

Increasing Productivity and Biomass of Corn Plants Toward Grant Organic Fertilizer and Liquid Organic Fertilizer

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Abstract

The use of corn as animal feed focuses on the use of biomass as feed for ruminants and shelled corn as poultry feed. One of the efforts to increase biomass and protein in corn is by applying fertilizer, namely organic fertilizer. Therefore, the purpose of this study is to determine the effectiveness of using granular and solid organic fertilizers and to determine the best concentration of both types of fertilizers in increasing maize productivity and biomass. The study was designed using a Split Plot Design with an environmental design, namely a Randomized Block Design (RAK). The main plot is organic fertilizer granule petrogranik consisting of 3 levels, namely control (G0), 1000 kg ha⁻¹ (G1) and 2000 kg ha⁻¹ (G2). The sub-plots were Biotani liquid organic fertilizer which consisted of 4 levels, namely control (P0), 2 cc/L (P1), 4 cc/L (P2), 6 cc/L (P3). The treatment of granule and liquid organic fertilizer increased the growth potential and productivity of maize. The optimal treatment of granulated organic fertilizer is G1 treatment. Meanwhile, the best treatment for liquid organic fertilizer is P1 treatment. The combination of G1P1 is still recommended even though there is no interaction between granule and liquid organic treatments.

Keywords: *Corn, Productivity, Biomass, Granulated Organic Fertilizer, Liquid Organic Fertilizer.*

A. INTRODUCTION

Corn (*Zea mays* L.) is a favorite commodity grown by farmers. The high demand for corn is the reason this crop is favored by farmers. The benefits of corn, both as a food and feed source, provide high economic opportunities and have a national impact. This makes the demand and production of corn continue to increase in line with the increase in population. This is proven by the national corn production in the last 5 years increasing by an average of 12.49 percent per year. However, this increase in production faces challenges from the shift of agricultural land to non-agriculture, so that maize extensification activities become difficult to carry out. Therefore, the development of corn intensification is a solution in increasing corn production, especially as a feed ingredient.

The use of corn as feed is very focused on shelled seeds. The shelled components are very useful in poultry feed. This is because corn has high carbohydrate and protein potential, so the use of shelled corn as the main source in poultry feed is important. However, the potential for feed in corn plants is not only found in the shelled seeds. The use of corn biomass as an animal feed product is also potential for use. Ali et al.; Hellin et al.; Shreck et al.; Terler et al. In general, corn biomass is all parts of the corn plant that are not used or not taken as staple food (stems, leaves, kelobot, and cobs) which ranges from 50-73% of the total corn component Zaidi et al. 9. In addition, based on the content, corn biomass contains 38% cellulase, 26% hemicellulase and 19% lignin. This composition is suitable as a source of feed for remedial livestock. Even in its use, corn biomass is only used as an alternative feed when general rumen feed is scarce. Terler et al.8. This was caused by drying and the rapid increase of lignin in the corn biomass after the cobs were harvested, so that the biomass was not suitable for livestock. Ahmad et al.; Terler et al. However, in dry conditions, the use of corn biomass becomes a good alternative for animal feed. Therefore, it is important to develop maize with suitable productivity and biomass for feed.

One of the efforts to increase biomass and protein in corn is by applying fertilizer. There are two types of fertilizers, namely organic fertilizers and inorganic fertilizers. However, the use of inorganic fertilizers that are too high and prolonged can cause soil conditions to be more damaged, so that the potential for biomass development and corn shell productivity is low. Utomo et al.12 The use of organic fertilizers is one of the efforts to reduce the negative impact of the use of chemicals such as chemical fertilizers and pesticides. Several studies have also reported the important role of the use of organic fertilizers in increasing the potential for crop productivity. suggesting that the use of chemical fertilizers adversely affects soil quality and decreases soil and crop productivity, while the use of organic agriculture or organic nutrients universally increases soil and crop productivity. In general, the use of organic fertilizers can improve the physical, chemical and biological conditions of the soil, although the improvement of soil chemistry is a slow process if it is not supported by chemical fertilizers Shaji et al. Therefore, organic fertilizer treatment is expected to optimize the potential productivity of shelled and biomass of corn plants.

