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Study of germination behavior and growth response of *Gliricidia sepium* towards various pre-seed treatments in Vindhyan region, India

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Abstract
Gliricidia sepium is promising multipurpose, leguminous, fast growing tree for agroforestry and also used as fuel wood, fodder and green manuring. This study was carried out to find out germination behavior and effects of different pre-sowing seed treatments on growth of gliricidia. In this experiment, gliricidia seeds were treated with six pre-sowing treatments viz. control-T_0, hot water treatment-T_1 (80 °C), cold water treatment-T_2, cow dung slurry treatment-T_3, H_2SO_4 treatment-T_4 (98% for 3 min.) & knuckling-T_5 and the effect on germination, growth and vigour was studied. The experiment was carried out in research farm, RGSC-BHU, Barkachha, Mirzapur India with five replications in RBD. The H_2SO_4 treatment provided the highest seed germination %, germination energy, number of nodules and vigour index while knuckling provided highest no. of leaves, shoot height, root length total seedling length, collar diameter and biomass accumulation which were at par with control and soaking in water. Germination was completely hindered in case of hot water treatment. As no significant difference found among control, knuckling and acid treatment, it was concluded that no treatment can significantly enhance germination and vigour in gliricidia but cow dung slurry treatment performed significantly inferior to control.

Keywords: Germination, dormancy, seed treatment, gliricidia

Introduction
Gliricidia sepium (Jacq). Walp is one of the promising multipurpose, leguminous, fast growing tree native to Central America and well spread in areas with tropical climate such as Africa, South America and many parts of south Asia (Simon, 1996). *Gliricidia* is known by many local names such as gliricidia, ree of iron, vincent palm, mexican lilac, mother of cocoa, quick stick, in English, Giripushpa in Marathi etc. It is commonly used in agroforestry and forestry as fuel wood, fodder and green manure. Gliricidia has been grown between rows of coconuts, used as a mulch in rice fields and gliricidia leaf mulch enhanced the yield and decreased time to harvest of yam tubers (Simons and Stewart, 1994) [22]. It is generally grows upto 10-15 m having medium crown, single or multistemed. It requires mean annual temp between 15 to 30 ºC and grows well in areas with annual rainfall of 600 to 3500 mm. It commonly found upto 1200 m elevation. It can grow in semi-arid subtropics and wet tropics (Stewart, 1996) [23]. *Gliricidia sepium* adapts very well in a wide range of soils (Rahman *et al*., 2019) [18]. Sumberg (1985) [24] reported seed yields of *Gliricidia* upto 89 g per tree per year, weighing about 8500 seeds per kg. Seed are orthodox in storage behavior having viability of 12 months in open storage. There is lack of studies regarding germination behavior and responses of such important species towards various seed treatments. Alamgir and Hossain (2006) [4] studied germination of gliricidia in Bangladesh and reported that initial growth and biomass production of seedlings was higher for nail clipping on distal end of seed and he recommended nail clipping for obtaining better quality seedlings though results from untreated seeds were satisfactory. But still no study was done in India. Keeping these facts into consideration the present investigation to find out effect of pre-seed treatments on germination, growth and vigour of *Gliricidia sepium* in Vindhyan region is conducted at Agricultural Research Farm, RGSC, Barkachha, Mirzapur, India.

Material and Method
Experimental site: Experimental site falls under the Barkachha, Mirzapur which was situated in Vindhyan region and located at 25º 10'N latitude, 82º 37'E longitude and altitude of 147 meters above mean sea level. Vindhyan region comes under agro-climatic zone III A (semi-arid eastern plain zone) characterized by rainfed and invariably poor fertility status. The soil of experimental field was sandy loam in texture, neutral in pH, low in available N and P, and

medium in available K. Experiment was conducted in RBD with five replications to determine the effect of pre-sowing treatment on germination and seedling growth attributes and six different treatments were applied. Total 30 (6 × 5) raised bed are prepared and one bed considered as one plot. These treatments include T_0- control (untreated), T_1- soaking in boiling water at 80 °C (initial) for 12 hours, T_2-soaking in cold water for 24 hours, T_3- soaking the seed in cow-dung slurry overnight followed by washing in water.T_4- knuckling (cutting distal end of seed coating by scissor), T_5-scarification with 98% H_2SO_4 for 3 minutes followed by washing in water. The germination trial was carried out by sowing healthy dried seeds on raised bed of forest soil mixed with decomposed cow dung at the proportion of 3:1 by volume. In each plot, 25 seeds were sown at depth of 0.5-1.0 cm. Under each treatment, germination of seeds was recorded everyday as daily germination count and continued until no further increase in the germination count. Emergence of the cotyledonary leaves out of soil was considered as germination. Germination percentage was calculated by using following formula.

