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Soybean Root Dynamics (*Glycine max* (L.) Merrill) on Balance of Fertilization and Garden Populations on different Varieties of Soy Cane Intercropping System

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ABSTRACT: The root is an important component of a plant. Root growth, root nodules and plant growth are highly dependent on soil fertility, plant varieties and plant isolation. This study aimed to determine the dynamics of soybean roots (*Glycine max* (L) Merrill) on the balance of fertilization and plant populations in various varieties in the soy cane intercropping system. The method used was the treatment of varieties, plant population and fertilizer balance. The results showed that the treatment of Burangrang (V2) varieties gave significant results in plants aged 35 days after planting (DAP) with an average plant height of 471.593 cm. The treatment of fertilizer balance of 90 kg Urea + 2 tons of Organic Fertilizer (P2) provideda real result on the total number of nodules with an average of 22,481 and the number of effective nodules with an average of 16.370. Treatment of plant populations of 500,000 plants per ha (J1) contributedsignificant results to plants aged 21.28 and 35 days after planting (DAP) with average plant heights of 23.643 cm, 32.743 cm and 48.857 cm. The interactions between varieties and fertilization, varieties and population, fertilization and plant spacing determined not all parameters observed. Interaction of Wilis Varieties, Urea Fertilizer 135 kg + 2 Tons of Organic Fertilizer and a population of 500,000 plants per ha (V1P3J1) gave tangible results on the number of effective root nodules with an average of 23.00 and the average between Burangrang varieties, 90 kg of urea fertilizer + 2 tons of organic fertilizer and a population of 500,000 plants per ha (V2P2J1) produced tangible results on the number of effective root nodules with an average of 27.83.

Keywords: Organic fertilizer, Urea fertilizer, Soybean plant, Root nodules, Plant populations.

Abbreviations: V, Varieties; P, Balance Fertilizer; J, Plant Population; BNJ, Honest Real Difference; DMRT, Duncan's Multiple Range Test.

I. INTRODUCTION

Soybean (*Glycine max* L.) is one of the important food commodities in Indonesia because it can be used as food, feed, and raw material for industrial purposes. Efforts towards self-sufficiency in soybeans continue to be carried out because domestic soybean needs are quite large. So far, the shortage of soybeans is still sufficient with loans. Soybean imports from year to year showed an increase. The Central Statistics Agency shows that soybean imports from 2013-2017 have increased. For the January-June 2018 period, soybean imports have reached 1.17 million tons or 43.7% of the total imports in the previous year. Data from the Ministry of Agriculture's Pusdatin recorded that 2018 soybean consumption reached 3.05 million tons while production only reached 864 thousand tons, resulting in a deficit of 2.19 million tons. The soybean deficit will continue to increase to 2.24 million tons in 2021 [3].

Using plants with two or more types of plants that are cultivated together in one place at the same time with regular planting spacing is known as shifting plants. This cropping pattern is considered able to reduce losses that cause price fluctuations, as well as increase operational costs such as labor and plant maintenance. In addition, the development of intercropping cropping patterns is expected to support government programs in supporting national food improvement [28]. Previous studies reported that nitrate inhibition was primarily host-plant-dependent but independent of nitrate metabolism in rhizobia [10]. Giving excessive nitrogen can inhibit the formation of root nodules [8]. The application of combined nitrogen, especially nitrate, to soybean plants is known to strongly inhibit nodule formation, growth and nitrogen fixation [18]. The inhibitory effects of nitrogen compounds appeared to be related to a decrease in photo assimilate partitioning in the nodules, rather than to 15 N transport into the nodules. The free amino acid concentrations after nitrogen treatments were increased in the nodules and leaves by nitrate, in the roots by ammonium, in the stems by urea, and the roots, stems, and leaves by glutamine treatment [21].

The use of superior varieties or suitable varieties in the environment (agroecology) is one of the important requirements in a soybean farming business. Achieving productivity is highly determined by the potential yield of superior varieties planted. Moreover, potential yield of seeds in the field is still related to genetic factors. If management of the growing environment is not carried out properly, the potential for high yield of seeds from superior varieties cannot be obtained (Adisarwanto *et al*, 2007) [25].

The root is an important organ in plants, especially for absorbing water and nutrients in the growing media. At the time of drought, anatomic and physiological changes might occur in plants, especially in the roots [7]. Plants develop more root systems in response to nutrient deficiencies and drought [13].

Giving the right organic fertilizer with a dose that suits the needs of plants is very influential on the growth and yield of soybean plants. According to Sarief (1986) [16], proper organic fertilizer application can improve soil quality, water availability, so as to facilitate plant nutrient uptake and stimulate root growth.

Plant spacing has an effect on plant growth and production. Increasing plant density per unit area to a certain extent can increase yield. Consequently, increasing the number of plants will further reduce the yield. Collins and Hawks (1993) added that spacing greatly determines the high growth rate and productivity level. Based on the description above, the authors are interested in conducting research to determine the dynamics of soybean roots (*Glycine max* (L.) Merrill) in the system of soy cane intercropping on the balance of fertilization and plant population in different varieties [24].

II. MATERIALS AND METHODS

The research was conducted at anexperimental farm managed by Faculty of Agriculture, University of Muhammadiyah Jember. Starting on February 21, 2018 until May 21, 2018 with ± 89 meters altitude above sea level (asl). The study was conducted as factorial (3 x 2) with a basic pattern of Group Random Design (RAK), which consisted of three factors: the first factor was varieties (V), the second factor was balancing fertilizer (P) and the third factor was plant population (J) which twice repetition for each treatment.

