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Rhizome Germination Rate of *Miscanthus* x *giganteus* at Different Rhizome Sizes

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A B S T R A C T

Miscanthus is a perennial rhizomatous grass that originated in the tropics and subtropics, although different species are found throughout a wide climatic range. In general, *Miscanthus* are grown from rhizomes under greenhouse conditions and subsequently transplanted into the field. To manage plants well, it is important to have uniform germination. However, the impact of rhizome size on the germination rate of *Miscanthus* species has not been thoroughly studied. The impact of rhizome size on germination rate and germination days was therefore investigated in three *Miscanthus* species (*M. sinensis*, *M. sacchariflorus*, and *M.* x *giganteus*). There was no considerable variation in germination days between the three *Miscanthus* species studied. However, the germination rate varied depending on rhizome size. Rhizome size does not affect the germination rate of *M. sacchariflorus*; thus, small rhizomes can be used for planting. The results of this study suggest the use of 15 − 20 g of rhizomes for *M. giganteus* and *M. sinensis* to ensure a 100% rate of germination.

Keywords: Germination days, Germination rate, *Miscanthus*, Rhizome size, Uniform field

Introduction

Miscanthus is a perennial rhizomatous grass originated in the tropics and subtropics although different species are adapted to be found throughout a wide climatic range worldwide including Asia (Lewandowski et al., 2000; Mutoh et al., 1985; Numata, 1974). It also yields 20 − 40 tons/ha of biomass and grows even in non-nutrient soil condition (Clifton-brown et al., 2004). Consequently, it has been widely studied since 1983 for combustion to produce heat and electricity in Europe and agricultural energy sources are expected to contribute more than 800 million tons annually to the US biomass industry for biofuels by 2030 in United States of America (Lewandowski et al., 2000; Perlack et al., 2005). Currently, only one clone, *Miscanthus giganteus* Greef et Deuter, is grown commercially (Xue et al., 2015). The main establishment technique for *M. giganteus* is planting of rhizomes into

the field directly. The plants of *Miscanthus* species are grown rhizome-derived plants in North America (Anderson et al., 2011).

To maintain and manage the field well, it is very important to achieve uniform germination of rhizomes. However, the germination rate of *Miscanthus* species depending on the rhizome size is hardly reported. Hence, it would be useful to know the proper size to increase the germination rate. This also could be beneficial not to plant over-sized rhizome to obtain the same germination rate/days. Thus, we tested the germination rate and germination days of three *Miscanthus* species including *M. sinensis*, *M. sacchariflorus*, and *M. giganteus*, depending on the rhizome size.

Materials and Methods

Plant materials were *M. sinensis*, *M. sacchariflorus*, and *M. giganteus*. Rhizomes of *M. sacchariflorus* and *M. sinensis* were cut into 5 − 10 g, 10 − 15 g, 15 − 20 g, and 20 − 30 g and *M. giganteus* was into 1 g, 3 g, 5 g, and 7 g since the rhizome of *M. giganteus* has the shorter nodes unlike the other two species. Those gram ranges of *M. sinensis* and *M. sacchariflorus* or four different grams of *M. giganteus* were categorized as I, II, III, and IV. They were weighed instead of length-measured because the diameters of each rhizome are not uniform which means that the volumes varies. Consequently, it is difficult to standardize the measure-unit with length. Cut rhizomes were planted in the 20 cm-diameter pots with artificial soil (Wonyebumyong, Dongbufarm Hannong, Seoul, Korea) and grown in the greenhouse at 30°C in Dongbu Technology Center, (Daejoen, Republic of Korea) from March 11th 2010 and measured traits to June 1st 2010. Each size for each species has 3 replications. Light was on for 10 hours during day and off for 14 hours during night. Germination was defined as emergence of shoot on the soil. Germination rate was examined in 15 days after planting and calculated with the same formula like following; (the number of germination/total number of planted seeds/rhizomes) ´ 100. Germination days was recorded when the germination is 100 percent.

