

## Original Research Article

# Standardization of Optimum Stage for Grafting in Moringa

[(~~Moringa~~oleifera Lam. (family)]

Comment [N1]:

Formatted: Font: Not Italic

### ABSTRACT

**Aims:** This research was carried out to standardize the suitable size and optimum stage for grafting of ~~annual~~ moringa ~~scion cv.~~ PKM 1 on perennial moringa rootstock based on the physical parameters of both rootstock and scion.

**Study design:** The study was carried out in Completely Randomized Design (CRD) with 5 treatments and 4 replications.

**Place and Duration of Study:** This study ~~has been done on~~ ~~was carried out~~ TNAU Orchard of Department of Vegetable Science, Horticultural College & Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2021-2022.

**Methodology:** Here the perennial rootstock used was Moolanur-1 and the ~~annual~~ scion was PKM-1. The physical parameters were recorded after 14 and 21 days after grafting. The biochemical parameters were estimated with respective procedures and instruments.

**Results:** ~~Based on the study, it result can be concluded~~ that the performance of the grafts of annual moringa cv PKM 1 scion on Moolanur 1 perennial moringa rootstock with 0.51 cm diameter attained at 40 days after germination was superior with regard to yield and quality parameters when compared with the rootstock and scion individually.

**Conclusion:** Perennial moringa ecotype Moolanur moringa (MO 1) at 40 days after germination with a thickness of 0.51 cm is the best rootstock stage for successful grafting with annual moringa scion var. PKM 1. The study will be continued to assess the field performance of the grafted plants.

**Keywords:** Moringa; grafting; PKM1; Perennial rootstock; ~~high yielding~~; rootstocks; scion.

Comment [N2]: Could you mention the study month?

### 1. INTRODUCTION

Drumstick (~~Moringa~~oleifera Lam. ~~(-) belongs to the monogeneric family~~ Moringaceae). It is a medium sized tree commonly known as drumstick ~~tree~~ and horseradish tree. There are 33 species in the Moringaceae family [1]. Moringa is a fast-growing tree with a capacity to be drought tolerant and also be compatible to varied ecosystems. The ~~world's~~ largest producer of moringa is India with an annual production of 1.1 to 1.3 million tonnes of tender fruits in an area of 38,000 ha. Tamilnadu is a pioneer state in moringa cultivation as it has varied genotypes owing to its diversified geographical area. Tamilnadu (7,408 ha) stands third in moringa production with Andhra Pradesh (15,665 ha) and Karnataka (10,280 ha) in the first and second place respectively with respect to area and production. *Moringaoleifera* an important food commodity which has had enormous attention as the 'natural nutrition of the tropics'. ~~Moringa leaves have been observed to be a rich source of protein, vitamin c, calcium, potassium, etc. and act as a good source of natural antioxidants; and thus enhance the shelf-life of foods due to the presence of various types of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids [2,3].~~

Formatted: Font: Not Italic

The crude extract of Moringa leaves has a significant cholesterol lowering action in the serum of high fat diet fed rats which might be attributed to the bioactive phytoconstituent i.e.  $\beta$ -sitosterol [4]. It is used as potential antioxidant, anticancer, anti-inflammatory, anti-diabetic and antimicrobial agent. *M.*

Comment [N3]: Too long

*oleifera* seed, a natural coagulant is extensively used in water treatment. The scientific effort of the research provides insights on the use of moringa and fortification of moringa in commercial products [5]. This research aims to standardize the suitable size and optimum stage for grafting of annual moringa scion cv. PKM 1 on perennial Moolanurmoringa rootstock (MO1) based on the physical parameters of both rootstock and scion.

Comment [N4]: Where is the problematic?

