International Journal of Multidisciplinary Research and Growth Evaluation.

Growth Response and Yield of Butternut Squash: The Impact of Various Types of Organic Fertilizers and NPK Application

Eko Setiawan [1*], **Tri Cenra Wijaya** [2], **Teti Sugiarti** [3]
Master of Natural Resource Management, University Trunojoyo Madura, East Java, Indonesia

* Corresponding Author: **Eko Setiawan**

Article Info
ISSN (online): 2582-7138
Volume: 06
Issue: 02
March-April 2025
Received: 15-02-2025
Accepted: 12-03-2025
Page No: 887-897

Abstract
Butternut Squash has various health benefits and high economic value. The cultivation of butternut squash in Pamekasan Regency is still largely dependent on the use of chemical fertilizers. The objective of this study is to examine the effect of organic fertilizers and NPK fertilizers on butternut squash, as well as to understand farmers' responses to the use of organic fertilizers in butternut squash cultivation. The research was conducted using an experimental method with a Randomized Block Design (RBD) to determine the impact of various organic and NPK fertilizers on the growth and yield of butternut squash. The results showed that the use of organic fertilizers and chemical NPK fertilizers significantly affected the growth response and yield of butternut squash. The best growth response and yield were observed in plants that received goat manure fertilizer at a dosage of 720 grams per plant.

Keywords: Organic Fertilizer, Randomized Block Design, Butternut Squash

Introduction

Butternut squash offers various health benefits, including providing essential nutrients for the body, boosting the immune system, managing diabetes, combating inflammation and infections, supporting lung health, treating nervous system disorders, promoting healthy vision, preventing anemia, increasing bone density, and improving digestion. This fruit is rich in vitamins and minerals, such as vitamins C, E, and B6, as well as other beneficial components like niacin, thiamine, folate, pantothenic acid, calcium, and iron. The abundant minerals in butternut squash include copper, magnesium, and potassium. Additionally, butternut squash is a valuable source of antioxidants, carotenoids, and anti-inflammatory agents (Makmur, 2018) [32].

One of the health benefits of butternut squash is its ability to regulate blood sugar levels, which is attributed to the presence of ethanolic extract in butternut squash (Junita *et al*., 2017; Marbun, 2022) [25, 34]. Another benefit of butternut squash is its antidiabetic properties (Adams *et al*., 2011; Chang *et al*., 2014) [3, 11], as it promotes insulin production and repairs pancreatic cells (Jin *et al*., 2013; Makni *et al*., 2010) [24, 33]. Additionally, butternut squash seed oil, which contains chromium, plays a role in carbohydrate metabolism by facilitating optimal chromium absorption (Glew *et al*., 2006) [20].

In addition to its high nutritional content and health benefits, butternut squash also has significant economic value (Sanjur *et al*., 2002) [48]. Its selling price is higher than that of other types of squash (Kurniati *et al*., 2018) [28]. From a farming feasibility perspective, butternut squash cultivation is considered viable based on the Benefit-Cost (B/C) ratio, Net Present Value (NPV), Internal Rate of Return (IRR), and payback period (Saleh, 2020).

The production of butternut squash in Indonesia is lower than domestic demand. Indonesia's butternut squash production was 566,846 tons in 2017, 454,001 tons in 2018, and 107,963 tons in 2019 (Badan Pusat Statistik, 2023) [7]. Meanwhile, the per capita domestic consumption of butternut squash was 1.822 kg per year in 2019 (Kementerian Pertanian Republik Indonesia, 2020) [26].

The significant health and economic benefits of butternut squash, combined with its low domestic production relative to consumption, make it an attractive crop for further development. Butternut squash can be optimally cultivated in warm regions with temperatures ranging from 18 to 30°C. It thrives well in lowland areas at 0 meters above sea level (masl) up to highland areas at 1,200 masl, with a humidity level of approximately 65% (Lolliani, 2017) [31].

One region that is suitable for the development of butternut squash based on its growing conditions is Pamekasan Regency. Pamekasan Regency is located at an elevation of 6 to 312 meters above sea level (masl). The average annual temperature in Pamekasan ranges from 27.3°C to 28.9°C, with humidity levels varying between 44% and 98%. (Badan Pusat Statistik, 2024) [8].

Butternut squash farming has started to be developed by farmers in Pamekasan Regency. Currently, there are 35 farmers in Pamekasan who have begun cultivating butternut squash. This number is likely to increase in line with the land suitability in Pamekasan for butternut squash cultivation, the high demand, market opportunities, and the economic feasibility of butternut squash farming.

Increasing the productivity of butternut squash in Pamekasan Regency is a challenge aimed at enhancing the overall production of horticultural commodities, boosting national income, and reducing dependence on imported commodities (Kurniati *et al*., 2018) [28]. The increase in butternut squash production is influenced by the application of the right fertilizers and appropriate dosage.

There are two types of fertilizers that can be applied to butternut squash plants: chemical fertilizers and organic fertilizers. The use of a combination of both types of fertilizers, with the correct dosage and timing, can enhance butternut squash production (Nuraini *et al*., 2023) [38].

The use of chemical fertilizers in crops plays a key role in per-hectare production and agricultural yield intensification (Crista *et al*., 2014) [13]. The nutrients contained in chemical fertilizers can enhance butternut squash productivity. On the other hand, the use of chemical fertilizers in agriculture also has negative impacts. Excessive use of chemical fertilizers can lead to soil salinity, accumulation of heavy metals, water eutrophication, nitrate buildup, and contribute to air pollution through the release of nitrogen- and sulfur-containing gases (Savci, 2012) [49].

The environmental issues arising from the use of chemical fertilizers have led experts to recommend the use of organic fertilizers to accelerate growth in the agricultural sector (Abebe *et al*., 2022) [2]. The application of organic fertilizers to butternut squash plants not only increases production but also helps maintain agroecosystems, particularly in preventing land degradation and improving soil fertility. A further impact of improved soil structure and fertility through organic fertilizers is the enhanced carbon absorption in the soil, which is crucial for climate change mitigation (Asian Development Bank, 2015) [5].

Organic materials that can be used as organic fertilizers include guano, compost, and manure from animals such as chickens, cows, goats, and others. These fertilizers contain essential nutrients required by butternut squash plants, including nitrogen (N), phosphorus (P), and potassium (K). The use of organic fertilizers can fulfill these nutrient needs while improving the physical, chemical, and biological properties of the soil. Fertilization with organic fertilizers also enhances soil organism life, as the organic matter provides the necessary nutrients for these organisms (Haryadi *et al*., 2015) [23].

One type of organic fertilizer is manure, which comes from solid and liquid excrement of livestock such as cows, chickens, goats, horses, and sheep, mixed with leftover feed and bedding materials. Livestock excrete a significant portion of the nitrogen, phosphorus, and potassium found in their food. Manure, whether solid or liquid, typically contains about 0.5% nitrogen (N), 0.25% phosphorus (P2O5), and 0.5% potassium (K2O). Manure is rich in organic matter, which can enhance the soil's capacity to absorb and retain water, thus helping to prevent erosion (Purba, Situmeang, *et al*., 2021) [42].

