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The Application of NPK Pearl Professional 9-25-25 on the Growth and Production of Red Bean Plants (*Phaseolus vulgaris L.*) in Lowlands

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Abstract: This study aims to determine the application of NPK Pearl 9-25-25 on the growth and production of red bean plants (Phaseolus vulgaris L.) in lowlands. The research was conducted from February to May 2023 in Airmadidi, North Minahasa Regency, North Sulawesi at an altitude of 100 meters above sea level. They were using a Randomized Complete Block Design with the application of NPK Pearl 9-25-25 at 4 levels (0 g/liter of water, 2 g/liter of water, 4 g/liter of water, and 6 g/liter of water). The observed variables were plant height, number of branches, flowering age, number of pods, and net dry weight. The application of NPK Pearl 9-25-25 at a dose of 4 g/liter of water on the 45th day after planting (DAP) resulted in the tallest plant height of 47.80 cm, the highest number of branches with 18 branches, while the fastest flowering age was 30 DAP with doses of 4 g/liter of water and 6 g/liter of water, the highest number of pods was 33.60 pods, and the heaviest net dry seed weight per plant was 66 grams at a dose of 4 g/liter of water. The application of NPK Pearl 9-25-25 had a non-significant effect on plant height and the number of branches but had a highly significant effect on the variables of flowering age, number of pods, and net dry weight. The application of NPK Pearl professional 9-25-25 doses on red bean plants can be applied in lowlands, and the best dose from this study is 4 g/liter of water.

Keywords: Lowlands; Red bean; NPK Pearl professional 9-25-25

Introduction

The people of North Sulawesi are familiar with red beans, known locally as "brenebon," which are consumed in various forms such as brenebon soup, rendang brenebon, brenebon ice, and brenebon cake, a traditional delicacy enjoyed by both children and adults in families.

In addition to being directly processed as a food ingredient, red beans can also be utilized for medicinal purposes. Among the estimated 250,000 species of medicinal plants worldwide, many are believed to contain anti-diabetes mellitus compounds that have yet to be discovered, with red beans being one of them. Red beans are known for being a food source rich in fiber and having a low glycemic index (Achmad et al., 2015). Red beans, a type of legume (Leguminoceae), are high in starch and fiber content, and they rank as the second-highest source of protein and phosphorus among all types of legumes in Indonesia, after peanuts, green beans, and lentils. The high fiber content of red beans helps prevent coronary heart disease (Arvita, Rosmedelima & Noviandi, 2019). In 100 grams of red bean plant, there are approximately 11.74 grams of water; 23.58 grams of protein; 0.83 grams of fat; 60.1 grams of carbohydrates; 7.6 grams of fiber; 1.5 grams of iron; 407 mg of phosphorus; 140 mg of magnesium; 0.397 mg of vitamin B1; and 24 mg of sodium (USDA, 2022).

Red beans have a relatively high market value since their production in Indonesia is still relatively low compared to other leguminous crops such as soybeans, peanuts, and green beans. The demand for leguminous

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crops in the future is expected to continue increasing along with the population growth. The average consumption of leguminous crops per capita per day in Indonesia is 35.88 grams (Astawan, 2009).

The production of red beans in Indonesia from 2012 to 2016 fluctuated each year. In 2012, it was 93,416 tons, increasing to 103,376 tons in 2013, then decreasing to 100,316 tons in 2014, 42,384 tons in 2015, and 37,167 tons in 2016 (Directorate General of Horticulture, 2017). Meanwhile, the production of red beans in North Sulawesi from 2019 to 2021 also fluctuated, with 8,391 metric tons in 2019, increasing to 16,015 metric tons in 2020, and decreasing to 7,738 metric tons in 2021 (Central Bureau of Statistics of North Sulawesi Province).

The agricultural commodity price statistics for 2022 show that the prices of red beans vary across different regions in Indonesia. The price of red beans in North Sulawesi tends to increase. From 2017 to 2021, the price of red beans steadily increased from Rp13,054/kg in 2017 to Rp21,019/kg in 2021.

