Technological Engineering to Improve the Growth of Soybean (*Glycine Max* (L.) Merril) under Dry Land Condition

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Abstract: Soybeans are one of the legumes of food and protein sources that are very beneficial for humans. Until now, certain soybean cultivars have not been found that have optimal technology package to increase the soybean growth under dry land condition. The study aims to identify technology engineering strategies in increasing soybean growth under dry land condition. Experimental design was a randomized block design with 2 factors and 3 replications. The first factor was soybean varieties (Demas, Anjasmoro, Dering, Devon). The second factor was application technology consisted of P_1, P_2 and P_3. The result showed that Anjasmoro variety had higher plant height 2-3 WAP than Dering, Demas and Devon, while Dering variety had higher shoot and root dry weight than other varieties. The application of technology package P_2 and P_3 increased the plant height. The application of technology package P_2 and P_3 on Anjasmoro or Dering variety increased the plant height 2-3 WAP, while the application of technology package P_1 on Dering variety increased the shoot and root dry weight.

1 INTRODUCTION

Soybean are one of the legumes of food and protein sources that are very beneficial for humans. In addition, isoflavones which are the main secondary metabolites in soybeans are very beneficial for human health. Soy isoflavones were demonstrated to possess numerous biological functions, such as antioxidant (Kao and Chen, 2006), inhibitory on cancer cell proliferation (Kao *et al*., 2007), anti-inflammatory (Kao *et al.*, 2003) and preventive of coronary heart disease (Dalais *et al*., 2003) and osteoporosis (Migliaccio and Anderson, 2003).

Soybean production in Indonesia until 2017 is still lack of production 1.5 million tons, this production shortage is overcome by the supply of imports. The Ministry of Agriculture began to stimulate soybean production to achieve the self-sufficiency target in 2018, through the addition of planting area and gradually reducing soybean imports. In 2017 a new planted area expansion of 500,000 ha was established in 20 provinces, namely Sumatra 153,000 ha, Java 130,000 ha, Kalimantan 27,000 ha, Sulawesi 110,000 ha, and Nusa Tenggara Barat and Nusa Tenggara Timur 80,000 ha using dry land, ex-mining land, plantations have not produced, fallow land, idle land, tidal land, and the former development of new corn planting areas. Farmer's community soybean planting area of 300,000 ha. Planting on new planting areas and productivity of 1.5 tons per ha, will encourage an increase in production of 2.9 million tons. While the total national soybean demand is 2.4 million tons. The average national soybean production is 800,000 - 1 million tons per year. The shortage was filled with soybean imports from the United States (Alfi, 2017)

In line with the program of the Government in the development of dry land as one of the areas to improve the national soybean production, hence the need for a concerted effort to increase the production of soybean under dry land condition-based on the characteristics of dry land. Dry land is a sub optimal land that can be develop as farmland, but has several problems such as low soil fertility, soil reacting acid, content of Al, Fe and Mn are high and poor macro-nutrient and organic matter.

Based on the above background, the study aimed to identify technology engineering strategies in increasing soybean growth under dry land condition.

Therefore, it is necessary to have soybean varieties that have high adaptability under dry land conditions. Until now, certain soybean cultivars have not been found that have optimal photosynthetic distribution patterns that can provide high productivity under dry land condition. The agronomic

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characteristics of each cultivar including its interaction with the environment, especially its relation to photoperiod, and other climates must be the main concern.

Based on the above background, the study aims to identify technology engineering strategies in increasing soybean growth under dry land condition.

2 MATERIALS AND METHODS

2.1 Study Area

The field experiment was conducted at the community land of soybean production centre at Tanjung Jati, Binjai (Indonesia). The field experiment was conducted at the community land of soybean production center at Tanjung Jati, Binjai (Indonesia) with altitude 35 m above sea level. The climate characteristic of the dry land are the average rainfall of monthly is 170.67 mm, temperature average monthly is 27.6 ºC, temperature minimum monthly is 21.6 ºC and temperature maximum monthly is 32.5 ºC. The soil characteristic are content of N 0.19%, P total 0.13%, K total 0.13% and pH 5.12.

