The response of three cane varieties’ bud chips seedlings with mycorrhizae isolate

Y Musa, A Mollah, and Sumiati

Department of Agronomy, Universitas Hasanuddin, Jl. Perintis Kemerdekaan KM.10 Makassar, Indonesia

Email: yunusmondi@gmail.com

Abstract. This study aimed to determine the effect of mycorrhizal utilization on the growth of sugar cane seedlings with bud chips system. The research was conducted in the form of a two-factor factorial experiment arranged based on a Randomized Group Design with 3 replications. The first factor was varieties with three levels namely Bulu Lawang, Kidang Kencana, and Camming while the second factor was mycorrhizae: Glomus sp 1, Acaulupora sp, and Glomus sp 2. The results showed that Kidang Kencana variety gave the highest average values in plant height and brix levels. Whereas Camming variety had the highest average value in stem diameter, root weight and root length. Glomus sp 1 mycorrhiza was a type that associated well in sugarcane compared to Acauluspora sp and Glomus sp 2. The combination of Camming variety and Glomus sp 2 mycorrhiza produced the highest average number of leaves at 2 weeks after planting (WAP).

1. Introduction

The increase in sugar consumption has not been balanced by domestic sugar production. According to the Indonesian Sugar Association (AGI), the stock of consumable sugar for this year is only around 1.08 million tons with an additional projection of local production of 2.05 million tons. Whereas, the need for sugar consumption is estimated at 3.16 million tons. Therefore, the government through the Ministry of Trade will make a way for 550,000 tons of raw sugar imports [1].

One cause of low domestic sugar production can be seen from the on farm side, including the preparation of seedlings and the quality of sugar cane seeds [2][3]. Quality seeds are characterized by their ability to adapt to new environments, can grow well in the field, healthy, and uniform [4][5].

One way to get quality seeds in a relatively short period of time is by using a bud chips system. Bud chips is one of the sugarcane nursery techniques using one bud only. The use of this planting material is the application of sugarcane cultivation technology in an effort to achieve the national sugar self-sufficiency program [6]. One hectare of seedlings producing field could produce 50-60 tons equivalent to 350,000-420,000 bud chips. It indicates the seedlings development through sugar cane bud chips are more efficient and able to reduce the area of seedlings as much as 75-80% [7].

1.1. Mycorrhizae

Mycorrhizae are a group of soil fungi that live in association with plant or tree roots, thriving by taking supply of liquid sugar from plants, and conversely they exchange it in the form of water and nutrients necessary for plant growth [8]. Mycorrhiza forms a mutualistic symbiotic relationship with
plant roots. In this connection the two organisms are mutually beneficial, the fungus acts as the hair root of the plant and acts as an extension of the root system. They receive carbohydrates (sugars) and minerals for their growth from plants, and subsequently plants receive many benefits, including increased absorption of nutrients [9]. Talanca [10] added that infection of mycorrhizal fungi with plant roots can expand the field of root absorption, so that it can absorb nutrients such as P, Ca, N, Cu, Mn, K, and Mg, with external hyphae that grow and develop through fine roots.

*Glomus* sp is characterized by the formation of khlamidospora which is the formation of spores that originate from hyphal development and has single or double spore walls. Characteristics of *Glomus* spores are often enable the clear sight of spore walls and hyphal tips attached to the surface of the spores (figure 1). *Acaulospora* mycorrhizal spores have different shapes but have the same ornamentation. The size of the *Acaulospora* spores are varied, ranging from 100-150 µm [11].

![Figure 1. Glomus sp (a) and Acaulospora sp (b)](image)

**1.2. Bud Chips**
Bud chips are vegetative sugar cane nursery techniques using one bud. Bud chips is a nursery technology adopted from Columbia. Nursery using bud chips is expected to produce large numbers of seedlings (growing lots of tillers) in a relatively short time, uniformly grow and healthy, hence it is capable for high production [12]. The use of a single bud (bud chips) can produce 10 saplings per plant compared to mule (conventional) seedlings which is only 5 saplings per plant [13]. Research Institute for Sugar and Fiber Plants [14] added the bud chips nursery technique was able to form a number of 10-20 tillers. The tillers will grow perfectly until harvest 8-10 stems per clump, while the conventional mule seedlings form only 1-4 tillers. The bud chips have several problems, one of which is the direct sunlight can damage the buds of the seedlings and inhibit the growth. Therefore it is necessary to provide shade [4]. Another constraint of the bud chips method is when the buds originating from the center of the stem, the growth is non-uniform with rather slow roots and shoots growth [15].