Organic fertilizers circulating among farmers consist of solid organic fertilizer and liquid organic fertilizer. The use of solid organic fertilizer is more optimal when it is formed in granules. According to Kuyik et al., the response of sweet corn plants with granule organic fertilizer treatment gave the best response to plant height and number of leaves. In addition, according to17, Parmila et al.18 and Pakpahan et al., the use of granular fertilizers such as petroorganics has advantages such as high C-organic content, granular form, safe, environmentally friendly (free of pathogenic microbes) and free from seeds/grains. The water content of petroorganic fertilizer is low so it is efficient in transportation and storage. This can support root development which is correlated with improvements in plant biomass and

productivity Samejima et al. Based on this, the application of petrogranular fertilizer is considered to be able to improve the productivity and biomass potential of corn.

The use of liquid organic fertilizers also has an important role in increasing maize production. According to, liquid organic fertilizer had a significant effect on plant height, leaf area, cob length, and cob weight. reported that the application of liquid organic fertilizer on Burangrang soybean variety showed the best production response with a seed weight of 17.67 gr and potential to be used as animal feed. Meanwhile, according to Syofia et al. reported that the application of liquid organic fertilizer sprayed can give the best results on the variables of cob length, cob diameter, cob weight per plant, and cob weight per plot of sweet corn varieties jamboree and bonanza. The results of this study prove the importance of the effect of liquid organic fertilizer on productivity and plant biomass, especially corn. Therefore, based on the explanation above, the application of granular and liquid organic fertilizers has potential in the productivity and biomass of corn plants as animal feed. The purpose of this study is to determine the effectiveness of using granular and solid organic fertilizers and to determine the best concentration of both types of fertilizers in increasing maize productivity and biomass.

B. METHODS

The study was carried out from July to December 2020. This research was carried out at the UPTD of the Central Seed Center for Food Crops and Horticulture, Polewali Mandar Regency, West Sulawesi Province.

This research was designed using Split Plot Design with an environmental design that is Randomized Block Design (RAK). The main plot was organic fertilizer granule petrogranik consisting of 3 levels, namely control (G0), 1000 kg ha⁻¹ (G1) and 2000 kg ha⁻¹ (G2). The sub-plots were Biotani liquid organic fertilizer which consisted of 4 levels, namely control (P0), 2 cc/L (P1), 4 cc/L (P2), 6 cc/L (P3). Each combination was repeated 3 times, so there were 36 experimental units.

The plot size of each experimental unit was 3 m x 1.3 m with a distance between plantings of 70 x 20 cm with a distance between plots and between replications of 1 m. Planting was carried out simultaneously by making planting holes with a spacing of 70 cm x 20 cm. After that, each hole is planted as much as 1 seed. Maintenance follows the guidelines for corn cultivation which consists of watering, replanting, weeding and hoarding, fertilizing and controlling plant pest organisms (OPT). Embroidery is done 7 days after planting. Watering is done every day on corn plants aged 1 to 4 weeks. Furthermore, watering is done every 2 days in the afternoon. The first weeding was done at the age of 3 weeks after planting and the second weeding was done when the plants were about 6 weeks after planting. Fertilization is carried

out based on the treatment and pest control is carried out with vegetable pesticides. Meanwhile, harvesting was done at the age of 102 days after planting. Harvesting was done by taking the cobs from the stems by breaking them.

Basic fertilizer application was carried out using fertilizers (urea 150 kg/ha, urea 250 kg/ha, SP 36 175 kg/ha, and KCL 75 kg/ha) with the application of urea fertilizer 2 times, at the age of 10 and 30 days after planting. SP 36 and KCL fertilizers were given once at the same time as the first fertilization with urea. Next prepare organic fertilizer granules had done 1 week before planting, given by spreading evenly according to treatment. Liquid organic fertilizer was applied 4 times, with an application interval of 15 days starting at the age of 10 days after planting, 25 days after planting, 40 days after planting and 55 days after planting. Fertilization was done by spraying directly on the leaves to the base of the plant.

