AJAB

Asian J Agric & Biol. 2019; Special Issue: 239-245.

Original Article

Effect of mulch and indigenous rhizobacteria isolate on growth and yield of potato (*Solanum tuberosum* L.)

Warnita Warnita*, Ardi Ardi, Yopi Zulfa
Department of Agronomy, Faculty of Agriculture, Universitas Andalas, Padang, Indonesia

Received:
March 10, 2019
Accepted:
October 17, 2019
Published:
December 05, 2019

Corresponding author email:
warnita@agr.unand.ac.id

Abstract

The research was conducted at the Center for Technology and Development of Agricultural Area (PAPTKP) Universitas Andalas, which was located at Jorong Galagah, Solok District from December 2016 to March 2017. The purpose of this study was to determine the interaction between indigenous rhizobacteria and plastic mulch, and the effect on growth and yield of potato. The method used was Randomized Block Design (RBD) with 2 factors (2x5) in 3 replications. The first factor was the use of plastic mulch (with and without plastic mulch) and the second factor was the indigenous rhizobacteria isolates (A1.1a1, A3.2a2, A3.2b1, BT1.2a2, and without rhizobacteria). The variables observed were morphological and physiological characteristics of indigenous rhizobacteria, plant height, tubers number, tuber weight per plant, and tuber diameter. The data were analyzed by using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) at a significant level of 5%. The results showed that there was no interaction between plastic mulch and indigenous rhizobacteria isolates on growth and yield of potato. The plastic mulch increased tuber weight and tuber diameter but the A3.2b1 isolate of indigenous rhizobacteria tended to increase plant height and increased significantly tuber weight of potato.

Keywords: Potato, PGPR, mulch, indigenous, rhizobacteria

How to cite this:

Warnita W, Ardi A and Zulfa Y, 2019. Effect of mulch and indigenous rhizobacteria isolate on growth and yield of potato (*Solanum tuberosum* L.). Asian J. Agric. Biol. Special Issue: 239-245.

Introduction

Potato is highly nutritious, low-calorie with complete amino acid. Warnita (2007) states that potato tuber contains no fat and cholesterol, but contains carbohydrates, sodium, dietary fiber, protein, vitamin A, vitamin C (about 50%), calcium, iron, and vitamin B6 are quite higher compare to rice According to Idawati (2012), nutrient content per 100 g of potato tuber i.e. 2 g of protein, 0.1 g of fat, 19.1 g of carbohydrates, 11 mg of calcium, 50 mg of phosphorus, 0.7 mg of iron, 0.3 g of fiber, 0.09 mg of vitamins B1, 16 mg of vitamin C and 83 Cal of calories. Therefore, the potato has priority to be developed, both in terms of increasing production and expansion of the area (Utami et al., 2012).

In the fact, the productivity of potato in Indonesia is relatively low caused by the cultivation technique is not optimum, the lack of availability of quality seeds and certified, and mostly still use the tuber from the remaining of consumption. The majority of quality potato seeds are imported from abroad, while 4.9%

supplied domestically (Baharuddin et al., 2012).

One effort to overcome this problem is to intensify the potato cultivation using mulch in the form of litter, straw or plastic. The use of plastic mulch provides several benefits for potato cultivation, both of physical and chemical aspects of the soil. The plastic mulch can keep the soil temperature more stable, retain moisture around the root, and prevent the direct radiation of the sun. The use of plastic mulch can also reduce maintenance and weeding due to prevent weed growth, and erosion or destruction of the soil surface (Doring et al., 2006).

Meanwhile, rhizobacteria is a heterogeneous group of bacteria found in complex rhizosphere, which is associated with plant root (Yanti et al., 2013). According to Khalimi and Wirya (2010), rhizobacteria has an important role in plant growth, in the form of: (a) Producing or changing the concentration of indole acetic acid (IAA) phytohormone, gibberellic acid, cytokines and ethylene or precursor (1-aminocyclopropane, ACC deaminase), (b) Antagonistic to plant pathogens by producing microbial siderophore, glucans enzymes, chitins, cellulose, antibiotics, and cyanide acid, (c) Becoming phosphate mineral solvent and other nutrients, (d) Regulating ethylene production at root, and (e) Reducing heavy metal toxicity. The activity of that rhizobacteria is influenced by several factors, such as humidity, oxygen pressure, temperature, pH, clay content, solubility ion, and soil organic phase.