2.2 Procedures

Treatments were arranged in a Randomized Block Design with two factors and three replications. The first factor was soybean varieties (V1 = Anjasmoro, V2 = Dering, V3 = Demas and V4 = Devon). The second factor was application of technology package as shown in Table 1.

Table 1: Technology package of soybean cultivation under dry land condition

Technology package of soybean cultivation	Input
P_1 = Package 1	Fertilizer (Urea 25 kg/ha), inoculant *B. japonicum* 200 g/40 kg of seed, SP-36 100 kg/ha, KCl 50 kg/ha, spacing 40 cm x 20 cm, dolomite 500 kg/ha, farmyard manure 2 ton/ha, maximum tillage, antioxidant ascorbic acid 100 ppm.
P_2= Package 2	Fertilizer (Urea 25 kg/ha), inoculant *B. japonicum* 200 g/40 kg of seed, SP-36 150 kg/ha, KCl 100 kg/ha, spacing 40 cm x 20 cm, dolomite 1.000 kg/ha, farmyard manure 2 ton/ha, maximum tillage, antioxidant ascorbic acid 200 ppm
P_3= Package 3	Fertilizer (Urea 25 kg/ha), inoculant *B. japonicum* 200 g/40 kg of seed, SP-36 250 kg/ha, KCl 150 kg/ha, spacing 40 cm x 20 cm, dolomite 1.000 kg/ha, farmyard manure 5 ton/ha, maximum tillage, antioxidant ascorbic acid 300 ppm

Soybean seeds that have been inoculated by *Bradyrhizobium japonicum* are planted with plant spacing 40 cm x 20 cm. Source of N, P and K fertilizer are applied based on the treatment dose of technology package cultivation (Table 1). Urea was given half the dose of N fertilizer at planting time and the rest at 4 WAP. Weeding was done manually by removing the weeds in accordance with the conditions of the field. Parameters observed was plant height at 2-4 week after planting (WAP), shoot dry weight and root dry weight.

2.3 Data Analysis

Data were subjected to analysis of variance (ANOVA) for comparison of means. Means were separated using Duncan's Multiple Range Test at the 0.05 probability level.

3 RESULT AND DISCUSSION

3.1 Plant Height

Based on Table 2. it can be seen that generally the treatment of varieties, technology package and interaction between them has significant effect on plant height at 2 and 4 WAP, except the treatment of technology package has not significant effect on plant height 2 WAP.

Anjasmoro variety (V_2) has the highest plant height at 2-3 WAP. In this case, the genetic factors cause differences as diverse as the appearance of plant phenotypes by displaying special characteristics and traits different from one another. This matter in accordance with Gabesius *et.al.,* (2017) and Hasanah and Sembiring (2018), which stated that differences genetic is a factor causes of diversity in plant appearance. Genetic composition can differ between seeds which comes from different plants, even from the same plant. This matter proved that Anjasmoro variety is superior in growth compared with other varieties under dry land condition. Increased plant growth soybean in Anjasmoro variety (V_2) is suspected because the variety are able to adapt well to growth under dry land condition, so it can appear a

good response to growth because the variety is capable adapt to this environment. Difference between characters owned by each variety caused by the different genetic on each variety so show a different response to environment and production factors. Previously research by Soverda and Hermawati (2009) and Mahdianoor *et al*. (2017), stated the results of a plant is determined by factors genetic which includes resistance to pests and pathogens and dryness and properties hybrid plant. Environmental factors include temperature, availability of water, sunlight, soil structure and composition, soil reaction as well as microorganisms.

