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Growth and Production of Celery Plants (*Apium Graveoles L*) in Response to Organic and Inorganic Fertilizers

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ABSTRACT
Celery belongs to the Apiaceae family and is widely used for flavoring food and maintaining health, by lowering high blood pressure and cholesterol. Organic and inorganic fertilizers promote its growth, meanwhile, the inorgranic have negative impact on the soil when used excessively. This study aims to determine celery (*Apium graveoles L*) growth response to organic and inorganic fertilizers. It was conducted from May to August 2020 at the Go Green Educational Institute Green House, Dukuh Saleh Street, Pejeruk, Ampenan. The CRD (Completely Randomized Design) method was used with 2 treatments namely organic fertilizer of goat compost 10 g and 15 g together with inorganic phonshka fertilizer 1 g and 1.5 g respectively. Meanwhile, the parameters observed include stem height, petioles number, root length, weight as well as planting wet weight. The results showed that for each meter observed, the goat compost organic fertilizer treatment 10 g + 1 g phonska had the highest value compared to other treatments which were not significantly different for all parameters. Moreover, the fertilizer ratio was more effective in accelerating celery growth and production compared to the addition of 15g organic fertilizer of goat compost with 1.5g Phonska, hence, it is recommended for celery cultivation.

KEYWORDS:
Organic Fertilizer, Inorganic, Celery

1. Introduction

Celery belongs to the Apiaceae family and is widely used for flavoring food and maintaining health, by lowering high blood pressure and cholesterol. In Indonesia, the plant has three varieties which include cutting (Sylvester variety), leaf (Secalium variety) and tuber celery (Repaceum variety) . The leaf celery variety (Secalium) has the characteristics of short plants with numerous leaves as well as tillers and is the most widely cultivated [1].

Furthermore, celery cultivation is not only in large areas but also in house yard using polybags or pots. The latter is easy to control and serves as an ornamental plant. The cultivation is supported by application of fertilizers to meet the needs of plant life. Fertilizers contribute 20% increase in agricultural production. Meanwhile, the two types of fertilizers include organic and inorganic.

Organic fertilizers are composed of living matter such as remains of plants as well as animal, and human waste. In contrast, inorganic are mineral fertilizers produced by chemical factories. Organic fertilizers restore the soil condition to become more fertile and loose, whereas excess application of inorganic fertilizers hardens the soil physical properties [2]. Compost organic fertilizer made from goat manure has high potassium (K) content compared to other manure, it stimulates growth of new roots and also strengthens plant stems [3].

This study aims to determine the growth response of celery (*Apium graveoles L*) to organic and inorganic fertilizers.

2. Literature Review

2.1 Subjective complaints

Subjective complaints is in form of musculoskeletal system disorder is often found in workers that work manually in a sitting position with extended legs in response to the body's reactions caused by work (task). In carrying out activities or jobs in a sitting position, the legs are extended while the hands muscles , fingers and back extended to the buttock play major role. Among the many types of muscles, the skeletal muscles receive most attention. The skeletal muscle functions to contract the bones while wrinkles occur when the muscle receive an impulse from central nerve [4].

Musculoskeletal system complaints are influenced by muscles that work abnormally as a result of an unnatural work attitude which causes muscle fatigue and discomfort. Meanwhile, discomfort leads to an urge for moving (unnecessary movement) to change positions by physiological and psychological factors. Furthermore, discomfort occurs due to pressure on soft tissue that

blocks the blood flow to the tissue which results in reduced oxygen as well as carbon dioxide build-up and production of lactic acid waste.
One of the factors responsible for muscle fatigue is the obstruction of metabolic process. Loss of muscle function due to fatigue increases the risk of injury to the musculoskeletal system. Hence, subjective complaints include physiological and psychological experience resulting in muscle fatigue. Besides,, muscle fatigue is a physiological phenomenon measured directly by electromyography (EMG) and is often used ergonomically to detect workspaces as well as task factors that cause fatigue. Subjective measurement techniques for workers was performed by showing body diagrams or questionnaires to determine the musculoskeletal system complaints location known as the Nordic Body Map.

2.2 Workload
Wordload is a number of processes or activities completed by a worker within a certain period of time. When a worker completely perfoms an assigned task, it does not become a workload, however, it becomes a workload when the worker is unsuccessful. Workload is divided into two groups [5].
a. External workload (stressor) is the workload that comes from the work being done. including tasks, organization and environment.
b. Internal workload is generated by individual worker factors which are somatic (gender, age, body size, health condition and nutritional status) and psychological in nature (motivation, perception, desire, etc.)

2.3 Work productivity
This is the ability of a person or group of people to produce products both in the form of goods and services which increase periodically. Productivity is obtained by comparing output with input per unit time. In the output, the role is determined by human, material, energy as well as information resources, while the input includes land, material, machinery, human resources and technology, however, human resources determines both output and input. Basically, productivity is closely related to the production process in which factors of labor, capital, work equipment, raw materials together with others are managed effectively and efficiently. The success of the production process is usually expressed in terms of work productivity or the amount of output ratio per input produced multiplied by the time to get the output. Hence, human performance is the main factor which determines efforts to increase work productivity [6].
The factors that affect work productivity include:
a. Workforce: age, nutrition, physical condition, skills and psychology of workers
b. Work equipment: tools used or machines, etc..
c. Work environment: heat, dust, equipment conditions, safety, noise, etc.
d. How to work: attitude, position, system etc
e. Work organization: administration, shifts, length of work, rest periods and so on.

