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Growth and Yield Response of Sweet Corn (*Zea Mays Saccharata* Sturt) on Some Green Manure *Tithonia Diversifolia* and Dose of EM4

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ABSTRACT

Soil fertility decline as a result of the use of inorganic fertilizers. *Tithonia diversifolia* is an green manure and EM4 is a mixture of beneficial microorganisms. Application of Tithonia and EM4 on sweet corn is an effort to replace the use of inorganic fertilizers. This study aims to obtain the interaction in application of Tithonia and EM4, to compare at different doses of green manure *Tithonia*, and to compare on the application of multiple doses of different EM4. Completely Randomized Block Design is used which consist of two factors. The first factor is the dose of Tithonia consisting of: 0 tons ha-1, 10 tons ha-1, 20 tons ha-1 and 30 ton ha-1. The second factor is the dose EM4 comprising: 0 ml L-1, 10 ml L-1 and 20 ml L-1 of water. The results showed that Tithonia diversifolia and EM4 have no effect on the growth and yield of sweet corn. Tithonia diversifolia of 30 tons ha-1 provide the highest plant height and the highest number of leaves and and the largest stem diameter and the highest level of leaf greenish. There is a tendency on the ascending EM4 dosage, will increase the average plant height, leaf number, stem diameter and leaf greenish level.

INTRODUCTION

Sweet corn crop cultivation include spacing, watering, weeding, pest control and fertilization. Fertilization either used organic or inorganic fertilizers, but commonly farmers use inorganic fertilizers. Currently inorganic fertilizers besides expensive are also hard to gain and have a negative effect when used continuously. To replace inorganic nutrients can be done using a fertilizer derived from weed *Tithonia diversifolia*.

Biomass fresh weight of Tithonia reach $9^{-1}1$ ton ha^{-1} when is grown over the dry season and $14^{-1}8$ ton ha^{-1} during the rainy season. *Tithonia diversifolia* contains 3.50 to 4.00% N, 0.35 to 0.38% P, 3.50 to 4.10% C, 0.59% Ca and 0.27% Mg (Lestari, 2016). According to Hakim *et al*., (2008), applying Tithonia can increase the productivity of land due to lowering Al, as well as increase the soil pH, organic matter, the content of N, P, K, Ca and Mg soil, thereby increasing the productivity of the plant.

Study of Lestari (2016), application of fresh Tithonia 3-4 tonnes ha^{-1} reduce the use of inorganic fertilizers and improve the growing media, as well as result in soybean weight up to 1.94 tonnes ha^{-1}. The content of C/N ratio of weed Tithonia is 8.64. The C/N ratio of Tithonia is lower which worth to be made into green manure (Dahlianah, 2014). To speed up the process of decomposition of weed Tithonia are made in the green manure can be done with the EM4.

Simatupang research (2014), showed that the dose Tithonia compost 20 tons ha^{-1} given to cauliflower plants produce a high growth rate, the number of leaves, and the highest leaf dry weight compare to doses below it (0.5 tons $ha^{-1)}$. Ghifari *et al*., (2014), also stated that the treatment of cow dung compost 75% (14.12 tons ha^{-1}) and Tithonia 25% (1,335 tons ha^{-1}) has a number of fruit and fruit fresh weight were higher on curls peppers when compared to other treatments with the potential harvest of 2,904 tons ha^{-1}.

Phabiola researchs (1997) showed that the effect of EM4 and NPK fertilization on P uptake and rice growth on Andisol soil showed that EM4 have very significant effect on all the observed growth and production parameters: the number of tillers, plant height, stem fresh weight, available P levels and shoots. The highest soil CO2 production compared with other treatments.

Study of Purnama (1998), shows the influence of the concentration of EM4 and source of organic

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material on the growth and yield of garlic (*Allium sativum* L.) that the interaction between treatment EM4 to the type of source of organic material have significant to very significant effects on all the observed variables: plant height, leaf area, root stem circumference, fresh tuber weight, the weight of oven dried tubers and harvest index. The interaction of rice straw treatment as source of organic material and EM4 concentration of 5,000 ppm, resulted in better growth and yield of garlic.

