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Seed Dormancy and Effect of Salinity on Germination of Citrullus Colocynthis L

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Abstract - Citrullus colocynthis L. has been garnering interest in recent times as a potential biodiesel feedstock crop due to its high seed oil content (up to 50%). There have been reports of seed dormancy in this crop, which can be a deterrent to its commercial cultivation. In this study, different pre-treatment methods to break seed dormancy were compared. Citrullus colocynthis is drought resistant, as established from the fact that it grows as a weed in arid and semi-arid lands. The tolerance of this crop to different levels of salinity during germination in vitro was investigated. An effective treatment to break seed dormancy was identified and locally collected germplasm was screened for salinity tolerance.
Keywords - Biodiesel feedstock, salinity tolerance, germination efficiency.

I. INTRODUCTION

Seed dormancy is most common in wild flora mainly for survival purposes under unfavorable environmental conditions (Hilhorst 1995; Bewley 1997; Geneve 2003; Baskin and Baskin 2004). Seed dormancy can be described as a temporary inability to germinate under conditions in which all the requirements for germination are fulfilled. Incorporation of native plants to agriculture was always accompanied by selection against this character. However, many modern crops still carry genes for seed dormancy. In most cases seed dormancy is not absolute where the entire seed population is dormant or non dormant. Therefore it should be expressed quantitatively (Richter and Switzer 1982). In cucurbit crops, it is common to have seed lots with delayed germination (Shifriss and George 1965), partial dormancy (Young 1949; Nerson 2002a) or short-term dormancy (Odland 1937) which are characterized by improved seed germination with increased storage compared to germination at seed harvest. Partial- and short-term dormancy are more likely to occur in immature compared to fully mature seeds (Saadiah and Junaidah 1986). The genetic control of seed dormancy in cucumber has been studied (Ali *et al*. 1991) using the dormant cultivar 'Boroda' and a non dormant cultivar 'Marketer'. Secondary dormancy in cucumber induced by two short cycles (15-60 minutes) of red – far red light during seed incubation also was reported (Amritphale *et al*. 1993).

Germination is the first developmental step in the life cycle of a plant to produce a new generation and the ability to accomplish this task is a prerequisite to start this cycle (Bewley 1997). Analytical methods to measure germination ability and speed have been reported (Tucker and Wright 1965; Heydecker 1966; Goodchild and Walker 1971; Janssen 1973; Scott *et al*. 1984; Tipton 1984; Hunter *et al*. 1984). However germinability is not a predictable event that ensures a plantlet will have a successful life cycle. For this purpose scientists frequently use the term seed vigor. This term describes how rapidly and uniformly the early vegetative growth of a population from germination to seedling establishment will occur (Perry 1982). Seed vigor has significant effects on yields of crops harvested at the vegetative or early reproductive phases but only a slight effect in species grown for their mature fruits (Tekrony and Egli 1991).

Citrullus colocynthis L., also known as desert gourd, Handhal and Thumba (in Arabic), is a member of the Cucurbitaceae family, known for its high seed protein (35%) and oil (50%) content (Achu, *et al.,* 2005). It grows in the wild in many regions of the world such as India, the Middle East. According to some reports this plant is listed as a medicinal halophyte that grows in coastal areas with salty or brackish waters (Qasim, *et al.* 2011).

II. MATERIAL AND METHODS

Seven different pre-treatment methods were compared (T_1-T_7) for their efficacy to overcome fresh seed dormancy. As test control, seeds were placed on 0.8% agar in petri plates at room temperature without any pre-treatments. It was observed that none of these seeds germinated.

A. T_1- Manual scarification using sandpaper followed by soaking for 48 hours and incubation at room temperature

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B. T_2- Manual scarification using sandpaper followed by soaking for 48 hours and incubation at 30˚C (Fig. 1)

C. T_3- Manual scarification using sandpaper followed by soaking for 48 hours and incubation at 30˚C in 0.8% agar containing 0.2% potassium nitrate

D. T_4- Incubate at 4˚C for 48 hours, followed by manual scarification using sandpaper and incubation at room temperature