3 Methodology
This study was conducted from May to August 2020 at the Go Green Educational Institute Green House, Dukuh Saleh Street, Pejeruk, Ampenan. The CRD (Completely Randomized Design) method was used with 2 treatments namely organic fertilizer of goat compost 10 g and 15 g and inorganic fertilizer of Phonshka 1 g and 1.5 g. Each treatment was repeated 3 times which altogether forms 12 experimental units consisting of 2 plants per pot.
The planting medium was soil + husk in 1: 1 ratio, weighing 2 kg per pot. Furthermore, the medium was prepared a week before planting by adding 10 grams (O1) and 15 grams (O2) to the organic goat compost treatment and Phonshka fertilizer of 1 gram (A1) and 1.5 grams (A2). All the media were mixed and put in a pot with a 15 cm diameter.
Celery seeds which were sown and have form 3-4 leaves at the age of weeks after planting (WAP) were transferred to a 15 cm diameter pot with 2 plants per pot.
The fertilizers according to treatment were applied once a week until harvest, which is 90 days after planting. Meanwhile, the parameters observed include stem height, petioles number, root length and weight as well as planting wet weight. Observations were made once a week.

4. Results and Discussion
4.1 Plant height
The analysis results of variance in Table 1 showed the effect of organic and inorganic fertilizer application on the height of celery plants aged 3 and 8 WAP. Meanwhile, the Duncan Test Treatment (A1O1) showed a significantly different effect from other treatment levels. Both goat manure organic and Phonska inorganic fertilizers influence the plant vegetative phase, meanwhile, the former contains potassium which strengthens the stems and optimize photosynthesis process.
The interaction between the application of 10g organic and 1g inorganic fertilizers provides additional nutrients from goat manure compost which provides N, Ca and K to support plant needs. Besides, the calcium nutrient contained in the goat manure strengthens plants.

Easterwood. G.W (2002) stated that calcium functions to strengthen and thicken plant cell walls which are the most important part of cell structure, hence, it enhance the formation of a strong plant structure by accelerating growth. Phonska fertilizer plays a role in strengthening plant stems and spurring vegetative as well as generative plants growth.

At age 6 and 8 WAP, application of 10 grams organic and 1 gram Phonska fertilizers showed the best growth response on plant height parameters which continued to increase significantly compared to 15 grams of goat manure and 1.5 grams Phonska fertilizer application as shown in Table 2.

A balanced fertilizer dose affects plant growth. Moreover, Husni (2015) stated that application of balanced fertilizer dose improves soil structure and fertility, however, excess fertilizer damages the soil structure and poison plants. In Figure 1, the treatment of 15 g goat compost and 1.5 Phonska fertilizer (A2O2) showed unhealthy plants, yellowing leaves, and poor growth. Therefore, excess doses of goat manure compost and Phonska poison plant which results in damage to plant cells.

Meanwhile, the availability of nitrogen in manure accelerates the formation of plant vegetative parts as meristem tissue induces cell division, extension, as well as enlargement of new cells and protoplasm, therefore, plant growth occurs appropriately (Rosmarkam and Yuwono, 2002)

Table 3 shows that 10 grams of goat compost and 1 gram of Phonska fertilizers treatment had the longest root length (20.2 cm). Meanwhile, it is assumed that each fertilizer is able to improve soil physical properties which develops the roots extensively. The root system grows optimally under appropriate physical and chemical soil condition (Nugroho, 2004). Distinctive roots absorbs maximum nutrient which affect plant growth and development.

Fahmi et al. (2010) stated that addition of nitrogen through fertilization stimulates growth and increases root weight. Moreover, roots in soil with sufficient N, are large, whereas, roots in soil with inadequate N are longer, small and abundant.

Based on Table 4, 10 grams of goat compost organic fertilizer and 1 gram of Phonska per plant treatment showed the heaviest root weight of 8.2 grams which was not significantly different from all treatments. Celery plants have a taproot system with short root fibers. The roots in this study are categorized as healthy roots in line with Wachjar and Anggayuhlin (2013) which stated that healthy roots are white and have lots of fiber. Furthermore, roots interact directly with soil particles such as nutrients, especially N, P, as well as K, hence, sufficient nutrient uptake results in growth and branching of the root resulting in wider and greater root weight. In line with Wijaya's (2008), nitrogen plays an important role in root growth and branching. Excessive supply of N changes the root characteristics and also stimulates crown growth compared to root growth, hence, the roots are unable to supply water as well as minerals such as P and K.

