LAND SUITABILITY FOR SOYBEAN (GLYCINE MAX (L.) MARILL) IN SANDY COASTAL LAND OF PARANGTRITIS, BANTUL REGENCY

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Submission date: 08-Jun-2020 04:58PM (UTC+0700)
Submission ID: 1339999687
File name: C.11-Gunawan_B.pdf (455.55K)
Word count: 3853
Character count: 19425

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Abstract. Outdoor research was conducted in the coastal region of Parangtritis from December 2015 up to April 2016, with the purpose is to determine the soil characteristic of coastal land of Parangtritis and its suitability for soybean cultivation. This research was conducted using the observation method by collecting primary and secondary data. Primary data were soil characteristics which determined using the laboratory analysis procedures, while secondary data were supporting information obtained from local government agencies. The results showed that the coastal land of Parangtritis had a sandy texture, very fast soil drainage, the effective depth of low to moderate soils, low salinity, low cation exchange capacity, percentage saturation of medium to high bases. Based on the results of the analysis of primary and secondary data, actually the sandy land of Parangtritis is categorized into land suitability class S3r-1; r-2 for soybean plants, with soil drainage and texture as a limiting factor. Potentially, to reduce the negative effects of existing limiting factors, the addition of large amounts of organic matter, inorganic amendments, and NPK fertilizer is highly recommended.

1. Introduction

Soybean is plants that have the potential to be developed because soybeans are the third most important food crop after rice and corn. Soybeans play a role as a source of vegetable protein which is very important in order to improve community nutrition because it is safe for health. According to the National Development Planning Agency 2014 report, Indonesia's total soybean consumption from 2008 to 2012 continued to increase by an average of 12.89% / year, but the amount of soybean production in the same period actually declined. On the other hand, the Central Bureau of Statistics of the Special Region of Yogyakarta stated that the soybean harvest area actually declined and resulted in a decreasing in soybean production by 38.19%.

The increase in agriculture land conversion is one of the factors that cause the decline of soybean production. Based on this fact, the use of marginal land for soybean cultivation is an alternative or solution that can be applied to overcome the intensive conversion of agricultural land into non-agricultural. On the other hand, the use of this kind of marginal land has not been widely developed and utilized for the cultivation of soybean plants.

The southern region of Bantul Regency stretches the South Coast from Srandakan, Sanden and Kretek Districts. The existence of a series of beaches in the southern part of Bantul Regency starting from Srandakan District, Sanden to Kretek Subdistrict makes the number of marginal land in the form

of coastal sandy land in Bantul Regency. Marginal land is land that has potential fertility because the land has several limiting factors that must be overcome first before being utilized. Land suitability evaluation is the procedure that can be done so that the potential of the land is known, land suitability and actions that need to be taken in utilizing sandy coastal land of Parangtritis. Thus in the effort of utilization can be carried out based on the limiting factors of the land so that the production results remain optimal and the quality and sustainability of the land is maintained [1].

2. Materials and Methods

This research was carried out using a survey method. The choice of location for taking land samples is carried out purposively, which is determined based on certain interests. The selection of research locations is based on the fact that coastal sandy land is a local resource that has not been developed and utilized in soybean cultivation. Determination of sample points based on sea tide boundaries, so that the land will be divided into 3 sites; site (1) is the area which is passed by seawater, site (2) is the area which is not passed by seawater and site (3) is the area which is not overtaken seawater but directly adjacent to river water, as shown in Figure 1. Soil samples from each site were taken compositely and collected as many as five soil samples per site.

Figure 1. Location of soil sample collection site

Data analysis was performed using a matching method between data of land characteristics and results of laboratory analysis on the requirements for growing soybean plants. Descriptive analysis was conducted to provide an explanation of the relationship between land characteristics factors and the results of land suitability classes and recommendations for treatments to reduce the negative impact of limiting factors.

