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Influence of sowing depth and gibberellic acids on germination of mango (*Mangifera indica* L.) seeds

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ABSTRACT

Mango is the most popular fruits and is used from the immature stage to the ripe stage and processed products. The present experiment was conducted to understand the effects of sowing depth and gibberellic acids (GA3) treatments on the seed percentage of mango. The experiment was carried out in the fruit nursery of the College of Horticulture and Forestry, Central Agricultural University (Imphal), Pasighat, Arunachal Pradesh during 2018. Freshly collected undescriptive mango seeds were sown in polythene bags filled with potting media (Soil: Sand: FYM @ 1:1:1). Different sowing depths (0, 5 and 10 cm) and GA3 strengths (0, 50, 100 and 200 ppm) were taken as factors for the study. Statistical analysis reveals that different depths of sowing (0, 5 and 10 cm) as individual factor had no significant influence on mango seed germination percentage. However, GA3 with different strengths (0, 50, 100 and 200 ppm) as individual factor significantly influenced the germination percentage (38.89, 66.16, 43.43 and 58.08% respectively). The interaction effect of seeds sown at 10 cm depth and treated with GA3@ 200 ppm showed the maximum germination percentage of 77.28%. The present findings would be useful for further understanding the mechanism of mango seed germination under hormonal effects for rapid production of seedling rootstocks for commercial mango propagation.

1. Introduction

Mango, *Mangifera indica L.* is popularly acknowledged as 'King of fruits'. It is said to be indigenous to North East India and North Myanmar in the foothills of eastern Himalayas. Mango is known amongst the communities in North Eastern Region of India by different vernacular names (Table 1), depicting that the fruit had not been introduced in the region. Mango fruits are consumed from the un-ripe stage (fruits as such, pickle- achar, chutney, RTS) to the ripen stage (fruits as such and for making juice). Popularity of mango can be gauged from the introduction of sweets blended with mango flavour, the recent most being 'Pulse', a kind of sweet blended with mango flavour Though mango is traditionally cultivated in South East Asian Countries, the crop is successfully adapted and adopted by growers and preferred by consumers in Western and European countries like Israel, USA (Hawaii, Florida, Columbia *etc.*), Mexico, Brazil, Cuba, Islands of West Indies. Expansion in mango cultivation in these countries

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has something to do with adaption strategies in the wake of climate change whereby temperate nations are becoming warmer. Thus, tropical and sub-tropical fruit crops are performing better than ever before. The recommended propagation technique for commercial production of mango is grafting, especially veneer grafting. However, other types of grafting methods are also adopted in nursery for mango such as soft-wood grafting, epicotyl or stone grafting *etc.* As the crop is highly cross pollinated and heterozygous as well as heterogeneous, therefore sexual propagation through seeds is not recommended. This particular aspect of propagation has made the utility of seeds more important to raise seedling rootstocks.

