

Growth and production of soybean Glycine max L

by Ermatita Ermatita

Submission date: 15-Oct-2022 09:40PM (UTC+0800)

Submission ID: 1925999084

File name: Growth_and_production_of_soybean_Glycine_max_L.pdf (271.63K)

Word count: 5931

Character count: 29371

Growth and production of soybean (*Glycine max* (L.) Merrill) with different fertilizer strategies in a tidal soil from South Sumatra, Indonesia

AUTHORS

Budianta D.^{1,*}
dedik_budianto@
yahoo.com

Napoleon A.¹

Paripurna A.²

Ermatita³

* Corresponding Author

¹ Soil Soil Science
Department, Faculty of
Agriculture, Universitas
Sriwijaya, Indralaya,
30662 South Sumatra,
Indonesia

² Department of
Horticulture, Food Crops
and Animal Husbandary
of Muara Enim,
Indralaya, 30662 South
Sumatra, Indonesia.

³ Faculty of Computer
Science, Universitas
Sriwijaya, Indralaya,
30662 South Sumatra,
Indonesia.

¹ *crecimiento y producción de soja (*Glycine max* (L.) Merrill) mediante diferentes estrategias de fertilización en un suelo mareal de Sumatra del Sur, Indonesia*
¹ *Crescimento e produção de soja (*Glycine max* (L.) Merrill) com diferentes estratégias de fertilização num solo na zona de maré do Sul de Sumatra, Indonésia*

Received: 27.02.2018 | Revised: 23.09.2018 | Accepted: 06.11.2018

ABSTRACT

The efforts to improve soybean growth and production in tidal lands include applying lime, supplying some nutrients, and using improved varieties. The objective of this study was to find the effect of lime and NK fertilizer application for soybean (*Glycine max* (L.) Merrill) growth in tidal land. The research was conducted at the greenhouse of the Agriculture Faculty of Sriwijaya University. The pot experiments used a complete randomized design arranged factorially with two factors. The first factor was six levels of lime (i.e., 0 ton ha⁻¹, 0.81 tons ha⁻¹, 1.63 tons ha⁻¹, 2.45 tons ha⁻¹, 3.26 tons ha⁻¹, and 4.07 tons ha⁻¹), and the second factor was two levels of fertilizer (i.e., site-specific fertilizer and fertilizer calculated based on FAO criteria) and fertilizer recommended by South Sumatera Agricultural Research. Each treatment combination was made of three replications; the total number of treatment pots was 36. The measured variables were plant height, number of pods, number of nonempty pods, number of seeds, weight of 100 seeds, and production. The results showed that liming significantly increased plant height, total number of pods, number of nonempty pods, number of seeds, weight of 100 seeds, and soybean production, while fertilizer did not significantly affect all variables. The interaction between fertilizer and lime significantly affected plant height and the weight of 100 seeds. Lime application of 3.26 tons ha⁻¹ gave the highest yield on lime treatment only with production at 2.853 tons ha⁻¹ compared to other treatments.

RESUMEN

¹ *Las medidas para mejorar el crecimiento y producción de soja en zonas mareales incluyen el encalado, el suplemento de nutrientes y la utilización de variedades mejoradas. El objetivo de este estudio fue determinar el efecto del encalado y la aplicación de fertilizantes con NK en el crecimiento de plantas de soja (*Glycine max* (L.) Merrill) en una zona mareal. Las investigaciones fueron llevadas a cabo en invernadero en la Facultad de Agricultura de la Universidad de Sriwijaya. Los experimentos se realizaron en macetas y se empleó un diseño experimental al azar factorial utilizando dos factores. El primer factor estaba compuesto de seis dosis de encalado (0 ton ha⁻¹, 0.81 tons ha⁻¹, 1.63 tons ha⁻¹, 2.45 tons ha⁻¹, 3.26 tons ha⁻¹, and 4.07 tons ha⁻¹) y el segundo factor por dos tipos de fertilizante (fertilizante específico del lugar y fertilizante calculado en base a criterios de la FAO) y el fertilizante recomendado por el South Sumatera Agricultural Research. Cada tratamiento constó de tres réplicas y el número total de tratamientos fue de 36. Se midió la altura de planta, número de vainas, número de vainas no*

DOI: 10.3232/SJSS.2019.V9.N1.04

4 SJSS, SPANISH JOURNAL OF SOIL SCIENCE • YEAR 2019 • VOLUME 9 • ISSUE 1

1 vacías, número de semillas, peso de 100 semillas y la producción de soja. Los resultados mostraron que el encalado incrementó significativamente todas las variables anteriores mientras que la adición de fertilizante no las afectó. La interacción entre fertilizante y encalado afectó significativamente a la altura de la planta y el peso de 100 semillas. La aplicación de encalado en dosis de 3.26 tons ha⁻¹ fue la que dio lugar a un mayor rendimiento solo bajo producción de 2.853 tons ha⁻¹ en comparación con otros tratamientos.