Comment [N5]: Could you tell us about grafting methods

## 2. MATERIAL AND METHODS

### 2.1 Location and Crop Variety

The present investigation was carried out in the experimental farm of Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, at Coimbatore during 2021-22 which is situated at 11° N latitude, 77° E longitude and an altitude of 426.26 m above mean sea level. The experimental materials consisted of one cultivable perennial ecotype viz., Moolanur – 1 (MO1) as rootstock and annual moringa cv. PKM 1 was used as scion. Six different stages of rootstock viz. 10 days, 20 days, 30 days, 40 days, 50 days and 60 days after germination were used with PKM 1 scion was used for the study to assess the best graft stage for grafting of perennial rootstock for annual moringa cv. PKM 1. The experiment was conducted in Completely Randomized Design with four replications. In each treatment, 50 plants were maintained per replication.

Comment [N6]: Could you give some specifications of scion

Comment [N7]: move this part to 2.3

Table 1. Treatment details

| Treatment      | Treatment Details   |
|----------------|---------------------|
| T <sub>1</sub> | 10 DAG of rootstock |
| T <sub>2</sub> | 20 DAG of rootstock |
| T <sub>3</sub> | 30 DAG of rootstock |
| T <sub>4</sub> | 40 DAG of rootstock |
| T <sub>5</sub> | 50 DAG of rootstock |
| T <sub>6</sub> | 60 DAG of rootstock |

\*DAG – Days after germination

### 2.2 Raising of rootstock and scion

The seeds of perennial moringa ecotype viz., moolanurmoringa were collected from native places of Tamil Nadu. Annual moringa cv. PKM 1 scion was collected from true to type plants in established fields from Department of Vegetable Science, HC & RI, TNAU, Coimbatore.

The seeds of MO1 were soaked in water for 6 hours to enhance the germination percentage. The seeds were then sown in polybags filled with media containing soil, sand and coir pith in the ratio of 2:1:1 and biofertilizers such as azospirillum and phosphobacteria. The seedlings of rootstocks were watered as and when required.

### 2.3 Grafting

The grafting was performed in 10 days, 20 days, 30 days, 40 days, 50 days and 60 days old seedlings using cleft or wedge method of grafting. Healthy rootstock seedlings were chosen and scion of equal thickness was taken for grafting. Rootstocks were beheaded at the top and a slit of 2.5 cm was made at the centre for inserting the scion. The scion was taken and a wedge shape cut of 2.5 cm was made at the bottom portion and inserted into the slit made in the rootstock. The graft union was secured tightly in position with grafting clips. The grafts were covered with polythene cover and kept in mist chamber at 95 per cent relative humidity and 25°-30° C to prevent the scion from drying out and keep it fresh till the union was formed. The polythene covers were removed seven days after grafting. The grafts were then transferred to a greenhouse for hardening and acclimatization. The grafting clips were also removed after the graft union is established [6,7].

Comment [N8]: could you give the size of scion?

### 2.4 Statistical analysis

The observations on percentage of germination, number of days taken to attain graftable thickness, number of days for graft union, percentage of grafting success and thickness of the rootstock at the time of grafting were recorded and found significant when analysed using SPSS software [8].

Formatted: Font: 10 pt

Comment [N9]: an you describe the parameters evaluated? What statistical tests did you perform?

Formatted: Font: 10 pt

### 3. RESULTS

#### Germination percentage

An overall germination percentage of 82.40 percent was recorded for MO1 which was used as rootstock.

#### Times Days taken for graft union

The number of days taken time for graft union varied with the stage of grafting. Number of days taken for graft union of PKM 1 scion with MO1 rootstock was 12.33 days for T<sub>1</sub> followed by 14.13 days for T<sub>2</sub>, 14.24 days for T<sub>3</sub>, 15.19 days for T<sub>4</sub>, 18.44 days for T<sub>5</sub>, 18.78 days for T<sub>6</sub>. (Table 2). Similar results were reported by [9] when tomato scion cv. Fanny was grafted on rootstock cv. AR-9704.

**Comment [N10]:** The time to fusion of the scion and rootstock is presented in Table 2. No significant difference was observed. However, the time ranged from 12.33 days to 18.78 days depending on the age of the rootstock (10 days to 60 days DAG).

