

## Phosphate Solubilizing-based Peat Soil Carrier Applied to Potato

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Date Received: 18<sup>th</sup> December 2019 / Date Accepted: 27<sup>th</sup> January 2020

### ABSTRACT

**Purpose :** The indigenous phosphate solubilizing stored in peat soil as a carrier is still a prospect as an ingredient of biological fertilizer, so it still needs to review how the indigenous phosphate solubilizing area of Tanjungsari, Sumedang worthy to be used as an ingredient Biological fertilizer.

**Research Method :** The experiment was conducted at the Faculty of Agriculture Univeritas Winaya Mukti with the land type Andisol and the altitude of 850 m asL, carried out in March to June 2019. Environmental design using random draft group combination repeated 3 times with treatment consists of 13 treatments that are a type of phosphate solubilizing combined with a dose of peat soil carrier. The data was analyzed further with Duncan's test at 5%.

**Findings :** Results showed that the Tanjungsari's indigenous phosphate solubilizing with peat soil effect on the Phosphate is available on the soil, Phosphate total domain, potato shoot root ratio, number of the cropping bulbs, the weight of the tuber per plant and the weight per tuber, but has no effect on pH Soil, bacterial population, cation exchange capacity soils and absorption Phosphate in plants.

**Limitations :** This research is done at medium place height where not the optimum altitude for potato.

**Value :** Phosphate solubilizing bacteria indigenous from Tanjungsari Sumedang with carrier materials peat soil has the potential to be used organic fertilizer.

**Keywords:** Peat soil carier, phosphate solubilizing, potato

### INTRODUCTION

The provision of inorganic fertilizer in Indonesia is still highly dependent on subsidies issued by governments. The use of unbalanced inorganic fertilizer creates damage to farmland. The use of organic materials enriched with microorganisms is very important, it is one way to reduce the use of excess inorganic fertilizer (Mareckova, Ondrej, Omelka, Kristufek, & Divis, 2015; Oteino *et al.*, 2015; Sudadi, Widijanto, & Hahsari Efendi Putri, 2008; Uddin *et al.*, 2014). The use of organic materials has the potential to increase potato production toward sustainable agriculture (Ekin, 2019).

Organic fertilizer enriched by microorganisms depends on the carrier material. The composition of carrier media such as manure, sand soil is able to increase the availability of phosphate nutrients in soil (Firdausi *et*

*al.*, 2016). Phosphate solubilizing bacteria incorporated into the carrier material of peat soil can withstand up to 7 weeks on storage period (Raharjo & Suprihadi, 2010). The sterilization process of the carrier after inoculation of the phosphate solubilizing will lead to a decrease in the phosphate population in carrying materials (Putri, Anas, & Hazra, 2010). The suitability combination of the inoculated phosphate solubilizing bacteria affects the increase in potato production (Santiago *et al.*, 2017). The use of chemical fertilizers can reduce soil aggregate levels, and microbial populations while the use of biofertilizer and chemical fertilizers is better

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in terms of microbial respiration and potato yield (Zabee & AL-Maliki, 2019).

It should be sterilized by autoclaving method of the carrier before the process of inoculation of the phosphate solubilizing bacteria so as not to reduce the number of bacterial populations in carrier material. So that the combination of phosphate solubilizing bacteria type with a dose of peat soil carrying material is able to give influence when inoculated in potatoes.

## MATERIALS AND METHODS

The trial was carried out in the experimental Garden Faculty of Agriculture University of Winaya Mukti, in March to June 2019 with the order of land of Andisol and the altitude of place 850 m above. Phosphate solubilizing used results from the isolation of Tanjungsari area, Sumedang (*Pseudacidovorax intermedius*, *Agrobacterium fabrum*, *Agrobacterium tumefaciens*, and *Serratia Nematodiphila*). The seeds of potatoes used are varieties of Medians second generation.