RESUMO

As medidas para melhorar o crescimento e a produção de soja em áreas sujeitas a maré incluem a aplicação de cal, adição de nutrientes e o uso de variedades melhoradas. O objetivo deste estudo foi o de determinar o efeito da calagem e da aplicação de fertilizantes com NK no crescimento de plantas de soja (*Glycine max* (L.) Merrill) numa zona sujeita a maré. A investigação foi feita em estufa na Faculdade de Agricultura da Universidade de Sriwijaya. Os ensaios em vaso seguiram um delineamento experimental inteiramente casualizado, organizado fatorialmente com dois fatores. O primeiro fator foi composto por seis níveis de cal (t ha⁻¹: 0; 0,81; 1,63; 2,45; 3,26; 4,07) e o segundo fator por dois níveis de fertilizante (i.é., fertilizante específico do local e fertilizante calculado com base nos critérios da FAO) e o fertilizante recomendado pelo South Sumatra Agricultural Research. Cada tratamento, dum total de 36, constou de três réplicas. Foram medidas as seguintes variáveis: altura das plantas, número de vagens, número de vagens não vazias, número de sementes, massa de 100 sementes e a produção de soja. Os resultados mostraram que a calagem aumentou significativamente todas as variáveis, mas a adição de fertilizante não as afetou. A interação entre fertilizantes e calagem afetou significativamente a altura das plantas e a massa de 100 sementes. A aplicação de cal na dose de 3,26 t ha⁻¹ foi a que determinou, comparativamente aos outros tratamentos, a maior produção (2853 t ha⁻¹).

1. Introduction

1 Soybean is a very important crop in Indonesia, as it is one of vegetable protein sources for the raw material for tempe (Indonesian name for fermented soybean), soy sauce, tofu, etc., which are foods that are required by humans for their daily needs. Indonesia uses two million tons of soybeans per year, but the national soybean production is only 30% of the demand. The rest is imported from abroad (Marwoto et al. 2008). The consumption of soy-based products has increased from 14.21 kg capita⁻¹ year⁻¹ in 2009 up to 15.01 kg capita⁻¹ year⁻¹ (Sutyorini and Waryanto 2013), so that the Government of Indonesia strives to meet domestic soybean demand. One of them is to develop soybean production outside Java. One of the land types that can be used for the cultivation of soybeans is tidal land.

The main problems faced in tidal land for food crops are water excess, pyrite, acidic pH, relatively low macro nutrient content (Budianta and Windusari 2016), high organic acid content, presence of Al and Fe ions that poison the plants (Susilawati et al. 2013), salt water intrusion, and high concentrations of Al and Fe (Susanto 2010), while micro elements of Cu, Fe, Mn, and Zn are generally low (Anwar 2014). These conditions limit crop growth in tidal land.

The development of soybeans in tidal land has many problems. Soybean cultivation is affected by environmental stress (Koesrini and William 2009) brought about by soil acidity (Uguru et al. 2012) and pyrite (Subagyo 2006). Soil acidity and pyrite are inhibitors of soybean growth when planted during the dry season without water (Sagala et al. 2011), which causes low

1 **KEYS WORDS**
Lime, tidal swamp
soil, site-specific.

PALABRAS
CLAVE
Encalado, suelos de
zonas de mareas,
específico del lugar.

PALAVRAS-
CHAVE
Cal, solo de zonas de
pântano, específico
do local.

2

soybean production at 800 kg/ha (Djayusman et al. 2001). Soybean is considered to be poorly tolerant to high soil acidity ($\text{pH} < 4.5$) and aluminum saturation (Al sat, $> 20\%$; Dierolf et al. 2001). Thus, if soybeans will be cultivated in this poor tidal land, there will be a low yield.

Soybean production in Indonesia is still low. Production in 2015 was 998.7 thousand tons with a mean productivity of $1.56 \text{ tons ha}^{-1}$ (Pusdatin 2015), while soybean production in South Sumatra was 16,818 tons with a mean productivity of $1.51 \text{ tons ha}^{-1}$ (BPS 2016). Soybean productivity in tidal land is lower, ranging from 1.0 to 1.3 tons ha^{-1} (Taufiq et al. 2004). This production can be increased through fertilization and liming (Adimihardja et al. 2006). Previous studies have concluded that lime application at the rate of 2 tons ha^{-1} increased soybean production from 1.8 tons ha^{-1} to $2.10 \text{ tons ha}^{-1}$ (Koesrini and William 2009), and lime application at $1.15 \text{ tons ha}^{-1}$ increased production from $1.32 \text{ tons ha}^{-1}$ to 1.5 tons ha^{-1} (Uguru et al. 2012). Anwar (2014) concluded that the application of 75 kg/ha of urea, $22.5\text{--}45 \text{ kg ha}^{-1}$ of P_2O_5 , and $50\text{--}100 \text{ kg ha}^{-1}$ of KCl is the recommended dosage of fertilizer for soybean growth in tidal land.

