Poll Res. 40 (4) : 1542-1546 (2021)

ISSN 0257–8050

RHIZOBIUM SYMBIOTIC MUTUALISM WITH RICE BEAN (*VIGNA ADIATA)* ROOT HAIR ON THE LAND POLLUTED BY SODIUM

HASAN BASRI JUMIN, NUR IKHSAN AND MAIZAR

Department of Agriculture Technology, Islamic University of Riau Pekanbaru 28284 Indonesia

(Received 12 April, 2021; accepted 30June, 2021)

ABSTRACT

Combination between *Rhizobium* and sodium have been interacting effect to production of rice bean seed dry weight. *Rhizobium* 15 g/kg seeds are more suitable dose for rice been. The effect of sodium to rice bean by growth decline gradually beginning from 0.5 g/kg seed in the soil. Net assimilation rate, mean relative growth rate and seed production was suppressed if high sodium concentration applied in the soil. However under dose of 0.5 g/l sodium was precisely utilized for growth of rice bean, because in low sodium concentration in the soil could replace potassium ion. Application of rhizobium 15 g/kg seed and sodium 0.5 g/l could cause nitrogen necessity efficiency to 136 % and is recommended for optimal plant growth.

KEY WORDS : Soil pollution, Rhizobium, Sodium in soil

INTRODUCTION

Riau province Indonesia mainly consists of the marginal land with high sodium contents mainly in coastal areas (Jumin *et al*., 2017). Actually, sodium is not an essential nutrient for plants, however in the land potassium deficiency, the sodium could substitute the potassium for plant growth. Even though the sodium is not essential element, however in small quantities can be applied for plant growth. There were similar functions with micro nutrients to assist in plant metabolism and synthesis of chlorophyll in leaf. In many cases, sodium could be applied as a partial alternate for potassium and assist in the opening and closing of stomata.

Sodium function in the plant growth in is dispersion of the clay particle increases density of soil, water tends to pool on the surface on the soil, the roots of the plant are not able to grow deep into the soil, effects water absorption on the plant, and causes stunted and leaf burn (Christable, 2019).

Rhizobium have realized an ecological and evolutionary success that has composed our biosphere. Although complex against, embrace a dual lifestyle of intracellular infection apart by a free-living phase in cultivated land. Rhizobium symbiosis has distributing and dispersion to hundreds of bacterial species and geographically throughout the globe (Brewin, 2010).

Dual ability of intracellular residual and symbiotic nitrogen fixation in soybean and other legumes is competent to retain rhizobium in the soil. With less nitrogen fertilizer up to 50%, the legumes are still normally grown and the seed growth is optimum.

On the other side, Rhizobium could be eliminated the negative effect of excess sodium in the soil. Moreover rhizobium is also could reache about 199 % of the nitrogen necessity efficiency on soybean under land polluted by fly ash and eliminate the stress of soybean (Jumin *et al*., 2019).

This research is conducted to analyze the effect of rhizobium symbiotic with rice bean to the root hair under land polluted by sodium.

MATERIALS AND METHODS

Study area

This research was conducted in the Faculty of Agriculture Islamic University of Riau, Indonesia. The experiment was arranged with randomly simple design with two factors. First factor was sodium concentration namely 0.0 g sodium/l, 0.5 g

Corresponding author's email: hbjumin@gmail.com

sodium/l, 1.0 g sodium/l, and 1.5 g sodium/l. Second factor was 0.0 g rhizobium/kg seed, 5 g rhizobium,/kg seed, 10 g Rhizobium/kg seed, and 15 g rhizobium/kg seed. The treatments were repeated three times. The plants were maintained under light condition with ± 11.45 – 12.15 hour photoperiod

Parameters

Mean Relative Growth Rates (MRGR)

Relative growth rate is the accumulation of dry weight of rice bean during their photosynthesis under light condition. The accumulation of dry weight describe the increasing of cell elongation and cell number in the rice bean. Mean relative growth rate (MRGR) can be calculated by sampling plant size at first time (t1) and second time (t2) in different age of plants. The equation for calculating the MRGR (South, 1995) is as follows;

$$\text{MRGR}=\frac{\ln W2-\ln W1}{t2-t1} \quad ..(1)$$

Where MRGR is mean relative growth rate; W1 and W2 are the dry biomass of rice bean at the time measured, beginning (t1) and end (t2) of the sampling period until the end of vegetative growth. and ***ln*** is the natural logarithm. Equation (1) is the most common formula used when comparing relative differences between sodium and rhizobium treatments.