### *Production of bacterial*

Inoculation that has been in the multitude and in inalignment for 24 hours on the media to oblique Pikovskaya, iniated in liquid Pikovskaya media. 10 ml of physiological NaCl 0.85% inserted to the incline containing bacteria, culprit until the bacteria did not stick on it to tilt. Input into medium 300 ml liquid pikovskaya Media, shake using shaker with speed 112 rpm at room temperature for 72 hours (for 3 days). The amount of phosphate solubilizing in liquid Pikovkaya solution reaches 109, hereinafter applied to the carrier material.

### *Inoculation process*

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### *Inoculation process*

The carrying materials of peat soil are sterilised first before it is inoculated so that the amount of the foosfat solubilizing that will be incubated is not decreased (Putri *et al.*, 2010). As much as 2 kg of peat soil with the smoothness of the material passes 100 mesh sieve, input plastic and in Strerilisais use autokalf with a temperature of 1210 for 60 minutes. Mixing phosphate solubilizing into the carrier material in Laminer water flow, 210 ml of pikovskaya liquid media in mix into the carrier material added aquades 300 ml, and fertilizer SP36 200 g. Then incubated for three days. and calculated population count The bacteria with the Total Plate Count method, after which can be applied to plants.

### *Inoculation of potatoes*

The design of the environment used is the random design of the combination group repeated 3 times. The treatment consists of a type of phosphate solubilizing combined with the following dose of Carier: A (Control); B (phosphate solubilizing *Pseudacidovorax intermedius* dose 50 Kg ha-1); C (phosphate solubilizing *Agrobacterium fabrum* phosphate dose 50 Kg ha-1); D (phosphate solubilizing *Agrobacterium tumefaciens* dose 50 Kg ha-1); E (phosphate solubilizing *Serratia nematodiphila* doses 50 Kg ha-1); F (phosphate solubilizing *Pseudacidovorax intermedius* dose 100 Kg ha-1); G (phosphate solubilizing *Agrobacterium fabrum* dose 100 Kg ha-1); H (phosphate solubilizing *Agrobacterium tumefaciens* dose 100 Kg ha-1); I (phosphate solubilizing *nematodiphila Serratia* dose 100 Kg ha-1); J (phosphate solubilizing *Pseudacidovorax intermedius* dose 150 Kg ha-1); K (phosphate solubilizing *Agrobacterium fabrum* dose 150 Kg ha-1); L (phosphate solubilizing *Agrobacterium tumefaciens* dose 150 Kg ha-1), M (solubilizing phosphate *Serratia nematodiphila* dose 150 Kg ha-1). The analyzed response is the potato shoot root ratio, the number of bulbs per plant,

the weight of the tuber per plant, the weight per tuber, P total soil (Olsen method), P available on the soil (the method of Bray I), KTK (leaching method Ammonium acetate 1 N pH 7), pH H<sub>2</sub>O (Electometry method), Number of bacteria (Total plate count method) and P uptake in plants (wet oxidation method HNO<sub>3</sub> and HClO<sub>4</sub>). Chemical fertilization is given half the recommended NPK fertilizer (200 kg ha<sup>-1</sup> N, 150 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 150 kg ha<sup>-1</sup> K<sub>2</sub>O). Potatoes are harvested at the age of 90 days after planting.

## RESULTS AND DISCUSSION

The results of the analysis of peat soil as a microbial enriched carrier material has fulfilled the quality standards of the decree of the Minister of Agriculture of Indonesia number 261/KPTS/SR/. 310/M/4/2019, which consists of 1.22% N, 22.3% C, 18.27 C/N ratio, soil cation exchange capacity 1.11, P<sub>2</sub>O<sub>5</sub> 1.86%, K<sub>2</sub>O 0.18%, pH 7.28 and water content 22.15%. The results of the population number before and after applied to the carrier material can be seen in table 01.

