

Response of Potato (*Solanum tuberosum*) in Medium Plains to Antagonistic Microbes and Potassium Fertilizers

Anis Rosyidah^{1,*}, Rose Novita Sari Handoko¹

¹Department of Agrotechnology Faculty of Agriculture, University of Islam Malang, Malang, Indonesia

*Corresponding author. Email: ard@unisma.ac.id

ABSTRACT

The use of antagonistic microbes and potassium fertilizer on potato cultivation at the medium land was carried out to improve plant endurance, yield and quality. Application of potassium doses and suitable antagonistic microbial types will strengthen plant cell walls and plant nutrients to be fulfilled. This research aims to study the growth response, yield and quality of potato bulb in land medium with the application of antagonistic microbes and potassium fertilizer. The height of the land is around 670 meters above sea level, the texture of the clay and the experimental design used is the Split Plot Design. Three kinds of antagonistic microbes are A1 (*Pseudomonas fluorescens*), A2 (*Streptomyces* sp. + *P. fluorescens*), A3 (*Trichoderma viride* + *Streptomyces* sp. + *P. fluorescens*), and three types of Potassium doses are: D1= 125 kg Ha⁻¹KCl, D2 = 250 kg Ha⁻¹KCl, D3 = 375 kg Ha⁻¹KCl. Each treatment has three replications, the number of plants per experiment plot is 22 plants, and the sample plants used in each trial plot are 6 plants. The results showed that the administration of *P. fluorescens* + *Streptomyces* sp. + *T. viride* and 250 kg Ha⁻¹KCl and 375kg Ha⁻¹KCl doses tend to produce growth, tuber fresh weight per hectare, tuber dry weight percentage, tuber specific gravity and higher sugar content than other treatments.

Keywords: *Solanum tuberosum* L., *Pseudomonas fluorescens*, *Streptomyces* sp., *Trichoderma viride*, potassium, medium plain

I. INTRODUCTION

In the development of Potato (*Solanum tuberosum* L.) the availability of nutrients in the soil needs attention. The availability of nutrients can be done through fertilization. Potato plants that produce bulb require a large amount of potassium compared to other macro elements. Potassium fertilizer 270 kg/ha can obtain the highest tuber and starch production with the desired physicochemical properties of starch [1].

Potassium was needed for potato plants for carbohydrate metabolism, enzyme activity, osmotic regulation, efficient use of water, nitrogen uptake, protein synthesis and assimilate translocation. Potassium can play a role in strengthening cell walls, involved in the process of sclerenchym tissue lignification [2]. Potassium administration causes the formation of thicker lignin compounds, so that the cell wall becomes stronger so that it can protect plants from outside influences. Potassium phosphite provides a defense response in potato through direct toxic effects on oomycetes, which can fight *Phytophthora infestans* [3]. Besides potassium deficient plants, its resistance component will be disrupted so that it will facilitate pathogens for penetration [4].

Potassium is an element that dissolves easily so that it is easily leached, consequently its availability in the soil is low. Potassium deficiency can result in stunted growth, because the leaves formed are inhibited so that the process of photosynthesis is disrupted. According [5] that the role of Potassium is very important in the formation of crop yields and product quality and plant resistance. In addition, plants lacking potassium will disrupt the process of photosynthate in wheat, potato, and grapes. Potassium (K) deficiency impacts on photosynthesis through synthetic constraints of diffusion and assimilation of CO₂ [6]. The purpose of this study was to study the response of growth, yield and quality of potato bulb in the plain medium due to the administration of antagonistic microbes and potassium fertilizer.

II. METHODS

The methods is divided into three types: plant material and experimental design, antagonistic microbes, analysis.

A. Plant Material and Experimental Design

This research was carried out in an endemic area of bacterial wilting at an altitude of 670 m above sea level, the texture of clay soil. The potato variety used is DTO-28, which is classified as a resistant variety planted on medium

plains [7,8]. The antagonists of *Trichoderma viride*, *Streptomyces* sp., and *Pseudomonas fluorescens* originated from the collections of the Faculty of Mathematics and Natural Sciences, University of Brawijaya (UB), Malang, which have been selected and tested to have antagonistic abilities with pathogenic *Ralstonia solanacearum* in vitro in the UB Laboratory of Pests and Diseases UB. The study was conducted experimentally using Split Plot Design. From the two treatments obtained 9 kinds of treatment combinations. Each treatment was repeated three times. The number of plants per experiment plot is 22 plants, and the sample plants used in each trial plot are 6 plants.

