Growth Analysis Of Soybean Varieties At Dry Land With Application Of Nitrogen Sources

Yaya Hasanah, Tengku Chairun Nisa, Hapsoh, Hamidah Hanum

Abstract: Soybean is annual major crops in the world and important legumes in food security. Increased soybean production can achieve through increased in the intensity of soybean cultivation and expansion of soybean cultivation to marginal lands such as dry land. Nitrogen is a limited nutrient at dry land. The objective of this research was to determine the growth analysis of three soybean varieties on dry land with application of Nitrogen sources. Research using randomized block design with 2 factors and 3 replications. The first factor is soybean varieties (Anjasmoro, Wilis and Sinabung). The second factor is the sources of N consists of without application of N, Urea 50 kg/ha, *Bradyrhizobium* sp., manure 10 tons/ha and combinations of *Bradyrhizobium* sp. + manure 5 tons/ha. The research result shown that Anjasmoro variety significantly increased the relative growth rate and net assimilation rate 5-6 WAP compared with Sinabung and Wilis. Application of *Bradyrhizobium* sp. significantly increased the plant growth rate and relative growth rate 5-6 WAP compared with other N treatments. Combination of *Bradyrhizobium* sp. and manure 5 tons/ha on Anjasmoro variety tent to increase the net assimilation rate 5-6 WAP.

Keywords: dry land, growth, nitrogen, soybean

1 INTRODUCTION

Soybean (*Glycine max* L. Merrill) is annual major crops in the world and important legumes in food security. Soybean is also a source of protein, oil, sugars, minerals and high enough of amino acids such as metionin, trypsin dan lysin so that it can be relied for fullfillment the nutrition and human food. In addition, soybeans also contain isoflavones as a secondary metabolites in reducing the potential risk of degenerative diseases (Mesina, 1999, Barnes, 2001, Clarkson, 2002, de Kleijn *et al.*, 2002, Mesina, 2003, Rochfort and Panozzo, 2007). National soybean demand continues to increase, along with increasing public knowledge of the benefits of soybean as a functional food. The increase in soybean demand is not in line with production caused the gap, so that the necessary efforts to improve the national soybean production. This is achieved through increased productivity approach, the increase in the intensity of soybean cultivation and expansion of soybean cultivation to marginal lands (sub- optimal) such as dry land. Soybean cultivation on dry land have problems such as soil less fertile, reacted acid, contain Al , Fe and Mn high, poor in organic matter and essential macro nutrients (N , P , K , Ca and Mg), water deficit, especially in dry season because of the limited water resources erratic rainfall, pests and diseases, weed and use of local varieties (Arsyad and Purwantoro, 2010).

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Nitrogen is a nutrient that is limited to dry land. In fact, nitrogen is one of the essential nutrients for the plants, the formation of the basic components of proteins, nucleic acids, amino acids and protoplasm, required in the synthesis of chlorophyll, the formation and growth of vegetative parts of plants (leaves, stems, and roots). Therefore, the application of various of N sources will affect on the soybean growth at dry land. Growth analysis is a way to follow the dynamics of photosynthesis as measured by dry matter production. Plant growth can be measured without destruction the plant, such as the measurement of plant height or number of leaves, but often less reflects the quantitative accuracy. Dry matter accumulation is preferred as a measure of growth because it reflects the ability of plants in binding energy of sunlight through photosynthesis, as well as its interaction with other environmental factors (Sumarsono, 2008). Component analysis of the growth of which is Plant Growth Rate, Relative Growth Rate, Net Assimilation Rate and Leaf Area Duration (Beadle, 1983). The potential results can be determined by studying the growth variables on soybean varieties at dry land. The objective of this research was to determine the analysis growth of three soybean varieties on dry land with application of Nitrogen sources.

2. MATERIALS AND METHODS

2.1. Location of the research

The research was conducted on October to December 2012 at dry land Sambirejo Village, District Binjai, Langkat (determining the location refers to soybean production center in Sumatra Utara and in accordance with the map Agroecological Zone, Sumatra Utara.

2.2. Materials of the research

The materials used are three varieties of soybean (Anjasmoro, Wilis and Sinabung), Urea, TSP and KCl, straw compost, manure, isolates of *Bradyrhizobium* sp. indigenous (collected from dry land Desa Sambirejo), plastic sheets, plastic bags, paper bags and label treatment. The tools used are scales, calculator, leaf area meter and stationery.

