS contains nutrients (N, P, K, Ca, and Mg) required by relatively high by plant and organic matter content is more than 50%.

Table 2: Analysis of Some TKS Properties

Sr. No.	Composition	Value (%)
1	Air	45-50
2	Abu	12,60
3	N	2 - 3
4	C	35,10
5	P	0,2 - 0,4
6	K	4 - 6
7	Ca	1- 2
8	Mg	0,8 - 1,0
9	C/N	15,03
10	Organic Matter	>50%

The C/N ratio is 15.03, indicates that the nutrients in TKS are in the mineralized phase, that is N-organic being transformed into inorganic which available to plants (Alexander 1977).

The high levels of organic matter in TKS can increase the soil organic matter and in turn improve soil physical, physic-chemical and biological properties that provide the good effect to soil quality and increase the growth and yield of corn.

3. Response of TKS Application on the Growth and Yield of Corn

The effect of TKS on the growth and yield of corn is presented in Table 3. Table 3 shows that TKS significantly affect all observed variables (plant height, stem diameter, leaf chlorophyll, fresh weight, dry weight, cob weight/plant, cob diameter, and pipe weight).

Table 3: Effect of TKS Application on the growth and Yield of Corn

Variable	TKS (kg/plot)			Regression coef		Correlation Coef
	0	2	4	a	b	r
plant height, cm	85.45cC	91.51bB	97.96aA	85,38	3,12	0.99
stem diameter, cm	1.46cC	1.85aA	1.81aAbB	1,53	0,08	0,66
leaf chlorophyll	38.63cB	39.15bB	40.13aA	78,02	75,34	0,82
fresh weight, g/tanaman	362.72bB	362.27bB	406.49aA	355,28	10,94	0,74
dry weight, g/tanaman	173.33bB	182.13bB	197.97aA	172,16	6,16	0,97
cob weight, g/tan	281.66cC	307.49bB	339.99aA	280,55	14,58	0,99
cob diameter, cm	4.11bB	3.59cC	4.40aA	3,88	0,07	0,12
pipe weight, g/tanaman	189.98cC	194.23bB	198.23aA	190,02	2,06	0,99

The numbers in rows followed by the same letter do not differ at P = 5% (lower case) P = 1% (uppercase) based on the DMRT (Duncan Multiple Range Test)

The result proves that TKS can increase the growth and production of corn on critical Inceptisol soil. This is because some TKS properties able to : (a) provide nutrients needed by plants such as K (6%), N (3%), and P (0, 4%), (b) improve the physical, chemical and biological properties of the soil through organic material in TKS, (c) improve soil structure that create better soil aeration conditions for the development of plant roots, (d) increase the water holding capacity so that it can regulate the adequacy of water to support nutrients solubility and ions mobility from the soil to the roots of plants, (e) releasing nutrients slowly to avoid nutrient leaching by percolation water and available constantly during the growth phase, and (f) stimulate better growth of the root system through humic acid, antibiotics and hormones (Basyaruddin, 2013; Pasaribu, 2010). Therefore, the resultant effect of TKS are improving critical Inceptisol soil properties and conditions and in turn, increase the growth and production of corn.

4. Effect of NPK Application on The Growth and Yield of Corn

The effect of NPK on the growth and yield of Corn is presented in Table 4. Table 4 shows that NPK significantly affects all observed variables including plant height, stem diameter, leaf chlorophyll, fresh weight, dry weight, Cob weight/plant, cob diameter, and pipe weight.