Successful development of soybean cultivation in tidal land requires proper nutrient management and soil improvement through water management (Badan Penelitian dan Pengembangan Pertanian 2013), soil amelioration, fertilization (Susilawati et al. 2013), and use of adaptive varieties (Pusat Penelitian dan Pengembangan Tanaman Pangan 2009; Syahri and Somantri 2014). Dolomite is one of the soil ameliorants that can increase soil pH. Adding Ca and Mg can support growth and crop development. Fertilizer, as a plant nutrient source, and lime application are ways to improve soil fertility; therefore, it is necessary to study soybean cultivation in tidal land through the site-specific application of lime and fertilizer to obtain optimal growth and productivity.

2. Materials and Methods

This research was conducted at the greenhouse of Agriculture Faculty of Sriwijaya University, Inderalaya Ogan Ilir scheduled from May to September 2017. The soil sample used was taken from a Sulfaquept (Soil Survey Staff 2014), corresponding to the D typology of tidal land from Banyu Urip Village, Tanjung Lago Sub District, Banyuasin District at the coordinates of S 02038'37", E 104043'16" at a depth of 0-20 cm (arable layer). The soil sample was air dried for several days and then ground and sieved at 2 mm in diameter. Next, 10 kg of soil were evenly mixed with lime according to the treatment and then put into a pot and incubated for 7 days (Wijanarko and Taufiq 2016). Watering was done every day in a state of field capacity. After 7 days of incubation, fertilizers were applied according to treatment.

The design of the experiment was a completely factorial randomized design with two factors, which were dolomite dosages consisting of six levels (0 tons ha^{-1} , $0.81 \text{ tons ha}^{-1}$, $1.63 \text{ tons ha}^{-1}$, $2.45 \text{ tons ha}^{-1}$, $3.26 \text{ tons ha}^{-1}$, and $4.07 \text{ tons ha}^{-1}$) and the fertilizer dosage, which was site-specific based on in situ soil chemistry analysis and FAO criteria: 562 kg ha^{-1} of urea and 86 kg ha^{-1} of KCl (Roy et al. 2006), and the recommended fertilizer of South Sumatera Agricultural Research (50 kg ha^{-1} of urea and 2 kg ha^{-1} of KCl). Each combination had three replicates, with 12 treatment combinations or 36 pot experiments total. The seeds were adaptive varieties to high acidity, which was the Demas 1 variety derived from Balai Penelitian Tanaman Aneka Kacang dan Umbi (Research Institute for Peanut and Tuber) Malang. The observed variables were plant height at 4, 6, and 8 weeks after planting (WAP), total number of pods, number of nonempty pods (checked by opening each pod), total number of seeds, weight of 100 seeds, and soybean production. The results of the observational data were analyzed by analysis of variance. If the F test results showed a significant effect, it was continued by the Least Significant Difference (LSD) test at the 5% level.

3. Results and Discussion

Based on the soil analysis results presented in Table 1 and the criteria for soil assessment of the Pusat Penelitian Tanah (Soil Research Center) (1982), it was found that the soil pH was classified as acidic with low N, very low Ca, low Mg, high CEC, and low Al saturation, and the soil texture is classified as clay loam. The soybean cannot grow properly in this poor soil fertility; thus, it should be improved. The low soil pH will be a direct cause of nonoptimal soybean growth or an indirect cause of low N, P, K, Ca, and Mg nutrient availability (Budianta et al. 2017). According to Dierolf et al. (2001), soybeans are less tolerant in high soil acidity with pH < 4.5, while soybeans can grow well in the pH range of 5.00-5.50 (Adimihardja et al. 2006) and produce higher in the pH range of 5.8-7.0 (Firmanto 2011).

The content of N is very low; thus, this soil needs to have N fertilizer applied and is not optimum for soybean growth. Meanwhile the optimum exchangeable content for soybeans is 0.2-0.3 cmol₍₊₎ kg⁻¹ for K, 2.8 cmol₍₊₎ kg⁻¹ for Ca, 1.4 cmol₍₊₎ kg⁻¹ for Mg (Fegeria 2009), and 0.55-1.33 cmol₍₊₎ kg⁻¹ for Al (Hanum et al. 2007; Taufiq and Sundari 2012), and a saturation level of Al of 20% (when above 50%, it is potentially poisonous for the crop; Taufiq and Sundari 2012; Wijanarko and Taufiq 2016). Al is capable of damaging the root system of the crop (Silva et al. 2010). Nutrient deficiency is common in soils with acidic pH, low base saturation, sandy texture, and high exchangeable aluminum (Taufiq and Sundari 2012). Therefore, the addition of fertilizer and lime to improve soil fertility and nutrient supply for crops is recommended.

