

Effectiveness of Organonitrofos Plus Fertilizer on Sweet Corn and Soil Chemical Properties of Ultisols

Dermiyati^a, Setyo Dwi Utomo^a, Kuswanta Futas Hidayat^a, Jamalam Lumbanraja^a, Sugeng Triyono^b, Hanung Ismono^c, Ni'malia Estika Ratna^a, Nidya Triana Putri^a, dan Rianida Taisa^a

^aDepartment of Agrotechnology, ^bDepartment of Agricultural and Biological Engineering,
^cDepartment Agricultural Economics, Faculty of Agriculture University of Lampung,
Jl. Sumantri Brojonegoro No. 1, Bandar Lampung 35145,
e-mail: dermiyati.1963@fp.unila.ac.id

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ABSTRACT

This Study aimed to examine the effect of Organonitrofos Plus fertilizer (OP) on sweet corn (*Zea mays* Saccharata L.) and soil chemical properties of Ultisols. Organonitrofos Plus fertilizer is an enhancement of Organonitrofos fertilizer enriched with microbes at the beginning of the manufacturing process. Research was conducted in the green house of Agriculture Integrated Field Laboratory of Lampung University. Treatment applied was a factorial of $4 \times 2 \times 3$ with three replications in a randomized block design. The first factor was the dose of OP fertilizer (0, 10, 20, 30 Mg ha⁻¹), the second factor was the dose of inorganic fertilizers (without inorganic fertilizers, and with inorganic fertilizers, namely Urea 0.44, 0.28 SP-36 and KCl 0.16 Mg ha⁻¹), and the third factor was the dose of biochar (0, 10, 20 Mg ha⁻¹). Application of OP fertilizer, inorganic fertilizer, and the interaction between the OP and the inorganic fertilizers increased the weight of dry stover, cob length, cob diameter, cob with husk and cob without husk of corn. OP fertilizers which are applied in Ultisols can improve soil fertility and increase corn production so that OP fertilizer can lessen the use of inorganic fertilizer and can be used as a substitute for inorganic fertilizer. RAE values were highest in treatment of O4K2B2 (30 Mg OP ha⁻¹, with inorganic fertilizer, 10 Mg biochar ha⁻¹) that was equal to 181%, followed by O2K2B3 (10 Mg OP ha⁻¹, with inorganic fertilizer, 20 Mg biochar ha⁻¹) with the difference in RAE value of 0.5%.

Keywords: Agronomic relative effectiveness, biochar, organic fertilizer, uptake of N, P, K

ABSTRAK

Penelitian ini bertujuan untuk melakukan pengujian pupuk Organonitrofos Plus (OP) pada jagung manis (*Zea mays* Saccharata L.) dan pengaruhnya terhadap perubahan sifat kimia tanah Ultisols. Pupuk Organonitrofos Plus merupakan pengembangan dari pupuk Organonitrofos yang diperkaya dengan mikroba pada saat awal proses pembuatannya. Penelitian dilakukan di rumah kaca Laboratorium Pertanian Terpadu Universitas Lampung. Perlakuan yang diterapkan adalah faktorial $4 \times 2 \times 3$ dengan 3 ulangan dalam Rancangan Acak Kelompok. Faktor pertama adalah dosis pupuk OP (0, 10, 20, 30 Mg ha⁻¹), faktor kedua adalah dosis pupuk anorganik (tanpa pupuk anorganik dan dengan pupuk anorganik, yaitu Urea 0,44, SP-36 0,28, dan KCl 0,16 Mg ha⁻¹), dan faktor ketiga adalah dosis biochar (0, 10, 20 Mg ha⁻¹). Pemberian pupuk OP tunggal, pupuk anorganik, dan interaksi antara OP dan anorganik meningkatkan bobot brangkasan kering, panjang tongkol, diameter tongkol, bobot tongkol dengan kelobot, dan bobot tongkol tanpa kelobot. Pemberian pupuk OP dapat memperbaiki kesuburan tanah Ultisols dan meningkatkan produksi tanaman jagung sehingga pupuk OP dapat mengurangi pemakaian pupuk anorganik dan dapat dijadikan substitusi pupuk anorganik. Nilai RAE tertinggi ada pada perlakuan O4K2B2 (30 Mg OP ha⁻¹, dengan pupuk anorganik, 10 Mg biochar ha⁻¹) yaitu sebesar 181 % diikuti O2K2B3 (10 Mg OP ha⁻¹, dengan pupuk anorganik, 20 Mg biochar ha⁻¹) dengan selisih nilai RAE sebesar 0,5%.

Kata kunci: Biochar, pupuk organik, relative agronomic effectiveness, serapan hara N, P, K.

