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Effects of Combining Application between Palm-oil Fruit Bunch Organic Fertilizer and Synthetic Nitrogen on Cucumber Yields

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ABSTRACT

Cucumber is one of popular vegetables among consumers and widely cultivated by in Indonesia. Since there is an increasing concern of fertilizer costs and sustainability of land resources, the use of synthetic fertilizer must be minimized by using more organic sources, including the use of waste of fruit bunch of palm oil as compost. This experiment aimed to determine the best combination of between palm-oil fruit bunch organic fertilizer and synthetic nitrogen on cucumber yields. Treatments were consisted of (1) without palm-oil bunch organic fertilizer + without Urea, (2) without palm-oil bunch organic fertilizer + Urea 50 kg ha^{-1}, (3) without palm-oil bunch organic fertilizer + Urea 150 kg ha^{-1}, (4) without palm-oil bunch organic fertilizer + Urea 250 kg ha^{-1}, (5) palm-oil bunch organic fertilizer 5 tons ha^{-1} + without Urea, (6) organic fertilizer palm-oil bunch 5 tons ha^{-1} + Urea 50 kg ha^{-1}, (7) palm-oil bunch organic fertilizer 5 tons ha^{-1} + Urea 150 kg ha^{-1}, (8) palm-oil bunch organic fertilizer 5 tons ha^{-1} + Urea 250 kg ha^{-1}, (9) palm-oil bunch palm-oil bunch organic fertilizer 10 tons ha^{-1} + without Urea, (10) palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 50 kg ha^{-1}, (10) palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 150 kg ha^{-1}, (12) palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 250 kg ha^{-1}. Results indicated that combination application between palm-oil fruit bunch organic fertilizer and synthetic nitrogen significantly effects fruit length, fruit diameter, number of fruit planted, fruit weight per plot, number of fruit per plot and fruit weight per plot. It was concluded that the use of 10 tons ha^{-1} of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) was the best treatment combination to increase cucumber yields.

Keywords: mustard, liquid organic fertilizer, peat soil

INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to family of *Cucurbitaceae* is native to Asian continent and very popular vegetable among consumers (Purnomo *et al*., 2013). High nutrition contents and other medicinal benefits are among the reasons for the consumers to make use of this plant in various ways of dishes (Rukmana, 1994; Sutarya *et al*., 1995). According to Badan Pusat Statistik and Directorate General of Horticulture (2012) cucumber production in Indonesia has fluctuated over the years, *i.e.* 581.205 tons (2007), 540.122 tons (2008), 583.139 tons (2009), 547.141 tons (2010) and 527.184 tons (2011), respectively. Such fluctuation was resulted from many factors, including the use of fertilizer in production practices. Bahri (2011) concluded that fertilization is the most important part for the growth and yield of cucumbers. According to Moekasan *et al*. (2014), cucumbers required 160, 72 and 120 kg ha^{-1} of N, P_2O_5, and K_2O, respectively, to have excellent yields.

Urea is one the most widely used synthetic fertilizers in cucumber cultivation as a nutrient source of N. Urea can improve plant vegetative growth, where plants that grow on sufficient N soil have more chlorophyll (Hardjowigeno, 1987). Nitrogen is one of the macro elements and is needed by cucumber

plants. The role of nitrogen is known as a material for growth, especially for cell development, cell division and chlorophyll synthesis (Soewito, 1988; Novizan, 2002). However, the growing concern of fertilizer costs and sustainability of land resources, the use of synthetic fertilizer must be minimized by using more organic sources. According to Riley *et al*. (2008) and Dinesh *et al*. (2010), the application of organic matter improves soil structure, increases water holding capacity, and increases soil biological life. In addition, Acquaah (2005) and Muktamar *et al*. (2016) coccluded that organic matter plays an important role in increasing soil fertility by improving soil physical, chemical, and biological properties. There are many organic fertilizers available in the surrounding of production areas, including the use of palm oil processing waste, *i.e*. husk of palm oil.

According to BKPM (2014) annual production of solid wastes from palm oil mounted to 5.47 tons. This waste is usually burned, used as oil palm mulch, processed into compost or organic fertilizer (Isroi, 2008). PT. Bio Nusantara Teknologi Bengkulu has produced organic fertilizer from palm oil wastes, by using solid and boiler ash (former burnt empty bunch). This organic fertilizer contained 1.26 % N, 4.60 % P_2O_5, 2.20 % K_2O, 3.64 % CaO, 1,67 % MgO, 20.10 % organic C, and 53.41% moisture content as well as micro nutrients of 0.41 % Fe, 0.01 % Cu, 0.05 % Mn, 0.01 % Zn and 0.005% Br (Pusat Penelitian Kelapa Sawit, 2014). Organic fertilizers can be applied with various plants as organic fertilizers, either alone or in combination with synthetic fertilizers. The availability of organic fertilizers is sometimes not immediately available to plants because it takes time for the weathering process to become available for plants. In addition, the use of palm oil husk organic fertilizer for crop production, including cucumbers, should be combined with the use of synthetic N, since this organic fertilizer has relatively low nitrogen content.

