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Optimization Of Sorghum Cultivation (*Sorghum Bicholor*) With Ameliorant Addition In The Post-Tin Mining Of Bangka, Indonesia

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***Abstract*—Sorghum is a drought-tolerance plant that have ability to survive on post-tin mining land. One way to increase the optimum growth and production of sorghum on post-tin mining land can be done by ameliorant addition. The objective of the study was to increase the optimum growth and production of sorghum in post-tin mining land. The experiment had been conducted in post-tin mining area located in Dwi Makmur Village, Merawang, Bangka, from November 2017 - May 2018. The experiment was conducted using Completely Randomized Design (RAL) with 1 (one) single factor as follows: Control (C0), NPK (C1), 40 gram phosphate solubilizing fungi (C2), SP_{36} 100 kg ha^{-1} (C3), SP_{36} 200 kg ha^{-1} (C4). The results showed that the application of 40 grams phosphate solubilizingfungi (C2) had the highest value on the dissolved solid total (° Brix). Complete NPK fertilizer (C1) has the highest root growth when its compared to other treatments. This indicates that full NPK fertilizer (C1) are able to increase the production of seeds/plant and harvest index (%). The addition of ameliorant is able to increase the optimum growth and production of sorghum in post-tin mining land of Bangka.**

Keyword—Sorghum, ameliorant, post-tin mining, phosphate solvent microorganism

I. INTRODUCTION

Indonesia Bangka Belitung Province is one of the tin-producing provinces in Indonesia. The main impacts of tin mining are critical landforms, landscape destruction, and damage in natural habitats and biodiversity[8]. As a result of the mining process is formed marginal land called tailings soil. Fertility of tailing soil is generally very low due to the loss of top soil, run-off and nutrient drift, and changes in physical, chemical and biological properties [14].The strategies for the cultivation of crops on the tailings land that to use plants that can adapt. Plants that can survive in post-mine land are the types of plants that can usually adapt in dry land and marginal land. The plants that have the ability to survive on post-mining land according to some studies are pineapple [7]. [15] states sorghum is a plant capable for adapting in marginal land, sleeping land, and nonproductive land.

Sorghum is a crop that has a prospect to be developed in Indonesia. Based on data from the Directorate of Cultivation of Cereals [4], the area of sorghum planting in Indonesia in 2015 was 2,615 ha Increasing the production of sorghum in Indonesia can be done by cultivation on marginal land.

The constraints in the cultivation of sorghum in the mine area is the nutrients availability so that there is competition in nutrients use for the sorghum plant. Provision of nutrients needed by plants by fertilization in accordance with the needs of plants. Fulfillment of macro elements such as N, P and K can be done by chemical fertilization or addition of organic matter. The use of chemical fertilizers containing nitrogen, phosphate and potassium is expected to increase the availability of nutrients needed by plants so as to increase the growth and production of sorghum. Phosphate (P) is one of the essential nutrients that play a role in photosynthesis, root development, fruit and seed formation. The nutrient element P is ground but can not be absorbed so it needs dissolution by microorganisms to be available for the plant. One technology that can overcome the low P element in the soil is to utilize the phosphate solvent microorganisms. [5] states that phosphate solvent microorganisms are microorganisms which can dissolve phosphate which is not available becomes available so it can be absorbed by the plant. Research of [13] giving phosphate solubilizing fungi to the plant can increase the growth and production of cassava plants. CPF is able to release bounded phosphate so it is available and able to be absorbed by plants. The treatment between chemical fertilizer and phosphate solubilizing fungi is expected to increase the growth crop and sorghum production can be used as the optimization step for the former tin mining area.

II. METHODS

The study was conducted from November 2017 until May 2018. The research was conducted on post-tin mining land owned by PT. TIMAH in Dwi Makmur Village, Merawang District, Bangka Regency.This research was conducted using an experimental method using Completely Randomized Design (RAL). The treatment levels were C0: Control, C1: NPK (urea 300 kg ha^{-1}, SP36 200 kg ha^{-1}, and Kcl 150 kg ha^{-1}, C2: phosphate solubilizing fungi 40 grams, C3: SP36 100 kg, C4: SP36 200 kg. The number of plant samples per replication was four plants. Each treatment consisted of five replications, so there were 25 experimental units. Total for sorghum plant unit was 100 sorghum plants, and the population of sorghum plant in this research were 900 plants.