Rhizobacteria can be isolated from the rhizosphere of various plants, such as cabbage, apple and soybean (Ikhwan, 2010). Rahni (2012) found that rhizobacteria as producers of phytohormones can increase the growth of maize. Suriyanti (2012) states that rhizobacteria can increase the growth of shallot tuber. Meanwhile, Yanti et al. (2017) reported that rhizobacteria of *B. cereus* strain JN 233 of had the best ability to increase growth rate, increase yield and suppress *R. Syringii* subsp. through the PGPR attribute mechanism by producing IAA, dissolving phosphate, producing siderophore and cyanide acid. The purpose of this study was to determine the interaction between indigenous rhizobacteria and plastic mulch, and the effect on growth and yield of potato (*Solanum tuberosum* L.).

Material and Methods

The research was conducted in December 2016 to March 2017 at the Center for Technology Transfer and Development of Agricultural Area (PATPKP) Universitas Andalas, which was located in Galagah Village, Solok Regency, West Sumatera Indonesia (1,600 m above sea level, the average rainfall was 351 mm, and daily temperature in range of 23 to 32ºC). Preparation of indigenous rhizobacteria isolates was conducted at the Laboratory of Microbiology, Faculty of Agriculture, Andalas University.

The method used was Randomized Block Design (RBD) factorial with two factors (2x5) in three replications. The first factor was plastic mulch (with and without mulch) and the second factor was the indigenous rhizobacteria isolates (without rhizobacteria, BT1.2a2, A3.2b1, A3.2a2 and A1.1a1 isolates). Each experimental unit consisted of 20 plants, so that 600 plants were prepared for this purposes.

Cingkariang variety of potato (Black stem potato) from the center of potato production in Agam Regency West Sumatera Province was used by choosing healthy seeds and uniform (premium seedlings). The seedlings were soaked for 15 minutes in indigenous rhizobacteria isolates with a density of 108 cells / ml (Yanti et al., 2013) and planted in seedbed. The potato plants were fertilized using urea (45% N), SP36 (36% P2O5), and KCl (60% K2O) in a dose of 330 kg/ha, 400 kg/ha and 200 kg/ha perceptively. SP36 fertilizer was applied at 14 days after planting (dap), urea was applied at 21 and 45 dap, while KCl was applied 21 and 45 dap. The soil in this research was classified into andosol that relatively acidic pH (5.97), the N content was moderate (0.239%), the P content was moderate (16.605%), the K content was very low (0.088) and the organic material was moderate (12.620%).

The variables observed were morphological and physiological characteristics of indigenous rhizobacteria, plant height, tubers number, tuber weight per plant, and tuber diameter. The potato tubers were harvested at 100 dap with the characteristics of yellowing leaves and drying followed by yellowing of stem at the bottom. The data were analyzed by using analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) at a significant level of 5%.

Results and Discussion

Morphology and physiology

The shapes of indigenous rhizobacteria were rhizoid, circular and irregular colonies. All colonies were flat,

while the margins were filiform, filament, entire and lobate. The diameter of the colony ranged from 0.5 - 0.8 cm, cream in color, classified as gram positive and had negative for hypersensitivity (Table 1).