**Table 2. Number of days taken for graft union**

| Treatment      | Time Days taken for graft union |
|----------------|---------------------------------|
| T <sub>1</sub> | 12.33                           |
| T <sub>2</sub> | 14.13                           |
| T <sub>3</sub> | 14.24                           |
| T <sub>4</sub> | 15.19                           |
| T <sub>5</sub> | 18.44                           |
| T <sub>6</sub> | 18.78                           |
| <b>C.D.</b>    | <b>1.31</b>                     |
| <b>SE(d)</b>   | <b>0.62</b>                     |

\*DAG – Days after Germination

#### Graft success percentage

Graft success percentage was recorded on 14<sup>th</sup> and 21<sup>st</sup> days after grafting. The grafted plants were kept under mist chamber at 95 per cent relative humidity for 15 days and success percentage was recorded. Success percentage was higher in T<sub>4</sub> (66.54% per cent) followed by T<sub>5</sub> (59.00% per cent), T<sub>2</sub> (56.45% per cent), T<sub>3</sub> (52.44 per cent), T<sub>6</sub> (46.44 per cent) and T<sub>1</sub> (26.47 per cent) (Table 3).

After the successful union of grafts, the grafted plants were transferred to a hardening chamber and the success percentage was observed at 21 days after grafting. Grafts under T<sub>4</sub> showed the highest success percentage of 57.47 per cent followed by T<sub>3</sub> (48.28 per cent), T<sub>5</sub> (45.56 per cent), T<sub>2</sub> (44.52 per cent), T<sub>6</sub> (41.12 per cent) and T<sub>1</sub> (17.53 per cent) (Table 3).

**Table 3. Success percentage of the grafts at different stages**

| Treatment      | Success percentage at 14 <sup>th</sup> day after grafting | Success percentage at 21 <sup>st</sup> day after grafting |
|----------------|---|---|
| T <sub>1</sub> | 26.47   | 17.53   |
| T <sub>2</sub> | 56.45   | 44.52   |
| T <sub>3</sub> | 52.44   | 48.28   |
| T <sub>4</sub> | 66.54   | 57.47   |
| T <sub>5</sub> | 59.00   | 45.56   |
| T <sub>6</sub> | 46.44   | 41.12   |
| <b>C.D.</b>    | <b>1.71</b>   | <b>1.53</b>   |
| <b>SE(d)</b>   | <b>0.81</b>   | <b>0.73</b>   |



#### Thickness of the rootstock

The diameter of the rootstock at the time of grafting was recorded. The scion of PKM 1 also was selected according to the thickness of the rootstock at the time of grafting. The thickness of the rootstock of T<sub>1</sub> was 0.26 cm, T<sub>2</sub> was 0.34 cm, T<sub>3</sub> was 0.42 cm, T<sub>4</sub> was 0.51 cm, T<sub>5</sub> was 0.57 cm and T<sub>6</sub> was 0.65 cm. (Table 4).

**Table 4. Thickness of the rootstock at the time of grafting**

| Treatment      | Thickness of the rootstock at the grafting (cm) |
|----------------|---|
| T <sub>1</sub> | 0.26  |
| T <sub>2</sub> | 0.34  |
| T <sub>3</sub> | 0.42  |
| T <sub>4</sub> | 0.51  |
| T <sub>5</sub> | 0.57  |
| T <sub>6</sub> | 0.65  |
| <b>C.D.</b>    | <b>0.02</b>                                     |
| <b>SE(d)</b>   | <b>0.01</b>                                     |

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted Table**

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

**Formatted:** Space After: 0 pt, Line spacing: single, Position: Horizontal: Left, Relative to: Column, Vertical: 0", Relative to: Paragraph, Horizontal: 0.1", Wrap Around

## Discussion

In the present study, the performance of the grafts at various stages was evaluated based on some physical and quality parameters. An overall germination percentage of 82.40 per cent was observed in MO1 rootstock was is similar to the reports given by [10] and [11]. Despite T<sub>1</sub> taking the lowest number of days taken for graft union, it showed the lowest graft success percentage. Following T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> took lesser number of days to establish graft union which is similar to the results reported by [9] and [10]. T<sub>4</sub> took 15.19 days for establishment of graft union but is considered as the best treatment due to its higher graft success percentage and negligible difference in the number of days taken for graft union from T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>. It can be concluded that the performance of the grafts of annual moringa cv. PKM 1 scion on perennial Moolanurmoringa (MO1) rootstock with 0.51 cm thickness attained at 40 days after germination was superior with regard to high success percentage.