Net assimilation rates (NAR)

The net assimilation rate is the weight of total dry weight per unit area of leaf in certain time.

$$E=\frac{1}{L}\frac{dW}{dt} \quad ..(2)$$

In measuring W the plant is destroyed to calculated dry weight thus changes in W is calculated by random sampling from all plants of rice bean. In this experiment samples are examined at intervals of 7 days form calculating W and L in during the vegetative growth. The W and L means may then be used to accumulate E_M, an estimate of the mean E for each time- interval (t2–t1), usually as proposed by (Vernon Allison, 1963). And isd shown in equation 3 thus;

$$E_{M}=\frac{(W2)-W1)\,(LogeL2-LogeL1)}{(T2-T1(L2-L1)} \quad ..(3)$$

Leaf area

Leaf area was measured on sub-sample using leaf area meter and image analysis software. Leaf area was measured four times on days 7, 14, 21 and 28 after planting. All data collected were analyzed by statistical analyses and presented in Tables, graphs and histograms.

Dry Weight

Dry weight of plants were measured 4 times during plants life cycle. Dry weight was used as a component to analyze the mean relative growth rate and net assimilation rate. The dry weight was calculated at beginning since 7 days after planting to soil till 28 days of planting.

Nitrogen Necessity Efficiency

Nitrogen necessity efficiency (NNE) was analyzed after 28 days of planting, because the vegetative growth ends on 28 days and afterward plants were promoted to generative growth as flowering. Nitrogen necessity efficiency data were taken from dry weight.

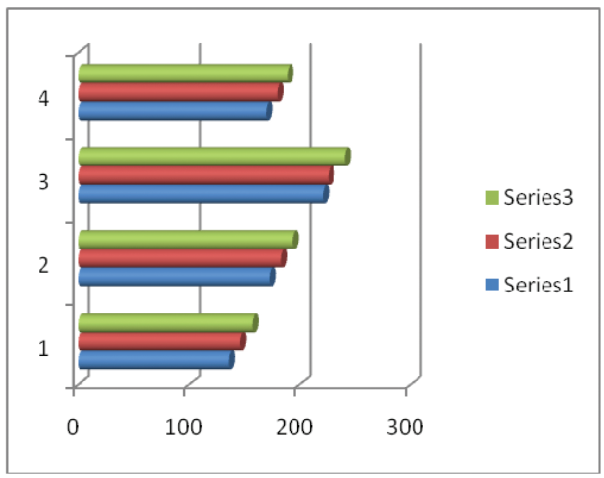


Fig. 1. Mean relative growth rate of rice bean on interaction between *rhizobium* treatment and sodium 15 g rhizobium/kg seed and 0.5 g sodium/l. Blue was 0.5 g/l, red was 0.0 g/l sodium/l, green was 1.0 g sodium/l and violet was 1.5 g sodium/l.Grub 1 on period 7 -14 days, 3 on period 14-21 days, and 5 on period 21-28 days.

RESULTS AND DISCUSSION

The application of *Rhizobium* could deduct nitrogen fertilizer in legumes by up to 25% in rice bean (Figure 6). The relationship between and sodium on the seed dry weight increases the seed dry weight and is composed of equations Y=14,621 – 981X – 688X2 with R2 = efficiency 0,368 (Figure 5) and the

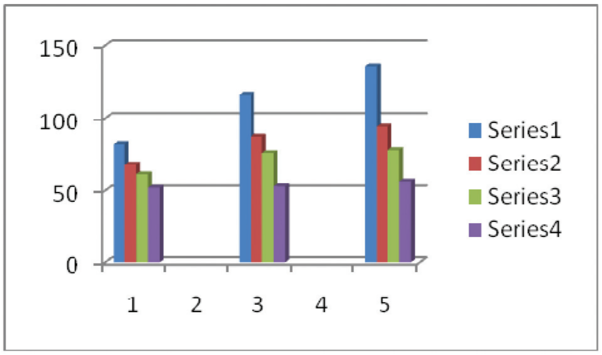
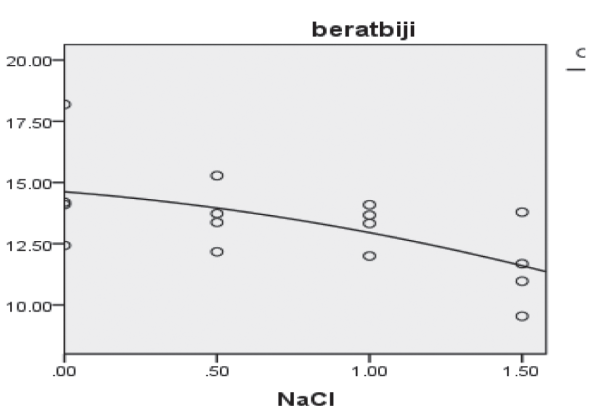