The first factor varieties of soybean (V), namely: V1: varieties Willis, V2: varieties Burangrang, V3: varieties Agromulyo, the second factor balancing fertilizers (P), namely: P1 45 kg urea / ha + 2 tons of organic fertilizer, P2 90 kg of urea / ha + 2 tons of organic fertilizer, P3 135 kg urea/ha + 2 tons of organic fertilizer and plant populations third factor (J), namely: J1: 500,000 plants /ha, J2; 250,000 plants/ha, J3: 125,000 plants/ha, each treatment was repeated twice. The real different varieties carried out a further BNJ test by 5%, while the influence of fertilization, soybean plant populations, and interaction among each with Duncan's Multiple Range Test (DMRT) [6].

Soybean planting wasdone with a spacing that varies according to the treatment (J1: 500,000 plants/ha, J2; 250,000 plants/ha, J3: 125,000 plants/ha) and each planting hole soybean seed planted two seedlings in anticipation of death. Meanwhile, planting cane was done by means of three books per holes planted with a spacing of 100 cm between rows and 15 cm between the planting holes. Soybean fertilization carried out in accordance with the treatment (P1 45 kg urea/ha + 2 tons of organic fertilizer, P2 90 kg urea / ha + 2 tons of organic fertilizer, P3 135 kg urea/ha + 2 tons of organic fertilizer) and plus fertilizer SP36: 150 kg/ha, KCl: 50 kg/ha in each treatment plot. As for soy cane, fertilization wasdone one day prior toplanting with a dose of 160 kg 120 kg Urea, TSP and 300 kg KCl / ha). Harvesting would be done when the plant is 95% ripe pods yellow, and marked by the falling leaves (there are 5-6 leaves). Parameter observations include: root length (cm), number of total root nodule, number of effective root nodules, effective dry weight of nodules roots (gram), and weight of total root nodules (gram).

III. RESULTS AND DISCUSSION

A. Root length

The results of analysis of the variance showed that all treatments did not significantly affect the root length of soybean plant. The average of root length of soybean plants affected by the treatment of varieties, fertilizers and populations are presented in Fig. 1.

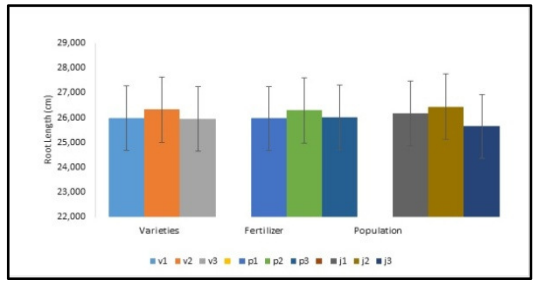

Fig. 1. The effect of varieties, fertilizers and populations on root length of soybean plants (cm).

Fig. 1 shows that the influence of the varieties on the root length of soybean plants, Burangrang varieties (V2) has the longest root length (26,339 cm) and that of Agromulyo varieties (V3) have the shortest root length (25,959). While the influence of fertilization on root length of soybean plant, fertilizations of 90 kg urea/ha + 2 tons of organic fertilizer (P2) showed the longest root length at 26.294 cm and fertilizations of 45 kg urea/ha + 2 tons of organic fertilizer (P1) showed the shortest root length at 25,972 cm. While the influence of population number on soybean root length was as followed; populations of 250,000/ha (J2), showed the longest root length (26.448 cm), and populations of 125,000 / ha (J3) showed the shortest root length (25,661 cm).

The average of root length of soybean plant that was affected by the interactions of varieties (V) with fertilizer (P), varieties (V) with population (J), fertilizer (P) with population (J), and the three interactions above showed that the effect was not significantly different (Fig. 2). Fig. 2 showed that the interactions between Burangrang varieties and fertilizers of 135 kg urea/ha + 2 tons of organic fertilizer (V2P3) were 26,706 cm which have the longest root length and the interactions between Agromulyo varieties and fertilizers of 45 kg urea/ha + 2 tons of organic fertilizer (V3P1) were 25,256 cm which have the shortest root length when compared to the other interactions. The interactions between Burangrang varieties and populations of 250,000 plants/ha (V2J2) at 26,628 cm have the longest root length and the interactions between Wilis varieties and populations of 125,000 plants / ha (V1J3) at 25,317 cm have the shortest root length when compared to all interactions. Interactions between fertilizers of 45 kg urea/ha + 2 tons of organic fertilizer and populations of 250,000 plants/ha (P1J2) were 26,717 cm which have the longest root length, while interactions between fertilizers of 135 kg urea/ha + 2 tons of organic fertilizer and plant population 125,000 plants/ha (P3J3) were 25,256 cm which have the shortest root length that were compared to all interactions. As well as interactions between Wilis varieties, fertilizers of 130 kg urea + 2 tons of organic fertilizer and populations of 125,000 plants/ ha (V1P3J3) were showing the average of the shortest root length (24,317 cm) and the longest root length of the interactions between Agromulyo varieties, fertilizers of 90 kg urea + 2 tons of organic fertilizer and populations of 125,000 plants/ha (V3P2J3) were 27,717 cm.

