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Influence of Different Pre-Sowing Seed Treatments on Germination and Early Growth Behavior of *T. arjuna:* A Potential Medicinal Tree

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***Abstract*:-**The present investigation has been taken to achieve an improvement in the germination and growth attributes of *Terminalia arjuna.* Different treatments like gamma irradiation exposure at different levels, water soaking treatment, hot water treatment and gamma irradiation+presoaking treatments, were subjected to the air dried seeds of *T. arjuna*. The results were compared to untreated seeds (Control). Across all the treatments the germination of the seeds was increased significantly from 57% to 84.6% by 10KRF+presoaking treatment, showing an improvement of 27.6% over control. Other treatments also show an stimulation in germination like 10KRC (11.5%), 10KRF (18.5%), soaking (8%), 10KRC+presoaking (22.5%) and hot water (13%) over control respectively. 10KRF+presoaking treatment also recorded a maximum improvement in the growth attributes of *T. arjuna.* All the treatments proved successful in stimulating the rate of early growth in *T. arjuna* in contrast to control. Depending upon the availability of the different treatment sources, the enhancement of germination, growth along with plant metabolites and overcoming all the barriers including dormancy could be employed for improving the quality of planting stock of *T. arjuna.*

***Keywords*:** *Terminalia arjuna*, germination, gamma irradiations, water soaking.

I. INTRODUCTION

Terminalia arjuna L. (Family Combretaceae) is widespread in India and plays an important role in the sericulture [1] and tannin industry. It is a remarkable medicinal tree for its important phytochemical presence in different parts of the tree [2]. *T. arjuna* based phytochemicals are considered as one of the best heart tonic [3] and can be used on daily bases as tonic for healthy cardiovascular system and hypertension [4,5,6]. The bark of the tree is white to pinkish-gray bark has been used as India's native Ayurvedic medicine from last three centuries. The tree is predominantly cultivated through seeds and the genetic diversity has been conserved through storage of seeds [7].

The propagation of *T. arjuna* is difficult through conventional methods, due to poor seed germination and seedling establishment. One of the reasons for its poor germination may be the hard seed coat. Different methods have been adopted for the enhancement in germination of this plant like cutting and layering, seed treatment with chemicals and growth hormones. In the present study we have applied different treatments to modify the germination and growth attributes of *T arjuna,* which can help in growing an elite plantation stocks at commercial basis.

II. MATERIAL AND METHODS

The fully mature seeds were collected from the forests of Achanakmar Amarkantak Biosphere reserve, Central India (Location: 21^0 15' to 22^0 58'N and 81^0 25' to 82^0 5'E). Different treatments like gamma irradiation exposure at different levels, water soaking treatment, hot water treatment and gamma irradiation + presoaking combination treatments, were subjected to the air dried seeds of *T. arjuna*. For gamma irradiation exposure the air dried seeds were subjected to to different gamma irradiation doses (10kR, 20kR, 40kR and 60kR) using a Co^{60} gamma source with strength of 0.3712 KGy/Hr (Gamma Chamber, Department of Chemistry, RTM University, Nagpur, Maharashtra, INDIA). The doses were given in two different ways as Continuous treatment and Fractionated treatment. For continuous doses the seeds have been irradiated continuously by giving the desired dose uninterruptedly. For fractionated doses, it was done by fractionating the doses in two equal parts by allowing an interval of 24 hours between two equal doses. For gamma irradiation + presoaking treatment the seeds were first exposed to gamma irradiation, then soaked in water for 36 hours. In this article we only considered the radiopotential doses (doses

showing improvement) and the doses which inhibited these parameters were not included in the article. Hundred seeds were used for each treatment. Each treatment was replicated four times with 25 seeds in each replicate and the whole experiment was arranged in a Randomized Block Design. Seeds without any treatment were taken as control. The seeds were sown in polypots in the Glass house of the Department. The germination percentage [8] and germination speed [9] were calculated. The different growth parameters were evaluated after two months from the date of seed sowing. The vigor index was calculated by the equation given by Akhasta et al., [10].Total chlorophyll content was calculated by measured by the protocol designed by Arnon [11]. In addition quick viability test was performed to assess seed viability test [12].