3. Results and Discussion

3.1. Land Characteristics

Land characteristics are interactions of several land characters that are sourced from atmospheric conditions (temperature and rainfall) and which are derived from soil conditions such as topography and soil properties. Based on BMKG (Meteorology Climatology and Geophysics Agency) data, the average temperature at Parangtritis (Kretek District, Bantul) is 26.9 oC. This condition indicates that the location

temperature is included in the S2 class or is quite appropriate while the most suitable place for soybean growth is between 23-25oC based on soybean crop suitability criteria.
Regarding the water availability, rainfall data in Bantul Regency is 1,955 mm / year. The rainfall conditions are classified into S2 classes or quite suitable because the amount of rainfall in Bantul Regency is between 1,500-2,500 mm/year. In 2015 Bantul Regency had 4 dry months/year, namely in July (54 mm), August (19 mm), September (3 mm) and October (39 mm). Based on this data, the location of the study can be categorized into the S1 class or very suitable. In 2015, Bantul Regency had air humidity of 82.83%. The humidity condition is categorized in the S2 class or quite appropriate because the amount of water vapor in the air is between 80-85% or higher than the moisture that suitable for soybean plants between 24-80%.

Observation on root zone should consider three main components, such as soil drainage, soil texture, and effective depth. As shown in Table 1, all sampling sites in coastal land of Parangtritis displayed rapid drainage with a sandy texture and effective depth ranging from 20-60 cm. Sandy coastal land of Parangtrits is a type of Typic Tropopsamment soil and is a young land that has not shown development without horizon differentiation. This land is dominated by sand fraction (more than 90%) with little or no dust and clay content, so it has low water retention and is always in dry conditions. Sandy soil is often associated with land dominated by sand fractions, crumbs with a weak structure or do not form aggregates or soil clods, and have low water content, so the properties of these sandy soils cause problems in their utilization for agricultural production [2, 3].

Table 1. Drainage, texture and effective depth of sandy soil in Parangtritis.

Sampling Site	Drainage	Texture	Effective depth
Site (1)	Very fast (2,500 cm/hour)	Sandy	20-40 cm
Site (2)	Very fast (2,250 cm/hour)	Sandy	20-60 cm
Site (3)	Very fast (424,50 cm/hour)	Sandy	20-60 cm

Nutrient retention of soil was determined based on its cation exchange capacity (CEC), base saturation, pH, and organic-C, as shown in Table 2. Cation Exchange Capacity (CEC) describes the nutrient content in the soil. The CEC value of Parangtritis soil samples is in the range of 7.0 - 8.5 me/100 grams of oven-dried soil samples and categorized into the S2 class or quite suitable for soybean plants. Soil base saturation of three sites, including in the S1 class or highly suitable where base saturation does not become a large limitation for soybean cultivation and does not significantly affect soybean production. Determination of soil pH shows that soil samples from all three sites have acidity around neutral, and are categorized into S2 classes or quite suitable for soybean plants, but has low content of organic matter (C-organic). In addition, this area was found to have no salinity problem.

Table 2. CEC, base saturation, pH and organic-C of soil at Parangtritis.

Sampling Sites	Exchangeable cation				CEC	Base	pH	Organic-C
	K	Na	Ca	Mg		Saturation	Extr.H_2O (1:5)	Walkey Black
	me/100 gram					%		%
Site (1)	0.01	0.89	1.67	0.76	7.60	43.79	7.36	0.05
Site (2)	0.17	1.82	2.30	0.65	7.36	67.25	5.85	0.57
Site (3)	0.03	0.52	5.81	0.91	8.64	84.14	7.53	0.19

The total N-content of the three soil sample sites (Table 3) is included into S2 class or is quite appropriate because the total N owned by the three soil samples is classified as low between 0.1-0.2%.

