



# Application of Guano Fertilizer and Types of Mulch on Growth and Yield of Potato (*Solanum tuberosum* L.)

Adinda Wahyuni<sup>1</sup>, Netti Herawati<sup>1</sup> and Warnita Warnita<sup>1\*</sup>

<sup>1</sup>Department of Agronomy, Agriculture Faculty, Andalas University, Padang, Indonesia.

## Authors' contributions

This work was carried out in collaboration among all authors. Author AW performed the research and performed the data, conducted statistical analysis and wrote the first draft of the manuscript. Author WW designed the study, checked data analysis, read and approved the final manuscript. Author NH read and approved the final manuscript.

## Article Information

DOI: 10.9734/APRJ/2021/v7i230150

### Editor(s):

(1) Dr. Shiamala Devi Ramaiya, Universiti Putra Malaysia, Malaysia.

### Reviewers:

(1) Edwin Ronnie Gakegne, Instituto de Investigação Agronômica (IIA), Angola.

(2) Baraa Almansour, Ministry of Agriculture, Syria.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/64967>

Original Research Article

Received 28 November 2020

Accepted 02 February 2021

Published 24 February 2021

## ABSTRACT

**Aims:** The purpose of this study was to obtain the best interaction between guano doses and mulch on the growth and yield of potato plants.

**Study Design:** The experimental design used was factorial 2 factors in a completely randomized design (CRD).

**Place and Duration of Study:** This experiment was carried out in Alahan Panjang, Lembah Gumanti District, Solok Regency, West Sumatra from March to June 2018.

**Methodology:** Factorial design 2 factors was use in research. The first factor consisted of 4 levels of guano fertilizer doses of 0, 3, 6 and 9 t ha<sup>-1</sup>. The second factor consisted of black silver plastic mulch and black plastic mulch. Data were analyzed statistically with the Fisher test and if significantly different then continued with the Duncan's New Multiple Range test ( $p \leq 0.05$ )

**Results:** No interaction between guano fertilizer and the two types of mulch tested with respect to plant height, number of leaves, and smallest tuber diameter were observed. Guano fertilizer at 9 t ha<sup>-1</sup> gave the best influence on the number of tubers and the diameter of tuber. Black plastic mulch had the best influence on the number of tubers, the diameter of tuber, the weight of

\*Corresponding author: E-mail: warnita@agr.unand.ac.id;

tubers per plant and the weight of tubers per hectare.

**Conclusion:** The dosage of guano fertilizer of 9 t ha<sup>-1</sup> gave the best effect on the number and diameter of tubers. The type of black plastic mulch gave the best effect on tuber number, tuber diameter, tuber weight per plant and tuber weight per hectare.

*Keywords: Dosage; fertilizer; guano; potato; mulch.*

## 1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is a horticultural product that can be used as raw material for industry and food diversification. In general, the average productivity of Indonesian potatoes is around 18 t ha<sup>-1</sup>. From year to year, potato production increased, especially in West Sumatra, starting from 2013 to 2016, but began to decline in 2017. In 2016 potato production was 50,582 tons, while in 2017 potato production was 40,398 tons. This figure shows that with the decreasing production of potatoes in West Sumatra, the amount of potato production in Indonesia has also decreased, although productivity has increased but has not been balanced with high consumer demand [1].

In general, farmers provide inorganic fertilizers to increase plant growth and yield. There will be degradation of the physical, chemical and biological fertility of the soil with the continuous application of inorganic fertilizers. One way to overcome this problem is by applying organic fertilizers. The application of organic fertilizers can not only improve soil chemical properties, but also improve soil physical and biological fertility in the long term [2,3,4].

Guano fertilizer is a type of organic fertilizer that comes from bat droppings. The elemental content of N, P, K of guano fertilizer is higher, i.e. 8-13% N, 5-12% P, and 1.5-2% K, than cow dung manure, i.e. 1.23% N, 0.55% P, 0.69% K and chicken manure, i.e. 3.77% N, 1.89% P and 1.76% K [5]. The use of Guano fertilizer can reduce the use of N, P and K fertilizers. [6]. Guano fertilizer contains a lot of important nutrients, i.e.: 8-13% N; 5-12% P; 1.5-2% K; 7.5-11% Ca; 0.5-1% Mg; and 2-3.5% S [7]. According to Samijan [8] for measuring the use of guano for food crops 1 - 2 t ha<sup>-1</sup>, for vegetable crops it can be 5 - 10 t ha<sup>-1</sup> and for plantation crops 5 - 10 g plant<sup>-1</sup>.