The objectives of this study are to obtain the interaction doses of green manure *Tithonia* diversifolia and EM4 on the growth and yield of sweet corn, to compare the growth and yield of sweet corn at different doses of green manure *Tithonia diversifolia*, and to compare the growth and yield of sweet corn on the apply of multiple doses of EM4.

MATERIALS AND METHODS

The experiment was conducted December 2016 to April 2017 at Kandang Limun Village, Subdistrict of Muara Bangkahulu, Bengkulu City with Ultisol. Furthermore corn seed used was Lorenza F1 varieties. Plot wide used was 7.3 m^2 obtaining 35 holes per plot.

Determining plant samples by random, in each plot contained 5 plants as a plant samples instead of the edge plants. EM4 application conducted twice on sweet corn crop at 2 and 5 weeks after planting which is each of half part of concentration.

Inorganic fertilizer is only given 50% of recommendations. According Nurmegawati et al., (2015) a dose of recommendations for sweet corn crop are urea 350 kg ha^{-1}, SP- 36 125 kg ha^{-1} and KCl 100 kg ha^{-1}. Urea is given three times, namely ⅓ part together with SP-36 and KCl at planting, ⅓ part is given at the age of 21 days after planting, and ⅓ part given at 35 days after planting.

All data collected from field were subjected to analysis of variance according to the procedure for complete randomized block designs. Means from individual biomass were compared using Duncan Multiple Range Test 5%.

RESULTS AND DISCUSSION

Implementing The study was conducted from December until April 2017 in Sub District of Muara Bangkahulu, Bengkulu city on Ultisol. Planting date of sweet corn was on January 16, 2017.

Fertilization is carried out on the age of the plant's first 1 wap (week after planting) or on January 23, 2017, but at 25 of Januari 2017 rains started early days, as well as in the second fertilization is at 5 wap or February 20th 2017, dated January 25, 2017 it was raining. At the time of corn aged 4-5 wap green locusts attacks (*Atractomorpha crenulata*) which attack the leaves of sweet corn plant, then carried the locusts pest control measures are chemically by spraying insecticides and damage can be suppressed.

Harvesting is done 2 times a harvest where the first harvest is done at the age of plant and harvest 90 dap second at 100 dap. Harvest is done by 2 times for some corn plant that has not been possible for a decent harvest so it must wait for a few days. Harvesting is done with the criteria of the corn crop has brown hair and dry, the color of husk is still green, if grain is pressed still concentrated discharge.

Results of Analysis Variant

The research data obtained was analyzed using Analysis of Variance (Anova) by F test at level 5%. The variables that significantly then tested further by Duncan multiple range test (Duncan Multiple) at level 5 %, Variance analysis results are presented in Table 1 are intended to see the effect of the treatment of the observed variables.

Green manure treatment of weed *Tithonia diversifolia* on the growth of sweet corn significantly effect on plant height at age 2 wap, 3 wap, wap 4, 5 and 6 wap, number of leaves at 3 wap, 4 wap, stem stem circumference 2 wap, 3 wap, 4 wap, 5 wap and 6 wap, level greenish leaves at 4 wap, while there is no real effect on the fresh weight of the plants, plant dry weight, the weight of cob per plot, weight of cob without husk, cob stem circumference, cob length, number of grains per ear and weight cobs ha^{-1}.

Application of EM4 on maize have no real effect on all variables were observed, as well as the

Table 1. Summary of F-calculated values for the treatment of Tithonia diversifolia and EM4 doses on the observation variables of growth and yield of sweet corn