The availability of N in the land is not a serious limitation but can reduce the product if it is not balanced with nitrogen nutrient input. The results of the determination of P nutrient availability in all three soil sample sites indicate that the sandy coastal land of Parangtritis is classified into S3 or low suitability because the amount of P element available in the three sections is very low, which is <15 mg / 100g (Table 3). The availability of K nutrients in the three sites of sandy coastal land of Parangtritis is classified into the S3 class, or low suitability with the available K nutrient content is very low, which is less than 10 mg / 100g (Table 3). Based on the results of the determination of nutrient availability of nitrogen, phosphorus and potassium, the three soil samples of Parangritis have a low fertility rate, which is categorized as marginal land (S2 and S3) with limiting factors for the availability of these three nutrients. Sandy soil problems, in general, are in need of improved nutrient status, because they have a deficiency in some of the main nutrients and cause sandy soils to have low productivity [4].

Table 3. Soil N-P-K availability of sandy land of Parangtritis

Sampling Sites	Total-N	Available-P	Available-K	Potential-P	Potential K
	Extract H_2SO_4	Extract Olsen	Extract Morgan Wolf	Extract HCl 25%	Extract HCl 25%
	%		mg/100 g		
Site (1)	0.18	2.560	1.848	250.10	15.44
Site (2)	0.16	2.655	2.236	219.97	17.44
Site (3)	0.12	2.527	3.137	333.59	21.92

3.2. Land Suitability Class the Sandy Coastal Land of Parangtritis for Soybean

Determination of land suitability evaluation before land use will provide information on land potential, the suitability of land use and actions that must be taken in land use. The results of the actual land suitability classification according to FAO [5]. The root zone is part of the interaction between soil and plants that determines the process of water supply and nutrient uptake. The root zone is one of the important parameters in determining land suitability classes. The root zone is the most important part of the function of the planting media and has three main components, namely soil drainage, soil texture, and effective depth of roots.

Soil drainage is the ability of the soil to reduce the water content of the soil surface and soil solum. Slow drainage is not in accordance with the growth of soybean plants, because these plants need good aeration around their roots. Poor drainage conditions cause stunted root growth and decreased nutrient uptake. Observation of soil drainage can be done by measuring the speed of soil infiltration or the speed of water in penetrating and moving in the body of the soil. The results of measuring soil infiltration from soil samples site (1) is 2,500 cm/hour, site (2) is 2,250 cm/hour, and site (3) is 424.53 cm/hour; and is categorized as having very fast infiltration (more than 25 cm / hour), exceeding the speed of soil infiltration in accordance with the growth of soybeans which are between 2.5 to 6.5 cm / hour. As a result, the sandy coastal land of Parangtritis cannot bind water and cannot provide water for soybean crops.

Parangtritis coastal land is one of the sandy landforms in the tropical region with a dry climate so that organic material decomposes quickly. Therefore, repairs to sandy land using organic materials must be given in large quantities. Research conducted by Budiyanto [1] in Kulonprogo beach sandy land, indicating that improvement in the nature of sandy land can be carried out through the provision of at least 30 tons / hectare organic material with a carbon-nitrogen ratio of 30-40.

Soil texture illustrates the diameter of the constituent particles which are expressed as a comparison of the proportions of sand, dust, and clay fractions. Soil texture is one of the properties of the soil that determines the ability of soil to store water through attractive forces between the surface of soil particles and water. Soil texture will affect the ability of soil to store water and provide water, and support plant nutrient uptake.

Based on observations in the field, the texture of three soil sample sites of Parangtritis including sandy fraction with very rough criteria and does not form an aggregate. Based on soybean crop suitability criteria, the texture of the soil in the form of sand is included in the N2 class or not suitable. This means that the soil texture in sandy coastal land of Parangtritis is a permanent barrier that will not be able to support land use for soybean cultivation. A land dominated by sand fraction has a lot of macropores or can be called porous, which easily passes water. Gravitational water which always moves out of the root zone will carry nutrients from the root zone and cannot be utilized by plants.