Red beans are suitable for cultivation in areas with a wet climate and varying altitudes. The suitable altitude for cultivation is 1000-1500 meters above sea level (masl). However, several research results have shown that red beans can be grown in dry land as well as in low-lying areas. Red bean plants in North Sulawesi are generally cultivated in highlands, whereas North Sulawesi, especially in North Minahasa regency, has low-lying areas with extensive dry land agroclimatic conditions suitable for red bean cultivation. Efforts to increase red bean production in low-lying areas can be made by using varieties that are suitable for the environmental conditions of the cultivation area, as well as by applying fertilizer at appropriate doses. NPK Mutiara Professional 9-25-25 fertilizer is a compound fertilizer that can contribute to increasing the production and quality of red bean products. Meanwhile, organic fertilizers generally have low nutrient content and slow release processes, whereas inorganic fertilizers are rich in nutrients and have faster nutrient release, making them more readily available (Benitez, 2013).

The application of inorganic fertilizers is commonly used by farmers in cultivating plants, but the doses used by farmers vary widely, hence the need for studies on the appropriate doses for red bean cultivation. Inorganic fertilizers have a positive effect on plants because they contain N, P, and K nutrients that can increase plant production (Zein and Zharah, 2013). NPK Mutiara Professional 9-25-25 is a complete fertilizer that provides balanced Potassium nutrients. Plants require potassium as it regulates water balance within cells, cell turgor, and water loss due to transpiration; responsible for protein production and formation; and enhances plant tolerance to drought or cold stress as well as pest and disease attacks. It improves the quality of production results in terms of color, taste, and shelf life.

Red beans have a relatively high market value, this is because red bean production in Indonesia is still relatively low compared to other leguminous crops such as soybeans, peanuts, and mung beans. One of the efforts made to increase production and seed quality is by applying the right dose, at the right time, the right type, and the right place of fertilization in crop cultivation. The application of inorganic fertilizers produces higher yields compared to organic fertilizers because inorganic fertilizers release nutrients faster than organic fertilizers (Safitry & Kartika, 2013). The application of NPK Mutiara Professional 9-25-25 fertilizer on red bean plants in low-lying areas can result in high production, good quality, and improve the availability of nutrients in the soil sustainably.

Method

Time and Location of Research

This research was conducted from February to May 2023 on the campus land of Klabat University, Airmadidi Bawah Village, North Minahasa Regency, at an altitude of 100 meters above sea level.

Materials and Tools

The materials used include red bean seeds, chicken manure fertilizer, and NPK Mutiara Professional 9-25-25 fertilizer. The tools used are hoe, shovel, machete, hammer, nail, rake, measuring tape, raffia rope, and writing tools.

Research Design

This research used a Randomized Complete Block Design (RCBD). It consists of 1 treatment factor, namely NPK Mutiara Professional 9-25-25 fertilizer, which consists of 4 treatments, with each treatment repeated 5 times. The total number of plants studied was 40 plants. The doses for the treatment factor are as follows:

Application of NPK Mutiara Professional fertilizer (denoted as K), consisting of 4 treatment levels, namely:

Ko = No Treatment
K1 = 2 grams/liter of water
K2 = 4 grams/liter of water
K3 = 6 grams/liter of water

The mathematical model used is $Yij = \mu + \tau i + \beta j + \varepsilon ij$

Where

Yij = observations in treatment i and group j
μ = population mean
τi = effect of treatment i
βj = influence of group j
εij = effect of error from treatment i and group j

