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GROWTH AND PRODUCTION OF SWEET CORN (*Zea mays* var. *Saccharata*) WITH ORGANIC AND ANORGANIC FERTILIZER IN KENDAL

Pertumbuhan dan Produksi Jagung Manis (*Zea mays* var. *Saccharata*) dengan Pemupukan Organik dan Anorganik di Kabupaten Kendal

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ABSTRACT

This study aims to examine the response of growth and production of sweet corn plants in application of organic and inorganic fertilizers. The research was conducted on July - October 2019 in Merbuh Village, Singorojo Sub-District, Kendal District–and at Ecology and Plant Production Laboratory, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang. The study used a randomized block design with 7 monofactor treatments with and each experimental unit was repeated 4 times. The treatments consisted of inorganic fertilizer (P0), chicken manure+inorganic (P1), goat manure+inorganic (P2), cow manure+inorganic (P3), chicken manure 'plus' (P4), goat manure 'plus' (P5), cow manure 'plus' (P6). Data were analyzed by variance and for treatments that showed signoficant differences further tests were carried out using DMRT at the 5% level. The observed variables were plant height, number of leaves, stalk diameter, cob production with cornhusk, and cob production without cornhusk. The results showed that the application of organic and inorganic fertilizers only affected stalk diameter. Stalk diameter in cow manure+inorganic gave the highest results compared to other treatments. There is no influence on variables observed shows that the addition of gamal leaves as a source of N-organic and phosphate rock (BP) as P-organic in manure plus (chicken, goat, cow) can be an alternative solution to substitute inorganic fertilizers (urea and TSP) on sweet corn plant.

Keywords : chicken manure, cow manure, goat manure, gamal leaves, rock phosphate

ABSTRAK

Penelitian ini bertujuan untuk mengkaji respon pertumbuhan dan produksi tanaman jagung manis pada pemberian pupuk organik dan anorganik. Penelitian dilaksanakan pada Juli – Oktober 2019 di Desa Merbuh, Kecamatan Singorojo, Kabupaten Kendal dan Laboratorium Ekologi dan Produksi Tanaman, Fakultas Peternakan dan Pertanian, Universitas Diponegoro, Kota Semarang. Penelitian menggunakan Rancangan Acak Kelompok (RAK) 7 perlakuan monofaktor dan setiap unit percobaan diulang 4 kali. Perlakuan terdiri dari pupuk anorganik (P0), pupuk kandang (pukan) ayam+anorganik (P1), pukan kambing+anorganik (P2), pukan sapi+anorganik (P3), pukan ayam plus (P4), pukan kambing plus (P5), pukan sapi plus (P6). Data dianalisis ragam dan pada perlakuan yang menunjukkan perbedaan nyata dilakukan uji lanjut DMRT pada taraf 5%. Variabel yang diamati adalah tinggi tanaman, jumlah daun, diameter batang, produksi tongkol berkelobot dan produksi tongkol tanpa kelobot. Hasil penelitian menujukkan bahwa pemberian pupuk organik dan anorganik berpengaruh hanya terhadap diameter batang tanaman. Diameter batang tanaman jagung manis pada perlakuan pukan sapi+anorganik memberikan hasil tertinggi dibanding perlakuan lainnya. Tidak adanya pengaruh pada variabel yang diamati menunjukkan bahwa penambahan daun gamal sebagai sumber N-organik dan batuan fosfat (BP) sebagai P-organik pada pukan plus (ayam, kambing, sapi) mampu menjadi solusi alternatif pengganti pupuk anorganik (urea dan TSP) pada tanaman jagung manis.

Kata Kunci : pukan ayam, pukan kambing, pukan sapi, daun gamal, batuan fosfat

INTRODUCTION

Corn is a primary food crop grain and main source of carbohydrate, especially in Indonesia. The types of corn cultivated in Indonesia are pioneer corn (Saragih *et al*., 2013); *kretek* (Irfany *et al*., 2016); *bisma*, *lamuru*, *gumarang* (Mariani, 2018); local purple corn, local white corn (Polnaya and Patty, 2018); *sukmaraga*, waxy corn (Kartinaty *et al*., 2019); and sweet corn (Triana *et al*., 2019). Sweet corn is one of the corn commodities with high demand and economic value. Its production is determined by soil fertility.