The percentage of tuber dry weight at harvest is calculated by the formula:

$$\text{tuber dry weight} = 100\% - \text{tuber water content} \quad (1)$$

$$\text{tuber water content} = (\text{fresh weight} - \text{dry weight}) / \text{fresh weight} \times 100\% \quad (2)$$

The kinds of combination of treatments carried out in this study are presented in Table 1.

Table 1. Treatments in research

| Code | Doses |
|------|--|
| A1D1 | <i>P.fluorescens</i> dan dosis 125 kg Ha ⁻¹ KCl |
| A1D2 | <i>P.fluorescens</i> dan dosis 250 kg Ha ⁻¹ KCl |
| A1D3 | <i>P.fluorescens</i> dan dosis 375 kg Ha ⁻¹ KCl |
| A2D1 | <i>P.fluorescens</i> + <i>Streptomyces</i> sp. and doses 125 kg Ha ⁻¹ KCl |
| A2D2 | <i>P.fluorescens</i> + <i>Streptomyces</i> sp. and doses 250 kg Ha ⁻¹ KCl |
| A2D3 | <i>P.fluorescens</i> + <i>Streptomyces</i> sp. and doses 375 kg Ha ⁻¹ KCl |
| A3D1 | <i>T.viride</i> + <i>P.fluorescens</i> + <i>Streptomyces</i> sp. and doses 125 kg Ha ⁻¹ KCl |
| A3D2 | <i>T.viride</i> + <i>P.fluorescens</i> + <i>Streptomyces</i> sp. and doses 250 kg Ha ⁻¹ KCl |
| A3D3 | <i>T.viride</i> + <i>P.fluorescens</i> + <i>Streptomyces</i> sp. and doses 375 kg Ha ⁻¹ KCl |

B. Antagonistic Microbes

T. viride isolates were grown on PDA (Potato Dextrose Agar) media, *Streptomyces* sp., and *P. fluorescens* isolates were grown on Kings B media at 30 °C for 48 hours. After pure culture was obtained, each was propagated on PDB (potato dextrose broth) media for *T. viride* and *Streptomyces* sp., While *P. fluorescens* was propagated with NB (nutrient broth) media and placed in a shaker for 24 hours. The culture that was available was subsequently suspended until it reached a concentration of 10⁸ cfu.mL⁻¹ for *Streptomyces* sp. and *P. fluorescens*[9] and 10⁷ spores.mL⁻¹ for *T. viride*.

Application of antagonistic microbes is done by splashing it on the planting medium as much as 25 ml and given 2 weeks before planting together with the administration of organic material for chicken manure [10]. The second Antagonistic Microbes application was carried out after planting. There are 22 plant populations per plot with a spacing of 30 x 70 cm. Organic doses of chicken manure used are 15 t Ha⁻¹, inorganic fertilizers given are: urea 300 kg.ha⁻¹, TSP 200 kg.ha⁻¹ and KCl according to treatment.

TSP fertilizer was applied at the same time as planting, while Urea and KCl half the dose were applied when the plants were 10 days after planting and half the doses were applied when the plants were 40 days old. Plants are maintained intensively and watered by grazing.

C. Analysis

To see the effect of the treatment on the observations made, the observational data were analyzed statistically based on the analysis of variance (ANOVA) and to see the significance continued with the LSD (Least Significance Different) test at a 95% confidence level.

III. RESULTS AND DISCUSSION

A. Plant Height

The response of plants due to the administration of antagonistic microbes and the application of potassium to plant height did not occur, but separately the types of antagonistic microbes significantly affected at 25, 35, 45, 55 DAP (days after planting). Potassium fertilizer application has a significant effect on all plant ages.

Table 2 shows that the administration of *T.viride* + *Streptomyces* sp. + *P.fluorescens* during plant growth has a tendency to produce higher plant height compared with the administration of *P.fluorescens* + *Streptomyces* sp., Although the same response occurs at the age of 45 days after planting. At the age of the plant 55 days after planting, the administration of *P. fluorescens* antagonist independently and in combination with *Streptomyces* sp. caused a decrease in plant height of 10.43% and 7.41%.