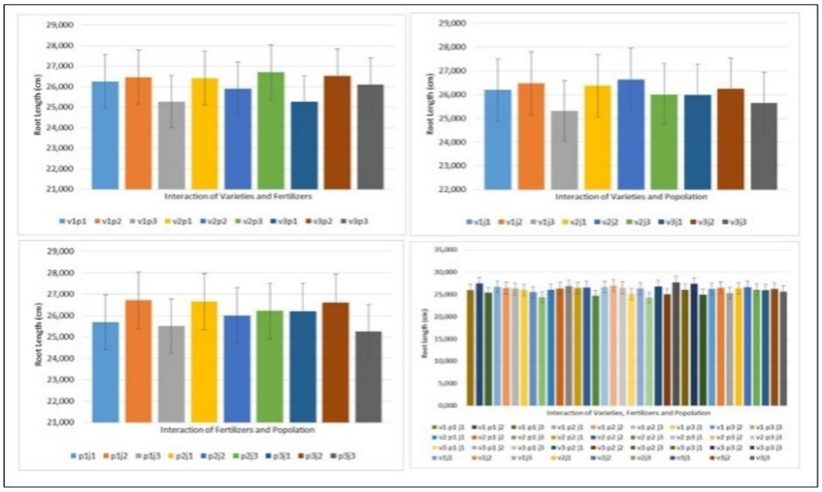

Fig. 2. (a) The effect of the variety with the fertilizer interaction (VP), on the root length, (b) the effect of variety with population interaction (VJ), on the root length, (c) the effect of the fertilizer with population interaction (PJ), on the root length, and (d) the effect of the variety with fertilizer and population interactions (VPJ) on the root length.

No effect of the varieties treatment (V), fertilization (P), and population (J), as well as the interactions between the treatments of the root length of soybean plants. It is thought to be due to the fact that nutrient requirements for plant growth can be fulfilled around plant roots, so that plant roots were not further development. As we know, most of the elements of plant needed are absorbed through the roots. The root is, therefore, the main vegetative organ that supplies water, minerals, and materials that were essential for plant growth and development. The important function of root is to absorb, add, store, transport water and nutrients [27].

B. The number of total root nodule

The average of total root nodule number of soybean plants that were affected by the treatment of variety and population showed an insignificant effect, while the effect of fertilizer on root nodules showed a significant effect.

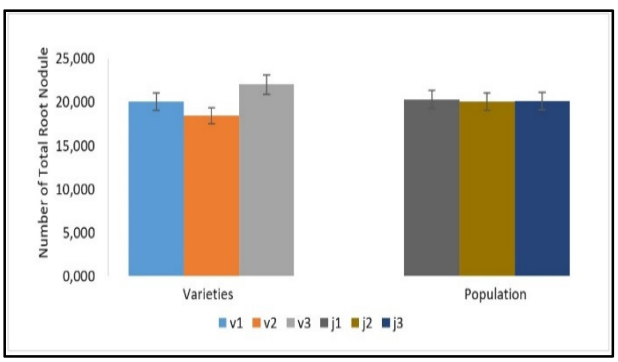

Fig. 3. The effect of varieties and populations on the number of total root nodules.

Fig. 3 showed that the influence of varieties on the number of total root nodules of soybean plants, the Agromulyo varieties (V3) had the highest number of total root nodules (22.037 pieces), and the Burangrang varieties (V2) had the smallest number of total root nodules (18.481 pieces). These results showed that the Agromulyo varieties (V3) could better adapt the formation of root nodules in the Soy Cane intercropping system.

These differences were thought to be due to genetic effect of each variety. Umarie and Holil (2016) stated that besides the environment factors, plant growth may also be influenced by the genetic factors of the variety itself [14]. While the effect of the number of population on the number of soybean total root nodules, the populations of 500,000/ha (J1), showed the highest number of total root nodules (20.333 pieces), and populations of 250,000/ha (J2) showed the smallest number of total root nodules (20.093 pieces). These results showed the number of population did not significantly affect the number of root nodules on soybean plants.

DMRT analysis (5%) on the number of total root nodules of fertilizer treatments of 90 kg urea + 2 tons of organic fertilizer (P2), showed the best number of total root nodules, that is 22.481 pieces. These results were significantly different from the fertilizations of 45 kg urea + 2 tons of organic fertilizer (P1) (Table 1). This trial was suspected due to differences in nutrient availability for plants as Armiadi (2009) [1] mentioned that factors also affect the development and activity of rhizobium in the soil includeing humidity, aeration, temperature, organic substance, soil acidity, inorganic nutrient supply, soil type, and percentage of sand and clay.

Table 1: The effect of fertilizer treatment on the number of total root nodules.

Fertilizer treatment	Number of Total Root Nodule	
(P1) 45 kg Urea + 2 Ton Organic fertilizer	18,148	b
(P2) 90 kg Urea + 2 Ton Organic fertilizer	22,481	a
(P3) 135 kg Urea + 2 Ton Organic fertilizer	19,963	ab

Note: The average followed by the same letter showed no significant difference in Duncan's Multiple Range Test (DMRT) level of 5%.

The average of root nodules of soybean plants number wasaffected by interactions of varieties (V) with fertilizers (P), varieties (V) with populations (J), and fertilizers (P) with populations (J) were presented in Fig. 4.