Raw materials for manure production are abundant in Pamekasan Regency. This is because most farmers in Pamekasan also work as livestock breeders. The number of large livestock in Pamekasan is 197,211 cattle, consisting of 74,777 male cattle and 122,434 female cattle. In addition to large livestock, manure materials in Pamekasan are also sourced from small livestock waste. The number of small livestock in Pamekasan includes 55,446 goats, 15,432 sheep, and 8,204 rabbits (Badan Pusat Statistik, 2024) [8].

The raw materials for manure production in Pamekasan Regency can also come from poultry waste. The amount of poultry manure is abundant in Pamekasan, generated by 739,134 native chickens, 155,844 broiler chickens, 335,023 laying hens, 48,405 ducks, and 22,479 Manila ducks (Badan Pusat Statistik, 2024) [8].

The abundant raw materials for manure production can be utilized by butternut squash farmers in Pamekasan Regency to help meet the nutritional needs of their crops. However, the phenomenon observed is that many butternut squash farmers in Pamekasan have not yet adopted the use of manure as a supplement to their crops' nutrition. This is because the butternut squash farmers in Pamekasan are not yet convinced of the benefits of manure as fertilizer.

Meanwhile, previous studies have shown that the contents of chicken, cattle, and goat manure significantly affect the growth and yield of butternut squash (Andriyadi, 2023; Nuraini *et al*., 2023; Robisetiawan, 2021) [4, 38, 44]. The optimal dosage of each type of manure varies. The best dosage of chicken manure for the growth and yield of butternut squash is 25 tons per hectare (Robisetiawan, 2021) [44]. The optimal dosage of cattle manure for the growth and yield of butternut squash is 20 tons per hectare (Andriyadi, 2023) [4]. Meanwhile, the best dosage of goat manure is 13 tons per hectare, combined with 375 kg per hectare of NPK fertilizer, for optimal growth and yield of butternut squash (Nuraini *et al*., 2023) [38].

In addition to animal manure, there are also organic fertilizers derived from plant by-products, one of which is sugarcane bagasse. Organic fertilizer from sugarcane bagasse also has an impact on plant growth. The application of sugarcane bagasse has been shown to have a significant effect on the growth and productivity of crops such as soybeans and green eggplant (Misda, 2022; Wafiroh *et al*., 2018) [35, 59].

Based on the above phenomena, conditions, and previous research, the author is interested in investigating the effects of various types of organic fertilizers and NPK chemical fertilizers on the growth and yield of butternut squash. This study aims to demonstrate that the use of organic fertilizers can result in good growth and yield of butternut squash. The goal is to influence farmers to believe that organic fertilizers can produce yields comparable to those obtained with chemical fertilizers.

Materials & Methods

The Location & Time

Butternut squash can be optimally cultivated in warm regions with temperatures ranging from 18 to 30°C. It grows well in lowland areas at 0 meters above sea level (masl) up to highland areas at 1,200 masl, with a humidity level of around

65% (Lolliani, 2017) [31]. The suitability of growing conditions affects the growth of butternut squash. Excessive rainfall negatively impacts nitrogen absorption (Shahadha *et al*., 2021) [50], thus disrupting the growth of the butternut squash plants.

This study was conducted at the Green House of the Agricultural Extension Center (BPP) in Pademawu District, Pamekasan Regency, at an altitude of 7 masl, with an average temperature ranging from 27.3 to 28.9°C, and humidity levels between 44% and 98% (Badan Pusat Statistik, 2024) [8] The research was carried out from August 2024 to November 2024.

Materials and Equipments

1. Materials

The materials used in this study consisted of Butternut squash F1 seeds, chicken manure, cow manure, goat manure, sugarcane bagasse ash fertilizer, NPK chemical fertilizer, water, and Antracol 70 WP fungicide.

The manure and sugarcane bagasse ash fertilizer applied were those that had undergone a fermentation process for 3 months. During the fermentation process, the temperature was maintained between 60–70°C. The moisture content was kept between 45–55%. The mature manure had an organic C/N ratio of less than 15% and nitrogen content greater than 1.8%. The final characteristics of the mature manure were that it had no livestock odor, was dark brown to black in color, was not hot, crumbly, and did not clump together.

2. Equipments

The equipment used in this study included a hoe, bamboo, watering can, measuring tape, machete, knife, scissors, bucket, plastic, raffia twine, wire, camera, and writing materials.

Research Method

The experimental method used in this study was a Randomized Block Design (RBD) to determine the effects of various types of organic fertilizers and NPK on the growth response and yield of butternut squash. This study consists of 6 treatment levels and 5 replications. The treatments are as follows:

P0 = Control, no application of chicken manure, cow manure, goat manure, sugarcane bagasse ash, or NPK
P1 = Application of 375 grams of chicken manure per plant
P2 = Application of 600 grams of cow manure per plant
P3 = Application of 720 grams of goat manure per plant
P4 = Application of 500 grams of sugarcane bagasse ash per plant
P5 = Application of 22.5 grams of NPK 16:16:16 chemical fertilizer per plant

The doses of manure used in treatments P1, P2, P3, P4, and P5 are based on previous research. The best growth and yield responses for butternut squash were observed with the following manure doses:

P1: Chicken manure at a dose of 375 grams per plant (Girsang, 2020) [19].
P2: Cow manure at a dose of 600 grams per plant (Andriyadi, 2023) [4].
P3: Goat manure at a dose of 720 grams per plant (Riyadi *et al*., 2022) [43].
P4: Sugarcane bagasse ash at a dose of 500 grams per plant (Munthe, 2019) [36].
P5: NPK 16:16:16 chemical fertilizer at a dose of 22.5 grams per plant (Hajar, 2021) [21].

Based on the experimental design above, there will be 30 plants (6 treatment levels × 5 replications), with each hole containing 1 plant, as follows:

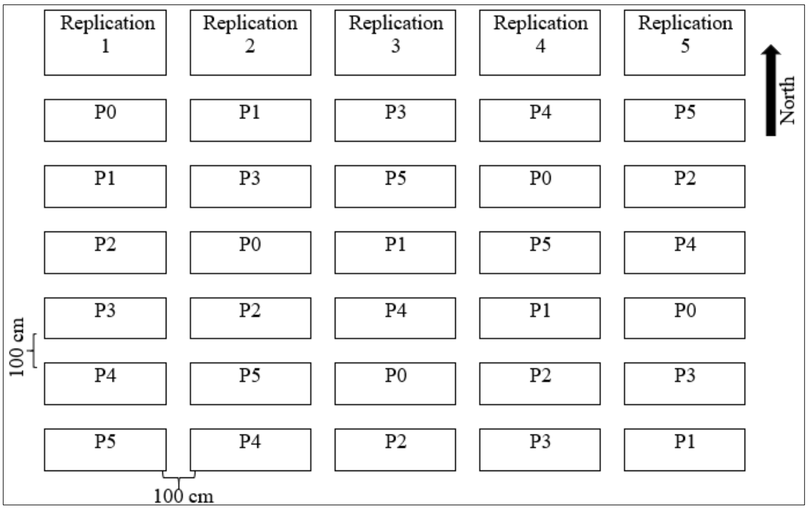

Fig 1: Layout of the Research in a Randomized Block Design

The research details are as follows:

Number of Replications	: 5 Replications
Number of Treatments	: 6 treatments
Spacing Between Plants	: 100 cm × 100 cm

Observation of Parameters

Observed Parameters in This Study:

1. Plant Height (cm)
   Plant height is measured from the standard marker to the tip of the plant's growing point. Measurements are made using a measuring tape. Plant height observations begin when the plant is 21 days after planting (DAP), with weekly intervals until the plant starts flowering.