INTRODUCTION

Sweet corn is one of a horticulture commodity that is very popular for Indonesian because it has several advantages compared to ordinary corn. Sweet taste in sweet corn is due to the high sucrose content in the endosperm at the milk stage (Joseph 2008). In addition, sweet corn has short age of harvesting than ordinary corn and the price is higher, so it is very profitable if cultivated (Anonymous 2012). However, the productivity of sweet corn in Indonesia is still low. Sweet corn production in Lampung in 2012 around 4-5 Mg ha⁻¹ (BPS 2013). According to Prasetyo and Suriadikarta (2006), one of the lowest obstacles for production of sweet corn in Lampung Province because the land in Lampung is dominated by Ultisols that contains low nutrients, high acidity and low soil organic matter. Ultisols in Lampung Province about 1.24 million ha (Subagyo *et al.* 2004). While Akil (2010) stated that for every 1 Mg of corn kernels produced, corn plants require 27.4 kg N, 4.8 kg P, and 18.4 kg K. Thus, to get the nutrients need of sweet corn as well as to increase soil productivity in Ultisols are required inorganic and organic fertilizers. The use of fertilizers in a balanced between inorganic and organic fertilizers can meet nutrients need of sweet corn.

In addition, the application of biochar as an ameliorant are also expected to improve soil fertility of Ultisols. Utilization of local potential in the Lampung Province, like organic waste from animals, plants, and industries, inspired Nugroho *et al.* (2012) assembled Organonitrofos fertilizer which later was developed into Organonitrofos Plus fertilizer made from fresh manure, MSG waste, coconut husk, etc. and enriched with microbes (such as, N-fixer, phosphate solubilizer, and *Trichoderma* sp.) in term to improve the quality of fertilizer. Therefore, the testing of Organonitrofos Plus fertilizer on sweet corn and its impact on changes in soil chemical properties of Ultisols were needed to be done.

MATERIALS AND METHODS

Experimental sites

Research was conducted in two activities, which was sweet corn planting in green house of Agriculture Integrated Field Laboratory at University of Lampung and Soil Analysis was at Laboratory of Soil Science University of Lampung.

Soil Preparation

The soil samples came from the field of Research Center of Agricultural and Land Resources Development at Taman Bogo, East Lampung. The soil samples were taken from the subsoil (20-40 cm). Soil sampling from subsoil aimed to get soil samples which were free from the effect of fertilizer and pesticide treatment which was applied to the previous field because it was difficult to get a soil sample from virgin soil. The soil was cleaned from the roots, dried, mashed, and sifted using a 2 mm diameter sieve. Then the soil is weighed according to its needs and put it in polybags. For sweet corn planting was used 20 kg soil (Dry weight from oven) and for Soil Analysis used soil as much as 1 kg (Dry weight from oven). Determination of dry weight from oven based on water content of soil samples. Measurement of moisture content by weighing 10 g of soil, then put the soils in the oven with 105 °C for 24 hours.

$$WC(\%) = \frac{WW - DW}{DW} \times 100\%$$

Notes :

WC = Water content (%)

WW = Wet weight

DW = Dry weight

Soil physical and chemical properties before planting as well as nutrients content of OP and biochar are presented in Table 1. Organonitrofos Plus and biochar fertilizers contains high Organic Carbon, N, P, and K.

Soil Analysis

The Soil Analysis was done through an incubation for 3 months on the treated Ultisols. Each polybag was filled by 1 kg of soil (Dry weight from oven) (WC = 6.38%) so that the weight of soil in each polybag as much as 1.06 kg. Each polybag was suitably treated and watered up to 75% of the field capacity. Then the polybag end was tied up and each polybag was weighed. Routinely every week polybags were weighed and water was added to the original weight if necessary. Changes in soil chemistry properties of Taman Bogo Ultisols due to treatment were observed after incubation for 3 months. The soil chemistry properties observed were total-N, total-P, available-P, total-K, K_{exc}, pH, Cation Exchange Capacity (CEC), Base Saturation, and Organic-C.

Plant Analysis

Sweet corn Bonanza variety was used as indicator plant. In each polybag was planted two

Table 1. Properties of Ultisols, Organonitrofos Plus” fertilizer and biochar.

| Properties | Ultisol | Organonitrophos Plus | Rice husks biochar |
|--------------------------------------|---------|----------------------|--------------------|
| Total-N (g kg ⁻¹) | 0.08 | 1.13 | 0.76 |
| Total-P (g kg ⁻¹) | | 5.58 | |
| Available-P (mg kg ⁻¹) | 3.25 | | 190.72 |
| Total-K (g kg ⁻¹) | | 1.13 | |
| Exchangeable-K (g kg ⁻¹) | 0.16 | | 1588 |
| Organic-C (g kg ⁻¹) | 0.95 | 9.52 | 2.82 |
| pH | 4.61 | 7.30 | 7.9 |
| CEC(me 100 g ⁻¹) | 3.43 | | |
| Soil texture | Clay | | |
| Sand (%) | 35.71 | | |
| Silt (%) | 16.24 | | |
| Clay (%) | 48.05 | | |

seeds of sweet corn, then thinning was done at one week after planting and grown one plant per polybag. The plant analysis was done to examined the effect of treatments on the growth and production of sweetcorn, the analysis was done by duplo study. A series of treatments were for growth observation to the final vegetative phase and one other series were for observation of sweet corn production up to the end of the generative phase. The variables observed were dry weight of plant, nutrient uptake of N, P, and K, cob diameter, length of cob, weights of cobeither with huskor without husk.