**2. Methodology**
The research was conducted at the Biotechnology & Biosciences Laboratory of the Department of Agriculture and the screen house (exfarm) of the Faculty of Agriculture, Hasanuddin University. This study used a randomized block design (RCBD) with two factors. The first factor was Variety (V); V1=Kidang Kencana (KK), V2=Bulu Lawang (BL) and V3=Camming (CM). The second factor was mycorrhiza (M); M0=control (without mycorrhiza), M1=mycorrhiza *Glomus* sp 1, M2=mycorrhiza *Acaulospora* sp, and M3=mycorrhiza *Glomus* sp 2. There were 12 treatment combinations, each treatment was repeated three times making a total of 108 experimental units.

**3. Results and discussion**

**3.1. Growth and yields observation variables**
Observations were conducted on several variables consisting of observation on growth and yields. The following tables presents the results.
Variance analysis on the plant height (table 1) showed that variety (V) significantly affected plant height at 2 WAP and had a very significant effect at 6, 8, 10 and 12 WAP but did not significantly affect the height at 4 WAP. The use of mycorrhizal (M) strain and the interaction between variety and mycorrhize did not significantly affect the height of sugarcane.

Table 1. Average cane height (cm) observed on week 2 - 12 after planting

| Varieties | Average plant height (cm) at different week after planting (WAP) |
|-----------|---------------------------------------------------------------|
|           | 2                | 4                | 6                | 8                | 10               | 12               |
| KK (V1)   | 9.22 a           | 9.22 a           | 9.22 a           | 9.22 a           | 9.22 a           | 9.22 a           |
| BL (V2)   | 6.74 b           | 6.74 b           | 6.74 b           | 6.74 b           | 6.74 b           | 6.74 b           |
| CM (V3)   | 15.48            | 15.48            | 15.48            | 15.48            | 15.48            | 15.48            |
| LSD 5%    | 0.65             | ns               | 2.67             | 2.44             | 3.29             | 3.42             |

Note: Numbers accompanied by the same letter of the same WAP showed no significant difference based on LSD test of 5%; ns = not significant; WAP = Weeks After Planting

Table 2 shows the highest average sugarcane stem diameter at 2 WAP was on Camming variety (V3) i.e. 6.36 mm which was significantly different from Kencana variety (V1) i.e. 5.93 mm, and varieties of Bulu Lawang (V2) i.e. 4.54 mm. The highest stem diameter at 4, 6 and 8 WAP were achieved by Camming (V3) with an average of 10.87, 11.13 and 14.34 mm respectively, which were significantly different from Kidang Kencana variety (V1) with an average of 7.99, 8.25 and 12.10 mm, and Bulu Lawang (V2) with an average of 7.19, 7.41 and 11.49 mm.

Table 3. Average Number of Leaves (Strands) 2 Weeks After Planting (WAP)

| Mycorrhizal | Sugarcane Varieties |
|-------------|---------------------|

The variance analysis (table 3) showed that the combination of sugarcane varieties treatment with mycorrhizae had a very significant effect on the number of sugarcane leaves in 2 WAP. While analysis on 4 WAP shown a significant effect. The varieties alone had a significant effect on number of leaves at 6, 8,10 and 12 WAP. The use of mycorrhizal strain alone and the interaction between variety and the mycorrhizal strains did not significantly affect the number of leaves.
| Type  | V1       | V2       | V3       |
|-------|----------|----------|----------|
| M0    | 3.33 cde | 3.56 abcde | 3.89 abcd |
| M1    | 3.22 cde | 3.67 abcd | 4.00 abc  |
| M2    | 3.11 de  | 4.22 ab   | 3.89 abcd |
| M3    | 3.44 bcde| 2.78 e    | 4.33 a    |
| LSD   | 0.87     |          |          |

Note: Numbers accompanied by the same letter of the same WAP showed no significant difference based on LSD test of 5%;

Table 3 show that the combination of Camming + Glomus sp 2 (V3M3), gave the highest average number of leaves (4.33), which was significantly different from the combination of Kidang Kencana + Glomus sp 2 (V1M3), Kidang kencana + without mycorrhizae (V1M0), Kidang kencana + Glomus sp 1 (V1M1), Kidang kencana + Acauluspora sp (V1M2), Bulu Lawang + Glomus sp 2 (V2M3), Kindang Kencana + Acauluspora sp (V1M2), and Bulu Lawang + Glomus sp 2 (V2M3). The V3M3 however did not significantly different from the rest of the treatments.