Plant height in the treatment of antagonistic microbes administration and application of potassium at various plant ages is presented in Table 2.

Table 2. Plant height after antagonistic microbes and potassium applications

| Treatm ent | Plant Height (cm) at Various Plant Age (DAP) | | | | | | | |
|---------------------------------------|--|----|-------|---|---------------|---|-------|----|
| | 25 | | 35 | | 45 | | 55 | |
| Antagonistic microbes | | | | | | | | |
| A1 | 15.11 | b | 27.47 | a | 44.17 | | 65.89 | a |
| A2 | 12.05 | a | 27.45 | a | 42.89 | | 68.11 | ab |
| A3 | 16.08 | b | 31.32 | b | 44.23 | | 73.56 | b |
| LSD 5% | 1.99 | | 3.83 | | Not really | | 6.15 | |
| Potassium Fertilizer dose per Hectare | | | | | | | | |
| D1 | 13.34 | a | 26.92 | a | 42.54 | a | 67.67 | a |
| D2 | 15.76 | b | 29.92 | b | 45.43 | b | 74.01 | b |
| D3 | 14.14 | ab | 29.98 | b | 45.41 | b | 73.84 | b |
| LSD 5% | 1.82 | | 2.94 | | 2.27 | | 4.93 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

Potato plant height during growth is influenced by the dose of potassium fertilizer. Potassium fertilizer 125 kg Ha⁻¹ KCl gives the lowest plant height and is significantly different than the 250 kg Ha⁻¹ KCl and 375 kg Ha⁻¹ KCl. At the age of the plant 55 days after planting, giving 250 kg

Ha⁻¹KCl of Potassium fertilizer and 375 kg Ha⁻¹KCl markedly increased plant height by 9.37% and 9.12%.

This happens because the combination of antagonistic microbes in the treatment is able to produce phytohormones such as cytokinins, abscisic acid (ABA) and auxin play an important role in plant development and regulatory processes in plants [11] and its ability to dissolve Phosphate, Nitrogen fixation [12] and stimulate lateral root growth [13]. The higher dose of Potassium used up to a dose of 250 kg Ha⁻¹KCl tends to have a significant effect on increasing plant height, a number of leaves and number of branches. This is presumably because K is able to improve the rate of assimilate translocation that forms plant growth. [14] state that potassium is absorbed in the form of K⁺. Adequacy of K⁺ in plants causes plants to grow faster, because one of the functions of potassium is to maintain a constant turgor cell pressure which ultimately stimulates the enlargement of cells that make up the meristem tissue. In line with the statement made [15] that the main function of Potassium for plants is as an activator of various enzymes.

Giving antagonistic microbes also functions as a decomposer of organic matter. The result of the organic material decomposition process is the release of nutrients contained in the organic material. The availability of sufficient nutrients for plant growth causes the metabolic processes that occur in plants to take place normally, so that it will affect the process of photosynthesis and respiration. *P. fluorescens* used in this study had an influence on plant growth (number of leaves, plant height), such as *Curcuma longa* L [16], *Vigna radiata* [17]. *Streptomyces* sp. has the ability to produce acidic and thermostable phytases and plant growth promoting (PGP) properties that show increased plant growth can have implications for acidic soils and also in arid regions [18]. The great potential of *T. viride* biological fertilizer in reducing NH₃ evaporation from alkaline soils and simultaneously increasing the utilization of N fertilizer by sweet sorghum [18].

B. Number of Leaves

Table 3. Number of leaves after antagonistic microbes and potassium applications at 35, 45, 55 DAP

| Treatment | Number of Leaves (Stems) at Age (DAP) | | | | | |
|-----------|---------------------------------------|-----|-------|-----|--------|-----|
| | 35 | | 45 | | 55 | |
| A1D1 | 32.50 | ab | 56.26 | a | 117.00 | a |
| A1D2 | 35.83 | bc | 62.11 | bc | 130.97 | bc |
| A1D3 | 34.72 | abc | 60.00 | abc | 131.66 | bcd |
| A2D1 | 31.06 | a | 59.28 | ab | 109.60 | a |
| A2D2 | 40.22 | d | 63.83 | c | 138.10 | cd |
| A2D3 | 37.99 | cd | 70.10 | d | 133.49 | bcd |
| A3D1 | 40.11 | d | 60.03 | abc | 126.50 | b |
| A3D2 | 40.95 | d | 70.10 | d | 141.53 | d |
| A3D3 | 38.11 | cd | 68.83 | cd | 138.50 | cd |
| LSD 5% | 4.20 | | 4.40 | | 8.85 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

The number of leaves due to the interaction of antagonistic microbes administration and fertilization of Potassium is presented in Table 3.

