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Application of Organic Coal Fertilizer and Rabbit Farm Waste on Pumelo (*Citrus grandis* L. Osbeck) Seed Growth

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Abstract
The pumelo population in Bali is declining one is caused of a lack of good-quality seeds. This research was conducted to determine the effectiveness of organic coal fertilizer and rabbit farm waste as organic fertilizers for the growth of pomelo grafting seedlings. The research design used a nested pattern randomized block design with 3 replications. There are two factors, the first factor is the type of fertilizer, which are Coal fertilizers, Rabbit Farm Waste fertilizers, and Cow Manure fertilizers. The second factor is the dose of each type of fertilizer which consists of 3 levels, namely: 10 tons/ha; 20 tons/ha; and 30 tons/ha. The results showed that the effectiveness of the treatment of the type of organic fertilizer and the dose of the type of organic fertilizer had no significant effect on all observed variables. This shows that both coal fertilizer and rabbit manure have almost the same quality as cow manure in influencing the growth of pomelo seedlings. The effectiveness of fertilizers tested on the average shoot length of grafting tends to show the highest yields obtained at the highest dose (30 tons/ha), namely Coal fertilizer which is 28.80 cm, rabbit manure is 31.87 cm, and cow manure obtained is 28.13 cm.

Keywords: *citrus grandis l. Osbeck; coal fertilizer; rabbit farm waste fertilizer*

1. Introduction

Pomelo (*Citrus grandis* L. Osbeck) is a native citrus originating from Indonesia and spread from Polynesia to Malacca which has various names according to the region. The names in each region for this type of orange vary, namely: Pandan Oranges, Srinyonya Oranges, Cikoneng Oranges, Nambangan Oranges, Pomegranates, Silempang Oranges, Oyod Gondong Oranges, Nambangan-Madiun Oranges, Bali Oranges, Roll Oranges, Pandanwangi Oranges [1]. Pomelo in Balinese speech is called "Jerungga, Jeruti, Muntis, Juuk Saba, Juuk Bona or Juuk Gede". This orange is the largest citrus species with thick skin and large pulp. Pumelo is usually cultivated in the yards of Balinese houses as a garden fruit plant that has fragrant flowers so that the yard becomes fresher. Pumelo has many benefits for health, both as a source of vitamins, as well as to heal several diseases. Also, the leaves, bark, and flowers are widely used for medicinal and cosmetic purposes [2, 3, 4, 5, 6].

The pummelo plant population continues to decline in Bali, in addition to the fact that most plants are infected with blendok disease [6, 7], also due to the lack of availability of good quality seeds. Breeding of grapefruit seeds has not been widely carried out, especially in Bali, so efforts to restore the population of this plant cannot be carried out sustainably [8]. To obtain good quality seeds, it is necessary to provide a technique for providing or breeding seeds by utilizing various kinds of organic fertilizers, as well as by grafting with rootstock and good quality entry sources from superior varieties native to Bali. Coal-based organic fertilizers that have been produced and applied to various plants have been reported to have a positive effect on various horticultural and food crops [9]. Likewise, the use of organic fertilizer made from raw material from rabbit farm waste, which in several plants has been proven to be effective in improving the quality of growth and crop yields, can be applied to grapefruit nurseries [10]. Based on the description above, it is necessary to research to determine the effectiveness of coal organic fertilizer and rabbit farm waste as organic fertilizer which has been widely used on agricultural land in the growth of grafted grapefruit seedlings.

2. Materials and Methods

This research was conducted at the "Balai Benih Induk (BBI) Tanaman Pangan dan Hortikultura" Bali Province, Luwus Village, Baturiti District, Tabanan Regency with an altitude of about 500m above sea level (asl) and the Agrotechnology Study Program Laboratory, Faculty of Agriculture, Warmadewa University, Denpasar starting January to November 2022.

The study was conducted using the experimental method, with the experimental design used being a nested pattern randomized block design with 3 replications. There are two factors studied, namely, the first factor is the type of fertilizer (P), which consists of 3 levels (types) of fertilizer, namely: P1 (Coal Fertilizer); P2 (Rabbit Farm Waste Fertilizer), and P3 (Cow manure). While the second factor is the Dosage (D) of each type of fertilizer which consists of 3 levels, namely: D0 (without using organic fertilizer); D1 (100g/seedling = 10 tonnes/ha); D2 (200g/seed = 20 tonnes/ha); and D3 (300g/seed = 30 tons/ha) and one control group (without organic fertilizer). Research using polybags with a distance between blocks of 50 cm and between polybags in one block of 50 cm.