Table 1. Soil analysis used for experiment

Variables	Unit	Values	Criteria*
pH H ₂ O	-	4.55	Acidic
Total N	%	1.68	Low
P-Bray	mg kg ⁻¹	58.95	Very high
K-exchangeable	cmol ₍₊₎ kg ⁻¹	0.58	Moderate
Al-exchangeable	cmol ₍₊₎ kg ⁻¹	4.96	-
Ca-exchangeable	cmol ₍₊₎ kg ⁻¹	1.54	Very low
Mg-exchangeable	cmol ₍₊₎ kg ⁻¹	0.86	Low
H-exchangeable	cmol ₍₊₎ kg ⁻¹	1.12	-
Al saturation	%	19.00	Low
CEC	cmol ₍₊₎ kg ⁻¹	26.10	High
Pyrite	%	0.25	-
Organic C	g kg ⁻¹	16.12	Very high
Texture			Clay loam
Sand	%	27.25	
Silt	%	35.83	
Clay	%	36.92	

1
*Soil criteria from Pusat Penelitian Tanah (Soil Center Research) (1982).

The result of the analysis of variance for plant height showed that there was a significant difference between lime treatment at 4, 6, and 8 weeks after planting (WAP) (Table 2). Regarding the interaction of lime and fertilizer, the lime doses of 2.45 tons ha⁻¹ and site-specific fertilizer doses had the best effect on plant height at 8 WAP with plant height at 63.25 cm but was

not different with 3.26 tons ha⁻¹ of lime. A lime dose at 3.26 tons ha⁻¹ and site-specific fertilizer had the best effect on 6 WAP of plant height with a value of 42.15 cm, while the lime dose of 4.07 tons ha⁻¹ and fertilizer recommendation had the best effect on plant height at 4 WAP with a value of 30.55 cm (Table 2).

Table 2. Interaction between lime and fertilizer on soybean plant height at 4, 6, and 8 weeks after planting (WAP)

Lime Rate (ton ha ⁻¹)	Site Specific Fertilizer			Recommendation Fertilizer		
	Plant height (cm)			Plant height (cm)		
	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP
0.00	25.42 ab	25.25 ab	33.18 ab	28.97 a	24.10 a	32.03 a
0.81	25.70 c	28.53 c	34.87 bc	25.93 cde	30.03 d	40.00 d
1.63	25.72 cd	33.30 e	47.33 e	27.95 fgh	34.13 ef	48.17 ef
2.45	27.58 fg	39.95 g	65.80 hi	27.80 cdef	40.20 gh	60.70 g
3.26	27.40 i	42.60 i	69.93 i	27.68 ghi	41.70 ghi	62.37 gh
4.07	30.38 i	42.32 i	66.32 hi	30.55 i	41.38 ghi	70.63 i
LSD 0.05	1.84	1.36	5.09	1.84	1.36	5.09

Note: The same small letters in the same column showing no significant difference.

Plant height data of the soybean crop is in accordance with the description of the average height of Demas 1 varieties at 66.3 cm. Several studies have concluded that dolomite application is capable of influencing the plant height of the soybean crops. Koesrini et al. (2009) stated that dolomite of 2.3 ton ha⁻¹ increased the plant height by 93.2% at 4 WAP, by 168.7% at 6 WAP, and by 210% at harvest when compared with no dolomite. Taufiq et al. (2011) showed that a dolomite application of 750 kg ha⁻¹ produced a height of 49 cm in soybean plants compared with no lime (43.9 cm). It can be concluded that the site-specific fertilizer application was better for soybean growth compared to the recommended fertilizer.

The treatment doses of NPK fertilizers in either site-specific doses or on the basis of the Balai Penelitian dan Pengembangan Pertanian recommendation did not have a significant effect; thus, there was no difference in the effect of the second treatment (Table 3). The use of urea fertilizer is required in soybean cultivation. Susilawati et al. (2013) explained that the use of as much as 75 kg ha⁻¹ of urea can increase plant

height to 68.78 cm when compared to 25 kg ha⁻¹ (59.24 cm) of urea at 7 WAP. The content of soybean protein is high, ranging from 35%-45%, which means that the requirement of nitrogen is also high (Roy et al. 2006). In the fact, the soil nitrogen level is low (Table 1). This is because tidal porosity makes it easy for nutrients like N to be washed away by water movement. Thus, improvements in soil fertility aspects in tidal land determine the yield of soybeans (Barus 2013).

The results of the analysis of the total number of pods, number of nonempty pods, number of seeds, weight of 100 seeds, and production per plant showed that there was a significant difference between the lime treatment (Table 3).

The dolomite applications had a significant effect on the average total pod number, number of nonempty pods, number of seeds, weight of 100 seeds, and soybean production. The lime dose of 4.07 tons ha⁻¹ had the best effect on the average total pod number, number of pods, and number of seeds, while the lime dose of 3.26 tons ha⁻¹ had the best effect on the average weight of 100 seeds and soybean production

(Table 3). Lime treatment increased the total number of pods, number of nonempty pods, number of seeds, weight of 100 seeds, and production, respectively, by 498%, 543%, 391%, 73%, and 722% compared to without lime. Meanwhile, in the NPK fertilizer treatment on the total number of pods, the number of nonempty pods, number of seeds, weight of 100 seeds,

and production per plant showed no significant effect. Fertilization in these conditions did not affect the evaluated variables, and there was no interaction between the lime and fertilizer on the total pod number, nonempty pod number, and seed number per plant. The interaction happened for the 100-seed weight but not for the yield (Table 4).

