



Research Paper

Germination and storability study in moringa (*Moringa oleifera* Lam.) seeds

Accepted 24th August, 2021

ABSTRACT

The study was conducted to find out the optimum temperature and suitable method for germination test and to assess the effect of containers on storability of Moringa seeds during 2019 and 2020. The results revealed that maximum germination (76.1%) was recorded in sand method followed by between paper method (73.3%) while it was minimum (39.3%) in top of paper method. Seedling length was found maximum (140.8 mm) in between paper method which was at par with sand method (139.2 mm). Other seed quality parameters *viz.*, seedling dry weight (0.20), Vigour index-I (11517) and vigour index-II (16.2) were also found maximum in sand method which was at par with between paper method. Among the temperatures, 30°C temperature registered maximum germination (79.1%) and minimum (55.3%) was recorded at 35°C temperature for all seed quality parameters. During storage, polythene bag showed superiority over cloth bags and maintained more germination (88.5%) after 18 months of storage. It is concluded from the study that 30°C is optimum temperature and both between paper and sand method are suitable for germination test in Moringa seeds. Polythene bags (>700 gauge) is a suitable storage container which can maintain germination up to 88% after 18 months of storage.

Axay Bhuker*¹, V. S. Mor¹, Puneeth Raj M.S.¹, Craig Robert McGill² and Sofkova-Bobcheva, Svetla Kancheva²

¹Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar- 125004, Haryana, India

²Institute of Agriculture and Environment, Massey University Palmerstone North 4410, New Zealand

*Corresponding author. E-mail:

bhuker.axay@gmail.com

Key words: *Moringa oleifera*, germination, storability, temperature, containers.

INTRODUCTION

Moringa (*Moringa oleifera*) commonly known as drumstick, horse radish, benzolive, kelor, marango, mlonge, moonga, mulangay, nebeday, saijhan, sajna, or ben oil tree, is a fast-growing, deciduous tree which belongs to Moringaceae family. It is native to western and sub Himalayan tracts, India, Pakistan, Sri Lanka, Asia Minor, Africa and Arabia and well established after introduction to Philippines, Cambodia, Syria, Central America, North and South America and Caribbean Islands. This wide distribution is due to adoptability for humid tropics or hot dry lands, tolerant to drought and less fertile soils. India is the largest producer of the Moringa contributing (41%) of the global production followed western Africa (33%), Malaysia and Philippines (12%), China (8%) and Venezuela (6%) (Sekhar et al., 2018). The optimum temperature for better growth is 25 to 35°C. It is highly susceptible to frost and high temperature exceeding 40°C cause flower shedding. Moringa is mainly propagated through seed and can reach up to a height of 12

m and the trunk can reach a diameter of 45 cm (1.5 ft). Medicinal plants have been used in healthcare since time immemorial and this is good resource for new drugs. All parts of Moringa tree (leaves, seeds, roots and flowers) are suitable for human and animal consumption and also used to cure different diseases. Fuglie, (1999) described many uses of Moringa tree *viz.*, medicinal uses, as a part of diet to fight against malnutrition in least developed countries, gum production, biomass production, as feed supplement for animals, in elimination of heavy metals from water that is, water purification, to increase soil fertility as green manure, environment protection by reducing emission of green house gases.

The awareness regarding the use of this plant based products is continuously increasing all the time. Recently, some attention has been paid to its adoption as agricultural crops. Moreover, some varieties of this crop have been released and tested for their adaptability in different parts

of the country. In this multipurpose crop, no seed standards have been developed so far. Therefore, it is necessary to develop seed standards for this crop for certification. The developed seed standards will be utilized by certification agencies to ensure seed quality and seed testing procedure will be used in seed testing laboratories. The main factors which influence germination are temperature, water, media, light etc., out of which temperature is most significant (Hartman et al., 2002). The low germination could create problems to seed producers, breeder, seed analyst and nurserymen. Seed quality plays a crucial role in agricultural production as well as in national economies and is important for achieving targets of agricultural production, but currently no validated test methods for assessing purity, germination or moisture are available. A germination test is the usual method for estimating seed viability. The germination test is required to determine the germination potential of a seed lot which can be used to compare the quality of different lots and also estimate the field planting value. Moringa domestication and commercialization of seed will be facilitated by the development of seed quality testing methods. Seair Exim Solutions (2016) reported that they exported 28,939 kg of Moringa seeds to different countries. The estimated worldwide demand of Moringa for 2011 to 2015 was USD 40 million which is expected to more than triple for next five years (2016-2020) to approximately USD 138 million.

