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RESEARCH ARTICLE

Impact of Seed Coating Agents on Single-Bud Seedcane Germination and Plant Growth in Commercial Sugarcane Cultivation

Yong-Jian Liang[1,4] · Xiao-Qiu Zhang[2] · Liu Yang[3] · Xi-Hui Liu[1,2] · Li-Tao Yang[1] · Yang-Rui Li[2]

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Abstract China is the third largest sugar-producing country in the world. The cost of sugarcane planting has increased rapidly in recent years, and the existing planting model needs to be changed to reduce the cost. The aim of this study was to evaluate the effects of commercial seed coating agents on the germination and yield of sugarcane. Six commercial seed coating agents (Premis, Gaucho, Colest, Dividend, Manshijin and Maishuping) used for other crops were used to coat the 4-cm-long single seedcane setts and stored for 7 days, respectively, at 22 °C before planting. It was found that all the seed coating agents were effective to reduce the water evaporation of seedcane setts and ensured better germination rate, and Premis, Gaucho, Colest and Maishuping were found better than Dividend and Manshijin. The economic traits of sugarcane, plant height, stalk diameter, single stalk weight and Brix were significantly higher in the Premis seedcane coating treatment than the control at maturity stage in a green house experiment. These results would be helpful to promote the development of the mechanical planting of single-bud seedcane setts for increasing sugarcane production.

Keywords Sugarcane · Seed coating · Cane sett · Mechanical cultivation

Yong-Jian Liang, Xiao-Qiu Zhang have contributed equally.

✉ Li-Tao Yang
liyr@gxu.edu.cn

✉ Yang-Rui Li
liyr@gxaas.net

1 State Key Laboratory of Conservation and Utilization of Subtropical Agro-Bioresource, College of Agriculture, Guangxi University, 100 East Daxue Road, Nanning 530005, China

2 Key Laboratory of Sugarcane Biotechnology and Genetic Improvement (Guangxi), Ministry of Agriculture, Guangxi Key Laboratory of Sugarcane Genetic Improvement, Sugarcane Research Center, Chinese Academy of Agricultural Sciences-Guangxi Academy of Agricultural Sciences, 174 East Daxue Road, Nanning 530007, China

3 Biotechnology Research Institute, Guangxi Academy of Agricultural Sciences, 174 East Daxue Road, Nanning 530007, China

4 XAIRCRAFT Technologies Co., Ltd, Room 3A01, 1 Sicheng Road, Tianhe District, Guangzhou 510000, China

Introduction

Sugarcane (*Saccharum* spp. hybrid) is the main cash crop in southern China, and responsible for 90% of the sugar productions in China. China is the third largest sugar-producing country in the world. Mechanization has been applied almost 100% in most of the field operations, such as soil preparation, planting, fertilization, plastic film mulching, weed and pest management practices. However, labor cost is expensive for field management and harvest practices. For the last many years, the cost for sugarcane planting increased very significantly in China (Li and Yang 2015).

Usually, cane cuttings or setts are used for commercial sugarcane planting. In the traditional cultivation, approximately 40-cm-long seedcane setts with 2–3 buds are used, which requires the seedcane rate about 12 t/ha (Li 2010). Therefore, the transport, handling and storage of seedcane setts are laborious and expensive. Jain et al. (2010) reported that the single-eye bud chips are much smaller than the traditional seedcane setts, so easier to be transported, and more economical, and would also reduce the planting cost. On-farm trials with bud chip were conducted in India and found that it can improve cane yield and net return and also reduces planting cost (Bhanupriya et al. 2014; Patnaik et al. 2017). However, this practice is so far not popular in China.

Seed coating with fungicides and insecticides has been tested in various crops such as corn, canola (Accinelli et al. 2016; Nuyttens et al. 2013), rice (Zeng and Shi 2009), cotton (Kunkur et al. 2010), rape (Qiu et al. 2005) and sugar beet (Duan and Burris 1997) before planting and found it was beneficial to seed germination, plant growth and yield attributes (Dadlani et al. 1992; Zeng and Shi 2009).

But so far, sugarcane seedcane coating response has not been reported. In our previous experiment, we have proven that 4-cm-long single-bud seedcane setts are good for mechanical cultivation, but more protection should be done to prolong the vitality of the seedcane setts (data not shown). So we investigated the effects of different seed coating agents on seedcane sett germination and growth in this study.