**Table 01: Population number of phosphate solubilizing bacteria on peat soil carrying materials on application time to potatoes and number of phosphate solubilizing bacteria in peat soil carrier material after 3 months of storage**

Types of phosphate solubilizing bacteria	Number of phosphate solubilizing bacteria on peat soil carrying materials	Number of phosphate solubilizing bacteria on carrier materials after stored for 3 months
<i>Pseudacidovorax intermedius</i>	2.5 x 10 <sup>9</sup> CFU/g	2.56 x 10 <sup>7</sup> CFU/g
<i>Agrobacterium fabrum</i>	3.7 x 10 <sup>9</sup> CFU/g	2.95 x 10 <sup>7</sup> CFU/g
<i>Agrobacterium tumefaciens</i>	7,9 x 10 <sup>9</sup> CFU/g	2.51 x 10 <sup>7</sup> CFU/g
<i>Serratia nematodiphila</i>	3,2 x 10 <sup>9</sup> CFU/g	1.81 x 10 <sup>7</sup> CFU/g

**Table 02: Combination of phosphate solubilizing type with carrier dose of P total soil, P available, NPA, number of bulbs per plant, tuber weight per plant and weight per plant**

Treatment	Total soil phosphate	Phosphate available	Root extinct ratio	Number of bulbs per plant	Tuber weight per plant	Weight per tuber
A	4993.3 a	13.62 ab	3.878 b	5.67 a	162.22 a	35.52 a
B	3992.6 a	18.67 ab	2.610 ab	5.89 a	242.78 ab	48.66 a
C	5996.4 a	18.44 ab	2.455 ab	6.11 a	365.33 b	49.57 a
D	2808.8 a	15.72 ab	1.919 a	4.67 a	342.00 ab	67.68 a
E	5446.5 a	15.46 ab	2.479 ab	4.33 a	255.56 ab	72.57 a
F	2816.3 a	15.90 ab	2.350 ab	6.22 a	523.89 c	89.31 b
G	5939.4 a	19.52 ab	2.446 ab	7.00 b	363.33 b	44.31 a
H	5812.9 a	13.18 ab	2.821 ab	5.89 a	408.33 b	48.64 a
I	3861.9 a	18.02 ab	2.454 ab	6.11 a	356.00 b	52.38 a
J	3423.0 a	17.13 ab	2.492 ab	5.22 a	327.78 ab	49.11 a
K	4233.3 a	25.04 b	2.553 ab	7.33 b	403.11 b	48.14 a
L	14407.9 b	19.45 ab	2.319 ab	5.89 a	356.11 b	51.71 a
M	2939.5 a	11.29 a	2.798 ab	5.22 a	293.56 ab	61.32 a

**Table 03: Combination of phosphate solubilizing type with carrier dose of pH, number of bacteria, cation exchange capacity and absorption P plant.**

Treatment	Soil pH	Number of bacteria (CFU/g)	Cation Exchange capacity	Absorption Pphosphate Plant
A	5.07	1.57	29.27	8.56
B	5.15	1.42	29.53	14.38
C	5.05	0.95	28.80	20.25
D	4.96	1.31	31.27	9.34
E	5.03	1.07	27.20	9.46
F	5.01	1.54	28.40	10.32
G	4.97	1.49	29.00	16.61
H	5.27	1.86	30.67	6.71
I	4.85	1.47	28.67	5.54
J	4.97	1.49	27.93	7.57
K	5.23	1.14	29.13	13.19
L	4.94	1.56	29.07	11.51
M	5.20	1.43	30.73	16.60

Soil nutrient content before the study of pH H<sub>2</sub>O 6.82, C-Organic 4.01% (high), N-Total 0.33% (moderate), C/N 12 (moderate), P<sub>2</sub>O<sub>5</sub> 37.13 mg/100g (medium), K<sub>2</sub>O<sub>5</sub> 39.69 mg/100g (moderate), cation exchange capacity 24.9 (moderate). The type of phosphate solubilizing bacteria in the peat soil carrying material with a dose of inoculated carrier material on the potatoes affects the total P soil, p is available on the ground, root extinct ratio, number of cropping bulbs, the weight of the land bulbs and weights Per tuber (table 02). The type of phosphate solubilizing *Agrobacterium tumefaciens* dose 150 Kg ha<sup>-1</sup> is able to increase P total soil highs. Phosphate solubilizing bacteria have the ability to produce extracellular enzymes such as phosphatase. This enzyme is able to mineralize organic phosphate into inorganic phosphate which provides high P for the plant (Li, Wu, Ye, & Yang, 2018). *Agrobacterium fabrum* dose 150 Kg ha<sup>-1</sup> is able to increase P available on soil and the number of highest bulbs. According to Panhwar *et al.*, (2013) posfat solubilizing bacteria are able to increase P available in soil without affecting soil pH. Meyer *et al.*, (2018) adds that the *Agrobacterium fabrum* bacteria are able to symbiosis in plant rhizosphere. Phosphate solubilizing *Pseudacidovorax intermedius* dose 100 Kg ha<sup>-1</sup> (F) is able to increase the weight of the tuber per plant and the highest of the weight. Souza *et al.*, (2013) also reported that the administration of *Pseudacidovorax intermedius* combined with chemical fertilizer half of the