The use of organic fertilizer made from empty palm oil fruit bunch has been widely used to increase growth and production such as mustard greens (Hidayat, 2013), pakcoy plants (Sundari, 2011), ginger plants (Susana, 2009), peanuts (Eleni, 2013), melon (Rezatiara, 2016), oil palm seeds (Alansyah, 2012), and oil palm pre-nursery (Agung *et al*., 2019). Research that combines organic fertilizers and urea fertilizers has been carried out on the sweet corn plant (Oktavia, 2016), and on the chili pepper (Jurniati, 2016). Nevertheless, the use of organic fertilizer made from empty palm oil fruit bunch and urea fertilizer has not been widely used to increase growth and yield of cucumber plants. Thus, it is necessary to conduct research on the use of organic fertilizers combined with urea fertilizer in cucumber production. This experiment aimed to determine the best combination between palm-oil fruit bunch organic fertilizer and synthetic nitrogen on cucumber yields.

MATERIAL AND METHOD

This experiment was carried out from October to December 2015 in the Agricultural Experiment Station of the Faculty of Agriculture, Bengkulu University, Tanjung Berdana, Bengkulu Tengah. Experiment was arranged in single factor of complete randomized block design with three replications. Treatments were consisted of (1) P1=without palm-oil bunch organic fertilizer + without Urea, (2) P2=without palm-oil bunch organic fertilizer + Urea 50 kg ha^{-1}, (3) P3=without palm-oil bunch organic fertilizer + Urea 150 kg ha^{-1}, (4) P4=without palm-oil bunch organic fertilizer + Urea 250 kg ha^{-1}, (5) P5= palm-oil bunch organic fertilizer 5 tons ha^{-1} + without Urea, (6) P6=organic fertilizer palm-oil bunch 5 tons ha^{-1} + Urea 50 kg ha^{-1}, (7) P7= palm-oil bunch organic fertilizer 5 tons ha^{-1} + Urea 150 kg ha^{-1}, (8) P8= palm-oil bunch organic fertilizer 5 tons ha^{-1} + Urea 250 kg ha^{-1}, (9) P9= palm-oil bunch palm-oil bunch organic fertilizer 10 tons ha^{-1} + without Urea, (10) P10= palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 50 kg ha^{-1}, (10) P11= palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 150 kg ha^{-1}, (12) P12= palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 250 kg ha^{-1}.

The experiment field was cleared, cleaned, plowed, and harrowed before 36 experiment units were established. Each experiment plot was 3 x 2 m^2 in size and separated by 0.5 within the plots and 1 m between the blocks. Two seed of Harmony cultivar was used as planting materials, sown in 3 cm in-depth, with plant spacing of 0.6 x 0.75 m^2, to make 10 plants per plot. After a week, the worse plant was removed to make a single plant per planting hole.

The application of palm-oil bunch organic and urea fertilizers was carried out at planting by placing it 10 cm away from the right and left of the planting hole. Palm-oil bunch, produced by PT Bio Nusantara Teknologi Bengkulu, was applied at full dosage, while synthetic fertilizer of N urea was applied twice (50% at planting and 50% at 20 days after planting). The application of SP36 fertilizer as much as 150 kg ha^{-1} (90 g $plot^{-1}$) and KCl 100 kg ha^{-1} (60 g $plot^{-1}$) was conducted at planting as well. .

Bamboo stakes (2 m height) was vertically installed at 15 days after planting next to the planting holes and the top of the stake was connected with other stakes by using raffia. Cucumbers were manually irrigated every other two-day at the time of no precipitation. Weeds were manually controlled, but insects were chemically controlled using insecticides (active ingredient Fipronil 50 g L^{-1} (Regent 50 SC) and Profenos 500 g L^{-1} (Curacron 500 EC).

Cucumbers were harvested when fruits had a uniform color of whitish green, conducted every three

days by cutting the fruit stalks with a scissor. Total harvests were four times. Treatments effects on weed growth were measured in terms of weed dry weight of broadleaf weeds and dry weight of narrow-leaf weeds plot^{-1}. The effect of treatments on cucumber yields was observed on five sample plants in terms of (1) fruit length (cm), (2) fruit diameter (cm), (3) number of fruits per plant (fruit), (4) fruit weight per plant (g), (5) number of fruit per plot (fruit), and (6) fruit weight per plot (g). Data were subjected to a homogenous test and then analyzed by using the Statistical Analysis System at $P<0.05$. Means of treatment effects were compared using Duncan's Multiple Range Test (DMRT) at the level a 5%.