Materials and Methods

Effects of Seed Coating on the Germination of Seedcane Setts

Sugarcane variety ROC22 (disease-free) was chosen as test plant material which was obtained from Sugarcane Research Institute, Guangxi Academy of Agricultural Science, Nanning, China. Cane stalks were cut into single-bud sett with length of 4 cm. The 4-cm seedcane setts with single bud were coated with different seed coating agents, viz. Premis (Triticonazole), Gaucho (Imidacloprid), Colest (Fludioxonil), Dividend (Difenoconazole), Manshijin (Fludioxonil and Mefenoxam) and Maishuping (Thiamethoxam, Fludioxonil and Mefenoxam) (Table 1), respectively, with distilled water as control. The experiment was done in three replications. Total 840 single-bud seedcane setts were used for each seed coating agent treatment. The 2.5% seed coating agent solution (w:w) was prepared by dissolving a solid seed coating agent into water in a 100-L container, and then coating treatment was done by dipping the seedcane setts in the container with seed coating agent (seed coating agent solution:seedcane setts = 20:80 in weight) and shaking until all the seedcane setts were coated completely. The coated 840 seedcane setts were divided into 12 batches (each had 70 seedcane setts). Every batch was placed on a stainless steel bed (50 × 40 cm) and kept at 22 °C to dry the sett surface. After 24 h, 20 seedcane setts were randomly sampled from each bed to drill a round stick (10 mm in diameter) in the center of seedcane sett, and the remaining setts were grown in sand bed. The 10-mm-round sticks were further sliced to 1-mm-thick pieces with a blade, and 10 g of the sliced pieces were dried in an oven water content measurement. The water content in the remaining seedcane setts was determined with the same method at 3, 5, and 7 days after storage, respectively.

Based on the seed coating agent selection experiment, the agent Premis was selected for further experiment. The plants from the setts coated with Premis were transplanted in planting furrows (5 × 1 m) in green house. There were 60 settlings in each furrow. Plant height, stalk diameter, single weight and Brix in sugarcane were measured at maturity stage. Plant height and stalk diameter were estimated with conventional method. Five cane stalks were randomly chosen for single stalk weight measurement. Brix was measured by Brix meter (Pocket Refractometer PAL-1, Japan).

Data Analysis

All the data were analyzed by Microsoft excel 2010, and the variation differences were analyzed with the software SPSS 19.0.

Table 1 Seed coatings used for seedcane setts screening

Product name and nature of seed coating agents	Manufacturer	Active ingredient content (g/L)
Premis (Triticonazole)	BASF, Germany	25
Gaucho (Imidacloprid)	Bayer, Germany	600
Colest (Fludioxonil)	Syngenta, Switzerland	25
Dividend (Difenoconazole)	Syngenta, Switzerland	30
Manshijin (Fludioxonil, Mefenoxam)	Syngenta, Switzerland	35
Maishuping (Thiamethoxam, Fludioxonil, Mefenoxam)	Syngenta, Switzerland	25
Control (water)		

Results

Effects of Different Seed Coating Agents on Water Content and Germination of Seedcane Setts

Although the total water content in seedcane setts declined with the increase in storage time in all the seed coating treatments and the control, that in the control declined much faster than the seed coating treatments. The total water content in seedcane setts was recorded significantly higher in all the treatments with seed coating agents than the control, and the highest was observed in the treatment with Gaucho (Imidacloprid) compared with the other treatments for storage duration of 1 and 7 days, and there was no significant difference with Premis for the storage duration of 3 and 5 days (Fig. 1).

The germination rate in the control declined fast with increase in storage duration more than 3 days, while that in the seed coating treatments declined much more slowly (Fig. 2). The germination rate of seedcane setts had no significant difference in all the treatments when they were stored for 1 and 3 days before planting, but significantly lower in the control than all the seed coating agent treatments when stored for 5 and 7 days before planting. There was no difference in germination rate of seedcane setts in the seed coating agent treatments except in the treatments with Dividend and Manshijin for the storage duration of 3 and 5 days and that with Dividend for the storage duration of 5 days before planting.

