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SUITABILITY OF CAPSULE AS A PADDY COATING MATERIAL FOR THE SYSTEM OF RICE INTENSIFICATION (SRI)

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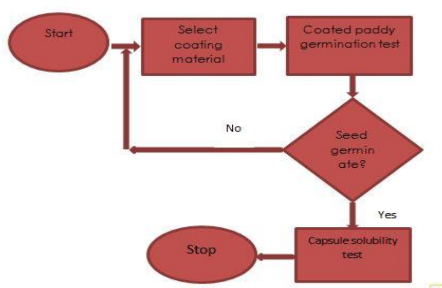
Graphical abstract



Abstract

One of the challenges faced by farmers in adopting the system of rice intensification is the seed establishment required high labor demand. This research aims at providing an alternative to seedling transplanting for the system of rice intensification. In this research the paddy seed was enhanced with the use of pharmaceutical capsule as a seed coating material for ease of seed singulation and suitability in handling by a conventional direct seeding technique. It covers the study of capsules as a suitable paddy seed coating material. The solubility of starch and gelatin capsules in water was studied at three different temperatures of 25°C, 35°C, and 45°C. Three paddy seed treatments of dry seeds, primed seed, and pre germinated were each placed in to the capsule at the ratio of 1:1 and planted in the soil with three replications. The planted seeds were irrigated two times daily for a period of 10 days within which the germination and emergence were recorded on daily bases. Gelatin capsule was found to be soluble in water at temperature of 45°C and above. Starch capsule on the other hand was found to be soluble at temperatures of 25°C which made it the more suitable paddy coating material in comparison with the gelatin capsule. The germination and emergence results of starch capsule coated paddy were found to be 95%, 83%, and 58% for the pre germinated, primed, and dry paddy seeds respectively.

Keywords: System of rice intensification, capsule, seed coating, seed singulation

1.0 INTRODUCTION

Rice is the world's most staple and vital food crop and the main food source for more than half the world's population. Malaysian farmers cultivate about 425,000 ha of paddy with an average yield of 3.8 t/ha, which is less than the average global yield of 4 t/ha. It is a known fact that urbanization is taking more of agricultural lands. While shortages of quality irrigation waters became the business of the day. An organic system of rice cultivation called the system of rice intensification SRI was developed in Madagascar in 1980s. The system of rice intensification SRI utilizes less amount of water, and gives high paddy yield without the use of chemical fertilizer and herbicides. SRI centers on the comprehensive management of paddy, soil, and water for increased paddy yield. A basic requirement of SRI is the placement of single seed per stand at a constant spacing. This distance depend on the soil fertility but usually range between 25- 35 cm. Another requirement of SRI is mechanical weeding at several stages of development in order to destroy the weeds for the purpose of reducing competition for nutrients and also to aerate the soil for good root growth and higher tiller establishment. This process could only be mechanized with constant spacing between the paddy seedlings. Despite the high yield attributed to SRI, farmers find it difficult to adopt due to its high labor demand especially at the seedling establishment stage. Many attempts were made by different researchers to mechanize this process, but less success was recorded. Seed coating has been a practice in the agricultural industry. It is a practice usually done to protect planting materials from damages by agents such as insects, rodents, and germs or to improve seed dormancy through incorporation of selected chemicals. It could also be made for the purpose of enhancing the planting material with a particular nutrient that is deficit in the soil, or to improve seeding operation. In the conventional method seed coating is achieved by mixing a small amount of the active ingredient to a large amount of inactive ingredient called carrier and then rubbed at the back of the seeds. For the purpose of this study pharmaceutical capsule was chosen as a paddy seed coating due to its solubility in water, uniform shape and size, for the purpose of enhancing paddy seeds for ease of seed establishment in SRI.

Seed coating has been used by different researchers for a variety of purposes. Coating technology was used to address the problem of witch weed. The witch weeds (striga hermonthica) kills and destroy, rice, maize and sorghum throughout sub Saharan Africa. Farmers here are losing the battle to the spread of striga. According to FAO about 100 million African farmers lose half of their crop to this root attaching flowering parasite [1]. To address such problems high dose localized herbicide was used to coat the seed, such coating was found to be cost effective in safe guarding the seeds against attack and damage from striga parasite in Kenya, Malawi, Tanzania, and Zimbabwe. To prove the effectiveness of this technology Imazapyr and pyrithiobac were used at the rates of 30-45 g/ha and 11-21 g/ha respectively at 3 experimental stations in 93 farmers plot for a period of six seasons. Coating maize seeds with Imazapyr and Pyrithiobac was found to have long time effective control of striga parasite with yield increment of 3-4 folds in comparison with when striga is present in the fields. With development of herbicide resistance variety this technology will be more effective in addressing the problems of striga parasite [2]. [3] Study the effect of using calcium peroxide in flooded soil in improving rice seedling establishment both in green house and field conditions. It was found that coating rice seed with commercial calper powder G. improved seed establishment irrespective of paddy variety used and temperature differences. Emergence of the coated seed was found to be best when the coated seeds are planted 1-2 cm below the soil surface.