The current world market for Moringa is estimated around USD 4 billion and is expected to grow to about USD 7 billion by 2020 (Culion Foundation Inc., 2017). There is a need to introduce *Moringa oleifera* into the ISTA Rules to allow International Certificates to be issued for seed export and to enable continuing growth of international trade in Moringa seeds. Thus there is urgent need to standardize the seed testing procedure for this important crop to assess the seed quality before the seeds are supplied to users/farmers. There is no defined standard protocol to test germination of Moringa seeds. Seed possesses maximum vigour at the time of physiological maturity and thereafter it starts decreasing. Loss in seed vigour and deterioration is a natural physiological process and cannot be stopped but the rate of deterioration can be reduced by selection of suitable containers. Storage container also plays an important role during storage. Hence, the present study was planned to find out optimum temperature and suitable method for germination test and to study the effect of containers on moringa seeds during storage.

MATERIALS AND METHODS

The freshly harvested seeds of moringa *Cv.PKM 1* were procured from Department of Vegetable Crops, Tamil Nadu Agricultural University, Coimbatore and study on seed quality parameters was conducted in the Department of Seed Science and Technology, CCS Haryana Agricultural

University, Hisar during 2019 and 2020. Observations on seed germination percentage, seedling length, seedlings dry weight and vigour indices were recorded. Germination test was conducted on four replications of 100 seeds by using three methods *viz.*, Top of Paper (TP), Between Paper (BP) and Sand (S) methods were used at three constant temperatures of 25, 30 and 35°C and one alternating temperature of 20-30° C (20°C for 16 h and 30°C for 8 h) with 90-95% relative humidity in seed germinator. The first count was taken on 5th day and final count on 7th day and only normal seedlings were considered for percent germination according to the rules of International Seed Testing Association (ISTA 2019). For estimation of seedling length, ten randomly selected normal seedlings were taken from each replication during germination test and average length of seedlings was recorded in millimeters for final calculation. After measuring the seedling length, these ten fresh seedlings were taken and dried in a hot air oven for 24 h at 80±1°C. The dried seedlings of each replication were weighed and average seedling dry weight was expressed in milligram. Seedling vigour indices were calculated according to following method suggested by Abdul-Baki and Anderson (1973):

Vigour Index-I = [Germination (%) x Average seedling length (mm)]

Vigour Index-II = [Germination (%) x Average seedling dry weight (g)]

The freshly harvested seed was stored with 5.6% moisture content in two storage containers that is, cloth bags and polythene bags (>700 gauge thickness) under ambient conditions. The observations on above mentioned seed quality parameters *viz.*, germination, seedling length, seedling dry weight and vigour indices were recorded in fresh seed, after 12 months and 18 months of storage by using optimum temperature (30°C) and suitable testing method (Between Paper) (Figure 1). Analysis of variance was done based on factorial completely randomized design as per standard method suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results revealed that maximum germination (76.1%) was recorded in Sand method while it was 73.3% in between paper method which clearly indicates that Between Paper and Sand methods are best for germination test because bold size seeds (1 cm diameter having 0.3g weight) can be fully covered thereby maintaining the required level of moisture necessary for germination and seedling growth in these methods. Minimum germination (39.3%) was recorded in Top of Paper method. The lowest germination in Top of Paper method might be due to insufficient moisture content required for germination. No