Relative Agronomic Efectiveness (RAE)

RAE isthe comparison between the yield increase due to the use of fertilizer which is being tested with the increase in yield on the standard fertilizer multiplied by 100%. The effectiveness test of OP Plus was calculated on the basis of Relative Agronomic Evaluation (RAE) with the formula :

$$RAE = \frac{\text{Tested fertilizer} - \text{control}}{\text{Standard fertilizer} - \text{control}} \times 100\%$$

Notes : RAE value > 100% then the tested fertilizer is effective compared to standard treatment.

Experimental Design

This research was conducted factorially 4 × 2 × 3 in a randomized block design, with 3 replications. The first factor was the dosage of Organonitrofos Plus fertilizer (0, 10, 20, 30 Mg ha⁻¹). The second factor was the dose of inorganic fertilizers (without inorganic fertilizers and Urea 0.44, SP-36 0.28, KCl 0.16 Mg ha⁻¹). Meanwhile, the third factor was the dosage of biochar (0, 10, and 20 Mg ha⁻¹).

Statistical Analysis

The data obtained were tested for their homogeneity with the Bartlett Test and its aditivity with the Tukey test. If the assumption was fulfilled then the data was analyzed by analysis of variance. The difference between the mean values was tested with the Honestly Significant Difference (HSD) at the 5% level.

RESULTS AND DISCUSSION

Sweet corn planting in Greenhouse Nutrient uptake of N, P, and K

The highest N uptake was in O3K2B3 treatment (OP 20 Mg ha⁻¹, with inorganic fertilizer, biochar 20 Mg ha⁻¹) which was followed by O2K2B3 treatment (OP 10 Mg ha⁻¹, with inorganic fertilizer, biochar 20 Mg ha⁻¹) with difference of 1% and O4K2B1 (OP 30 Mg ha⁻¹, with inorganic fertilizer, without biochar) with 3% difference, while the lowest yield was found on O1K1B1. Moreover, the highest P uptake was on O4K1B1 treatment (OP 30 Mg ha⁻¹ + without inorganic fertilizer + without biochar) which was followed by O3K2B3 treatment (OP 20 Mg ha⁻¹ + with inorganic fertilizer + biochar 20 Mg ha⁻¹) with difference of 4%, while the lowest result was in O1K1B1. The highest K uptake was present in the O4K2B3 treatment (OP 30 Mg ha⁻¹ + with inorganic fertilizer + biochar 20 Mg ha⁻¹) followed by O4K1B2 treatment (OP 30 Mg ha⁻¹ + without inorganic fertilizer + biochar 10 Mg ha⁻¹) with a difference of 22%, while the lowest yield is in O1K1B1 (Figure 1). The inorganic fertilizer applied to K2 was 0.44 Mg Urea ha⁻¹, 0.28 Mg SP-36 ha⁻¹, 0.16 Mg KCl ha⁻¹.