Research Procedure

a. Seed Preparation: The seeds used are Redbean variety red bean seeds with a germination rate above 90%.
b. Land Preparation: The first tillage was done on March 17, 2023, the second tillage on March 24, and the third tillage on March 31, 2023, by removing weeds, loosening the soil, and making beds measuring 250 cm x 150 cm, with a bed height of 30 cm and a distance between plots of 50 cm, a planting distance between replications of 100 cm, and a total of 20 plots.
c. Fertilization: The base fertilizer is chicken manure fertilizer at a rate of 1 kg/plot, evenly applied on the bed surface and then mixed with the soil on the bed before planting the red bean seeds. The application of NPK Mutiara Professional 9-25-25 fertilizer is done according to the predetermined treatment doses. The application of NPK Mutiara Professional fertilizer is done on the 18th, 28th, and 38th (Days After Planting) by diluting it in water according to the predetermined dose and applying it in the afternoon from 4:00 PM until completion.
d. Planting: The seeds are planted, with three seeds per hole at a planting depth of 3 cm, using a planting distance of 70 x 30 cm.

Observation Variables

Plant Height

Plant height is measured by measuring from the base of the stem to the tip of the highest leaf. Plant height observations are made at 25, 35, and 45 Days After Planting (DAP).

Number of Branches

The number of branches is observed by counting the number of branches on the red bean plants. Observations on the number of branches are made at 25, 35, and 45 DAP.

Flowering Age

The flowering age data is collected on the plants when they have produced perfect flowers.

Number of Pods

Counting the number of red bean pods per plant from the sample plants at 65 Days After Planting (DAP).

Dry Seed Weight

Calculating the dry seed weight per red bean plant that has been dried.

Data Analysis Method

The research is analyzed using analysis of variance (ANOVA) to observe the differences between treatments, followed by Duncan's test.

Result and Discussion

Plant Height

The analysis results of plant height data at 25 DAP, 35 DAP, and 45 DAP indicate that the NPK Mutiara 9-25-25 treatment did not have a significant effect on plant height at 25 DAP (sig = 0.72>0.05) and 35 DAP (sig = 0.26>0.05), but had a significant effect on plants at 45 DAP (sig = 0.03<0.05).

Table 1. Plant height (cm) of red beans when applying NPK Mutiara professional 9-25-25

NPK Pearl Professional	25 HST	35 HST	45 HST
0 gr/liter of water	28.00 a	32.40 a	43.30 a
2 gr/liter of water	29.00 a	34.60 a	44.60 a
4 gr/liter of water	29.60 a	36.80 a	47.80 b
6 gr/liter of water	29.60 a	37.00 a	46.80 b

Table 1 shows the application of NPK Mutiara Professional 9-25-25 at 25 Days After Planting (DAP), with the tallest plants at doses of 4 gr/liter of water and 6 gr/liter of water measuring 29.60 cm, which did not differ significantly from the application of all treatment doses.

Mahdianoor et al. (2016) state that plants enter a phase of becoming new or in a slow growth phase, so at this stage, the roots have not developed optimally to absorb nutrients from the soil but already require nutrients for optimal growth. In the observation at 35 DAP, the tallest plants were at a dose of 6 gr/liter of water, measuring 37.00 cm, which did not differ significantly from 0 gr/liter of water, which was 32.40 cm. The increase in plant height is suspected to be due to nitrogen, phosphorus, and potassium nutrients in the soil from the initial basal fertilization before the application of additional nitrogen, phosphorus, and potassium nutrients. According to Advinda (2018), nitrogen is an essential component for plants, playing a role in cell formation, amino acids, nucleic acids, chlorophyll, and hormones. However, in the observation at 45 DAP, the tallest plants were at a treatment dose of 4 gr/liter of water/plot, measuring 47.80 cm, significantly different from the treatment doses of 0 gr/liter of water, which measured 43.30 cm, and 2 gr/liter of water, which measured 44.60 cm. The application of NPK Mutiara fertilizer at the appropriate dose for the plant's age will provide a vegetative growth response before entering the generative growth phase. According to Zhang, F., Chen, X., Vitousek, P., Zhao, & Liu, X. (2013), the proper application of NPK fertilizer can provide the necessary nutrients for plants, such as N, P, and K, which positively affect plant growth, development, and harvest yield. Phosphorus is crucial for plants in the early growth stage, especially to stimulate root growth and development, and N can

affect the availability and increase the absorption of P. When P is applied together with N, P becomes more available, so more is absorbed by plants compared to when P is applied as a single fertilizer.