Plant height, leaf number, leaf area, stem diameter, male flower age, female flower age, cob weight, seed weight, stem wet biomass weight, stem dry biomass weight, leaf wet biomass weight, leaf dry biomass weight, total wet biomass weight, and yield.

The data were analyzed by analysis of variance (Anova). Then, the analysis continued with Pearson correlation analysis. Characters that are significantly correlated with the main character are selected for further testing. Further tests were carried out with the Least Significant Difference (BNT) follow-up test at the level of 0.05.

C. RESULTS AND DISCUSSION

The results of the ANOVA table show that all characters have a coefficient variation that is tolerated or less than 20% with the highest coefficient variation owned by BBTkl at its Coefficient variation Value of 18.96% (Table 1). Based on the effect of variation, granule fertilization has a significant effect on the characters of BTkl, BBBB, BBKB, BBBB, BBKD, BBBB and BBKT (Table 1). Organic fertilizer has a significant effect on the character of leaf area, BTkl, BBj, BBKB, BBKD and BBKT. The variation of interactions between granular fertilizer and liquid organic fertilizer only significantly affects leaf area. These results indicate that further analysis can be carried out in this study.

Table 1 Analysis of Variance (ANOVA) of Granulated Organic Fertilizer and Liquid Organic Fertilizer

Character	Granulated Organic Fertilizer (POG)	Liquid Organic Fertilizer (POC)	POG x POC	CVa	CVb
TT	127.71	74.39	30.95	4.05	2.45
JD	0.23	1.09	0.57	2.19	4.40
DB	0.01	0.00	0.00	5.28	2.26
LD	10256.44	21083.13**	9008.76*	15.59	9.59
UBJ	0.86	1.30	0.71	2.69	1.67
UBB	0.58	0.25	1.36	1.07	2.04
BTKl	58.54*	6.61*	1.08	18.96	14.18
BBj	7.06	2.80*	0.63	12.94	9.56
BBBB	37632.69*	730.91	1250.30	11.87	9.26
BBKB	4979.19**	84.60*	25.65	18.37	11.16
BBBD	8153.81*	1673.10	608.34	16.54	15.41
BBKD	449.20**	226.45**	13.68	6.81	5.01
BBBT	196749.11**	14169.93	7005.33	14.15	13.31
BBKT	5274.38**	237.08**	60.01	12.13	6.41
Rendemen	0.00	0.00	0.00	12.33	8.14

Note: TT = Plant Height, JD = Number of Leaves, DB = Stem Diameter, LD = Leaf Area, UBJ = male flower age, UBB = female flower age, BTKl = cob weight, BBj = seed weight, BBBB = stem wet biomass weight, BBKB = stem dry biomass weight, BBBD = leaf wet biomass weight, BBKD = leaf dry biomass weight, BBBT = total wet biomass weight, BBKT = total dry biomass weight, yield.

The correlation analysis in Table 2 shows that the weight of the cobs has the most significant positive correlation compared to other characters. Characters that are significantly correlated with cob weight are seed weight (0.81), BBBB (0.68), BBKB (0.34), BBBD (0.45), BBKD (0.55), BBBT (0.76) and BBKT (0.32). The male flower age character only has a significant positive correlation with leaf area. The seed weight character also has a significant positive correlation with the number of leaves (0.57), cob weight (0.58), BBBB (0.56), BBBD (0.31), and BBBT (0.60). BBBB character also has a significant positive correlation with BBKB (0.64), BBBD (0.61), BBKD (0.49), and BBBT (0.76) and BBKT (0.60). BBKB character also has a significant positive correlation to BBBD (0.56) and BBBT (0.60). BBBD character also has a significant positive correlation with BBKD (0.58), BBBT (0.60). However, in this study, the research focused on the character of seed weight and biomass, so further analysis focused on characters that are significantly correlated with seed weight and biomass.