Sweet corn needs nitrogen (N) amounting to 200 kg N/ha for vegetative growth, and phosphate (P) amounting to 150 kg P_2O_5 kg/ha for corncob formation. Farmers keep the nutrients adequate with inorganic fertilizers (Siyamto *et al*., 2014). Inorganic fertilizers are chosen to accommodate the sweet corn's nutrient demand because it is high nutrients, water-soluble, and easily absorbed by plant roots. However, continuous excessive use of inorganic fertilizers might negatively impact soil's physical, chemical, and biological properties and might also damage soil structure and reduce fertility.

Soil fertility refinement could be made by substituting inorganic fertilizers with the organic one. Porous organic materials would create micro spaces (pores) in soil, reduce the density of contents and soil, and increase aggregate solidity resulting in soil's better ability in binding water (Zulkarnain *et al*., 2013). Organic fertilizers might add the nutrients that are necessary for sweet corn in its growth and development. Organic fertilizers include manure that is made of animal feces. The nutrients in manure are complete, although it is not directly available and is small in amount. Therefore, manure requires an enrichment innovation to increase its quality in providing more nutrients and evolve into manure plus. Manure plus is the usual manure with gamal (*Gliricidia sepium*) leaves-N and rock phosphate-P enrichment.

The addition of gamal-leaves and rock phosphate in manure is made simultaneously with the manure production because the decomposition produces organic acids that could dissolve Gamal and rock phosphate into available N (nitrogen) and P (phosphorus) nutrients. The decomposition process produces organic acids that bind Al (aluminum) and Fe (iron) to increase P nutrients availability (Siyamto *et al*., 2014). The organic nitrogen from gamal-leaves is intended to replace inorganic N from urea. The organic phosphor from rock phosphate is intended to replace inorganic P from TSP. Manure plus is *slow-release* so the residue produced could be utilized by the next season. Manure plus is expected to save the fertilizer cost, minimize soil pollution caused by urea and TSP, be eco-friendly, and still produce sweet corn with quality equal to inorganic fertilizers usage.

MATERIALS AND METHODS

Research Time and place of implementation

The research was held on May 10th – October 2nd 2019 in Merbuh Village, Singorojo District, Kendal Regency, Central Java, Indonesia. Soil and manure analysis have been carried out at the Plant Ecology and Production Laboratory, Plant Physiology and Plant Breeding Laboratory, Faculty of Animal and Agricultural Science, Diponegoro University, Semarang, Central Java, Indonesia.

Research Experimental Design

This research design used was a Randomized Block Design (RCBD) monofactor pattern of 7 treatments with 4 replications so there were 28 plot units. The treatments given are as follows :

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P0: Inorganic (Urea + TSP)
P1: Chicken manure + inorganic
P2: Goat manure + inorganic
P3: Cow manure + inorganic
P4: Chicken manure plus
P5: Goat manure plus
P6: Cow manure plus

Research Materials and Tools

Material :

Chicken, goat, and cow feces are 133.12 kg, equivalent to 20 tons/ha (journal)

Gamal (*Gliricidia sepium*) 76.8 kg based on 2% N (journal) equivalent to 200 kg N/ha (journal) (real result analysis 2.57% N)

Rock phosphate (BP) 11.52 kg based on 10% P_2O_5 (journal) equivalent to 150 kg P_2O_5/ha (journal) (real result analysis 12.47% P_2O_5)

EM-4, *molasses*, water.

Sweet corn seeds (Talenta varieties) + carbofuran

Inorganic fertilizer (urea, KCl, TSP)

Tools:

Hoes, shovels, spray bottles, sacks, tarps, buckets, digital and analytical scales, ruler, meter, caliper.