On the other hand, propagation of clonal rootstocks in mango is not very successful and popular. Development of seeds in mango initiates along with the development of fruits. The peak growth of both the fruit and the seed within the fruit is correlated positively correlated (Singh, 2009). As the fruit approaches maturity, endocarp (hard seed coat) development also progresses. Mango seed is recalcitrant, containing around 85% moisture, and the viability degrades rapidly with the reduction in moisture with complete loss in viability at 25-30% moisture on dry weight basis (Corbeneau *et al.,* 1986) and thus cannot be stored for long period. The favourable temperature for germination of mango seeds range ideal is 25-40OC. Freshly extracted seeds from ripen fruits remain viable for 30-45 days provided moisture level is sufficiently high. Due to typical recalcitrant nature of the seed, it is necessary to understand techniques that would enhance its germination so that large scale production of seedling rootstocks can be achieved to meet the ever increasing demand of grafted quality planting materials of this 'king of fruits'. Polyembryony, the phenomenon in which the production of more than one embryo from a single seed, is also commonly observed in some varieties of *Mangifera indica* L. In rare occasion phenomenon of vivipary can be induced by application of paclobutrazol (PBZ) @ 2.3 g per metre canopy in cultivar like Fazli (Singh and Ram, 1999). Mango seeds positively respond to the pre-sowing treatment of bio-formulations. Dawale, *et al.* (2011) reported that germination of mango seeds is influenced by different bioformulations, among which seeds treated with Panchagya significantly improved germination (70.83%) over the untreated control (52.00%) besides vegetative growth parameters. Teichman *et al.*, 1988 reported an interesting feature of mango seeds-the protective nature of the thick seed coat is substituted by the specialized sclerenchymatous endocarp. This particular evolutionary development of this large, one seeded fruit (drupe) whose dispersal is prominently assisted by animal and human makes it a more effective and advanced fruit type in the nature. Availability of quality planting materials remains a constraint for prospect mango growers in North Eastern Region of India. While seeds are not commercial propagules in mango, they are used to raise seedling rootstocks for commercial propagation. Seeds from ripen fruits are extracted and shade dried for one or two days before subjecting to sowing. Nurserymen sow them in raised seed beds or polythene bags and essential care is taken for germination and subsequent raising of the seedlings till they attain graftable stage-pencil size stem thickness (10-12 months old). Studying the effect of sowing depth is important as nurserymen tend to follow either sowing the seeds in polybags wherein seeds are embedded or sown directly on seed beds in rows with almost exposed without covering the seeds properly. Just placing the seeds on the media-filled polybags would be an easier practice for nurserymen and growers. Enhancement of seed germination due to gibberellic acid treatment in fruit crops has been reported. Influence of gibberellic acids on seed germination in general and that of mango has been reported in some earlier experiments (Karrsen, 1989; Shaban, 2010; Pandey, *et al.,* 2017; Patel, *et al.,* 2017). However, strength of the growth regulators and their influence on germination appeared to be varying with crop species and location of the experiment.

Table 1. Vernacular names of *Mangifera indica* L. among different communities of North Eastern Region of India.

Arunachal Pradesh		Mizoram		Tripura	
Adi/ Mishing	*Tagung*	Mizo	*Theihai*	Hindi/ Bengali	*Aam*
Galo/Tagin	*Tagu*	Chakma	*Am*	Kokboro	*Thaichuk*
Nyishi	*Togu*			Bishnupriya Manipuri	*Heinou*
Assam		**Sikkim**		**Meghalaya**	
Assamese	*Aam*	Nepalese	*Aap*	Garo	*Tegatchu*
Boro	*Thaijow/Taijou*	Bhutia	*Aambi*	Jaintia	*Sohpein/Sapein*
Karbi	*Ther-ve*			Khasi	*Sohpieng*
				Pynursla (area)*	*Sohpeng*
				Bhoi (area)*	*Sohpiun*
				Lynngam (area)*	*Sohpiang*
Manipur				**Nagaland**	
Meitei:	*Heinou*			Angami	*Aam She*
Tangkhul	*Heinuthei*			Ao	*Teti*
Rongmei/Zeliangrong	*Abathai*			Chakesang	*Amuchee*
Paite/Mizo/Hmar/Vaiphei	*Thehai*			Lotha	*Tsupyonthi*
Gangte/Simte	*Hai*			Phom	*Ashoi*
Thadou	*Haithei*			Rengma	*AamSha*
Mao	*Movushii*			Sema	*Mujhoithi / Am*
Other Language/ Dialects					
Kanada	*MaavinHannu*			Tamil	*Mampalam*
Malayalam	*Maanga*			Telugu	*Mamidikaya*

Objective: The present experiment was carried out with the following objectives:

a. To study the influence of sowing depth on mango seed germination.
b. To evaluate the strength of GA_3 for enhancing the mango seed germination.
c. To understand the interaction of sowing depth and GA_3 on mmago seed germination

2. Materials and Methods

The present experiment to study the 'Influence of sowing depth and GA_3 on seed germination in Mango, *Mangifera indica* L.' was carried out in the Fruit Nursery, Department of Fruits Science, College of Horticulture & Forestry, CAU (Imphal), Pasighat, Arunachal Pradesh during 2018. The study was conducted in Factorial CRD with three sowing depths and four GA_3 strengths.