Land management was done manually and the plot was made with size 5 m × 3 m. Total beds used were 25 plots. Then added cow manure 15 kgplot^{-1}.Planting materials used were seeds of sorghum. The sorghum seeds used were variety of Samurai (BATAN). Seedling use pot tray tools, with topsoil and organic material ratio of 1: 1. Planting process was done by entering the seeds of sorghum that already had 3-4 leaves to the planting hole. Planting hole sorghum 70 cm × 20 cm. The preparation of phosphate solubilizing fungi was conducted in the form of maize solid as the carrier according to treatment dose. The application ameliorant was done once at age 30 days after planting. The application was done by making a hole around the plant, then the fungus sprinkled on the hole and the hole backfilled with soil (Pratama 2012). The application of NPK fertilizer treatment with urea dose of 300 kg ha^{-1} , Kcl 200 kg ha^{-1}, and 150 kg ha^{-1} SP36 at the time of sorghum plants aged 35 DAP (Day Afer Planting) For the treatment of SP36 with a dose of 100 kg / ha and SP36 200 kg. Harvest was done after the plant was ready to be harvested and have entered physiologically mature. Determination of harvest time for sorghum was identified by looking at the visual characteristics of the seeds. Harvesting can also be done after the appearance of such characteristics as the leaves are yellow and dry.

The data obtained were analyzed using the F test at 95% significant level. It will be tested further by using BNT test with α 5% using Statistical Analysis System (SAS) program.

III. RESULTS AND DISCUSSION

Currently fertile land in the archipelago of Bangka Belitung is constantly transformed into a critical land due to tin mining activities(Nurtjahya et al. 2017). The impact of tin mining in Bangka Belitung needs to be decreased by reclamation. Soil on tin mining area in Dwi Makmur Merawang village, Bangka district has a soil content of C-Organic 0.097% (very low), N-total0.001% (very low), KTK 10.88 cmolkg^{-1} (very low) and sand texture 51.78%, 40.69% dust, clay 7.53% (soil laboratory Unsri). This shows the availability of small nutrients for the needs of the plants in the ex-mining tin land of Bangka. Post-mining land can be utilized then there should be an effort to restore land that has been damaged as a result of mining activities. Improvement efforts of mining land are done through reclamation and revegetation program with addition of amelioration of organic material (Inonu et al. 2011).

The result of variance analysis showed that the treatment difference had a very significant effect on dissolved solid total/DST(°Brix), significantly different for crown dry weight, root dry weight and number of leaves. However, for plant height, diameter of stem, number of leaves, root length, wet root weight, dry weight of stem and seed weight had no significant effect (Table 1).

TABLE 1. ANALYSIS OF THE AVERAGE VARIATION OF GROWTH OF SORGHUM PLANT

Variable	Treatment F hit	Treatment Pr > f	CV(%)
Plant height (cm)	0.41 tn	0.7974	7.76
Number of leaves ()	0.55 tn	0.7026	10.59
Diameter of stem (cm)	0.50 tn	0.7344	10.50
Roots length (cm)	0.42 tn	0.7917	8.86
Number of roots	3.62*	0.0225	10.82
DST (°Brix)	4.79**	<0.0001	12.92
Seed weight(g)	0.63 tn	0.6497	24.40
Roots fresh weight (g)	2.47 tn	0.0780	38.45
Shoots fresh weight (g)	3.88*	0.0172	27.53
Roots dry weight (g)	3.51*	0.0250	28.43
Roots dry weight (g)	0.97 tn	0.4471	33.46

Note: CV : The coefficient of variation, **: siginificant at the level of 1%, *: significant at the level of 5%, tn: not significant
Pr> F: probability value

Based on the result of LSD test (Table 2) on the variable of total soluble solids treatment of phosphate solubilizing fungi/PSF 40 gram (C2) solvent was higher than other treatments, C2 was significantly different to control treatment (C0), complete NPK (C1) and SP36 200 kgha^{-1} (C4) but not significantly different to SP36 100 kgha^{-1} (C3).Treatment C1 had more amount of root number than the treatments C2 and C4 but not significantly different to C0 and C3.