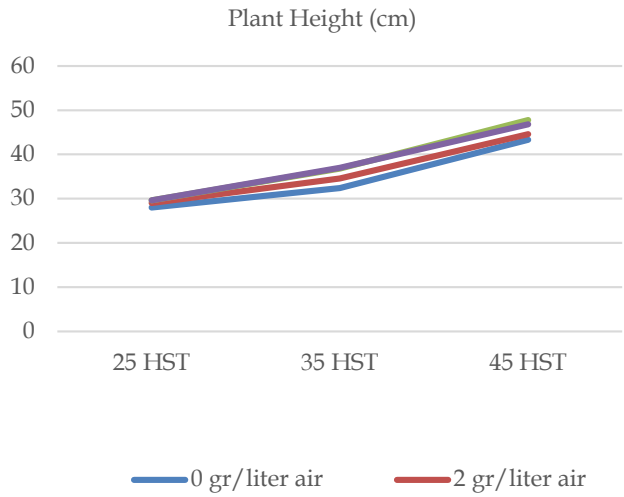

Figure 1. Plant height growth when applying the Mutiara professional NPK dose 9-25-25

Figure 1. Plant height growth, with the application of Mutiara NPK doses of 25 HST, 35 HST, and 45 HST. The highest plant from all application doses showed a dose of 4 gr/liter of water at 46.80 cm which was higher than the dose of 6 g/liter of water at 17.10 cm. Duan and Wang argued that the addition of a certain amount of nitrogen is susceptible to plant growth and development under heat stress and salt stress.

Number of branches

The results of data analysis on the number of branches applying NPK Mutiara Professional 9-25-25 did not have a significant effect on the number of branches aged 25 DAP (sig = 0.315>0.05), 35 HST (0.15<0.05) but in the Duncan test results there was a significant difference in effect on old plants. 45 HST (sig = 0.02<0.05).

Table 2. Number of red bean branches in the implementation of Mutiara Professional NPK 9-25-25

NPK Pearl Professional	25 HST	35 HST	45 HST
0 gr/liter of water	7.40 a	12.10 a	15.80 a
2 gr/liter of water	7.10 a	13.60 b	17.00 ab
4 gr/liter of water	8.10 a	14.30 b	18.00 b
6 gr/liter of water	8.50 a	13.60 b	17.10 ab

Note: Numbers in columns from the same treatment group which are followed by different notations are significantly different at the 5% level according to Duncan's distance test

Table 2, the application of NPK Mutiara Professional 9-25-25, the highest number of branches at 25 Days After Planting (DAP) was 8.50 branches with a treatment dose of 6 gr/liter of water, not significantly different from other treatment doses, and the lowest dose was 0 gr/liter of water, with 7.40 branches. At 35 DAP observation, the highest number of branches was 14.30 branches at the treatment dose of 4 gr/liter of water, significantly different from the dose of 0 gr/liter of water, which was only 12.10 branches. At 45 DAP, the highest number of branches was 18.00 branches with the application of a dose of 4 gr/liter of water/plot, significantly different from the dose of 0 gr/liter of water, which was 15.80 branches. The application of NPK Mutiara Professional fertilizer yielded different results compared to no fertilizer application. Potassium plays a role in branch growth, strengthening the plant's body to prevent branches from easily breaking. Furthermore, (Lingga and Marsono, 2003) state that potassium for plants acts as an energy source in facing drought and disease attacks.

Meanwhile, Nitrogen is an essential element in stimulating vegetative growth, including branch growth. The application of NPK can provide the necessary nutrients for the formation of new branches in plants (Taiz & Zeiger, 2010). This is consistent with the opinion of Rahcman et al. (2008) that the application of N, P, and K can function well in the process of photosynthesis, improving plant growth and the number of plant branches by converting NPK nutrients into energy or what is called metabolism process.