Plant height

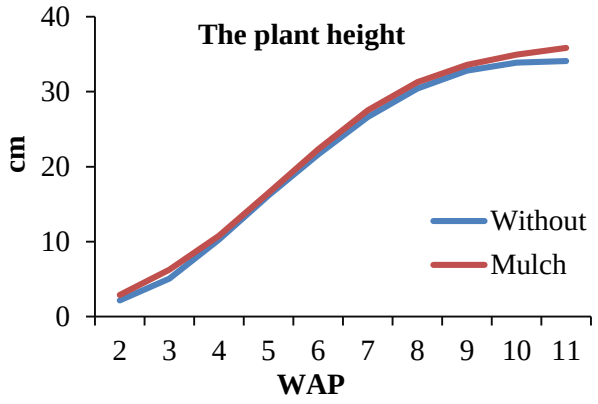
There was no interaction between plastic mulch and indigenous rhizobacteria isolate to plant height. The use of plastic mulch on potato field and also indigenous rhizobacteria had relatively no effect on the height increase of potato (Table 2). [Table 2]

Plastic mulch provides relatively equal on the growth of potato plant height. This was caused by mulch providing various benefits to plant growth including plant height. Doring et al. (2006) report the advantages are both physical and chemical aspects of the soil. Physically mulch is able to keep the soil temperature more stable and able to maintain moisture around the roots of plants. The use of mulch will affect the temperature of the soil. The use of mulch will prevent direct radiation from the sun. In the absence of direct solar radiation, the land will be kept moist, it can provide enough water to the high growth of plants. The observation period weekly from silver and black plastic mulch and indigenous rhizobacterial isolates can be seen in Figure 1.

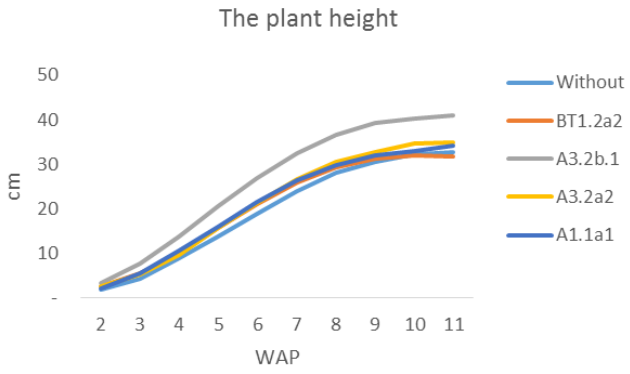
Potato plant height with the application of rhizobacteria isolates had no significant effect that the bacterial isolates given did not show significant results on plant height variables. The complexity of the role of PGPR (rhizobacteria) for plant growth and the diversity of physical, chemical and biological conditions of the rhizosphere will affect plant height. The less dynamic environmental conditions do not support the growth of better plant height. According to Shahzad et al. (2014), the influence of plant microbial associations on plant growth can be positive, neutral or negative. It is suspected that the role of rhizobakteria indirectly affects the potato plant height but as in biological control. According to Van Loon (2007), stimulation of rhizobacteria indirectly in plant growth

The plant height increased slowly at first, then rapidly until it reached the maximum rate of stem elongation at 9 weeks after planting (wap), then slows down again (Figure 1a). The plant height of potato that applied by several types of indigenous rhizobacteria isolates were relatively similar at 3 wap, and increasing plant height occurred at 4 to 11 wap. The potato that applied with A3.2b1 isolate had plant height of 40 cm, and became the highest height compared to other treatments (Figure 1b).

We assumed that the A3.2b1 isolate had the ability to colonize plant roots better, so that it can produce phytohormones needed for plant growth. Noumavo et al. (2013) stated that PGPR applied to corn, wheat, soybean and sugar beet can increase plant growth, increase nitrogen fixation, phosphate solubility and phytohormones production. While Hamdani (2009) stated that the use of plastic mulch in potato cultivation (Panda cultivar) showed the highest plant height (68.2 cm) at 8 weeks after planting.



(a)



(b)

Figure-1: (a) Height increase of potato with plastic mulch from 2 to 11 weeks after planting (wap), (b) Height increase of potato which was applied with indigenous rhizobacteria isolates from 2 to 11 wap.