Table 3. Average of total pods number, number of pods content, weight of 100 seeds and production of seed per plant at several lime dosages

Lime rate (ton ha ⁻¹)	Average of total pods number	Average of number of content pods	Average of seeds number	Average of 100 seeds weight (g)	Production (ton)
0.00	14.17 a	10.67 a	16.83 a	5.86 a	0.341 a
0.81	24.17 b	17.33 ab	30.33 ab	7.31 bc	0.767 ab
1.63	34.33 c	30.00 c	48.33 bc	6.88 ab	1.155 b
2.45	59.67 d	53.00 d	74.83 d	8.21 cd	2.151 d
3.26	78.00 e	66.33 e	80.83 d	10.14 e	2.852 e
4.07	84.67 e	68.67 e	82.67 d	9.89 e	2.832 e
LSD 0.05	7.04	12.57	19.30	1.06	0.54

1
Note: The same small letters in the same column showing no significant difference.

Table 4. Interaction of lime and fertilizer on the average of 100 seed weight and soybean production per plant

Lime rate (ton ha ⁻¹)	Site-specific fertilizer		Fertilizer recommendation	
	100 seeds weight (g)	Production (ton)	100 seeds weight (g)	Production (ton)
0.00	6.23 ab	0.323	5.79 a	0.358
0.81	6.72 abcd	0.757	7.89 ef	0.776
1.63	6.42 abc	1.160	7.35 cde	1.150
2.45	8.18 efg	2.150	8.24 fgh	2.153
3.26	10.59 i	2.853	9.69 i	2.851
4.07	10.18 i	2.850	9.00 i	2.814
BNT 0.05	1.06		1.06	

Note: The same small letters in the same column showing no significant difference.

Lime at the rate of 3.26 tons ha⁻¹ and a site-specific dose of fertilizer had the best effect on the weight of 100 seeds compared to other treatments (Table 4). The size of soybean seeds is classified into three classes, namely small (6-10 g/100 seeds), medium (11-12 g/100 seeds), and large seeds (13 g or more/100 seeds). Based on Table 8, the lime interaction at

3.26 tons ha⁻¹ and site-specific fertilizer yielded 100 seeds at 10.59 g of medium seeds, while other treatments yielded small seeds. Several studies concluded that dolomite application influences the total number of pods, number of seeds, and weight of 100 soybean seeds. Susilawati et al. (2013) explained that the use of 2 tons ha⁻¹ dolomite on Agromulyo varieties

of soybean increased the number of pods, seed number, and weight of 100 seeds, respectively, by 32.60 pods, 61.73 seeds, and 14.03 g compared to that without dolomite, respectively, of 23.06 pods, 61.60 seeds, and 12.31 g.

Furthermore, Wijanarko and Taufiq (2016) suggested that the addition of dolomite at the rate of 5.0 tons of ha^{-1} significantly increased the number of soybean pods from 12.8 (without dolomite) to 18.8 pods and increased the weight of 100 seeds from 15.3 g (without dolomite) to 16.2 g. Other studies (Taufiq et al. 2011) suggested that dolomite 750 kg ha^{-1} was able to increase the number of pods from 25 pods (without dolomite) to 34 pods per plant in Talang Jabung Jambi. Koesrini and William (2009) concluded that lime application of 1 ton ha^{-1} was able to produce a total pod content of 47 pods and 62 pods on lime application with 2 tons ha^{-1} on soybean strain B4F4HW-192-01-333.

The lowest production is found without lime application. Without lime application, high soil acidity was caused by the pyrite compound in tidal soil. The low yields are caused by stunted growth in terms of plant height, number of pods, number of non-empty pods, and number of seeds. This is because soybean is an intolerant crop in acidic soils (Koesrini et al. 2009). Lime application of 3.26 tons ha^{-1} provides the highest yield on lime only application and lime and fertilizer interaction. The increase of these results indicates that the addition of lime has a very significant effect on soybean growth. Some studies have reported a positive effect of lime on increasing soybean yields. Wijanarko and Taufiq (2016) concluded that the application on tidal land in South Kalimantan of 5 ton ha^{-1} lime yielded a soybean production of 1.61 tons ha^{-1} compared with no dolomite, which produced 0.69 tons ha^{-1} . Taufiq et al. (2011) studied the tidal soil of Jambi and found that a lime application 750 kg ha^{-1} produced soybeans at about 1.54 tons ha^{-1} compared with no dolomite, which produced only 1.24 tons ha^{-1} of soybeans.

