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Study the Effect of Plant Growth Regulators on Seed Germination of Various Tree Species of Rajasthan

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ABSTRACT

This research paper delves into the influence of plant growth regulators (PGRs) on the germination percentage of four distinct plant species, specifically *Albizia lebbeck* (L.) Benth., *Holoptelea integrifolia* (Roxb.) Planch., *Acacia catechu* (L.f.) Willd., and *Terminalia bellirica* (Gaertn.) Roxb. The study was conducted at Arid Forest Research Institute, Jodhpur, during the summer of 2022. The study employed three PGRs: gibberellic acid (GA3), indole acetic acid (IAA), and indole-3-butyric acid (IBA) at two concentrations of 500 ppm and 1000 ppm. The primary objectives of this study were to evaluate the germination percentage of the four plant species and to ascertain the optimal PGR treatment for seed germination. The results of this research could potentially aid in the development of effective strategies to enhance seed germination and overall plant growth. The study revealed that the impact of PGRs on germination percentage was dependent on the plant species and the concentration of the PGR used. The findings indicated that the use of PGRs at appropriate concentrations could increase the germination percentage of seeds. Of the three PGRs used in the study, GA3 was found to be the most effective at enhancing seed germination for all four plant species, followed by IAA and IBA. Overall, this research has demonstrated that the use of PGRs can significantly improve seed germination percentage and can provide valuable insights into the optimal concentration of PGRs required for the best possible results. The study results could potentially assist in the development of PGR-based strategies to enhance plant growth and productivity, which could have important implications for agricultural and environmental sustainability.

Keywords: PGRs; Sowing media; Seed treatment and sowing; Germination percentage.

1. Introduction

An understanding of how plants grow is a topic of intrinsic interest and as a result, a lot of research has been done regarding this. A common message that has been emerged from these studies is that these development progresses are regulated by specific endogenous chemicals. These compounds were earlier called as ‘plant hormones’ but recently the term ‘plant growth regulators’ have been adopted. Plant growth regulators (PGR) are natural or synthetic chemicals that can influence the growth of a plant or plant part. Plant growth hormones (PGRs) play a vital role in cell division, growth and differentiation (Hooley, 1994). There are 5 classes of compounds in the premier division of endogenous PGRs. These are auxins, gibberellins (GAs), cytokinins (CKs), abscisic acid (ABA) and ethylene. Generally speaking, the auxins and GAs have been classified as cell elongation regulators, CKs as cell division regulators, ABA as general inhibitor and ethylene as volatile with various effects. Plant growth regulators such as gibberellic acid (GA3), abscisic acid (ABA), kinetin and ethylene are known to influence the dormancy status of seeds (Karssen 1995). Changes in hormone concentration and tissue sensitivity mediate a range of developmental processes in plants, many of which involve interactions with environmental factors (Buchanan et al., 2015). New, naturally occurring substances in these categories are still being discovered. At the same time, novel structurally related compounds are constantly being synthesized. There are also many new but chemically unrelated compounds with similar hormone-like activity being produced. More recently discovered natural growth substances that have phytohormonal-like regulatory roles (polyamines, oligosaccharins, salicylates, jasmonates, sterols, brassinosteroids, dehydrodiconiferyl alcohol glucosides, turgorins, systemin, unrelated natural stimulators and inhibitors), as well as myoinositol. Many of these growth active substances have not yet been examined in relation to growth and organized development in vitro.

Plant growth regulators are widely used in modern agriculture, horticulture and viticulture. “True” plant growth regulators interfere directly with the plant’s hormonal status. They are represented by plant hormones or their synthetic analogs, by inhibitors of hormone biosynthesis or translocation and by hormone receptor blockers. “Atypical” plant growth regulators act by displaying a local and/or transient phytotoxic effect. Approximately 40 active ingredients are in use, applied either as a single component or as combinations. Many plant developmental processes can be actively regulated in cultivated plants, for example, acceleration or delay of seed germination, dormancy breaking in woody perennials, stimulation or reduction of shoot elongation, induction of flowering and fruiting, reduction or increase of fruit set, acceleration or delay of senescence processes including fruit ripening and defoliation. The achieved benefits range from facilitating crop management to increasing and securing yield and quality of the harvested produce and improving its storage and shelf life. Systematic use of plant growth regulators started in the 1930s.