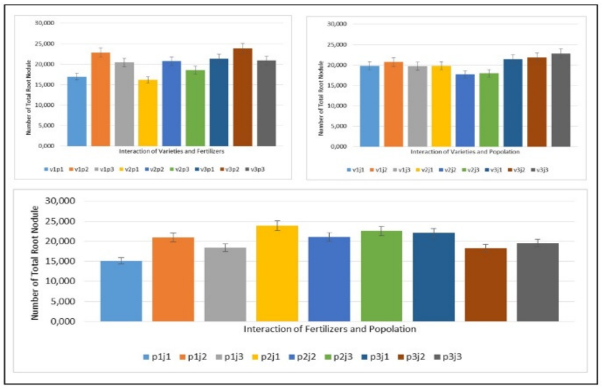

Fig. 4. (a) The effect of varieties with fertilizers interactions (VP), on the number of total root nodules (pieces), (b) the effect of varieties with populations interactions (VJ), on the number of total root nodules (pieces), and (c) the effect of fertilizers with populations interactions (PJ), on the number of total root nodules (pieces).

Fig. 4 showed that the interaction between Agromulyo varieties and fertilizers of 90 kg urea/ha + 2 tons of organic fertilizer (V3P2) at23,889 had the largest number of total root nodules and the interactions between Burangrang varieties and fertilizers of 45 kg urea/ha + 2 tons of organic fertilizer (V2P1) at 16,167 had the smallest dry weight that were compared to all interactions. Interactions between Agromulyo varieties with populations of 125,000 plants/ha (V3J3) had the largest number of total root nodules and interactions between Burangrang varieties and populations of 250,000 plants/ha (V2J2) had a smallest number of total root nodules that were compared to all interactions. The interactions between fertilizers of 90 kg urea/ha + 2 tons of organic fertilizer and populations of 500,000 plants/ha (P2J1) at23,833 had the largest number of total nodules and the interactions between fertilizers of 145 kg urea/ha + 2 tons of organic fertilizer and populations of 500,000 plants/ha (P1J1) 15,111 had the smallest number of total root nodules that were compared to all interactions.

DMRT analysis (5%) (Table 2) on the number of total root nodules, the treatment of the interactions between Burangrang varieties, fertilizers of 90 kg urea + 2 tons of organic fertilizer and populations of 500,000 plants / ha (V2 P2 J1) were not significantly different from the interactions between Agromulyo varieties, fertilizers of 135 kg urea + 2 tons of organic fertilizer and populations of 250,000 plants/ha (V3 P3 J2), interactions between Burangrang varieties, fertilizers of 45 kg urea + 2 tons of organic fertilizer and populations of 500,000 plants/ha (V2 P1 J1), interactions between Burangrang varieties, fertilizers of 45 kg urea + 2 tons of organic fertilizer and populations of 250,000 plants/ha (V2 P1 J2), interactions between Burangrang varieties, fertilizers of 90 kg urea + 2 tons organic fertilizer and populations of 250,000 plants/ha (V2 P2 J2) and interactions between Wilis varieties, fertilizers of 45 kg urea + 2 tons of organic fertilizer and populations of 500,000 plants/ha (V1 P1 J1), while interactions were combined with other treatments showed insignificant effect. The interactions between Burangrang varieties, fertilizers of 90 kg urea + 2 tons of organic fertilizer and populations of 500,000 plants/ha (V2 P2 J1) gave the best results (Table 2). This was assumed due to differences in genetic factors, plant density and availability of nutrient so the plants have different responses in each variety. In addition, plants also competed with each other for nutrients and defend themselves by forming root nodules in order to obtain adequate nitrogen supply from the air by means of rhizobium bacteria that were found in root nodules. Genetic characteristic influenced the growth and development of plants, growth was a result of the interaction between the various internal factors that stimulated growth (namely in genetic control) and climate, soil and biological elements of the environment [29]. The formation of root nodules can be influenced by interactions between plant varieties and infecting bacteria [9].

Table 2: The effect of varieties, fertilizer and population interactions on the number of total root nodules.

Treat ment	Average total root nodules (pieces)	Treat ment	Average total root nodules (pieces)	Treat ment	Average total root nodules (pieces)
V1P1J1	13,50 d	V2P1J1	15,33 bcd	V3P1J1	16,50 abcd
V1P1J2	21,00 abcd	V2P1J2	15,17 cd	V3P1J2	26,67 ab
V1P1J3	16,33 abcd	V2P1J3	18,00 abcd	V3P1J3	20,83 abcd
V1P2J1	19,33 abcd	V2P2J1	27,83 a	V3P2J1	24,33 abcd
V1P2J2	24,67 abcd	V2P2J2	15,17 cd	V3P2J2	23,33 abcd
V1P2J3	24,50 abcd	V2P2J3	19,17 abcd	V3P2J3	24,00 abcd
V1P3J1	26,50 abc	V2P3J1	16,17 abcd	V3P3J1	23,50 abcd
V1P3J2	16,50 abcd	V2P3J2	22,83 abcd	V3P3J2	15,50 bcd
V1P3J3	18,33 abcd	V2P3J3	16,67 abcd	V3P3J3	23,67 abcd

Note: The average was followed by the same letter showed no significant difference in the Duncan's Multiple Range Test (DMRT) level of 5%.

C. Number of Effective Root Nodules

The average of effective root nodules number of soybean plants that was affected by the treatment of varieties and populations showed an insignificant effect, while the effect of fertilizer on root nodules showed a significant effect.