Table 2 Pearson Correlation Analysis

	TT	JD	DB	UBB	LD	UBJ	Btkl	BBj	BBBB	BBKB	BBBD	BBKD	BBBT1	Rendemen	PK
TT	1														
JD	0.48	1													
DB	0.65	0.55	1												
UBB	0.39	0.31	0.49	1											
LD	-0.38	-0.31	-0.66	-0.52	1										
UBJ	-0.49	-0.33	-0.48	-0.40	0.62	1									
Btkl	0.45	0.38	0.44	0.57	-0.54	-0.52	1								
BBj	0.57	0.57	0.64	0.56	-0.54	-0.58	0.81	1							
BBBB	0.33	0.40	0.30	0.52	-0.41	-0.24	0.68	0.56	1						
BBKB	-0.17	0.04	-0.29	0.20	0.04	0.04	0.34	0.05	0.64	1					
BBBD	-0.02	0.11	-0.03	0.38	-0.04	0.10	0.45	0.31	0.61	0.56	1				
BBKD	-0.09	0.11	-0.18	0.33	0.08	-0.03	0.55	0.41	0.49	0.54	0.58	1			
BBBT	0.37	0.39	0.49	0.51	-0.37	-0.29	0.76	0.60	0.76	0.44	0.60	0.44	1		
BBKT	-0.24	-0.02	-0.37	0.20	0.05	0.05	0.32	0.10	0.60	0.92	0.55	0.67	0.37	1	
Rendemen	-0.05	0.04	-0.01	-0.02	-0.07	0.08	0.01	-0.14	0.04	0.20	-0.02	0.12	0.10	0.20	1

Note: TT = Plant Height, JD = Number of Leaves, DB = Stem Diameter, LD = Leaf Area, UBB = male flower age, UBBB = female flower age, UBBT = cob weight, BBj = seed weight, BBBB = stem wet biomass weight, BBKB = stem dry biomass weight, BBBD = leaf wet biomass weight, BBKD = leaf dry biomass weight, BBBT = total wet biomass weight, BBKT = total dry biomass weight, yield.

The results of the BNT 0.05 follow-up test on leaf area characters are shown in Table 3. This further test is focused on simple interaction or effect analysis. Based on the comparison between granular fertilizer and liquid fertilizer, P1, P2, P3 had no difference in leaf area between granular fertilizers, while at P0, treatment G0 was the treatment with the lowest leaf area (419.42). Meanwhile, based on the comparison between liquid fertilizers in each granulated fertilizer treatment, it is shown that P3 as the concentration of liquid fertilizer had the largest leaf area (648.89), but this leaf area was not significantly different from P1 treatment. In the G1 and G2 treatments, there was no significant difference between the liquid fertilizer treatments.

Table 3 Leaf Area

Treatment	P0	P1	P2	P3	Average
G0	419.42Cb	612.64Aba	528.10Ba	648.89Aa	552.2617
G1	568.77Aa	615.93Aa	536.64Aa	579.12Aa	575.1158
G2	598.53Aa	592.09Aa	581.89Aa	668.68Aa	610.2975
Average	528.91	606.89	548.88	632.23	579.225

Note: G = granule organic fertilizer, P = liquid organic fertilizer

The results of a further test of BNT 0.05 on the character of cob weight show that P3 has the best cob weight (10.00 tons/ha) and is significantly different from P0, P1 and P2 (Table 4). On the other hand, P0 treatment is the lowest treatment (6.15 tons/ha). Based on the granular fertilizer treatment, G2 treatment is the treatment with the largest cob weight (10.39 tons/ha), although it is not significantly different from G1 treatment. On the other hand, G0 treatment is the lowest treatment with a cob weight value of 6.24 tons/ha.

