SJSS
SPANISH JOURNAL OF SOIL SCIENCE

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

*Crecimiento y producción de soja (*Glycine max *(L.) Merill) mediante diferentes estrategias de fertilización en un suelo mareal de Sumatra del Sur, Indonesia*

*Crescimento e produção de soja (*Glycine max *(L.) Merill) com diferentes estratégias de fertilização num solo na zona de maré do Sul de Sumatra, Indonésia*

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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.) Merill) 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

*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.) Merill) 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 vaínas no*

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

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.) Merill) 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}).*

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.

1. Introduction

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 soybean production at 800 kg/ha (Djayusman et al. 2001). Soybean is considered to be poorly tolerant to high soil acidity (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 tons ha^{-1} (Pusdatin 2015), while soybean production in South Sumatra was 16,818 tons with a mean productivity of 1.51 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 tons ha^{-1} (Koesrini and William 2009), and lime application at 1.15 tons ha 1 increased production from 1.32 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, 22.5-45 kg ha^{-1} of P_2O_5, and 50-100 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 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 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_2O	-	4.55	Acidic
Total N	%	1.68	Low
P-Bray	mg kg^{-1}	58.95	Very high
K-exchangable	$cmol_{(+)}$ 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	

*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-Spesific Fertilizer			Recommendation Fertilizer		
	Plant height (cm)			Plant height (cm)		
	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP
0.00	20.42 ab	25.25 ab	33.18 ab	18.97 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	26.80 cdef	40.20 gh	60.70 g
3.26	30.40 i	42.60 i	69.93 i	28.58 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	Avarege 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 bc
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

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	9.60 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 $cmol_{(+)}$ kg^{-1} in soil solution (Taufiq and Sundari 2012). Purwantoro et al. (2007) concluded that the Wilis 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 $cmol_{(+)}$ 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 $cmol_{(+)}$ kg^{-1}, respectively. Another study by Thamrin et al. (2011) showed that varieties of Wilis 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 Wilis 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}), Wilis (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 Wilis 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.

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