2. Number of Leaves (leaves)
   The number of leaves is observed by counting the fully opened leaves of the plant. Observations begin when the plant is 21 DAP, with weekly intervals until the plant

starts flowering.

3. Leaf Area (cm2)
The leaf area is measured by calculating the area of the largest leaf on the plant. Observations start when the plant is 21 DAP, with weekly intervals until the plant starts flowering. Leaf area is measured using the Lalang Buana method with the formula proposed by Sitompul & Guritno (1995) [52] in (Girsang, 2020) [19] sebagai berikut:
Y = -58,1404 + 5,4328x1 + 0,9628x2
Where:
Y = Leaf Are (cm2)
X1 = Leaf Length (cm)
X2 = Leaf Width (cm)

4. Flowering Age (days)
Flowering age is observed when the plant has produced more than 60% of flowers on each plant.

5. Number of Flowers (flowers)
The number of flowers is counted for all flowers on the butternut squash plant.

6. Fruit Length (cm)
Fruit length is measured at harvest by measuring from the base to the tip of the fruit.

7. Fruit Diameter (cm)
Fruit diameter is measured at harvest by measuring the circumference of the upper and lower parts of the fruit and then averaging the two. The circumference is calculated using the formula (Girsang, 2020) [19]:
Circumference = 2 π r
r = Circumference/(2π)
D = r x 2
D = Fruit Diameter

8. Number of Fruits per Plant (fruits)
This observation is done by counting the number of fruits on the plant that meet the harvest maturity criteria.

9. Fruit Weight per Plant (kg)
Fruit weight per plant is obtained by weighing the fruits that have been harvested from each plant.

Analysis Method
Soil Analysis
Soil analysis is used to determine the levels of nitrogen (N), phosphorus (P), potassium (K), and water content in the soil. Soil samples from each treatment are analyzed. The initial soil analysis is done at the start of the research to assess the nutrient content of the soil before treatment is applied. A follow-up analysis is done after harvesting to evaluate the soil conditions post-treatment. The soil analysis is performed at the Soil Laboratory of Puslit Sukosari, Lumajang.
Soil samples are collected in plastic bags from each treatment. Before being sent to the laboratory, the samples are prepared by air-drying the soil at room temperature, then grinding and sieving. The sieved soil samples are then submitted to the laboratory for analysis.

Data Analysis
The data obtained from the research will be analyzed using Analysis of Variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) for further comparison. The linear model for the Randomized Block Design (RAK) used in this study is as follows:
Xij = αij + βj + Pi + eij
Where:
Xij = Observation of the i-th treatment in the j-th replicate
αij = True mean
βj = Effect of the j-th replicate
Pi = Effect of the i-th treatment
eij = Error effect for the i-th treatment and the j-th replicate

Result and Discussion
Growth and yield response of butternut squash plants
The application of different types of fertilizers resulted in varying growth and yield responses in butternut squash plants. Below are the results of the analysis of the growth and yield responses of butternut squash plants as a result of applying different types of fertilizers.

Plant Height
The plant height was measured at 21 days after planting (DAP), with subsequent measurements taken weekly. Therefore, measurements were conducted at 21 DAP, 28 DAP, and 35 DAP.
Based on the analysis results, it was found that the application of various types of fertilizers, including chicken manure (375 grams per plant), cow manure (600 grams per plant), goat manure (720 grams per plant), sugarcane bagasse ash (500 grams per plant), and chemical fertilizer NPK 16:16:16 (22.5 grams per plant), significantly affected plant height.

Table 5.1: Plant Height (cm) of Butternut Squash with the Application of Various Types of Fertilizers

Treatment	Plant Height (cm) at Observation Age (DAP)		
	21	28	35
P0	9,4 a	27,8 a	69,0 a
P1	18,4 b	76,8 c	146,8 b
P2	16,4 b	62,6 bc	141,4 b
P3	22,8 c	103,6 d	216,0 c
P4	9,4 a	48,2 b	104,0 b
P5	9,4 a	50,8 b	140,0 b
Duncan's Test 5%	*	*	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

Based on Table 5.1, it can be observed that the plant height measurements for the application of goat manure at a dose of 720 grams per plant showed the highest average plant height for butternut squash at each observation. Additionally, the application of goat manure at a dose of 720 grams per plant was significantly different from the application of other fertilizer types at each observation.

This occurred because of the high nitrogen (N) content in goat manure. According to the analysis of several composting studies summarized by Novitasari & Caroline (2021) [37], the average N content in goat manure is higher than that of cow and chicken manure. The N nutrient in goat manure is essential for plants during the vegetative phase (Saleem *et al.*, 2012). During the vegetative phase, N is required by plants for chlorophyll formation and to stimulate the development of leaves, buds, branches, and stems.

Number of Leaves

The measurement of the number of leaves was conducted at 21 days after planting (DAP), with measurements taken weekly. Therefore, measurements were taken at 21 DAP, 28 DAP, and 35 DAP.

Table 5.2: Number of Leaves (Blades) of Butternut Squash Under Different Fertilizer Applications

Treatments	Number of Leaves (Blades) at Observation Ages (DAP)		
	21	28	35
P0	6,4	8,0 a	12,0 a
P1	6,6	11,6 cd	17,2 cd
P2	6,0	10,2 bc	15,4 b
P3	6,6	12,6 d	18,4 d
P4	6,4	9,6 b	14,8 b
P5	6,4	9,8 b	15,8 bc
Duncan's Test 5%	tn	*	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

Based on the analysis, the application of various types of fertilizers, including chicken manure at 375 grams per plant, cow manure at 600 grams per plant, goat manure at 720 grams per plant, sugarcane bagasse ash fertilizer at 500 grams per plant, and NPK 16:16:16 chemical fertilizer at 22.5 grams per plant, significantly affected the number of butternut squash leaves at 28 DAP and 35 DAP.

