

The Soybean Growth and Yield with Different Water Depths and Bed Widths on Mineral Soil

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ABSTRACT----- *One of marginal lands in Indonesia is acid sulphate soil, which is potential for agriculture. Saturated soil culture is one of cultivation technologies that suitable on acid sulphate soil, because it can prevent pyrites oxidation and maintains soil moisture during plant growth. This research aimed to study the effect of water depth and bed width under soil culture on soybean growth. The experiment was held on mineral soil type in South Sumatera Province, Indonesia from April-September 2014. The experiment was arranged in a split plot design with three replications. The main plot of the experiment was water depths consisted of 10 and 20 cm below soil surface. The sub plot of the experiment was bed widths consisted of 2, 4, 6 and 8 m. The bedwidth of 4 m as same as 8 m and 20 cm water depth below soil surface gave the highest yield on mineral soil.*

Keywords– Glycine max (L.) Merr., irrigation, overflow, pyrite

1. INTRODUCTION

Tidal swamps land in Indonesia is one of marginal lands with approximately 24.7 million hectares; about 9.54 million hectares are suitable for agricultural. Soil type of tidal swamps land divided into acid sulphate soil, peat soil, potential soil and saline soil (Noor, 2014). This research conducted on acid sulphate soil of tidal land, which was mineral soil. Mineral soil had 3.4% C-organic matter. Mineral soil on acid sulphate soil containing pyrite layer on its soil structures. When this soil drained for development (for agriculture), the pyrite layer might be exposed into atmospheric conditions and subsequently oxidized. Pyrite oxidized will releasing high amounts of acidity (Shamshuddin et al., 2013). To reduce the negative impacts of drainage, the water depth has to managed properly.

Saturated soil culture is one of cultivation technology that suitable on acid sulphate soil. Hunter et al. (1980) explained that is an alternative technology to alter growth and yield of soybean compared to the conventional irrigation. Saturated soil culture is cultivation with continuously irrigation to maintained the stability of water table (approximately 5 cm under soil surface) and made saturated layer under soil surface. Ghulamahdi et al. (2009) showed the result of soybean yield with saturated soil culture was 4.63 t ha⁻¹, whereas yield by conservative irrigation only 850 kg ha⁻¹ on tidal land.

2. MATERIALS AND METHODS

The research was conducted on mineral soil type in Tanjung Lago, Banyuasin District, South Sumatera Province, Indonesia from April until September 2014. The experimental design was Split-plot design with three replications. The main plot of the experiment was water depth below soil surface in the trench consisted of 10 and 20 cm. The subplot of the experiment was bed width consisted of 2, 4, 6, and 8 m. The statistical analysis method was Anova followed by Duncan Multiple Range Test with level error 5%. The t-student was used to compare between two soils with level error 5%. The soybean variety was Tanggamus that is adopted to acid soil. Minimum tillage was conducted on both soils to prevent pyrite oxidation and each bed width surrounded by 25 cm wide and 30 cm depth trench. Water was given at the planting time and kept until the maturity stage to maintain soil in saturated condition.

Two weeks before planting, soil bed were applied with 1 ton dolomite ha⁻¹ and 2 ton manure ha⁻¹. At planting date, seed were inoculated with *Bradyrhizobium* sp and treated with insecticide with active agent Carbosulphan 25.53%. Fertilizers 200 kg SP-36 ha⁻¹, 100 kg KCl ha⁻¹ were also applied at planting date beside planting hole. The planting distance were 12.5 cm x 40 cm. The observed variables were plant height, branch numbers, dry weight, root dry weight, pod numbers, seed weight per plant and soybean yield.

3. RESULT AND DISCUSSION

3.1 Soybean Growth and Yield on Mineral Soil Type

There was no interaction between the water depth below soil surface and the bed width for all variables on mineral soil. The water depth and bed width was not influence during vegetative phase in mineral soil due to the steady growth and simultaneously on its phase. On the other hand, the generative phase was affected by water depth treatment shown by pod numbers and yield. Meanwhile, the bed width influenced on yield only (Table 1).

Table 1: Soybean growth and yield on mineral soil type with various water depths and bed width treatment.