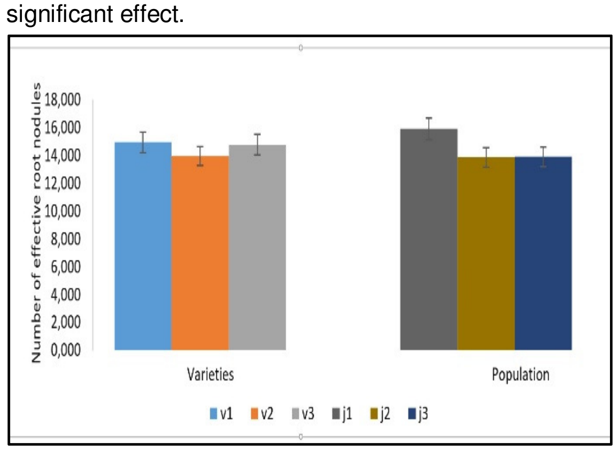

Fig. 5.

Fig. 5 showed the influence of varieties on the number of effective root nodules of soybean plants, Willis varieties (V1) had the highest number of effective root nodules (19.944 pieces), and Burangrang varieties (V2) had the lowest number of effective root nodules (14.963 pieces).

These results showed that the Willis varieties (V2) could better adapt the effective root nodule formation on Soy Cane intercropping system. This difference was possibly due to the genetic influences of each variety. Umarie and Holil (2016) stated that besides the environment factors, plant growth is also influenced by genetic factors of variety itself [14]. While the influence of the population number on the number of effective root nodules of soybean, populations of 500,000/ha (J1), showed the highest number of effective root nodules (15.907 pieces), and populations of 250,000/ha (J2) showed the smallest number of effective root nodules (13.870 pieces). These results showed that the population number did not affect the number of root nodules on soybean plants significantly.

DMRT analysis (5%) of the number of effective root nodules in fertilizer treatments of 90 kg urea + 2 tons of organic fertilizer (P2), showed the best number of effective root nodules, that was16.370 pieces.These results were significantly different from fertilizations of 45 kg urea + 2 tons of organic fertilizer (P1) (Table 1).

Table 3: The effect of fertilizer treatment to the number of effective root nodules.

The treatment of fertilizer	Number of effective root nodules	
(P1) 45 kg Urea + 2 Tons of Organic Fertilizer	12.370	b
(P2) 90 kg Urea + 2 Tons of Organic Fertilizer	16.370	a
(P3) 135 kg Urea + 2 Tons of Organic Fertilizer	14.944	ab

Note: The average was followed by the same letter showed no significant effect on Duncan's Multiple Range Test (DMRT) level of 5%.

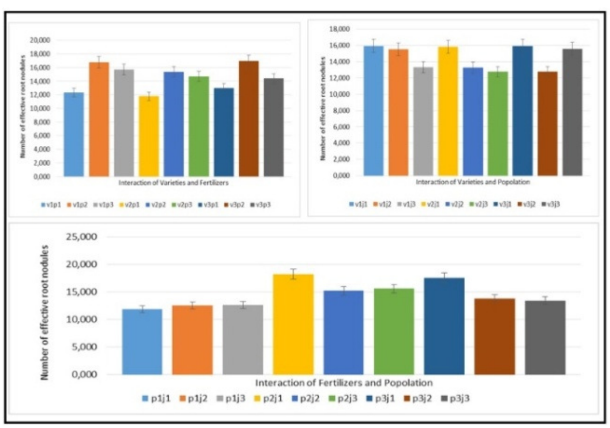

Fig. 6. (a) The effect of interaction with fertilizer varieties (VP), of the total effective root nodules (fruit), (b) the effect of interaction with the population varieties (VJ), against total effective root nodules (fruit), and (c) the effect of fertilizer interaction with population (PJ), to the amount of effective total root nodules (fruit).

This trial was expected due to the differences in nutrient availability to plants as Armiadi (2009) [1] posited that the factors that also affect the development and activity of rhizobium in the soil, such as moisture, aeration, temperature, organic substance, soil acidity, inorganic nutrient supply, soil type, and the percentage of sand and clay (Table 5). The effect of fertilizer treatment to the number of effective root nodules.Fig. 6 indicatesthat the interaction betweenAgromulyo varieties and fertilizer 90 kg Urea/ha + 2 Tons of Organic Fertilizer (V3P2) showed the greatest effective number of root nodules, while interaction between Burangrang varieties and fertilizer 45 kg Urea/ha + 2 Tons of Organic Fertilizer (V2P1) has a dry weight of the smallest compared to all interactions. Interaction between varieties of Willis and a population of 500,000 plants per ha (V1J1), and interaction varieties Agromulyo and a population of 125,000 plants per ha (V3J1) has a number of root nodules effectively the largest and interaction between varieties Burangrang and a population of 125,000 plants per ha (V2J3) and interaction varieties Agromulyo and a population of 250,000 plants per ha (V3J2) has a number of effective root nodule is small compared to all interactions. Interaction between Urea Fertilizer 90 kg/ha + 2 tons of organic fertilizer and a population of 500.