From the table above, it can be observed that at 21 DAP, there was no significant difference in the number of leaves among the treatments. The average number of leaves for all treatments was approximately six leaves per plant. The application of goat manure at a dose of 720 grams per plant resulted in the highest average number of leaves in butternut squash plants. This can be seen at 28 DAP, with an average of 12.6 leaves, and at 35 DAP, with an average of 18.4 leaves, which were the highest among all observation periods. Furthermore, the application of goat manure at 720 grams per plant also showed a significant difference in the number of leaves compared to other fertilizer treatments at 28 DAP and 35 DAP.

Goat manure has a positive impact on plant growth. Its application is essential during both the vegetative and generative phases of plant development. Research findings indicate that applying green manure to the soil improves soil biological properties, nutrient availability, crop yield, and maize quality (Hariadi *et al.*, 2016) [22].

The increased leaf growth in plants treated with goat manure, compared to other treatments, is due to its high nitrogen (N) content. Additionally, goat manure contains high levels of potassium (K), which plays a crucial role in enhancing plant resilience, preventing leaf, stem, flower, and fruit drop, and reducing plant susceptibility to breakage (Purba, Ningsih, *et al.*, 2021) [41].

Leaf Area

Leaf area was observed when the plants reached 21 DAP. The leaf area was calculated using the formula: Y= -58,1404 + 5,4328x1 + 0,9628x2. where Y represents the leaf area (cm²), X_1 is the leaf length (cm), and X_2 is the leaf width (cm). After conversion using this formula, the relationship between the application of different types of fertilizers and the leaf area of butternut squash plants is as follows.

Based on the analysis, it was found that the application of various fertilizers, including chicken manure at 375 grams per plant, cow manure at 600 grams per plant, goat manure at 720 grams per plant, sugarcane bagasse ash fertilizer at 500 grams per plant, and NPK 16:16:16 chemical fertilizer at 22.5 grams per plant, had a significant effect on the leaf area of butternut squash plants.

Based on the table above, it can be observed that the application of goat manure at a dose of 720 grams per plant resulted in the highest average leaf area in butternut squash plants. This is evident from treatment P3, which consistently produced the highest values compared to other treatments at each observation period. Additionally, the application of goat manure at a dose of 720 grams per plant showed a significant difference compared to other treatments.

The application of goat manure can increase leaf area and electrical potential differences compared to plants grown solely in soil media. Goat manure is more effective in enhancing plant leaf area than cow manure (Hariadi *et al.*, 2016) [22].

This is because butternut squash plants receive sufficient nitrogen (N) from goat manure. Butternut squash plants with adequate nitrogen supply tend to have a larger leaf surface area (leaf length and diameter) (Kusumawati, 2021) [29].

Table 5.3: Leaf Area (cm²) of Butternut Squash Plants Under Different Types of Fertilizer Applications

Treatments	Leaf Area (cm²) at Different Observation Ages (DAP)		
	21	28	35
P0	7,5 a	19,1 a	26,8 a
P1	21,4 b	47,2 c	50,2 b
P2	16,8 b	38,4 bc	40,6 ab
P3	35,1 c	67,9 d	77,0 c

P4	7,5 a	28,5 ab	34,8 ab
P5	7,5 a	37,7 bc	48,6 b
Duncan's Test 5%	*	*	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

Flowering initiation age

The flowering initiation age was recorded when the first butternut squash plants started to bloom. Based on the analysis results, the application of different types of fertilizers, including 375 grams of chicken manure per plant, 600 grams of cow manure per plant, 720 grams of goat manure per plant, 500 grams of sugarcane filter cake ash per plant, and 22.5 grams of NPK 16:16:16 chemical fertilizer per plant, significantly affected the flowering initiation age of butternut squash plants.

Furthermore, based on Table 5.4, there were no significant differences in the flowering initiation age among the different fertilizer treatments

Table 5.4: Flowering Initiation Age (DAP) of Butternut Squash Plants with Different Types of Fertilizer Application

Treatments	Flowering Initiation Age (DAP)
P0	0,0 a
P1	43,2 b
P2	43,4 b
P3	43,4 b
P4	43,2 b
P5	43,4 b
Duncan's Test 5%	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

The results of this study are consistent with the research conducted by Riyadi *et al*. (2022) [43], which found that the application of various combinations of organic and inorganic fertilizers on butternut squash plants did not result in significant differences in the age of flowering initiation. Another study showed that the application of fish waste liquid organic fertilizer (POC) and chicken manure, as well as the interaction of both treatments, did not significantly affect the parameter of flowering initiation age in butternut squash plants (Girsang, 2020) [19].

The lack of significant differences in the age of flowering initiation due to the application of various types of fertilizers is because the age of flowering initiation is a genetic trait of the butternut squash plant. Therefore, planting butternut squash with the same variety will result in an average age of flowering initiation that is consistent, approximately 43 days after planting (DAP).

Number of Flowers

The number of flowers was counted for all flowers, both those that developed into fruits and those that did not, per plant. Based on the analysis, it can be observed that the application of various types of fertilizers, such as chicken manure at 375 grams per plant, cow manure at 600 grams per plant, goat manure at 720 grams per plant, sugarcane bagasse ash at 500 grams per plant, and NPK fertilizer 16:16:16 at 22.5 grams per plant, had a significant effect on the number of flowers in the butternut squash plants.

As shown in Table 5.5, it can be seen that plants without fertilizer application (P0) did not produce any flowers. On the other hand, plants that were applied with organic fertilizers (manure, sugarcane bagasse ash) and NPK fertilizer did produce flowers. However, the number of flowers produced by plants receiving the different types of fertilizers did not differ significantly from each other.

Table 5.5: Number of Flowers of Butternut Squash Plants with Different Types of Fertilizer Treatments

Perlakuan	Number of Flower (Flowers)
P0	0,0 a
P1	3,0 b
P2	4 c
P3	3,4 bc
P4	3,4 bc
P5	3,4 bc
Duncan's Test 5%	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

Butternut squash plants without treatment or fertilizer application did not produce flowers. This is because plants without fertilizer application lacked macro nutrients such as N, P, and K, which led to impaired plant growth. Nitrogen (N) and Phosphorus (P) are essential for flower formation in plants. Therefore, plants lacking these nutrients experience disrupted flower development (Kusumawati, 2021; Purba, Ningsih, *et al*., 2021) [29, 41].

Number of fruits per plant

The number of fruits was counted when the fruits were ready for harvest. Based on the analysis, it can be concluded that the application of various types of fertilizers, such as chicken manure 375 grams per plant, cow manure 600 grams per plant, goat manure 720 grams per plant, sugarcane bagasse ash fertilizer 500 grams per plant, and NPK chemical fertilizer 16:16:16 22.5 grams per plant, had a significant effect on the number of fruits of butternut squash. The highest average number of fruits per plant was produced by the application of goat manure and NPK chemical fertilizer, with an average of 3 fruits per plant (Table 5.6).