Table 1. Saputra Coal fertilizer laboratory test results:

No	Parameter	Value	Unit	Metode
1.	pH H_2O	5.1	-	Potensiometri / pH meter
2.	Water content	24.63	%	Gravimetric
3.	Other ingredients	0.0	%	Gravimetric
4.	C-Organic	30.87	%	Gravimetric
5.	N-Total	2.05	%	Kjeldahl / Destilasi
6.	C/N Ratio	15	-	-
7.	P_2O_5 Total	0.89	%	HNO_3/ Spektrofometri
8.	K_2O Total	1.55	%	HNO_3/F-AAS
9.	Fe - tersedia	134	ppm	EDTA/ F-AAS
10.	Mn - total	252	ppm	HNO_3/F-AAS
11.	Zn - total	84	ppm	HNO_3/F-AAS
12.	Pb - total	5.7	ppm	HNO_3/F-AAS
13.	Cd - total	1.3	ppm	HNO_3/F-AAS
14.	As - total	td	ppm	HNO_3/F-AAS
15.	Hg - total	td	ppm	HNO_3/F-AAS
16.	La - total	td	ppm	HNO_3/MP-AES
17.	Ce - total	td	ppm	HNO_3/MP-AES

Source: Test Results from the Testing Laboratory of Soil Research Institute, Agricultural Research, and Development Center, Bogor.

Table 2. Results of Experimental Soil Analysis

Type of Analysis	Mark	Unit	Information
pH H_2O (1:2,5)	7.1		Neutral
Electrical Conductivity	0.39	mmhos/cm	Very low
C-organic	2.88	%	Moderate
N-total	0.32	%	Moderate
P-available	164.78	ppm	Very high
K-available	237.93	ppm	High
Water content:			
Field Capacity	42.39	%	
Moisture content dry soil air	5.51	%	
Textur :			
Sand	46.54	%	
Dust	32.29	%	
Clay	21.17	%	

Source: Laboratory of Soil Science and Soil Fertility, Faculty of Agriculture, Udayana University, Denpasar 2022

The experiment was carried out through the following stages:

a) Preparation of rootstock and grafting eye patch

b) Preparation of planting media using 5 kg polybags. with filling according to treatment.

c) Implementation of grafting

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d) Selecting grafting seeds that have been successful
e) Observation of the development and growth of seedling shoots
f) Measurement of observed variables.

3. Results and Discussion

3.1. Results

The results of the statistical analysis of the significant effect of the type of fertilizer (P) and the dose in the type of organic coal fertilizer (P1), rabbit compost (P2), and cow manure (P3) on the observed variables are presented in Table 3.

Table 3. Significance of the effect of type and dose of organic coal fertilizer, rabbit compost, and cow manure, on all observed variables

Variable	Types of Fertilizer	Dosage In Types of Fertilizers		
	P	P_1	P_2	P_3
1. When growing grafting shoots (days)	ns	ns	ns	ns
2. Rootstock cutting (days)	ns	ns	ns	ns
3. Length of bud grafting (cm)	ns	ns	ns	ns
4. Diameter of grafting bud (mm)	ns	ns	ns	ns
5. Number of leaves (strands)	ns	ns	ns	ns
6. Total leaf area (cm^2)	ns	ns	ns	ns

Description: * = significant (P<0.05), ** = very significant P(<0.01), ns = non significant (P>0.05)

Table 3. shows the type of organic fertilizer (P) and the dosage of the type of organic fertilizer had no significant effect (P>0.05) on all the observed variables, namely when the grafting shoots grew (days), rootstock cutting (days), shoot length grafting (cm), grafting shoot diameter (mm), number of grafting shoot leaves (strands), and total grafting leaf area (cm^2).

3.1.1 Time to grow grafting shoots (days)

Based on the results of the analysis, it was obtained that the type of fertilizer (P) on the growth of grafting shoots showed that the treatment of organic coal fertilizer (P1), rabbit compost (P2), and cow organic fertilizer (P3) had no significant effect (P> 0.05) (Table 4).

