QUALITY ASSESSMENT ON FOUR GENOTYPES OF SWEET SORGHUM SAP WITH DOSAGE VARIATIONS OF ARBUSCULAR MYCORRHIZA AND HUSK CHARCOAL AS BIOLOGICAL FERTILIZER AND SOIL CONDITIONER FOR BIOETHANOL

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ABSTRACT

The aims of this study were to determine : 1. the interaction between sweet sorghum genotypes and combination of both arbuscular mycorrhizae and husk charcoal. 2. the response to arbuscular mycorrhizae biological fertilizer and soil conditioner. 3.the appropriate dose of mycorrhizae and husk charcoal to produce a high sap quality “Arbuscular Mycorrhiza and Husk Charcoal as a Biological Fertilizer and Soil Conditioner on Four Genotypes of Sweet Sorghum for Bioethanol" The research was conducted through a field experiment with split plot design in which the main plot is the arbuscular mycorrhizae/husk charcoal and the sub plots are sorghum genotypes, with three replications. The main plot which is the combination of arbuscular mycorrhizae and husk charcoal consists of: P1: arbuscular mycorrhizae 10g/plant, P2: arbuscular mycorrhizae 10g/plant + husk charcoal 30g/plant, P3: husk charcoal 30g/plant. The Sub-plot which is the sorghum genotype consists of G1: HZ-30, G2: Saber, G3: Patir 9, and G4: Patir 3. Of the two factors mentioned above, twelve combination treatments are obtained and repeated three times with each combination of treatments consists of 30 plants making total number of existing plant is 1080 plants. Observations were made on the content of sorghum sap (ml), the percentage of sorghum sap content (%) and sugar content of sorghum sap (%). Data variability was analyzed at 5% significance level. To examine the difference between treatments, Duncan's multiple range test level was conducted at 5% significance level. The results show that there was an interaction between genotypes and combinations of mycorrhizae-husk charcoal on sweet sorghum sugar content (%) with the highest value obtained is 7.6144% at the combination of 30g/plant-HZ-30 (P3G1). Each sweet sorghum genotype shows different reactions on the treatment combination of arbuscular mycorrhizae and husk charcoal.

Keywords: *dosage, mycorrhizae, husk charcoal, sap quality*

I. PREFACE

A. Research Background

Sorghum *(Sorghum bicolor* L. Moench) is a grain cereal crop which is included in gramineae family or grass. In Indonesia, currently sorghum provides an opportunity to develop as a plant food, feed and producer of bioethanol (bioenergy). As food, sorghum can be an alternative food source that can be developed to support the diversification and food resilience. Sorghum is commonly consumed in the form of bread, porridge, drinks, chips, etc. For livestock, sorghum grain can also be used as a concentrate mixture. Sorghum leaf and stem residues can also be used for fodder or for compost fertilizer. Some countries like the United States, India and China are already using the sap from the stems of sorghum as raw material for bioethanol (Sukmadi, 2010).

According to Sumarno and Karono (1995), sorghum has an advantage to resist from drought compared to other cereal crops. This crop is able to adapt in vast areas ranging from areas with

dry tropical climate (semi-arid) to wet temperate regions. Sorghum crop can still produce seeds on marginal land. It can be cultivated easily with relatively low cost, can be grown in monoculture and intercropping, productivity is very high and can be harvested more than once in a single plant with much different results, depending on the maintenance of the plant. Furthermore, sorghum plants are more resistant to pests and diseases meaning that the risk of failing is relatively small (Samanhudi, 2010).

As a raw material for bioethanol, sweet sorghum does not compete with food crops or fodders. There are several reasons to support this including botanically most of bioethanol is produced by the stem, while the seeds can be processed into bioethanol or for foodstuffs and animal feed. This makes the dual benefits such as sweet sorghum as a plant that is able to meet the needs for food, animal feed, and energy in one dimension of space and time (Rajvanshi, 1989; Yudiarto 2006 in Anonymous, 2013).

Sorghum is a crop that has great prospects for development as a feedstock for ethanol. Sweet sorghum stem, bagasse (dry pulpy residue left after the extraction of juice from sap) and the seeds can be processed into ethanol after extraction process. High ethanol production per unit area of sweet sorghum sap beside is affected by the concentration of ethanol per kg is also largely determined by the stem biomass production of each variety (Anonymous, 2011).

In cultivating sweet sorghum, the problem lies on the low productivity level in both quantity and quality. This is partly due to the use of fertilizers that do not suit your needs, nutrient-poor soils, pest and diseases that have not been effective, agro-climatic factors and the lack of technical mastery of cultivation by farmers. To increase the production of sweet sorghum, it can be done in various ways including through improved farming technologies such as the use of improved varieties, the use of organic and biological fertilizers, pest and disease control with biological pesticides, and post-harvest improvement (Sukmadi, 2010).