Table 4. Actual land suitability

No	Land Quality/ characteristic	Soil sample site		
		(1)	**(2)**	**(3)**
1	Temperature (t)	**S2**	**S2**	**S2**
	Mean of yearly (°C)	26.88°C		
2	Water availability (w)	**S2**	**S2**	**S2**
	1. Dry season (<75 mm)	S1 (4 months)		
	2. Yearly rainfall (mm)	S2 (1,955 mm/year)		
	3. Humidity (%)	S2 (82.83 %)		
3	Root zone (r)	**N2**	**N2**	**N2**
	1. Soil drainage	N2 (2,500 cm/hour)	N2 (2,250 cm/hour)	N2 (424.53 cm/hour)
	2. Soil texture	N2 (sand)	N2 (sand)	N2 (sand)
	3. Effective depth (cm)	S2 (10-40)	S1 (10-60)	S1` (10-60)
4	Nutrient retention (f)	**S2**	**S2**	**S2**
	1. Soil CEC	S2 (7.60)	S2 (7.36)	S2 (8.64)
	2. Base saturation %	S1 (43.79 %)	S1 (67.25 %)	S1 (84.14 %)
	3. Soil pH	S2 (7.36)	S2 (5.85)	S2 (7.53)
	4. C-organic (%)	S2 (0.05 %)	S2 (0.57 %)	S2 (0.19%)
5	Toxicity (x)	**S1**	**S1**	**S1**
	Salinity (mmhos/cm)	S1 (0.00)		
6	Available nutrient (n)	**S3**	**S3**	**S3**
	1. Total N	S2 (0.18%)	S2 (0.16%)	S2 (0.12%)
	2. P_2O_5	S3 (2.560 mg/100g)	S3 (2.655 mg/100g)	S3 (2.527 mg/100g)
	3. K_2O	S3 (1.848 mg/100g)	S3 (2.236 mg/100g)	S3 (3.137 mg/100g)
7	Flooding (b)	**S1** (never)		
Sub-class of actual land suitability		**S3-r**	**S3-r**	**S3-r**
Unit of actual land suitability		**S3r-1, r-2**	**S3r-1, r-2**	**S3r-1, r-2**

According to Budiyanto [1], improvements that can be made to reduce fast drainage of sandy land of Parangtritis can be done through the application of organic materials, subsurface mulch, and zeolite

rocks into soil. The application of the plastic mulch below the surface of the soil (as deep as rooting) is an attempt to maintain the water content and nutrients in the root zone. While the use of zeolite rocks is one form of hydrated allumino-silicate crystals that are structured in such a way that they have greater absorption power and the ability to store water. The use of plastic mulch and zeolite rocks can provide better results, but it results in an increase in operational costs while the utilization of organic materials can be done comprehensively through increasing production of sources of local organic materials, for example through cultivation of cover crops, animal feed, and livestock. The application of sustainable farming is one of the cheap technologies to maintain the supply of local organic material sources.Table 4 shows that the sandy coastal land of Parangtritis has S3 actual land suitability classes with drainage and soil texture as the limiting factors (S3r-1, r-2). The addition of input to reduce the negative effects of drainage and texture can increase the potential for land suitability, as shown in Table 5.

Table 5. Potential land suitability

No	Actual Land Suitablity		Improvement input (moderate to high)	Potential Land Suitability	Soil sites
	Sub-class	Unit			
1	S3-r	S3r-1, r-2	High doses of organic matter application	S3r-2	Site (1); site (2) dan site (3)

Table 5 showed that the application of organic matter in large doses is highly recommended to reduce the rate of soil drainage. According to Cooperband [6], the residues of animals and plants will be decomposed immediately if added to the soil and will immediately affect the soil properties. Organic material can be used in the form of manure, compost from agricultural waste, or other organic wastes. The application of manure can significantly increase the organic C content in the soil, nitrogen content, and cation exchange capacity (CEC). The addition of municipal waste with a dose of 25 tons/hectare increased the nitrogen content in cucumber fruit by 1.62% [7, 8]. The experiments conducted by Hou *et al.* [9] proved that the addition of 10% organic matter (compost) per soil weight could improve the performance of sand soils in storing water and increasing the growth of tomato plants. The addition of organic fertilizer into sandy soil was also carried out by Ellmer and Baumecker [10], the results proved that farmyard manure (organic fertilizer) has the most effect on increasing of C-organic content compared to crop rotation treatment and N-mineral fertilizer. Based on this research, the application of organic matter into sandy soil will increase the quality of soil physical properties in one planting period.

