International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 739-744

Received: 16-09-2019
Accepted: 18-10-2019

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Seed germination of drumstick Cv. PKM-1 as effected by different concentrations of Gibberellic acid and soaking time

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Abstract
The present experiment was carried out at Dryland Horticulture Farm, Sirsod, Department of Horticulture, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.). The experiment was laid out in Complete Randomized Design (CRD) with eight treatments and three replications. All the treatments were randomized within whole experiment at once**.** Observations of the characters under study of drumstick plants were recorded. The five randomly selected plants from each treatment for observations were undertaken. The data was recorded as per the standard procedure and analyzed statistically as per design. Days taken to first seedling emergence were counted. It was recorded daily when the first foliage leaf appeared. Germination was visually monitored through the counting of germinated seedlings after every seven days and then was finalized at 25 days. The minimum days taken to germination (4.28) was taken under seed soaked in the solution of 10ppm GA_3 for 24 hours (T_4) followed by seed soaked in 10ppm GA_3 solution for 48 hours (T_8) (4.72), seed soaked in 7.5ppm GA_3 for 24 hours (T_3) (4.88), seed soaked in 7.5ppm GA_3 for 48 hours (T_7) (5.08) while maximum days for emergence (5.91) was taken by seed soaked in normal water for 48 hours (T_5) followed by seed soaked in normal water for 24 hours (T_1) (5.85), which was at par with each other. There was no significant difference recorded between seed soaked in 5ppm GA_3 concentration for 24 and 48 hours. Results also indicated that the seed soaked in different concentrations of GA_3 for 24 hours was found superior over seed soaked in the same concentrations of GA_3 for 48 hours. The days taken to 50% germination were significantly influenced with different treatments. Minimum days (5.88) taken to 50% germination were counted with seed soaked in 10ppm GA_3 for 24 hours (T_4) followed by seed soaked in 10ppm GA_3 for 48 hours (T_8) (5.92), seed soaked in 7.5ppm GA_3 for 24 (T_3) and 48 hours (T_7) (6.27 and 6.38), respectively. However, there was no significant difference between seed soaked in 10ppm GA_3 for 24 and 48 hours. Maximum days taken to 50% germination were counted with seed soaked in normal water for 48 (T_5) and 24 hours (T_1) (8.33 and 8.17), respectively which was at par with each other. the different seed soaking treatments were significantly affected to germination percentage of drumstick. The seed soaked in 10ppm GA_3 solution for 24 hours (T_4) was exhibited maximum germination percentage (70.83%) followed by seed soaked in 10ppm GA_3 for 48 hours (T_8) (67.12%) and seed soaked in 7.5ppm GA_3 solution for 24 hours (T_3) (66.82%) which was at par with each other. Whereas, minimum germination percentage (52.32%) was noted with seed soaked in normal water for 48 hours (T_5) followed by seed soaked in normal water for 24 hours (T_1) (55.77%).

Keywords: Gibberellic acid, soaking time, drumstick, seed germination, PKM-1

Introduction
Drumstick (*Moringa oleifera* Lamk.) is an important perennial tree vegetable belonging to the family Moringaceae having chromosome no. 2n = 28. It has tremendous economic and dietetic importance. It is a fast-growing deciduous**,** nitrogen fixing and drought - resistant tree, native to North-Western India, and widely cultivated in Middle East and some other tropical countries, where its seeds, pods and leaves are used as vegetables. Popularly known as 'Ganigana', 'Mullakkai', 'Murrugi', 'Sahjan' and 'Muringa'. It is grown for its green pods, an essential component of sambhar, a South Indian curry. Tender pods are sliced and used in culinary preparations and pickles. Flowers and tender leaves are eaten as potherb. Fried seeds taste like peanuts. Twigs and leaves provide valuable fodder for cattle. In India, it is commercially grown in Tamil Nadu. India is the largest producer of drumsticks. It is highly valued for the distinct and appealing flavour of its tender fruits. The production of drumsticks

is basically accelerated in the southern region of India and not familiar in the central zone. Its production is higher than many other secondary vegetables.