Table 4. Average Number of Leaves (Strands) 4 - 12 Weeks After Planting (WAP)

| Treatments | Average number of leaves at different week after planting (WAP) |
|------------|---------------------------------------------------------------|
|            | 4             | 6             | 8 | 10        | 12        |
| KK (V1)    | 6.11 b        | 7.33 b        | 8.81 b | 10.25 b | 11.56 b |
| BL (V2)    | 6.00 b        | 7.14 b        | 8.81 b | 10.89 ab | 12.00 ab |
| CM (V3)    | 6.94 a        | 8.11 a        | 9.50 a | 11.28 a | 12.53 a |
| LSD 5%     | 0.77          | 0.68          | 0.49 | 0.68      | 0.66      |

Note: Numbers accompanied by the same letter of the same WAP showed no significant difference based on LSD test of 5%;

Table 4, shows that the highest average number of sugarcane leaves at 4, 6, and 8 WAP was achieved by Camming variety (V3) with an average of 6.94, 8.11 and 9.50 respectively. This value was significantly different from the Kidang Kencana (V1), with 6.11, 7.14, 8.81, and also different from Bulu Lawang (V2) i.e. 6.00, 7.14, and 8.81. The Camming also gave the most number of leaves at 10 and 12 WAP with 11.28 and 12.53, respectively, which was not significantly different from variety of Bulu lawang (10.89 and 12.00). However at 10 and 12 WAP, the Camming was significantly different from variety of Kidang Kencana with an average of 10.25 and 11.56.

The results seen on table 5 revealed that the treatment of variety (V) had significant effect on the brix level, and mycorrhizal treatment (M) gave a very significant effect. However, the interaction between the two treatments did not have a significant effect on sugarcane brix levels.

Table 5. Average Sugar Cane Brix Levels at 12 weeks after planting (WAP)

| Treatment | Sugarcane varieties | Average NP M BNJ |
|-----------|---------------------|------------------|
|           | V1      | V2      | V3      |         |
| M0        | 1.18    | 1.06    | 1.09    | 1.11 y  |
| M1        | 1.52    | 1.28    | 1.22    | 1.34 x  |
| M2        | 1.13    | 1.00    | 1.14    | 1.09 y  | 0.17    |
| M3        | 1.18    | 1.09    | 1.13    | 1.13 y  |
| Average   | 1.25 a  | 1.11 b  | 1.14 ab |          |
| LSD       | 0.14    |         |         |          |

Note: Numbers accompanied by the same letter of the same WAP showed no significant difference based on LSD test of 5%;
Table 5 shows that the highest brix level was achieved by the Kindang Kencana variety (V1) which was not significantly different from the Camming variety (V3), but was significantly different from the Bulu Lawang variety (V2) with the brix levels: 1.25, 1.14, and 1.11 respectively. The mycorrhizal strains have a significant effect on sugarcane brix levels. The highest result was achieved by *Glomus* sp 1 (M1), which was significantly different from *Glomus* sp 2 (M3) no mycorrhizae (M0) and *Acaulospora* sp (M2) with an average brix levels of 1.34, 1.13, 1.11 and 1.09 respectively.

The variance (table 6) shows that the treatment of varieties significantly affected the number of sugarcane tillers. The use of mycorrhizal strains (M) and their interaction did not significantly affect the number of sugarcane tillers at 12 WAP.

Table 6. The average number of tillers at 12 weeks after planting (WAP)

| Mycorrhizal Type | Sugarcane Varieties |
|------------------|---------------------|
|                  | KK (V) | BL (V2) | CM (V3) |
| M0               | 1.42   | 1.36    | 1.59    |
| M1               | 1.60   | 1.16    | 1.65    |
| M2               | 1.44   | 1.24    | 1.57    |
| M3               | 1.56   | 1.37    | 1.63    |
| Average          | 1.51 b | 1.28 b  | 1.61 a  |

LSD 0.24

Note: Numbers accompanied by the same letter of the same WAP showed no significant difference based on LSD test of 5%;

Table 7 shows the highest average number of tillers achieved by the use of Camming variety (V3), which was 1.61, and was significantly different from Bulu Lawang (V2), i.e. 1.28, but not significantly different from the variety of Kindang Kencana (V1) i.e. 1.51.

Results on root weight parameter (table 7) showed that the treatment of sugarcane varieties had a very significant effect on root weight, whereas the treatment of mycorrhizae (M) did not significantly affect the root weight and nor the interaction of both treatments.