Meanwhile Anwar's (2014) study of soybean production reached 1.72 tons ha^{-1} with the dolomite application of 1 ton ha^{-1} and reached 1.52 tons ha^{-1} with application of 2 tons ha^{-1} . Koesrini and William (2009) concluded the B5F3-W80-279-174-109 yielded less than

1.5 tons ha^{-1} , while the other strains were more than 1.5 tons ha^{-1} , and the B44F4HW-192-01-333 strain had the highest yield of 1 ton ha^{-1} of lime producing 2.50 tons ha^{-1} of soybeans and 2 tons ha^{-1} of lime producing 2.71 tons ha^{-1} of soybean. The same results were reported by Uguru et al. (2012), where the addition of lime at 1.15 tons ha^{-1} increased the soybean yield from 1.32 tons ha^{-1} to 1.5 tons ha^{-1} . Koesrini et al. (2009) found that a lime application of 2.3 tons ha^{-1} increased the soybean yield from 0.23 tons ha^{-1} at pH 4.5 and Al saturation at 70.6% to 2.17 tons ha^{-1} at pH 5.6 and, at better fertility with pH 4.5 and Al saturation of 24.3%, the soybean yield reached 1.81 tons ha^{-1} (Koesrini et al. 2011).

In addition to the lime application, adaptive varietal planting can also increase soybean production in tidal land (Koesrini et al. 2009; Yardha and Adri 2013; Balai Penelitian Tanaman Aneka Kacang dan Umbi 2015). Several varieties of soybeans in Indonesia currently have a critical limit of Al toxicity of about 1.33 $\text{cmol}_{(+)}$ kg^{-1} in soil solution (Taufiq and Sundari 2012). Purwantoro et al. (2007) concluded that the Willis varieties are more tolerant to high Al saturation compared to Tanggamus, as Willis and Tanggamus varieties are capable of producing 1.88 tons ha^{-1} and 1.61 tons ha^{-1} in a pH of 4.4 and exchangeable Al of 1.2 $\text{cmol}_{(+)}$ kg^{-1} and 1.69 tons of ha^{-1} and 1.47 tons ha^{-1} under pH conditions of 5.5 and exchangeable Al of 1.6 $\text{cmol}_{(+)}$ kg^{-1} , respectively. Another study by Thamrin et al. (2011) showed that varieties of Willis produce 0.61 tons ha^{-1} compared to the Tanggamus varieties at 0.44 tons ha^{-1} and the Anjosmoro variety at 0.30 tons ha^{-1} . According to the research of Susilawati et al. (2013), Argomulyo varieties resulted in soybean production of 0.96 tons ha^{-1} compared to Tanggamus varieties at 0.72 tons ha^{-1} and Anjosmoro at 0.63 tons ha^{-1} . Taufiq et al. (2004) concluded that the Sibayak varieties yielded a production of 1.82 tons ha^{-1} , with Tanggamus at 1.20 tons ha^{-1} , and Willis at 1.37 tons ha^{-1} . Koesrini and William (2009) found that the Menyapa variety produced 2.79 tons ha^{-1} compared to the Lawit (2.13 tons ha^{-1}), Willis (2.29 tons ha^{-1}), and Slamet varieties (2.09 tons ha^{-1}).

Released in 2014, Demas 1 varieties are adaptive varieties in tidal soil, which have advantages over Tanggamus and Willis varieties,

with a seed yield of 1.70 tons ha⁻¹, which is higher than Wilis (1.41 tons ha⁻¹) and Tanggamus (1.45 tons ha⁻¹) with the potential to reach 2.5 tons ha⁻¹ (Balai Penelitian Tanaman Aneka Kacang dan Umbi 2015). These varieties are adaptive varieties for soil acidity (Pusat Penelitian dan Pengembangan Tanaman Pangan 2009; Balai Penelitian Tanaman Aneka Kacang dan Umbi 2015), but the resulting production is still influenced by soil factors (Budianta and Windusari 2016), water, environment (Rahmi et al. 2015), and regional characteristics (Syahri and Somantri 2014).

4. Conclusions

Tidal land of type D from Banyu Urip of Banyuasin, South Sumatra has a high C-organic content with acidic pH and low N, Ca, Mg, and Al saturation and pyrite but has high cation exchange capacity. In the greenhouse in-pot experiment, the lime application had a significant effect on all variables, while the interaction of the lime and fertilizer significantly affected the plant height and weight of 100 seeds, and the application of fertilizer has no significant effect on all variables. Lime application of 3.26 tons ha⁻¹ had the highest yield on lime treatment only with the production of 2.853 tons ha⁻¹ compared to other treatments. Application of site-specific fertilizer did not have a significant effect on the growth and production of soybeans compared to the fertilizer recommendation.