It is called *"Miracle tree"* because it contains all kinds of nutrient and amino acids needed for human body. The high proportion of minerals and vitamins suggest its value for both human beings and animals. Its fresh leaves contain 19.3 - 26.4 per cent crude protein which are essential for livestock (Aregheore, 2002) [2]. Leaves are also rich in vitamin-C(seven times more than orange), calcium and protein (four times and two times more respectively than milk), Potassium (three times more than banana), iron (three times more than Indian spinach) and vitamin A (four times more than carrot) (Anonymous. 2010; Hossain *et al.* 2012) [1, 22]. Being rich in all the nutrients, this crop can effectively combat with malnutrition exists in children. Madhya Pradesh is recording highest infant mortality rate (54 per 1000 birth) in the country. Hence, Madhya Pradesh government has geared up its machinery to ensure availability of drumsticks to malnutrished children in the state.

Drumstick wood is soft, white, spongy and perishable; used for making shuttles and picking-sticks for the textile industry. Wood pulp is also considered useful for newsprint. The white gum exuded by the tree turns red-brown on oxidation. It swells in water and produces a viscous solution, locally used in Calico printing. The seeds contain a colourless, oil known commercially as 'Ben oil', used by watch-makers and much valued by perfume manufactures owing to its power of absorbing and retaining delicate scents. Oil is used locally for edible purposes, illumination and in cosmetics.

It has also a medicinal value, leaves of drumstick rich in vitamins A and C hence are useful in scurvy, beri-beri and catarrhal, they are also empirically used as anti-anemia for pregnant woman. A leaf paste is applied externally on wounds. Flowers are used as a tonic and diuretic; seeds as an antipyretic. The seed oil is applied in gout and rheumatism. The roots contain an antibiotic and yield an oil which is pungent, antispasmodic, stimulant and expectorant. Its pods have long been popular for treatment of diabetes and also used as pain killer for joints in human beings.

Drumstick cultivated on a variety of soils, preferring alluvial sandy soil and avoiding stiff clay and water-logged soils. The tree is fast-growing and the wood is not durable. It can be grown on farm boundaries and near water channels. It does not affect the agricultural crop production due to its deciduous nature and light foliage. It is a useful plant in kitchen garden for its pods.

Drumstick is propagated through seeds and stem cutting. Initially slow and late emergence rate of this plant due to seed coat hardening, lead smaller and weak seedlings that affect the uniformity of the crop and ultimately affect the yield, quality and net return. Hence, for obtaining better seedlings along with strong establishment, priming techniques may helps in reducing the time between seed sowing, seedling emergence and synchronized emergence (Parera and Cantliffe, 1994) [34].

Priming is a technique in which seeds are soaked in different solutions with high osmotic potential. This prevents the seeds from absorbing enough water for radicle protrusion, thus suspending the seeds in the lag phase (Taylor *et al*., 1998) [48]. Hydro priming involves soaking seeds in plain water before drying for storage or before sowing. The seed needs to be wet to soften the seed coat and a presoak provides this necessary moisture. A seed in the soil may not be fully contact with the soil or water and those areas not in contact will pull moisture from the areas of the seed in contact with soil or moisture and this interferes with the imbibitions process of the seed. When the seed coat is softened, the seedling has less energy to use on emerging out of the seed coat can thus concentrate on growing (Nelson, 2003) [30].

Hydration method of priming is sufficient to allow pre-germination metabolic activation to take place, but insufficient to allow radical protrusion through the seed coat. Hormonal priming technique may allow radical protrusion through the seed coat with increase in the seed vigor, germination and growth rate and seedling uniformity.

Presently, synthetic plant growth regulators have received wide spread acceptance and application in the field of horticulture. Among the various uses of growth regulators, seed germination and initiation of rooting in the cutting is most useful to the growers. The treated cutting rapidly produces a uniform and extensive root system, which when transplanted survives better than untreated cuttings. Among the different plant growth regulators, auxin is most effective as a rooting aid. Auxins stimulate adventitious root formation in stem cutting.