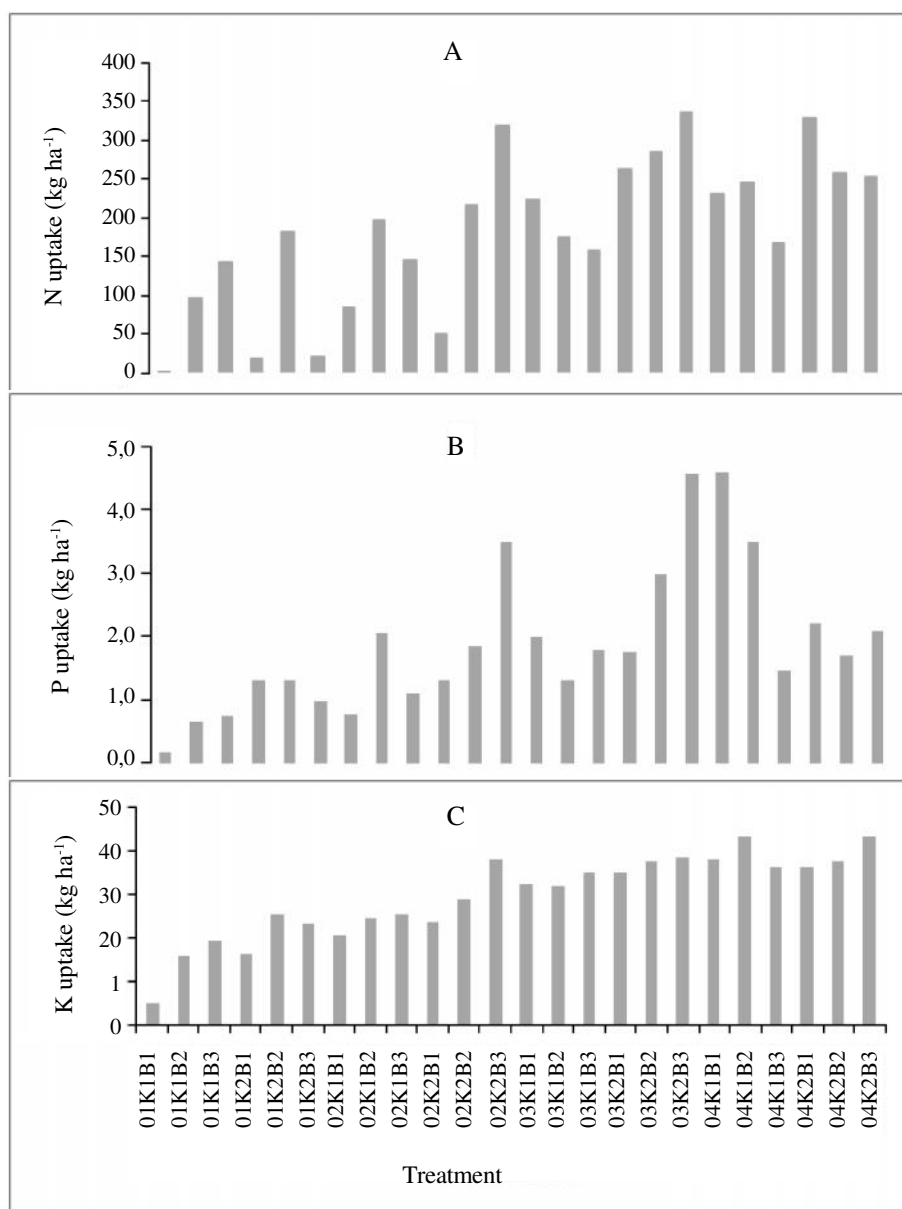


Figure 1. Bar Charts of N uptake (A), P uptake (B), and K uptake (C) of sweet corn plants after application of OrganonitrophosPlus fertilizer, Inorganic fertilizers, and Biochar at the end of vegetative phase(7 DAP). OP= Organonitrofos plus, O1 = 0 Mg OP ha⁻¹; O2 = 10 Mg OP ha⁻¹; O3 = 20 Mg OP ha⁻¹; O4 = 30 Mg OP ha⁻¹; K1 = Without inorganic fertilizer application; K2 = with inorganic fertilizer application, i.e. 0.44 Mg Urea ha⁻¹, 0.28 Mg SP-36 ha⁻¹, 0.16 Mg KCl ha⁻¹; B1= 0 Mg biochar ha⁻¹; B2= 10 Mg biochar ha⁻¹, B3 = 20 Mg biochar ha⁻¹.

The application those fertilizers such as Organonitrofos Plus (OP), inorganic fertilizer, and biochar affected nutrient uptake of N, P, and K of sweet corn. This is because Organonitrofos Plus fertilizer is an organic material, and biochar is a soil enhancer that can improve the physical, chemical, and biological properties of the soil. One of the functions of organic matter to soil physical properties

is to improve soil permeability, soil porosity, soil structure, water holding power and soil cations (Syamsu 2013). Having soil physical properties then allow the roots of sweet corn are able to easily absorb nutrients in the soil so that nutrients that have been absorbed can be utilized properly by the plant during the growth phase. While inorganic fertilizer is able to provide nutrients N, P, and K in large quantities and easily available for plants, so that combined with

organic fertilizer, it will provide enough nutrients for plants.

The Production of Sweet Corn

The variables for sweet corn production include weight of dry stover, diameter of ear, length of cob, weight of cob either husk or without husk. Table 2 shows that there are the interaction between OP and inorganic fertilizer to the weight of dry stover of sweet corn. The application of OP 10 Mg ha⁻¹ with inorganic fertilizer yielded the weight of the dry stub is heavier compared without OP and without inorganic fertilizer treatment. However, between each OP doses, between OP and inorganic fertilizer produce weights dry stover which is no different with application of OP fertilizer without inorganic fertilizer. This shows that the role of inorganic fertilizers do not affect that much, presumably

because of the Cation Exchange Capacity(CEC) is low (Table 1) so that the soil colloids can not absorb the nutrients properly and consequently the nutrient will easily leached and lost with the water movement in the soil, and finally the nutrients are not available for crops (Utami 2009).