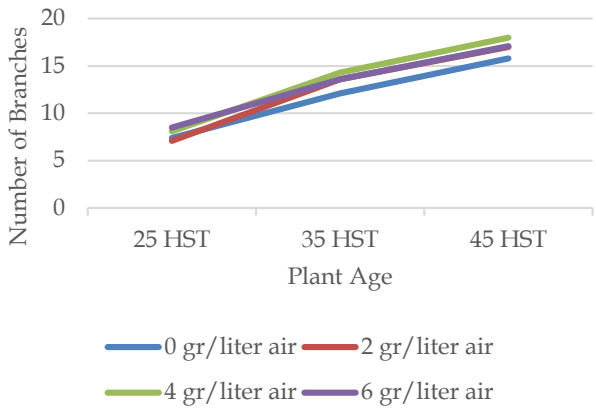

Figure 2. Growth in the number of branches with the application of the Mutiara professional NPK dosage 9-25-25

Figure 2 depicts the application of NPK Mutiara 9-25-25 fertilizer at 25 DAP, 35 DAP, and 45 DAP. The highest number of branches, 18 branches, was observed in all applications of NPK Mutiara Professional with a dose of 4 gr/liter of water at 45 DAP. The application of the appropriate dose of NPK Mutiara Professional for plant needs can enhance metabolism in plant tissues, thus stimulating vegetative growth. However, if the applied dose exceeds the optimum requirement, it may disrupt plant growth in terms of height, diameter,

number of branches, production; the number of flowers, fruits, and fruit weight per plant.

Flowering Age

The analysis of variance for flowering age showed that the application of NPK Mutiara Professional 9-25-25 significantly affected the flowering age (sig=0.00<0.01). Plants flowered the fastest with doses of 4 gr/liter of water and 6 gr/liter of water.

The results of the analysis of variations in flowering age showed that the application of NPK Mutiara professional 9-25-25 fertilizer had a very significant effect on flowering age (sig=0.00<0.01). The fastest plant flowering is at a dose of 4 grams/liter of water and 6 grams/liter of water

Table 3. Age of flowering of red bean plants with the application of NPK Mutiara professional 9-25-25

NPK Pearl Professional	Flowering Age (DAP)
0 gr/liter of water	31.20 b
2 gr/liter of water	30.20 a
4 gr/liter of water	30.00 a
6 gr/liter of water	30.00 a

Note: Numbers in columns from the same treatment group which are followed by different notations are significantly different at the 5% level according to Duncan's distance test

From Table 3, the application of NPK Mutiara 9-25-25 showed that the plants that flowered the fastest were those treated with doses of 4 gr/liter of water and 6 gr/liter of water, which took 30.00 days, not significantly different from the dose of 2 gr/liter of water, which took 30.20 days, while the slowest flowering was observed in the 0 gr/liter of water treatment, which took 31.20 days. A study conducted by Barchia et al. (2022) found that the increased availability of N and P nutrients correlated with the increased NPK dose given, which correlated with plant growth.

The Duncan test results for flowering age showed that the application of NPK Mutiara Professional 9-25-25 significantly affected the flowering age at doses of 2 gr/liter of water, 4 gr/liter of water, and 6 gr/liter of water compared to the control at 0 gr/liter of water. This suggests that the application of NPK Mutiara fertilizer can increase the availability of N, P, and K nutrients in the soil, especially the role of P, which is crucial for accelerating flowering. Marsono and Sigit (2005) stated that P is an essential element in the generative growth phase, including the processes of flowering, fertilization, and fruit ripening.