recommended fertilizer for rice plants is able to increase the growth of the same as recommended dose fertilizer. Wedage *et al.*, (2019) ditemukan terutama di zona basah Sri Lanka. Fiksasi nitrogen dilakukan oleh penduduk nodular dari tanaman penutup ini, sebanding dengan bakteri nodule-tinggal dari kebanyakan tanaman kacang-kacangan lainnya. Kami mengisolasi bakteri (Sub1 added that *Pseudacidovorax intermedius* impases indole acetic acid and produces the production of nitrogenase enzymes. The phosphate solubilizing *Agrobacterium tumefaciens* dose 50 Kg ha<sup>-1</sup> (D) is given indicating the most small root extinct ratio of this which indicates that the plant growth is more balanced when compared to the control where the root of a extinct is larger so that more growth into the pupus. All treatments show the growth of the root part is better than the control, White *et al.*, (2018) explains the root power of potatoes affecting the plant acquired phosphate. Phosphate solubilizing bacteria are able to dissolve the insoluble phosphate thereby encouraging plant growth (Yang *et al.*, 2018). Phosphoric administration has an impact on the increase of potato yield, in accordance with the results of the experiment where the treatment is able to improve the number of bulbs per plant, the weight of cropping bulbs and bulbs per Plant (Debaba, Hartono, Sudadi, & Indriyati, 2019; Soratto, Fernandes, Pilon, & Souza, 2019).



Types of phosphate solubilizing bacteria in peat soil carrying material with a dose of inoculated carrier material in potatoes has no effect on soil pH, number of bacteria, cation exchange capacity and absorption P plant (table 03). The provision of biological fertilizer with the addition of half the recommended dose of chemical fertilizer does not increase soil pH, this is in line with the results of research Eissa (2019) where chemical fertilizer can reduce soil pH. The soil pH was preliminary before the 6.82 experiment, and after the soil pH experiment the initial pH value for all treatment is shown below. The number of bacteria in the soil does not show any different results with the control, which according to Guimere *et al.*, (2019), the availability of P soil that will affect the level of bacteria interaction. All of the treatment showed that it is able to provide the availability of phosphate in soil but not different from the control so, it shows the number of bacteria that does not differ also by control. The value of the cation exchange rate at the beginning of the test indicates moderate (24.9), so the provision of the entire treatment does not show different results with control. Phosphate uptake of plants throughout the treatment shows results that are not different from the control, where according to Potarzycki & Grzebisz (2019) phosphate is not a factor that limits the growth of potatoes where phosphate content in the bulbs is smaller.

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## CONCLUSION

The results showed that the solubilizing indigenous phosphate of Tanjungsari with peat soil carrier as the potential organic fertilizer. The treatment of organic fertilizer is able to increase the phosphate available on 188.5% soil, total soil phosphate 83.11%, potato shoot root ratio, number of cropping bulbs 29.4%, bulb weight per plant 222, 9% and the weight per tuber 151.4%, but has no effect on soil pH, Bacterial populations, soil cation exchange capacity and absorption of phosphate in plants.

## Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on a reasonable request.

## ACKNOWLEDGMENTS

The author would like to thank BUDI-LPDP as a contributor to the research Fund, mentor lecturer at the Faculty of Agriculture, Universitas Padjadjaran, Faculty of Agriculture at Winaya Mukti University.

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