Table 7. The average root weight (g) at 12 weeks after planting (WAP)

| Mycorrhizal Type | Sugarcane Varieties |
|------------------|---------------------|
|                  | KK (V) | BL (V2) | CM (V3) |
| M0               | 36.67  | 41.56   | 49.22   |
| M1               | 43.78  | 44.78   | 49.22   |
| M2               | 37.56  | 45.11   | 40.22   |
| M3               | 40.33  | 44.56   | 54.11   |
| Average          | 39.58 b| 44.00 ab| 48.98 a |

LSD 5.34

Note: Numbers accompanied by the same letter of the same WAP showed no significant difference based on LSD test of 5%;

Table 7 shows the Camming variety (V3) produced the weighest root weight at 12 WAP (48.98 g) which was significantly different from the Kindang Kencana variety (V1) i.e. 39.58, but not significantly different from the Lawang Bulu variety (V2) which was 44.00.

3.2. Discussion

The response shown by each variety was different, some varieties gave good response to plant height, brix content and some had a good response on stem diameter, number of leaves, number of tillers and root weight. The difference in response occurred because of differences in the genetic traits of the varieties tested. Marliah, Hidayat, & Husna [16] stated that differences in genetic traits cause differences in the response of the three varieties to various environmental conditions, so that the
indicated growth activities are different. Three different plant varieties if planted in the same environmental conditions will still show different growth results. Besides being determined by gene factors, differences in plant growth are also influenced by environmental conditions.

The results showed that mycorrhizal treatment had a significant effect on brix levels but it did not significantly affect the length of sugarcane roots. The highest yields on *Glomus* sp 1 mycorrhizae were significantly different from *Glomus* sp 2, treatment without mycorrhiza, and *Acaulospora* sp. It could happen due to the level of infectivity of *Glomus* sp 1 was greater in colonizing sugar cane roots. This more infective *Glomus* sp allows more intraradical and extraradical hyphae to form. The extraradical phase of mycorrhizae acts as an extension of the root system to absorb mineral nutrients from the soil. Nutrients are then transported into intraradical structures and absorbed by root cells in the root cortex [17][18]. The high frequency of the Glomus presence was probably related to the *Glomus* species which are very numerous and more symbiotic than other types. *Glomus* sp was also the most dominant type of CMA that have been identified [19].

Mycorrhizal infections were higher in Camming varieties compared to other varieties. The effectiveness of mycorrhizal *Glomus* sp. which was better in symbiosis with sugarcane than the *Acaulospora* sp. caused by the level of infectivity and their greater amount in colonizing sugar cane roots. In addition, the level of mycorrhizal infection is also influenced by the ability of plants in symbiosis with soil microbes [9]. Mycorrhize is a fungus that lives in the soil, this fungus is always associated with higher plants and both provide mutual benefits [20]. Mycorrhiza plays a role in increasing the absorption of soil nutrients required by plants such as P, N, K, Zn, Mg, Cu, and Ca. Host plants obtain a variety of nutrients, water, biological protection and others, while fungi get photosynthate as a source of carbon [21]. This mutualistic association is an interaction between host plants, fungi and soil factors [22]. Mycorrhizal infections in plants are also influenced by temperature, pH, humidity, light, and nutrient availability. High temperatures will increase mycorrhizal activity [23][24].

4. Conclusion

Variety treatment had a significant effect on plant height, stem diameter, number of leaves, root weight, number of tillers. The Kidang kencana variety gave the highest average values in plant height and brix content. Whereas Camming variety had the highest average stem diameter, root weight and root length. *Glomus* sp 1 was a type of mycorrhiza that was associated well in sugarcane compared to *Acaulospora* sp. The interaction of Camming varieties with *Glomus* sp 2 mycorrhiza gave the highest average for the number of leaves at 2 WAP. *Glomus* Sp 2 infection was higher in Camming varieties compared to other varieties.