DMRT analysis (5%) (Table 4) against the number of effective root nodules, treatment with the interaction between Willis varieties, fertilizer urea 135 kg + 2 tons of organic fertilizer and a population of 500,000 plants per ha (P3 V1 J1) indicates the mostnumber of effective nodules (23.00 total).These results showed significant difference from varieties interaction Burangrang, urea 135 kg + 2 tons of organic fertilizer and a population of 125,000 plants per ha (V2 P3 J3), the interaction between varieties Agromulyo, urea 45 kg + 2 tons of organic fertilizer and a population of 500,000 plants per ha (V3 P1 J1), the interaction between varieties Willis, urea 135 kg + 2 tons of organic fertilizer and a population of 250,000 plants per ha (V1 P3 J2), interaction between varieties Burangrang, urea 45 kg + 2 tons of organic fertilizer and a population of 500,000 plants per ha (V2 P1 J1), the interaction between varieties Agromulyo, fertilizer 45 kg urea + 2 tons of organic fertilizer and a population of 250,000 plants per ha (V3 P1 J2), the interaction between Burangrang varieties, fertilizer urea 135 kg + 2 tons of organic fertilizer and a population of 500,000 plants per ha (V2 P3 J1), the interaction between varieties Burangrang, urea 90 kg + 2 tons of organic fertilizer and a population of 125,000 plants per ha (V2 P2 J3), the interaction between varieties Willis, Urea 135 kg + 2 tons of organic fertilizer and a population of 125,000 plants per ha (V1 P3 J3), the interaction between varieties Burangrang, urea 90 kg + 2 tons of organic fertilizer and a population of 250,000 plants per ha (V2 P2 J2), The interaction between Willis varieties, fertilizer urea 45 kg + 2 tons of organic fertilizer and a population of 125,000 plants per ha (V1 P1 J3), the interaction between varieties Willis, urea 45 kg + 2 tons of organic fertilizer and a population of 500,000 plants per ha (V1 P1 J1), the interaction between varieties Agromulyo, urea 135 kg + 2 tons of organic fertilizer and a population of 250,000 plants per ha (V3 P3 J2) and the interaction between varieties Burangrang, urea 45 kg + 2 tons of organic fertilizer and a population of 250,000 plants per ha (V2 P1 J2). This is presumably due to differences in genetic factors, plant density and the availability of nutrients so plants showeddifferent responses in each variety in addition to the plants are also competing for nutrients thus mutually defend themselves by forming root nodules in order to obtain nitrogen supply from the air above assistance from rhizobium bacteria in the root nodules.

Demand Fuskhah, *et al.,* (2009) the formation of nodules can be influenced by the interaction between varieties of plants with infectious bacteria [9]. Armiadi (2009) [1] stated that the factors affecting the development and activity of Rhizobium in the soil, among others, moisture, aeration, temperature, organic matter content, soil acidity, inorganic nutrient supply, soil type, and the percentage of sand and clay. In addition to the environment of nodule was also influenced by the nutrients, the presence of nutrients in the soil affect the existence of the bacteria and the formation of nodules on the plant. According to Bachtiar and Setiyo (2013) [26], biological and urea fertilizer can increase the number of root nodules. The bacteria found in the soil could not entirely infect the roots of leguminous plants forming nodules. The effectiveness of a nodule, as found in the study, was affected by infectious bacteria and varieties of plants.

Table 4: Effect of the interaction of varieties, fertilizers and plant spacing to the number of effective root nodules.

Treatment	Number of effective root nodules	Treatment	Number of effective root nodules	Treatment	Number of effective root nodules
P1V1J1	10.50 b	V2P1J1	12.50 b	V3P1J1	12.67 b
V1P1J2	15.50 ab	V2P1J2	9.67 b	V3P1J2	12.50 b
V1P1J3	11.00 b	V2P1J3	13.17 ab	V3P1J3	13.83 ab
P2V1J1	14.33 ab	V2P2J1	22.67 ab	V3P2J1	17.83 ab
V1P2J2	18.67 ab	V2P2J2	11.33 b	V3P2J2	15.67 ab
V1P2J3	17.33 ab	V2P2J3	12.17 b	P2V3J3	17.33 ab
P3V1J1	23.00 a	V2P3J1	12.33 b	P3V3J1	17.33 ab
V1P3J2	12.50 b	P3V2J2	18.83 ab	P3V3J2	10.17 b
V1P3J3	11.67 b	V2P3J3	13.00 b	P3V3J3	15.67 ab

Note: On average, followed by the same letter shows no significant effect on the test Duncan's Multiple Range Test (DMRT) level of 5%.

D. Effective dry weight of nodules roots

The average of effective dry weight of nodules roots of soybean plants affected by the treatment of varieties fertilizers and populations showed no significant difference.

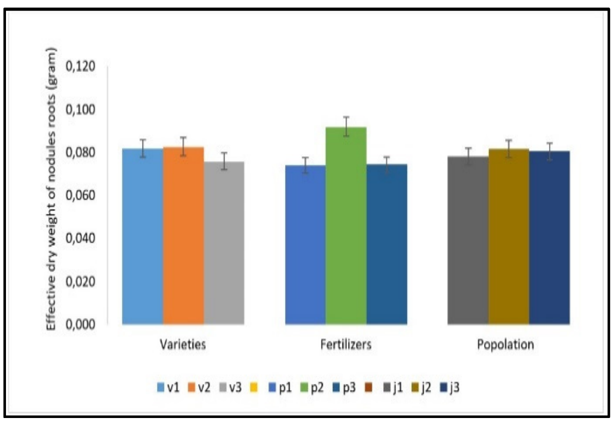

Fig. 7. Effect of varieties, fertilizers and population of the effective dry weight of nodules roots.