2.3. Design of the research

Research using randomized block design with 2 factors and 3 replications. The first factor is soybean varieties (Anjasmoro, Wilis and Sinabung). The second factor is the sources of N consists of without application of N, Urea 50 kg/ha, Bradyrhizobium sp., manure 10 tons/ha and combinations of Bradyrhizobium sp. + manure 5 tons/ha. There are 3 x 5 x 3 = 45 experimental units (plots).

2.4. Stage of the research

Dry land used consisted of 45 plots with size of each plot is 2 m x 2 m. Among the plot bounded by drainage channels. Liming with dolomite 500 kg/ha during land preparation 2 weeks before planting date. P and K fertilizer is done with dose of P and K fertilizer recommendations for soybean crop, such as 150 kg P_2O_5. ha^{-1} and 75 kg KCl.ha^{-1}. Isolates of *Bradyrhizobium* sp . inoculated according to treatment . Isolates were mixed with soybean seed, done in the shade just before planting the morning. Soybean seeds that have been mixed isolates of *Bradyrhizobium* sp. as much as 2 seeds for each planting hole. Urea and manure application in accordance with the treatment done at the time of planting. Urea fertilizer is given a half dose at planting and the remaining half dose at 30 days after planting (DAP). Prevention of pest attacks carried out by using organic pesticide with active ingredient of azadirachtin, ricin acid, polyphenols, alkaloids, citral, eugenol, annonain , nicotine, with a concentration of 10 cc per liter of water, made in the afternoon at 4, 6 and 8 DAP. Harvesting is done when the soybean crop has been harvested criteria indicated that the pods have brown skin and stems and leaves have dried up. Variables observed include plant growth rate (PGR), relative growth rate (RGR) and net assimilation rate (NAR) are calculated by the formula :

$$PGR = \frac{W_2 - W_1}{t_2 - t_1} \quad (g.day\text{-}1)$$

$$RGR = \frac{\ln W_2 - \ln W_1}{t_2 - t_1} \quad (g.g^{-1}.day^{-1})$$

$$NAR = \frac{\ln A_2 - \ln A_1}{A_2 - A_1} \times \frac{W_2 - W_1}{t_2 - t_1} \quad (g.cm^{-2}.day^{-1})$$

Note : W_2 = biomass total on t_2 (g)
W_1 = biomass total on t_1 (g)
A_2 = leaf area total on t_2 (cm^{-2})
A_1 = leaf area total on t_1 (cm^{-2})

The data analyzed with analysis of variance (F test) at the level of α = 5%, if there is a significant difference then performed Duncan's Mutiple Range Test at the α = 5%.

3 RESULT

3.1. Plant Growth Rate

Table 1 shown that the source of N Bradyrhizobium sp. increased significantly of PGR compared with other N source treatment, while treatment of Urea and without application of N gave the lowest PGR 5-6 week after planting (WAP). Anjasmoro varieties tent to increase PGR compared to Sinabung and Wilis. Combination treatment of *Bradyrhizobium* sp. + manure (5 tons/ha) on Anjasmoro varieties tent to increase the PGR 5-6 WAP (0.700 $g.day^{-1}$).

3.2. Relative Growth Rate

Based on Table 2 shown that the Anjasmoro variety RGR 5-6 WAP is significantly higher than Wilis and Sinabung. Sources N Bradyrhizobium sp. provided the highest RGR 5-6 MST than all other treatments, while the treatment without N application gave the lowest RGR 5-6 WAP. Application of *Bradyrhizobium* sp. on Anjasmoro varieties tent to increase the RGR 5-6 WAP.

3.3. Net Assimilation Rate

Based on Table 3 shown that the Anjasmoro variety increased significantly of NAR compared with Willis and Sinabung. Sources N Bradyrhizobium sp. tent to give higher NAR than all other treatments of N sources, while the urea treatment gave the lowest NAR 5-6 WAP. Application of *Bradyrhizobium* sp. on Sinabung variety tent to give higher NAR 5-6 WAP compared with other treatment interactions.