Gibberellic Acid (GA3) is the most important growth regulator, which breaks seed dormancy, promotes germination, hypocotyls growth and cell division in cambial zone and increases the size of leaves. GA3 stimulates hydrolytic enzymes that are needed for the degradation of the cells surrounding the radicle and thus speeds germination by promoting seedling elongation growth of cereal seeds (Rood *et al*. 1990) [42].

Appropriate socking time and concentration of growth regulator (GA3) is important to help in boosting up seed germination of drumstick.

Material and Methods

The present experiment was carried out at Dryland Horticulture Farm, Sirsod, Department of Horticulture, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.).

Climate and weather conditions

The Sirsod Research Farm, Department of Horticulture, College of Agriculture, Gwalior is located at 26˚ 13' N latitude and 78˚ 14' E longitude at a height of 211.5m above the mean sea level in the Gird Agro-climatic region of Madhya Pradesh. The climate of Gwalior is sub-tropical with hot and dry summers where maximum temperature exceeds 45˚ C in May and June. The winters are cool and minimum temperature reaches as low as 2˚ C in December and January. The occurrence of frost is expected from the last week of December to the first week of February. Usually the monsoon arrives in the second fortnight of June and lasts till September. Occasionally light rains are expected during winter.

Location and site

The experimental field is located between 26°14' N and 78°50' E latitude and longitude, respectively and at an elevation of 207 m above the sea levels belonging to the northern part of the Madhya Pradesh.

Climate

The locality of the experimental area was a typical sub-tropical monsoon climate with extremes of temperature both in summer and winter. Severe frost is of rare occurrence but cold waves are experienced from the middle of December to

end of February. The average annual rainfall is between 760 to 1060 mm, most of which occurs in the months of July, August and September with scanty rains during winter months of November to January. The meteorological information's regarding temperature, rainfall, relative humidity and evaporation were collected from the Agriculture Meteorology, College of Agriculture, Gwalior during the period of experiment.

Design and layout of the experiment
The experiment was laid out in Complete Randomized Design (CRD) with eight treatments and three replications. All the treatments were randomized within whole experiment at once

Details of treatments
Treatment factors
1. **Soaking time of seeds in gibberellic acid concentrations**
   a. 24 hours
   b. 48 hours
2. **Concentrations of gibberellic acid**
   a. Seed soaking in water
   b. 5ppm
   c. 7.5ppm
   d. 10ppm

Treatment	Symbol
1. Seeds soaking in water for 24 hours	T_1
2. GA3 5ppm for 24 hours	T_2
3. GA3 7.5ppm for 24 hours	T_3
4. GA3 10ppm for 24 hours	T_4
5. Seeds soaking in water for 48 hours	T_5
6. GA3 5ppm for 48 hours	T_6
7. GA3 7.5ppm for 48 hours	T_7
8. GA3 10ppm for 48 hours	T_8

Seed Source
Freshly harvested drumsticks seeds PKM-1 were obtained from the College of Agriculture, Gwalior (M.P.).

Preparation of nursery
In order to raise seedlings in the nursery, a mixture of soil, sand and vermicompost in a ratio of 2:1:1 was prepared and treated by drenching with the solution of captan @ 0.2% uniformly then leaved it for 24 hours. Total 720 polythene bags (18x12 cm size) were filled with this soil mixture.

Preparation of GA3 Solutions for Seeds treatment
Required quantity 5 mg, 7.5 mg and 10 mg of the gibberellic acid were weighted with the help of an electronic balance. After weighing, different quantities of gibberellic acid were transferred separately into different glass beakers with the help of soft brush. For dissolving the gibberellic acid, a few drops of 95% ethyl alcohol were added just to dissolve the gibberellic acid. 1000 ml of distilled water was added in each concentration of gibberellic acid containing labeled beakers to make the solution of 5ppm, 7.5ppm and 10ppm.

Seed soaking
The seeds were removed from pod and kept in 1000 ml of glass beaker (90 seeds in each treatment) for soaking for 24 hours and 48 hours. Freshly prepared solution of gibberellic acid in different concentration was added in each glass beaker as per treatment, separately.

Experiment Management
Sowing of seeds
After completion of the soaking period, seeds were removed from beakers and used for sowing. One seed in each polythene bag was sown at two to three-centimeter depth. Light irrigation was given after sowing.

