Original Research Article

Standardization of Optimum Stage for Grafting in Moringa [*Moringa oleifera* Lam. (Moringaceae)]

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 6 treatments and 4 replications.
Place and Duration of Study: This study 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 moringa (MO 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: It 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; annual scion; high yielding.

1. INTRODUCTION

"Drumstick *Moringa oleifera* Lam. (Moringaceae) 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. Tamil Nadu is a pioneer state in moringa cultivation as it has varied genotypes owing to its diversified geographical area. Tamil Nadu (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. *Moringa oleifera* 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].

"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 a bioactive phytoconstituent i.e. β-sitosterol [4]. It is

used as potential antioxidant, anticancer, anti-inflammatory, anti-diabetic and antimicrobial agent. *M. 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]. Graft with Moolanur moringa rootstock recorded the highest pod setting percentage of 2.84 per cent and also recorded a high yield of 21.27 kg/tree. The pods of the grafted plants also registered high nutritional content *viz.,* ascorbic content (121.90 mg 100 g^{-1}), protein content (2.29 mg g^{-1}), calcium content (31.61 mg 100 g^{-1}) and potassium content (22.508 mg 100 g^{-1}) when compared to the rootstock and scion [6]. This research aims to standardize the suitable size and optimum stage for grafting of annual moringa scion *cv*. PKM 1 on perennial Moolanur moringa rootstock (MO1) based on the physical parameters of both rootstock and scion.

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 11^0 N latitude, 77^0 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 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 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.

Table 1. Treatment details

Treatment	Treatment Details
T_1	10 DAG of rootstock
T_2	20 DAG of rootstock
T_3	30 DAG of rootstock
T_4	40 DAG of rootstock
T_5	50 DAG of rootstock
T_6	60 DAG of rootstock

*DAG – Days after germination

2.2 Raising of rootstock and scion

"The seeds of perennial moringa ecotype *viz.,* Moolanur moringa 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". [10]

"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 *azospirillium* and *phosphobacteria*. The seedlings of rootstocks were watered as and when required". [10]

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". [10] 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 25^0-30^0 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 [7,8].

3. RESULTS

Germination percentage

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

Days taken for graft union

The number of days taken 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_1 followed by 14.13 days for T_2, 14.24 days for T_3, 15.19 days for T_4, 18.44 days for T_5, 18.78 days for T_6. (Table 2). Similar results were reported by [9] when tomato scion *cv*. Fanny was grafted on rootstock *cv*. AR-9704.

Table 2. Number of days taken for graft union

Treatment	Days taken for graft union
T_1	12.33
T_2	14.13
T_3	14.24
T_4	15.19
T_5	18.44
T_6	18.78
C.D.	**1.31**
SE(d)	**0.62**

*DAG – Days after Germination

Graft success percentage

Graft success percentage was recorded on 14th and 21st day 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_4 (66.54 %) followed by T_5 (59.00 %), T_2 (56.45 %), T_3 (52.44 %), T_6 (46.44 %) and T_1 (26.47 %) (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_4 showed the highest success percentage of 57.47 per cent followed by T_3 (48.28 %), T_5 (45.56 %), T_2 (44.52 %), T_6 (41.12 %) and T_1 (17.53 %) (Table 3).

Table 3. Success percentage of the grafts at different stages

Treatment	Success percentage at 14th day after grafting	Success percentage at 21st day after grafting
T_1	26.47	17.53
T_2	56.45	44.52
T_3	52.44	48.28
T_4	66.54	57.47
T_5	59.00	45.56
T_6	46.44	41.12
C.D.	**1.71**	**1.53**
SE(d)	**0.81**	**0.73**

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_1 was 0.26 cm, T_2 was 0.34 cm, T_3 was 0.42 cm, T_4 was 0.51 cm, T_5 was 0.57 cm was T_6 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_1	0.26
T_2	0.34
T_3	0.42
T_4	0.51
T_5	0.57
T_6	0.65
C.D.	**0.02**
SE(d)	**0.01**

2.4 Statistical analysis

The observations on percentage of germination, number of days taken to attain optimum 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 after analysis.

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 [6] and [10]. Despite T_1 taking the lowest number of days taken for graft union, it showed the lowest graft success percentage. Following T_1, T_2 and T_3 took lesser number of days to establish graft union which is similar to the results reported by [6] and [10]. T_4 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_1, T_2 and T_3. It can be concluded that the performance of the grafts of annual moringa *cv*. PKM 1 scion on perennial Moolanur moringa (MO1) rootstock with 0.51 cm thickness attained at 40 days after germination was superior with regard to high success percentage. The study will be continued to assess the field performance and evaluate the yield and quality parameters of the grafted plants.

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, 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 (Moolanur moringa) at 40 days after germination with a thickness of 0.51 cm is the best rootstock stage for successful grafting with annual moringa scion *cv.* PKM 1. The study will be continued to assess the field performance and quality parameters of the grafted plants.

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