[4] reported that Calcium peroxide coated rice increase germination, seedling establishment, as well as seedling growth in flooded paddy field. Study was carried out to develop a new coating technique using three different binding agents viz water (control), sodium silicate, and sodium lignosulfonate in maintaining the adhesion force between the coating materials and rice seeds and evaluate coating strength, germination and seedling establishment potential of the new technique. Rice seeds were soaked for 24 hours and then coated with 40% calcium peroxide, 30% gypsum, and 30% starch flour (filler) of the seed weight. The binders of water, sodium silicate, and sodium lignosulfonate were then sprayed according to treatments, the coated seed allowed to dry. Dried seeds were subjected to strength test using TA-XT2i texture analyser, after which their germination and seedling establishment were evaluated. Coating strength was higher in sodium silicate binder in comparison with control. In terms of germination and seedling establishment control was found to have a better performance. All the seed coat discussed above was applied either for nutrient incorporation or control of pest, parasite or disease causing organisms. In this research paddy is coated to attain uniform planting material and achieve seed singulation.

2.0 MATERIAL AND METHODS

2.1 Coated Seed Germination Test

The ability of paddy seeds to germinate with a higher germination rate inside a capsule formed the basis for this research. As stated earlier in the literature, seed coating is done for a variety of purposes. For the course of this study the aim of coating the seeds is to achieve seed singulation, which ordinarily cannot be achieved due to the irregular shape of paddy seeds. Having this aim in mind a gelatin capsule was acquired and subjected to germination test after feeding capsule with pre germinated paddy seed at the ratio of 1: 1. This first germination test was carried out as a preliminary study using gelatin capsule as a coating material for pre germinated paddy seeds where only 14% germination count was recorded after 15 days of planting coated seeds at a depth of 2-3 cm followed by daily irrigation.

2.1.1 Germination Test of Starch Capsulated Paddy

Due to the poor performance of gelatin capsule in terms of germination, further review of literature was made and gelatin was found to be soluble only at a temperature above 37^{o}C, and starch capsule was found to have a better solubility at a lower temperature corresponding to the soil temperature under natural environmental conditions. For this reason the germination test was repeated using starch capsule.

The germination test for the starch capsulated paddy as shown in Figure 1 was carried out in a seedling tray using organic compost mixed with a loamy soil at the ratio of 1:1. Three seeds treatments: pre germinated, primed, and untreated seeds were used for the experiment. After soil preparation, each treatment was planted in three replicate. The trays were irrigated every morning and evening, and germination observed and recorded up to the 8th day

Figure 1 Germination test of capsulated paddy

2.3 Solubility of Gelatin and Starch Capsule in Water

Twenty seven pieces each of gelatin and starch capsules were collected. The test was made of three different temperature treatments: 25°C, 35°C, and 45°C. Two 25 ml of tap water collected at room temperature were each poured in to separate beakers leveled starch and gelatin. The two beakers were then placed outside the laboratory for 30 minutes to attain equilibrium. The water temperature was then taken from a clinical thermometer and was found to be 25°C. Three pieces each of gelatin and starch capsule were then placed in its own designated beaker as shown in Figurer 2 (a). The capsules were then observed for solubility at five minutes interval. After 20th minute observation the solution was then discharged and the beakers washed for another experiment. The second, and third batches was done by stabilizing the water temperature to 35°C, and 45°C respectively through placing the beakers in an electric oven shown in Figure 2 (b), after which the capsules were placed in the beaker and the solubility observed at 5 minutes intervals for a period of 20 minutes. The solubility of the two capsules in water at three different temperatures was then recorded. Note that the solubility was given scales of 0, 1, 2, 3, and 4. Where, 0 means water has no effect on the starch, 1 means the capsule is soft and maintained its shape, 2 means the capsule lost shape, 3 means partial dissolution of capsule, and 4 means complete dissolution of capsule in water.

a b

Figure 2 Starch and gelatin capsule solubility test

3.0 RESULTS AND DISCUSSION

3.1 Germination Test of Capsulated Seed

The mean effect of seed coating on germination Count with time is as presented in Table 1. From the three treatments observed.