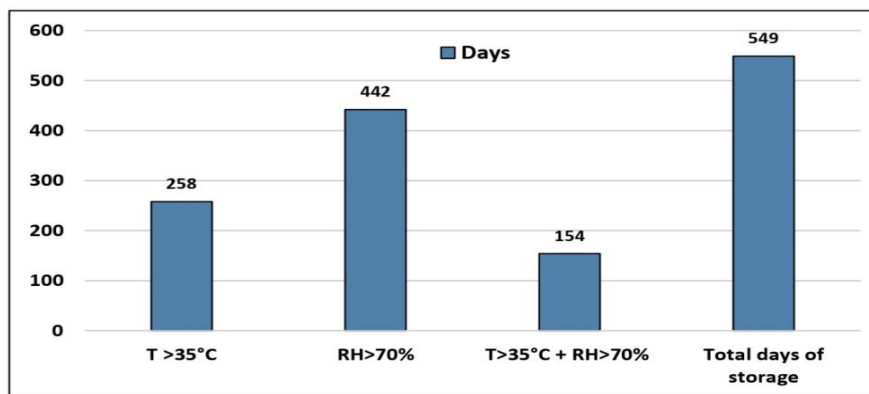


Figure 1: Temperature and Relative Humidity during seed storage period

Table 1: Effect of temperature and testing method on seed germination, seedling length, seedling dry weight (mg) and vigour indices in *Moringa olifera* Cv. PKM 1.

Temperatures in °C (T)	Germination (%)				Seedling Length (mm)				Seedling Dry Weight (mg)				Vigour Index- I				Vigour Index- II			
	TP	BP	S	Mean	TP	BP	S	Mean	TP	BP	S	Mean	TP	BP	S	Mean	TP	BP	S	Mean
25	42.0	71.3	77.3	63.6	106.7	110.0	106.7	107.8	0.14	0.16	0.17	0.15	4493	7853	8253	6867	5.7	11.0	13.1	9.9
	(40.4)	(57.6)	(61.6)	(53.2)																
30	48.0	93.3	96.0	79.1	190.0	220.0	270.0	226.7	0.32	0.29	0.31	0.31	9113	20527	25913	18518	15.4	26.9	30.0	24.1
	(43.8)	(75.0)	(78.7)	(65.9)																
35	36.0	67.3	62.7	55.3	18.3	140.0	73.3	77.2	0.04	0.17	0.19	0.13	660	9420	4600	4893	1.5	11.7	11.7	8.3
	(36.9)	(55.1)	(52.3)	(48.1)																
20-30	31.3	61.0	68.3	53.6	60.0	93.3	106.7	86.7	0.11	0.14	0.15	0.13	1870	5693	7300	4954	3.6	8.4	10.0	7.3
	(34.0)	(51.3)	(55.8)	(47.0)																
Mean	39.3	73.3	76.1		93.8	140.8	139.2		0.15	0.19	0.20		4034	10873	11517		6.52	14.5	16.2	
	(38.8)	(59.8)	(62.1)																	
C.D. at 5%	T=1.8, M=1.6, TxM=3.1				T=8.4, M=7.2, TxM=14.5				T=0.006, M=0.005, TxM=0.01				T=571, M=495, TxM=991				T=0.65, M=0.56, TxM=1.1			

Figures in parenthesis are angular transformed values, TP= Top of Paper, BP= Between Paper, S= Sand

hard seed were observed during germination test indicating absence of dormancy in *Moringa* seeds which was in confirmation with the results reported by Mubvuma et al., 2013. Marimuthu et al., (2001) also stated that *Moringa* seeds have no dormancy, due to this property planting can be done soon after maturity and remain viable for up to one year. Although significant effect of temperature was

observed on germination but no germination was recorded below 20°C temperature. Seedling length was found maximum (140.8 mm) in Between Paper method which was at par with Sand method (139.2 mm). Similarly maximum seedling dry weight (0.20 mg), Vigour index-I (11517) and vigour index-II (16.2) were found in Sand method which was at par with Between Paper method. Among the

temperatures, 30°C temperature registered maximum germination (79.1%) and minimum (55.3%) was recorded at 35°C temperature. The same trend was also seen for other seed quality parameters also and maximum seedling length (226.7mm), seedling dry weight (0.31g), Vigour index-I (18518) and Vigour index-II (24.1) were recorded at 30°C temperature (Table 1).