Fig. 2. Average NAR of rice bean on interaction between rhizobium and sodium, series 1 (7-14 days), series 2 (14-21 days), group 3 (21-28 days). Grub 1 Na 1.5 g/l, grub 2 Na 1.0 g/l, grub 3 Na 0.5 g/l and grub 4 Na 0.0 g/l

interaction effect of *Rhizobium* and low sodium dose has been shown to have a positive effect on rice bean with interrelated patterns Y=16,261 – 1,305X – 1,253X2 R2 = 0,226X2 (Figure 3). It has become evident that Rhizobium is capable to increase the nitrogen fertilizer by making nodules in root hair in legumes. The application of Rhizobium could deduct nitrogen fertilizer in legumes by up to 25% (Figure 6).

The interaction effect between rhizobium and sodium on the seed dry weight parameter, there is increase in the seed dry weight. There are shown in the equations Y=14.621 – 981X – 688X2 with R2 = efficiency 0.368 (Figure 5). The interaction effect between rhizobium and low sodium dose has been shown to have a positive effect on rice bean with interrelated patterns Y=16,261 – 1,305X – 1,253X2 R2 = 0,226X2 (Figure 3). It has become evident that rhizobium is capable to emerge the nodule in root hair.



Y= 16,261 – 1,305X – 1,253X2 R2 = 0,226

Fig. 3. Mean relative growth rate of rice bean under sodium stress.

The vegetative growth of rice bean was increased by the application of rhizobium to the seed under salinity conditions. rhizobium could make sodium resistance up to 0.5 g/l, it was indicated no significant effect difference between the mean relative growth rate, the net assimilation rate and the dry weight of the seed. When *Rhizobium* applied alone the net assimilation rate, the mean relative growth rate and the dry weight of the seed or the number of nodules effectively increased (Figure 1 and 2).

Combination of *Rhizobium* and sodium more than 0.5 g/kg of seed made the obstruction in all vegetative growth parameters.

Symbiotic mutualism between rhizobium and rice bean at a sodium concentration of 0.5 g/l could eliminate the salinity stress effect. It is indicated by NAR, MRGR and seed dry weight, there are not significantly differ to nodules effectively.

This symbiosis has also been constant and has been reshaped over millions of years in the history of *Rhizobium*. A bacteria well known for its symbiotic relationship with rice bean. It has become evident that Rhizobium is capable to emerge nodule in rice bean root hair.

The application of *Rhizobium* could deduct nitrogen fertilizer in legumes by up to 25% efficiency nitrogen fertilizer in rice bean (Figure 6). The relationship between Rhizobium and sodium on the seed dry weightis increases the seed dry weight and it is composed of equations Y=14,621 – 981X – 688X2 with R2 = efficiency 0,368 (Figure 5). The interaction effect of *Rhizobium* and low sodium dose has been shown to have a positive effect on rice bean with

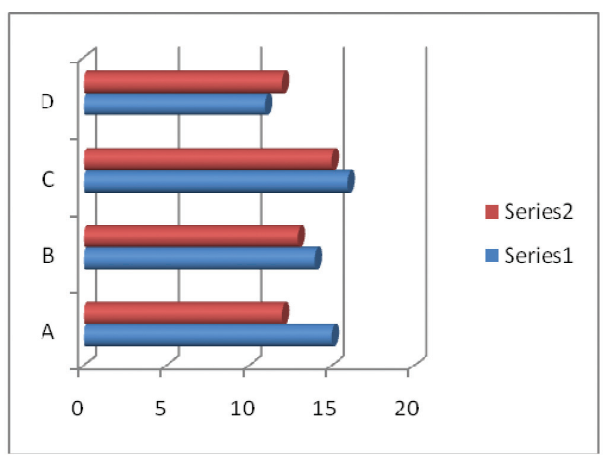


Fig. 4. Seed dry weight (*Rhizobium* blue = series 2, red = sodium series 2), A = sodium 0.0 g/l, B = sodium 1.0 g/l, C = sodium 0.5 g/l, and D = sodium 1.5 g/l.