**Comment [N11]:** The discussion must be resumed. The results obtained must be announced and then clearly explained with physiological mechanisms. Finally it is necessary to compare them with the work of some authors who have done similar work.

## Conclusion

In the present investigation, 40 days old rootstock of MO1 showed superiority over the other stages of perennial rootstock viz., 10 days, 20 days, 30 days, 40 days, 50 days and 60 days after germination in the traits viz., days taken for graft union and percentage of grafting success. From this experiment it can be concluded that perennial moringa ecotype MO1 (Moolanurmoringa) at 40 days after germination with a thickness of 0.51 cm is the best rootstock stage for successful grafting with annual moringa scion var. PKM 1. The study will be continued to assess the field performance of the grafted plants.

**Comment [N12]:** It is not conclusion but results. Make a synthesis for all results

## Reference

1. Ramachandran C, Peter KV, Gopalakrishnan PK. Drumstick (*Moringaoleifera*): A multipurpose Indian vegetable. *Economic botany* 1980, P276-283.
2. Dillard, C. J. and J. B. German. 2000. Phytochemicals, Nutraceuticals and human health: A review. *J Sci Food Agric.*, 80: 1744-1756.
3. Siddhuraju, P and K. Becker. 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro-climatic origins of drumstick tree (*Moringaoleifera Lam.*). *J. Agric. Food. Chem.*, 15: 2144-2155.
4. Ghasi, S., E. Nwobodo, and J.O. Ofili.2000. Hypocholesterolemic effects of crudeextract of leaf of *Moringaoleifera Lam.* Inhigh-fat diet fed wistar rats. *J.Ethnopharmacol.* 69:21–25.
5. Lakshmipriya, G., Kruthi, D., Devarai, S.K. 2016.*Moringaoleifera*: a review on nutritive importanceand its medicinal application. *Food Science andHuman Wellness*, 5: 49-56
6. Dhivya, R. 2014. Screening studies of wild rootstocks for biotic stresses and its performance on grafting in tomato (*Solanum Lycopersicon 1.*). Ph.D. Dissertation. Tamil Nadu Agricultural University.
7. Priyanka A, Sujatha K, Sivakumar T, Rajasree P. "Morphological changes in the compatible grafts of tomato cv. PKM 1 with different solanaceous rootstocks" *Journal of Pharmacognosy and Phytochemistry* 2019;8(3):2416-2419
8. Ranajit Chakraborty, Paul A Fuerst, Masatoshi Nei, Statistical studies on protein polymorphism in natural populations ii. Gene differentiation between populations, *Genetics*, Volume 88, Issue 2, 1 February 1978, Pages 367–390
9. Fernandez- Garcia NIEVES, Carvajal M, Olmos E. Graft union formation in tomato plants: peroxidase and catalase involvement. *Annals of Botany* 2004;93(1):53-60
10. Priyadharshini, G., and P. Irene Vethamoni. "Standardization of perennial moringa rootstocks for successful grafting with annual moringa var. PKM 1 (*Moringaoleifera Lam.*)."*Trends in Biosciences* 8.3 (2015): 816-819.
11. Elavarasan, K., Sumathi, T., Pugalendhi, L., &Ravichandran, V. (2021). Graft compatibility of different perennial moringa rootstocks on annual scion. *Journal of Pharmacognosy and Phytochemistry*, 10(1), 2855-2857.

Comment [N13]: Refer you to SDI-paper-template of Submission Guide