Hakim (2012) argued that plant metabolic processes such as photosynthesis and flower initiation are influenced by the fulfillment of nutrients, carbohydrates, proteins, vitamins, fats, and amino acids, which act as flowering stimuli. Darjanto (2000) added that with the appropriate addition of phosphorus and potassium intake, the speed of primordia and flower initiation in plants will improve. According to Lingga and Marsono (2001), phosphorus is needed by plants to stimulate root growth, serve as a basis for protein formation, assist in assimilation processes, and accelerate flowering and fruit ripening, while potassium is useful for protein and carbohydrate formation, strengthening plant tissues so that leaves, flowers, and fruits do not easily fall off, and increasing resistance to drought

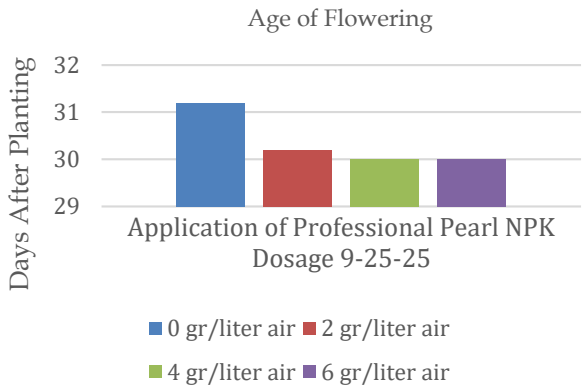

Figure 3. Age of flowering when applying the Pearl Professional NPK dosage 9-25-25

Number of Pods

The analysis of variance showed that the application of NPK Mutiara 9-25-25 fertilizer had a highly significant effect on the number of pods per plant (sig = 0.00 < 0.01).

From Table 4, the treatment with the highest number of pods was observed in the treatment with a dose of 4 gr/liter of water, which was 23.60 pods, significantly different from the treatment with a dose of 2 gr/liter of water, which had 16.30 pods, and the lowest number of pods was found in the treatment with 0 gr/liter of water, with only 12.90 pods. This is because the balanced application of NPK Mutiara 9-25-25 fertilizer can provide the necessary nutrients for the plants. At the dose of 4 gr/liter of water, the fertilizer was able to help the plants produce well, as the application of NPK Mutiara 9-25-25 fertilizer contains nutrients and food substances that strengthen the plant's body and also contribute to increasing the number of pods. Agusline (2009) stated that phosphorus (P) plays an important role in energy transfer within plant cells, promotes root development and early fertilization, strengthens the stem to prevent lodging, and increases absorption during early growth. Potassium (K) also plays a significant role in plant growth, for example, by stimulating the translocation of carbohydrates from leaves to plant organs.

Plants will not yield maximally if the required nutrients are not available. This is consistent with the findings of Marlina et al. that the application of complete fertilization with N, P, K at the right time and dosage can improve the growth and yield of sweet corn.

Table 4. Number of Pods with the application of NPK Mutiara Professional 9-25-25

NPK Pearl Professional	Number of Pods
0 gr/liter air	12.90 a
2 gr/liter air	16.30 b
4 gr/liter air	23.60 c
6 gr/liter air	22.30 c

Note: Numbers in columns from the same treatment group which are followed by different notations are significantly different at the 5% level according to Duncan's distance test

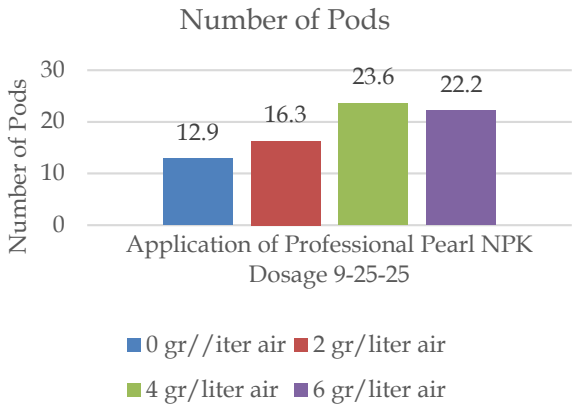

Figure 4. Number of pods when applying the professional Mutiara NPK dose 9-25-25

Figure 4 shows that the highest number of pods was at a treatment dose of 4 gr/liter of water, 23.60 pods, followed by a treatment dose of 6 gr/liter of water, 22.30 pods, followed by a treatment dose of 2 gr/liter of water, 16.30 pods, and the lowest was a treatment dose of 0 gr/ liters of water 12.90.

