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Response of the use of Organic Fertilizer and Mulch to the Growth and Yield of Pumpkin (*Cucurbita moschata*)

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Abstract:- Pumpkin (*Cucurbita moschata*) is a plant commodity that has the opportunity as an alternative food crop. Various efforts have been made to increase pumpkin production, such as by developing plant cultivation techniques. The use of mulch and organic fertilizers can be a solution to increase production while implementing sustainable agriculture. This study aimed to determine the response to the use of various types of mulch and the application of various types of organic fertilizers on the growth and yield of pumpkin plants. This study used a Factorial Completely Randomized Design (CRD), with the first factor being the type of mulch (plastic mulch, organic mulch, and without mulch) and the second factor being the type of organic fertilizer (compost, cow manure, and no organic fertilizer). The results showed that the interaction of treatment using mulch and applying organic fertilizer was significantly different on vegetative growth, especially at the age of 6 and 8 Weeks after Planting (WAP), but not significant for pumpkin fruit yields. Separately, organic fertilizers have more effect on the growth and yield of pumpkin plants than the use of various types of mulch. In addition, plastic mulch treatment with compost had the highest stem diameter growth, number of leaves, and number of branches. Then the treatment of organic mulch with compost has the highest productivity estimation results. Separately, compost was also able to produce the highest number of fruits (113 pieces/plot) and the highest estimated productivity (13.19 tons/ha).

Keywords:- *Pumpkin, Mulch, Organic Fertilizer.*

I. INTRODUCTION

Pumpkin (*Cucurbita moschata*) is one of the agricultural commodities cultivated as an alternative food crop. Pumpkin is a plant that Indonesian farmers have not widely cultivated. However, this can be an opportunity because it considers pumpkins' nutritional contentrelatively high. Besides having a lot of carbohydrates, pumpkin is also rich in fibre, phosphorus, and vitamins A, C, E, and B complex. In addition, pumpkin also contains several substances that are very useful for health, such as carotenoids in the form of beta-carotene, whose function is to protect the eyes from cataracts and the body from cancer and diabetes. Pumpkin fruit is also widely used by the community as a raw material for making soups, cakes, porridge, and many others (Lubis *et al.*, 2021; Kurniati *et al.*, 2018).

Pumpkin production can be increased by optimizing the availability of nutrients through fertilization. Fertilization can use inorganic fertilizers and organic fertilizers. Inorganic fertilizers are generally more often used because the nutrient content is known. However, using inorganic fertilizers for a long time harms soil microorganisms; if left unchecked, soil fertility will continue to decline. Therefore, inorganic fertilizers in balance with organic fertilizers can be suitable for dealing with these problems. Most of the raw materials for organic fertilizers come from animals and plants that have undergone an engineering process to improve the soil's physical, chemical, and biological properties. Therefore, applying organic fertilizer to soil can improve the quality of soil's physical properties and even increase crop yields, especially in organic agriculture (Makinde *et al.*, 2016). The advantages of organic fertilizers are that they loosen the soil, stimulate the growth of microorganisms, and help transport soil nutrients to plant roots. However, the weakness is that the volume dose required is more than chemical fertilizers, and the manufacturing process is relatively long and takes 10-30 days (Suwahyono U, 2011).

Another technology that can increase pumpkin productivity is mulch in the cultivation process. Mulch is a material that covers part or all of the soil surface. Materials included in the mulch category can be in the form of plant remains classified as organic mulch and synthetic or plastic materials classified as inorganic mulch. The function of mulch is to modify the microclimate of plants. Mulch can maintain evapotranspirationand prevent excessive heating, soil nutrient leaching, and weed growth (Fahrurrozi, 2018).

The cultivation of plants in the garden can use various types of mulch. One of them is organic mulch. Organic mulch comes from the waste of living things, plants, and animals. Organic mulch is effective for minimizing nitrate leaching, improving soil physical quality, increasing biological activity, balancing the nitrogen cycle, providing organic matter, controlling temperature and water retention, and reducing erosion. However, the use of organic mulch in the production of horticultural crops is quite limited. It was caused to high costs, limited availability, and requires great effort in obtaining raw materials. So, large-scale cultivation rarely uses organic mulch (Wang *et al.*, 2014; El-Beltagi *et al.*, 2022).Another type of mulch that is widely used for cultivation activities in the garden is plastic mulch. This mulch is included in inorganic mulch. The use of plastic mulch can reduce soil evaporation and increase soil moisture levels (Li *et al.*, 2014).