Table-1: The characteristic of morphology and physiology of indigenous rhizobacteria isolates in the form of gram and hypersensitivity (HR) test

Isolate	Shape	Elevation	Margin	Diameter (cm)	Color	Gram	HR
A1.1a.1	Irregular	Flat	Lobate	0.6	Cream	+	-
A3.2a.2	Circular	Flat	Entire	0.5	Cream	+	-
A3.2b.1	Rhizoid	Flat	Filamentous	0.8	Cream	+	-
BT1.2a.2	Rhizoid	Flat	Filiform	0.6	Cream	+	-

Table-2: The effect of plastic mulch and indigenous rhizobacteria indigenous on plant height of potato

Plastic mulch	Rhizobacteria isolates (cm)					Average
	A1.1a1	A3.2a2	A3.2b1	BT1.2a2	Without	
With	29.3	37.8	38.8	38.4	35.0	35.9
Without	37.5	32.2	41.2	26.7	32.4	34.0
Average	33.4	35.0	40.0	32.55	33.7	(-)

CV = 15.92%

(-) = there is no interaction between two factors

Tuber number

There was no interaction between the use of plastic mulch and indigenous rhizobacteria isolates to tuber number. Tuber number ranged 2.4 - 6.8 tuber. This is presumably because the indigenous rhizobacteria application have not been increased efficiency of nutrients absorption that needed by plants to increase the number of tuber, such as phosphorus. Rizhobakteria as PGPR can dissolve P nutrients bound in the soil so that it is available to plants (Jacquot et al., 2015).

The number of tubers that are almost the same in all rhizobacteria treatments may be caused by communication of bacteria with plants. Expressions that appear on plants depend on the environment of the rhizosphere. The number of tubers that are almost the same is obtained due to the same environmental conditions. Egamberdiyeva (2007) reports that the expression of functional characters that emerge is a response to physical and chemical conditions in the rhizosphere.

Mulch serves as Light affects the temperature of the soil and the work of enzymes in plants. At the right temperature the enzymes in plants can stimulate growth so that the production of plant biomass and light absorption that can be absorbed by the leaves to carry out photosynthesis increases. The use of mulch can reflect a large part of the sunlight it receives. The magnitude of the reflected sunlight will increase the absorption of the Sun's light on the process of photosynthesis (Noorhadi and Supriadi, 2003). The photosynthetic produced will affect plant growth, including plant height. High soil temperature can increase the height of potato plants due to elongation of stem segments or the addition of the number of stem segments so that the growth of the upper part of the plant will be more dominant (Hamdani, 2009). Mulch especially reduces water evaporation from the soil arid helps to maintain stable soil temperature.

Tuber weight per plant

There was no interaction between plastic mulch and indigenous rhizobacteria isolates, but each factors influenced tuber weight separately. The use of plastic mulch increased tuber weight significantly (95.46 gram), and the application of indigenous rhizobacteria of A3.2b1 also increased tuber weight significantly (Table 4).

The tuber formation process is related to the activity of plant growth visible above ground level such as plant height, leaves number, branches number and stems number. Radley et al. (1968) explained that to some extent the increase in leaf area was followed by the addition of tuber weight. Development of tuber size over a period of two to three weeks after the first linear and subsequent exponential functions. When the tuber weight was fixed, the formation of plants in the soil such as leaves and branches decreased. The results on Granola potato variety (Prayoga et al., 2016) showed that the use of plastic mulch can improve plant growth in plant height, leaf number, leaf area, root dry weight, total dry matter of plant better than without using mulch.