Water depths (cm)	Plant height (cm)	Branch numbers	Dry weight (g)	Roots dry weight (g)	Pod numbers	yield (t ha ⁻¹)
10	86.9	2.8	30.2	2.4	103.5 b	3.6 b
20	91.1	3.1	34.1	2.6	128.9 a	4.4 a
Bed widths (m)						
2	89.8	3.1	33.8	2.6	115.9	3.9ab
4	87.8	3.1	30.7	2.5	128.7	4.5a
6	89.4	2.7	30.1	2.3	102.3	3.4b
8	88.9	2.9	33.9	2.6	118	4.1ab

footnote : the number followed by letter in the same column not significantly different by Duncan Range Test with error 5%

Inradewa et al. (2002) also concluded there was no influence of bed width during vegetative phase of soybean cultivation on mineral soil under saturated soil culture. The 20 cm of water depth below soil surface gave the best pod numbers and yield. Water availability during flowering to pod filling is critical period for soybean yield. Therefore, the provision under saturated soil culture increase the availability of water for crops during the period. Ghulamahdi et al. (2009) also showed high yield on 20 cm of water depth below soil surface was 4.63 ton yield ha⁻¹ in mineral soil. The availability of water under saturated soil culture extend the vegetative phase and delay the leaves senescence during pod filling and thereby extending the time remobilization of nutrients from the leaves to the seeds. Agarwal et al. (2012) also concluded, that delaying on senescence by ethylene biosynthesis on the plant, that occurred under saturated soil culture.

Soybean roots under saturated soil culture will be acclimated by changing the taproot into fibrous thus increase the weight of the roots. Ghulamahdi (1999) explains that the acclimatization begins with an increase of the ACC (aminocyclopropane-1-carboxylic acid) at the root. Oxygen will then trigger the change of ACC into ethylene and increase ethylene content in roots. Increased ethylene will induce growth responses such as the establishment of aerenchyma, development of adventitious roots (Verstraeten et al., 2014) and increased shoot elongation (Bailey-Serres and Voesenek, 2008). Shaharoon et al. (2011) and Ghulamahdi et al (2009) also explained how the enhanced formation of adventitious roots increasing the formation of nodule. Formation of nodule will increase the activity of nitrogenase and nutrients absorption. Ghulamahdi et al. (2009) showed that soybean yield under saturated soil culture reached 4.63 tons ha⁻¹, while soybean yield with conventional irrigation amounted to only 850 kg ha⁻¹ on acid sulphate soil.

Bed width was influence on yield only. Bed width on 4 m gave highest yield, but not different with 2 m and 8 m (Table 1). This is due to the growth of plant simultaneously and evenly during the vegetative phase in mineral soil. Therefore, the 20 cm of water depth below soil surface and 8 m of bed width is recommended for soybean crop on mineral soil under saturated soil culture. It aims to ease the provision of irrigation water as well as reducing the tillage cost and gave 4.4 ton yield ha⁻¹.

The duncan analysis showed that 20 cm water table depth under soil surface significantly higher than 10 cm water table depth under soil surface for pod numbers and yield (Table 1). Seed growth processes, however, are dynamic and influenced by reproductive duration and environmental factor such as solar radiation and temperature which, in turn, are influenced by sowing date (Bastidas et al., 2008). Sowing date on both soil conducted at the end of rainy season with rainfall at May was 93 mm month⁻¹ with 27.9°C, 112 mm month⁻¹ with 28°C at pods forming and filling pods at July, 63 mm month⁻¹ with at ripening and 16 mm month⁻¹ with 28°C at harvest time at September.

The water table depth on 15 cm under soil surface enhanced seed protein content and seed protein weight (Indradewa et al., 2004; Ghulamahdi et al., 2006). However, water table depth of 10 cm under soil surface reduce oxygen on rhizosphere, under oxygen insufficiency was one of many factors that prohibit plant growth on the overly saturated or waterlogging conditions (Table 1). Ghulamahdi et al. (2009) concluded that soybean during maturing stage under saturated soil culture prolonged photosynthesis activity, hence produced more assimilates for plant growth, pods formation and filling. Agarwal et al. (2012) also added the attempts to procrastinate senescence by ethylene biosynthetic pathway, that occurred under saturated soil culture.

4. CONCLUSION

The 8 m of bed width and 20 cm of water depth gave the best soybean growth and yield on mineral soil of acid sulphat soil.

5. ACKNOWLEDGMENTS

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