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Applying organic mulch and fertilizer to the soil can improves soil quality and increases crop yields. In addition, the use of organic fertilizers and organic mulch can also control weeds, prevent erosion, maintain soil moisture, keep soil productivity by improving soil physical and biological conditions, and avoid soil degradation. Therefore, the use of organic fertilizers and mulch is recommended in cultivation activities, considering the high price of inorganic fertilizers, high nutrient runoff, and environmental problems caused by agricultural chemical residues (Ibeawuchi *et al.*, 2015).

Lubis*et al.* (2021) have studied the application of organic fertilizer to pumpkins.The application of chicken manure was able to increase pumpkin weight when harvested.Ummah *et al.*(2022) also researched the effect of using mulch and liquid organic fertilizer on the growth and yield of pumpkins. Mulch application in pumpkin cultivation increased vegetative growth and the number of pumpkin fruit.

This study aims to determine the response of the use of various types of mulch and the application of various types of organic fertilizers on the growth (stem diameter, number of leaves, and number of branches)and yield (amount, weight, and productivity) of pumpkin fruit. So from this study, we can get recommendationsfor types of organic fertilizers and mulch that can increase the growth and yield of pumpkin plants.

II. RESEARCH METHODS

This research was conducted in the experimental field of the Starch Technology Center - BPPT, Negara Bumi Ilir Village, Anak Tuha District, Central Lampung Regency. This research was conducted for four months, from January to June 2019.

A. Materials and tools

The materials used were pumpkin seeds of SUPREMA F1 variety, organic fertilizer (cow manure and compost), inorganic fertilizer (NPK pearls), insecticide to attract fruit flies, and water.

The tools used to cultivate pumpkin plants are tractors and tillage implements, hoes, sickles, machetes, mulch (plastic mulch and organic mulch), plastic, buckets, scales, sprayer, and water pump.

B. Research design

This study used a factorial completely randomized design (CRD), with the first factor being the type of mulch and the second factor being the type of organic fertilizer. Types of mulch include organic, plastic, and no mulch. The types of organic fertilizers include compost, cowmanure, and without organic fertilizer. From these two factors, there will be nine treatment combinations repeated three times, so there will be 27 experimental units. Each experimental unit contained 10 sample plants with an area of 155 m^2 of each experimental block. The type of organic mulch used comes from litter or corn stalks. Meanwhile, each dose of compost is 6,000 kg/ha, and cow manure is 6,000 kg/ha.

C. Seed Preparation

Pumpkin seeds (SUPREMA F1) were sown in the screenhouse and selected based on uniformity of seed shape. Afterward, the seeds were planted in the area in each experimental plot.

D. Response Analysis

Parameters of non-destructive for the vegetative part were stem diameter, number of leaves, and number of branches. In addition, the yield parameters werethe number of fruits per plot, fruit weight per plant, production per plot, and productivity estimation per hectare. After the experiment, the data were analyzed by analysis of variance using a general linear model with post-test Duncan test level = 5%.

III. RESULTS AND DISCUSSION

A. Effect of Types of Mulch and Organic Fertilizers on Pumpkin Diameter

Plant growth is an irreversible increase in the size of plant physiology, such as leaves, stems, and roots. Plant growth can be seen from increased stem diameter, the number of leaves, and the number of branches. The addition of this part will increase with the age of the plant. In pumpkin cultivation, high plant growth rates are expected to support high productivity and good fruit quality. The analysis of the diameter variance of pumpkin plantsshowed an interaction between the use of various types of mulch and the application of various types of organic fertilizers at the age of 6 and 8 WAP. While at the age of 2 and 4 WAP, the interaction between treatments was not significantly different from the parameters of stem diameter. Applying organic fertilizer and mulch can affect the diameter of the stem when the pumpkin plant enters the flowering phase. It is becauseorganic fertilizers are slowly released, so it takes a longer time to be utilized by plants. Separately, various types of mulch significantly affected the diameter of pumpkin stems at 4, 6, and 8 WAP. In addition, applying various types of organic fertilizers also significantly affected the diameter of the pumpkin stems at the ages of 2, 4, 6, and 8 WAP. The results of the analysis can be seen in Table 1.