Table 4 Weight of Cobs

Treatment	P0	P1	P2	P3	Average
G0	6.15	5.67	5.99	7.14	6.24b
G1	8.21	9.60	9.92	10.79	9.63a
G2	10.16	9.33	10.00	12.06	10.39a
Average	8.17b	8.20b	8.64b	10.00a	2.86

Note: G = granule organic fertilizer, P = liquid organic fertilizer

The results of further tests on the character of seed weight showed that the P1 fertilization treatment is the treatment with the best seed weight (6.31 tons/ha) (Table 5). However, this treatment is not significantly different from the P2 and P3 treatments. On the other hand, P0 treatment is the lowest with a seed weight of 5.52 tons/ha.

The results of further BNT tests on BBBB, BBBD, and BBBT characters are shown in Tables 6, 7 and 8, respectively. Based on the BBBB treatment, treatment G2 is the treatment with the best BBBB (341.73 g), while treatment G0 is the treatment with the lowest BBBB at 230.08. based on BBBD character, treatment G2 is the best

treatment (191.73), but it is not significantly different from treatment G1. On the other hand, G0 treatment is the lowest treatment with a BBBB value of 140 g. As for BBBT characters, treatment G1 is the best treatment (774.35 g), although the treatment is not significantly different from treatment G2. On the other hand, G0 treatment also becomes the treatment with the lowest BBBT with a value of 520.79 g.

Table 5 Weight of seeds

Treatment	P0	P1	P2	P3	Average
G0	5.29	6.13	5.57	5.58	5.64
G1	5.87	6.30	6.00	5.53	5.93
G2	5.41	6.50	6.11	6.64	6.16
Average	5.52c	6.31a	5.89ab	5.92ab	5.91

Note: G = granule organic fertilizer, P = liquid organic fertilizer

Table 6 BBBB

Treatment	P0	P1	P2	P3	Average
G0	206.25	232.92	237.00	244.17	230.08c
G1	302.00	265.92	261.50	283.33	278.19b
G2	310.33	345.33	354.67	356.58	341.73a
Average	272.86	281.39	284.39	294.69	283.33

Note: G = granule organic fertilizer, P = liquid organic fertilizer

Table 7 BBBB

Treatment	P0	P1	P2	P3	average
G0	206.25	232.92	237.00	244.17	230.08c
G1	302.00	265.92	261.50	283.33	278.19b
G2	310.33	345.33	354.67	356.58	341.73a
average	272.86	281.39	284.39	294.69	283.33

Note: G = granule organic fertilizer, P = liquid organic fertilizer

Table 8 BBBT

Treatment	P0	P1	P2	P3	Average
G0	461.00	519.92	544.92	557.33	520.79b
G1	667.83	737.75	621.08	688.00	774.35a
G2	692.58	747.50	794.25	863.08	657.94a
Average	607.14	668.39	653.42	702.81	703.65

Note: G = granule organic fertilizer, P = liquid organic fertilizer

The treatment of granule organic fertilizer and liquid organic fertilizer statistically shows a significant effect. These results are also conveyed by Kuyik et al and Apaeva et al. on granular fertilizers and Ginandjar et al. on liquid organic fertilizers. However, the two treatments are considered to have independent characteristics. This is proven by the relatively insignificant effect of the interaction between the two, except for leaf area. Although there are several characters that are influenced

together without any interaction effect (Btkl, BBKB and BBKD). This shows that the two fertilizers have an independent effect on certain characters. Based on the characters that are affected, organic fertilizer granules petrogranular relatively affect the weight of plant stover. The effect of this petrogranular fertilizer has also been reported by Parmila et al on watermelon and Pakpahan et al. on peanuts. In addition, according to the research of Kuyik et al. and Apaeva et al., the application of granulated organic fertilizer in general can increase corn stover and productivity. Meanwhile, liquid organic fertilizer relatively affects dry weight (BBKB and BBKD), productivity (BTKl and BBj) and photosynthetic system (leaf area). The success of organic liquid fertilizer in increasing leaf area, biomass and productivity of maize by, Kasim et al., Mukhtar et al and Suleimenov et al. Therefore, the study of the effect of fertilizer treatment on maize growth is focused independently.