Variable	F hitung 5 %		
	Tithonia	EM4	Interaction
Plant height			
2 wap	4.10*	0.91^{ns}	0,69^{ns}
3 wap	4.41*	0.24^{ns}	0,93^{ns}
4 wap	5.64**	0.60^{ns}	0,92^{ns}
5 wap	4.05*	0.36^{ns}	0,72^{ns}
6 wap	3.12*	0.36^{ns}	0,58^{ns}
Leaf number			
2 wap	1.99^{ns}	0.84^{ns}	0,63^{ns}
3 wap	3.52*	0.64^{ns}	0,91^{ns}
4 wap	3.17*	0.50^{ns}	0,68^{ns}
5 wap	1.10^{ns}	0.31^{ns}	0,41^{ns}
6 wap	2.07^{ns}	0.05^{ns}	0,46^{ns}
7 wap	2.25^{ns}	0.07^{ns}	0,17^{ns}
Stem circumference			
2 wap	4.63*	0.26^{ns}	0,66^{ns}
3 wap	3.76*	0.09^{ns}	0,69^{ns}
4 wap	5.16**	0.16^{ns}	0,76^{ns}
5 wap	3.80*	0.16^{ns}	0,61^{ns}
6 wap	3.38*	0.21^{ns}	0,53^{ns}
Leaf greenish level			
2 wap	2.44^{ns}	0.47^{ns}	0,49^{ns}
3 wap	3.62*	0.16^{ns}	0,38^{ns}
4 wap	0.54^{ns}	0.18^{ns}	0,17^{ns}
8 wap	0.44^{ns}	0.08^{ns}	0,18^{ns}
Plant fresh weight	1,39^{ns}	0.23^{ns}	0.80^{ns}
Plant dry weight	1,56^{ns}	0.30^{ns}	0.81^{ns}
Cob weight per plot	1,44^{ns}	0.45^{ns}	0.49^{ns}
Cob weight w/o husk	1,45^{ns}	0.48^{ns}	0.64^{ns}
Cob stem circumference	0,95^{ns}	1.07^{ns}	1.09^{ns}
Cob length	1,79^{ns}	0.43^{ns}	0.67^{ns}
Seed numbers per cob	0,97^{ns}	0.36^{ns}	0.93^{ns}

interaction between *Tithonia diversifolia* and EM4 also have no real effect on all variables observation.

Effect of green manure *Tithonia diversifolia* on Sweet Corn Plant Growth.

Plant height is one of the important variables plant growth. Plant height describe the level of plant growth that can be useful in augmenting the weight of sweet corn plants as a form of growth rate, which states whether or not the disruption of sweet corn (Sigalingging, 2016). The results of analysis of variance of *Tithonia diversifolia* dosage and EM4 concentration of plant height showed significant variables (Table 2) that was followed by a further test DMRT at 5% level can be seen in Table 3.

presumably the higher organic matter content *Tithonia diversifolia* capable of increasing the water supply for the needs of the sweet corn crop. This is consistent with the statement (Naldo, 2011), that the organic material can also improve the water supply for the needs of the plant, because the organic material can absorb and store water beyond its own weight. It is also stated by Hutomo *et al*., (2015), that with the ability to store water *Tithonia diversifolia* can increase soil moisture, affect the growth of sweet corn crops. The role of water as a solvent of nutrients in the soil causing plants sweet corn easily take the nutrient as a foodstuff through the roots. Organic material also serves as a source of energy for microbes (Nugroho *et al*., 2013).

Table 2. Effect of dosages of Tithonia diversifolia and EM4 on the mean height of sweet corn plants at 2. 3. 4. 5. and 6 wap.

Treatment	Average				
	2wap	3wap	4wap	5wap	6wap
Tithonia diversifolia Doses					
- 0 tonnes ha^{-1}	18.913 b	25.529 b	32.613 b	42.987 b	53.478 b
- 10 tons ha^{-1}	19.064 b	26.236 b	33.489 b	44.293 b	55.693 b
- 20 tons ha^{-1}	21.069 ab	31.351 ab	41.624 b	53.931 ab	68.176 ab
- 30 tons ha^{-1}	23.889 a	38.622 a	55.376 a	71.082 a	85.844 a
EM4 Concentration					
- 0 ml L^{-1}	19.847 a	29.087 a	37.438 a	49.482 a	60.902 a
- 10 ml of L^{-1}	20.612 a	30.678 a	41.725 a	53.608 a	67.233 a
- 20 ml of L^{-1}	21.733 a	31.538 a	43.163 a	56.130 a	69.258 a