Factor A (Sowing Depth)	Factor B (GA_3 Strengths)
• Deeply Sown (10 cm)	• Water Soaking (0 ppm)
• Shallow Sown (5cm)	• GA_3 (50 ppm)
• Exposed (0 cm)	• GA_3 (100 ppm)
	• GA_3 (200 ppm)

The experiment was replicated six times to minimize the experimental errors. Ripen healthy mango fruits were sourced. After extraction of seeds, they were spread on gunny bag in nursery overnight. This allows seeds to lose excess pulpy liquids on the seed cover and helps better absorption of GA_3 in subsequent treatment. The following day, the mango seeds in four different lots were soaked in four different containers having capacity of 10 litre filled with plain water (control), GA_3 50 ppm, GA_3 100 ppm and GA_3 200 ppm for 24 hours and sown in the polythene bags were filled with nursery media consisting of Soil: Sand: FYM: 1:1:1) proportion. Three sets of polythene bags (Size: 10 cm X 17 cm) were prepared. In first set, media were filled with 1/3 volume (so that seeds were covered with media 10 cm above them); In second set; bags were filled with 1/2 volume (so that seeds were covered with media 5cm above them) and, in third set, bags were fully filled keeping 3 cm below edge (so that seeds remain exposed over the media). The filled polythene bags were kept under net house (50% shade) with following standard good nursery management practices (GNMP) for seed germination.

Data were recorded on the following parameters:

Days to germination:

Number of days from the date of sowing to germination was counted for each treatment and replication and their average were calculated for analysis. Germination of a seed is considered only when emergence of radical/ plumule is visibly protruded.

Days to 50% Germination:

Number of days from the date of sowing to 50% germination was counted for each treatment and replication and their average were calculated for analysis.

Germination percentage:

Germination in each treatments and replications was observed and recorded upto 90 days from the day of sowing and germination percentage was worked out for analysis with the following formula.

$$\text{Germination Percentage} = \frac{\text{Number of Seeds Germinated}}{\text{Number of Seeds Sown}} \text{ X } 100\%$$

All the statistical analysis was carried out using online statistical tool, Web Agri Stat Package 1.0 (WASP 1.0) software (http://www.ccari.res.in/wasp1.0/index.php) developed by ICAR-GOA, India Centre

3. Results and Discussion

The results of the experiment are presented in Table 2 and 3 for the parameters of days taken for germination from the day of sowing and germination of seeds in the following 90 days after sowing. Perusal of the data presented in Table-2 reveals that depth of sowing had significant influence on days taken to germination, while different strengths of GA3 have no significant effect on earliness of germination. The earliness in germination is influenced by depth of sowing, deeply sown (10 cm) seeds germinated significantly earlier taking an average of 31.71 days as compared with those sown shallow (5 cm) and placed exposed (0 cm) that took 32.62 and 40.79 days respectively. It was observed that seeds sown exposed on the growth media took significantly more number of days to germinate. The different strengths (50, 100 and 200 ppm) of growth regulator GA_3 had no significant influence on earliness of germination. Seeds soaked in plain water and sown deeply (10 cm) germinated earliest (24.83 days) and long time to germinate was recorded in those seeds soaked in plain water and placed exposed (45.67 days). On the other hand, careful perusal of the data of Table-3 that represents the influence of sowing depth and GA3 concentrations on seed germination percentage reveals that sowing depth had no significant effect. Deeply sown (10 cm) seeds recorded highest germination percentage (57.57%) which was, however, statistically at par with shallow (5 cm) sown (50.00%) and exposed seeds (47.35%). However, GA3 strength exhibited significant influence on germination percentage. As individual effect, significantly highest germination (66.16%) was recorded in seeds pre-treated with GA3 50 ppm and lowest in control (38.89 %). It was also observed that germination percentage was better in 50 ppm (43.43%) and 200 ppm (58.08%) strength of GA3. However, as an individual effect, 100 ppm GA3 showed unnatural trend of influence exhibiting lowest among the three GA3 strengths, which needs further investigation. As interaction influence, seeds treated with GA3 200 ppm and sown deepest (10cm) showed highest germination (77.28%) which was statistically at par with seeds treated with GA3 50 ppm and sown at 10 cm (60.60%), 5 cm (68.18%) and exposed (69.69%). The trend of days taken for germination and depth of seed sowing was in the line of result obtained by Ali *et al.* (2016). Exposure of seeds render loss of inherent moisture and cotyledons are subjected to stress thereby taking longer time to wake up. Germination of such seeds are influenced by the change in weather- hot, cold, wind, *etc.* However, seeds covered with media ensure that cotyledons are protected from desiccation and the enzymatic activities would be more stable as compared to those openly exposed. When seeds were regularly irrigated, seeds sown deeper remain drenched for longer duration as compared to those sown shallow or kept exposed on media. Softening of seed coats would have been more pronounced in seeds sown deeper thereby, cotyledons tend to emerge. earlier. The radicles after emergence grow faster in deeply sown seeds which were corresponded by emergence of plumules.