RESULT AND DISCUSSION

Environmental condition

The average monthly rainfall during the experiment from October to December 2015 was 448.4 mm with an average number of rainy days for 12 days. The average daily temperature was 27.10 ^{o}C, whereas the average humidity was 85 %. Soil analysis of experimental soil indicated that its pH was 4.0 and is classified as acid, with a nutrient content of N -total 0.14%, C-total 3.97%, P_2O_5 3.0 ppm, K-*ex* 0.12 me 100 g^{-1}, Na-*ex* 0.15 me 100 g^{-1}, Ca-*ex* 0.86 me 100 g^{-1}, Mg-*ex* 0.53 me 100 g^{-1}, CEC 7.26 me 100 g^{-1}, Al-*ex* 4, 80 me 100 g^{-1}, H-*ex* 0.48 me 100 g^{-1}. During the early growth of cucumbers, plants experienced slow growth due to very hot temperatures. However, 7 days after the day the plants started to show good growth with the better development of stems and leaves.

Cucumber yields

Results indicated that combination application between palm-oil fruit bunch organic fertilizer and synthetic nitrogen significantly effects fruit length, fruit diameter, number of fruit planted, fruit weight per plot, number of fruit per plot and fruit weight per plot. Table 1 summarized the effects of treatments on fruit length, fruit diameter, number of fruits per plant, fruit weight per plant, number of fruits per plot and fruit weight per plot.

Fruit length

Results indicated that the application of 10 tons ha^{-1} of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) produced the longest fruit length (23.21 cm) which was not different from those produced by P11, P7, P8, and P10. However, P12 was significantly different from P1, P2, P3, P4, P5, P6, and P9. This suggested that maximum doses of both organic fertilizers and urea fertilizers provided nutrients for plants which are important for cucumber fruit. The availability of nutrients that can be absorbed by plants is one of the factors that can affect the level of productivity of a plant. According to Koswara (1992), nutrient availability determines the rate of photosynthesis. During the reproductive phase, fruits become very strong in utilizing photosynthetic products and limit the sharing of assimilation products to the vegetative growth areas which eventually improve fruit development.

Fruit diameter

Similar to fruit length, the application of 10 tons ha^{-1} of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) produced the widest fruit diameter (47.38 mm which was not different from those produced by P11 and P10. The smallest diameter is 25.88 mm and found in treatment P1 (without fertilizers). Fruit diameter is related to fruit weight, usually the bigger the fruit, the bigger the fruit diameter. This result suggested that the use of solid organic fertilizers and urea fertilizers has an effect on the growth of cucumber fruit. Fruit diameter is influenced by the availability of nutrients in the soil and absorption by plants. Applying fertilizer with the right dose will give fruit yields including a wide diameter. This is in line with the research of Purnomo *et al*. (2013) who concluded that the application of organic and inorganic fertilizers had a significant effect on fruit diameter. The availability of nutrients that can be absorbed by plants is one of the factors that can affect the level of productivity of a plant. As it is known that the hybrid cucumber plant requires more fertilizer, especially nitrogen fertilizer than the ordinary cucumber plant, this is because the growth of the hybrid cucumber plant is very fast. This is following the statement of Lingga & Marsono (2004), which states that the main role of nitrogen is to stimulate plant growth as a whole.

Number of fruits per plant

The application of 10 tons ha^{-1} of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) produced the highest number of cucumber fruits (2.86) compared to all treatments (Table 1). The lowest number of fruit was found in treatment P1 (without fertilizers), *i.e.* 1.33 fruits. This suggested that increased soil nutrients due to treatments had the physiological effect to increase the number of cucumber fruits. According to Jumin (2002), the availability of sufficient nutrients leads to rapid cell formation, increases photosynthesis rates, increases translocation of photosynthesis to plant parts, induces fruit formation, and development. This result was is in line with Permanasari (2015) who concluded that the combined application of solid organic fertilizers and synthetic fertilizers increased the number of cucumber fruits. However, the number of fruits produced was smaller than the description of

Harmony variety. The lower fruit number might have been due to high monthly rainfall, (448.4 mm), which reduced the percentage of fruit formation, due to flower abortion.