Table 3 shows that application of *Tithonia diversifolia* dose of 30 tons ha^{-1} significantly different to the treatment *Tithonia diversifolia* 0 tons ha^{-1} and 10 ton ha^{-1} but no significant effect on treatment of 20 tons ha^{-1}, Treatment of 30 tons ha^{-1} have an average plant height the highest in 2 wap (18.913 cm), 3 wap (25.529 cm), 4 wap (32.613 cm), 5 wap (42.987 cm) and 6 wap (53.478 cm) and treatment 0 tonnes ha-1 has a lowest plant height in 2wap (18.913 cm), 3 wap (25.529 cm), 4 wap (32.613 cm), 5 wap (42.987 cm) and 6 wap (53.478 cm). This case is presumably because of nutrient content at a dose of 30 tons ha^{-1} more available to plants so that the plants sweet corn is getting nutrients N, P, and K while at doses of 0 tonnes ha^{-1} cause unavailability of nutrients from *Tithonia diversifolia* treatment. This is consistent with the statement (Lingga, 2001) that the availability of N, P and K in a sufficient amount influence on a metabolism both plants vegetative and generative. This is also consistent with the results Hutomo *et al*., (2015), that application *Tithonia diversifolia* increase corn plant height. It is because the nitrogen in the compost *Tithonia diversifolia* can increase vegetative growth corn.

The use of green manure of *T. diversifolia* capable of delivering high growth on sweet corn crop increases. High treatment of *Tithonia diversifolia* dose at given such as 30 ton ha^{-1} further improve the high growth of sweet corn plants anyway. This is

Number of leaves

The results of analysis of variance test dosage and concentration *Tithonia diversifolia* EM4 indicates a variable number of leaves significant (Table 2) that was followed by a further test DMRT at 5% level can be seen in Table 4. The treatment dose of 30 tons ha^{-1} *Tithonia diversifolia* significantly different to the treatment 0 tons ha^{-1} and 10 ton ha^{-1} but no significant effect on treatment of 20 tons ha^{-1} (Table 4). Treatment 30 ton ha^{-1} has an average number of leaves at most that on average 3 wap.While on treatment 0 ton ha^{-1}

Tabel 3. Effect of *Tithonia diversifolia* dose and concentration of EM4 to the average number of leaves of the plant on 3 and 4 wap

Treatment	Average	
	3 wap	4 wap
T. diversifolia Doses		
- 0 tons ha^{-1}	4.2b	4.0 b
- 10 tons ha^{-1}	4.4b	4.1 b
- 20 tons ha^{-1}	4.9ab	4.5 ab
- 30 tons ha^{-1}	5.6a	5.4 a
EM4 Concentration		
- 0 ml L^{-1}	4.6a	4.3 a
- 10 ml of L^{-1}	4.8a	4.5 a
- 20 ml of L^{-1}	5.0a	4.7 a

Description: The figures followed the same letter in a column explaining no significant effect on DMRT at 5% level. wap = weeks after planting.

Tabel 4. Effect of *Tithonia diversifolia* dose and concentration of EM4 to the mean stem ring of the plant at 2. 3. 4. 5. and 6 wap.

Treatment	Average				
	2 wap	3 wap	4 wap	5 wap	6 wap
T. diversifolia doses					
0 tons ha^{-1}	2.98 b	5.23 b	7.04 b	8.67 b	10.23 b
10 tons ha^{-1}	3.12 b	5.34 b	7.30 b	9.66 b	10.90 b
20 tons ha^{-1}	3.56 b	6.45 ab	9.12 b	11.18 ab	12.60 ab
30 tons ha^{-1}	4.23 a	8.28 a	12.83 a	14.96 a	16.01 a
EM4 Concentration					
0 ml.L^{-1}	3.35 a	6.20 a	8.67 a	10.57 a	11.81 a
10 ml. L^{-1}	3.48 a	6.26 a	9.06 a	11.51 a	12.66 a
20 ml. L^{-1}	3.35 a	6.55 a	9.48 a	11.81 a	12.84 a

has an average number of leaves at least 3 wap i.e. at an average of 4.2 and 4 wap is 4.0 strands. This is presumably because the condition of the amount of nutrients at a dose of 30 tons ha^{-1} more available to plants and sweet corn as compared with the other treatments. Availability of nutrients easily absorbed and immediately used by especially in the formation of leaf crops (Nyakpa *et al*., 2013).