Table 4. Average growth of grafted shoots (days) and cutting of rootstock in the treatment of types and doses of organic fertilizers

Treatment	Time to grow grafting shoots (days)	Rootstock Cutting (days)
P1 Coal Fertilizer	11.56 a	8.89 a
P2 Compost for Rabbits	10.89 a	9.22 a
P3 Cow Manure	10.67 a	8.44 a
LSD 5%	-	-
D in P1 (Coal Fertilizer)		
P1 D1 (10 ton/ha)	12.33 a	10.00 a
P1 D2 (20 ton/ha)	10.33 a	8.00 a
P1 D3 (30 ton/ha)	12.00 a	8.67 a
D in P2 (Rabbit Compost)		
P2 D1 (10 ton/ha)	10.33 a	7.67 a
P2 D2 (20 ton/ha)	11.00 a	9.67 a
P2 D3 (30 ton/ha)	11.33 a	10.33 a
D in P3 (Cow Manure)		
P3 D1 (10 ton/ha)	11.67 a	9.00 a
P3 D2 (20 ton/ha)	11.67 a	7.67 a
P3 D3 (30 ton/ha)	8.67 a	8.67 a
LSD 5%	-	-

Description: The mean value followed by the same letter in the same treatment and column means that the difference is not significant in the 5% BNT test.

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The average growth of grafting shoots was faster in the cow manure (P3) treatment, which was 10.67 (days), but not significantly different from the coal fertilizer treatment, which was 11.56 (days), and rabbit compost, which was 10.89 (days). The average growth of grafting shoots was faster at the dose of Coal fertilizer (P1), namely dose (D2) of 20 tons/ha 10.33 (days), Rabbit compost fertilizer (P2) namely dose (D1) of 10 tons/ha 10.33 (days), and cow manure (P3), namely the dose (D3) 30 tons/ha 8.67 (days) (Table 4).

3.1.2 Rootstock cutting (days)

Based on the results of the analysis obtained in the type of fertilizer treatment (P) on rootstock cutting showed that the treatment of coal fertilizer (P1), rabbit compost (P2), and cow manure (P3) had no significant effect (P>0.05) (Table 3).

The average rootstock cutting was faster in the cow fertilizer (P3) treatment, which was 8.44 (days), but not significantly different from the coal fertilizer treatment, which was 8.89 (days), and rabbit compost, which was 9.22 (days). The average rootstock cutting was faster at the dose of Coal fertilizer (P1), namely dose (D2) 20 tons/ha 8.00 (days), Rabbit compost fertilizer (P2) namely dose (D1) 10 tons/ha 7.67 (days), and cow manure (P3), namely the dose (D2) 20 tonnes/ha 7.67 (days) (Table 4).

3.1.3 Length of Grafting Shoots (cm)

Based on the results of the analysis, it was found that the treatment of the type of fertilizer (P) on the length of grafting shoots showed that the treatment of organic coal fertilizer (P1), rabbit compost (P2), and organic cow fertilizer (P3) had no significant effect (P> 0.05) (Table 3).

Table 5. Average grafting shoot height (cm) and grafting shoot diameter in the type and dose of organic fertilizer treatment at 12 weeks after grafting (wag)

Treatment	Length of Grafting Shoots (cm)	Diameter of Grafting Bud Stem (mm)
P1 Coal Fertilizer	28.03 a	4.77 a
P2 Compost for Rabbits	28.88 a	4.96 a
P3 Cow Manure	23.46 a	4.65 a
LSD 5%	-	-
D in P1 (Coal Fertilizer)		
P1 D1 (10 ton/ha)	28.74 a	4.81 a
P1 D2 (20 ton/ha)	26.52 a	5.06 a
P1 D3 (30 ton/ha)	28.81 a	4.41 a
D in P2 (Rabbit Compost)		
P2 D1 (10 ton/ha)	28.78 a	4.98 a
P2 D2 (20 ton/ha)	26.02 a	4.56 a
P2 D3 (30 ton/ha)	31.88 a	5.37 a
D in P3 (Cow Manure)		
P3 D1 (10 ton/ha)	22.08 a	4.84 a
P3 D2 (20 ton/ha)	20.21 a	4.22 a
P3 D3 (30 ton/ha)	28.14 a	4.87 a
LSD 5%	-	-

Description: The mean value followed by the same letter in the same treatment and column means that the difference is not significant in the 5% LSD test

The average grafting shoot length was higher in the rabbit compost (P2) treatment, which was 28.88 cm, but not significantly different from the coal fertilizer treatment, which was 28.03 cm, and cow manure, which was 23.47 cm. The average grafting shoot length was higher at the dose of Coal fertilizer (P1), namely dose (D3) 30 tons/ha 28.81 cm. Rabbit compost fertilizer (P2) namely dose (D3) 30 tons/ha 31.88 cm, and Cow manure (P3) namely dose (D3) 30 tons/ha 28.14 cm (Table 5).