REFERENCES

- Adimihardja A, Subagyo, MK Al-Jabri. 2006. Konservasi dan Rehabilitasi Lahan Rawa. Di dalam: Suriadikarta DA, Kurnia U, Suwanda MH, Hartatik W, Setyorini D, editors. Karakteristik dan Pengelolaan Lahan Rawa. Ed ke-1. Bogor: Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian, Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian. p. 229-274.
- Anwar K. 2014. Ameliorasi dan Pemupukan untuk Meningkatkan Produktivitas Kedelai di Lahan Gambut. Prosiding Seminar Nasional Inovasi Teknologi Pertanian Spesifik Lokasi. Banjar Baru 6-7 Agustus 2014; Banjar Baru; p. 353-360.
- Badan Penelitian dan Pengembangan Pertanian. 2013. Teknologi Budidaya Kedelai di Lahan Pasang Surut. <http://www.litbang.pertanian.go.id/berita/one/1393/>. [Di akses 24 Januari 2017].
- Balai Penelitian Tanaman Aneka Kacang dan Umbi. 2015. Demas 1: Varietas Kedelai Adaptif Lahan Kering Masam. <http://balitkabi.litbang.pertanian.go.id/info-teknologi/1836-demas-1-varietas-kedelai-adaptif-lahan-kering-masam.html>. [Di akses 19 Januari 2017].
- Barus J. 2013. Potensi pengembangan dan budidaya kedelai pada lahan suboptimal di Lampung. Prosiding Seminar Nasional Lahan Suboptimal; Palembang; 20-21 September 2013.
- BPS. 2016. Sumatera Selatan Dalam Angka Tahun 2015. Badan Pusat Statistik Sumatera Selatan. Palembang.
- Budianta D, Ermatita, Napoleon, Hermawan A, Wijayanti H. 2017. Evaluation of some soil chemical properties of tidal swamp land after long-term cultivation. International Journal of Engineering Research and Science & Technology 6(2):12-21.
- Budianta D, Windusari Y. 2016. Beneficial effect of local resources to improve food crop production in tidal swamp of Indonesia. International Journal of Environmental & Agriculture Research (IJOEAR) 2(1):98-101.
- Dierolf T, Fairhurst T, Mutert E. 2001. A toolkit for acid, upland soil fertility management in Southeast Asia. Singapore: Potash & Phosphate Institute.
- Djayusman M, Suastika IW, Soelaeman Y. 2001. Refleksi pengalaman dalam pengembangan sistem usaha pertanian di lahan pasang surut, Pulau Rimau. Seminar Hasil Penelitian Pengembangan Sistem Usaha Pertanian Lahan Pasang Surut Sumatera Selatan. Badan Penelitian dan Pengembangan Pertanian, Pusat Penelitian dan Pengembangan Tanah dan Agroklimat. Bogor, Juni 2001.
- Fegeria NK. 2009. The use of nutrients in crops plants. Brazil: CRS Press. 430 p.