In addition, the low productivity of potato plants can be overcome by modifying the root environment of plants such as the use of mulch.

Mulch can prevent direct solar radiation. The use of plastic mulch can also reduce maintenance and weeding costs and reduce erosion or destruction of the soil surface [9].

The mulching can reduce direct heating so that the soil temperature does not rise and water does not quickly decrease because the evaporation is held back by mulch which causes moisture to the soil surface so that the plants grow well [10]. Mulches function as cover crop and reduce tillage operations that have some ecological advantages over conventional land preparation tasks causing minimum alterations in soil environment [11]. The use of black silver plastic mulch on shallot plants resulted in the best plant height, number of leaves, tillers, and tuber diameter per sample [12]. Bharati et al. [13] also reported enhanced emergence, plant height and number of stems of potato increases with black plastic mulching.

This study aims to determine the effect of the interaction of several doses of guano fertilizer and the best type of mulch on the growth and yield of potato plants.

## 2. MATERIALS AND METHODS

### 2.1 Place, Time and Material

The research was conducted in Jorong Galagah Kanagarian Alahan Panjang, Lembah Gumanti District, Solok Regency, West Sumatra with an altitude of 1,450 m above sea level from March to June 2018. The use material were potato tuber Cingkariang variety, silver black plastic, black plastic, guano fertilizer, urea, SP-36 and KCl. The tool were tractor, hoe, camera and stationary.

### 2.2 Method

Factorial design in completely randomized design with 2 factor was used in research. The first factor was guano fertilizer doses and the second factor was mulch type. The doses of guano: 0, 3, 6 and 9 tons / ha The type of mulch consist two treatment: silver black plastic mulch and black plastic mulch.

There were 8 treatment combinations with 3 replications (24 experimental units / plots). Each experimental unit consists of 20 plants so that the total plants total 480 plants. The samples observed were 6 plants for each experimental unit. The data were analyzed by using the F test followed by Duncan's New Multiple Range Test (DNMRT) at the 5% level.

### 2.3 Procedure

The soil in this research was classified into andosol, the N content was moderate (0.304%), the P content was low (4.891 ppm), C/N 19.98 (low). Land cultivated with tractors and then made beds as high as 20 cm with hoe. The size of the bed used is 300 cm x 120 cm. The beds are covered with silver black plastic mulch and black plastic mulch. Guano fertilizer was applied to each planting hole with a dose according to treatment (0, 3, 6, and 9 t ha<sup>-1</sup>), then incubated for one week.

The planting material is a variety of Cingkariang originating from Agam Regency, West Sumatra. The criteria for the quality of healthy seed tubers, not defects, not attacked by pests or diseases, uniform size seeds and the seeds had sprouted.

After the incubation process, the seeds are planted ± 5 cm deep in the planting hole with a spacing of 70 cm x 30 cm. Additional fertilizer is given twice, namely at the age of 3 and 8 weeks of plants. At the first fertilization, a dose of urea was given 50 kg ha<sup>-1</sup>, SP-36 50 kg ha<sup>-1</sup> and KCl 25 kg ha<sup>-1</sup>. Then in the second fertilization, the dose of Urea fertilizer is 75 kg ha<sup>-1</sup>, SP-36 100 kg ha<sup>-1</sup> and KCl 25 kg ha<sup>-1</sup>.

The potato tuber are harvested when the potato plant has the characteristics of the leaves and

stems showing a yellowish and dry color and the skin of the tubers does not peel easily when rubbed with fingers.

The parameters observed were plant height, number of leaves, number of tubers per plant, weight of tubers per plant, largest tuber diameter and tuber yield per hectare.