As seen in Fig. 7, by disclosing the influence of varieties on the dry weight of effective root nodules, showed that the Burangrang variety (V2) had the largest effective root nodule dry weight and Agromulyo variety (V3) had the smallest effective root nodule dry weight of other varieties. While the influence of fertilization on the dry weight of effective root nodules, it is known that multiplied fertilizer 90 kg Urea/ha + 2 tons of organic fertilizer (P2) has dry weight of nodules effectively the largest and treatment of manure 135 kg urea/ ha + 2 tons of organic fertilizer (P3) has a dry weight of the smallest effective nodule other fertilizing. While for the effect of population size on the effective root dry weight, it was found that the population of 250,000 plants per ha (J2) has the largest effective root nodule weight and a population of 125,000 plants per ha (J3) has the smallest effective root nodule dry weight of other populations.

The average dry weight of effective root nodules of soybean plants are influenced by the interaction of varieties (V) with fertilizer (P), the interaction of varieties (V) with a population (J), fertilizer interaction (P) with population (J), and to-interaction his 3 shows the effect of no significant (Fig. 8).

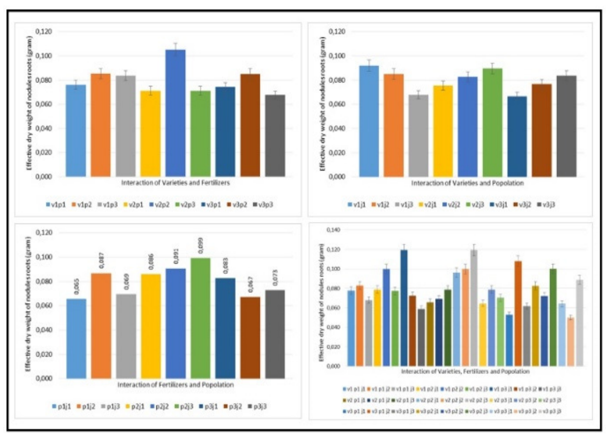

Fig. 8. (a) The effect of interaction with fertilizer varieties (VP), of the dry weight of root nodules effectively, (b) the effect of interaction with the population varieties (VJ), to the dry weight of root nodules effectively, (c) the effect of fertilizer interaction with population (PJ), to effectively root nodule dry weight, and (d) the effect of the interaction of varieties with fertilizer and population (VPJ) of the dry weight of nodules effectively.

Fig. 8 shows that the interaction between Burangrang varieties and 90 kg urea/ha + 2 tons of organic fertilizer (V2P2) has the largest effective root nodule dry weight and the interaction between Agromulyo varieties and 135 kg urea/ha + 2 tons of organic fertilizer (V3P3)) has the smallest effective root nodule dry weight when compared to all interactions. Interaction between Wilis varieties and populations of 500,000 plants per ha (V1J1) had the largest effective dry nodule dry weight and interactions between Agromulyo varieties and populations of 500,000 plants per ha (V3J1) had small effective root nodule dry weights compared to all interactions. Interaction between fertilizer 90 kg Urea/ha + 2 Tons of Organic Fertilizer and population of 125,000 plants per ha (P2J3) has the biggest effective dry nodule dry weight and interaction between fertilizer 45 kg Urea/ha + 2 Tons of Organic fertilizer and population of 500,000 plants per ha (P1J1) has the smallest effective root nodule dry weight compared to all interactions. As well as the average of the smallest effective root nodules dry weight is the interaction between varieties of Agromulyo, 135 kg urea fertilizer + 2 tons of organic fertilizer and a population of 250,000 plants per ha (V3P3J2) and the largest effective root nodule dry weight is the interaction between Wilis varieties, fertilizer 135 kg urea + 2 tons of organic fertilizer and population of 500,000 plants per ha (V1P3J1) and interactions between Burangrang varieties, fertilizer 90 kg urea + 2 tons of organic fertilizer and population of 125,000 plants per ha (V2P2J3).

E. Weight of total root nodules

The average total weight of nodules of soybean plants affected by the treatment of varieties, fertilizers and populations showed no significant effect.

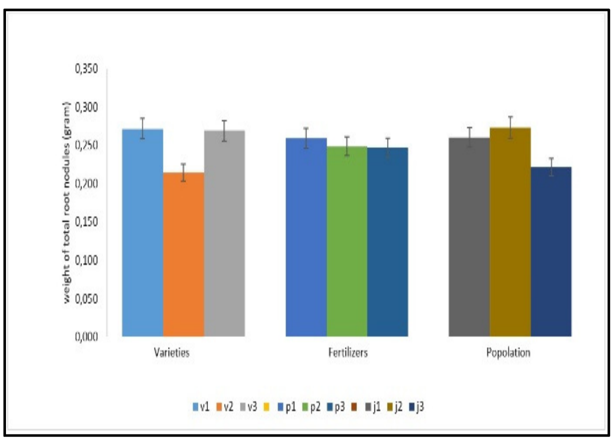

Fig. 9. The influence of varieties, fertilizers and population against the weight of total root nodules.