The single factor of Organonitrofos Plus fertilizer had a direct impact on the production of sweet corn (Table 3). Raw material of Organonitrofos plus fertilizer which was formed by manure, MSG wastes, with microbial enrichment with a score of C/N less than 20 was allegedly capable to supply nutrients to sweet corn. This estimate is reinforced by another study of Muyasir (2006) that the application of waste fertilizer from MSG was able to increase the concentration of N and P in the tissues of maize which was obtained from the results of high mineralization of organic

Table 2. The effects of interaction between OP and inorganic fertilizer application on the dry weight of sweet corn plant biomass at the end of vegetative phase.

| NPK fertilizer (Mg ha ⁻¹) | Organonitrofos Plus (Mg ha ⁻¹) | | | |
|--|--|-------------|-------------|-------------|
| | O1 | O2 | O3 | O4 |
| K1 | 1.14 a A | 2.13 b A | 2.59 b A | 2.98 c A |
| K2 | 2.21 a B | 2.69 a A | 2.81 a A | 2.79 a A |
| HSD = 0.81 | | | | |

Notes : OP (Organonitrofos Plus): O1(OP 0 Mg ha⁻¹), O2 (OP 10 Mg ha⁻¹), O3 (OP 20 Mg ha⁻¹), O4 (OP 30 Mg ha⁻¹), K1 (without inorganic fertilizer application), K2 (with inorganic fertilizer application, i.e. 0.44 Mg Urea ha⁻¹, 0.28 Mg SP-36 ha⁻¹, 0.16 Mg KCl ha⁻¹). The same letters indicate no significant difference based on LSD test at 5% significance level. The lowercase are read horizontally and the uppercase are read vertically.

Table 3. The effects of the single factor of Organonitrofos Plus application and inorganic fertilizer application on the production of cobs of sweet corn.

| Treatment | Cob diameter (mm) | Cob length (cm) | Weight of cob with husks (Mg ha ⁻¹) | Weight of cob without husks (Mg ha ⁻¹) |
|----------------------|----------------------|--------------------|--|---|
| Organonitrofos Plus | | | | |
| O1 | 18.02 a | 7.99 a | 0.83 a | 0.52 a |
| O2 | 21.44 ab | 9.49 ab | 1.32 ab | 0.93 ab |
| O3 | 25.31 b | 10.89 b | 1.45 b | 1.14 b |
| O4 | 25.68 b | 10.34 b | 1.52 b | 1.02 b |
| HSD 5% | 6.90 | 2.87 | 0.63 | 0.50 |
| Inorganic Fertilizer | | | | |
| K1 | | | | |
| K2 | 20.38 a 24.85 b | 7.53 a 11.83 b | 0.93 a 1.63 b | 0.66 a 1.14 b |
| HSD 5% | 3.79 | 1.23 | 0.31 | 0.26 |

materials on MSG. Meanwhile, according to Ismayana (2012), organic fertilizer that has a C/N <20% indicated that the level of decomposition of organic matter was quite good so it could contribute nutrients to the plant.

The application of Organonitrofos Plus fertilizer dose of 20 and 30 Mg ha⁻¹ got a better production of sweet corn (diameter of cob, length of cob, weights of cob with the husk, and the weight of the cob without the husk) than the treatment without Organonitrofos Plus fertilizer. The production of sweet corn from the dose of 10 Mg ha⁻¹ of Organonitrophos Plus fertilizer had no different compare to the treatment without Organonitrofos Plus fertilizer. This is likely because of N content in Organonitrofos plus is still low but increasing dose of Organonitrofos plus will increase the nutrients in soil.

The application of inorganic fertilizer to the sweet corn was able to produce a better cob diameter, cob long, weights of cobs either with husk or without husk compared to the treatment without inorganic fertilizers. The nutrients content of 46% N in Urea, 36% P in SP-36, and 60% K in KCl is able to meet nutrient needs of sweet corn because the results show that after the application of inorganic fertilizers has a better nutrients

uptake compared to the treatment that was not given inorganic fertilizer which only had N 0,08 g kg⁻¹ and P 3,25 g kg⁻¹.

However, the sweet corn production in this study is still much lower than the potential description of Bonanza F1 (data not shown). This is likely due to the condition of Ultisols in Taman Bogo have low acidity so it makes the availability of P which is for the development of cob is insufficient because it is adsorbed by Fe, Al, and Ca. As explained by Prasetyo and Suriadikarta (2006) that the symptoms of P deficiency will cause both cob and stigma development incomplete, consequently the pollination is not perfect.