To increase the yield of sweet sorghum biomass aside from the use of superior varieties, addition of arbuscular mycorrhizael fungi as biological fertilizer and husk charcoal for soil fertilizer can also be done. Arbuscular mycorrhizael fungi are very beneficial for plants in improving nutrient absorption, especially phosphorus (P) and other nutrients such as Zinc (Zn), molybdenum (Mo), copper (Cu) and potassium (K). In addition to improve nutrition, arbuscular mycorrhizael fungi are also known to protect plants from drought and have the ability to improve plant resistance to pathogen attacking the roots (Sukmadi, 2010; Kusnadi, 2010; and Yuwono, 2006). A research

result by Corryanti et al. (2007) shows that mycorrhizae inoculation can enhance the growth of teak seedlings.

Husk charcoal as soil fertilizer is able to sequester carbon and improve soil functions, assisting soil to hold nutrients and water, as well as improving the quality of water (Kurnia Adi, 2013). A research conducted by Nurbaity *et al*. (2011) shows that a treatment combining arbuscular mycorrhizae fungi inoculant with planting media consisting of husk charcoal with zeolite mixture (1:3) gives a better result compared with arbuscular mycorrhizae fungi inoculant with only zeolite as the media.

Another research by Sukmadi (2010) shows that the application of combined biofertilizers mycorrhizae and Trichoderma sp. is able to increase the productivity of sorghum either combined with organic fertilizer and inorganic fertilizer. Meanwhile, cultivating sorghum with applying organic fertilizers, biological fertilizers and biological perticides can yield the highest sorghum dry seed weight reaching 30 g per plant or equal with 3.42 tonnes/hectare and 134.17 g/rod with sap content with the amount of 72.5 ml (54%).

The performance of genotypes in quantitative properties such as yield components and yields, frequently change from an environmental condition (micro) to another environmental condition due to the interaction beteween genotypes and environment. Therefore, it is required to study the possibility to obtain a variety with high adaptability and have high stability of yield (Soehendi, R. dkk, 2000). By applying improved varieties of improved verieties and an addition of impartial combination of arbuscular mycorrhizae fungi and application of anorganic fertilizer is expected to increase the quality and quantity of sorghum.

B. Research Methodology

The research was conducted in May 2014 until November 2014 in the laboratory of Plant Breeding and in the Agrovet garden of the Faculty of Agriculture UPN "Veteran" Yogyakarta which is located in Condong Catur, Depok, Sleman. Materials used in this study is the seed of sorghum genotypes: Patir 5, Mandau, Patir 9, Patir 3, arbuscular mycorrhizae (Technofert), husk charcoal, Furadan 3G, Curacron, Score 250 EC, manure, NPK 15-15-15. The tools used are calipers, rulers, analytical scales, polybags, hoe. The research was conducted with a field experiment with split plot design with the main plot is the arbuscular mycorrhizae/husk charcoal and as sub plot genotypes of sorghum, with three replications.

The main plot is arbuscular mycorrhizae/husk charcoal P1: arbuscular mycorrhizae 10 g/plant, P2: arbuscular mycorrhizae 10 g/plant + husk charcoal 30 g/plant P3: husk 30 g/plant. Sub-plots are sorghum genotypes: G1: HZ-30 G2: Mandau, G3: Patir 9, G4: Patir 3. Of the two factors

obtained twelve treatment combinations, repeated three times, each treatment combination consisting of 30 plants which make a total number 1,080 plants.

II. THE RESULT AND THE ANALYSIS

The data were analyzed its variability in the level of significance of 5%. To find out the difference between treatments, a further test were was conducted which is Duncans Multiple Range Test (DMRT) at 5% significance level.

1. The content of sap in sorghum stem (ml)

For the parameter of content sap content in sorghum stem, the result indicates that the a combined treatment between mycorrhizae-husk charcoal produces no significant evidence, but on the contrary the combined treatment between genotypes significantly affects the content of sap in sorghum stem. There is no interaction between a combined treatment between mycorrhizae-husk charcoal with the treatment of genotype. Duncan test result shows that the treatment of mycorrhizae-husk charcoal on each level are not significantly different; whereas the treatment of genotype shows that genotypic Mandau (G2) is significantly lower than other genotypes.

Tabel 1. The content of sap in sorghum stem with a treatment of combined mycorrhizae-husk charcoal and genotypes (ml)

Mycorrhizae-husk charcoal	Genotype				
	G1(HZ-30)	G2(Mandau)	G3(Patir 9)	G4(Patir 3)	Mean
P1(mycorrhizae 10 g)	79.6666	63.6666	99.0000	108.3333	**87.6666 a**
P2(mycorrhizae 10 g + husk charcoal 30 g)	91.6666	41.3333	58.6666	81.6666	**68.3333 a**
P3(husk charcoal30 g)	84.6666	36.3333	90.0000	102.0000	**78.2500 a**
Mean	**85.3333 p**	**47.1111 q**	**82.5555 p**	**97.3333 p**	-

Description : Mean followed by the same letter in the same row or column shows no significant difference in the Duncan test at 5% significance, (-): no interaction

2. The percentage of sorghum stem sap content (%)

The result of analysis of variance on the percentage of sorghum stem sap levels indicates that a combined treatment of mycorrhizae-husk charcoal shows no significant effect, however on the genotypes treatment, it shows a significant affect on the percentage content of sorghum stem sap and there is no interaction between combined mycorrhizae-husk charcoal treatment with the treatment of genotype. Meanwhile, Duncan test results show that the treatment of mycorrhizae-husk on each level is not different significantly, and for the treatment of genotypes, it shows that genotypic Mandau (G2) is significantly lower than other types of genotype.