Figure 9 shows that the influence of varieties on total root nodule weights of soybean plants, it was found that the Wilis variety (V1) had the largest total root nodule weights and the Burangrang variety (V2) had the smallest total root nodule weights than other varieties. These results show that the Willis (V2) variety could better adapt in the formation of total root nodule weights in the soybean intercropping system. This difference is thought to be due to more genetic influence of each variety. Umarie and Holil (2016) stated that in addition to environmental factors, plant growth is also influenced by the genetic factors of the variety itself [14]. The effect of fertilization on the total root nodule weight is known that fertilizer per kg 45 kg urea/ha + 2 tons of organic fertilizer (P1) has the largest total root nodule weight and fertilizer treatment 135 kg urea/ha + 2 tons of organic fertilizer (P3) has the weight of nodules the smallest total of other fertilizers. These results show that large urea fertilization mightnot significantly influence the weight of the root nodules, even a small amount of urea fertilization is sufficient to obtain a total root nodule. Urea fertilizer in soybean plants only functions as a starter for the formation of root nodules, then the need for Nitrogen will be fulfilled by Rhizobium bacteria that are symbiotic with soybean roots. While the effect of the population on total root nodule weights is found that a population of 250,000 plants per ha (J2) has the largest total root nodule weights and a population of 125,000 plants per ha (J3) has the smallest total root nodule weights than other populations. Soybean is known to have the ability to bind N2 in the air (a form of N that is not available to plants) because it works with root nodules or Rhizobium in the soil. The nitrogen is then used by plants to support the soybean growth and development cycle. Furthermore, nitrogen is absorbed and then functioned as seed formation material in the physiological processes of plants [22].

Average dry weights of effective root nodules of soybean plants affected by interaction of varieties (V) with fertilizer (P), interaction of varieties (V) with population (J), interaction of fertilizers (P) with population (J), and the interaction of the three shows different effects (Fig. 10).

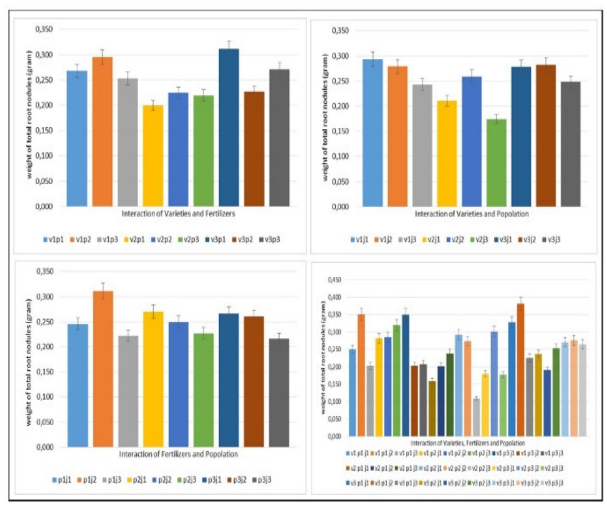

Fig. 10. (a) The effect of the interaction of varieties with fertilizer (VP), on the weight of total root nodules, (b) the effect of interaction of varieties with population (VJ), on the weight of total root nodules, (c) the effect of interaction of fertilizer with population (PJ), on the total root nodule weight, and (d) the effect of interaction of varieties with fertilizer and population (VPJ) on the total root nodule weight.

Fig. 10 shows that the interaction between Agromulyo varieties and 45 kg Urea/ha + 2 Tons of Organic fertilizer (V3P1) has the largest total root nodule weight and the interaction between Burangrang varieties and 45 kg Urea / ha + 2 Tons of Organic fertilizer (V2P1) has the smallest total root nodule weight compared to all interactions. Interactions between Wilis varieties and populations of 500,000 plants per ha (V1J1) have the largest total root nodule weights and interactions between Burangrang varieties and populations of 125,000 plants per ha (V2J3) have small total root nodule weights compared to all interactions. Interaction between 45 kg Urea/ha + 2 Tons of Organic fertilizer and population of 250,000 plants per ha (P1J2) has the largest total root nodule weight and interaction between 45 kg Urea/ha + 2 Tons of Organic fertilizer and population of 125,000 plants per ha (P3J3) has the smallest total root nodule weight compared to all interactions, such asinteraction between Burangrang varieties, 90 kg urea fertilizer + 2 tons organic fertilizer and 125,000 plants per ha (V2P2J3) gram population and the biggest effective nodule root dry weight is the interaction between Agromulyo varieties, 45 kg urea fertilizer + 2 tons organic fertilizer and 250,000 plants population per ha (V3P1J2).

IV. CONCLUSION

This study shows that the treatment of Burangrang (V2) varieties indicatedsignificant results on plants aged 35 days after planting (HST) with an average plant height of 47,1593 cm. The fertilizer balance treatment of 90 kg Urea + 2 Tons of Organic Fertilizer (P2) gave a real result on the total number of nodules with an average of 22,481 and the number of effective nodules with an average of 16,370. The treatment of plant population of 500,000 plants per ha (J1) gave significant results on plants aged 21, 28 and 35 days after planting (HST) with an average plant height of 23,643 cm, 32,743 cm and 48,857 cm. The interaction between varieties and fertilization, varieties and population, fertilization and plant distance shows not real on all parameters observed. Wilis Varieties Interactions, Urea Fertilizers 135 kg + 2 Tons of Organic Fertilizers and a population of 500,000 plants per ha (V1P3J1) give tangible results on the number of effective root nodules with an average of 23.00 and the average between Burangrang varieties, 90 kg urea fertilizer + 2 tons of organic fertilizer and a population of 500,000 plants per ha (V2P2J1) yielded tangible results on the number of effective root nodules with an average of 27.83.

V. FUTURE SCOPE

Agriculture.

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Conflict of Interest. Author Tanabe, Author Jalil, Author Umarie and Author Tripamadeclare that they have no conflict of interest.

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