## 3. RESULTS AND DISCUSSION

### 3.1 Plant Height

There is no effect of the guano fertilizer treatments, the type of mulch and their interaction to the height of the potato plant. Potato plant height data is shown in Table 1.

Based on Table 1, shows that mulch and guano fertilizer have almost the same effect on potato plant height. The plant height observed ranged from 29.50-36.20 cm where the plant height obtained was below the description, i.e. 70-80 cm. While Hamdani [14] stated that the use of plastic mulch in the cultivation of potato cultivar Vanda showed plant height of 68.2 cm at 8 weeks after planting.

There is no effect of guano fertilizer on the height of the potato plant, presumably because this guano fertilizer is a fertilizer that is slow to release nutrients due to its low solubility as an organic fertilizer. Hasibuan [15] states that organic fertilizers have a big difference compared to chemical fertilizers, both in terms of response to plants, nutrient supply and their impact on the environment where the response of organic fertilizers to plants is slow. Guano fertilizer contains nutrients needed by plants, but decomposes for a long time so that the nutrients can be utilized by plants.

**Table 1. Potato plant height at the application of several doses of guano fertilizer and several types of mulch at the age of 9 week after planting (WAP)**

Dosage of Guano Fertilizer	Type of mulch	
	Silver Black Plastic	Black Plastic
	----- cm -----	
0 ton/ha	29,50	31,90
3 ton/ha	31,60	32,03
6 ton/ha	33,16	33,64
9 ton/ha	36,10	36,20
CV=10%		

*Note: similar letter indicates not significantly different*

### 3.2 Number of Leaves

The results indicate that there was no interaction between the various doses of guano fertilizer and several types of mulch on the number of leaves of the potato plant. The treatment of guano fertilizers and types of mulch also did not have significant effect. Data on the number of leaves of potato plants is shown in Table 2.

Table 2 shows that the application of various types of mulch has almost the same effect on the number of leaves, so that the number of leaves is not significant. Meanwhile, according to Jella, et al [16] the application of silver black plastic mulch to local seed tubers provides leaf area, LAI and Plant Growth Rate (PGR) values higher than other treatments.

Guano fertilizer dosage also had almost the same effect on the number of leaves. This is because the organic fertilizers used are slowly available. According to Lakitan [17], plants are deficient in nutrients, so metabolic processes such as growth of roots, stems, leaves will be disrupted. On the contrary, excess nutrients can also cause poisoning to plants.

Although the nutrients contained in the guano fertilizer are relatively complete, both macro and micro, if the availability is slow, the growth in the number of leaves is almost the same. No difference in fact the number of leaves may also be caused by slow leaf growth.

### 3.3 Number of Tubers per Plant

The result indicates that there was no interaction between the application of various doses of guano fertilizer and several types of mulch on the number of tubers in the plant. For each treatment of guano fertilizer and type of mulch also showed a significantly different effect on the number of tubers. Data on the number of potato tubers is shown in Table 3.

Table 3 indicate that the best average number of potato plant tubers was found in the treatment using black plastic mulch, i.e. 5.21 tubers, while the lowest was in the treatment using black silver plastic mulch. Tuber number observed in black plastic mulch is more because mulching help to regulate the temperature and proper environment condition. Bharati et al. [13] also reported number of stems of potato increases with black plastic mulching. In this case an increase in the number of stems will support the formation of tubers.

In the treatment, the dosage of guano fertilizer produced the highest potato plant tubers in the treatment of 6 t ha<sup>-1</sup> of guano fertilizer, i.e. 5.76 tubers. According to Aulia [18] the difference in the number of tubers is thought to be due to the many stolons that come out to the surface, so that the stolon that are formed do not become tubers but become stems.

According to Afa [19] the use of organic fertilizer guano 15 t ha<sup>-1</sup> still increases the growth of shallots. The best growth and production of tomato plants was found in the combination of guano fertilizer dosage treatment of 12 t ha<sup>-1</sup> with NPK 250 kg / ha [20]. The highest yield of fresh potato tubers was found in the zigzag planting system with guano organic fertilizer of 14.30 t ha<sup>-1</sup> [21].