Number of fruits per plot

The highest number of fruit per plot was found in cucumber plants fertilized with 10 tons/ha of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) which produced the highest number of fruit per plot of 15.58 (Table 1). However, this was not significantly different from P11, 10, P8, and P7. However, the lowest number of fruits per plot was found in P1 (without fertilizers), *i.e.* 8.58 pieces. Research conducted Panupesi (2012), concluded that the application of solid organic fertilizers and synthetic fertilizers increased the fruit numbers of cucumber. The effect of treatment has not resulted in improved physical and biological properties of the soil, but also the chemical properties of the soil. The combination of solid organic fertilizers and urea fertilizers provide a large number of nutrients, especially N. These nutrients are important in the process of filling the seeds in fruit which will affect the number of fruits. The nutrients available from solid organic fertilizers and urea fertilizers increased cucumber photosynthesis and translocated more photosynthetic products to all plant parts. According to Hardjowigeno (1987), the balance of nutrients absorbed by plants is very important in increasing the number of fruit.

Fruit weight per plot

Results from this experiment indicated that the application of 10 tons ha^{-1} of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) produced the highest fruit weight per plot (3896.89 g) (Table 1). The lowest fruit weight per plot was found in cucumber had no fertilizer (P1) with the fruit weight of 1108.53. This suggested that the treatment of organic fertilizers and urea fertilizers increase the weight of the cucumber fruit. Rismunandar (1992) states that with sufficient plant nutrient needs, both macro and microelements, plant growth and productivity will run smoothly. This will support fruit formation optimally, resulting in a larger size and weight of cucumber fruits. This result was in line with research conducted by Hamma *et al.* (2012), who concluded that the application of organic fertilizers on the growth and yield of cucumbers had a positive effect. The greater the fertilizer dose used, the resulting fruit weight also increased significantly. According to Agustina (2004), balance fertilization is very important to have excellent crop yields.

Table 1. Effect combination application between palm-oil fruit bunch organic fertilizer and synthetic nitrogen on fruit length, fruit diameter, number of fruits per plant, fruit weight per plant, number of fruits per plot, and fruit weight per plot

Treatments	Fruit length (cm)	Fruit diameter (mm)	Number of fruits per plant	Fruit weight per plant (g)	Number of fruits per plot	Fruit weight per plot (g)
P1	18.24 d	34.15 c	1.33 f	243.32 c	8.58 e	1108.53 d
P2	19.94 cd	37.92 bc	1.53 ef	261.91 c	10.41 de	1507.78 cd
P3	20.18 cd	40.28 bc	1.51 ef	336.68 bc	11.58 cd	1697.30 cd
P4	20.44 cd	39.05 bc	1.71 de	276.05 bc	11.00 cd	1567.65 cd
P5	20.52 cd	38.91 bc	1.65 de	301.89 bc	12.41 bcd	1601.71 cd
P6	20.71 bc	39.93 bc	1.76 de	402.71 abc	12.91 bcd	2307.85 bc
P7	21.71 abc	39.46 bc	1.86 cd	382.20 abc	13.16 abc	2099.83 bcd
P8	21.14 abc	40.70 bc	2.16 bc	377.60 abc	13.33 abc	2412.54 bc
P9	20.46 cd	39.47 bc	1.9 cd	349.22 abc	12.91 bcd	1975.01 bcd
P10	20.95 abc	41.43 ab	2.31 b	411.91 abc	13.58 abc	2331.58 bc
P11	22.98 ab	42.40 ab	2.41 b	438.65 ab	14.41 ab	2852.39 b
P12	23.21 a	47.38 a	2.86 a	517.05 a	15.58 a	3896.89 a

Notes: Means of treatments in the same column followed by the same letter are not significantly different according Duncan's Multiple Range Test 5%. P1=without palm-oil bunch organic fertilizer + without Urea, P2=without palm-oil bunch organic fertilizer + Urea 50 kg ha^{-1}, P3=without palm-oil bunch organic fertilizer + Urea 150 kg ha^{-1}, P4=without palm-oil bunch organic fertilizer + Urea 250 kg ha^{-1}, P5= palm-oil bunch organic fertilizer 5 tons ha^{-1} + without Urea, P6=organic fertilizer palm-oil bunch 5 tons ha^{-1} + Urea 50 kg ha^{-1}, P7= palm-oil bunch organic fertilizer 5 tons ha^{-1} + Urea 150 kg ha^{-1}, P8= palm-oil bunch organic fertilizer 5 tons ha^{-1} + Urea 250 kg ha^{-1}, P9= palm-oil bunch palm-oil bunch organic fertilizer 10 tons ha^{-1} + without Urea, P10= palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 50 kg ha^{-1}, P11= palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 150 kg ha^{-1}, P12= palm-oil bunch organic fertilizer 10 tons ha^{-1} + Urea 250 kg ha^{-1}.

CONCLUSION

Based on this experiment, it is concluded that the use of 10 tons ha^{-1} of palm-oil bunch organic fertilizer in combination with 250 kg ha^{-1} of Urea (P12) was the best treatment combination to increase cucumber yields.

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