The correlation test show that there were a good correlation between pH, organic-C, available-P with the weight of the plant's dry stover (Figure 2). This means the increasing of pH, organic-C, and available-P will increase the total of dry weight of sweet corn. Furthermore, there is also a very good correlation between nutrient uptake of N and weight of cob with sweet corn starch (Figure 2). This is likely because Organonitrofos plus fertilizer is an organic fertilizer which has a capability to repair soil aggregates that can make roots easier to penetrate to the soil pores to get the nutrients through the process of mass flow. The process of mass flow is

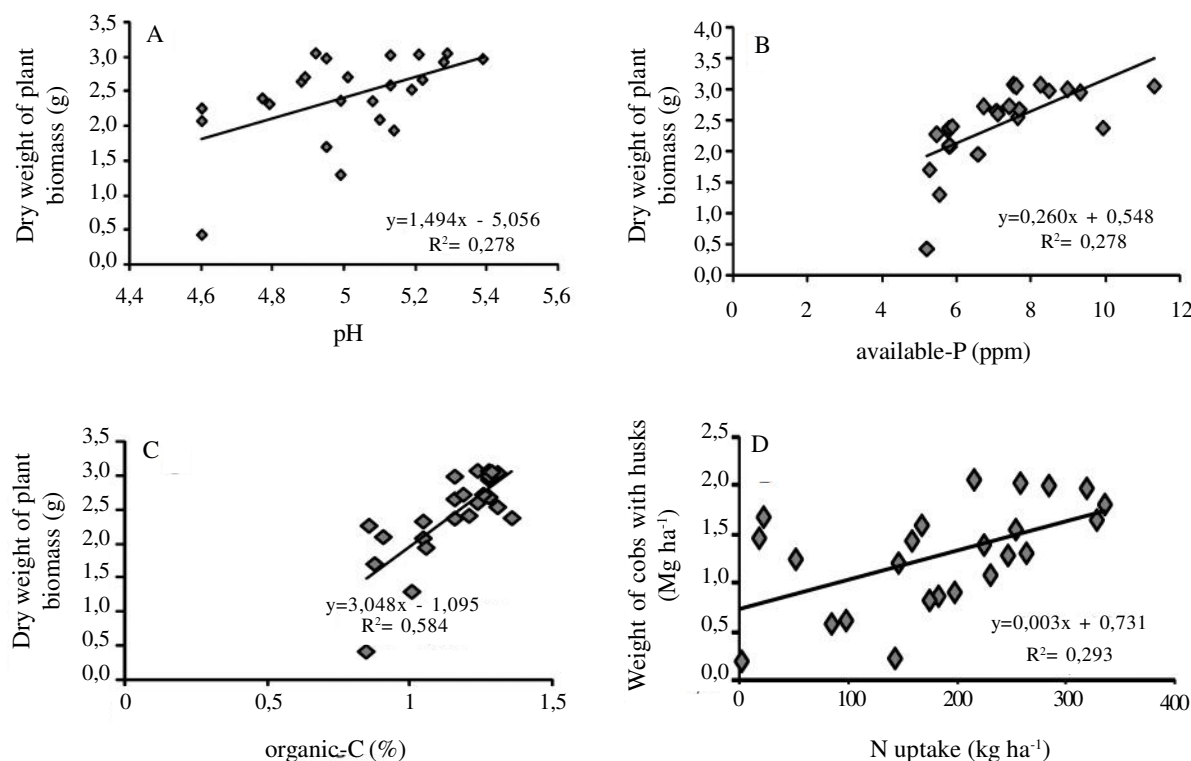


Figure 2. Correlations between (a) pH (b) available-P (c) organic-C and dry weight of plant biomass, and correlation between (d) N uptake and weight of cobs with husks.

a process of nutrient movements inside the ground toward the surface of the plant roots through the movement of water mass, N uptake occurs through the process of mass flow due to N is very mobile in the soil. N are absorbed by the roots in the form of NO_3^- , the magnitude of the movement of NO_3^- in mass flow influenced by several factors, among other levels and the potential of groundwater, soil porosity, and transpiration (Mukhlis 2003). While the correlation between nutrient uptake of P and K with weights of cobs have no correlation. This matter is likely because of low soil pH so that P is bounded by clay, aluminum, iron or calcium and became unavailable to the plants (Yafizham 2012; Njurumana *et al.* 2008), while K on acid soils are not easily absorbed so it is easy to leach and not available to plants.

Relative Agronomic Effectiveness (RAE)

The relative value of agronomic effectiveness (RAE) was calculated based on a predetermined

formula and presented in Table 4. The O4K2B2 treatment (30 Mg OP ha^{-1} , with an inorganic fertilizer, 10 Mg biochar ha^{-1}) had the highest RAE value 181% followed by 2K2B3 treatment (10 Mg OP ha^{-1} , with inorganic fertilizer, 20 Mg biochar ha^{-1}) with difference of RAE value of 0.5%. Thus, for the same dosage of the same inorganic fertilizer it can be applied O4K2B2 or O2K2B3 treatment for sweet corn cultivation, because the existing content in both treatments are able to improve soil properties thus increasing the growth and production of sweet corn.