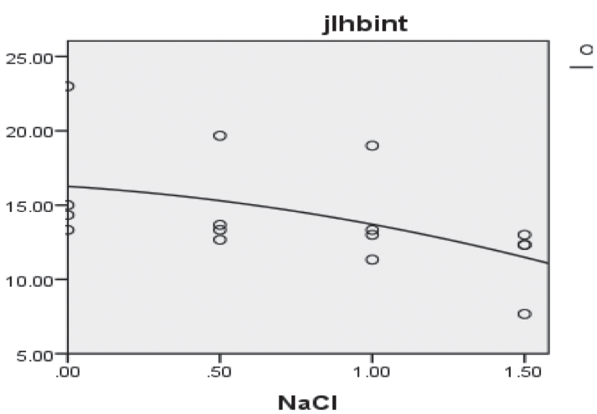
interrelated patterns Y=16,261 – 1,305X – 1,253X2 R2 = 0,226X2 (Figure 3). It has become evident that Rhizobium is capable to make root hair nodules if low dose and the number of rhizobium applied was enough.

The environment is naturally capable to depleting natural cleaning mechanisms with certain amounts of excess sodium. However, if sodium concentrations increase, the mechanisms of nature become overburdened and physiological stress problems begin to arise (Ördög, 2011, Jumin, 2017).

Plant is naturally able to adapt to controlling and recovery growth and other physiological mechanism with certain amounts of excess sodium. Combination of Rhizobium and sodium more than 0.5 g/kg seed could cause obstruction in all vegetative growth parameters. Symbiotic mutualism between Rhizobium and rice bean at a sodium concentration of 0.5 g/l could eliminate the salinity stress effect. It is indicated by NAR, MRGR and seed dry weight is significantly differ nodules effectively of rice bean (Figure 3).

The effect of sodium on soil between de-flocculation or dispersion of clay particles increases the density of soils, water tends to pool on the surface of the soil, the roots of the plant are unable to grow deep into the soil, it affects the absorption of water in the soil and causes stunted growth and leaf burns (Christable 2019)

Mutualism Symbiosis of *Rhizobium* between and legumes may be able to absorb less used nitrogen rhizobium in the atmospheres of nitrogen, and then it appears to have become ion nitrogen. Rhizobium mutualism symbiosis with leguminous infection and became a nodule in the root hair. Application of rhizobium to soil at high level of sodium has



Y=16,261 – 1,305X – 1,253X2 R2 =0,226X2

Fig. 5. The number of seed dry weight on the sodium concentration treatments

significantly decline the nitrogen efficiency.

NAR is calculated four times with (t1) 7 days after planting and (t2) 14 days and so on. Net

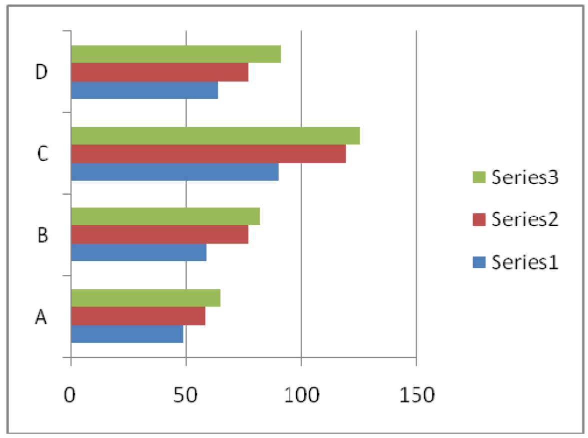


Fig. 6. The effect of rhizobium on the nitrogen necessity efficiency under sodium treatments. Green was period 7-14 days, red was the period 14-21 days, blue was period 21-28 days, Group A Rhizobium 0.0 g/kg seed, B is Rhizobium 5 g/kg seed, C is Rhizobium 15g/kg seed, and D is the Rhizobium 10 kg/seed.

assimilation rate is based on rated photosynthesis and an increase in biomass weight, and also on leaf area at a fixed time (t) in all sodium and rhizobium treatments and is positively correlated with mean MRGR (South, 1995). The net assimilation rate of photosynthetic plant efficiency was measured by (Vernon and Allison, 1995). The net assimilation rate of rice bean (E) is as the rate of increase in the dry weight (W) per unit leaf area (L). There ere informant parameters to detect the significantly effect to plants growth.

CONCLUSION

Sodium at high concentration causes decline in vegetative growth and production. However interaction between 0.5 g sodium/l and 15 g/kg seed precisely increase the vegetative growth and production of rice bean.

ACKNOWLEDGEMENT

We thank to rector of Islamic University of Riau for financing support of this research. Specially thank to Director of Post Graduate School Islamic University of Riau for assistance support of the computer laboratories.

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