Sweet corn crop at a low dose treatment *Tithonia diversifolia* experiencing barriers to the formation of the leaves of plants, especially when the sweet corn treated with a dose of *Tithonia diversifolia* 0 ton ha^{-1}. Putri (2011) also stated that the formation of the leaves on the plant strongly influenced by the availability of nutrients N and P on the medium available to plants. The more the number of leaves of sweet corn plants, the greater too broad leaves of the plant so that the process of photosynthesis will be higher thus increasing the number of leaves, plant height and trunk stem circumference. The growth of leaves of the plant will increase the length and width when the nutrients available to plants in sufficient quantity (Hakim *et al*., 1986). It is also stated that high dose of organic material can optimize the absorption of nutrients resulting in a growing fotosintat. C/N ratio of green manure is very low but it is allegedly very quickly decompose, so the plants sweet corn significantly affect the number of leaves on 3 and 4 wap.

Stem circumference

Outcome analysis of variance test dose of *Tithonia diversifolia* and EM4 concentration shows a variable number of leaves significant (Table 2) that the results of a further test DMRT at 5% level are shown in Table 5. There were significantly different to the treatment 0 ton ha^{-1}, 10 tons ha^{-1} and 20 ton ha^{-1} at 2 and 4 wap. Giving green manure weed *Tithonia diversifolia* 30 ton ha^{-1} significantly different to the treatment 0 tonnes ha^{-1} and 10 ton ha^{-1} but no significant effect on treatment of 20 tons ha^{-1} at 3, 5 and 6 wap. Treatment of 30 tons ha^{-1} The plant produces stem circumference at 2 wap, 3 wap, wap 4, 5 and 6 wap wap when compared with other treatments, while giving treatment 0 tonnes ha^{-1} showed the smallest stem circumference of the plant. Stem circumference a treatment plant 30 ton ha^{-1} *Tithonia diversifolia* at 2 wap (4.227 mm), 3 wap (8,280 mm), 4 wap (12, 829 mm), 5 wap (14.956 mm) and 6 wap (16.011 mm) higher than the treatment 0 tonnes ha^{-1} at 2 wap (2,979mm), 3 wap (5,271mm), 4 wap (7.036 mm), 5 wap (8.686 mm) and 6 wap (10.230 mm).

Greeness of leaves

The high organic matter will optimize the process of absorption of nutrients and the more fotosintat results produced by the plant. Results fotosintat that many large stem circumference will increase the plant stem sweet corn.

The content of nutrients N, P and K are owned *Tithonia diversifolia* was instrumental to the growth of sweet corn crops. N is a macro nutrient most needed by plants. According Fahmf *et al*., (2009), P is the limiting factor for the growth of the corn crop nutrient needs of plants, other than P already given in an amount calculated sufficient to support optimum growth.

In Table 6 shows that the administration of green manure weed *Tithonia diversifolia* 30 tons ha^{-1} differently to treatment 0 tons ha^{-1} and 10 ton ha^{-1} but no significant effect on treatment of 20 tons ha. *Tithonia diversifolia* treatment dose of 30 tons ha^{-1} produces an average level of the highest leaf greenness at 4 wap 34.769 and treatment doses of *Tithonia diversifolia* 0 ton ha $^{-1}$ shows the average level of the green leaves of the plant lowest in 4 wap is 23.768. Level greenish leaf on sweet corn significantly different at 4 wap allegedly because the supply of nutrients from *Tithonia diversifolia* available for plants gradually or slowly available to

Table 5. Effect of the dose of Tithonia diversifolia and EM4 concentration on the average greenish level of plant leaves at 4 mst

Treatment	Greenish
Tithonia diversifolia doses	
0 tons ha^{-1}	23.768 b
10 tons ha^{-1}	20.768 b
20 tons ha^{-1}	25.816 ab
30 tons ha^{-1}	34.769 a
EM4 Concentration	
0 ml.L^{-1}	25.092 a
10 ml. L^{-1}	27.308 a
20 ml. L^{-1}	26.422 a

plants. It is also stated Damanik *et al.*, (2011), which states some of the weaknesses of organic fertilizer is as follows: 1) low nutrient content; 2) relatively l difficult obtain in large quantities; 3) slowly available to plants and 4) transport and application costly because it is needed in large quantities. According Sinaga *et al*., (2014), nutrients N is needed for growth plant because it helps the process of photosynthesis. Through nutrient nitrogen would be the process of photosynthesis in the presence of chlorophyll. With the increase of photosynthesis then also increase the amount of chlorophyll of leaves, which chlorophyll derived from the element nitrogen.