Research Methods

Preparation phase - chicken, goat, and cow manure manufacture. Prepared chicken, goat, and cow feces each 133.12 kg (equivalent to 20 tons/ha). Manure and manure plus are made of the same dose with respectively 20 tons/ha (based on journal), in concordance with fertilizer requirement calculation. Manure plus is added with 200 kg N/ha of gamal-leaves and 150 kg P_2O_5/ha of rock phosphate (based on journal). Each manure material (chicken manure, goat, cow) is placed on the ground (grounded sack), then mixed with gamal and rock phosphate (and some other without mixed with gamal and rock phosphate), then added EM-4 and molasses molasses. into water in a bucket. The mixture of fertilizer material is covered with a sack and rocked until it is completely covered without any gaps, then coated again with a tarp. Every week, tarpaulin hoods and sacks are opened, then sprinkled with water to keep it moist. A piece of wood is put into each organic fertilizer mixture, to determine the occurrence of decomposition. The existence of decomposition can be known from the warm or hot temperatures on the wood that has been inserted. After 8 weeks of ripening, the hood of the tarpaulin and the sack are opened, manure and manure plus have already been decomposed and ready to apply. Before it's applied, the analysis of fertilizer nutrition is performed after the manure and manure plus were produced.

The next step was tillage and the making of 28 plots with size 3,2 x 2 m each plot, the gap was 50 cm between each plot and 100 cm between each replication group. The treatment was given randomly on each replication group plot.

After the plots were tilled twice, the soil was taken randomly as samples on each replication group; then, the initial soil chemical analysis was conducted.

Then the ready-made manure are given to the experimental plot according to treatment. Sweet corn seeds were planted with 40 x 40 cm gap, which resulted in 40 holes on per plant each plot (Siyamto *et al.*, 2014). Each treatment plot got a 150 kg K_2O/ha dose of KCl fertilizer as the base fertilizer. Urea and TSP fertilizers on the plots in concordance with treatment were given two weeks after the planting. Twelve middle plants were taken as the sample of each plot for growth and production parameters.

The harvest was done on day 75 after the planting by picking corncob samples on all plots. The cob each plot production were observed shortly after the harvest.

Collection and processing data :

The height of the plant, the amount of leaves, and stalk diameter were

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observed before the sweet corn was harvested. Height and number of leaves observed every week. Observing height of plant from week 1 after planting to week 10 after planting. Observing number of leaves from week 1 after planting to week 6 after planting. stalk diameter was observed once (1x) on 7th week. Post-harvest data collection by observing the weight production of sweet corncobs per plot (with cornhusk and without cornhusk) by converting the production of corncob weight per sample to weight production of corncob per plot using digital scale.

Data processing by using analysis of variance (ANOVA) to find the effect of treatments, and then continued by DMRT test (*Duncan's Multiple Range Test*) at 5% level to find out the differences between treatments.

RESULTS AND DISCUSSIONS

The Growth of Sweet Corn

The variance analysis results show that organic and inorganic fertilizers treatment did not affect the plant's height and the number of leaves, but significantly (P<0,05) affected the diameter of the sweet corn stalk. The DMRT test results of organic and inorganic treatments toward the stalk diameter are listed in Table 1.

Table 1. Height, Number of Leaves, and Stalk Diameter of Sweet Corn Plant with Organic and Inorganic Fertilization

Types of Fertilizers	Height	Number of Leaves	Stalk Diameter
	..cm/plant..	..leaves/plant..	..mm/plant..
P0. Inorganic (Urea+TSP)	199,50	12,33	23,13^{d}
P1. Chicken manure+inorganic	207,66	12,42	25,35^{ab}
P2. Goat manure+inorganic	201,20	11,94	25,05^{abc}
P3. Cow manure+inorganic	200,55	12,06	25,49^{a}
P4. Chicken plus manure	195,75	11,54	24,25^{abcd}
P5. Goat plus manure	190,66	11,57	23,08^{d}
P6. Cow plus manure	192,45	11,69	23,58^{cd}

Information: different superscript on the same column shows significant difference (P<0,05)