Figure 2: Moringa seeds with wings, without wings and without seed coat



Figure 3: Polyembryony in Moringa

Higher temperature prevented the germination in many species including medicinal plants (Kumar et al., 2011). Extremely high and low temperature may adversely affect the viability of embryos and availability of water. Hassanein and Al-Soqeer, 2017 also concluded in their study that high temperature increased the germination speed but reduced the germination percentage. High temperature may induce stress during germination. Wings are found on moringa seeds, to reduce the bulkiness and to make marketing easy, these wings are removed (Figure 2). During germination test, no effect of wings was observed on germination as germination percentage was observed at par in seeds with wings and without wings. It was also observed that seeds without seed coat can be germinated easily (figure 2). Some polyembryonic seeds were also observed during germination test (Figure 3). Kamaha and Maguire (1992) reported that lower germination was observed at alternative temperature of 25-30°C as compared to constant temperature in wheat crop, which could be attributed to the inability of the seeds to crop up the metabolic activities with a shift in the diurnal temperature. Although Muhl et al., 2011 conducted an experiment and concluded that 20/30°C temperature regime was found to

be most favourable for both germination and seedling growth in Moringa. It may be due to genetic makeup of the seed material used in the study. The results of the storage study revealed that moringa is good storer crop and maintained more than 75% germination even after 18 months of storage. However, there was reduction in vigour content as the storage period increased. Polythene bag showed superiority over cloth bags and maintained more germination (88.5%) after 18 months of storage (Table 2).

Less germination in cloth bag may be due to fluctuation of moisture content in the seed. Like seed germination, other seed quality parameters *viz.*, seedling length, seedling dry weight and vigour indices also reduced as storage period increased but reduction was more in vigour parameters as compared to seed germination. Bhuker et al. (2013) also found the same results in jatropha seed and reported that polythene (700 μ) bag is suitable container for safe storage of Jatropha seed which maintained 68% germination after 9 months. Pallavi et al. 2021 reported that aluminum foil pouch treated with captaf (2 g/kg) can maintain the germination up to 70% after 24 months of storage. Due to its impervious nature polythene (>700 gauge) bags maintained same moisture content of seeds throughout the

Table 2: Effect of storage containers on germination, seedling length and seedling dry weight and vigour indices in *Moringa olifera* Cv. PKM 1 during storage.

Storage containers (C)	Germination (%)			Seedling Length (mm)			Seedling dry weight (mg)			Vigour index-I			Vigour index-II		
	Storage period in months (P)														
	Initial (0)	12	18	Initial (0)	12	18	Initial (0)	12	18	Initial (0)	12	18	Initial (0)	12	18
Cloth bag	93.3 (75.0)	85.5 (70.9)	75.8 (67.6)	220.0	171.0	60.8	0.29	0.26	0.16	20527	14615	4605	26.9	22.3	12.0
Polythene bag	93.3 (75.0)	89.3 (70.2)	88.5 (60.5)	220.0	219.0	75.5	0.29	0.29	0.20	20527	19543	6683	26.9	25.7	17.3
Mean	93.3 (75.0)	87.4 (69.2)	82.1 (65.3)	220.0	195.0	68.0	0.29	0.28	0.18	20527	17079	5644	26.9	24.0	14.7
C.D. at 5%	P=1.73, C=1.73, Px C=2.44			P=4.7, C=4.7, Px C=6.7			P=0.02, C=0.02, Px C=NS			P=347, C=347, Px C=491			P=1.1, C=1.1, Px C=NS		

Figures in parenthesis are angular transformed values

storage period, might have resulted in slow rate of lipid peroxidation, thereby release of less free radicals, leads to maintenance of membrane integrity. Sivasubramanian (1996) also reported in his study that usually moringa seed are viable for one year but seeds treated with Bavistin treated at 2 g/kg stored in 700 gauge polyethylene bag can be stored longer than untreated seeds in cloth bag. It is concluded from the study that 30°C temperature is optimum and both Between Paper and Sand method are suitable for germination test in moringa seeds. Polythene bags (>700 gauge) is a suitable storage container for Moringa seeds which can maintain germination up to 88% after 18 months of storage.