Pinching
Pinching was done at thirty days interval in each plant to strengthen uniform growth of drumstick plants and also removing over topped leaves to make maximum use of space.

Irrigation
Light irrigation was given just after sowing of seeds in each treatment and subsequent irrigations was given uniformly, as and when required depending upon climatic conditions.

Weeding
Two hand weeding were done at 15 and 30 days after seed sowing.

Plant Protection Measures
A specific pest called leaf eating caterpillar *Noorda blitealis* earlier considered as a minor pest usually infests the crops. The leaves appear papery and get dried. Severe infestation occurs on new flush of the crop during June-August which later recedes. Plant Protection measures were performed uniformly in the experiment at different stages.

Observations
Observations of the characters under study of drumstick plants were recorded. The five randomly selected plants from each treatment for observations were undertaken. The data was recorded as per the standard procedure and analyzed statistically as per design.

Germination parameters
Days taken to start germination
Days taken to first seedling emergence were counted. It was recorded daily when the first foliage leaf appeared. The data was recorded as per standard procedure and analyzed statistically as per design.

Days taken to 50% germination
Days taken to fifty percent seedling emergence were counted. It was recorded daily when the first foliage leaf appeared. The data was recorded as per standard procedure and analyzed statistically as per design.

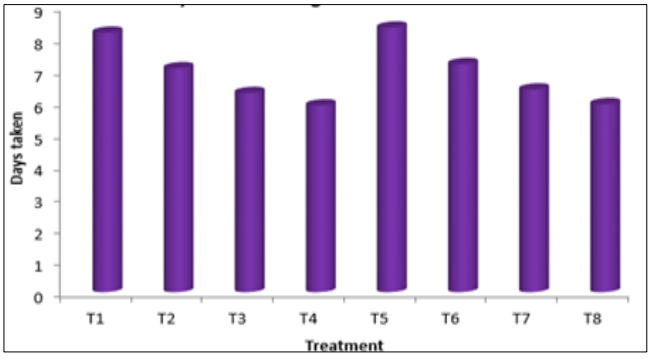

Fig 1: Effect of soaking time and concentrations of Gibberellic acid on days taken to 50% germination of drumstick seeds

Germination percent (%)

Germination was visually monitored through the counting of germinated seedlings after every seven days and then was finalized at 25 days. A drumstick seed is considered to be germinated when the stalk appears above the ground. Data collected were subjected to analysis of variance and graphical representations. Germination percentage was recorded by the formula as given below-

$$\text{Germination (\%)} = \frac{Total\ number\ of\ seeds\ geminated}{Total\ number\ of\ seed\ sown} \text{ X } 100$$

Result and discussion

Days taken to start germination

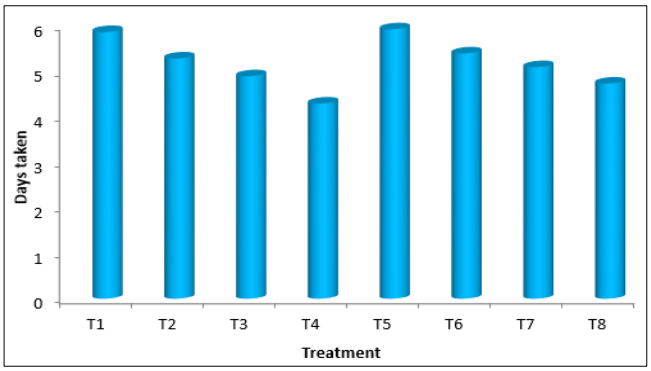

Fig 2: Effect of soaking time and concentrations of Gibberellic acid on days taken to start germinations of drumstick seeds

The days taken to start germination of drumstick seed were significantly affected by different concentrations of gibberellic acid and soaking time. The minimum days taken to germination (4.28) was taken under seed soaked in the solution of 10ppm GA_3 for 24 hours (T_4) followed by seed soaked in 10ppm GA_3 solution for 48 hours (T_8) (4.72), seed soaked in 7.5ppm GA_3 for 24 hours (T_3) (4.88), seed soaked in 7.5ppm GA_3 for 48 hours (T_7) (5.08) while maximum days for emergence (5.91) was taken by seed soaked in normal water for 48 hours (T_5) followed by seed soaked in normal water for 24 hours (T_1) (5.85), which was at par with each other. There was no significant difference recorded between seed soaked in 5ppm GA_3 concentration for 24 and 48 hours. Results indicated that the seed soaked in different concentrations of GA_3 for 24 hours was found superior over seed soaked in the same concentrations of GA_3 for 48 hours.