Soil Properties

Changes in soil properties before and after incubation are presented in Tables 1 and 5. Based on the criteria of soil chemical properties of Hardjowigeno (2003), Ultisols in Taman Bogo has a pH of 4.61 which is included in the category of acid soils, containing nitrogen (0.08 g kg^{-1}), available-P (3.25 mg kg^{-1}), exc-K (0.16 g kg^{-1}),

Table 4. The results of calculation of *Relatif Agronomic Effectiveness* (RAE).

| Treatment Organonitrofos Plus – Urea – SP-36 – KCl – biochar | Dry weight of plant biomass (Mg ha^{-1}) | Weight of cobs with husks (Mg ha^{-1}) | RAE of total biomass (%) |
|---|--|--|--------------------------------|
| O ₁ K ₁ B ₁ (0-0-0-0-0) | 0.72 | 0.18 | 0 |
| O ₁ K ₁ B ₂ (0-0-0-0-10) | 1.65 | 0.60 | 49 |
| O ₁ K ₁ B ₃ (0-0-0-0-20) | 1.03 | 0.21 | 13 |
| O ₁ K ₂ B ₁ (0 – 0,44 – 0,28 – 0,16 – 0) | 2.19 | 1.45 | 100 |
| O ₁ K ₂ B ₂ (0 – 0,44 – 0,28 – 0,16 – 10) | 3.01 | 0.86 | 108 |
| O ₁ K ₂ B ₃ (0 – 0,44 – 0,28 – 0,16 – 20) | 3.49 | 1.67 | 155 |
| O ₂ K ₁ B ₁ (10 – 0 – 0 – 0 – 0) | 2.08 | 0.57 | 64 |
| O ₂ K ₁ B ₂ (10 – 0 – 0 – 0 – 10) | 2.64 | 0.90 | 96 |
| O ₂ K ₁ B ₃ (10 – 0 – 0 – 0 – 20) | 2.20 | 1.20 | 91 |
| O ₂ K ₂ B ₁ (10 – 0,44 – 0,28 – 0,16 – 0) | 2.90 | 1.24 | 118 |
| O ₂ K ₂ B ₂ (10 – 0,44 – 0,28 – 0,16 – 10) | 3.49 | 2.06 | 169 |
| O ₂ K ₂ B ₃ (10 – 0,44 – 0,28 – 0,16 – 20) | 3.87 | 1.97 | 180 |
| O ₃ K ₁ B ₁ (20 – 0 – 0 – 0 – 0) | 3.47 | 1.38 | 144 |
| O ₃ K ₁ B ₂ (20 – 0 – 0 – 0 – 10) | 2.47 | 0.81 | 87 |
| O ₃ K ₁ B ₃ (20 – 0 – 0 – 0 – 20) | 3.46 | 1.43 | 145 |
| O ₃ K ₂ B ₁ (20 – 0,44 – 0,28 – 0,16 – 0) | 3.79 | 1.30 | 152 |
| O ₃ K ₂ B ₂ (20 – 0,44 – 0,28 – 0,16 – 10) | 3.60 | 2.00 | 171 |
| O ₃ K ₂ B ₃ (20 – 0,44 – 0,28 – 0,16 – 20) | 2.96 | 1.80 | 141 |
| O ₄ K ₁ B ₁ (30 – 0 – 0 – 0 – 0) | 2.44 | 1.07 | 95 |
| O ₄ K ₁ B ₂ (30 – 0 – 0 – 0 – 10) | 3.06 | 1.28 | 125 |
| O ₄ K ₁ B ₃ (30 – 0 – 0 – 0 – 20) | 3.57 | 1.59 | 155 |
| O ₄ K ₂ B ₁ (30 – 0,44 – 0,28 – 0,16 – 0) | 4.00 | 1.64 | 173 |
| O ₄ K ₂ B ₂ (30 – 0,44 – 0,28 – 0,16 – 10) | 3.86 | 2.02 | 181 |
| O ₄ K ₂ B ₃ (30 – 0,44 – 0,28 – 0,16 – 20) | 4.21 | 1.54 | 177 |

Notes : OP= Organonitrofos Plus, O1 = 0 Mg OP ha^{-1} ; O2 = 10 Mg OP ha^{-1} ; O3 = 20 Mg OP ha^{-1} ; O4 = 30 Mg OP ha^{-1} ; K1 = without inorganic fertilizer application; K2 = without inorganic fertilizer application, i.e. 0.44 Mg Urea ha^{-1} , 0.28 Mg SP-36 ha^{-1} , 0.16 Mg KCl ha^{-1} ; B1 = 0 Mg biochar ha^{-1} ; B2 = 10 Mg biochar ha^{-1} ; B3 = 20 Mg biochar ha^{-1} . Total biomass = dry weight of plant biomass + weight of cobs with husks.