2. Material and Methods

The study was conducted at Arid Forest Research Institute, Jodhpur during the summer of 2022 during the period of April-May.

(a) Selection of plant species

The selection of the plant species for the study was done on the basis of the availability and importance of the species.

(b) Selected plant species

Four plant species have been selected to conduct this experiment. The seeds of all species have been taken from the seed bank of Silviculture and Forest Management division, AFRI, Jodhpur.

Plant name	Collection site	Collection date
Acacia catechu (L.f.) Willd.	Bhawar Mata Vaan Khand N $24^{0}21^{'}042^{''}$ E $74^{0}41^{'}300^{''}$	24/03/2022
Albizia lebbeck (L.) Benth.	Manaklaav Village, Nagaur Road N $25^{0}17.815^{'}$ E $77^{0}05.897^{'}$	21/01/2022
Holoptelea integrifolia (Roxb.) Planch.	Samod N $25^{0}19.274^{'}$ E $75^{0}79.947^{'}$	03/03/2022
Terminalia bellirica (Gaertn.) Roxb.	Ana Sagar Pond Rajpur, Shahabad N $26^{0}44^{'}83.29^{''}$ E $73^{0}02^{'}27.73^{''}$	17/02/2022

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(c) PGRs

Three plant growth regulators have been used in this experiment and these PGRs are GA_3, Indole acetic acid (IAA), Indole–3–butyric acid (IBA). 2 different concentrations i.e., 500 ppm and 1000 ppm were used. A GA_3 solution of 1000 ppm concentration was prepared by dissolving 1 gm of GA_3 in 1 ml absolute alcohol, followed by dilution with water to 1000 ml. Another GA_3 500 ppm solution was made by dissolving 0.5 gm GA_3 in 1000 ml water. IAA (1000 ppm, 500 ppm) and IBA (1000ppm, 500 ppm) were prepared in similar way. Control was done without any PGR treatment.

(d) Sowing media

Seeds were sown in a controlled environment inside the lab. Sowing media that has been used is crushed marble powder. The temperature in the lab where the seeds were sown was 31^0C and the humidity has been recorded to be 30%.

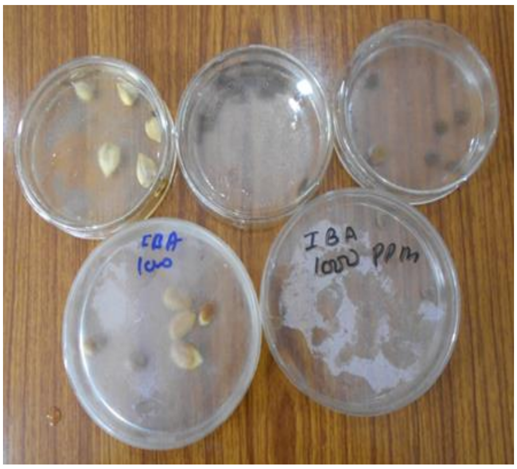
(e) Seed treatment and sowing

The seeds of the selected plant species were first kept in different PGR solutions for 16 hours. Chemically treated seeds were then sown in the trays containing vermiculite and kept in the lab under controlled environment. Germination data was taken every day upto 21 days.

