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

Anis Rosyidah¹*, 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 Hα-KCl, D2 = 250 kg Hα-KCl, D3 = 375 kg Hα-KCl. 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 Hα-KCl and 375 kg Hα-KCl 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. Potato 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 phosphate 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 photosynthesis 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 are 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:

\[
tuber \text{ dry weight} = \frac{100\%}{\text{tuber dry weight}}
\]

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

Table 1. Treatments in research

| Code   | Doses                                      |
|--------|--------------------------------------------|
| A1D1   | P. fluorescens dan dosis 125 kg Ha\(^{-1}\) KCl |
| A1D2   | P. fluorescens dan dosis 250 kg Ha\(^{-1}\) KCl |
| A1D3   | P. fluorescens dan dosis 375 kg Ha\(^{-1}\) KCl |
| A2D1   | P. fluorescens + Streptomyces sp. and doses 125 kg Ha\(^{-1}\) KCl |
| A2D2   | P. fluorescens + Streptomyces sp. and doses 250 kg Ha\(^{-1}\) KCl |
| A2D3   | P. fluorescens + Streptomyces sp. and doses 375 kg Ha\(^{-1}\) KCl |
| A3D1   | T. viride + P. fluorescens + Streptomyces sp. and doses 125 kg Ha\(^{-1}\) KCl |
| A3D2   | T. viride + P. fluorescens + Streptomyces sp. and doses 250 kg Ha\(^{-1}\) KCl |
| A3D3   | T. viride + P. fluorescens + Streptomyces 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 10\(^8\) cfu mL\(^{-1}\) for Streptomyces sp. and P. fluorescens[9] and 10\(^7\) 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 application and administration of potassium at various plant ages is presented in Table 2.

Table 2. Plant height after antagonistic microbes and potassium applications

| Treatments in Research | Plant Height (cm) at Various Plant Age (DAP) |
|------------------------|---------------------------------------------|
|                        | 25          | 35          | 45          | 55          |
| Antagonistic microbes  | A1          | A2          | A3          | LSD 5%      |
| A1                     | 15.11 b     | 27.47 a     | 44.17 a     | 65.89 a     |
| A2                     | 12.05 a     | 27.45 a     | 42.89 b     | 68.11 ab    |
| A3                     | 16.08 b     | 31.32 b     | 44.23 b     | 73.56 b     |
| LSD 5%                 | 1.99        | 3.83        | Not really  | 6.15        |
| Potassium Fertilizer dose per Hectare | D1          | D2          | D3          | LSD 5%      |
| 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%.
utilization of N fertilizer by sweet sorghum [18]. The great potential of increased plant growth can have implications for acidic ability to produce acidic and thermostable phytases and from alkaline soils and simultaneously increasing 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 mesophyll 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 P. fluorescens, by 17.33%, 22.56% and 10.62% in P. fluorescens + Streptomyces 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 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.

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%.

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 kg Ha\(^{-1}\) KCl. These results are the same as the treatment of P. fluorescens + Streptomyces sp. with a dose of Potassium fertilizer 125 kg Ha\(^{-1}\) KCl and 250 kg Ha\(^{-1}\) KCl and P. fluorescens with 250 kg Ha\(^{-1}\) KCl 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\(^{-1}\) KCl and 250 kg Ha\(^{-1}\) KCl. 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 kg Ha\(^{-1}\) KCl and 375 kg Ha\(^{-1}\) KCl also gave the same response as the previous treatment.

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

| Treatment | 25 | 35 | 45 | 55 |
|-----------|----|----|----|----|
| A1D1      | 3.95 | ab | 3.94 | ab | 4.31 | a | 5.00 | a |
| 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 kg Ha\(^{-1}\) KCl and 375 kg Ha\(^{-1}\) KCl 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\(^{-1}\) KCl and 375 kg Ha\(^{-1}\) KCl 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\(^{-1}\) KCl 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 kg Ha\(^{-1}\) KCl and 375 kg Ha\(^{-1}\) KCl 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\(^{-1}\) KCl and 375 kg Ha\(^{-1}\) KCl 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\(^{-1}\) KCl 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. 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 c |
| 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 kg Ha⁻¹KCl, which was not significantly different if the plants were given antifungal microbes and potassium applications at harvest. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl in T. viride + P. fluorescens + Streptomyces sp. resulting in a decrease in fresh weight per hectare by 24.87% and 27.59% in the antagonist microbial P. fluorescens and a dose of Potassium 375 kg Ha⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl in T. viride + P. fluorescens + Streptomyces sp. and a dose of Potassium 250 kg Ha⁻¹KCl 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 kg Ha⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kg Ha⁻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⁻¹ KCl 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 kg Ha⁻¹KCl was not significantly different from the 375 kg Ha⁻¹KCl dose. Reduction of Potassium fertilizer dose to 125 kg Ha⁻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                             |

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 percentage of bulb dry weight at harvest due to the interaction of antagonistic microbial and potassium fertilization is presented in Table 10. 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 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 kg Ha⁻¹KCl was not significantly different from the 375 kg Ha⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kg Ha⁻¹KCl in T. viride + P. fluorescens + Streptomyces sp. resulting in a decrease in tuber specific gravity at harvest 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 kg Ha⁻¹ KCl produce the most bulb per hectare.

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. 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 kg Ha⁻¹KCl produces the highest percentage of bulb dry weight at harvest.
250 kg Ha⁻¹KCl was not significantly different from the 375 kg Ha⁻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%. 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      | 0.06493 bc               |
| A2D2      | 0.06457 cd               |
| A2D3      | 0.06987 f                |
| A3D1      | 0.06837 ef               |
| A3D2      | 0.06837 ef               |
| 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 kg Ha⁻¹KCl was not significantly different from the 375 kg Ha⁻¹KCl. Reduction of Potassium fertilizer dose to 125 kg Ha⁻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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