Table 2. Days taken to seed germination as influenced by sowing depth and GA_3

	Sowing Depth (Factor-A)			
GA_3 Strength (Factor-B)	**Deeply Sown (10 cm)**	**Shallow Sown (5 cm)**	**Exposed Sown (0 cm)**	**Average**
Control (Water)	**24.83**	34.33	**45.67**	34.94
GA_3 50 ppm	33.83	32.50	36.17	34.17
GA_3 100 ppm	33.17	32.67	36.17	34.00
GA_3 200 ppm	35.00	31.00	45.17	37.06
Average	31.71	32.62	40.79	
Critical Difference Values at		CD 5%	CD 1%	
Factor A		4.28	5.70	
Factor B		4.94	6.57	
Treatment (AXB)		8.54	11.39	

Table-3: Interaction of sowing depth and GA_3 treatments on seed germination percentage:

	Sowing Depth (Factor-A)			
GA_3 Strength (Factor-B)	**Deeply Sown (10 cm)**	**Shallow Sown (5 cm)**	**Exposed Sown (0 cm)**	**Average**
Control (Water)	37.88	45.46	33.33	38.89
$GA_3$50 ppm	60.60	68.18	69.69	**66.16**
GA_3 100 ppm	54.55	39.39	36.37	43.43
GA_3 200 ppm	**77.28**	46.97	50.00	58.08
Average	57.57	50.00	47.35	
Critical Difference Values at		CD 5%	CD 1%	
Factor A		10.51	14.00	
Factor B		12.14	16.16	
Treatment (AXB)		21.03	27.99	

Even though GA3@ 100 ppm treatment results in earliest (34.00 days) to germinate, individually it was statistically at par with all the other treatments. Interaction between sowing depth and GA3 had significant influence time taken to germinate (as early as 38.89 days and longest as 66.16 days). Seeds soaked in water (control) and sown deepest (10cm) germinated earliest taking only 24.83 days which was statistically significant over seeds soaked in water (control) and sown exposed (45.67 days). Karssen, *et al.* 1989 reported that enhancement in germination of non-dormant seeds by GA3 application is due to dual mechanisms of reserve food mobilization and stimulated embryo (radical & plumule) growth. Further, Patel *et al.* (2017) also reported that seed germination in mango was maximum when treated with GA3 100pm in an experiment conducted at Navsari Agricultural University, Navsari Gujarat. However, the lowest strength of GA3 applied during the experiment was 100 ppm and therefore, the finding in the present study is thought to be not in contradiction wherein GA3 50 ppm is giving the highest germination percentage. However, Shaban, 2010, at Giza, Egypt revealed that highest germination percentage was found when seeds (with or without seed coat) treated with GA3 200 ppm. Therefore, from this experiment it can be concluded that mango seed sown at 10 cm depth and treated with GA3 200 ppm can be recommended for large scale multiplication of seedling rootstock production of mango in future.

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5. Disclaimer

The authors do hereby declare that they have no conflict of interest within themselves.

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