The variance analysis results show no treatment effect on the height of sweet corn plants. The plant height on treatment P1, P2, P3, P4, P5, and P6 has no difference respectively, the same goes to P0 (Table 1). This happened because all fertilization treatment had met the nutrients need for the height of sweet corn plants. Nitrogen nutrient absorbable by root plants influenced the height of sweet corn plants. According to Kresnatita *et al.* (2013) N nutrient content was the constituent of amino acids, amide, and nucleoprotein that worked on cell division. A cell division running well would support the plant growth indicated by the growth of size, volume, weight, and number of cells. All treatments with manure plus produced quality plants that equal to the treatment of manure+inorganic. According to Lestari *et al.* (2010) sweet corn plants received all kinds of treatments, be it organic or inorganic fertilizer, as long as it met the nutrients needed to grow and develop.

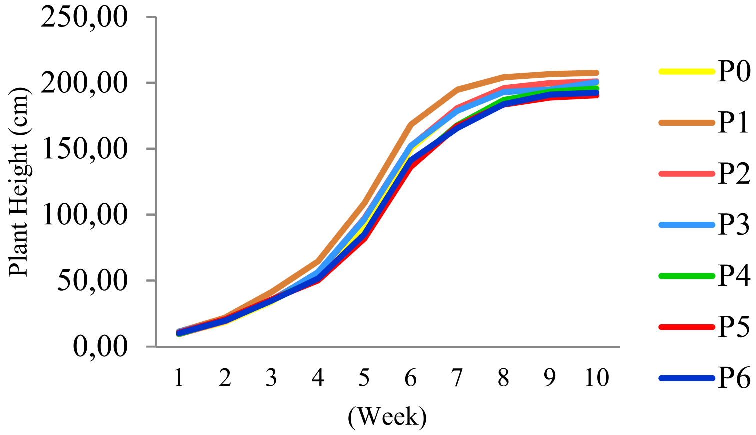

Figure 1. Sweet Corn Plant Height Growth Graphic

The graphic of sweet corn plant height growth (figure 1) shows the sigmoid curve on all treatments. N nutrient content plays a role in plants' vegetative growth (stalk length). Nitrogen also stimulates the sweet corn vegetative growth, including the stalk height growth (Ningsih *et al*., 2015). It proves that gamal leaves-N in manure plus could increase the plant height just as urea. According to Hartati *et al*. (2012) the addition of *Gliricidia sepium* as organic fertilizer could optimize the height of sweet corn plants. Based on the result's research of Anisa and Sudiarso (2019) that the use of nitrogen fertilizer in the form of urea or others did not produce a significant height of sweet corn plants.

The results of variance analysis show that no treatment effect on the number of leaves of sweet corn plants. Treatment P1, P2, P3, P4, P5, and P6 respectively resulted in different number of leaves, the same goes with P0 (control) (Table 1). Chicken, goat, and cow manure with the addition of organic NP is believed to accommodate the nutrients needed by sweet corn plant to form leaves equivalent to inorganic NP. This statement is in accordance with Pasta *et al*. (2015) research stating that organic fertilizer produces equal results to inorganic fertilizer. The leaf formation becomes influenced much by the availability of N nutrient content. If sweet corn roots could sufficiently absorb the available N nutrient content, the leaves will be lusher. According to Arif *et al*. (2014); Hartanti *et al*. (2014); Purwati and Islami (2019) the available N nutrient content is absorbed by the plant roots and works during the metabolism and photosynthesis process. The photosynthate produced is translocated for the formation and growth of the number of leaves (increases the vegetative part in terms of size and amount). Nitrogen always moves in the plant body. If there are plenty of N, the growing sprouts will not take the nutrition of the leaves underneath the plant, which could speed up the photosynthesis (Kresnatita *et al*., 2013). Plants' metabolism activity depends on the adequacy of nitrogen (N) during the growing phase (Ramadhani *et al*., 2016).