Table 5. Properties of soils incubated for 3 months.

| Treatment | pH (H ₂ O) | Total-N (%) | Available-P (ppm) | Organic-C (%) | CEC (me 100g ⁻¹) | Base saturation (%) |
|-----------|-----------------------|-------------|-------------------|---------------|------------------------------|---------------------|
| O1K1B1 | 4.6 | 0.05 | 5.23 | 0.85 | 3.62 | 47.15 |
| O1K1B2 | 4.99 | 0.11 | 5.55 | 1.01 | 5.54 | 36.35 |
| O1K1B3 | 4.95 | 0.12 | 5.29 | 0.88 | 5.27 | 42.58 |
| O1K2B1 | 4.6 | 0.14 | 5.49 | 0.86 | 4.64 | 47.39 |
| O1K2B2 | 4.79 | 0.13 | 5.78 | 1.05 | 4.41 | 49.12 |
| O1K2B3 | 4.6 | 0.06 | 5.84 | 1.05 | 4.57 | 39.80 |
| O2K1B1 | 5.1 | 0.07 | 5.83 | 0.91 | 5.32 | 57.44 |
| O2K1B2 | 5.14 | 0.13 | 6.6 | 1.06 | 4.56 | 51.43 |
| O2K1B3 | 5.08 | 0.08 | 5.83 | 1.16 | 4.65 | 41.63 |
| O2K2B1 | 4.77 | 0.13 | 5.9 | 1.21 | 4.27 | 45.15 |
| O2K2B2 | 4.88 | 0.12 | 7.09 | 1.16 | 4.75 | 47.43 |
| O2K2B3 | 4.92 | 0.11 | 7.54 | 1.24 | 4.35 | 47.52 |
| O3K1B1 | 5.19) | 0.1 | 7.64 | 1.31 | 4.31 | 53.99 |
| O3K1B2 | 5.13 | 0.13 | 7.12 | 1.24 | 4.53 | 53.13 |
| O3K1B3 | 5.22 | 0.06 | 7.7 | 1.28 | 5.54 | 51.81 |
| O3K2B1 | 4.89 | 0.13 | 6.72 | 1.26 | 4.78 | 45.13 |
| O3K2B2 | 5.01 | 0.08 | 7.44 | 1.19 | 4.56 | 49.32 |
| O3K2B3 | 5.13 | 0.1 | 7.62 | 1.31 | 4.47 | 58.03 |
| O4K1B1 | 5.28 | 0.06 | 9.34 | 1.28 | 4.25 | 65.53 |
| O4K1B2 | 5.29 | 0.11 | 8.27 | 1.28 | 4.48 | 63.48 |
| O4K1B3 | 5.39 | 0.08 | 8.5 | 1.16 | 4.58 | 69.28 |
| O4K2B1 | 4.95 | 0.13 | 8.98 | 1.28 | 4.73 | 50.95 |
| O4K2B2 | 4.99 | 0.15 | 9.93 | 1.36 | 5.62 | 48.61 |
| O4K2B3 | 5.21 | 0.08 | 11.32 | 1.29 | 4.37 | 78.31 |

Notes: OP= Organonitrofos Plus, O1 = 0 Mg OP ha⁻¹; O2 = 10 Mg OP ha⁻¹; O3 = 20 Mg OP ha⁻¹; O4 = 30 Mg OP ha⁻¹; K1 = without inorganic fertilizer application; K2 =with inorganic fertilizer application, i.e. 0.44 Mg Urea ha⁻¹, 0.28 Mg SP-36 ha⁻¹, 0.16 Mg KCl ha⁻¹; B1= 0 Mg biochar ha⁻¹; B2= 10 Mg biochar ha⁻¹, B3 = 20 Mg biochar ha⁻¹

organic-C (0.95 g kg⁻¹), and CEC (3.43 me 100 g⁻¹) which is very low. Taman Bogo Ultisols is a marginal land with very low fertility.

The application of those Organonitrofos, inorganic fertilizers, and biochar increased soil fertility of Ultisols in Taman Bogo. The soil properties after incubation for 3 months tended to increase (Table 5). Increased dose of OP can increase pH, availability of P, organic-C, CEC and base saturation. This suggests that giving OP can improve the fertility of Ultisols. However, biochar application has not been shown to affect the chemical properties of Ultisols.

CONCLUSIONS

The results of the study through soil analysis (incubation) in the laboratory and the planting test in greenhouse showed that Organonitrofos Plus fertilizers, inorganic fertilizers and biochar can be used to improve the fertility of marginal soil.

The application of OP can improve soil fertility of Ultisols in Taman Bogo and increase the production of sweet corn, so that OP fertilizer can be used as substitution of inorganic fertilizer. Application of OP fertilizer only, inorganic fertilizer only, and interaction between OP and inorganic fertilizers increased the weight of the dried straw, the length of the cob, the diameter of the ear, the weights of the cob with the husk, and the weight of the cob without husk.

There was a positive correlation between pH, organic-C, available-P and total dry weight of sweet corn. In addition, there was also a positive correlation between N uptake and cob weight with sweet corn husk.

The highest RAE values were in the O4K2B2 treatment (30 Mg OP ha⁻¹, with inorganic fertilizer, 10 Mg biochar ha⁻¹) of 181% followed by O2K2B3 (10 Mg OP ha⁻¹, with inorganic fertilizer, 20 Mg biochar ha⁻¹) with difference of RAE value 0.5%.

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