References

[1] Hidayat A and Hidayat K 2020 Pasokan gula menipis, produksi dalam negeri masih kurang, impor akan dibuka Kontan.co.id
[2] Putri R S J, Nurhidayati T and Budi W 2010 Uji ketahanan tanaman tebu hasil persilangan (Saccharum spp. hybrid) pada kondisi lingkungan cekaman garam (NaCl) Inst. Sepuluh Nopember. Surabaya, hlm 3
[3] Situmpul R R, Sitepu F E and Meiriani M 2015 Respons Pertumbuhan Bibit Bud Chips Tebu (Saccharum officinarum L.) terhadap Dosis dan Frekuensi Pemberian Pupuk N, P dan K pada Wadah Pembibitan yang Berbeda J. Agroekoteknologi Univ. Sumatera Utara 3 105406
[4] Irwan A and Edi P 2012 Pembuatan Persemaian dan Teknik Pembibitan Oper. Wallacea Trust. Bogor
[5] Ningrum M K, Sumarni T and Sudiarsso S 2014 Pengaruh Naungan Pada Teknik Pembibitan Bud Chip Tiga Varietas Tebu (Saccharum Officinarum L.) J. Produksi Tanam. 2
[6] Basuki 2013 Pengaruh Cendawan Mikoriza Arbuskula (CMA) terhadap karakteristik agronomi tanaman tebu sistem tanam bagal satu
[7] Tabloid Sinar Tani 2016 Teknik Pembibitan Tebu Bud Chips
[8] Turjaman M 2013 Fungsi Mikoriza sebagai Input Teknologi Konservasi Jenis Tanaman Hutan Langka dan Rehabilitasi Lahan Terdegradasi Orasi Karya Ilm. P3KR 1
[9] Muchovej R M 2001 Importance of mycorrhizae for agricultural crops (University of Florida Cooperative Extension Service, Institute of Food and …)
[10] Talanca A H 2005 Mikoriza dan manfaatnya pada tanaman Prosiding Seminar Ilmiah dan Pertemuan Tahunan PEJ dan PFJ Komda Sulawesi Selatan vol 311 p 315
[11] Octavianti E N dan Ermavitalini D 2014 Identifikasi Mikoriza dari Lahan Desa Poteran, Pulau Poteran, Sumenep Madura J. Sains dan Seni ITS 3 E53–7
[12] Adinugraha I, Nugroho A dan Wicaksono K P 2017 Pengaruh asal bibit bud chip terhadap fase vegetatif tiga varietas tanaman tebu (Saccharum officinarum L.) J. Produksi Tanam. 4
[13] Gujja B, Loganandhan N, Goud V, Agarwal M dan Dalai S 2009 Sustainable sugarcane initiative: Improving sugarcane cultivation in India
[14] Mahfudin I 2019 Pengaruh kombinasi ekstrak tanaman terhadap pertumbuhan beberapa varitas batang bawah bud chip tebu (Saccharum officinarum L.)
[15] Selvia I N, Meiriani M and Hasanah Y 2015 Keragaan Bibit Bud Chips Tebu (Saccharum officinarum L.) dengan Perlakuan Lama Perendaman dan Konsentrasi IAA J. Agroekoteknologi Univ. Sumatera Utara 3 103849
[16] Marliyah A, Hidayat T dan Husna N 2012 Pengaruh varietas dan jarak tanam terhadap pertumbuhan kedelai [Glycine Max (L.) Merrill] J. Agrista 16 22–8
[17] Linderman R G 2000 Effects of mycorrhizas on plant tolerance to diseases Arbuscular mycorrhizas: Physiology and function (Springer) pp 345–65
[18] Neumann E and George E 2010 Nutrient uptake: the arbuscular mycorrhiza fungal symbiosis as a plant nutrient acquisition strategy Arbuscular mycorrhizas: Physiology and function (Springer) pp 137–67
[19] Morton J B, Bentivenga S P and Wheeler W W 1993 Germ plasm in the International Collection of Arbuscular and Vesicular-Arbuscular Mycorrhizal Fungi (INVM) and procedures for culture development, documentation and storage Mycotaxon 48 491–528
[20] Nuhamara S T 1994 Peranan mikoriza untuk reklamasi lahan kritis Progr. Pelatih. Biol. dan Bioteknol. Mikoriza
[21] Brundrett M, Bougher N, Dell B, Grove T and Malajczuk N 1996 Working with mycorrhizas in forestry and agriculture (Australian Centre for International Agricultural Research Canberra)
[22] Rao N S S 1994 Mikroorganisme Tanah dan Pertumbuhan Tanaman Edisi Kedua Penerbit UI-Press. Jakarta
[23] Islami T and Utomo W H 1995 Hubungan tanah, air dan tanaman IKIP Semarang
[24] Wattab. A H 2015 Pengaruh Inokulan Trichoderma dan Mikoriza terhadap Pertumbuhan Bibit Kakao (Theobroma Cacao L) (Universitas Hasanuddin)