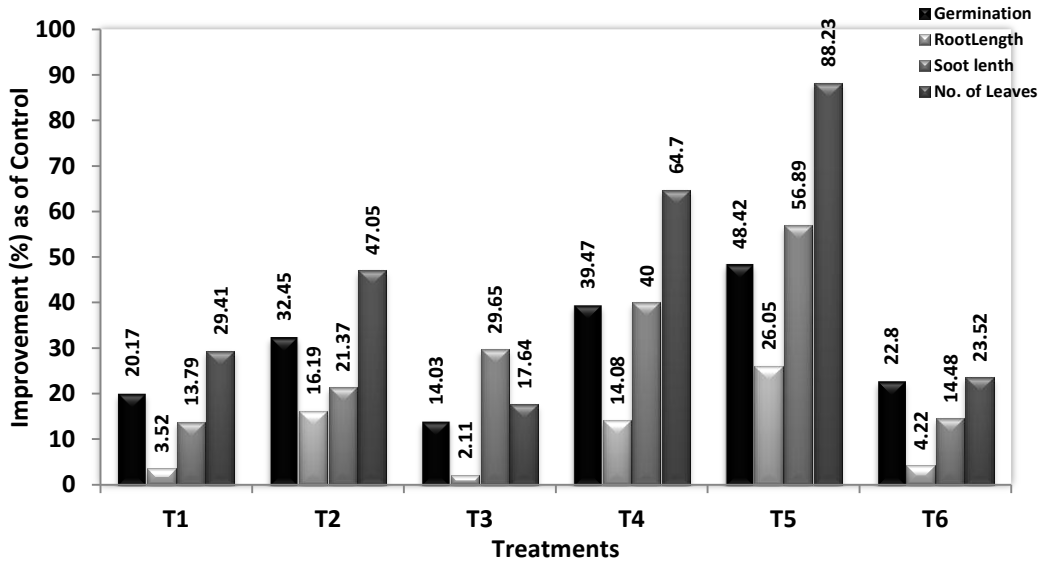
III. RESULTS AND DISCUSSION

Table: Effects of various pre-sowing seed treatments on germination and vigor index of *T. arjuna*

Treatment	Germination %	Germination speed	Vigor index	Viability
Control	57.0±1.08	07.6±0.13	501.6±12.2	100
10KRC	68.5±1.55	09.8±0.18	822±10.61	100
10KRF	75.5±0.90	11.5±0.10	875.8±8.25	100
Presoaking (36hrs)	65.0±2.84	08.5±0.21	621.3±6.54	100
10KRC +Presoaking	79.5±1.32	10.5±0.19	778.6±8.80	100
10KRF+ Presoaking	84.6±0.94	13.6±0.24	957.2±9.77	100
Hot Water	70.0±1.67	09.0±0.09	676.6±10.24	100
Anova (One way)	**	*	**	NS

¶The data shown are mean±SE of four replicates. Means within a column followed by same letter are not significantly different ($p \leq 0.05$), Different letters a, b, c, d and e denote significant difference ($p \leq 0.05$) between different treatments.
$* = p \leq 0.05$,$** = p \leq 0.01$.

The results of the different treatments were compared with the untreated set (Control). Across all the treatments the germination of the seeds was increased significantly from 57% to 84.6% by 10KRF+presoaking treatment, showing an improvement of 27.6% over control. Other treatments also show an improvement in germination like 10KRC (11.5%), 10KRF (18.5%), soaking (8%), 10KRC+presoaking (22.5%) and hot water (13%) over control respectively (Fig 1). The speed and vigor index was stimulated by these treatments significantly. The lower doses of gamma rays show a good potential in improving the germination percentage, germination speed and vigor index than the control respectively. The lower doses of γ-irradiation may have increased the enzymatic activation system and thus awakening of young embryo, which results in the enhancement in the rate of cell division thus increases the germination percentage [13]. These lower gamma irradiation doses can also be responsible for activation of the hormonal signaling pathway [14] and activation of genes regulating the process of seed germination. Similar results were obtained for *Tectona grandis* [15], *Albizia lebbeck* [16] and *Pinus* [17].Some authors refer to the concept of hormesis, that occurs when seeds are subjected to pre-irradiation with low doses of a radiation source [18]. In contrast the higher doses of gamma irradiation were found to be lethal [19].