The highest germination count (95%) was observed in pre germinated coated paddy seed, followed by primed coated seed. Whereas the lowest germination counts (58%) was observed in the untreated seed (control). Pre germinated seed was also found to have earlier germination period with germination observed in the second day in comparison to prime and the untreated paddy seed whose germination started at day 3 and 4 respectively. Germination stabilizes at day 5 for pre germinated seed, and day 6 for both primed and untreated seeds.

Table 1 Effect of Seed Coat on the germination count

	Coated seed		**Uncoated**
Day	**pre germinated**	**primed and dried**	**Dry untreated**
	GC%	GC%	GC%
1	0.00	0.00	0.00
2	20.00	0.00	0.00
3	75.00	6.00	0.00
4	86.00	36.00	21.00
5	94.00	80.00	35.00
6	95.00	83.00	58.00
7	95.00	83.00	58.00

Where: GC is germination count (%)

3.1 Capsule Solubility Test

Result of solubility test for starch and Gelatin capsules in water at different temperatures of 25°C, 35°C and 45°C are presented in Figure 3, 4, and 5 respectively. The solubility scale were described in chapter 3.2 where: 0 means water has no effect on the starch; 1 means the capsule is soft and maintained its shape; 2 means the capsule lost shape; 3 means the capsule is partially dissolved and 4 means complete dissolution of capsule in water. In all the three temperatures considered, starch capsule was observed to be completely dissolved at the 15th minutes, whereas only partial dissolution was observed at the 15th minutes with Gelatin capsule, with only one incident of complete dissolution recorded at 20 minutes with 45°C. This agree with what was reported by [5] that gelatin capsule dissolved at temperature above 37°C, whereas starch capsule dissolved at temperature as low as 10°C. From the solubility curves at 25°C shown in Figure 3, the solubility increases with time for the starch capsule, and the curve reaches equilibrium after 15 minute. For the Gelatin capsule, relationship of solubility with time was direct proportionality from 0 to 10 minute, and decreased with time from 10 to 15 minutes, and increased linearly from 15 to 20 minutes. In the 35°C solubility curve shown in Figure 4. The starch capsule solubility increases with time from 0 to 12 minutes, and stabilizes after 14 minutes, whereas for the gelatin capsule solubility increases with time from 0 to 5 minutes, it then decreases from 5 to 9 minutes and increases from 9 to 17 minutes and then decreases up to 20 minute. For the 45°C treatment solubility curve shown in Figure 5 the solubility is linear for both Gelatin and Starch capsule, with starch capsule stabilizing at 17 minute. But both of them reach complete dissolution, with gelatin capsule dissolving completely at 20 minutes. This agrees with what was reported by [5] that gelatin capsule dissolved at a temperature above 37°C, and starch capsule dissolve at temperature as low as 10°C.