Table 4: Effect of NPK Application on The Growth and Yield of Corn

Variable	NPK (g/plot)			Regression coef		Correlation Coef
	0	30	60	a	b	R
plant height, cm	81.14cC	91.82bB	101.96aA	81,23	0,34	0,99
stem diameter, cm	1.53cC	1.74bB	2.25aA	1,48	0,01	0,94
leaf chlorophyll	38.26cC	39.16bB	40.48aA	38,19	0,03	0,98
fresh weight, g/tanaman	345.44cC	371.41bB	414.63aA	342,57	1,15	0,97
dry weight, g/tanaman	165cB	179.38bB	209.06aA	162,45	0,73	0,96
cob weight, g/tan	254.71cC	326.10bAB	348.33aA	261,9	1,56	0,91
cob diameter, cm	3.73cC	4.10bB	4.28aA	3,76	0,009	0,96
pipe weight, g/tanaman	187.22cC	194.40bB	200.82aA	187,35	0,22	0,99

The numbers in rows followed by the same letter do not differ at P = 5% (lower case) P = 1% (uppercase) based on the DMRT (Duncan Multiple Range Test).

Table 4 also shows that there is a strong linear relationship between NPK application and all the observed variables as shown by the high correlation coefficient (r), 0.91 to 0.99, in the regression (a and b).

The high response and correlation of NPK application on the growth and yield of Corn at critical Inceptisol soil can be explained by soil condition and crop properties, such as (a) Soil nutrient content is low namely N (0.02%), P (24.04 Ppm), K (0.17 me/100g), (b) Soil organic matter is low (1.02%), (c) demand of corn on N, P and K is relatively high (4) corn is indicators plant that has high response to fertilization. Low nutrient and soil organic matter; coupled with high demand for NPK and high response of Corn can be met by NPK application to support response on growth and yield of Corn. Based on the linear regression relationship between growth and yield, the calculation of NPK requirement of Corn on critical Inceptisol soil was 60 g/plot.

5. Interaction of TKS an NPK application on The Growth and Yield of Corn

The relationship between TKS and NPK applications with the weight of corn cobs is shown in Figure 1. Figure 1 shows that the relationship of TKS and the cob weight at each NPK dosage is linear. In the treatment of TKS without NPK (No), the relationship is Y = 21.66x + 211.3, r = 0.86, N_1 is Y = 8.125x + 309.8, r = 0.38, and N_2 is Y = 13.96x + 320.4, r = 0.99.