The highest fresh weight was showed at C0, and significantly different from other treatments. The highest root dry weight was achieved at C3, where C3 treatment was significantly different to treatment of C0, C1 and C4, but not significantly different with treatment of C2 (Tabel 2).Table 2 shows that all treatments showed statistically different on dissolved solid total, number of leaves, shoots fresh weight and roots dry weight.

The fresh weight of the sorghum included the fresh weight of the crown and the root. Based on the histogram results in Fig. 1, the fresh weight treatment was tied between different roots and shoot.The highest root wet weight at C3 treatment was followed by treatment of C4, C1, C0 and C2 lowest. The highest wet weight of the canopy was treated with C0, C1, C4 and C2. C0: Control, C1: NPK (urea 300 kg ha^{-1}, SP36 200 kg ha^{-1}, and Kcl 150 kg ha^{-1}, C2: phosphate solubilizing fungi 40 grams, C3: SP36 100 kg, C4: SP36 200 kg.

TABLE 2. DATA OF BNT TEST RESULTS ON TPT VARIABLES, ROOT QUANTITY, CROWN WET WEIGHT, AND ROOT DRY WEIGHT

Treatment	Variable: Dissolved solid total	Number of leaves	Shoots fresh weight	Roots dry weight
Control	9.27 bc	36.80 ab	282.64 a	21.60 b
NPK	8.78 c	42.05 a	188.45 b	25.55 b
PSF 40 g	11.63 a	35.30 b	161.10 b	30.96 ab
SP36 100 kgha^{-1}	10.80 ab	37.80 ab	190.05 b	37.84 a
SP36 200 kgha^{-1}	9.00 c	32.85 b	172.55 b	23.15 b

Note: The number followed by the same letter in the same column is not significantly different

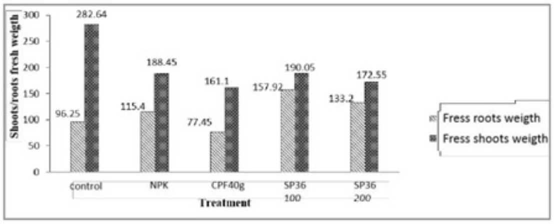

Figure 1. Shoot/roots fresh weight of sorghum at different amelioration treatments

The results showed that the application of complete NPK fertilizer (C1) had the highest growth of roots of sorghum plants compared to other treatments. This indicates that full NPK fertilizer (C1) was also able to increase the production of seeds/plant. Fulfillment of macro elements such as N, P and K with chemical fertilization or addition of organic matter can improve the optimization of growth and production of sorghum in ex-tin mining sites in Bangka. The study of sorghum showed that the addition of N, P, K and Ca fertilizers can increase the growth of sorghum dried crops [1]. The giving top dose soil and 20% oganic ingredients provide the best growth for forestry crops in sand tailings [14].

The results showed that 40 ml of phosphate solvent (C2) had the highest value on total dissolved solids content (° Brix). Solute from the stem of sorghum has a sugar content (glucose, fructose, maltose and xylose) which can be fermented into bioethanol. The sugar content is an important indicator as raw material for producing bioethanol [9]. Sorghum plant can be developed in dry land [2]. The addition of phosphate solvent fungi to cassava plants has an effect of growth and superior production compared to cassava planted without the addition of phosphate solvent fungi [13].

The results showed that 40 ml of phosphate solvent (C2) had the highest root length compared to other treatments. It showed by giving of phosphate solvent mushroom giving a real effect to the increase of phosphate solvent mushroom population in soil [11]. The presence of P increases sorghum tolerance to drought stress.

The dry weight of the sorghum canopy with control treatment showed significantly different than other treatments. The addition of ameliorant did not optimally increase the dry weight of the canopy. Sorghum with plant height, high amounts and fresh weight had the potential to be developed as a source of feed. Tolerance of sorghum plants against drought stress conditions in ex-tin mining area is seen from the comparison of plant growth performance in optimum condition and the condition is tense. This experiment is only planted on the condition recorded on the land of tin mining without comparing the condition without stress. It is also reported, which only selects on one environment in the acid soil of Jasinga Bogor [9]. The local sorghum plants and more national varieties in the saline field [3].