TABLE 1.
PLANT GROWTH RATE OF THREE SOYBEAN VARIETIES WITH APPLICATION OF NITROGEN SOURCES ON DRY LAND

Treatment	Plant Growth Rate (g.day-1)		
	3-4 WAP	4-5 WAP	5-6 WAP
Variety (V)			
V1 = Anjasmoro	0.139	0.137	0.442
V2 = Wilis	0.180	0.145	0.262
V3 = Sinabung	0.191	0.124	0.290
Source of N			
N0 = Without N application	0.174	0.171	0.204c
N1 = Urea (50 kg.ha-1)	0.219	0.137	0.235c
N2 = *Bradyrhizobium* sp.	0.156	0.098	0.449a
N3 = Manure (10 tons.ha-1)	0.149	0.097	0.370b
N4= *Bradyrhizobium* sp.+ manure 5 tons.ha-1	0.152	0.175	0.359b
V *N			
V1 N0	0.166	0.168	0.265
V1 N1	0.142	0.201	0.200
V1 N2	0.122	0.054	0.641
V1 N3	0.132	0.040	0.405
V1 N4	0.135	0.221	0.700
V2 N0	0.145	0.210	0.152
V2 N1	0.177	0.108	0.236
V1 N2	0.191	0.045	0.560
V2 N3	0.194	0.209	0.180
V2 N4	0.191	0.152	0.182
V3 N0	0.212	0.135	0.194
V3 N1	0.338	0.100	0.269
V3 N2	0.155	0.194	0.270
V3 N3	0.120	0.042	0.525
V3 N4	0.129	0.150	0.195

Note: *Numbers followed by the same letter in the same colomn and treatment represent no significant difference on Duncan's Mutiple Range Test ($p < 0.05$)*

4. DISCUSSION

Plant growth rate analysis indicated the plant development as net accumulation of photosynthesis result is an integrated with the time as measured by dry matter production. Based on the results of research, Anjasmoro

variety has higher PGR and NAR than Sinabung and Wilis. This difference is due to te difference of genetics source varieties tested. As reported by Shorter and Norman (1982) that soybean genotypes with different genetic background will influence growth rate. The difference of PGR, RGR and NAR due to the difference of cultivars tested has been reported previously by Totok and Utari (2002)

TABLE 2.
RELATIVE GROWTH RATE OF THREE SOYBEAN VARIETIES WITH APPLICATION OF NITROGEN SOURCES ON DRY LAND

Treatment	Relative Plant Growth (g.g-1. day-1) 3-4 WAP	3-4 WAP	3-4 WAP
Variety (V)			
V1 = Anjasmoro	0.102	0.064	0.116a
V2 = Wilis	0.124	0.064	0.068c
V3 = Sinabung	0.150	0.051	0.084b
Source of N			
N0 = Without N application	0.124	0.065	0.052e
N1 = Urea (50 kg.ha-1)	0.168	0.056	0.071d
N2 = *Bradyrhizobium* sp.	0.121	0.045	0.129a
N3 = Manure (10 tons.ha-1)	0.095	0.045	0.108b
N4 = *Bradyrhizobium* sp.+ manure 5 tons.ha-1	0.119	0.088	0.086c
V *N			
V1 N0	0.108	0.066	0.070
V1 N1	0.130	0.073	0.061
V1 N2	0.090	0.033	0.176
V1 N3	0.082	0.020	0.116
V1 N4	0.098	0.130	0.160
V2 N0	0.120	0.086	0.043
V2 N1	0.119	0.057	0.065
V1 N2	0.120	0.019	0.132
V2 N3	0.118	0.096	0.059
V2 N4	0.143	0.063	0.042
V3 N0	0.143	0.044	0.045
V3 N1	0.255	0.038	0.087
V3 N2	0.153	0.083	0.080
V3 N3	0.085	0.020	0.150
V3 N4	0.117	0.070	0.056

Note: *Numbers followed by the same letter in the same colomn and treatment represent no significant difference on Duncan's Mutiple Range Test (p < 0.05)*

Application of *Bradyrhizobium* sp. significantly increased the PGR and RGR 5-6 WAP (Table 1 and 2). This indicated the role of bacteria *Bradyrhizobium* sp . as bacterial of N fixation in supporting the growth and development of soybean organs, such as the number of branches , leaf area and increase plant dry weight (Situmorang, 2008). *Bradyrhizobium* sp . is the root nodule bacteria the form of gram-negative bacteria and symbiosis with soybean plants by infecting the roots of soybean plants, and form a special root structures called nodules. In the nodule, the bacteria differentiate into bacteroids and change the N2 into ammonia using the enzyme nitrogenase complex , the process is called fixation N so that N is available to support the growth of soybean plants. Salisbury and Ross (1991) reported that N nutrient role to improve the photosynthesis process in plants. Furthermore, photosynthate be translocated throughout the plant tissue and then used for