Plant wet weight is influenced by water content, Mutryarny et al., (2014) stated that this variable flunctuates greatly depending on the state of plant humidity. Furthermore, Jumin (2008) reported that the amount of water demand at each growth phase is directly related to physiological, morphological and environmental factors. The heaviest consumption weight was produced by 10 grams of goat compost organic and 1 gram of Phonska fertilizer treatment namely 41.5 grams which is significantly different from the control as well as 15 grams of goat compost and 1.5 grams of Phonshka organic fertilizer treatment respectively (Table 5). Therefore, it is suspected that the dosage is in accordance with the needs of celery plant. This is in line with Palimbungan et al. (2006) which stated that the application of fertilizer in an amount according to plant needs results in optimal growth which induces rapid cell division and elongation process. Meanwhile, the response of celery plants to 15 grams goat compost and 1.5 grams phonska treatment resulted in low wet and plant consumption weight. It is assumed that the celery plant is saturated with nutrients which enables it to absorb nutrients optimally. Moreover, Indrakusuma (2000) stated that the low wet and dry weight of celery plants are caused by addition of organic fertilizers which increase nutrients in the planting medium.

FIGURES AND TABLES

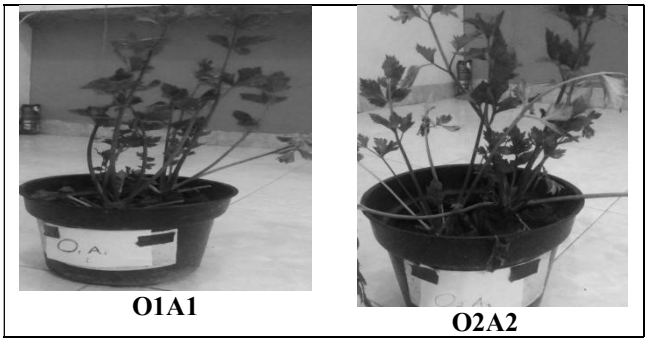

Figure 1. Celery plant growth

Table 1. The Effect of Organic and Inorganic Fertilizers Interaction on the Average Plant Height (cm) at the Age of 3-8 WAP.

Day	Organic fertilizer	Inorganic fertilizer	
		A1	A2
3 WAP	O1	10,6 a A	7,05 b A
	O2	9,93 a A	8,03 A B
4 WAP	O1	12,97 a A	7,77 b b
	O2	10,58	9.05
5 WAP	O1	13.67 a A	8,36 b B
	O2	10,83	12,8
6 WAP	O1	13.06a A	10.06b B
	O2	12.08a A	9.08b B
7 WAP	O1	15.09a A	11,07b B
	O2	12,40a A	10.85b +B
8 WAP	O1	13,04a A	12.13b B
	O2	10.05a A	9.23b B

Description: The numbers followed by the same letter (uppercase in horizontal direction and lowercase in vertical direction) are not significantly different according to Duncan's Multiple Range Test of 5%.

Table 2. Celery Plants Petioles Number in Response to Organic and Inorganic Fertilizers

Treatment	Average number of petioles (strands) Week After Planting (WAP)					
Organic fertilizer	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
O1	4.,7a	6.2a	7.4a	8.3a	8.7a	9.5a
O2	4.2a	4,4b	6.3b	6.8b	6.9b	7.1b
Inorganic fertilizer						
A1	4,6a	6.5a	6.8a	7.9a	8.6a	9.4a
A2	4.1a	5.4b	5.6b	6.4b	6.8b	7.4b

Description: The numbers followed by the same letter are not significantly different according to Duncan's Multiple Range Test of 5%

Table 3. Length of Celery Roots in Response to Organic and Inorganic Fertilizers

Treatment	Average total root length (cm) Week After Planting (WAP)
Organic fertilizer	8 WAP
O1	19.5 a
O2	18.1 b
Inorganic fertilizer	

A1	20.2a
A2	17.4b

Description: The numbers followed by different letters are not significant according to Duncan's Multiple Range Test of 5%.

Table 4. Plant Root Weight in Response to Organic and Inorganic Fertilizers

Treatment	Average total root length (cm) Week After Planting (WAP)
Organic fertilizer	8 WAP
O1	7.5 a
O2	7.1 a
Inorganic fertilizer	
A1	8.2a
A2	7. 9a

Description: The numbers followed by different letters are not significant according to Duncan's Multiple Range Test of 5%.

Table 5. Wet Plant Weight in Response to Organic and Inorganic Fertilizers

+ Treatment	Average wet plant weight (cm) Week After Planting (WAP)
Organic fertilizer	8 WAP
O1	40.5 a
O2	36.1 b
Inorganic fertilizer	
A1	41.5a
A2	38.6 b

Description: The numbers followed by different letters are not significant according to Duncan's Multiple Range Test of 5%.

5. Conclusion

Based on the results:

1. The application of goat compost organic fertilizer 10g + Phonska 1g showed the highest value compared to other treatments.
2. The treatments showed no significant difference for all parameters. In addition, the application of organic fertilizer goat compost 10 g + Phonska 1 g was more effective in accelerating the growth and production of plants compared to 15g goat compost organic fertilizer + Phonska 1.5 g, hence, it is recommended for celery cultivation.

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Conflict of Interest

Author has no conflict of interest regarding all elements in this study

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