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

Total germination period determined by recording days required to completion of germination. Germination energy is counted as a germination percentage when mean daily germination reached at its peak. Randomly three seedlings from each plot of the replications were selected carefully and used for recording average root length (cm), Shoot length (cm), total length (cm), No. of leaves per seedling, Collar diameter (cm), dry matter content (g), Root shoot length ratio, Number of nodules per seedling at 60 DAS. Seedling vigour index was calculated by adopting the method suggested by Abdul-Baki and Anderson (1973) [1] as given bellow.

$$\text{Vigour index} = \text{Germination (\%)} \times \text{Total seedling length}$$

ANOVA was applied for statistical analysis of data by the method suggested by Gomez and Gomez (1984) [12] and the critical difference (C.D.) was worked at 5% level of significance.

Result and Discussion

Germination attributes: Maximum germination percentage is recorded in acid treatment (92.8%) which statistically at par with knuckling (88%), cold water (84.00%) and control (78.40) whereas germination % for cow dung slurry treatment (43.20%) was significantly lower among all treatment. Germination was completely absent in hot water treatment (00.00%) indicates that boiling water is harmful for the embryo of the species accordance with findings of Alamgir and Hossain, 2005 [3]. germination energy (79.20%) was estimated in acid treatment (T_5) which was at par with T_4 knuckling (73.6%), T_2 cold water (66.4%) and control (69.6%). Significantly lowest germination energy was observed for T_3 cow dung slurry treatment (34.40%). Seed coat plays important role in germination. In this study seed treatments could not enhance germination as compared to control because of the soft seed coat of *G. sepium*. Knuckling might allowed fast entrance of water and air into the seed thus resulted in high uptake of solutes. Entry of water and exchange of gases resulting in enzymatic hydrolysis and thus transforming the embryo into a seedling. Soaking in water dissolves and leaches out the chemicals causing dormancy (Deghan *et al*., 2003) [10]. The considerable germination recorded with concentrated H_2SO_4 occurred as a result of the ability of the acid to degrade the seed coat of *Gliricidia sepium* thereby re-activating the physiological and biochemical activities needed for seed germination. These results are accordance with findings of Ren and Tao (2004) [19]. Variation in imbibition period among treatment was found non-significant because of the soft seed coat of *G. sepium*. Significantly maximum germination period of 13.6 days was observed in control (T_0) and it was observed at par with T_4 knuckling (12.8 days), T_2 cold water (12.6 days) and T_3 cow dung slurry treatment (11.8 days). These findings have conformity with Addis (2003) [2]; Al Manae *et al*. (2010) [5]; Bohra *et al*. (1994) [8]; Harsh *et al*. (2004) [13]; Catalan and Balazarini (1992) [9]; Schelin *et al*. (2004) [20]; Negi and Todariya (1997) [15]; Nainar *et al*. (1999) [14].

Growth parameters: Significantly highest number of nodules per seedling was found in T_4 knuckling (16.80) followed by T_5 acid treatment (15.80), control (14.10) and cold water treatment (11.54) respectively. Significantly largest number of leaves per seedlings were observed in T_4 knuckling (14.75) which is at par with T_5 acid treatment (14.53) and superior to rest of treatments. Higher seedling height was observed in knuckling (45.22 cm) which was at par with T_5 acid treatment (43.07 cm), T_2 cold water (42.52 cm) and T_3 cow dung slurry treatment (41.54 cm). Higher root length of seedlings was observed for in knuckling (26.68 cm) which was statistically at par with T_5 acid treatment (25.42 cm), control (25.14 cm), T_2 cold water (20.75 cm) and T_3 cow dung slurry treatment (22.82 cm). Significantly higher root shoot length ratio of seedlings is observed for T_0 control (0.62) as compared to T_4 knuckling (0.59) and knuckling (0.59), followed by T_2 cold water (0.57) and T_3 cow dung slurry treatment (0.55). Higher total seedling length was observed in T_4 knuckling (71.90 cm) which is statistically at par with T_5 acid treatment (68.67 cm), T_3 cold water treatment (67.37 cm), control (64.67 cm), T_2 cow dung slurry treatment (64.35 cm). Largest collar diameter of seedlings was observed for T_4 knuckling (0.88 cm) which was statistically at par with T_5 acid treatment (0.80 cm), T_3 cow dung slurry treatment (0.8 cm), T_0 control (0.76 cm) and T_2 cold water treatment (0.68 cm). Significantly largest shoot dry weight of seedlings was observed in T_4 knuckling (8.63 g) among all and rest of the treatments are at par with each other. Largest root dry weight of seedlings was observed for T_4 knuckling (2.49 g) among all followed by T_5 acid treatment (1.75 g) and T_0 control (1.58 g) resp. It was observed that root dry weight for T_0 control (1.58 g) and T_2 cold water treatment (1.17 g) and cow dung treatment (1.25 g) are statistically at par with each other. Significantly largest total dry weight of seedlings was observed for T_4 knuckling (11.12 g) among all treatments followed by T_5 acid treatment (9.01 g) cow dung slurry treatment (6.33g), T_0 control (6.23 g) and T_2 cold water treatment (4.85 g) whereas cow dung slurry treatment (6.33g) was statistically at par with T_0 control (6.23 g). Lowest total dry weight of seedlings was observed for T_2 cold water treatment (4.85 g) as compared to others. Obviously knuckled seeds and seeds geminated earlier had an advantage of absorption of much water and started the photosynthesis process much faster than others resulted to fast growth and higher biomass accumulation. These findings were accordance with the finding of Ghosh and Sen (1988) [11] in