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treatment	Age of plant			
	2 WAP	4 WAP	6 WAP	8 WAP
A (without mulch)	0,2622a	0,5889ab	0,9267ab	1,2044a
B (plastic mulch)	0,2500a	0,6300b	1,0222b	1,4144b
C (organic mulch)	0,2589a	0,5744a	0,8822a	1,1611a
Duncan test 5 %	ns	s	s	s
X (without mulch)	0,2500a	0,5511a	0,8122a	1,0678a
Y (compost)	0,2689b	0,6233b	1,0356b	1,3856b
Z (cow manure)	0,2522a	0,6189b	0,9833b	1,3267b
Duncan test 5 %	s	s	s	s

Table 1: The Effect of Using Types of Mulch and Organic Fertilizers on Stem Diameter of Pumpkin

Note: The numbers in the column followed by the same letter mean that they are not significantly different based on Duncan's test 5%, ns: not significant, s: significant

Mulch type	Fertilizer type		
	without organic fertilizer	compost	cow manure
(without mulch)	0,7700Aa	0,9900Aab	1,0200Ab
(plastic mulch)	1,0100Aa	1,0600Aa	0,9967Aa
(organic mulch)	0,6567Aa	1,0567Ab	0,8367Aab

Table 2: Interaction of Types of Mulch and Organic Fertilizers on Stem Diameter of Pumpkinat 6 WAP

Note: Numbers followed by the same letter are not significantly different according to Duncan's test at the 5% level. Capital letters are read vertically (columns), and lowercase letters are read horizontally (rows).

Mulch type	Fertilizer type		
	without organic fertilizer	compost	Cow manure
(without mulch)	0,9733Aa	1,3000Aa	1,3400Aa
(plastic mulch)	1,4600Ba	1,4533Aa	1,3300Aa
(oganic mulch)	0,7700Aa	1,4033Ab	1,3100Ab

Table 3: Interaction of Types of Mulch and Organic Fertilizers on Stem Diameter of Pumpkinat 8 WAP

Note: Numbers followed by the same letter are not significantly different according to Duncan's test at the 5% level. Capital letters are read vertically (columns), and lowercase letters are read horizontally (rows).

Based on the results in Table 1. only the mulch treatment at the age of 2 WAP was not significantly different. In contrast,the pumpkin diameter values in each treatment differed significantly at the other ages. Plastic mulch treatment had the largest stem diameter, while organic mulch had the smallest. The use of organic mulch and without mulch resulted in relatively higher and more weed growth. According to Kilkoda*et al.* (2015), the presence of weeds in the cultivation process can result in serious competition for water, nutrients, sunlight, and a place to grow, resulting in crop yields not being able to show their true potential. The use of plastic mulch is relatively better for plant vegetative growth compared to organic mulch and without mulch. Plastic mulch can keep soil moisture more stable, so plants can easily absorb water from the soil. Then the presence of plastic mulch can minimize the occurrence of nutrient leaching so that plants can optimally absorb the fertilizer given. In addition, using plastic mulch can also maintain a more stable soil temperature to optimize the growth of leaves and plant stems (El-Beltagi*et al.*, 2022). The application of organic fertilizers, especially compost fertilizers, also significantly affected the addition of pumpkin diameter compared to no fertilizer application. Applying organic fertilizers can maintain soil nutrient status and improve soil physical properties. The organic content in fertilizers can prevent nutrient leaching so that the content of C, N, K, Ca, and Mg can last longer after NPK fertilization or when measured after harvest (Michael, 2021).

Based on the results in Tables 2 and 3, the interaction of the use of mulch types and the use of various types of fertilizers had a significant effect at the ages of 6 and 8 WAP, where the use of plastic mulch with compost fertilizer could produce the largest diameter of pumpkin compared to other treatments. Panjaitan et al. (2015) stated that the size of the stem diameter could be an indicator of the strength of the plant stem so that with larger stem diameter, it is expected to form a sturdier plantthat is not easy to fall.