The treatment of technology package P_2 and P_3 significantly increased the plant height 2-4 WAP than P_1. Interaction between variety Dering and technology package P_2 increased the plant height 2 WAP, while interaction between variety Anjasmoro and technology package P3 also increased the plant height 2 and 3 WAP. This is suggested because Anjasmoro and Dering have adapted under dry land conditions, and the P_2 technology package provides good input for plants by increasing phosphorus (P) and potassium fertilizer and dolomite applications.

Based on the result of soil analysis before the study found that pH of the soil is 5.12, therefore liming application using dolomite increased the pH so it suitable for soybean cultivation.

Soybean need P for growth throughout their life cycle, especially during early stages of growth and development. The primary of P compounds in plants are to store and transfer energy that is produced through the photosynthetic process to be used for growth and reproduction (Xiurong W, X Yan, H Liao 2010).

Adequacy of K is useful in increasing growth of soybean because K deficiency appears to limit plant growth and root development by suppressing the process of supply and transport of sugar, metabolites and other minerals among plant organs more than direct inhibition of carbon assimilation (Römheld and Kirkby, 2010 ; Kanai et al., 2011 ; Singh and Reddy, 2014)

3.2 Shoot and Root Dry Weight

The result showed that Dering variety have higher shoot and root dry weight than other varieties. The application of technology package P2 tend to increase the shoot and root dry weight than other technology package. The combination of Dering variety and technology package P_1 increased shoot and root dry weight. This suggests that Dering variety has adapted under dry land condition so that the dry weight of the shoot and its roots increased. The height of shoot and root dry weight in the Dering variety with P_1 application showed that the technology input at P_1 such as application of fertilizer (Urea 25 kg/ha), inoculant *B. japonicum* 200 g/40 kg of seed, SP-36 100 kg/ha, KCl 50 kg/ha, spacing 40 cm x 20 cm, dolomite 500 kg/ha, farmyard manure 2 ton/ha, maximum tillage, antioxidant ascorbic acid 100 ppm was sufficient to increase the shoot and root dry weight in the Dering variety.

Table 2: Plant height 2-4 WAP of soybean varieties with application of technology packages

WAP	Variety	Technology package			Mean
		P_1	P_2	P_3	
		…… cm ……			
2	Demas	9.26cd	9.20cd	9.29 cd	9.25b
	Anjasmoro	9.59bc	10.55a	9.99 ab	10.04a
	Dering	9.68c	10.60a	9.28 cd	9.85ab
	Devon	8.08e	8.74de	9.17 cd	8.66c
	Mean	9.15	9.77	9.43	
3	Demas	13.02bc	12.54cde	12.97c	12.84b
	Anjasmoro	12.80cd	13.97a	13.69a	13.49a
	Dering	12.52cde	13.57ab	12.80cd	12.96a
	Devon	10.20f	12.16ef	12.24de	11.53c
	Mean	12.14b	13.06a	12.92a	
4	Demas	20.02ab	19.40c	20.34a	19.92a
	Anjasmoro	19.71b	19.91ab	19.23cd	19.62b
	Dering	18.12g	18.90de	18.97cde	18.66c
	Devon	14.39h	18.58ef	18.22fg	17.06d
	Mean	18.06b	19.20a	19.19a	

Note: Different letter represent significant differences as Duncan's Multiple Range Test (p=0.05)

Table 3: Shoot and root dry weight of soybean varieties with application of technology packages

Variety	Technology package			Mean
	P_1	P_2	P_3	
	…… g ……			
Shoot dry weight				
Demas	3.73bcd	5.14abc	3.77 bcd	4.21b
Anjas moro	2.95cd	2.80d	3.10c d	2.95c
Dering	6.96a	5.89ab	4.37 bcd	5.74a
Devon	3.81bcd	4.38bcd	4.08 bcd	4.09b
Mean	4.36	4.55	3.83	
Root dry weight				
Demas	0.60h	0.84d	0.61 h	0.68c
Anjas moro	0.70f	0.60h	0.71f	0.67d
Dering	1.10a	1.01c	1.08 b	1.06a
Devon	0.78e	0.82d	0.67 g	0.76b
Mean	0.79	0.82	0.77	