E. T_5- Manual scarification followed by incubation at 30˚C

F. T_6- Incubation at 40˚C for 48 hours and manual scarification using sandpaper followed by incubation at 30˚C

G. T_7- Soaking for 48 hours followed by incubation at 30˚C

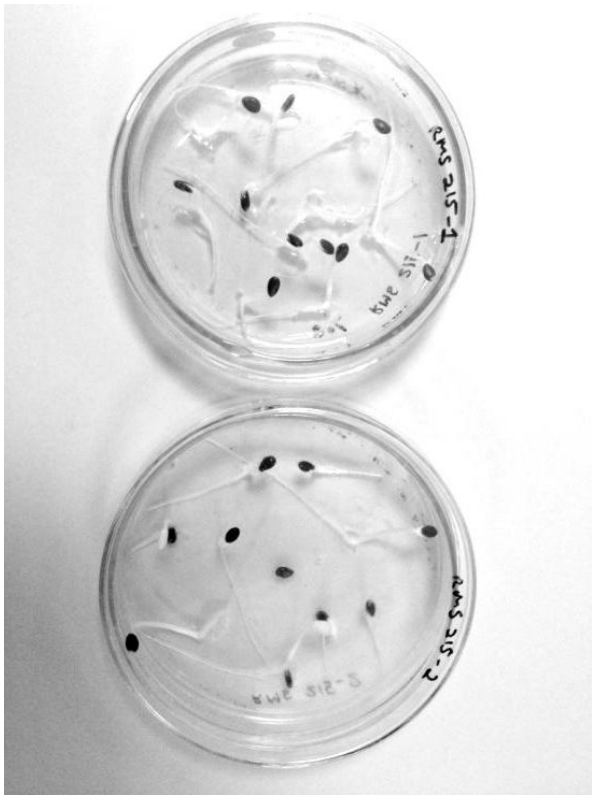


Fig.1 : In vitro germination of seeds on 0.8% agar after pre-treatment (T_2)

Two replicates each of 10 seeds were tested in each accession. The treated seeds were placed on 0.8% agar in petri plates and observed daily for germination.

Twenty seeds each of the 30 accessions were manually scarified using sandpaper, soaked for 48 hours and incubated on 0.8% agar at 30˚C and germination data was observed and recorded daily. This was done in order to identify a smaller number of accessions with high germination efficiency for the salinity screening.

Seeds of 10 accessions were subjected to two different salinity levels with 0.8% agar medium containing 50 mM NaCl and 100 mM NaCl respectively. 0.8% agar was used as the control treatment. Two petri-plates with 10 seeds each were maintained for each treatment, for all 30 accessions. Germination was recorded daily.

III. RESULTS AND DISCUSSION

Mature fruits of *Citrullus colocynthis* were collected from different locations in the study area. The geographical coordinates, morphological characteristics and features of the plants were recorded.

In all accessions, no germination was observed without any pre-treatment (control). Among the different dormancy breaking treatments studied, manual scarification followed by soaking for 48 hours and incubation at 30˚C gave the best results, with almost 100% germination occurring within 48 hours (Table 1). Manual scarification or soaking alone did not have the same effect. Neither

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did scarification and soaking followed by incubation at room temperature. This suggests that seed dormancy in *C. colocynthis* could be attributed to both mechanical and bio-chemical factors. It is possible that the seed contains certain inhibitory factors that need to leach out (for which the seed coat breach and soaking is necessary) in order for germination to occur. The temperature requirement is in keeping with the plants natural environment.

Table 1 : Pre-treatment methods and effect on germination.

	Heat treatment @ 40°C	Manual scarification	Soaking (48 h)	0.2% KNO_3	Incubation @4°C (48h)	Incubation @RT	Incubation @30°C	Germination
T_1		X	X			X		-
T_2		X	X				X	Within 48h
T_3		X	X	X			X	Within 62h
T_4		X			X	X		-
T_5		X					X	-
T_6	X	X					X	-
T_7			X					-

The *in vitro* tests for salinity tolerance showed that *C. colocynthis* is highly sensitive to salinity. At 50 mM NaCl germination decreases by between 10 and 100% in comparison with the control, depending on the accession. Considering the overall performance at salinities, were found to be relatively tolerant. In general however, *C.colocynthis* appears to be sensitive to salinity, with germination being affected at higher levels of salinity.

Since salinity tolerance/sensitivity varies depending on developmental stage, further studies are necessary under field conditions to assess the effect of salinity on growth performance and yield potential.