The DMRT test (Table 1) shows that goat manure plus (P5) treatment produced 45,04 mm stalk diameter, significantly lower than goat + inorganic (P2), resulting in 56,74 mm. The cow manure plus (P6) treatment produced 23,58 mm stalk diameter, significantly lower than cow + inorganic (P3) treatment, 56,74 mm. The chicken manure plus (P4) treatment produced 24,25 mm stalk diameter, insignificantly different from chicken + inorganic (P1) that resulted in 25,35 mm. N nutrient content played a role in the stalk organ formation. The sweet corn N nutrient fulfillment was given in the form of organic and inorganic. Insignificant difference on stalk diameter produced by chicken manure + inorganic and chicken manure plus was due to the addition of the same dose of N nutrient content by 200 kgN/ha on different sources (P1 N-inorganic, P4 N-organic). According to Septian *et al*. (2015) organic fertilization with N composition based on the recommended dosage (200 kgN/ha) could support the growth and production of sweet corn, equal to the inorganic fertilization with the same dosage. According to the statement of Dewanto *et al*. (2013) and Martajaya (2018) that the sufficient N nutrient content made the leaves greener with high chlorophyll content that could increase the accumulation of assimilates for the bigger corn stalk.

The size of sweet corn stalk diameter was not only determined by the available nitrogen nutrient content, but also the available phosphate nutrient content. P nutrient content worked on the plant organ development to make it stronger and sturdy (Polli and Tumbelaka, 2012). That was also supported by the research result of Hartanti *et al*. (2014) that the availability of nutrients content in soil influenced the development of the sweet corn stalk, especially P nutrient content that worked on plant cell division and growth.

Production of Sweet Corn Plant

The variance analysis results showed that there was no effect of the treatment given on the production of cob with and without husk. DMRT test results of organic and inorganic fertilization on the production of sweet corn cob with and without husk shown in Table 2.

Table 2. Cob Production with Husk and Cob Production without Husk of Sweet Corn with Organic and Inorganic Fertilization

Types of Fertilizers	Cob Production with Husk	Cob Production without Husk
	..kg/plot..	..kg/plot..
P0. Inorganic (Urea+TSP)	13,70	9,46
P1. Chicken manure+inorganic	14,84	10,16
P2. Goat manure+inorganic	13,36	8,70
P3. Cow manure+inorganic	13,55	8,76
P4. Chicken plus manure	12,33	8,13
P5. Goat plus manure	13,10	8,84
P6. Cow plus manure	13,12	8,97

Information: different superscript on the same column shows significant difference (P<0,05)

The variance analysis results showed that there was no effect of the treatment given on the production of cob with and without husk. Cobs per plot production on treatment P0 was equal to treatment P1, P2, P3, P4, P5, and P6 (Table 2). Sweet corn cob was influenced by N and P nutrients content. The adequate N would accelerated the polymerization of hexose sugars into structure polysaccharides or sucrose. The structure formed were rebuild to produce energy in the growth of cob's size and weight (Kresnatita *et al*., 2013). P nutrient availability facilitated photosynthesis and boosted photosynthate accumulation allocated on a corncob and made it bigger and heavier (Hartanti *et al*., 2014).

Phospor (P) nutrient content that worked during the cob formation was sufficiently available from the addition of organic and inorganic fertilizers. Inorganic P fertilization from TSP and P organic from RP on manure plus with equal dosage (150 kgP_2O_5/ha) could accommodate sweet corn plant nutrients needed for its cob development. P element in ion P_2O_5 form acted as the energy supplier during photosynthesis to form more carbohydrates (Angraeni and Guritno, 2018). According to Purwati and Islami (2019) P nutrient element influenced the availability of N nutrient. The N nutrient determined the vegetative growth that affected generative growth, cob production, and sweet corn quality.

CONCLUSIONS

Manure 'Plus' (chicken, goat, cow) give the result of the height, number of leaves, cob production with cornhusk, cob production without cornhusk, fresh straw production, dry straw production equivalent to manure+inorganic fertilizer. Addition of *Gliricidia sepium* leaves as Nitrogen (N) source can increase levels of nutrient N and addition of phosphate rocks as phosphorus (P) source increases nutrient levels of P (P_2O_5) of manure plus. Chicken manure+inorganic treatment gave the highest results compared to other treatments on the length of cob and chlorophyll content variables.

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