Results and Discussion

For germination rate, *M. sacchariflorus* had 100% in all sizes (Fig. 1). However, it increased as the rhizome size is bigger for *M. giganteus* from 33% in category I to 100% in category III and IV. Interestingly, it varied for *M. sinensis* in different rhizome sizes.

For germination days, *M. sacchariflorus* had about 2 days apart between the earlies and latest and *M. sinensis* did about 4 days (Fig. 2). In both species, the germination days had no tendency depending on the rhizome sizes. *M. giganteus* also had different germination days in an irregular manner; however, the germination days in 5 − 10 g was notably high, 48 days. This could be the nature of the germination days in this rhizome size of *M. giganteus*, but it is also possible the rhizomes used in that treatment were not healthy in the first place. It may need the further investigation on it.

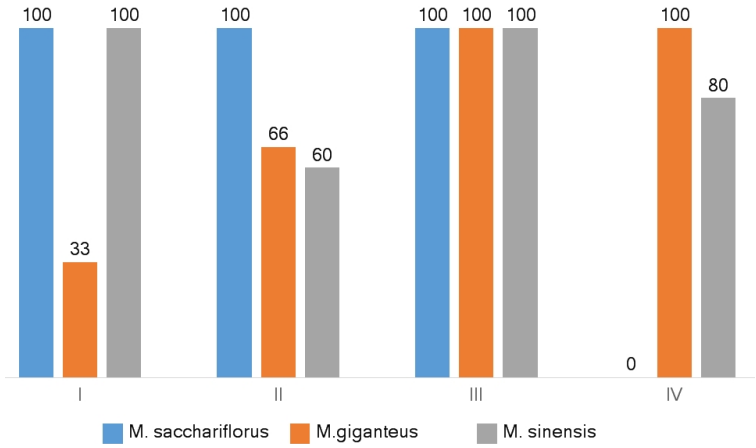

Fig. 1. Germination rate presented as percentages for *Miscanthus sacchariflorus*, *M.* x *giganteus*, and *M. sinensis*, depending on different rhizome sizes. Category I, II, III, and IV for *Miscanthus sacchariflorus* and *M. sinensis* indicate 5 - 10 g, 10 - 15 g, 15 - 20 g, and 20 - 30 g, respectively; for *M.* x *giganteus* they indicate 1 g, 3 g, 5 g, and 7 g, respectively.

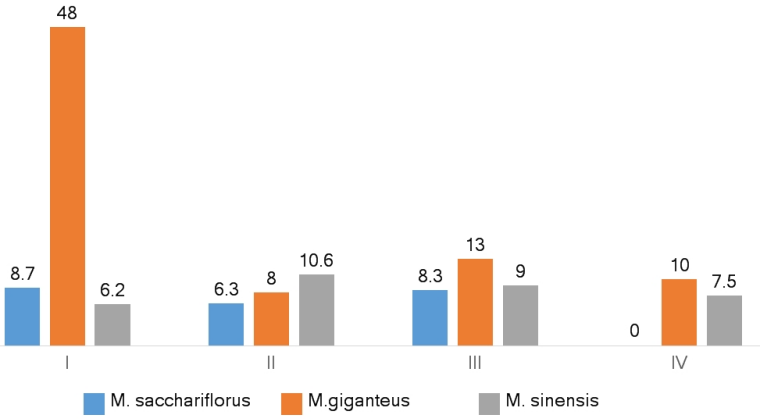

Fig. 2. Germination days for *Miscanthus sacchariflorus*, *M. giganteus*, and *M. sinensis*, depending on different rhizome sizes. Category I, II, III, and IV for *Miscanthus sacchariflorus* and *M. sinensis* indicate 5 - 10 g, 10 - 15 g, 15 - 20 g, and 20 - 30 g, respectively; for *M. giganteus* they indicate 1 g, 3 g, 5 g, and 7 g, respectively.