The number of butternut squash fruits suitable for harvest from plants applied with chicken manure did not significantly differ from the number of fruits produced by plants applied with cow manure and sugarcane bagasse ash fertilizer. Butternut squash plants applied with chicken manure and sugarcane bagasse ash fertilizer produced an average of 2.2 fruits per plant, while plants applied with goat manure and NPK chemical fertilizer produced an average of 3 fruits per plant.

Table 5.6: Number of Fruits of Butternut Squash Plants Under Different Fertilizer Treatments

Treatments	Number of Fruits
P0	0,0 a
P1	2,2 b
P2	2,4 b
P3	3,0 c
P4	2,2 b
P5	3,0 c
Duncan's Test 5%	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

The phosphorus (P) nutrient plays a role in stimulating fruit formation in butternut squash plants (Kusumawati, 2021) [29]. The phosphorus content in goat manure fertilizer and NPK chemical fertilizer is sufficient to meet the phosphorus nutrient requirements of butternut squash plants. As a result, the number of fruits produced by plants treated with these two fertilizers is higher compared to those treated with other fertilizers.

The potassium (K) nutrient in goat manure and NPK fertilizers reduces the level of flower drop in butternut squash plants, thereby increasing the percentage of flowers that turn into fruits. The application of potassium (K) in fruiting plants has been proven to significantly reduce fruit drop. Using potassium at 2% can reduce fruit drop by 21.16% compared to plants without potassium application. The combination of K and N nutrients can be highly effective in reducing fruit drop (Ullah Khan *et al*., 2022). This, in turn, increases the fruit yield of butternut squash plants.

The fruit length

The fruit length was measured at harvest time. Based on the analysis, it can be concluded that the application of different types of fertilizers 375 grams of chicken manure per plant, 600 grams of cow manure per plant, 720 grams of goat manure per plant, 500 grams of sugarcane ash per plant, and 22.5 grams of NPK 16:16:16 chemical fertilizer per plant—had a significant effect on the fruit length of butternut squash plants. The highest average fruit length was obtained from the application of goat manure, which was 25.24 cm (Table 5.7.). Based on Table 5.7., the average fruit length of butternut squash plants from the application of chicken manure did not significantly differ from that of cow manure or chemical fertilizer. However, the application of goat manure significantly differed from the other types of fertilizers in terms of the fruit length of the butternut squash plants.

Goat manure contains a high level of potassium (K), which is highly beneficial for the growth, development, and quality of fruit. Potassium supports the transfer of photosynthetic products to the fruit, thereby aiding in the formation and filling of fruit. According to a study by Novitasari & Caroline (2021) [37], which compared the quality of various types of manure fertilizers from several researchers with the SNI 19-7030-20024 standard, goat manure contains 1.82% potassium. The potassium content in goat manure is higher than that of other types of manure.

The potassium content in goat manure has been proven to enhance fruit length. The combined presence of potassium and nitrogen (K and N) in goat manure is very effective in increasing fruit length (Ullah Khan *et al*., 2022) [58].

Table 5.7: Fruit Length of Butternut Squash Plants with the Application of Different Types of Fertilizers

Treatments	Fruit Lenght (cm)
P0	0,0 a
P1	21,8 c
P2	22,6 c
P3	25,2 d
P4	17,9 b
P5	23,2 c
Duncan's Test 5%	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

Fruit Diameter

Fruit diameter was measured at harvest. Based on the analysis, it was found that the application of various types of fertilizers, including 375 grams of chicken manure per plant, 600 grams of cow manure per plant, 720 grams of goat manure per plant, 500 grams of sugarcane ash per plant, and 22.5 grams of NPK chemical fertilizer (16:16:16) per plant, significantly affected the fruit diameter of butternut squash plants. The highest average fruit diameter was produced by the application of goat manure at 9.62 cm (Table 5.8.).

Table 5.8: Fruit Diameter of Butternut Squash Plants with Different Types of Fertilizer Applications

Treatments	Fruit Diameter (cm)
P0	0,0 a
P1	8,1 bc
P2	8,5 cd
P3	9,6 d
P4	7,4 b
P5	9,1 cd
Duncan's Test 5%	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

Based on the table above, it can be observed that the fruit diameter of butternut squash resulting from the application of goat manure fertilizer is not significantly different from the fruit diameter of butternut squash resulting from the application of chemical NPK fertilizer. Similarly, the fruit diameter of butternut squash from the application of cow manure fertilizer is not significantly different from the fruit diameter resulting from the application of chicken manure fertilizer, and also not significantly different from the fruit diameter of plants treated with goat manure fertilizer.

The nutrient content in both manure and chemical NPK fertilizers is crucial for plants during the fruit formation process. The combined roles of nitrogen (N), phosphorus (P), and potassium (K) in the fertilizer play an important role in fruit formation and quality (Purba, Ningsih, *et al*., 2021; Ullah Khan *et al*., 2022) [42, 58]. Nitrogen (N) assists in plant tissue formation and supports healthy vegetative growth, including fruit. Phosphorus (P) plays a role in fruit formation and development, and enhances fruit quality. Potassium (K) increases fruit size, resistance to diseases, and the quality of the harvest.

The fruit weight per plant

The fruit weight per plant was calculated by weighing all the marketable fruits produced by each plant. Based on the analysis, it can be observed that the application of various types of fertilizers, including chicken manure (375 grams per plant), cow manure (600 grams per plant), goat manure (720 grams per plant), sugarcane bagasse ash (500 grams per plant), and chemical NPK 16:16:16 (22.5 grams per plant), had a significant effect on the fruit weight of butternut squash plants. The heaviest average fruit weight of butternut squash plants was obtained from the application of goat manure, with an average of 6.54 kg per plant (Table 5.9). This weight was not significantly different from the average fruit weight produced by plants treated with chemical NPK, which was 6.27 kg.

Table 5.9: Fruit Weight of Butternut Squash Plants with Various Types of Fertilizer Applications

Treatments	The Fruit Weight (kg)
P0	0,0 a
P1	4,4 b
P2	5,0 c
P3	6,6 d
P4	3,9 b
P5	6,3 d
Duncan's Test 5%	*

Note: Numbers accompanied by different letters in the same column indicate a significant difference between treatments in the Duncan's 5% test. "tn" = not significant, "*" = significantly different

The average fruit weight of butternut squash plants that were applied with cow manure fertilizer is significantly different from the average fruit weight per plant produced by those applied with other types of fertilizers. Meanwhile, the average fruit weight produced by butternut squash plants applied with chicken manure fertilizer does not significantly differ from those applied with sugarcane bagasse ash fertilizer.