### 3.4 The Largest Diameter of Tuber

The results showed that there was no interaction between the application of various doses of guano fertilizer and several types of mulch on the largest tuber diameter of potato plants and each treatment of guano fertilizer and the type of mulch had a significantly different effect on the largest tuber diameter. The data on the largest average tuber diameter of potato plants is shown in Table 4.

**Table 2. Number of leaves of potato plants in the application of several doses of guano fertilizer and several types of mulch at the age of 9 WAP**

Dosage of Guano Fertilizer	Type of mulch	
	Silver Black Plastic	Black Plastic
	----- leaf -----	
0 ton/ha	35,80	35,33
3 ton/ha	40,46	40,86
6 ton/ha	38,06	37,13
9 ton/ha	37,40	40,80
CV =11,60%		

Note: similar letter indicates not significantly different

Table 4 indicate that the highest average tuber diameter is found in the treatment of guano fertilizer dosage of 9 t ha<sup>-1</sup>, i.e. 38.55 mm and the lowest is in the treatment of guano fertilizer dosage 0 tons / ha, which is 34.14 mm. This result is due to the use of guano organic fertilizer dosage. The higher the dosage of guano organic fertilizer that is applied, of course, the more influential it is in increasing the tuber diameter. These results are not much different from Warnita et.al. [21] research with a diameter of 38.63 mm. The diameter of the tuber is related to the size of the tuber, where the large diameter of the tuber is of course large in size.

In this study using guano fertilizer, the nature of the guano fertilizer is slow to decompose so that the plant will also absorb the P elements in this guano fertilizer longer. Guano fertilizer itself contains high P elements, where P elements are essential nutrients needed by plants for optimum growth and yield [22].

The tuber diameter in black plastic mulch is bigger than the silver black plastic mulch, which is 37.37 mm. Plastic mulch increases tuber

weight and diameter [23]. Plastic mulching results in lower weed population enhancing nutrient availability to the plants as well as optimizes the soil temperature for crop growth and development Bhatta et al. [24].

### 3.5 Fresh Weight of Tubers per Plant

The results indicate that there was no interaction between the application of various doses of guano fertilizer and several types of mulch on the tuber weight of potato crops. For each treatment, several types of mulch had significantly different effects on tuber weight. Data on the tuber weight for a potato crop is shown in Table 5.

Table 5 show that there is an effect of tuber weight per potato plant using mulch. The average tuber weight of a good potato crop was using black plastic mulch which was 141.66 g and the lowest was using black silver plastic mulch at 100.83 g. According to the results of research by Karo et al. [25] the use of black plastic mulch has an effect on tuber weight per potato plant, which is 1.56 kg higher than using silver plastic mulch, which is 1.49 kg.

**Table 3. Number of potato tubers in the application of several doses of guano fertilizer and several types of mulch**

Dosage of Guano Fertilizer	Type of mulch	
	Silver Black Plastic	Black Plastic
	----- tuber -----	
0 ton/ha	5.00	4.53
3 ton/ha	3.06	3.93
6 ton/ha	5.13	6.40
9 ton/ha	4.13	6.00
Average	4.33 b	5.21 a
CV=15,68%		

**Table 4. The largest tuber diameter of potato plants on several doses of guano fertilizer and several types of mulch**

Dosage of Guano Fertilizer	Type of mulch		
	Silver Black Plastic	Black Plastic	Average
	----- mm -----		
0 ton/ha	33.30	34.98	34.14 C
3 ton/ha	36.89	37.52	37.20 AB
6 ton/ha	35.06	37.26	36.16 B
9 ton/ha	37.38	39.73	38.55 A
Average	35.65 b	37.37 a	
CV=4,09%			

Note: Means with different letters, in the same row and column differ significantly ( $p \leq 0.05$ , according to Duncan's New Multiple Range test

**Table 5. The weight of potato tubers for various doses of guano fertilizer and several types of mulch**

Dosage of Guano Fertilizer	Type of mulch	
	Silver Black Plastic	Black Plastic
	----- g -----	
0 ton/ha	110,00	126,67
3 ton/ha	83,33	140,00
6 ton/ha	100,00	143,33
9 ton/ha	110,00	156,67
Average	100,83 b	141,66 a
CV =35,00%		

Note: Means with different letters, in the same row differ significantly ( $p \leq 0.05$ , according to Duncan's New Multiple Range test)

The low weight of the tubers in the silver black plastic mulch may be due to higher light reflection and lower soil temperature in the root zone, which affects the absorption of water and nutrients. In contrast, black plastic mulch absorbs light and soil temperature in the root zone is higher so that the water and nutrient absorption is better, it can increase tuber weight.