Tabel 2. Percentage of sorghum stem sap levels at treatment mycorrhizae-husk and genotypes (%)

Mycorrhizae-husk charcoal	Genotype				Mean
	G1(HZ-30)	G2(Mandau)	G3(Patir 9)	G4(Patir 3)	
P1(mycorrhizae 10 g)	47.8010	49.2960	46.2346	48.9786	**48.0775 a**
P2(mycorrhizae 10 g + husk charcoal 30 g)	54.0346	42.3350	49.3793	51.9610	**49.4275 a**
P3(husk charcoal30 g)	49.8516	47.7813	47.2303	61.6820	**51.6363 a**
Mean	**50.5624 p**	**46.4707 q**	**47.6147 p**	**54.2072 p**	-

Description : Mean followed by the same letter in the same row or column shows no significant difference in the Duncan test at 5% significance, (-): no interaction

3. The sugar levels of sorghum stem sap (%)

Results of analysis of variance showed that there was an interaction between mycorrhizae-husk charcoal treatment and the genotype treatment. A combination treatment of husk charcoal 30 g/plant-HZ-30 (P3G1) shows a significantly higher sugar content of sorghum stem sap than other treatment combinations i.e. 7.6144%, while the lowest rate is shown by a combined treatment 10 g of mycorrhizae and 30 g/plant of husk charcoal (P2G4) with a value of 3.1669%

Table 3. sorghum stem sap sugar levels at treatment of mycorrhizae-husk and genotypes (%)

Mycorrhizae-husk charcoal	Genotype				Mean
	G1(HZ-30)	G2(Mandau)	G3(Patir 9)	G4(Patir 3)	
P1(mycorrhizae 10 g)	**3.5039 k**	**4.5253 j**	**6.4237 f**	**6.4957 e**	5.2371
P2(mycorrhizae 10 g + husk charcoal 30 g)	**7.0089 d**	**5.7520 g**	**5.6254 h**	**3.1669 l**	5.3883
P3(husk charcoal30 g)	**7.6144 a**	**7.4462 c**	**4.8630 i**	**7.5053 b**	6.8572
Mean	6.0424	5.9078	5.6374	5.72265	+

Description : Mean followed by the same letter in the same row or column shows no significant difference in the Duncan test at 5% significance , (+): there is an interaction

III. DISCUSSION AND CONCLUSION

Results of analysis of variance shows that there is an interaction between treatment of mycorrhizae-husk charcoal and treatment of genotypes on the parameter of stem sap sugar levels. This shows that every sweet sorghum genotypes is affected by a treatment of mycorrhizae-husk charcoal. In other words every sweet sorghum genotype shows different reactions when they are treated with mycorrhizae-husk charcoal. The result shows that the sugar content of stem sap is vary, and the combined treatment of husk 30 g/plant-HZ-30 (P3G1) gives the best result reaching percentage of 7.6144%, meanwhile the lowest rate is shown by a combined treatment 10 g mycorrhiza – 30 g/plant of husk charcoal – genotype Patir 3 (P2G4) amounting percentage value of only 3.1669%.

Husk charcoal (bio-charcoal) inside the soil serves to increase soil fertility, improve soil structure, therefore the capability of soil to sequester water increases, pressing the soil surface flow which in turn can increase biomass production and biomass quality (Supriyanto, 2010). Soehendi, R. *et al*., (2000),

argue that the performance of genotypes for quantitative properties such as yield and yield components, often change from one environment (micro) to another environment due to the interaction between the genotype and the environment, so it is necessary to study the possibility of obtaining a variety which have a high adaptability and high yield stability.

Furthermore, a parameter of sap content percentage of sorghum stem with Mandau (G2) genotype is significantly lower than most other genotypes. This is in line with the morphology of the sorghum stem with Mandau genotypes which tends to be lower so that the sap content of the stem and the percentage level of sap is also directly proportional to the weight of the sorghum rod.

CONCLUSION

limited on the results of research and the discussion above, there are some that can be concluded:

There is an interaction between types of genotype with combined treatment of mycorrhizae and husk charcoal on stem sap sugar content (%), in which the highest value is obtained in the combination of treatment between 30 g/plant of husk charcoal – HZ-30 (P3G1) amounting the percentage of 7.6144%. Each sweet sorghum genotype provides different reactions on the treatment of husk charcoal – arbuscular mycorrhizae given.

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