Effect of green manure *Tithonia diversifolia* and EM4 on Sweet Corn Crop

The results of analysis of variance test treatment dose *Tithonia diversifolia* and EM4 indicates variables fresh weight of the plants, plant dry weight, the weight of cob Tanpe berkelobot, cob stem circumference and length of the cob were not significant (Table 2), the average yield of sweet corn can be seen in Table 6 it is suspected because of the availability of nutrients in weeks 5 and 6 wap is no longer available, it is also seen in a variable amount of sweet corn plant leaves that effect at week 3 and 4 wap, but on 5 and 6 wap no real effect. In addition to the number of leaves of the plant, the leaf greenness level variables also seen that the level of greenish leaves only real effect on 4 wap.

Table 6 shows that the higher the dose of *Tithonia diversifolia* it will increase the value of the average yield of sweet corn that is the plant fresh weight, dry weight of plants, heavy berkelobot Tanpe cob, cob stem circumference and length of the cob. This is due to the higher dose of *Tithonia diversifolia*, it will increase the availability of nutrients for plants.

EM4 concentration of no real effect because it is allegedly less than optimal storage EM4. EM4 storage are strongly advised to do storage at room temperature is low, so that the microorganisms contained in the EM4 not die. The weather at the time of spraying EM4 also greatly affected. Favorable weather conditions for spraying is in the late afternoon so that at night the microorganisms given in plants can be utilized. In research carried out when spraying EM4 rain in the research area, giving rise to the washing on the EM4 sprayed, in addition to the slopes used are also influential. When it rains down on sloping land, it will cause erosion so that the nutrients contained in the map is reduced. Table 7 shows the higher concentration of EM4 then tend to the higher average plant fresh weight, dry weight of plants without husk, cob weight, stem circumference and length of the cobs of sweet corn plants

CONCLUSIONS

Combination of *Tithonia diversifolia* dose treatment and EM4 no effect on the growth and yield of sweet corn. The dosages of *Tithonia diversifolia* 30 ton ha^{-1} at 2, 3, 4, 5, and 6 weeks after planting showed a row of plant height of 23.9 cm; 38.6 cm; 55.4 cm; 71.1 cm and 85.8 cm, number of leaves on the 3rd and 4th highest wap strands 5.4 and 5.6, the largest stem stem circumference at 2, 3, 4, 5 and 6 wap with of 4.2 mm; 8.3 mm; 12.8 mm; 15 mm and 16 mm, and leaf greenness at the highest level 4 wap of 34.8. Concentration of EM4 treatment had no effect on the growth and yield of sweet corn

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Tabel 6. Effect of *Tithonia diversifolia* dose and concentration of EM4 to mean fresh weight of the plants. plant dry weight. weight without berkelobot cob. cob stem circumference and length of the cob

Treatment	Plant fresh weight (g)	Plant dry weight (g)	No husk cob weight (g)	Cob stem cir-cumference (mm)	Cob length (cm)
T. diversifolia doses					
0 tons ha^{-1}	69.34	20.91	49.57	27.47	10.54
10 tons ha^{-1}	93.99	29.66	69.69	30.93	12.66
20 tons ha^{-1}	104.27	30.83	71.17	31.99	12.69
30 tons ha^{-1}	138.36	42.86	108.14	35.99	14.23
EM4 doses					
0 $ml.L^{-1}$	98.81	29.92	69.76	29.84	12.02
10 $ml.L^{-1}$	99.07	30.61	73.18	32.09	12.34
20 $ml.L^{-1}$	106.59	32.67	81.00	32.86	13.23

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