In Table 5 is shown that the application of guano organic fertilizer increases tuber weight per plant which is almost the same even though the dosage is different. According to Maulidani et al. [20] by increasing the availability of nutrients in soil given guano fertilizers and mulch as a result of mineralization of organic matter by decomposing microbes, releasing a number of nutrients that can be absorbed by plant roots. Part of the nutrients absorbed by plants is to compose organic compounds.

### 3.6 Fresh Weight of Tuber Per Hectare

The results showed that there was no interaction between giving various doses of guano fertilizer and several types of mulch to tuber weight per hectare of potato plants and each type of mulch

treatment had a significantly different effect on tuber weight per hectare. Data on the tuber weight per hectare of potato is shown in Table 6.

Table 6 indicate that the highest average tuber weight per hectare is in the treatment using black plastic mulch, i.e.  $6.85 \text{ t ha}^{-1}$  and the lowest is the treatment using silver black plastic mulch, i.e.  $4.96 \text{ t ha}^{-1}$ . This is because black plastic mulch can absorb sunlight and increase soil temperature so that nutrient absorption by roots is good. The relatively low yields on silver black plastic mulch may be due to high light reflections and excessive rainfall during tuber formation and growth. Setyowati et al [26] stated that the application of black plastic mulch was able to increase the number of leaves and plant height which ultimately increased the total weight of potato plants compared to the treatment without mulch. Haque et al [27] reported that plastic mulch has a tremendous effect on increasing plant growth and yield in salty soils where plant growth is generally very poor. Bhatta et al [24] state that it is better to use perforated black plastic mulch for optimum growth and yield of potato production.

**Table 6. Tuber weight per hectare of potato plant given several doses of guano fertilizer and several types of mulch**

Dosage of Guano Fertilizer	Type of mulch	
	Silver Black Plastic	Black Plastic
	----- ton/ha -----	
0 ton/ha	5,42	6,18
3 ton/ha	4,15	6,91
6 ton/ha	4,88	7,14
9 ton/ha	5,39	7,17
Average	4,96 b	6,85 a
CV =34,00%		

Note: Means with different letters, in the same row differ significantly ( $p \leq 0.05$ , according to Duncan's New Multiple Range test)

Dwipa et al [28] also reported that black plastic mulch was the best treatment for fresh weight of shallots per plant (11.74 t ha<sup>-1</sup>). Meanwhile, Mahadeen [29] states that black plastic mulch has the ability to absorb 90% of sunlight. This absorption power is important for controlling soil temperature so that it is good for highland cultivation crops such as shallots, asparagus and horticulture.

The yield of tubers per hectare with guano organic fertilizer was almost the same, namely 6.18 - 7.17 t ha<sup>-1</sup>. Meanwhile, the research results of Warnita et al. [21] the highest fresh weight of tubers per hectare was obtained from the provision of organic fertilizer 2 t ha<sup>-1</sup>, namely 14.30 tons / ha.

In this study, the thing that causes the results to be lower is the influence of environmental factors. According to Anwar et al [30] One of the environmental components which is a determining factor for the success of a plant cultivation business is climate / weather.

During the research, it often rains so that the photosynthetic process is disrupted and the photosynthetic results are also small. The result of photosynthesis (assimilation) is the main ingredient in plant growth and production. The amount of assimilate which is then transported and stored as food reserves is what determines the tuber weight per plant.

The number of leaves with a lot of leaf area is larger so that photosynthesis is more and will increase the resulting fresh weight higher [31]. Furthermore, Oktaviana et al [32] stated that the result of photosynthetic is used for tuber formation, because the tuber process is closely related to the growth activity of the upper plants, so that the growth rate of the tubers increases.