Table 3 shows that the interaction of antagonistic microbes administration and Potassium dosage at 35 days after planting showed the highest number of leaves achieved in the administration of *P. fluorescens* + *Streptomyces* sp. + *T. viride* at all levels of Potassium fertilizer. These results are the same as the treatment of *P. fluorescens* + *Streptomyces* sp. with a dose of Potassium 250 kg Ha⁻¹KCl and 375 kg Ha⁻¹KCl.

Age 45 days after planting showed that the highest number of leaves was achieved by antagonizing *P. fluorescens* + *Streptomyces* sp. + *T. viride* with a dose of Potassium 250 kg Ha⁻¹KCl and 375 kg Ha⁻¹KCl. These results are the same as the treatment of *P. fluorescens* + *Streptomyces* sp. with a dose of Potassium 375 kg Ha⁻¹KCl fertilizer.

Age 55 days after planting showed that the highest number of leaves was achieved by antagonizing *P. fluorescens* + *Streptomyces* sp. + *T. viride* with a dose of Potassium 250 kg Ha⁻¹KCl and 375 kg Ha⁻¹KCl. These results are the same as the treatment of *P. fluorescens* + *Streptomyces* sp. with the same dose of Potassium fertilizer and *P. fluorescens* at a dose of 375 kg Ha⁻¹KCl. Reducing the dose of Potassium fertilizer to 125 kg Ha⁻¹KCl at 55 days after planting resulted in a decrease in the number of leaves respectively by 17.33%, 22.56% and 10.62% in *P. fluorescens*, *P. fluorescens* + *Streptomyces* sp. and *T. viride* + *Streptomyces* sp. + *P. fluorescens*.

Separately at the age of 25 days after planting kinds of antagonistic microbes had no significant effect, while the dose of potassium fertilization had a significant effect. Table 4 shows that at the age of 25 days after planting different types of antagonistic microbes gave the same response to the number of leaves. Potassium fertilizer dose 250 kg Ha⁻¹KCl and 375 kg Ha⁻¹KCl produces more leaves than 125 kg Ha⁻¹KCl of Potassium. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl resulted in a decrease in the number of leaves by 18.09%.

The number of plant leaves in antagonistic microbes and potassium fertilizer application at various plant ages is presented in the Table 4.

Table 4. Number of leaves after antagonistic microbes and potassium applications at 25 DAP

| Treatment | Number of Leaves (Stems) at Age 25 DAP | |
|--|--|---|
| Antagonistic Microbes | | |
| A1 | 16.31 | |
| A2 | 16.81 | |
| A3 | 17.28 | |
| LSD 5% | Not really | |
| Potassium Fertilizer Doses per Hectare | | |
| D1 | 15.34 | a |
| D2 | 18.73 | b |
| D3 | 18.44 | b |
| LSD 5% | 3.078 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

Not only in potato plants, the application of potassium fertilizer is very important in almost all plants. Potassium (K) plays an important role in the metabolism of carbon (C) and nitrogen (N). The results of research on cotton plants showed that leaf K content, number of leaves, leaf area, number of boll, reproductive dry weight and total dry weight were significantly lower under K deficiency [19].

C. Total Main Branch

The number of main branches due to the interaction of antagonistic microbes administration and fertilization of Potassium is presented in Table 5.

Table 5 shows that the interaction of antagonistic microbes administration and Potassium dose at the age of 25 days after planting shows the highest number of branches achieved in the administration of *P.fluorescens* with a dose of Potassium 250 kgHa⁻¹KCl. These results are the same as the treatment of *P.fluorescens* + *Streptomyces* sp. with a dose of Potassium fertilizer 125 kgHa⁻¹KCl and 250 kgHa⁻¹KCl and *P.fluorescens* with 250 kg Ha⁻¹KCl of Potassium fertilizer.