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3.1.4 Diameter of Grafting Bud (mm)

Based on the results of the analysis, it was found that the treatment of fertilizer type (P) on the diameter of grafting shoots showed that the treatment of organic coal fertilizer (P1), rabbit compost (P2), and organic cow fertilizer (P3) had no significant effect (P> 0.05) (Table 3).

The average diameter of grafting buds was larger in the rabbit compost (P2) treatment, which was 4.96 mm, but not significantly different from the coal fertilizer treatment, which was 4.77 mm, and cow manure, which was 4.65 mm. The average diameter of grafting buds was larger at the dose of Coal fertilizer (P1), namely dose (D2) of 20 tons/ha 5.06 mm, Rabbit compost fertilizer (P2) namely dose (D3) of 30 tons/ha of 5.36 mm, and Cow manure (P3) namely dose (D3) 30 tons/ha 4.88 mm (Table 5).

3.1.5 Number of Grafting Shoots (cm)

Based on the results of the analysis, the treatment of the type of fertilizer (P) on the number of grafting shoots showed that the treatment of organic coal fertilizer (P1), rabbit compost (P2), and organic cow fertilizer (P3) had no significant effect (P> 0.05) (Table 3).

Table 6. The average number of grafted shoot leaves (strands) and total grafted leaf area in the type and dose of organic fertilizer treatment

Treatment	Number of Grafting Bud Leaves (strands)	Total Leaf Area of Grafting Buds (cm^2)
P1 Coal Fertilizer	7.89 a	226.94 a
P2 Compost for Rabbits	7.67 a	279.30 a
P3 Cow Manure	7.11 a	221.49 a
LSD 5%	-	-
D in P1 (Coal Fertilizer)		
P1 D1 (10 ton/ha)	7.00 a	266.32 a
P1 D2 (20 ton/ha)	7.67 a	248.59 a
P1 D3 (30 ton/ha)	9.00 a	165.91 a
D in P2 (Rabbit Compost)		
P2 D1 (10 ton/ha)	7.67 a	278.53 a
P2 D2 (20 ton/ha)	7.33 a	246.14 a
P2 D3 (30 ton/ha)	8.00 a	313.23 a
D in P3 (Cow Manure)		
P3 D1 (10 ton/ha)	5.67 a	215.29 a
P3 D2 (20 ton/ha)	6.67 a	199.64 a
P3 D3 (30 ton/ha)	9.00 a	249.52 a
LSD 5%	-	-

Description: The mean value followed by the same letter in the same treatment and column means that the difference is not significant in the 5% LSD test

The average number of grafted shoot leaves was higher in the Coal fertilizer (P1) treatment, namely 7.89 strands, but not significantly different from the Rabbit compost treatment, namely 7.67 strands, and Cow manure, namely 7.11 strands. The average number of grafted shoot leaves was higher at the dose of Coal fertilizer (P1), namely dose (D3) 30 tons/ha 9 strands, Rabbit compost (P2) namely dose (D3) 30 tons/ha 8 strands, and cow manure (P3) namely the dose (D3) 30 tons/ha 9 strands (Table 6).

3.1.5 Total Leaf Area of Grafting Shoots (cm^2)

Based on the results of the analysis, the type of fertilizer treatment (P) on the total leaf area of grafting shoots showed that the treatment of organic coal fertilizer (P1), rabbit compost (P2), and organic cow fertilizer (P3) had no significant effect (P> 0.05). (Table 3).

The average total leaf area of grafting shoots was greater in the Rabbit compost (P2) treatment, namely 279.30 cm^2, but not significantly different from the Coal fertilizer treatment, namely 226.94 cm^2, and Cow manure, namely 221.49 cm^2. The average total leaf area of grafting shoots was greater at the dose of Coal fertilizer (P1), namely the dose (D1) of 10 tons/ha 266.32 cm^2, Rabbit compost

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fertilizer (P2) namely the dose (D3) of 30 tons/ha 313.23 cm^2, and cow manure (P3), namely the dose (D3) of 30 tonnes/ha 249.52 cm^2 (Table 6).

Seedlings grafted the effect of coal fertilizer | Seedlings grafted effect of fertilizer Rabbit | Seedlings grafted effect of fertilizer cow | Grafted seedlings without fertilizer (control)

Figure 1. Performance of grapefruit grafting seedlings on various organic fertilizer treatments.

3.2 Discussion

Type and dose treatment of organic fertilizer types had no significant effect (P>0.05) on all observed variables, namely grafting shoot growth (days), rootstock cutting (days), grafting shoot length (cm), grafting shoot diameter (mm), the number of grafting leaves (strands), and the total area of grafting leaves (cm^2).