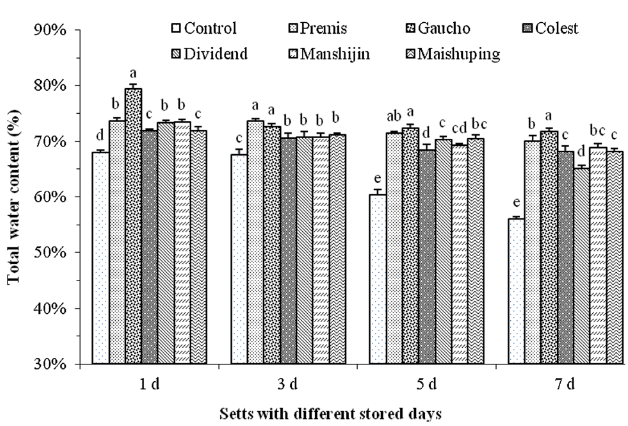

Fig. 1 Total water content of seedcane setts coated with different seed coatings and stored at 22 °C for different days (d). Data are presented as mean ± SE, and data labeled with different letters are significantly different ($P < 0.05$) among different seed coatings at the same time

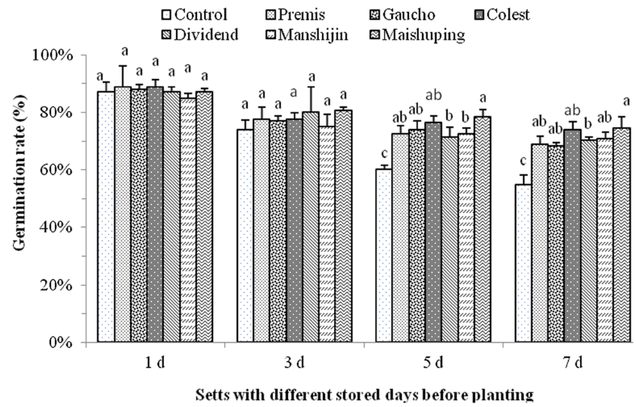

Fig. 2 Germination rate of seedcane setts coated with different seed coatings and stored at 22 °C for different days (d) before planting. Data are presented as mean ± SE, and data labeled with different letters are significantly different ($P < 0.05$) among different seed coatings for the same time

Growth of Plants from the Seedcanes Coated with Premis in Greenhouse

Based on the results of the above experiments, we selected Premis only for further greenhouse experiment. The results in greenhouse experiment showed that seedcane sett coating treatment with Premis improved the plant height (Fig. 3A), stalk diameter (Fig. 3B) and single stalk weight (Fig. 3C) of sugarcane. The stalk weight, stalk diameter and plant height were significantly higher in the coating treatments with Premis than the control when the seedcane setts were stored for 3, 5 and 7 days before planting (Fig. 3A–C) However, the seed coating treatment did not show much influence on Brix, except for coating treatment stored for 3 days which showed significantly higher Brix than the control (Fig. 3D).

Discussion

Patnaik et al. (2017) reported that sugarcane bud chip technology can improve cane yield and reduce cost in sugarcane production, and the bud chips could be easily planted in fields by a planter (Naik et al. 2013). In China, the cost of planting has been increasing rapidly in the recent years, so it is necessary to change planting model to reduce the cost of planting in sugarcane production. In the traditional cultivation, multiple buds seedcane of about 40 cm was used as planting material (Li 2010), which requires more seedcane material. Recently, we found that application of 4-cm-long seedcane setts could greatly reduce the seedcane quantity and the cultivation cost. The smaller seedcane setts could be also more easily transported, and good for mechanical planting. To prolong the vitality of the seedcane setts, various attempts have been