Table-3: The effect of plastic mulch and indigenous rhizobacteria indigenous on tuber number of potato

Plastic mulch	Rhizobacteria isolates (tuber)					Average
	Without	BT1.2a2	A3.2b1	A3.2a2	A1.1a1	
mulch	3.70	4.70	6,80	5.00	4.70	4.98
Without	3.90	2.40	4.40	3.60	6.50	4.16
Average	3.80	3.50	5.60	4.30	5.60	(-)

KK = 22.26%

(-) = there is no interaction between two factors

Table-4: The effect of plastic mulch and indigenous rhizobacteria indigenous on tuber weight per plant of potato

Plastic mulch	Rhizobacteria isolates (gram)					Average
	Without	BT1.2a2	A3.2b1	A3.2a2	A1.1a1	
Mulch	82.80	80.60	144.50	75.40	94.00	95.46 a
Without	43.30	19.90	57.20	40.20	95.70	51.26 b
Average	63.05 b	50.25 c	100.85 a	57.80 b	94.85 a	(-)

KK = 26.01%

(-) = There is no interaction between plastic mulch with rhizobacteria isolates

The number followed by different small letter horizontally and vertically is different significantly at 5% significance level. For analysis purposes, the data has been transformed by using log data X, but data presented here is original.

Table-5: The effect of plastic mulch and indigenous rhizobacteria indigenous on tuber diameter of potato

Plastic mulch	Rhizobacteria isolates (mm)					Average
	Without	BT1.2a2	A3.2b1	A3.2a2	A1.1a1	
Mulch	41.30	38.60	44.90	33.80	31.70	38.06 a
Without	24,10	12.20	22.70	13.80	36.40	21.84 b
Average	32.70	25.40	33.80	23.80	34.05	(-)

KK = 24.11%

(-) = There is no interaction between plastic mulch with rhizobacteria isolates

The number followed by different small letter vertically is different significantly at 5% significance level.

The formation of tuber without plastic mulch assumed of having an abnormality, result in cleavage and arid soil, causing growth of the tuber to be blocked. According to Nonnecke (1989), when the development of tubers occurred during high temperature pressure, the tuber produced will be abnormally shaped due to new growth of tubers forming secondary growth. According to Utomo et al. (2013), the use of plastic mulch can increase the fresh yield of tuber weight of local potato by 57.38%.

Indigenous rhizobacteria was able to support vegetative growth by increasing the availability of nutrients. It can be compared to vegetative growth such as leaves and branches on tuber growth or the influence of photosynthetic activity on the recipient (sink). Lakitan (1996) stated that internal factors that affect tuber growth are the rate and quantity of photosynthetic supplied from the plant canopy. Nookaraju et al. (2011) reported that the application of PGPR on potato seeds can increase vegetative growth, the number of tubers and tuber yield. According to Acuna et al. (2011) inoculum of beneficial microbes such as PGPR can improve plant growth through the secretion of the growth of plants such as IAA. The application of exogenous IAA through rhizobacteria act as signaling molecules that can cause early tuber initiation and enlargement of potato tuber (Henagamage et al., 2016). Rhizobacteria can also increase the growth of onion bulbs (Suriyanti, 2012).

Tuber diameter

There was no interaction between plastic mulch and indigenous rhizobacteria isolates on the longest diameter of potato tuber. The use of plastic mulch increased diameter of tuber, especially on the biggest tuber (Table 5).

This is possible because mulch was able to maintain a stable temperature and able to maintain the humidity in the root zone. According to Hadiyanti et al. (2015), mulch can reduce soil temperature during the day by an average of 3 to 6ºC. The low of soil temperature can reduce root respiration rate so that assimilation that contribute to the accumulation of reserves of food becomes more than without mulch. At night, the higher temperatures produced more leaves, branches, flowers and stolon to form stems so that plant produced less number of tuber, and the lower can cause the opposite. Furthermore, application several indigenous rhizobacteria have not been given different results. Haque et al. (2018) report that Plastic mulch had a tremendous effect to increase plant growth and yield in saline soils where generally plant growth is very poor. Plastic mulch potentially reduces the soil salinity by reducing the evaporation loss of moisture from the soil. It increases soil temperature and reduces soil electrical conductivity. Plastic mulch is very effective to reduce excess availability of sulfur in soil. The application of indigenous rhizobacteria isolates produced the same tuber diameter. It is assumed that each bacterium has a different role in increasing tuber growth such as tuber diameter According to Gil et al. (2000), an increase in plant growth depends on bacterial species involved in colonizing plant roots.
The application of Rhizobacteria (PGPR) is to increase the number of active bacteria around the roots of plants so as to benefit the plants Root exudates are a habitat for various types of microbes such as rhizobacteria. Niro et al. (2016) reported that root exudates affect the effectiveness of microorganisms in the soil so that they have different responses to plant growth and yield.