Soil texture is a physical property of the soil that is difficult to change unless additional material is added to reduce the dominance of the sand fraction. In addition to organic materials, several inorganic materials have been used to change the composition of soil particles per unit volume. One of the amendment materials used to change the composition of sand soil particles is clay particles, mainly intended to reduce the gravitational water rate which can give rise to the impact of nutrient leaching. The experiments conducted by Tahir and Marschner [11] by adding a number of clay particles into the sand soil prove that the addition of clay particles as much as 10-20% per soil weight can significantly reduce nutrient leaching of N and P.

Application of the combination of organic material and clay particles into the sand soil proves that incorporation between clay particles and organic matter increases aggregate stability, total porosity, and water availability [3]. Most of the sandy soil, include sandy coastal land of Parangtritis has low quality of fertility. With the low of nutrient content caused any processes (low content of clay and organic material also the domination of sand fraction), the sandy coastal land of Parangtritis needs comprehensive treatment in utilizing the land. Senjobi *et al.* [4] had improved sandy soil using organic materials and mineral fertilizer. Four levels of poultry manure, cow dung, Gateway fertilizer and organo-mineral fertilizer and combined with NPK-fertilizer significantly increase the productivity of sandy land.

4. Conclusion

This study showed that Parangtritis sandy coastal land is marginal soil which is limited by very fast drainage and dominance of sand fraction, low fertility quality, and not suitable for soybean plants (S3r-1; r-2). Utilization of this land for soybean cultivation requires management of limiting factors using amendments (organic and inorganic materials) and NPK fertilizers.

Acknowledgement

The authors would like to acknowledge local government for permitting the use of location and Universitas Muhammadiyah Yogyakarta Research Grant 2015/2016.

References

[1] Budiyanto G 2014 *Manajemen Sumberdaya Lahan* (Yogyakarta) p 152-60
[2] Bruand A, Hartmann C and Lesturgez G 2006 *Physical properties of tropical sandy soils, a large of behaviours. management of tropical sandy soils for sustainable agriculture. a holistic approach for sustainable development of problem soil in the tropic* (Thailand: Khon Kaen University) p 10.
[3] Djajadi D, Heliyanto B and Hidayah N 2012 *AGRIVITA, J. Agric. Sci.* **33** 245-50.
[4] Senjobi B A, Akinsete S J, Ande O T, Plantation M and Ademoye O A 2003 *J. Biol. Life Sci.* **4**.
[5] FAO 1976 *A Framework for Land Evaluation* (Rome: Bulletin F S) p 79
[6] Cooperband L 2002 *Building soil organic matter with organic amendments* (Madison: Centre for Integrated Agricultural Systems, University of Wisconsin) p 16
[7] Hoa H T T, Tu P K, Ha P Q, Chiang C N and Dufey J 2010 *Assessment of the efficiency of organic amendments in coastal sandy soil area of Thua Thien Hue province, Central Vietnam* (Vietnam: APIPNM)) p 6
[8] Hussein A H A 2009 *J. Appl. Sci.* **9** 1401-11.
[9] Hou Y, Hu X, Yan W, Zhang S and Niu L 2013 *Agric. Sci.* **4** 31.
[10] Ellmer F and Baumecker M 2008 Soil organic matter of a sandy soil influenced by agronomy and climate. *International Meeting in Soil Fertility, Land Management and Agroclimatology.* Turkey: 10.
[11] Tahir S and Marschner P 2017 *Commun. Soil Sci. Plant* **48** 1813-21.

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