B. Effect of Types of Mulch and Organic Fertilizer on Number of Leaves of Pumpkin Plants

Based on the analysis of variance in the number of leaves of pumpkin plants, it was shown that there was an interaction between the use of various types of mulch and the application of various types of organic fertilizers at the age of 6 WAP. Meanwhile, at 2, 4, and 8 WAP, the interactions between treatments were not significantly different for the number of pumpkin leaves. Therefore, it was indicated that using mulch and applyingorganic fertilizer only had an effect when the plant entered 6 WAP. It was because, at the age of 6 WAP,pumpkin plants enter the growth of vegetative organs, which are quite mature and ready to enter the generative phase. Separately, the use of

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various types of mulch significantly affected the number of leaves at the age of 2 and 6 WAP. In addition, applying various types of organic fertilizers also significantly affected the number of leaves at the ages of 4 and 6 WAP. The results of the analysis can be seen in Table 4.

treatment	Age of plant			
	2 WAP	**4 WAP**	**6 WAP**	**8 WAP**
A (without mulch)	4,3000b	11,0222a	37,7556ab	64,0111a
B (plastic mulch)	3,7889a	11,1778a	40,8222b	73,9000a
C (organic mulch)	4,0556ab	9,7444a	32,6667a	61,4778a
Duncan test 5 %	s	ns	s	ns
X (without mulch)	3,9667a	9,1111a	29,2556a	55,4000a
Y (compost)	4,2111a	12,2000b	41,2222b	71,4444a
Z (cow manure)	3,9667a	10,6333a	40,7667b	72,5444a
Duncan test 5 %	ns	s	s	ns

Table 4: The Effect of the Use of Mulch and Organic Fertilizers on the Number of Leaves of Pumpkin Plants

Note: The numbers in the column followed by the same letter mean that they are not significantly different based on Duncan's test 5%, ns: not significant, s: significant

Mulch type	Fertilizer type		
	Without organic fertilizer	compost	Cow manure
(without mulch)	26,13ABa	41,30Ab	45,83Bb
(plastic mulch)	42,10Ba	40,70Aa	39,67Aba
(organic mulch)	19,53Aa	41,67Ab	36,80Ab

Table 5: Interaction of Types of Mulch and Organic Fertilizer on Number of Leaves of Pumpkin Plants at 6 WAP

Note: Numbers followed by the same letter are not significantly different according to Duncan's test at the 5% level. Capital letters are read vertically (columns), and lowercase letters are read horizontally (rows).

Based on the results in Table 4. The compost fertilizer treatment had the highest number of leaves, while without organic fertilizer, the smallest. According to Simanungkalit *et al.*(2006), compost can facilitate the transport process in plant metabolism to increase vegetative growth. In addition, plastic mulch treatment produced the highest number of leaves compared to other treatments. It is similar to what was done by Ummah *et al.*(2022), where plastic mulch can prevent weed growth so that plant competition becomes smaller, keeping the soil temperature relatively more stable and resulting in better leaf growth. Obalum *et al.*(2017) also stated the same thing, where pumpkins at the age of more than 6 WAP had a higher leaf fresh weight when cultivated with mulch when compared to without using mulch. In Table 5. The interaction of cow manure treatment and without mulch at 6 WAP had the most significant average number of leaves, 45.83. Meanwhile, without organic fertilizer and organic mulch, a minor average was 19.53.

C. Effect of Types of Mulch and Organic Fertilizer on Number of Branches of Pumpkin Plants

Based on the analysis of variance in the number of branches of pumpkin plants, it was shown that there was an interaction between the use of various types of mulch and the application of various types of organic fertilizers at the age of 6 WAP. While at 2, 4, and 8 WAP, the interactions between treatments were not significantly different. Separately, various types of mulch greatly affected the number of branches at the age of 6 WAP. In addition, applying various types of organic fertilizers also significantly affected the number of branches at the ages of 4 and 6 WAP. The results of the analysis can be seen in Table 6.