Dry Seed Weight

The results of the analysis of variations in dry bean weight showed that Mutiara NPK fertilizer treatment had a very significant effect on the dry weight of red beans (sig = 0.00<0.0).

Table 5. Dry seed weight per plant with the application of NPK Mutiara 9-25-25

NPK Pearl Professional	Net Dry Weight
0 gr/liter air	47.52 a
2 gr/liter air	51.52 a
4 gr/liter air	66.00 c
6 gr/liter air	58.80 b

Note: Numbers in columns from the same treatment group followed by different notations are significantly different at the 5% level according to Duncan's distance test

From Table 5, the treatment with the heaviest dry seed weight was observed in the treatment with a dose of 4 gr/liter of water, which was 66.00 grams, significantly different from 6 gr/liter of water, which was 58.80 grams, and 2 gr/liter of water, which was 51.52 grams, while the lowest result was found in the treatment with 0 gr/liter of water, which was 47.52 grams. The statistical analysis results indicate that the application of NPK Mutiara Professional 9-25-25 fertilizer significantly affects the dry seed weight because the proper application of NPK Mutiara Professional 9-25-25 fertilizer can provide good results.

The heaviest dose of application of NPK Mutiara Professional 9-25-25 fertilizer is 4 gr/liter of water. This is because phosphorus plays a role in the growth and development of plants, especially by stimulating root growth, the formation of certain proteins, assisting in the assimilation and respiration processes of plants, and accelerating pod ripening. The treatment with a dose of 4 gr/liter of water yielded a production per plant of 66.00 grams, while 0 gr/liter of water yielded 47.52 grams, the lowest among all NPK Mutiara Professional treatments. This is because plant growth will be optimal if sufficient nutrients are provided compared to fertilizer application.

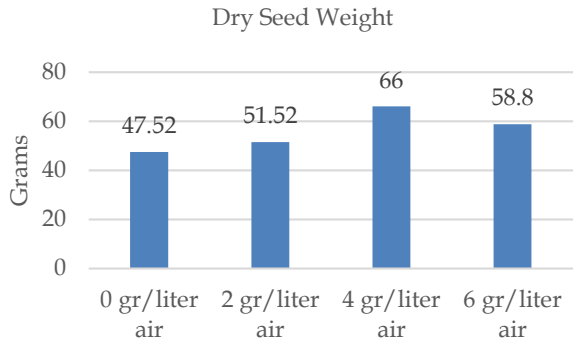

Figure 5 shows the dry net weight per plant at various doses of NPK Mutiara 9-25-25 treatment

Figure 5 shows the highest net dry weight with the NPK Mutiara Professional 9-25-25 treatment dose of 4 gr/liter of water, which is 66 grams, followed by 6 gr/liter of water at 58.8 grams, then 2 gr/liter of water at 51.52 grams, and the lowest being the treatment with 0 gr/liter of water at 47.52 grams. This is because the NPK Mutiara 9-25-25 fertilizer with the application of 4 gr/liter of water can already meet the needs of red bean plants

Conclusion

The application of NPK Mutiara 9-25-25 did not significantly affect the plant height and number of branches per plant at the age of 25 HST and 35 HST but was significant at the age of 45 HST. Flowering age,

number of pods, and dry seed weight with the application of NPK Mutiara Professional 9-25-25 significantly affected with a dose of 4 gr/liter of water. The tallest plant reached 47.80 cm, with the highest number of branches being 18 branches and the highest number of pods per plant being 23.60 pods, the fastest flowering age being 30 HST, and the heaviest net dry weight per plant being 66.00 grams. The best application of NPK Mutiara Professional for the growth and production of red bean plants in lowland areas is 4 gr/liter of water/plot.

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