Age 35 days after planting showed the highest number of branches achieved in the administration of antagonist *P.fluorescens* + *Streptomyces* sp. with a dose of Potassium fertilizer 125 kg Ha⁻¹KCl and 250 kgHa⁻¹KCl. This dose also gives the highest number of main branches and is not significantly different from the previous treatment when given the microbial antagonist *P. fluorescens*. The combination of *P.fluorescens* + *Streptomyces* sp. + *T.viride* with a dose of Potassium 250 kgHa⁻¹KCl and 375 kgHa⁻¹KCl also gave the same response as the previous treatment.

Table 5. Total main branches after antagonistic microbes and potassium applications

| Treatment | Total Main Branch at Age (DAP) | | | | | | | |
|-----------|--------------------------------|-----|------|-----|------|----|------|-----|
| | 25 | | 35 | | 45 | | 55 | |
| A1D1 | 3.95 | ab | 3.94 | ab | 4.31 | a | 5.00 | a b |
| A1D2 | 4.33 | bc | 4.50 | bc | 4.72 | ab | 5.10 | b |
| A1D3 | 3.78 | ab | 4.00 | abc | 4.49 | ab | 5.10 | b |
| A2D1 | 3.72 | a | 4.95 | ab | 4.37 | ab | 4.20 | a |
| A2D2 | 4.61 | c | 4.61 | c | 4.72 | ab | 5.85 | c |
| A2D3 | 4.17 | abc | 3.78 | a | 4.16 | a | 5.82 | c |
| A3D1 | 3.72 | a | 3.73 | a | 4.23 | a | 5.07 | b |
| A3D2 | 3.78 | ab | 3.95 | abc | 4.95 | bc | 5.95 | c |
| A3D3 | 4.17 | abc | 4.50 | bc | 5.45 | c | 5.86 | c |
| LSD 5% | 0.55 | | 0.66 | | 0.58 | | 0.71 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

Age 45 days after planting the combined *P.fluorescens* + *Streptomyces* sp. + *T.viride* with a dose of Potassium 250 kgHa⁻¹KCl and 375 kg Ha⁻¹KCl clearly produced the highest number of branches. Age 55 days after planting the combined *P.fluorescens* + *Streptomyces* sp. + *T.viride* with a dose of Potassium 250 kg Ha⁻¹KCl and 375 kgHa⁻¹KCl significantly produced the highest number of branches, this dose was not significantly different when combined with the microbial antagonist *P.fluorescens* + *Streptomyces* sp.

Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl resulted in a decrease in the number of branches by 14.79% and 28.21%.

Age 45 days after planting the combined *P.fluorescens* + *Streptomyces* sp. + *T.viride* with a dose of Potassium 250 kgHa⁻¹KCl and 375 kg Ha⁻¹KCl clearly produced the highest number of branches. Age 55 days after planting the combined *P.fluorescens* + *Streptomyces* sp. + *T.viride* with a dose of Potassium 250 kg Ha⁻¹KCl and 375 kgHa⁻¹KCl significantly produced the highest number of branches, this dose was not significantly different when combined with the microbial antagonist *P.fluorescens* + *Streptomyces* sp. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl resulted in a decrease in the number of branches by 14.79% and 28.21%.

The availability of potassium in the soil causes guaranteed plant rigidity and stimulates root growth and will affect the development of plant parts such as the number of leaves, branch growth. In addition, the function of Potassium is to increase nutrient uptake of N, P and K [20, 21, 22].

D. Potassium Absorption in Plant Leaves

Potassium uptake in plant leaves due to the interaction of antagonistic microbes administration and potassium fertilization is presented in Table 6.

Table 6 shows that the interaction between administration of antagonistic microbes and the dose of Potassium fertilizer at 47 days after planting to Potassium uptake in leaves shows variable results. Plants that were given *T.viride* + *P.fluorescens* + *Streptomyces* sp. The highest uptake of Potassium in the leaves was achieved at 250 kgHa⁻¹KCl and 375 kg Ha⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl in the same antagonist microbes resulted in a decrease in Potassium uptake of 7.81%. Potassium (K) deficiency is a general abiotic stress that can inhibit plant growth and thus reduce plant productivity [23].