Perlakuan	Age of plant			
	2 WAP	**4 WAP**	**6 WAP**	**8 WAP**
A (without mulch)	0a	0,9667a	2,6778ab	3,4222a
B (plastic mulch)	0a	0,8444a	3,0111b	3,8667a
C (organic mulch)	0a	0,7333a	2,4333a	3,2889a
Uji Duncan 5 %	ns	ns	s	ns
X (without organic fertilizer)	0a	0,3111a	2,0556a	3,0111a
Y (compost)	0a	1,2889b	3,2000b	3,7444a
Z (cow manure)	0a	0,9444b	2,8667b	3,8222a
Uji Duncan 5 %	ns	s	s	ns

Table 6: The Effect of Using Types of Mulch and Organic Fertilizers on the Number of Pumpkin Branches

Note: The numbers in the column followed by the same letter mean that they are not significantly different based on Duncan's test 5%, ns: not significant, s: significant

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Mulch type	Fertilizer type		
	Without organic fertilizer	compost	Cow manure
Without mulch	1,80Aa	3,17Ab	3,07Ab
Plastic mulch	3,27Bb	3,10Ab	2,67Aa
Organic mulch	1,10Aa	3,33Ab	2,87Ab

Table. 7: Interaction of Mulch Type and Organic Fertilizer on Number of Branches of Yellow Pumpkin Plants at 6 WAP

Note: Numbers followed by the same letter are not significantly different according to Duncan's test at the 5% level. Capital letters are read vertically (columns), and lowercase letters are read horizontally (rows).

Based on the results in Table 6. This mulch had no significant effect on the number of branches at ages 2, 4, and 8 WAP. Only 6 WAP is different, whereas the plastic mulch has more branches. Then the type of organic fertilizer treatment significantly affected the number of branches of pumpkin plants at the age of 4 and 6 WAP. The application of compost produced the highest number of branches compared to other treatments. According to Atkana et al. (2019),compost is a complete source of macro and micro minerals, although in relatively small amounts (N, P, K, Ca, Mg). Giving compost to pumpkins can improve soil structure. Nutrients from compost can increase plant growth both vegetatively and generatively. The growth of many branches is expected to produce more fruit so that pumpkin production can be higher. Based on the results of the interaction test using types of mulch and organic fertilizer in Table 7, treatment of organic mulch with compost at the age of 6 WAP gave the highest yield on the number of branches of pumpkin plants. Organic fertilizers can provide higher N elements in the soil than without organic fertilizers, where N elements support plant vegetative growth. (Antonious *et al.*, 2021). These results indicate that adding organic matter can increase the vegetative part of the plant.

D. Effect of Types of Mulch and Organic Fertilizer on Pumpkin Yield

The main output of pumpkin cultivation activities is to get good quality fruit with high production. Using mulch and applying organic fertilizers is expected to achieve this goal. Based on the results of the analysis of variance for pumpkin yields showed that there was no interaction between the use of mulch types and the application of organic fertilizers for all of the observed yield parameters. Separately only the provision of various types of organic fertilizers significantly affects the number of pumpkin fruit. Meanwhile, other parameters and treatments had no significant effect. The results of the analysis can be seen in Table 8.

Treatment	Parameter			
	Number of Fruits	Weight per Fruit	Production per Plot	Estimated Productivity per Ha
A (without mulch)	100,67a	2,08a	210,98a	11.393a
B (plastic mulch)	91,50a	2,16a	200,73a	10.840a
C (organic mulch)	90,33a	2,11a	194,25a	10.490a
Uji Duncan 5 %	ns	ns	ns	ns
X (without organic fertilizer)	74,17a	2,06a	156,46a	8.449a
Y (compost)	113,17b	2,14a	244,20a	13.187a
Z (cow manure)	95,17ab	2,15a	205,30a	11.086a
Uji Duncan 5 %	s	ns	ns	ns

Table. 8. The Effect of Using Mulch and Organic Fertilizer on Pumpkin Yield

Note: The numbers in the column followed by the same letter mean that they are not significantly different based on Duncan's test 5%, ns: not significant, s: significant