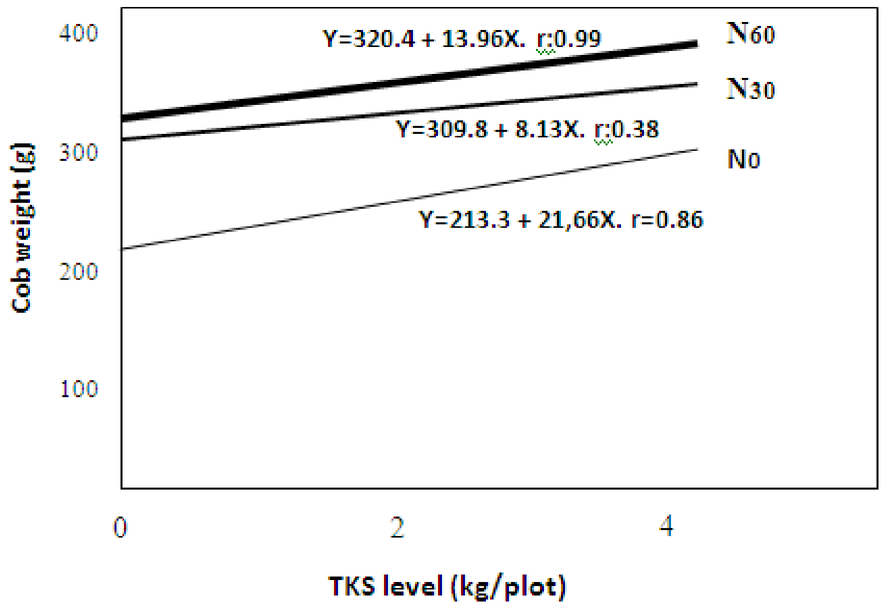

Figure 1: Effect of TKS at different NPK level

The relationship as shown in Figure 1 proves that there is an interaction between TKS and NPK application. TKS application increases the effect of NPK on the cobs weight. In other words, the effect of NPK is increased by increasing of TKS application. The phenomenon of interaction effects of TKS-NPK can be caused by several mechanisms such as: (a) TKS increase N, P and K in the soil and more available for plant growth, (b) TKS add organic material that improves the quality of physical, chemical and biological soil properties which create conducive soil for root system development. (c) TKS may act as ground cover that reduces N evaporation and maintains their availability, (d) organic matter components, especially humic acid, may extend soil CEC which potentially reduce loss of K, Ca, Mg by leaching, and prevent P from Fe-oxide (and/or –Al) absorption processes so that the efficiency, effectiveness, and availability of P increases, (e) the organic matter in TKS also increases the water holding capacity which supports the dissolution process and mobility of nutrient ions from NPK and maintain nutrient absorption process during the growth period. Such condition creates positive synergy of TKS-NPK interaction to improve soil quality which in turn improve the growth and yield of corn.

The interaction of TKS-NPK shows that the effect of NPK is more dominant than TKS. Such condition appears in the relation of increased NPK doses with cob weight compared to the effect of TKS (Figures 1 and 5).

Table 5. Mean of Cobs Weight with TKS and NPK application and TKS-NPK effect ratio

TKS does (kg/plot)	Mean of Cobs Weight TKS (g/plant)	NPK dose (g/plot)	Mean of Cobs Weight NPK (g/tan)	Ratio TKS/NPK*
0	281,66	0	254,71	1,11
2	307,49	30	326,1	0,94
4	339,99	60	348,33	0,98

**) TKS/NPK ratio: means of cob weight TKS/ means of cob weight NPK*

The dominant effect of NPK, as shown in Figure 1, can be caused by among others: NPK reacts faster in the soil so easily available and can be directly absorbed by the plant, while the nutrients contained in TKS are likely to be slower available as part of decomposition and mineralization process but better to improve soil physical properties. However, the interaction of TKS-NPK is positive, mutual improvement, it can be an alternative to improve soil quality and support the growth and yield of corn.

6. Efficiency of TKS application on NPK

Relative Efficiency (ER) is calculated based on the ratio of the maximum value of TKS effect (TKS-max) to the maximum value of NPK effect (NPK-max) on each variable expressed in percent. (ER = TKS-max / NPK-max x 100%).

The ER calculation is shown in Table 6. Table 6 shows that all variables have ER value greater than 1, except the leaf chlorophyll equal to 1 (100%), and cob diameter is less than 1 (0.97). In general, however, the ER value is close to 1 indicating that the effect of TKS is lower but not significantly different from NPK effect. In general, ER at NPK is higher (2-5%) than TKS in improving plant growth and yield. In other words, the application of TKS can improve the efficiency of NPK for corn in critical Inceptisol soil.

Table 6: Ratio of TKS_{max}/NPK_{max} and Relative Efficiency according to maximum effect on each variable

Sr. No.	Peubah	Nisbah NPK_{max}/TKS_{max}	Efisiensi Relatif (ER)(Nisbah x100%)	Kriteria ER		
				<1	1	> 1
1	Plant height	1,04	104,08			*
2	Stem diameter	1,24	124,30			*
3	Leaf chlorophyll	1	100,00		*	
4	Fresh weight	1,02	102,00			*
5	Dry weight	1,05	105,60			*
6	Cob weight	1,02	102,45			*
7	Cob diameter	0,97	97,27	*		
8	Pipe weight	1,01	101,30			*

Note: NPK_{max}/TKS_{max}= the highest data value of NPK and TKS. Ratio value with criteria = 1= effect of NPK= TKS ;<1= effect of NPK < TKS ; >1= effect of NPK > TKS

CONCLUSION

1. Inceptisol soil is characterized by low N content, low K, medium P, and very low soil organic matter then considered as critical soil.