Days taken to 50% germination

The days taken to 50% germination were significantly influenced with different treatments. Minimum days (5.88) taken to 50% germination were counted with seed soaked in 10ppm GA_3 for 24 hours (T_4) followed by seed soaked in 10ppm GA_3 for 48 hours (T_8) (5.92), seed soaked in 7.5ppm GA_3 for 24 (T_3) and 48 hours (T_7) (6.27 and 6.38), respectively. However, there was no significant difference between seed soaked in 10ppm GA_3 for 24 and 48 hours. Maximum days taken to 50% germination were counted with seed soaked in normal water for 48 (T_5) and 24 hours (T_1) (8.33 and 8.17), respectively which was at par with each other.

Days taken to 50% seed germination were significantly decreased with increasing concentration of GA_3 up to 10ppm under both the soaking times. However, soaking times (24 and 48 hours) was found at par with each other at same concentration of GA_3. Results also indicated that seed soaked for 24 hours was found superior over seed soaked for 48 hours.

Germination percentage

Result indicated that the different seed soaking treatments were significantly affected to germination percentage of drumstick. The seed soaked in 10ppm GA_3 solution for 24 hours (T_4) exhibited maximum germination percentage (70.83%) followed by seed soaked in 10ppm GA_3 for 48 hours (T_8) (67.12%) and seed soaked in 7.5ppm GA_3 solution for 24 hours (T_3) (66.82%) which was at par with each other. Whereas, minimum germination percentage (52.32%) was noted with seed soaked in normal water for 48 hours (T_5) followed by seed soaked in normal water for 24 hours (T_1) (55.77%).

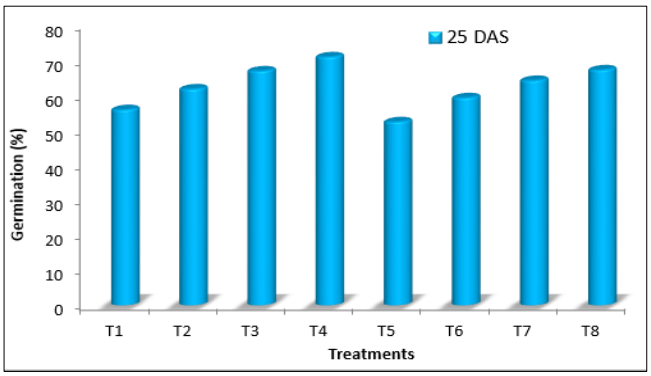

Fig 3: Effect of soaking time and concentrations of Gibberellic acid on germination percentage of drumstick seeds

Germination percentage was significantly increased with increasing concentration of GA_3 under both the seed soaking times. However, seed soaked for 24 hours was found superior over seed soaked for 48 hours at same concentrations of gibberellic acid as well as normal water also.

Table 1: Seed germination parameters as affected by different concentrations of GA_3 and soaking times

Treatment	Days taken to start germination	Days taken to 50% germination	Germination percentage
T_1	5.85	8.17	55.77
T_2	5.27	7.05	61.67
T_3	4.88	6.27	66.82
T_4	4.28	5.88	70.83
T_5	5.91	8.33	52.32
T_6	5.38	7.18	59.17
T_7	5.08	6.38	64.1
T_8	4.72	5.92	67.12
S.E.(m) ±	0.05	0.06	0.79
C.D. (at 5%)	0.15	0.17	2.39

Conclusion

From the present investigation, it could be concluded that among all the treatments, pre sowing seed treatment of drumstick seeds with soaking in 10ppm GA_3 concentration for 24 hours was found to be the most suitable for inducing early germination in moringa Var PKM-1 seeds.

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