Note: Different letter represent significant differences as Duncan's Multiple Range Test (p=0.05)

4 CONCLUSION

Anjasmoro variety had higher plant height 2-3 WAP than Dering, Demas and Devon, while Dering variety had higher shoot and root dry weight than other varieties. The application of technology package P2 and P3 increased the plant height. The application of technology package P2 and P3 on Anjasmoro or Dering variety increased the plant height 2-3 WAP, while the application of technology package P1 on Dering variety increased the shoot and root dry weight,

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REFERENCES

Alf,i A. N. 2017. *Pemerintah Pacu Produksi Kedelai Loka*l. Industri Agribisnis. https://www.industri.bisnis.com. Diakses tanggal 20 Januari 2018.

Dalais, F. S., Ebeling P. R., Kotsopoulos D, McGrath B.P, Teede H. J. 2003 *The effects of soy protein containing isoflavones on lipids and indices of bone resorption in postmenopausal women***.** Clin Endocrinol (Oxf) 58 704 –709

Gabesius, Y.O., L.A.M Siregar dan Y. Husni. 2012. *Respon pertumbuhan dan produksi beberapa varietas Kedelai (Glycine max (L.) Merrill) terhadap pemberian pupuk bokashi*. J. Online Agroekoteknologi 1(1): 220-236.

Hasanah, Y., M. Sembiring. 2018. *Effect of foliar application of chitosan and salicylic acid on the growth of soybean (Glycine max (L.) Merr.) varieties*. IOP Conf. Series: Earth and Environmental Science 122 (2018) 012027

Kanai, S, Moghaieb, R.E., El-Shemy, H.A., Panigrahi, R, Mohapatra, P.K, Ito J, Nguyen N.T, Saneoka H, Fujita, K. 2011. *Potassium deficiency affects water status and photosynthetic rate of the vegetative sink in green house tomato prior to its effects on source activity.* Plant Sci. 180, 368–374.

Kao, T.H, Chen, B.H. 2006. *Functional components in soybean cake and their effects on antioxidant activity*. J Agric. Food Chem 54 544–7555

Kao, T. H., Huang, R.F.S., Chen, B.H. 2007 *Anti proliferation of hepatoma cell and progression of cell cycle as affected by isoflavone extracts from soybean cake***.** Int. J. Mol. Sci. 8 1095–1110.

Kao, T. H, Wu W.M, Hung C.F, Wu W.B, Chen B.H. 2007 *Anti-inflammatory effects of isoflavone powder produced from soybean cake*. J. Agric. Food Chem 55 11068–11079

Mahdiannoor, N., Istiqomah, Syahbudin 2017 *Pertumbuhan dan hasil dua verietas kedelai (Glycine max L.) dengan pemberian pupuk hayati (Growth and Yield Two Soybean Varieties (Glycine max L.) with Biofertilizer Application)* ZIRAA'AH 42 (3) 257-266

Migliaccio S, Anderson J. J. 2003. *Isoflavones and skeletal health: are these molecules ready for clinical application.* Osteoporos Int. 14 361–368

Römheld, V, Kirkby E. 2010. *Research on potassium in agriculture: needs and prospects*. Plant Soil 335, 155–180

Singh S K, Reddy V. R. 2014. *Combined effects of phosphorus nutrition and elevated carbon dioxide concentration on chlorophyll fluorescence, photosynthesis and nutrient efficiency of cotton*. J. Plant Nutr. Soil Sci. 177, 892–902

Soverda, N. dan Hermawati, T. 2009. *Respon tanaman kedelai (Glycine max (L.) Merill) terhadap pemberian berbagai konsentrasi pupuk hayati* J. Agronomi 13(1):6-12

Xiurong, W, X Yan, H. Liao. 2010. *Genetic improvement for phosphorus efficiency in soybean: a radical approach*. Ann Bot. 2010 Jul; 106(1):215–222