Note: T1: 10KRC, T2:10KRF, T3: Presoaking in water (36hrs), T3: Presoaking+10KRC, T4: Presoaking + 10KRF, T6: Hot Water

Fig 1: Improvement (in percentage) in germination and growth parameters of *T. arjuna* in comparision to control.

One of the reasons of the poor germination in this tree can be its hard and lignified seed coat. We tried the mechanical breaking of the coat but it caused damage to the seed.Thus we preferred the seed soaking and hot water. The presoaking and hot water treatments performed well in softening and depulping the seed coat and thus making the availability of seed moisture earlier than control, resulting in the enhancement in the germination percentage by these treatments. The presoaking and hot water treatments has also performed well by enhancing the germination and vigor in some forest trees [20].

The root growth, shoot growth and leafing are considered to be the best indicators of the early seedling establishment. As the seed germinates, its successful establishment depends upon the rate of growth which the seedling puts during a specific time. An improvement in shoot growth by 56.89%, root length by 26.05% and number of leaves by 88.23% over control was observed by 10KRF+presoaking.This was the maximum improvement recorded across all the treatments. The Lower doses of γ- irradiation are important as physical growth activator and productivity promoter in plants [21]. The lower doses of γ-irradiation increase the mitotic index of different seedling tissues and hence promotes physical growth, in contrast the mitotic index decrease with increasing doses of gamma radiation [22,23].

Table: Effects of various pre-sowing treatments on growth parameters and chlorophyll content of *T. arjuna*

Treatment	Root Length(cm)	Shoot Length(cm)	Leaves	Leaf area (cm^2)	Chlorophyll content (mg/g FW)
Control	14.2±1.28	29±1.56	17±2.32	32.5±1.82	09.98±0.24
10KRC	14.7±0.95	33±2.68	22±1.66	35.5±1.63	11.15±1.45
10KRF	16.5±0.65	35.2±2.42	25±1.18	37.3±2.11	11.60±0.17
Presoaking (36hrs)	13.5±1.21	35.6±1.20	19±0.97	32.2±0.76	09.50±0.17
10KRC +Presoaking	16.2±0.87	40.6±2.90	28±1.12	38.0±1.21	13.32±0.32
10KRF+ Presoaking	17.9±0.94	45.5±1.65	32±1.32	41.6±1.37	14.86±0.47
Hot Water	14.8±0.22	33.2±1.32	21±0.63	33.0±0.79	10.40±0.10
Anova (One way)	*	*	*	*	*

¶The data shown are mean±SE of four replicates.Means within a column followed by same letter are not significantly different ($p \leq 0.05$), Different letters a, b, c, d and e denotes significant difference ($p \leq 0.05$) between different treatments. * = $p \leq 0.05$.

Surprisingly the pre soaking and hot water treatment don't show a significant influence on the different growth attributes of *T. arjuna*. Whereas the gamma irradiation proved successful in enhancing the rate of early growth in *T. arjuna*. The chlorophyll content of the leaf is a good indicator of the photosynthesis which is of special significance for precision forestry [24]. The increase in the total chlorophyll content by 67.16% over control was addressed by 10KRF+presoaking treatment. The other treatments also increased the total chlorophyll content. The increase in the chlorophyll content in the present study can cause increase in the total yield of the plants of *T. arjuna*.

IV. CONCLUSION

The germination of a seed is a very complex mechanism. Before a seed can germinate a set of stages must be completed like availability of food stored in the seed, activation of specific enzymes and pathway, breaking of seed dormancy, physical and physiological maturity of seed etc. Once these factors are favorable the seed starts to germinate. The improvement of the seed germination work on these principles i.e. to make all these factors favorable. In the present work we tried to modify these factors by exposing the seeds of *T. arjuna* to different treatments. Across all the treatments the 20KRF+presoaking treatment showed the highest rate of improvement in germination and other growth attributes. Enhancement of germination, growth along with plant metabolites and overcoming all the barriers including dormancy, using irradiation technology, could be employed for improving the quality of planting stock of *T. arjuna*. Further more if the irradiation facilities are not available the hot water and presoaking treatments can also enhance the seed germination and the seedling establishment.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest

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