Conclusion

There was no interaction between plastic mulch and indigenous rhizobacteria isolates on growth and yield of potato. The plastic mulch increased tuber weight and tuber diameter. The A3.2b1 isolate of indigenous rhizobacteria tended to increase plant height and increased significantly tuber weight of potato.

Acknowledgement

The research was funded by Grant Professor of the Universitas Andalas, Padang, Indonesia, with contract no. 524/XIV/A/UNAND on May 9, 2016. The authors sincerely thank to Rector of Universitas Andalas.

Contribution of Authors

Warnita W: Conceived idea, conducted experiment and write up of article
Ardi A: Helped in experiment and article write up
Zulfa Y: Helped in experiment, compilation of results and statistical analysis

Disclaimer: None.
Conflict of Interest: None.
Source of Funding: Funded through research grant for Professor of Universitas Andalas, Padang, Indonesia

References

Acuna JJ, Jorquera MA, Martínez OA, Blackburn DM, Fernández MT, Marschner P, Greiner R and Mora ML, 2011. Indole acetic acid and phytase activity produced by rhizosphere bacilli as affected by pH and metals. J. Soil. Sci. Plant Nutr. 11(3): 1-12.

Baharuddin, Kuswinanti T and Lamba SE, 2012. Seed potato seed availability acceleration through introduction sustainable biotechnology packages in North Toraja Regency, pp 336-344. In. Proceeding of Insinas, 29-30 November 2012, Institut Pertanian Bogor, Bogor, Indonesia.

Doring T, Heimbach U, Thieme T, Finckch M and Saucke H, 2006. Aspects of straw mulching in organic potatoes-I, effects on microclimate, *Phytophtora infestans* and *Rhizoctonia solani*. Nachrichtenbl. Deut. Pflanzenschutzd. 58(3): 73-78.

Egamberdiyeva D, 2007. The effect of PGPR on growth and nutrient uptake of maize in two different soils. Appl. Soil. Ecol. 36(1). P: 184-189.

Hadiyanti D, Suparwoto and John A, 2015. Penggunaan mulsa plastik pada usaha tani kentang [The use of plastic mulch on potato farming] , pp. 98-104. In proceeding of the National Seminar Swasembada Pangan Polinela, 29 April 2015, Lampung State Polytechnic, Lampung, Indonesia.

Hamdani JS, 2009. Effect of type mulch on growth and results three cultivars potato (*Solanum tuberosum* L.), the grown plain medium. J. Agron. 37(1): 14-20.

Haque M A, Jahiruddin M and Clarke D, 2018. Effect of plastic mulch on crop yield and land degradation in south coastal saline soils of Bangladesh. Int.

Soil.Water. Conserv. Res. 6: 317–324.

Henagamage AP, Seneviratne G, Abayasekera C and Kodikara KMS, 2016. Screening for crop response to Diazotrophic bacteria isolated from potato rhizosphere. Ceylon. J. Sci. 45(3) 2016: 55-63.

Idawati N, 2012. Complete guidelines planting Potatoes. New Library Press, Yogyakarta, Indonesia.

Jacquot A, Eskenazi T, Wuillemin ES, Montalan B, Proust J, Grezes J and Conty L, 2015. Source unreliability decreases but does not cancel the impact of social information on metacognitive evaluations. Front. Psychol. 6:1-11.

Ikhwan, 2010. Test potensi rhizobakteri perombak pestisida DDT sebagai biofertilizer (Biofertilizer). Publication-P2U-biofertilizer, Indonesia.

Khalimi K and Wirya G, 2010. Utilization of plant growth promoting rhizobacteria for biostimulants and bioprotectans. Ecotrophic. 4(2): 131-135.