2. TKS application has significant effect on plant height, stem diameter, leaf chlorophyll, fresh weight, dry weight, cob weight, cob diameter and pipe weight.

3. NPK application has significant effect on plant height, stem diameter, leaf chlorophyll, fresh weight, dry weight, cob weight, cob diameter and pipe weight.

4. Interaction of TKS and NPK significantly increase the amount of leaf chlorophyll, cob weight, and diameter.

5. TKS application increase ER of NPK by 2-5% in improving growth and yield of corn on critical Inceptisol soil.

6. TKS can be used to substitute part of NPK and increase the role or effect on corn at critical Inceptisol soil.

RECOMMENDATION

1. To obtain more applicative and extensive agrotechnology, research needs to be done on the effective composition of TKS-NPK, either related to soil type (Ultisol, Oxisol, etc.) and crop types.
2. Perlu diteliti lebih lanjut tentang pengaruh residu terhadap perubahan sifat tanah dan aplikasi pupuk pada generasi tanaman berikutnya.
3. It should be further investigated the effect of residues on soil properties and fertilizer application on the next generation.

REFERENCES

1. Ade Iwan Setiawan, 1996. Penghijauan Lahan Kritis. Penebar Swadaya. Jakarta.
2. Agustina, A.F. 2004, Pengaruh Komposisi Media dan Jenis Pupuk terhadap Pertumbuhan Bibit. PT Bumi Aksara. Jakarta.
3. Basyaruddin. 2013. Pengelolaan Tanah dan Air. Ciptapustaka.ISBN 203 hal
4. AKK.1993. Teknik Bercocok Tanam Jagung. Yogyakarta.Kanisius.
5. Alexander, M. 1977. Introduction to Soil Microbiology. 2th. John Wiley and Sons, 467 p
6. Anonymous, 2003. Teknik Bercocok Tanam Jagung. Kanisius, Yogyakarta.
7. Anonimus, 2004. Syarat Pertumbuhan Tanaman, PT. Raja Grafindo. Jakarta.
8. BPS, 2002. Statistik Indonesia. Biro Pusat Statistik, Jakarta.
9. Iskandar, D. 1998. Pengaruh Dosis Pupuk N,P dan K Terhadap Pertumbuhan dan Produksi Tanaman jagung di Lahan Kering. Jurnal Sains dan Teknologi BPPT.http://www.iptek.net.id.htm.
10. Novizan, 2005. Petunjuk Penggunaan Pupuk Yang Efektif. Agromedia Pustaka, Jakarta.
11. Pasaribu,M 2010 *Pemanfaatan Tandan Kosong sawit(TKS) dan Mikoriza Sebagai Media Tumbuh Anakan Gaharu(Aquilaria malaccensis Lamk).* Skripsi Sarjana Pertanian Universitas Sumatera Utara.Medan.
12. PPKS, 2008. Aplikasi Kompos TKS pada Kelapa Sawit TM. Pusat Penelitian Kelapa Sawit.
13. Purwono dan R. Hartono, 2005. Bertanam Jagung Unggul. Penebar Swadaya, Jakarta.
14. Sania. 1988. Teknologi. Pusat Penelitian dan Pengembangan Tanaman Pangan. Bogor. Badan Penelitian dan Pengembangan Pertanian.
15. Suprapto, H.S. 2000. Bertanam Jagung. Penebar Swadaya, Jakarta.
16. Wahono, 2002. Rehabilitasi Lahan. Dinas Kehutanan dan Pekerbunan Kabupaten Kapuas Hulu, Putussibau.
17. Yani,A. 2010.Pemanfaatan Sisa Kelapa Sawit. http//ms.shvoong.com/tugas/pemanfaatan-Sisa-Sawit.
18. Barrow,C.J.1991. Land Degradation, Development and Breakdown of Terrestrial Environment. Cambridge Univ.Press 295 p.
19. Brady, N. and R.Weil. 2002. The Nature and Properties of Soils. 13th Ed.Prantice Hall, New Jersey 960p