The length of grafting shoots (cm), the diameter of grafting shoots (mm), and the total leaf area of grafting shoots (cm^2) were higher in the Rabbit compost treatment (P2), namely 28.89 cm, 4.97 mm, and 279.30 cm^2 but not significantly different in the treatment of Coal Fertilizer and Cow Manure. The average grafting shoot length increased by 18% when compared to the lowest yield in the cow manure treatment (P3), which was 23.47 cm. The average diameter of grafting buds increased by 6.6% when compared to the lowest yield in the cow manure treatment (P3), which was 4.67 mm. The average total leaf area of grafting shoots increased by 21% when compared to the lowest yield in the cow manure treatment (P3), which was 221.49%. This relates to the results of the analysis of organic fertilizers where the N element content is low, namely 0.84% [11], while the N element is needed by plants, especially during the vegetative period because it stimulates plant growth [12, 13]. According to [14] rabbit manure contains the highest nitrogen content compared to other livestock manure. According to [15], rabbit manure increased SOM compared with other organic manures. The increase in SOM of rabbit manure could be related to its high C: N and lignin content. Plant constituents, such as lignin retard decomposition. Organic materials with high C: N and lignin generally would favor nutrient immobilization, organic matter accumulation, and humus formation. Table 3.3 analysis of rabbit compost stated that the nutrient content of N, P, and K was very high but did not have an insignificant effect on the initial growth of grapefruit grafting. This is because the roots have not been able to absorb nutrients from fertilizer. After all, organic fertilizers are slowly released so the response of plants to organic fertilizers is slower. Organic fertilizers are more indicated for C-organic content, if the ratio of C-organic is very large with nutrients it can cause immobility or a reduction in the number of nutrient levels in the soil by microbial activity so that the levels of these nutrients that can be used by plants are reduced [16, 17, 18].

Leaf growth is part of vegetative growth. In vegetative growth the most important nutrient is nitrogen. According to [19], nitrogen promotes the growth of organs related to photosynthesis, namely leaves. Nitrogen is the main nutrient for plant growth [20, 21, 22] because it is a constituent of all proteins and nucleic acids, and thus is a constituent of the protoplasm as a whole.

The average grafting shoot length was higher at the dose of Coal fertilizer (P1) obtained at the dose (D3) of 30 tonnes/ha, namely 28.80 cm, an increase of 8% when compared to the dose (D2) of 20 tonnes/ha, namely 26.53 cm. The average grafting shoot length was higher at the dose of Rabbit compost (P2) obtained at the dose (D3) of 30 tons/ha, namely 31.87 cm, an increase of 18% when compared to the dose (D2) of 20 tons/ha, namely 26.03 cm. The average grafting shoot length was

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higher at the dose of cow manure (P1) obtained at the dose (D3) of 30 tons/ha, namely 28.13 cm, an increase of 28% when compared to the dose (D2) of 20 tons/ha, namely 20.20 cm. In Figure 4.1, in the 6th week, the shoot height growth was very low, but in the 8th week, grafting shoot growth increased and in the 10th and 12th weeks it experienced little growth. This is presumably due to the small dose and treatment given only once at the start of the nursery [24, 25, 26]. According to Feil & Fraga [21], states that at the beginning of plant growth, the nutrient content has not been absorbed by the plant, besides that in the vegetative growth phase, plants are influenced by the genetic nature of the plant itself so external influences from plant factors do not significantly affect plant height. Furthermore [25, 26], states that apart from external factors (environment), plant growth is also influenced by factors that exist within the plant itself.

4. Conclusion

The effectiveness of the interaction of the type of organic fertilizer and the dose in the type of organic fertilizer had no significant effect on all observed variables, namely the growth of grafting shoots, the time of cutting of rootstock, the height of grafting shoots, the diameter of grafting shoots, the number of grafting leaves, and the total area of shoot leaves grafting. The effectiveness of rabbit manure treatment on grafting shoot length, grafting shoot stem diameter, and total leaf area of grafting shoots tended to be higher, namely 28.88 cm, 4.96 mm, and 279.30 cm^2 but not significantly different from the coal fertilizer treatment and cow manure. The effectiveness of the three types of fertilizers tested on the average grafting shoot length tended to show the highest yields obtained at the highest dose at the level of this experiment, namely coal fertilizer at a dose of 30 tons ha^{-1}, namely 28.81 cm, rabbit manure at a dose of 30 ton ha^{-1} is 31.88 cm, and the dose of cow manure is obtained at a dose of 30 ton ha^{-1} which is 28.14 cm.

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