Lakitan B, 1996. Growth and development of plant physiology (1st ed). King Grafindo Persada, Jakarta, Indonesia.

Niro E, Marzaioli R, Crescenzo S, Abrosca B, Castaldi S, Esposito A, Fiorentino A and Rutigliano F, 2016. Effects of the allelochemical coumarin on plants and soil microbial community. Soil. Biol. Biochemist. 95: 30-39.

Nonnecke LI, 1989. Vegetable production. Van Norstrand, Reinhold, Canada.

Noumavo PA, Kochoni E, Didagbé YO, Adjanohoun A, Allagbé M, Sikirou R, Gachomo EW, Kotchoni SO and Baba ML, 2013. Effect of different plant growth promoting rhizobacteria on maize seed germination and seedling development. Am. J. Plant Sci. 4: 1013- 1021.

Nookaraju A, Kappachery S, Yu JW and Park SW, 2011. Rhizobacteria influence potato tuberization through enhancing lipoxygenase activity. Am. J. Pot Res. 88:441–449.

Noorhadi and Supriadi, 2003. The influence of water and mulch against the granting of micro-climate on the plant of chili (*Capsicum annum* L.) in entisol soil. Sains. Tanah. 3(2):68-72.

Prayoga K, Marta, Maghfoer MD and Suryanto A, 2016. Study of use of plastic mulch and seed tuber three different generations in commodities of potato (*Solanum tuberosum* L.) granola variety. J. Plant. Prod. 4(2): 137-144.

Rahni NM, 2012. The efect of phytohormone PGPR on growth maize plant (*Zea mays*): J. Agribis. Bang. Wil. 3(2): 27-35.

Radley RW, Taha MA and Bremner PM, 1968. Tuber bulking in the potato crop. Nature. 191: 782-783.

Shahzad SM, Khalid A, Arif MS, Riaz M, Ashraf M, Iqbal Z and Yasmeen T, 2014. Co-inoculation integrated with P-enriched compost improved nodulation and growth of Chickpea (*Cicer arietinum* L.) under irrigated and rainfed farming systems. Biol. Fert. Soil. 50:1–12.

Suriyanti L, 2012. Peranan rhizobakteri terhadap pertumbuhan, hasil dan frekuensi pemakaian pestisida pada umbi bawang merah (*Allium ascalonicum* L.). Universitas Taman Siswa, Padang, Indonesia.

Susan L, 2008. Introduction to biological control of plant piseases. King Grafindo Persada, Jakarta, Indonesia.

Utomo RRA, Suryanto and Sudiarso, 2013. Penggunaan mulsa dan umbi bibit (G4) pada tanaman kentang (*Solanum tuberosum* L.) varietas granola [The use of mulch and seed tuber (G4) in potato plant (*Solanum tuberosum* L.) Granola varieties]. J. Plant. Prod. 1 (1): 9 – 16.

Warnita, 2007. Growth and yield of eight potato genotypes in West Sumatera. Akta Agros. J. 10(1): 94-99.

Utami U, Hariani L and Setyaningrum R, 2012. Testing the potential of endophytic bacteria on the growth of the population of yellow cyst nematode (*Globodera rostochiensis*) on potato (*Solanum tuberosum* L.). Sci. Made. 1(2): 104-14.

Van Loon LC, 2007. Plant responses to plant growth-promoting rhizobacteria. Eur. J. Plant. Pathol. 119:243–254.

Yanti Y, Habazar T, Resti Z and Suhailita D, 2013. Screening of isolates rhizobacteria of rooting of soybean plants: Healthy for pustules bacterial disease control (*Xanthomonas axonopodis* pv. glycines). J. Hama. Peny. Tumb. Trop. 13 (1): 24-34.

Yanti Y, Warnita, Reflin and Nasution CR, 2017. Effectivity of *Bacillus cereus* to control *Ralstonia syzygii* subsp. Indonesiensis and growth promoting of chili pepper. J. Biopest. 10(2):113-119.