IV. CONCLUSION

In this study an effective pre-treatment was identified to break dormancy in *C. colocynthis* seeds. The identification of the specific biochemical factors involved in the inhibition of seed germination is an area in which analysis is currently underway. *C. colocynthis* being an exceptionally hardy plant with a potential for use as biodiesel feedstock, the salinity tolerance potential is worth exploring for its economic exploitation through large-scale cultivation in marginal and salt-affected lands. Further investigation is warranted to identify the threshold level beyond which germination and growth are effected, especially under saline growing conditions.

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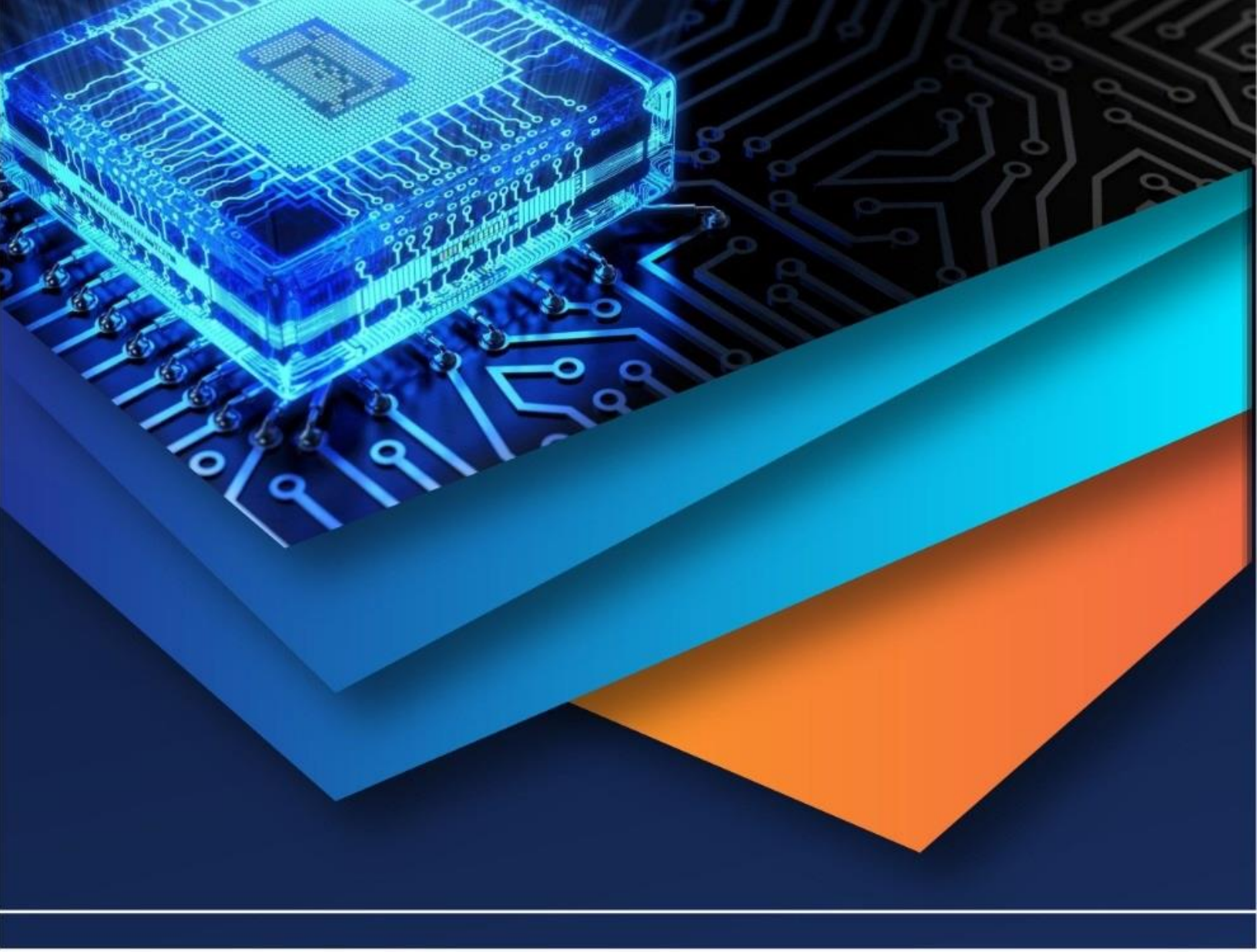
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