Potassium (K) is an essential nutrient for fruit filling. Potassium plays a crucial role in carbohydrate metabolism, including the formation, breakdown, and translocation of starch, by maintaining the charge balance at ATP production sites. Potassium also helps transport photosynthesis products (sugars) to plant parts to support growth or store them in fruits and roots. Furthermore, along with nitrogen, potassium contributes to protein synthesis (Purba, Ningsih, *et al*., 2021) [41]. The combined role of potassium with nitrogen enhances fruit weight. This aligns with the research conducted by Chen *et al*. (2019) [12], which found that the combination of N and K fertilizers resulted in heavier butternut squash than the combination of P and K or N and P fertilizers. This result is supported by the findings of Ullah Khan *et al*. (2022) [58], which demonstrated that the combination of N and K fertilizers significantly increased fruit weight in plants.

Soil laboratory test results

Soil testing in agriculture is conducted to determine the soil fertility levels. Soil testing is crucial for providing precise fertilization recommendations, as well as for understanding the physical, biological, and chemical properties of the soil (Eviati *et al*., 2023) [17]. By understanding the specific needs of the soil and crops, farmers can manage agricultural inputs more efficiently, ultimately increasing land productivity and crop yields.

In this study, soil testing was conducted to assess the remaining levels of nitrogen (N), phosphorus (P), potassium (K), and soil moisture after the application of various types of fertilizers to butternut squash plants. The soil analysis was performed at the Sukorsari Sugar Research Center's Soil Physics and Chemistry Laboratory, with sample registration number 078.

The soil testing methods used to determine soil moisture (SM) was the absolute dry weight method. The nitrogen content (N) was determined using the Kjeldahl method. Phosphorus (P) content was analyzed using the Olsen method, and potassium (K) was measured using the ammonium acetate extraction method. The results of the soil analysis for the butternut squash plant samples are as follows:

Table 5.10: Soil Test Results for Butternut Squash Plants

Sample	Analysis Results			
	KA (%)	N (%)	P_2O_5 Olsen (ppm)	K_2O (Cmol (+) Kg)
X	3,7	0,1 **	29,0 ***	0,1 *
P0	2,9	0,1 **	33,3 ****	0,1 *
P1	1,4	0,1 **	95,6 *****	0,1 *
P2	1,4	0,1 *	45,1 ****	0,1 *
P3	1,7	0,1 **	42,8 ****	0,2 *
P4	1,8	0,1 **	41,0 ****	0,2 *
P5	1,2	0,1 **	61,3 *****	0,2 *

Source: Results of Analysis at the Soil Physics and Chemistry Laboratory, Sugar Research Center, Sukosari, 2024.
Note: * = Very Low, ** = Low, *** = Moderate, **** = High, ***** = Very High (Classification Based on the Soil and Fertilizer Instrument Testing Center, 2023)

The nitrogen content in the soil is essential for plants during the vegetative growth phase. Nitrogen plays a crucial role in the quality of the leaves of butternut squash plants. Plants that are adequately supplied with nitrogen have larger leaf areas (leaf length and leaf diameter). Nitrogen is a key component of chlorophyll, which is why plants with sufficient nitrogen have optimized photosynthesis reactions (Boschiero *et al*., 2019; Kusumawati, 2021; Purba, Ningsih, *et al*., 2021) [10, 29, 41].

The phosphorus (P) content influences the length of the plant, as well as the formation of flowers and fruits in butternut squash plants. Phosphorus stimulates growth and is active in cell division. Plants that are sufficiently supplied with phosphorus are more resistant to diseases and are less likely to topple. Therefore, butternut squash plants that lack phosphorus experience slow, weak, and inhibited growth and development (Kusumawati, 2021; Purba, Ningsih, *et al*., 2021) [29, 41].

Potassium (K) plays a role in mitigating the negative effects of excessive nitrogen application, making butternut squash plants less susceptible to pest and disease attacks and preventing them from becoming brittle and easily shedding their leaves, branches, flowers, and fruits (Purba, Ningsih, *et al*., 2021) [41]. Additionally, potassium functions in photosynthesis, activating plant enzymes, supporting protein formation and respiration, and enhancing plant resistance (Kusumawati, 2021) [29].

Based on the results of soil laboratory analysis, the phosphorus (P) content in the soil is classified as high to very high. This is due to the characteristic of soil in Madura Island, which is primarily limestone soil. According to Puslitan, 1966 in (Supriyadi, 2007) [53], the soil in Madura is generally formed from wet and dry limestone materials. Limestone soils, with their high calcium content and basic pH, primarily bind phosphorus in less soluble forms such as calcium phosphate (Ca-P). In calcareous soils, the content of CaCO3 is very high, and phosphorus is bound in the form of Ca-P. The availability of phosphorus to plants in calcareous soils is relatively low because most of the phosphorus is bound by magnesium (Mg) and calcium (Ca) (Liu *et al*., 2015) [30].

The phosphorus content in the soil applied with chicken manure (P1) is higher than in soils applied with other types of manure. This is because the phosphorus content in chicken manure is higher compared to other types of manure. Laboratory test results from several researchers summarized by (Novitasari & Caroline, 2021) [37] menunjukkan kandungan fosfor pada indicate that the phosphorus content in chicken manure is higher than that in cow and goat manures.

Conclusion

The use of various organic fertilizers and NPK chemical fertilizers significantly influences the growth response and yield of butternut squash plants. The nutrient content in the soil after planting butternut squash showed that nitrogen (N) was low to very low, phosphorus (P) ranged from medium to very high, potassium (K) was very low, and the average soil moisture content was 2%.

It is recommended that farmers apply goat manure at a dose of 720 grams per plant for butternut squash cultivation. It is necessary for the Food Security and Agriculture Office to conduct outreach programs to raise farmers' awareness by providing extension services on the benefits of applying organic fertilizers to butternut squash plants.