- Firmanto BH. 2011. Praktis Bercocok Tanam Kedelai secara Intensif. Penerbit Angkasa. Bandung.
- Hanum C, Mugnisjah WQ, Yahya S, Supandi D, Idris K, Sahar A. 2007. Soybean root's growth in aluminum and drought stress. *Agritrop*. 26(1):13-18 (in Indonesian).
- Koesrini, Anwar K, Barlian E. 2009. Penggunaan Kapur dan Varietas Adaptif untuk Meningkatkan Hasil Kedelai di Lahan Sulfat Masam Aktual. *Berita Biologi* 14(2):155-161.
- Koesrini, Anwar K, Nurita. 2011. Perbaikan Kualitas Lahan untuk Meningkatkan Produktivitas Kedelai di Lahan Rawa Sulfat Masam Potensial. *Jurnal Tanah dan Iklim*, Edisi Khusus Rawa:55-62.
- Koesrini, William E. 2009. Penampilan Genotipe Kedelai pada Dua Tingkat Perlakuan Kapur di Lahan Pasang Surut bergambut. *Penelitian Pertanian* 28(1):29-33.
- Marwoto, Simatupang P, Swastika DKS. 2008. Soybean development and policy research in Indonesia. In: Makarim AK et al., editors. *Proceedings of the Workshop on Soy-bean Development at Suboptimal land*. Indonesian Agency for Agricultural Research and Development. p. 1-18 (in Indonesian).
- Purwantoro, Suhartina, Taufiq A. 2009. Daya hasil Pendahuluan Galur Kedelai Toleran Kekeringan. *Prosiding Seminar Hasil Penelitian Aneka Kavang dan Umbi*. Malang Tahun 2012. p. 82-89
- Pusat Penelitian Tanah (Soil Research Center). 1982. Term of Reference Survei Kapabilitas Tanah. *Proyek Penelitian Pertanian Menujang Transmigrasi (P3MT)*. Bogor.
- Pusat Penelitian dan Pengembangan Tanaman Pangan. 2009. Deskripsi Varietas Unggul Palawija 1918-2009. Pusat Penelitian dan Pengembangan Tanaman Pangan. Bogor.
- Pusdatin. 2015. Outlook Komoditas Pertanian Subsektor Tanaman Pangan: Kedelai. Pusat Data dan Sistem Informasi Pertanian. Kementrian Pertanian. Jakarta.
- Rahmi O, Susanto RH, Siswanto A. 2015. Pengelolaan Lahan Basah Terpadu di Desa Mulia Sari Kecamatan Tanjung Lago, Kabupaten Banyuasin. *Jurnal Ilmu Pertanian Indonesia (JIPI)* 20(3):201-207.
- Roy RN, Finck A, Blair GJ, Tandon HLS. 2006. Plant nutrition for food security: A guide for integrated nutrient management. *FAO Fertilizer and Plant Nutrition Bulletin*, 16. Rome: Food and Agriculture Organization Of United Nations.
- Sagala D, Ghulamahdi M, Melati M. 2011. Pola Serapan Hara dan Pertumbuhan Beberapa Varietas Kedelai dengan Budidaya Jenuh Air di Lahan Rawa Pasang Surut. *Jurnal Agroqua* 9(1):1-10.
- Silva S, Pinto-Carnide O, Martins-Lopes P, Matos M, Guedes-Pinto H, Santos C. 2010. Differential Alluminium Changes on Nutrient Accumulation and Root Differentiation in an Al Sensitive vs toleran Wheat. *Environmental and Experimental Botany* 68(1):91-98.
- Soil Survey Staff. 2014. *Keys to Soil Taxonomy*. 20th edition. Washington, D.C.: USDA, NRCS.
- Subagyo H. 2006. Klasifikasi dan Penyebaran Lahan Rawa. Di dalam: Suriadikarta DA, Kurnia U, Mamat HS, Hartatik W, Setyorini D, editors. *Karakteristik dan Pengelolaan Lahan Rawa*. Ed ke-1. Bogor: Balai Besar Penelitian Dan Pengembangan Sumberdaya Lahan Pertanian, Badan Penelitian Dan Pengembangan Pertanian, Departemen Pertanian. p. 1-22.
- Susanto RH. 2010. Pengelolaan rawa untuk pembangunan pertanian berkelanjutan. *Seminar Fakultas Pertanian*. Universitas Sriwijaya, Inderalaya. 173 p.
- Susilawati KS, Suwigno RA, Hayati R. 2013. Adaptasi Beberapa Varietas Unggul Kedelai yang berdaya Hasil Tinggi dengan Pemberian Dolomit dan Urea di Lahan Pasang Surut. *Jurnal Lahan Suboptimal* (3)2:126-131.
- Sutyorini S, Waryanto B. 2013. *Agriculture statistics 2013*. Center for Agricultural Data and Information System, Ministry of Agriculture, Republic of Indonesia. 316 p (in Indonesian).
- Syahri, Somantri RU. 2014. Optimalisasi Lahan Sub Optimal untuk Pengembangan Kedelai di Sumatera Selatan Melalui Penerapan Inovasi Teknologi. *Prosiding Seminar Nasional Lahan Suboptimal 2014*, Palembang 26 - 27 September 2014.
- Taufiq A, Kuntastuti H, Wardani C, Prahoro T. 2004. Kapur dan Pupuk Kandang pada Kedelai di lahan Kering Masam. *Penelitian Pertanian* 26(02):78-85.
- Taufiq A, Sundari T. 2012. Respons Tanaman Kedelai terhadap Lingkungan Tumbuh. *Buletin Palawija* 23:13-26.
- Taufiq A, Wijanarko A, Suyamto S. 2011. Takaran Optimal Pupuk NPKS, Dolomit dan Pupuk Kandang pada Hasil Kedelai di Lahan Pasang Surut. *Penelitian Pertanian Tanaman Pangan* 30(1):52-57.
- Thamrin T, Soehendri R, Kuswantoro, Syahri H. 2011. Uji Galur-Galur Harapan Kedelai Toleran Kemasaman di Lahan Pasang Surut Sumatera Selatan. *Prosiding Seminar Nasional PPSL*. 2011
- Uguru MI, Oyiga B, Jandong EA. 2012. Responses of Some Soybean Genotypes to Different Soil pH Regimes in Two Planting Seasons. *The African Journal of Plant Science and Biotechnology* 6(1):26-37.
- Wijanarko A, Taufiq A. 2016. Effect of lime application on soil properties and soybean yield on tidal land. *Agrivita* 38(1):14-23.
- Yardha, Adri. 2013. Teknologi Budidaya dalam Upaya Peningkatan Produksi Kedelai di Lahan Pasang Surut. *Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang dan Umbi*. Jambi Tahun 2014. p. 395-400.

Growth and production of soybean Glycine max L

ORIGINALITY REPORT

91%
SIMILARITY INDEX

18%
INTERNET SOURCES

92%
PUBLICATIONS

70%
STUDENT PAPERS

PRIMARY SOURCES

- 1

Dedik Budianta, Adipati Napoleon, Akbar Paripurna, E Ermatita. "Growth and production of soybean (Glycine max (L.) Merrill) with different fertilizer strategies in a tidal soil from South Sumatra, Indonesia", Spanish Journal of Soil Science, 2019
Publication

82%
- 2

Submitted to Universitas Brawijaya
Student Paper

4%
- 3

sjss.universia.net
Internet Source

4%
- 4

hdl.handle.net
Internet Source

1%

Exclude quotes On

Exclude bibliography On

Exclude matches < 1%