Table 6. Potassium uptake in plant leaves after antagonistic microbes and potassium applications at 45 DAP

| Treatment | Potassium Absorption in Plant Leaves | |
|-----------|--------------------------------------|---|
| A1D1 | 2.616 | a |
| A1D2 | 2.432 | c |
| A1D3 | 2.500 | d |
| A2D1 | 2.171 | a |
| A2D2 | 2.483 | d |
| A2D3 | 2.535 | e |
| A3D1 | 2.396 | b |
| A3D2 | 2.598 | f |
| A3D3 | 2.599 | f |
| LSD 5% | 0.018 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

E. Fresh Weight of Bulb Per Clump

The fresh weight of bulb per clump due to the interaction of antagonistic microbial administration and potassium fertilizer is presented in Table 7.

Table 7. Fresh weights of bulb per clump after antagonistic microbes and potassium applications at harvest

| Treatment | Fresh Weight of Bulb Per Clump (gram) | |
|-----------|---------------------------------------|----|
| A1D1 | 265.84 | a |
| A1D2 | 326.75 | ab |
| A1D3 | 325.73 | d |
| A2D1 | 264.00 | a |
| A2D2 | 292.40 | ab |
| A2D3 | 299.25 | bc |
| A3D1 | 274.87 | ab |
| A3D2 | 373.87 | d |
| A3D3 | 365.86 | d |
| LSD 5% | 28.73 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

Table 7 shows that the interaction between antagonistic microbial administration and the dosage of Potassium fertilizer on the fresh weight of bulb per clump at harvest shows variable results. The highest fresh tuber weight per clump was achieved in the administration of *T.viride* + *P.fluorescens* + *Streptomyces* sp. and a dose of Potassium 250 kg Ha⁻¹KCl and 375 kgHa⁻¹KCl, which was not significantly different if the plants were given antifungal microbial *P.fluorescens* and a dose of Potassium 375 kg Ha⁻¹KCl.

Reduction of Potassium fertilizer dose to 125 kgHa⁻¹KCl in *T.viride* + *P.fluorescens* + *Streptomyces* sp. resulting in a decrease in fresh weight of bulb per clump by 24.87% and 27.59% in the antagonist microbial *P.fluorescens*. The N and K fertilization provides good nutrition for the growth of amaryllis flowers (*Hippeastrum* spp.). Amaryllis flower production is strongly influenced by tuber size [24].

F. Fresh Weight of Bulb per Hectare

The fresh weight of bulb per hectare due to the interaction of antagonistic microbial administration and the application of Potassium is presented in Table 8.

Table 8. Fresh weight of bulb per hectare after antagonistic microbes and potassium applications at harvest

| Treatment | Fresh Weight of Bulb Per Hectare (ton/hectar) | |
|-----------|---|----|
| A1D1 | 10.1270 | a |
| A1D2 | 12.4477 | c |
| A1D3 | 12.4087 | c |
| A2D1 | 10.0570 | a |
| A2D2 | 11.1390 | ab |
| A2D3 | 11.4003 | bc |
| A3D1 | 10.4713 | ab |
| A3D2 | 14.2427 | d |
| A3D3 | 13.9373 | d |
| LSD 5% | 1.0947 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

Table 8 shows that the interaction between antagonistic microbial administration and the dosage of Potassium fertilizer to the fresh weight of bulb per hectare at harvest

shows varied results. The highest fresh tuber weight per hectare was achieved in the administration of *T.viride* + *P.fluorescens* + *Streptomyces* sp. and a dose of Potassium 250 kg Ha⁻¹KCl was not significantly different from the 375 kgHa⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kgHa⁻¹KCl in *T.viride* + *P.fluorescens* + *Streptomyces* sp. resulting in a decrease in tuber fresh weight per hectare by 26.48%. The results obtained indicate that one of the functions of K⁺ is as nutrient transport, water and photosynthesis results. With the increase in the provision of KCl fertilizer, the results that are transported to the bulb also increase. These results are in accordance with research [25], which states that potato plants fertilized with 250 kgHa⁻¹KCl produce the most bulb per hectare.

G. Percentage of Dry Weight of Bulb When Harvesting

The percentage of dry weight at harvest due to the interaction of antagonistic microbial and potassium fertilization is presented in Table 9.

The highest percentage of tuber dry weight at harvest was achieved in the administration of *T.viride* + *P.fluorescens* + *Streptomyces* sp. and a dose of Potassium 250 kgHa⁻¹KCl was not significantly different from the 375 kgHa⁻¹KCl dose. Reduction of Potassium fertilizer dose to 125 kgHa⁻¹KCl in *T.viride* + *P.fluorescens* + *Streptomyces* sp. resulting in a decrease in tuber dry weight of 12.63%. According to [26], based on conducted research on the administration of N, P, K, Ca, Mg, S, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn in potato plants, the results obtained by production efficiency much higher recorded for mineral fertilizers N, P and K.