References

1. Abdulah R, Syakur A. Pengaruh pemberian pupuk kandang kambing terhadap pertumbuhan dan hasil tanaman pakcoy (Brassica chinensis L.). Agrotekbis. 2022;10(2):457–64.
2. Abebe TG, Tamtam MR, Abebe AA, Abtemariam KA, Shigut TG, Dejen YA, *et al*. Growing use and impacts of chemical fertilizers and assessing alternative organic fertilizer sources in Ethiopia. Appl Environ Soil Sci. 2022;2022(1):1–14. https://doi.org/10.1155/2022/4738416
3. Adams GG, Imran S, Wang S, Mohammad A, Kok S, Gray DA, *et al*. The hypoglycaemic effect of pumpkins as anti-diabetic and functional medicines. Food Res Int. 2011;44(4):862–7. https://doi.org/10.1016/j.foodres.2011.03.016
4. Andriyadi M. Respon pertumbuhan dan hasil tanaman labu madu (Cucurbita moschata L.) akibat pemberian pupuk kandang kotoran sapi. Universitas Tridinanti; 2023.
5. Asian Development Bank. Organic agriculture and post-2015 development goals: building on the comparative advantage of poor farmers. Asian Development Bank; 2015. Available from: www.adb.org
6. Ayuningtyas WS, Suwarno WB. Respon empat genotipe labu madu (Cucurbita moschata) terhadap perlakuan silika. Institut Pertanian Bogor; 2019.
7. Badan Pusat Statistik. Produksi tanaman labu madu di Indonesia tahun 2017-2019. Badan Pusat Statistik; 2023 Oct.
8. Badan Pusat Statistik. Kabupaten Pamekasan dalam angka 2024. In: Mauludin I, Rapha MA, editors. 29th ed. Badan Pusat Statistik; 2024. Available from: https://pamekasankab.bps.go.id/id/publication/2024/02/28/e62b5817beba7cb6e71a6598/kabupaten-pamekasan-dalam-angka-2024.html
9. Bergstrand KJ. Organic fertilizers in greenhouse production systems – a review. Sci Hortic. 2022;292:1–8.
10. Boschiero BN, Mariano E, Azevedo RA, Ocheuze Trivelin PC. Influence of nitrate-ammonium ratio on the growth, nutrition, and metabolism of sugarcane. Plant Physiol Biochem. 2019;139:246–55. https://doi.org/10.1016/j.plaphy.2019.03.024
11. Chang CI, Hsu CM, Li TS, Huang SD, Lin CC, Yen CH, *et al*. Constituents of the stem of Cucurbita moschata exhibit antidiabetic activities through multiple mechanisms. J Funct Foods. 2014;10:260–73. https://doi.org/10.1016/j.jff.2014.06.017
12. Chen Y, Zhou X, Lin Y, Ma L. Pumpkin yield affected by soil nutrients and the interactions of nitrogen, phosphorus, and potassium fertilizers. HortScience. 2019;54(10):1831–5. https://doi.org/10.21273/HORTSCI14152-19
13. Crista F, Boldea M, Radulov I, Lato A, Crista L, Dragomir C, *et al*. The impact of chemical fertilization on maize yield. Res J Agric Sci. 2014;46(1):172–7. Available from: https://cabidigitallibrary.org
14. Dermawan R, Kaimuddin, Dungga NE, Sjahril R, Mollah A, Yuniarti NS. Response of growth and development of butternut squash (Cucurbita moschata) to the combination of bioslurry and NPK fertilization. IOP Conf Ser Earth Environ Sci. 2020;575(1). https://doi.org/10.1088/1755-1315/575/1/012119
15. Dermiyati. Sistem pertanian organik berkelanjutan. Plantaxia; 2015.
16. Elfianis R. Syarat tumbuh tanaman labu. Agrotek.Id

[Internet]. 2020 Jul 25. Available from: https://agrotek.id/syarat-tumbuh-tanaman-labu/#5_Kondisi_Tanah
17. Eviati, Sulaeman, Herawaty L, Anggria L, Usman, Tantika HE, *et al*. Analisis kimia tanah, tanaman, air, dan pupuk. In: Sipahutar IA, Wibowo H, Siregar AF, Widowati LR, Rostaman T, editors. Petunjuk Teknis. 3rd ed. Vol. 3. Kementerian Pertanian Republik Indonesia; 2023. Available from: https://tanahpupuk.bsip.pertanian.go.id
18. Firmansyah I, Syakir M, Lukman L. Pengaruh kombinasi dosis pupuk N, P, dan K terhadap pertumbuhan dan hasil tanaman terung (Solanum melongena L.). J Hortikultura. 2017;27(1):69–78. https://doi.org/10.21082/jhort.v27n1.2017.p69-78
19. Girsang YP. Pertumbuhan dan produksi tanaman labu madu (Cucurbita moschata) pada pemberian POC limbah ikan dan pupuk kandang ayam. Universitas Muhammadiyah Sumatera Utara; 2020.
20. Glew RH, Glew RS, Chuang LT, Huang YS, Millson M, Constans D, *et al*. Amino acid, mineral, and fatty acid content of pumpkin seeds (Cucurbita spp) and Cyperus esculentus nuts in the Republic of Niger. Plant Foods Hum Nutr. 2006;61(2):51–6. https://doi.org/10.1007/s11130-006-0010-z
21. Hajar I. Pengaruh pupuk bokashi ampas tahu dan NPK 16:16:16 terhadap produksi tanaman labu (Cucurbita moschata). Universitas Islam Riau; 2021.
22. Hariadi YC, Nurhayati AY, Hariyani P. Biophysical monitoring on the effect of different composition of goat and cow manure on the growth response of maize to support sustainability. Agric Agric Sci Procedia. 2016;9:118–27. https://doi.org/10.1016/j.aaspro.2016.02.135
23. Haryadi D, Yetti H, Yoseva S. Pengaruh pemberian beberapa jenis pupuk terhadap pertumbuhan dan produksi tanaman kailan (Brassica alboglabra L.). Jom Faperta. 2015;2(2).
24. Jin H, Zhang YJ, Jiang JX, Zhu LY, Chen P, Li J, *et al*. Studies on the extraction of pumpkin components and their biological effects on blood glucose of diabetic mice. J Food Drug Anal. 2013;21(2):184–9. https://doi.org/10.1016/j.jfda.2013.05.009
25. Junita D, Setiawan B, Anwar F, Muhandri T. Komponen gizi, aktivitas antioksidan, dan karakteristik sensori bubuk fungsional labu kuning (Cucurbita moschata) dan tempe. J Gizi Pangan. 2017;12(2):109–16. https://doi.org/10.25182/jgp.2017.12.2.109.116
26. Kementerian Pertanian Republik Indonesia. Statistik Pertanian 2020. In: Susanti AA, Supriyatna MA, editors. Pusat Data dan Sistem Informasi Pertanian; 2020.
27. Kirana R, Gaswanto, Hidayat M. Budidaya dan produksi labu kuning. Litbang Kementerian Pertanian; 2009.
28. Kurniati F, Hodiyah I, Hartono T, Nurfalah I. Respons labu madu (Cucurbita moschata Durch) terhadap zat pengatur tumbuh alami dengan berbagai dosis. Agrotech Res J. 2018;2(1):16–21.
29. Kusumawati A. Buku ajar kesuburan tanah & pemupukan. 1st ed. Vol. 1. Poltek LPP Press; 2021.
30. Liu Z, Li YC, Zhang S, Fu Y, Fan X, Patel JS, *et al*. Characterization of phosphate-solubilizing bacteria isolated from calcareous soils. Appl Soil Ecol. 2015;96:217–24. https://doi.org/10.1016/j.apsoil.2015.08.003
31. Lolliani. Variabilitas lima genotipe labu kuning (Cucurbita sp) berdasarkan kandungan nutrisi dari Kecamatan Danau Kembar dan Lembah Gumanti Kabupaten Solok. Universitas Andalas; 2017.
32. Makmur D. Budidaya labu madu. Dadi Makmur; 2018.
33. Makni M, Sefi M, Fetoui H, Garoui EM, Gargouri NK, Boudawara T, *et al*. Flax and pumpkin seeds mixture ameliorates diabetic nephropathy in rats. Food Chem Toxicol. 2010;48(8–9):2407–12. https://doi.org/10.1016/j.fct.2010.05.079
34. Marbun EP. Pengaruh pemberian pupuk NPK terhadap pertumbuhan dan hasil tanaman labu madu (Cucurbita moschata L.). Universitas Tridinanti Palembang; 2022.
35. Misda RN. Pengaruh ampas tebu (Saccharum officinarum) sebagai pupuk organik cair pada pertumbuhan dan hasil kedelai (Glycine max L.). Universitas Teuku Umar; 2022.
36. Munthe Y. Respon pertumbuhan dan produksi tanaman melon (Cucumis melo L.) terhadap pemberian kompos ampas tebu dan pupuk organik cair (POC) kulit buah pisang kepok. Universitas Medan Area; 2019.
37. Novitasari D, Caroline J. Kajian efektivitas pupuk dari berbagai kotoran sapi, kambing, dan ayam. Seminar Teknologi Perencanaan, Perancangan, Lingkungan, dan Infrastruktur II; 2021. p. 442–7.
38. Nuraini E, Susana R, Basuni B. Pengaruh pemberian pupuk kandang kambing dan pupuk NPK terhadap pertumbuhan dan hasil tanaman labu madu (Cucurbita moschata) di tanah gambut. J Sains Pertanian Equator. 2023;12(4):975–82. https://doi.org/10.26418/jspe.v12i4.64509
39. Paris HS, Brown RN. The genes of pumpkin and squash. HortScience. 2005;40(6):1620–30. https://doi.org/10.21273/hortsci.40.6.1620
40. PT. East West Seed Indonesia. Labu madu. Panah Merah [Internet]. 2024 Nov 14. Available from: https://www.panahmerah.id/id/product-detail/labumadu
41. Purba T, Ningsih H, Purwaningsih, Junaedi AS, Gunawan B, Junairiah, Firgiyanto R, Arsi. Tanah dan Nutrisi Tanaman. Yayasan Kita Menulis; 2021.
42. Purba T, Situmeang R, Rohman HF, Mahyati, Arsi, Firgiyanto R, Junaedi AS, Saadah TT, Junairiah, Herawati J, Suhastyo AA. Pupuk dan Teknologi Pemupukan. Yayasan Kita Menulis; 2021.
43. Riyadi S, Priyono, Triyono K. Pengaruh Pemberian Konsentrasi Pupuk Organik Cair dan Pupuk Kandang Kambing Terhadap Pertumbuhan dan Hasil Tanaman Labu Madu (Cucurbita moschata). Jurnal Inovasi Pertanian. 2022;24(1):101–107.
44. Robisetiawan J. Respon Pertumbuhan dan Hasil Tanaman Labu Madu (Cucurbita moschata) Akibat Pemberian Berbagai Takaran Pupuk Bokashi Kotoran Ayam. Universitas Tridinanti Palembang; 2021.
45. Rowell RM, Young RA, Rowell JK. Paper and Composites from Agro-Based Resources. CRC Press, Inc.; 1996.
46. Saleem MF, Ghaffar A, Anjum SA, Cheema MA, Bilal MF. Effect of Nitrogen on Growth and Yield of Sugarcane. Journal American Society of Sugar Cane Technologists. 2012;32:75–93. Available from: https://www.researchgate.net/publication/263472687
47. Saleh K. Analisis Kelayakan Finansial Pengembangan Usahatani Labu Madu di Kabupaten Pandeglang Provinsi Banten. Jurnal Agribisnis Indonesia.