Based on our results, there was no huge variation in the germination days among three *Miscanthus* species except one stated above. However, the germination rate fluctuated depending on rhizome sizes. The rhizome size does not matter for the germination rate for *M. sacchariflorus*; thus, the small size of rhizome can be planted to save the rhizome for planting. It would be good to use category III of rhizome for *M. giganteus* and *M. sinensis* for 100% germination.

Based on the analysis of three *Miscanthus* species, the germination time of *M. sinensis* among different rhizome sizes was not differentiated except the smallest size, which is category I (Fig. 2). The germination time among three *Miscanthus* species, *M. sacchariflorus* in category III was fasted, suggesting that this sized rhizome is most suitable to plant for fast. Although some conditions resulted in poor germination rate/days such as the germination rate of *M. giganteus* in category II (33%), it could be caused by other factors such as temperature. Thus, this species needs to

be planted with larger size of rhizome to have uniform field. Further, it would be worth to investigate on this species for the germination rate in various environments to know how this species could be utilized. In the current study, all rhizomes were treated at 30°C. Thus, it would be worth to examine the germination rate/days depending on the temperature as well.

We hope that our results could be the useful tool to decide the rhizome size to plant in the field to achieve uniform germination.

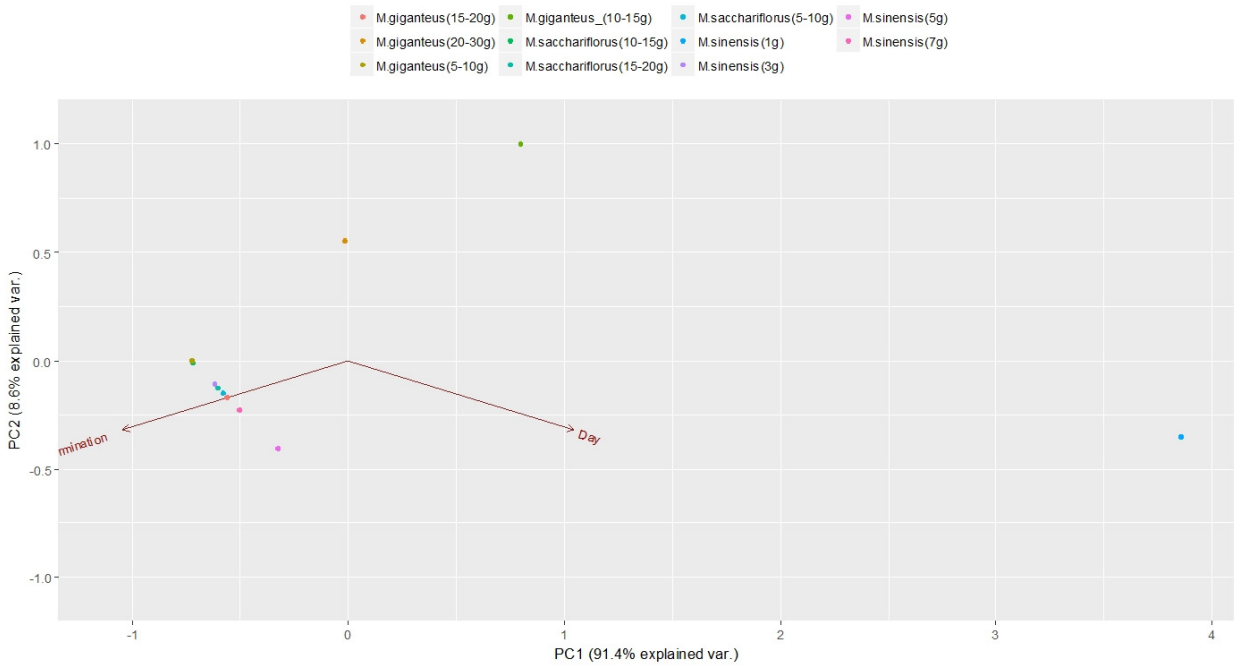

Fig. 3. Principle Component Analysis plot based on the germination data for all three species: *Miscanthus sacchariflorus*, *M.* x *giganteus*, and *M. sinensis*.

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