ACKNOWLEDGEMENTS

We wish to acknowledge the Scheme for Promotion of Academic and Research Collaboration (SPARC), Ministry of Human Resource Development (MHRD), Govt. of India for providing funds and Department of Seed Science and Technology, CCS HAU, Hisar for providing facilities to conduct this study. We also wish to acknowledge the faculty of Massey University, Palmerstone North, New Zealand for

providing technical advice to conduct the study.

REFERENCES

- Abdul-Baki AA, Anderson JD (1973). Relationship between decarboxylation of glutamic acid and vigour in soybean seed. *Crop Sci.* 13(2): 222-226.
- Bhuker A, Kumari S, Punia RC, Kashyap RK (2013). Seed germination and storage studies in *Jatropha* (*Jatropha curcas* L.) Range Manag. *Agroforestry.* 34(2):196-200.
- Culion Foundation Inc. (2017). Market demand analysis of *Moringa olerifera* in the Philippines. Unpublished report 121 pp.
- Fuglie LJ (1999). *The Miracle Tree: Moringa oleifera: Natural Nutrition for the Tropics.* Church World Service, Dakar. 68 pp; revised in 2001 and published as *The Miracle Tree: The Multiple Attributes of Moringa*, 172 pp.
- Hartmann HT, Kester DE, Davies, FT, Geneve RL (2002). *Plant Propagation-principles and practices.* 7th Edition. Prentice Hall.
- Hassanein AMA, Al-Soqeer AA (2017). Evaluation of Seed Germination and Growth Characteristics of *Moringaoleifera* and *M. peregrina* under Laboratory, Greenhouse, and Field Conditions. *Int. J. Agric. Biol.* 19(4): 873-879.
- International Seed Testing Association (ISTA) (2019). *International Rules for Seed Testing for 2019, Full issue-i-19-8 (300).* International Seed Testing Association. Zürichstr. 50, CH-8303 Bassersdorf, Switzerland. Chapter 5: 5-53.
- Kamaha C, Maguire JD (1992). Effect of temperature on germination of six winter wheat cultivars. *Seed Sci. Technol.* 20(1):181-185.
- Kumar GP, Kumar R, Chaurasia OP (2011). Conservation status of medicinal plants in Ladakh: Cold arid zone of Trans-Himalayas. *Res. J. Med. Plant.* 5(6): 685-694.
- Marimuthu R, Athmanathan U, Mohan S (2001). Changing scenario in the production systems of horticultural crops. *South Indian Hortic.* 49: 34-36.
- Mubvuma MT, Mapanda S, Mashonjowa E (2013). Effect of storage temperature and duration on germination of moringa seeds (*Moringa oleifera*). *Greener J. Agric. Sci.* 3(5): 427-432.
- Muhl QE, du Toit ES, Robbertse PJ (2011). Temperature effect on seed germination and seedling growth of *Moringa oleifera* Lam. *Seed Sci. Technol.* 39(1): 208-213.
- Pallavi HM, Aravinda Kumar JS, Patil B (2021). Effectiveness of provenance, container and seed treatment on seed viability and longevity for long term conservation in drumstick (*Moringa oleifera* Lam. (syn. *M. pterygosperma* Gaertn.). *J. Pharmacogn. Phytochem.* 10(2): 772-777.
- Panse VG, Sukhatme PV (1985). *Statistical methods for agricultural workers*, 4th Ed., ICAR, New Delhi.
- Sekhar, C., Venkatesan N., Muruganathi D. and Vidhyavathi, A. (2018). Status of value addition and export of moringa produce in Tamil Nadu—a case study. *Int. J. Hortic.* 8(3):16-28
- Sivasubramanian K (1996). Studies on certain aspects of seed quality in Moringa (*Moringa pterygosperma* Gaertn.) Pkm-1. Ph.D. (Ag) Thesis. Tamil Nadu Agricultural University, Coimbatore. 323 pp.