2020;8(2):131–141. Available from: https://doi.org/10.29244/jai.2020.8.2.131-141
48. Sanjur OI, Piperno DR, Andres TC, Wessel-Beaver L. Phylogenetic Relationships Among Domesticated and Wild Species of Cucurbita (Cucurbitaceae) Inferred from a Mitochondrial Gene: Implications for Crop Plant Evolution and Areas of Origin. Proceedings of the National Academy of Sciences. 2002;99(1):535–540. Available from: www.pnas.org
49. Savci S. Investigation of Effect of Chemical Fertilizers on Environment. APCBEE Procedia. 2012;1:287–292. Available from: https://doi.org/10.1016/j.apcbee.2012.03.047
50. Shahadha SS, Wendroth O, Ding D. Nitrogen and Rainfall Effects on Crop Growth - Experimental Results and Scenario Analyses. Water (Switzerland). 2021;13(16):1–25. Available from: https://doi.org/10.3390/w13162219
51. Simatupang P. Pengaruh Pupuk Kandang dan Penutup Tanah terhadap Erosi pada Tanah Ultisol Kebun Tambunan A DAS Wampu, Langkat. Jurnal Ilmu Pertanian Kultura. 2005;40(2):89–92.
52. Sitompul SM, Guritno B. Analisis Pertumbuhan Tanaman. Gadjah Mada University Press; 1995.
53. Supriyadi S. Kesuburan Tanah di Lahan Kering Madura. Embryo. 2007;4(2):124–131.
54. Suwarno, Suranto. Studi Variasi Morfologi dan Profil Pola Pita Protein pada 3 Varietas Lokal Tanaman Waluh (Cucurbita moschata) dari Jawa Tengah. Seminar Nasional Pendidikan Biologi. 2010;67–73.
55. Tedianto. Karakterisasi Labu Madu (Cucurbita moschata) berdasarkan Penanda Morfologi dan Kandungan Protein, Karbohidrat, Lemak pada Berbagai Ketinggian Tempat. Universitas Sebelas Maret; 2012.
56. Tjitrosoepomo. Morfologi Tumbuhan. Gadjah Mada University Press; 2011.
57. Tumewu P, Paruntu CP, Sondakh TD. Hasil Ubi Kayu (Mannihot esculenta Crantz.) Terhadap Perbedaan Jenis Pupuk. Jurnal LPPM Bidang Sains Dan Teknologi. 2015;2(2):16–27.
58. Ullah Khan S, Ahmad Alizai A, Ahmed N, Sayed S, Junaid M, Kanwal M, Ahmed S, Alqubaie AI, Alamer KH, Ali EF. Investigating The Role of Potassium and Urea to Control Fruit Drop and to Improve Fruit Quality of “Dhakki” Date Palm. Saudi Journal of Biological Sciences. 2022;29(5):3806–3814. Available from: https://doi.org/10.1016/j.sjbs.2022.02.060
59. Wafiroh B, Esti Wahyuni FR, Ege B, Bustami Y, Supiandi MI, Studi P, Biologi P, Persada S, Sintang K, Corresponding S. Pengaruh Ampas Tebu Terhadap Pertumbuhan dan Produktivitas Tanaman Terong Hijau. Techno. 2018;7(1):91–104. Available from: http://ejournal.unkhair.ac.id/index.php/Techno
60. Wang Y, Zhu Y, Zhang S, Wang Y. What Could Promote Farmers to Replace Chemical Fertilizers with Organic Fertilizers? Journal of Cleaner Production. 2018;199:882–890. Available from: https://doi.org/10.1016/j.jclepro.2018.07.222