TABLE 3.
NET ASSIMILATION RATE OF THREE SOYBEAN VARIETIES WITH APPLICATION OF NITROGEN SOURCES ON DRY LAND

Treatment	Relative Plant Growth ($g.g^{-1}$. day^{-1}) 3-4 WAP	3-4 WAP	3-4 WAP
Variety (V)			
V1 = Anjasmoro	0.0008	0.0001	0.0010a
V2 = Wilis	0.0009	0.0001	0.0007b
V3 = Sinabung	0.0009	0.0001	0.0008b
Source of N			
N0 = Without N application	0.0007	0.00006	0.0007
N1 = Urea (50 kg.ha-1)	0.0012	0.00007	0.0006
N2 = *Bradyrhizobium* sp.	0.0008	0.00006	0.0011
N3 = Manure (10 tons.ha-1)	0.0008	0.00004	0.0008
N4 = *Bradyrhizobium* sp.+ manure 5 tons.ha-1	0.0009	0.00008	0.0009
V *N			
V1 N0	0.0007	0.00004	0.0007
V1 N1	0.0010	0.00008	0.0008
V1 N2	0.0009	0.00005	0.0012
V1 N3	0.0006	0.00004	0.0009
V1 N4	0.0010	0.00008	0.0015
V2 N0	0.0007	0.00007	0.0006
V2 N1	0.0013	0.00006	0.0005
V1 N2	0.0007	0.00007	0.0012
V2 N3	0.0010	0.00005	0.0005
V2 N4	0.0007	0.00013	0.0006
V3 N0	0.0008	0.00006	0.0007
V3 N1	0.0012	0.00007	0.0007
V3 N2	0.0009	0.00005	0.0009
V3 N3	0.0008	0.00004	0.0009
V3 N4	0.0009	0.00094	0.0007

Note: *Numbers followed by the same letter in the same colomn and treatment represent no significant difference on Duncan's Mutiple Range Test (p < 0.05)*

plant growth and development. In addition, it is also related to the adequacy of water (indicated by the rainfall in July as much as 283 mm/month) for N_2 fixation by bacteria *Bradyrhizobium* sp. Adequacy of the water causes no drought so bacteria develop well for helping N_2 fixation in soybean plants. Net assimilation rate is the rate of accumulation of dry weight per unit leaf area per unit time. NAR is a measure of the average efficiency of leaf photosynthesis in a plant community cultivation. NAR highest value when the plants are still small and most of the leaves are exposed to direct sunlight. With the growth of cultivated plants and with increasing leaf area index, the more protected leaves, causing a decrease in NAR throughout the growing season. Net assimilation rate is a measure of the average efficiency of leaf photosynthesis in a plant community culture (Gardner *et al*., 1991). Net assimilation rate can describe the production of dry matter or a dry matter production per unit leaf area assuming dry matter composed mostly of CO_2 (Kastono *et al*., 2002). Net dry weight of plants is a function of the ability of plants to absorb light and positively correlated with the rate of photosynthesis, which influenced by environmental conditions (nutrients, water and climate). On environmental conditions enough nutrients, water, and avoid of disease pests, plants provide optimal results. The rate of plant growth under conditions optimal only affected by radiation

and temperature. temperature and low radiation are often the cause of poor growth and low yields (Penning de Vriest *et al*., 1989). In this research, combination of *Bradyrhizobium* sp. and manure 5 tons/ha on Anjasmoro variety tent to increase the net assimilation rate 5-6 WAP (Table 3). Interactions between the biological fertilizer and genotype affect NAR has been reported previously reported by Totok (2002).\

5. CONCLUSSION

Anjasmoro variety significantly increased the relative growth rate and net assimilation rate 5-6 WAP compared with Sinabung and Wilis. Application of Bradyrhizobium sp. significantly increased the plant growth rate and relative growth rate 5-6 WAP compared with other N treatments. Combination of *Bradyrhizobium* sp. and manure 5 tons/ha on Anjasmoro variety tent to increase the net assimilation rate 5-6 WAP.

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