A small number of assimilates will result in a smaller tuber weight per plant. Conversely, if the amount is large, it will increase tuber weight per plant and will also affect tuber weight per hectare.

#### 4. CONCLUSION

There is no effect of interaction between guano and mulch on the growth and yield of potato crops. The dosage of guano fertilizer of 9 t ha<sup>-1</sup> gave the best effect on the number and diameter of tubers. The type of black plastic mulch

gave the best effect on tuber number, tuber diameter, tuber weight per plant and tuber weight per hectare.

#### ACKNOWLEDGEMENT

Thank you to the chairman of the Center for Technology Transfer and Regional Development of Andalas University, plant physiology laboratory technicians and all those who have helped carry out this research.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Central Bureau of Statistics. Agricultural survey on vegetable and fruit crops production. Central Bureau of Statistics: Jakarta; 2019.
2. Harjono. Sistem Pertanian Organik. Aneka Solo; 2000.
3. Widowati LR. Peranan pupuk organik terhadap efisiensi pemupukan dan tingkat kebutuhannya untuk tanaman sayuran pada tanah inceptisols ciharang. J. Tanah Tropika. 2009;14:221-228.
4. Siwanto T, Sugiyanta, Melati M. Peran pupuk organik dalam peningkatan efisiensi pupuk anorganik pada Padi Sawah (*Oryza sativa* L.). J. Agron. Indonesia. 2015;43(1):814.
5. Suwarno, Idris K. Potensi dan kegunaan penggunaan pupuk guano secara langsung sebagai pupuk di Indonesia. Jurnal Tanah dan Lingkungan. 2007;9(1):37-43.
6. Wahyudin A, Wicaksono FY, Irwan AW, Ruminta, Fitriani R. Respons tanaman kedelai (*Glycine max*) varietas Wilis akibat pemberian berbagai dosis pupuk N, P, K, dan pupuk guano pada tanah inceptisol jatinangor. Jurnal Kultivasi. 2017;16(2):333-339.
7. Lingga P, Marsono. Petunjuk penggunaan pupuk. Penebar Swadaya, Jakarta; 2004.
8. Samijan. Guano fertilizer. Agricultural Research and Development Center. Bogor; 2010.
9. Doring T, Heimbach U, Thieme T, Finckch M, Saucke H. Aspect of straw mulching in organic potatoes-I. Effects on microclimate, phytophthora infestans and