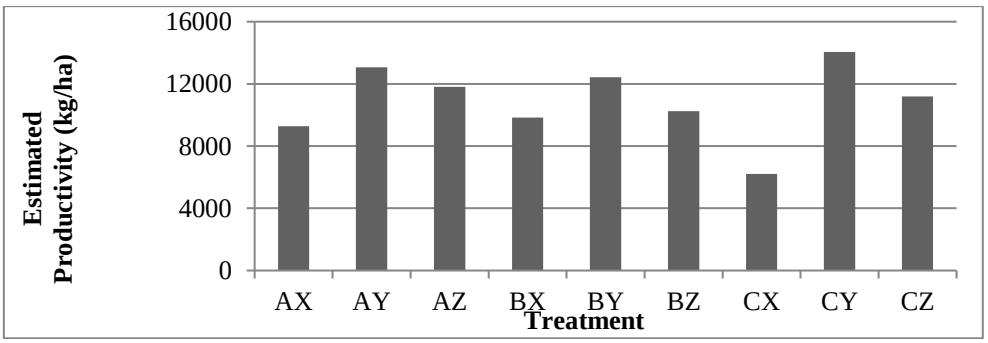

Fig. 1: Graph of Estimated Pumpkin Productivity for Each Treatment

Note: AX: without mulch with without organic fertilizer, AY: without mulch with compost, AZ: without mulch with cow manure, BX: plastic mulch with without organic fertilizer, BY: plastic mulch with compost, BZ: plastic mulch with cow manure, CX: organic mulch with without organic fertilizer, CY: organic mulch with compost, CZ: organic mulch with cow manure

Based on the results in Table 8. it can be seen that the difference in the use of mulch types did not provide significant results. The mulch type treatment only affected plant growth but not pumpkin fruit yield. There were higher yields in the no-mulch treatment for the number of fruits, production per plot, and estimated productivity per hectare. However, the weight parameter per fruit has the lowest yield. It is because,at the treatment without mulching, the pumpkin fruit directly touches the soil so that the fruit condition becomes more moist and easy to rot. While in the other two treatments, the yield obtained was slightly smaller, but the quality of the fruit obtained was better. The use of plastic mulch can increase the thickness of edible fruit flesh with a larger fruit size than without mulch.In addition, using plastic mulch makes the fruit stronger because the fruit does not directly contact with soil, so the quality is better (Mwaura *et al.*, 2021). Wyenandt (2008) also got the same result in his experiment, where using leaf mulch and without mulch in pumpkin cultivation had insignificant results for total fruit weight. However, leaf mulch has a higher weight per fruit than without mulch.

The application of various types of organic fertilizers also did not show a significant difference in results. However, for the parameter of the number of fruits in the compost fertilizer treatment, the results were significantly different and the highest compared to other treatments. Because compost fertilizer with a higher organic matter content than cow manure can release nutrients faster than other fertilizers, the absorption rate in plants will be higher (Simanungkalit*et al.*, 2006). Not only that, the experiment conducted by Evanylo*et al.*(2008) showed that composting as much as 144 Mg/ha for three years could increase the soil organic C content, total N, and available P by 60%, 68%, and 225% compared without using compost. So that the production value and the number of pumpkin fruit can be higher in the compost fertilizer treatment, this is also supported by the availability of more nutrients than other treatments. Apart from that, the compost fertilizer treatment also showed positive results, which could produce pumpkin fruit productivity with an estimate of around 13.18 tons/ha. Based on the results in Figure 1, Using organic mulch with compost gave the highest estimated productivity of about 12.5 tons/ha. Once again, this proves that adding organic matter to the soil can increase the productivity of pumpkins. In addition, the smallest productivity estimate is found in the treatment of organic mulch with no organic fertilizer, which isaround 4.6 tons/ha. So we can say that the use of mulch has no significant effect on the estimation of pumpkin productivity. On the contrary, the use of organic fertilizers has a substantialimpact on the estimation of pumpkin productivity.

IV. CONCLUSION

The interaction of treatment using mulch and application of organic fertilizer had significantly different results on pumpkin vegetative growth, especially at the age of 6 and 8 WAP, but not significantly on pumpkin fruit yield. Separately, organic fertilizers have more effect on the growth and yield of pumpkin plants than the use of various types of mulch. In addition, the treatment of plastic mulch with compost also had a relatively good average result for vegetative growth, such as stem diameter, number of leaves, and number of branches. The treatment of organic mulch with compost has the highest estimated productivity of around 12.5 tons/ha.

SUGGESTION

It is necessary to study the proper dosage of compost in pumpkin cultivation.

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