IV. CONCLUSIONS

1. Ameliorant increases growth and production of sorghum in ex-tin mining area i.e. number of leaves, stem diameter, shoot and root fresh weight, shoot and root dry weight root length, root number and seed yield.
2. Complete NPK treatment could increase the production of seed crops and root quantities, while the CPF treatment of 40 g could increase the content of total dissolved solids (°brix).

REFERENCES

[1] Astiko W, Fauzi MT, Sukartono."Mycorrhizal population on various cropping systems on sandy soil in dryland area of North Lombok, Indonesia," *Nusbiosci.*, Vol. 8, no.2, pp. 66-70, 2016.

[2] Badriyah IN, Taryono, Murti RH. "Performance of sugar yield and grain yield some sweet sorghum cultivars in the three dry land of Pekalongan and Batang, Centrak Java,"*Pros Sem Nas Masy Biodiv Indon*. Vol. 1, no.4,pp. 809-813, 2015.

[3] Benggu YI, Nguru E ST. "Short Comunication : The tolerance level of local sorghum genotypes from sabu-raijua and belu districts, Indonesia to saline soil," *Tropical Dryland*. Vol. 2, no. 1,pp.1-4, 2018.

[4] Direktorat Budidaya Serealia. 2016. Cereals cultivation directorate annual report year 2015.Jakarta: *Direktorat Jenderal Tanaman Pangan, Kementan RI.*

[5] Hutagaol D, Hasrizat I, Sofian A. "Application of indigenous phosphate solubilizing fungi from paddy soil increased P availainility and its P uptake on rice,"*J. Agron. Indonesia.*, Vol.45, no.1, pp. 9-13, 2017.

[6] Inonu I, Budianta D, Harun MU, Yakup, Wiralaha. "Amelioration of organic materials on sand tailings media derived from tin-post mining for rubber seedling growth," *Jurnal Agrotropika*., Vol. 16 no.1, pp. 45-51, 2011.

[7] Lanoviadi A, Mustikarini ED, and Widyastuti U. "The adaptability and Production of Local Pineapple of Bangka on The Sandy Tailing Land of Tin Mining Activities," *Jurnal Enviagro.,* Vol. 4, no.1, pp. 1-10, 2011.

[8] Lestari T, Abdi Z, Widodo J, Yohanes. "The vegetation analize of ex-tin mining land in Rebo village, Bangka," *Jurnal Enviagro.*, Vol. 2, no.2, pp. 1-28, 2008.

[9] Lestari T, Sopandi D, Trikoesoemaningtyas, Ardie SW. "Screening of several sorghum genotypes on acid soil tolerance," *International Journal of Agronomy and Agricultural Research.,* Vol.5, no.5, pp.170-176, 2014.

[10] Lestari T, Trikoesoemaningtyas, Ardie SW, Sopandie D. "The role of phosphorus in improving sorghum tolerance to aluminum stress," *J. Agron. Indonesia.*, Vol. 45, no.1, pp. 43-48, 2017.

[11] Nasution R M, Sabrina T, Fauzi. "Ultilization of phosphate solubilizing fungi and mycorrhizae in increasing P avability and P absorption by maize on alkaline soil," *Jurnal Agroekoteknologi.*, Vol. 2, no. 3, pp. 1003-

[12]

[13]

[14]

[15] 1010, 2014.
Nurtjahya E, Franklin J, Umroh, Agustina F. "The impact of tin mining in Bangka Belitung and its reclamation studies," *Matec Web of Confrerences*, Sicest 2016, 2017.
Pratama D, Kartika, Khodijah NS. "Optimizing growth and production of 1 variety and 3 accessions of cassava on ultisols with the addition of phosphate solubilizing fungi," *Jurnal Enviagro*., Vol.7, no.2, pp.1-48, 2014.
Pratiwi, Santoso E, Turjaman M. "Determination of ameliorant compounds dosage for soil of quartzitic sandy tailing as forest seedling media," *Jurnal Penelitian Hutan dan Konservasi Alam*., Vol. 9, no. 2, pp.163-174, 2012.
Suarni. "Role of sorghum physicochemical properties in food diversification and industry and its development prosfect,"*J. Litbang Pert*., Vol.35, no.3, pp. 99-110, 2016.

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