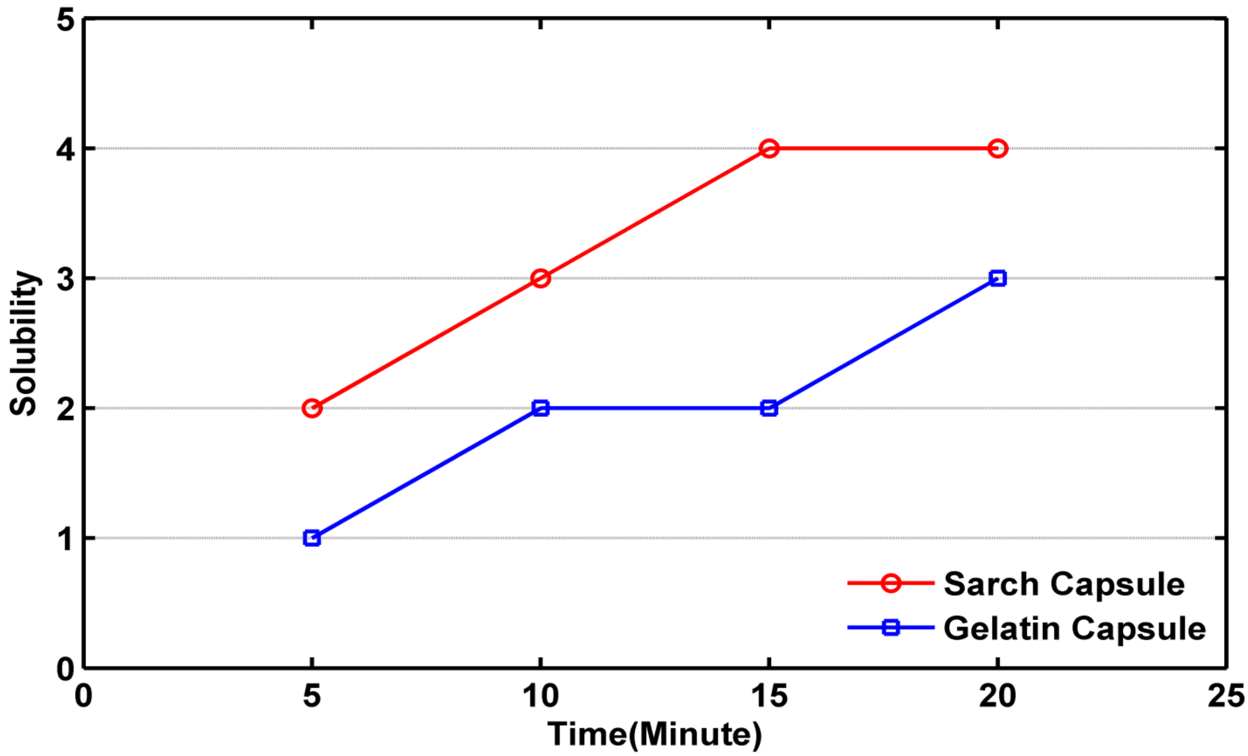


Figure 2 Capsule Solubility curves at 25°C

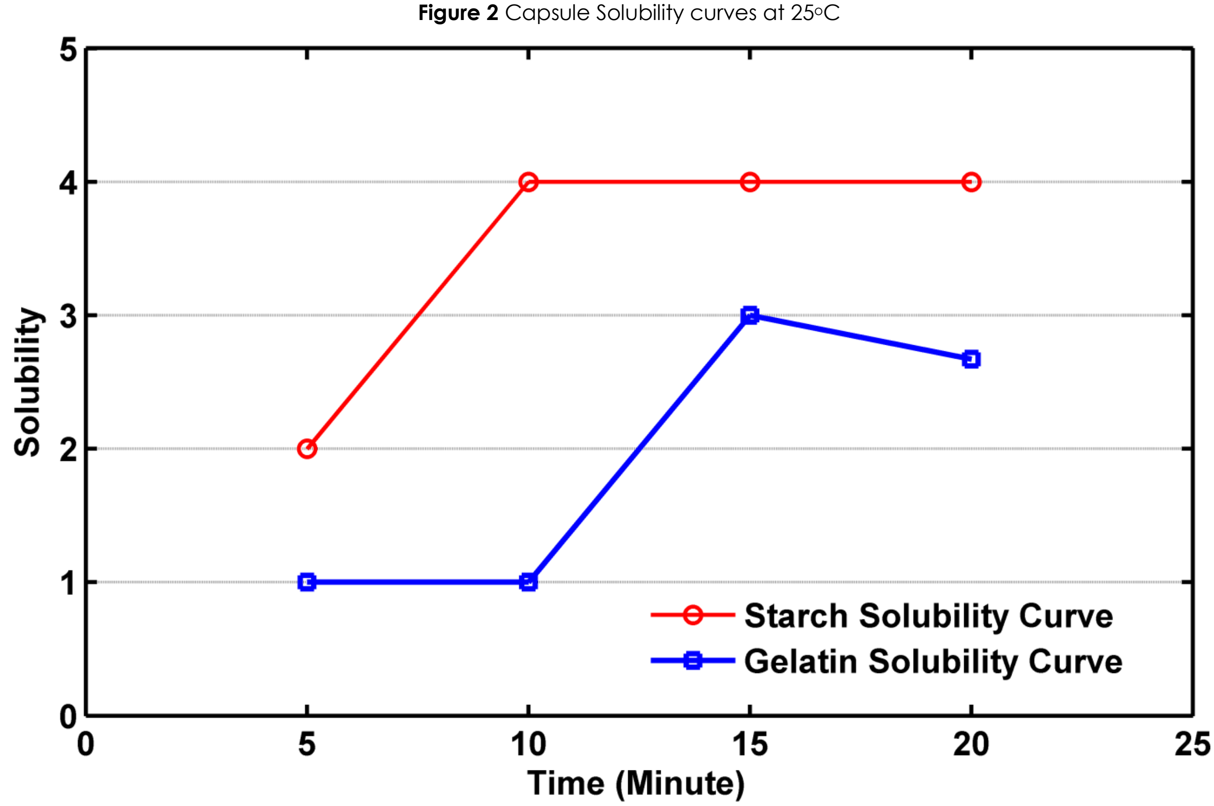


Figure 3 Capsule solubility curves at 35°C

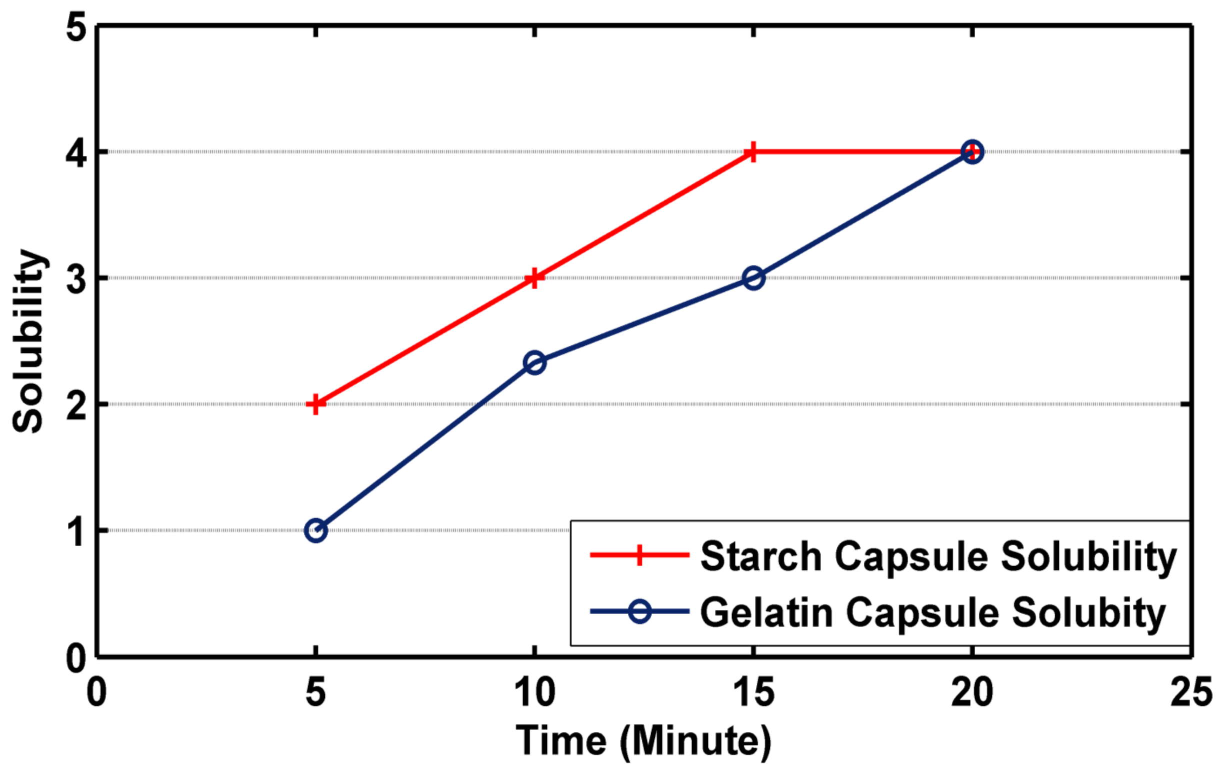


Figure 4 Capsule solubility curves at 45°C

4.0 CONCLUSION

With its good solubility in water at a lower temperature within the range of the Malaysian paddy field temperature and a higher germination count of 95% with pre germinated paddy seeds. The starch capsule is a good coating material for paddy seed and will aid in seed singulation for use in SRI direct seeding process. This will in turn reduce the drudgery experience by farmers in adopting the system of rice intensification thereby increasing paddy yield and productivity. The use of pharmaceutical technology should be adopted for the commercial feeding of paddy seeds in to the starch capsule for the purpose of mechanizing the coated paddy seed planting using the conventional planters.

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