Assessment of the effect of an efficient treatment is carried out based on the results of correlation analysis. In general, correlation can provide information about the characters related to the main character in a plant. Farid et al.; Anshori et al., so that the assessment becomes more focused in assessing a treatment. Based on the results of correlation analysis, the characters of leaf number, cob weight, leaf area, BBBB, BBBB and BBBB are characters that have a significant positive correlation with seed weight as the main character. These results indicate that seed weight and plant biomass have a good correlation. A significant correlation between productivity and biomass is also reported by Anders et al., A significant correlation between seed productivity and biomass will provide two economic benefits, namely profits as shelled feed and feed for rumen biomass. Based on this, the study of these characters is a good assessment in determining the best granule and liquid organic fertilizer treatment, both in increasing the productivity of shelled and maize plant biomass feed.

The results of further BNT test on characters that correlated with seed weight show that G0P0 treatment is the lowest treatment for all characters. This treatment is a control treatment without fertilization. On the other hand, fertilizer application showed an increase in growth compared to G0P0 treatment. Based on these results, the application of organic fertilizer, both granular and liquid, have a significant effect on the growth of corn plants. this is also reported by previous studies; Kasim et al.; Kuyik et al.; congress et al.; Apaeva et al.; Suleimenov et al. Although, both do not have a dominant or independent interaction effect, giving both treatments is still important to do. This is because each fertilizer has a relatively different role in inducing growth. Organic petrogranular granule fertilizer consists of cow dung, chicken manure, goat manure, sugar factory waste (blo-thong), palm oil mill waste (empty bunches), mixtro, supplements, and filler (lime/clay). This fertilizer also contains other nutrients such as: N, P₂O₅ and K₂O by 4%, petrogranular fertilizer also contains micro nutrients namely Fe, Mn and Zn. The composition can optimize changes in the physical, biological and chemical structure of the soil. It was also

reported by Hirzel et al., the application of granulated organic fertilizer with several combinations of mixtures can improve the mineral status and physical condition of the soil. Meanwhile, the liquid organic fertilizer used is Super Biota Plus. This fertilizer contains macro and micro nutrients (N, P, K, CA, Mg, S, B, Fe, Cu, Cl, Mn, n, and Mo) in available form (can be absorbed by plants) in optimal composition and Indole hormone. Acetic Acid (IAA), gibberellins and zeatin. In general, the fertilizer composition of the fertilizer improves metabolic processes, especially the process of photosynthesis and increases in dry matter (Muktamar et al.²⁶; Suleimenov et al. Based on this, the combination of the two fertilizer treatments becomes important in the process of optimizing maize growth in general). Therefore, the determination of the optimal treatment in the combination of the two treatments is still carried out, even though the concept of determination is independent

Based on the treatment of granulated organic fertilizer, G1 treatment is the optimal granular organic fertilizer treatment, although the growth of corn in this treatment was lower than that of G2. However, statistically and economically, this treatment is not significantly different and has a lower economic value than the G2 treatment. Meanwhile, based on the treatment of liquid organic fertilizer, the treatment of liquid organic fertilizer P1 is the best treatment for all characters studied in depth. Therefore, based on the overall assessment, the combination of G1P1 fertilization is the best combination of organic fertilizers for maize growth, especially in maize productivity and biomass production.

D. CONCLUSION

In conclusion, the treatment of granule and liquid organic fertilizer increased the growth potential and productivity of maize. The optimal treatment of granulated organic fertilizer is G1 treatment. Meanwhile, the best treatment for liquid organic fertilizer is P1 treatment. The combination of G1P1 is still recommended even though there is no interaction between granule and liquid organic treatments.

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