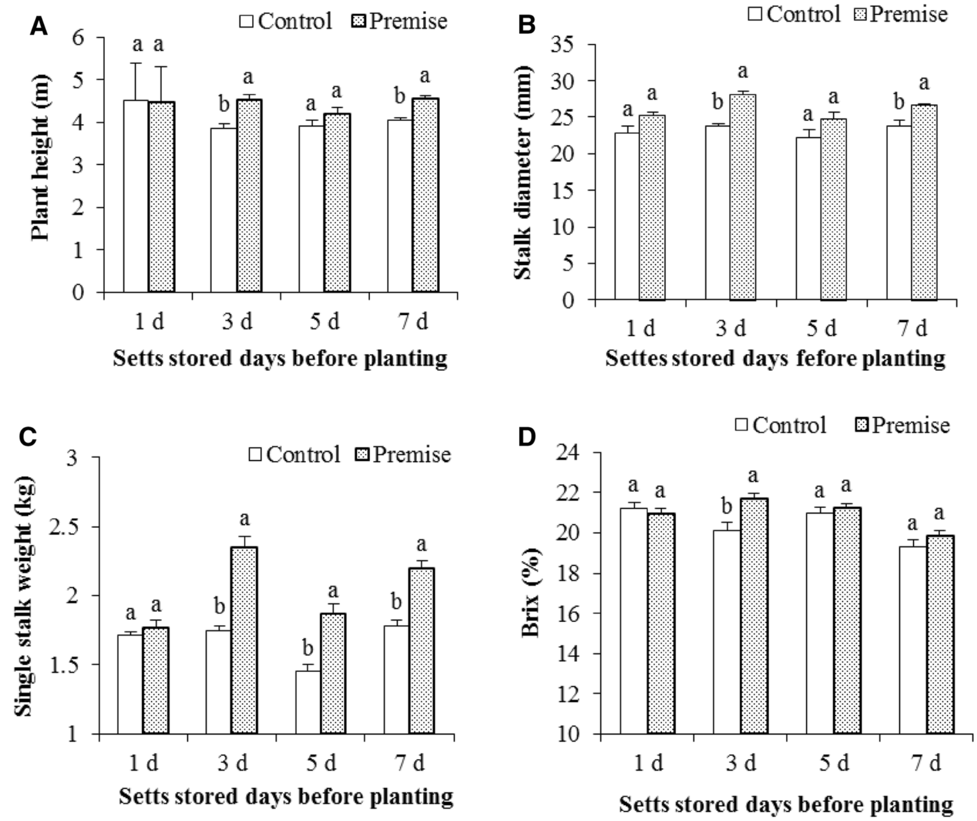

Fig. 3 Economic traits of sugarcane from seedcanes coated with Premis planted in green house at processing maturity stage. Data are presented as mean ± SE, and data labeled with different letters are significantly different ($P < 0.05$) between control and treatment at the same time

made with different seed coating agents consisted of fungicides, pesticides, biological products, and micronutrients which are reported to protect seeds from diseases and pests and improve the germination and increased yield and quality (Dadlani et al. 1992; Taylor et al. 1998; Qiu et al. 2005). In the present study, the plant height, stalk diameter and single stalk weight in the treatment with 2.5% Premis coating for 3 and 7 days before planting were found significantly higher than those in the control, and the single stalk weight and Brix were significantly higher in the treatments coated with 2.5% Premis coating for 5 days before planting than the control, suggesting that the seed coating agent might also have plant growth promoting effect on sugarcane. The plant height, stalk diameter and single stalk weight were the important cane yield components (Li 2010), and their improvement by seed coating agent indicated that seedcane setts coating agents have potential implications to be applied in commercial sugarcane production.

Seed coating has been used in various seeds such as corn, canola (Accinelli et al. 2016), rice (Zeng and Shi 2009), cotton (Kunkur et al. 2010), rape (Qiu et al. 2005) and sugar beet (Duan and Burris 1997), and proven that seed coating was effective to restrain fungus growth (Zeng and Shi 2009). Seed coating treatment may retain seed viability by reducing the moisture loss from seed during storage period and may also have positive influence on germination. In the present study, the total water content in seedcane setts coated with seed coatings was higher than the control, which indicated that the seed coating agents could also prevent water evaporation because of the properties of film protection (Robani 1994). It was reported that the seed germination rate of rape, rice and cotton coated with seed coatings had been improved (Qiu et al. 2005; Zeng and Shi 2009; Kunkur et al. 2010). In the present study, the germination rate of seedcane setts coated with seed coating agents was 19.6 and 22.3% higher than the control, and the germination rate was recorded over 70% after storing for 5 and 7 days, which supports the previous reports and indicated that the seed coatings also could be used for increasing germination of seedcane setts.

Conclusion

The results in the present study indicated positive impact of coating and using 4-cm seedcane sett with Premise, which could be used to promote the development of the mechanical planting of single-bud seedcane setts for better sugarcane production.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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