ber (*Ziziphus mauritiana*) seeds, Padma *et al.* (1994) [17] in *Leucaena leucocephala*, *Albizzia labbeck* and *Samanea saman* & Okunlola *et al*. (2010) in African locust bean (*Parkia biglobosa*).

Vigour index: It was observed that vigour index of seedlings was significantly maximum for T_5 acid treatment (6380.31) which was statistically at par with T_4 knuckling (6251.94), T_2 cold water treatment (5598.71) and T_0 control (5070.38). Significantly lowest vigour index of seedlings was observed for T_3 cow dung slurry treatment (2664.54) among all. Obviously the seeds which commence germinating earlier also produces more vigorous seedlings.

Similar results were obtained by Babeley and Kandya (1988) [6] in *Cassia fistula*, Babeley *et al*. (1986) [7] in *Albizia lebbek*, Okunlola *et al.*, (2010) in African locust bean (*Parkia biglobosa*). These findings were differ from Alamgir and Hossain (2006) [4], this may be due to difference in genotype and locality.

Table 1: Effect of pre-seed treatments on germination parameters and vigour of *Gliricidia sepium* in Vindhyan region, UP, India

Treatment	Germination percentage (%)	Imbibition period (days)	Germination energy (%)	Germination period (days)	Vigour index
Control (T_0)	78.40	4.20	69.60	13.60	5070.58
Hot water treatment(T_1)	0.00	0.00	0.00	0.00	0.00
Cold water treatment (T_2)	84.00	3.40	66.40	12.60	5598.71
Cow dung slurry treatment(T_3)	43.20	3.60	34.40	11.80	2664.54
Knuckling (T_4)	88.00	2.40	73.60	12.80	6251.94
Acid treatment (T_5)	92.80	3.80	79.20	10.60	6380.31
SE (m)	3.90	0.80	3.76	0.54	291.25
CD at 5%	11.30	2.31	10.89	1.57	842.42
	S	NS	S	S	S

*Significant at $P \leq 0.05$; NS- Non Significant at $P > 0.05$
S- Significant and NS- Nonsignificant

Table 2: Effect of pre-seed treatment on growth of *Gliricidia sepium* in Vindhyan region, UP, India

Treatment	No. of nodules per seedling	No. of leaves per seedling	Shoot length (cm)	Root length (cm)	Total Seedling Length (cm)	Root shoot length ratio	Collar diameter (cm)	Shoot dry weight (g)	Root dry weight (g)	Total Dry weight (g)
Control (T_0)	14.10	13.06	39.91	25.14	64.76	0.62	0.76	4.71	1.58	6.23
Hot water treatment(T_1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cold water treatment (T_2)	13.00	13.93	42.52	24.25	67.37	0.57	0.68	3.68	1.17	4.85
Cow dung slurry treatment(T_3)	11.54	13.73	41.54	22.82	64.35	0.55	0.80	5.08	1.25	6.33
Knuckling (T_4)	16.80	14.53	45.22	26.68	71.90	0.59	0.88	8.63	2.49	11.12
Acid treatment (T_5)	15.80	14.75	43.07	25.42	68.67	0.59	0.80	7.26	1.75	9.01
SE (m)	0.32	0.58	1.71	1.02	2.69	0.003	0.03	0.36	0.13	0.48
CD at 5%	0.95	1.68	4.96	2.95	7.78	0.01	0.10	1.04	0.09	1.40
	S	S	S	S	S	S	S	S	S	S

*Significant at $P \leq 0.05$; NS- Non Significant at $P > 0.05$
S- Significant and NS- Nonsignificant

Conclusion

The H_2SO_4 treatment provided the highest seed germination %, germination energy, number of nodules and vigour index while knuckling provided highest No. of leaves, shoot height, root length total seedling length and biomass accumulation which were at par with control and soaking in water. Germination was completely hindered in case of hot water treatment as boiling water is harmful for embryo of seed of *Gliricidia sepium*. As no significant difference found among control, Knuckling and acid treatment, it was concluded that no treatment can significantly enhance germination and vigour in gliricidia.

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