(f) Germination

Seed germination is the process of initiating growth of a previously quiescent or dormant embryo. For most seeds, germination begins with imbibition of water. In order that a seed can germinate, it must be placed in environmental conditions favourable to this process (Craufurd *et al*. 1996). Among the conditions required is an adequate supply of water, a suitable temperature range and, for some seeds, light (Collis-George and Williams 1968, Levitt 1980, Long and Woodward 1998). The result is measured in terms of the extent to which seeds have germinated. Germination percentage has been calculated to see the effect of the different PGRs. The germinated seeds were counted after three weeks to calculate the germination percentage as the following:

Germination (%) = (Seeds germinated/Total seed) × 100



(a)

(b)

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(c)

(d)

(e)

(f)

Figure 1.(a). Seed soaking, **(b)**. Sowing media, seed germination of **(c)**: *Terminalia bellirica*, **(d)**: *Albizia lebbeck*, **(e)**: *Acacia catechu*, and **(f)**: *Holoptelea integrifolia*

3. Result and Discussion

Table 1. Seed Germination Data

Species	Number of days observation recorded	Control	Germination % in GA3		Germination % in IBA		Germination % in IAA		Hot	Cold
			1000 ppm	500 ppm	1000 ppm	500 ppm	1000 ppm	500 ppm		
Acacia catechu	21	60	80	60	60	80	100	80	80	60
Albizia lebbeck		100	80	100	0	0	0	0	80	0
Holoptelea integrifolia		60	60	60	0	0	0	20	60	0
Terminalia bellirica		60	80	20	0	20	0	0	40	60

All seeds were treated with 3 different PGRs i.e. GA_3, IBA and IAA. Each PGR had 500 ppm and 1000 ppm concentrations. Seeds were kept soaked in treatment for 16 hours. For control, seeds were soaked in water. The germination results revealed different results in different plant species. In *Albizia lebbeck* and *Holoptelea integrifolia* no particular effect of any hormone is seen. The seeds of *Albizia lebbeck* treated with GA3 showed the earliest germination on the 3rd day. The seeds of *Holoptelea integrifolia* treated with 1000 ppm GA_3 showed the earliest emergence on the 5th day. In *Acacia catechu*, seeds treated with 1000 ppm GA_3 and IAA and 500 ppm IBA and IAA showed more germination than control seeds. The control seeds of *Acacia catechu* showed earliest emergence on the 4th day. In *Terminalia bellirica*, seeds treated with 1000 ppm GA_3 showed earlier and more germination. The seeds of *Terminalia bellirica* which were treated with 1000 ppm GA_3 germinated earliest i.e. on the 5^{th} day.

4. Conclusion

The conclusion of this study conducted is to determine the most effective plant growth regulators for improving seed germination rates of four different tree species. The four species tested were *Acacia catechu, Albizia lebbeck, Holoptelea integrifolia*, and *Terminalia bellirica*. The study aimed to identify the optimal concentration of two plant growth regulators, Indole-3-acetic acid (IAA) and Gibberellic acid (GA3), in enhancing seed germination rates. The results indicated that seeds of *Acacia catechu* had the highest germination rates when treated with 1000 ppm of IAA. *Albizia lebbeck*, on the other hand, had the highest germination rates when treated with 500 ppm of GA3, while seeds of *Holoptelea integrifolia* showed the highest germination rates when treated with either 1000 or 500 ppm of GA3. Seeds of *Terminalia bellirica* showed the highest germination rates when treated with 1000 ppm of GA3. The study concluded that seed treatment with GA3 was the most effective plant growth regulator in promoting germination rates for *Albizia lebbeck*, *Holoptelea integrifolia*, and *Terminalia bellirica*. Overall, the study provides valuable insights into the effectiveness of plant growth regulators in improving seed germination rates for different tree species. The results could be useful in promoting the growth of trees for reforestation and afforestation programs, as well as for commercial plantations. Further research may be needed to determine the optimal concentration of plant growth regulators for other tree species and to investigate the effects of these plant growth regulators on the growth and development of the resultant plants.

Declarations

Source of Funding

We are thankful to CSIR for financial support.

Conflict of Interest

The authors declare that they have no conflict of interest.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contribution

All the authors took part in literature review, research, and manuscript writing equally.

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