- rhizoctonia solani. Nachrichtenbl. Deut. Pflanzenschutzd. 2006;58(3):73-78.
10. Lasmuni SA, Wahyudi I, Rosmini. Application of mulch and cow urine bioculture on growth and yield of shallots. J. Hort. Indonesia. 2018;9(2):103–110.
  11. Ahmed NU, Mahmud NU, Hossain A, Zaman AU, Halder SC. Performance of mulching on the yield and quality of potato. International Journal of Natural and Social Sciences. 2017;4(2):07-13.
  12. Fauziah R, Susila AD, Sulistyono. 'Cultivation of shallots (*Allium ascalonicum* L.) on dry land uses sprinkler irrigation at various volumes and frequencies. Horticultural crops research and development center '. J. Hort., Indonesia. 2016;7(1):1– 8.
  13. Bharati S, Joshi B, Dhakal R, Paneru S, Dhakal S, Joshi K. Effect of different mulching on yield and yield attributes of potato in Dadelhdhura, Nepal. Malaysian Journal of Sustainable Agriculture (MJSA). 2020;4(2):54-58.
  14. Hamdani JS. Effect of type mulch on growth and results three cultivars potato (*Solanum tuberosum* L.), the grown plain medium. J. Agron. 2009;37(1):14-20.
  15. Hasibuan BE. Pupuk dan Pemupukan. Universitas Sumatera Utara, Fakultas Pertanian. Medan. USU Press; 2006.
  16. Jella ER, Suryanto A, Setyobudi L. Impact of mulch application and seed tuber generation (g2, g3, local) on potato (*Solanum tuberosum* LINN). Buana Sains. 2017;17(2):153-166.
  17. Lakitan B. Dasar – dasar fisiologi tumbuhan. PT. Raja Grafindo Persada. Jakarta; 2007.
  18. Aulia AL. The yield potential trial of seven potato clones (*Solanum tuberosum* L.). Jurnal Produksi. 2014;1(6):519.
  19. Afa M. The effect of natural guano organic fertilizer on growth and yield of spring onion (*Allium fistulosum* L.). Agrotech J. 2016;1(1):26-32.
  20. Maulidani A, Kurniawan Jumini T. Pengaruh dosis pupuk guano dan NPK terhadap pertumbuhan dan produksi tanaman tomat (*Lycopersicum esculentum* Mill.). Jurnal Ilmiah Mahasiswa Pertanian. 2018;3(4):26-33.
  21. Warnita W, Novrita AP, Sari R, Oktari S. Respon Pertumbuhan dan hasil tanaman kentang pada beberapa sistem tanam dan pupuk organik. Prosiding forum komunikasi perguruan tinggi pertanian Indonesia (FKPTPI) 2018. Universitas Syiah Kuala Banda Aceh. 2018;306–312:306-312.
  22. He ZT, Griffin S, Cuth Honney W. Evaluation of soil phosphorus transformation by sequential fraction and phosphorus hydrolysis. Soil Sci. 2004;169:515-527.
  23. Warnita, Ardi WA, Zulfa Y. Effect of mulch and indigenous rhizobacteria isolate on growth and yield of potato (*Solanum tuberosum* L.). Asian J Agric and Biol. 2019;239-245.
  24. Bhatta M, Shrestha B, Devkota AR, Joshi KR, Bhattarai S, Dhakal U. Effect of plastic mulches on growth and yield of potato (*Solanum tuberosum* L.) in Dadelhdhura, Nepal. Journal of Agriculture and Natural Resources. 2020;3(2):228-240.
  25. Karo, Bina B, Marpaung AE, Lasmono A. The effect of rabbit urine planting techniques on growth and production of granola potato (*Solanum tuberosum* L). Proceedings of the National Seminar on Agricultural Science and Technology Innovation; 2014.
  26. Setyowati N, Aziz F, Satria. Pertumbuhan dan Hasil Kentang Dataran Tinggi Rejang: Teknik Pemulsaan dan Pemupukan Bokhasi terhadap Pertumbuhan Gulma. J Agronomy. 2003;1(4):8-13.
  27. Haque MA, Jahiruddin M, Clarke D. Effect of plastic mulch on crop yield and land degradation in south coastal saline soils of Bangladesh. Int. Soil.Water. Conserv. Res. 2018;6:317–324.
  28. Dwipa I, Warnita, Safitri Y. Effect of mulches types use and chicken manure doses to growth and yield of shallot. Asian Plant Research Journal. 2020;4(3):31-38.
  29. Mahadeen AY. Effect of polyethylene black plastic mulch on growth and yield of two summer vegetable crops under rain-fed conditions under semi-arid region conditions. American Journal of Agricultural and Biological Sciences. 2014;9(2):202-207.
  30. Anwar MR, Liu DL, Farquharson R, Macadam I, Abadi A, Finlayson J, Wang B, Rajian T. Climate change impacts on phenology and yields of five broadacre crops at four climatologically distinct locations in Australia. Agricultural Systems. 2015;132:133-144.
  31. Warnita, Akhir N, Vina. Growth response of two varieties chrysanthemum (*Chrysanthemum* sp.) on some media composition. International Journal on



- Advanced Science, Engineering and Information Technology. 2017;7(3):928-935.
32. Oktaviana T.I, Syarif Z, Yanti Y, Warnita W. The growth and yield of potato (*Solanum tuberosum* L.) with application of indigenous rhizobacteria and coumarin. Int. J. Agric. Innov. Res. 2018;7(1):74- 78.

© 2021 Wahyuni et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*  
The peer review history for this paper can be accessed here:  
<http://www.sdiarticle4.com/review-history/64967>