Table 9. Interaction between antagonistic microbial and Potassium fertilizer at harvest

| Treatment | Percentage of Dry Weight of Bulb (%) | |
|-----------|--------------------------------------|----|
| A1D1 | 11.703 | b |
| A1D2 | 12.210 | bc |
| A1D3 | 12.917 | de |
| A2D1 | 10.293 | a |
| A2D2 | 12.523 | cd |
| A2D3 | 12.930 | de |
| A3D1 | 11.873 | b |
| A3D2 | 13.240 | ef |
| A3D3 | 13.590 | f |
| LSD 5% | 0.632 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

H. Weight Bulb at Harvest

The percentage of bulb dry weight at harvest due to the interaction of antagonistic microbial and potassium fertilization is presented in Table 10.

Table 10 shows that the interaction between antagonistic microbial administration and dosage of Potassium fertilizer on tuber specific gravity at harvest shows varied results. The highest percentage of tuber specific gravity at harvest was achieved by the administration of *T.viride* + *P.fluorescens* + *Streptomyces* sp. and a dose of Potassium

250 kgHa⁻¹KCl was not significantly different from the 375 kgHa⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl in *T.viride* + *P.fluorescens* + *Streptomyces* sp. tuber dry weight resulted in a decrease of 8.97%.8.97%. Giving KNO₃ has a good effect on the productivity of onion bulb[27].

Table 10. Weight bulb after antagonistic microbial and Potassium fertilizer at harvest

| Treatment | Tuber Specific Gravity (g cc ⁻¹) | |
|-----------|--|----|
| A1D1 | 0.920 | a |
| A1D2 | 0.957 | b |
| A1D3 | 0.973 | bc |
| A2D1 | 0.953 | b |
| A2D2 | 0.970 | bc |
| A2D3 | 0.970 | bc |
| A3D1 | 0.913 | a |
| A3D2 | 0.983 | cd |
| A3D3 | 1.003 | d |
| LSD 5% | 0.024 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

I. Reduced Sugar Levels

The percentage of reduced sugar levels due to the interaction of antagonistic microbial administration and fertilizer application of Potassium is presented in Table 11.

Table 11. Reduced sugar levels (%) due to the interaction of antagonistic microbial and the dose of Potassium fertilizer at harvest

| Treatment | Reduced Sugar Levels (%) | |
|-----------|--------------------------|----|
| A1D1 | 0.06343 | ab |
| A1D2 | 0.06230 | a |
| A1D3 | 0.06270 | a |
| A2D1 | 0.06270 | a |
| A2D2 | 0.06493 | bc |
| A2D3 | 0.06570 | cd |
| A3D1 | 0.06683 | de |
| A3D2 | 0.06887 | f |
| A3D3 | 0.06837 | ef |
| LSD 5% | 0.00168 | |

Note: Numbers accompanied by different letters in the same column show a significantly different level of LSD test at 5%.

Table 11 shows that the interaction between antagonistic microbial administration and dosage of Potassium fertilizer on tuber-reduced sugar levels at harvest shows variable results. The highest sugar-reduced tuber levels at harvest were achieved with the administration of *T.viride* + *P.fluorescens* + *Streptomyces* sp. and a dose of Potassium 250 kgHa⁻¹KCl was not significantly different from the 375 kg Ha⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kgHa⁻¹KCl in *T.viride* + *P.fluorescens* + *Streptomyces* sp. Result in a decrease in tuber reduced sugar levels by 2.96%.

Increasing the amount of antagonistic microbial diversity and dosage of Potassium fertilizer indicates that the role of K in the physiological processes of plants runs well which

includes: enhancement and development of plant tissue through simple sugar synthesis, starch, carbohydrate translocation and protein synthesis [28]. Thus the process of photosynthesis can run optimally.

IV. CONCLUSION

Provision of *P.fluorescens* + *Streptomyces* sp. + *T. viride* and 250 kg Ha⁻¹KCl and 375kg Ha⁻¹KCl doses tend to produce growth, tuber fresh weight per hectare, tuber dry weight percentage, tuber specific gravity and higher sugar content than other treatments.

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