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IMPACT OF DIFFERENT SIZE OF POLYBAGS ON MANGO GRAFTS UNDER PROTECTED STRUCTURES

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ABSTRACT

The present investigation entitled "Impact of different size of polybags on mango grafts under protected structures" was carried out at Fruit Nursery, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra during the year 2022-23 with the objectives to study the effect of different poly bag size and protected structures on success and survival of mango grafts. The experiment was laid out in Factorial Randomized Block Design with factor A as different poly bag size *viz*., B_1 (6''×9"), B_2 (7''×11'') and B_3 (8''×12") and Factor B as protected structures *viz*., S_1 (Insect proof net), S_2 (50% green shade net), S_3 (70% green shade net), S_4 (Polytunnel) and S_5 (Open conditions) replicated four times. The result of the present investigation revealed that the polybag size B_3 was significantly superior in the length of scion (17.58 cm), number of leaves per graft (14.64) and diameter of graft union (7.15 mm) as compared to B_1 and B_2 at 150 DAG. Study on protected structures revealed that at 150 DAG the length of scion (19.10 cm), the maximum number of leaves (15.33), the diameter of graft (7.29 mm), the success percentage (79.16%) and final survival percentage (86.74%) of grafted plants was recorded to be superior in S_1 followed by S_2 as compared to other treatments. The interaction between poly bag size and protected conditions revealed that treatment combination S_1B_3 was significantly superior in length of scion (21.74 cm), number of leaves (16.61) and diameter of graft (7.66 mm) as compared to other treatment combinations at 150 DAG.

Key words : Insect-proof net, Green shade net, Polytunnel, Poly bags, Softwood grafting.

Introduction

Mango (*Mangifera indica* L), which belongs to the family Anacardiaceae is revered as the "King of Fruits", holds a prominent position among fruit crops in India. Its distinct flavor and delightful taste make it an economically significant fruit worldwide. However, achieving optimal mango production requires addressing critical factors, with the quality of planting material being paramount. In recent years, there has been a growing demand for high-quality mango planting material. The availability of superior planting material plays a pivotal role in achieving successful mango production. Unfortunately, small-scale farmers in various regions often encounter subpar planting materials, which directly impact potential yields and overall crop performance. The scarcity of quality seedlings has significantly hampered mango production and productivity. The congenial condition prevailing during grafting has an influence on various growth parameters including days required for sprouting, number of leaves per graft, leaf area, number of sprouts, scion and stock diameter, scion and stock length, etc. which are direct indications of a successful graft. Crops grown in open conditions are affected by various abiotic and biotic factors. In the recent period, protected structures have been used for reducing thermal radiation, improving the micro-environment, providing physical protection and enhancing growth (Jain, 2021).

Mango is a deeply tap-rooted and fast-growing fruit crop (Ranjit Singh, 1969). By the time of the sale of grafts, many times the roots are penetrated through the plastic bags. Further, such grafts take a longer time for establishment in the field after transplanting and subsequent growth remains slow. Healthy grafts with strong undisturbed root system establish quickly in the field and can be trained early for canopy development (Haldankar *et al*, 2014).

Maintaining a congenial microclimate for the successful establishment of mango grafts in open conditions is a challenge in the Vidarbha region of Maharashtra due to hot and dry climatic conditions and this leads to mortality of the grafts. The technique for the establishment of mango propagation under protected conditions may be adopted in climate of the Vidarbha region of Maharashtra since in the summer season, the temperature reaches 45°C and relative humidity 10% to 20%. The success or failure of grafting is highly dependent on the environmental conditions under which it is performed. Choosing the right grafting season is crucial for successful grafting as it ensures rapid healing and the subsequent formation of the graft union. In the present investigation, grafting was carried out in the first week of November. The impact of climate change has led to an increase in rainy days. Atmospheric humidity is maximum in the month of November and also the success percentage is higher. So, considering this premise, the present research work was carried out to ascertain the combination of polybag size and protected structure for maximum success and survival of mango grafts.

Materials and Methods

The experiment entitled "Impact of different size of polybags on mango grafts under protected structures" was carried out at Fruit Nursery, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra during the year 2022-23 with the objectives to study the effect of different poly bag size and protected structures and their combination on success and survival of mango grafts. The experiment was laid out in Factorial Randomized Block Design with factor A as different poly bag size *viz*., B_1 (6"×9"), B_2 (7"×11") and B_3 (8"×12") and Factor B as protected structures *viz*., S_1 (Insect proof net), S_2 (50% green shade net), S_3 (70% green shade net), S_4 (Polytunnel) and S_5 (Open conditions) with fifteen treatment combinations replicated four times.

Methodology

Three different-sized poly bags such as 6×9, 7×11, and 8×12 inches were used for raising the rootstock. Locally available mango stones were collected and immediately raised in three different-sized polythene bags. The poly bags were filled with potting mixture consisting of soil, silt, and FYM in a ratio of 2:1:1. Healthy and diseased-free mango stones were selected and a single

Fig. 1 : Grafts in polybag size 6 × 9''.

Fig. 2 : Grafts in polybag size 7 × 11''.

Fig. 3 : Grafts in polybag size 8x12''.

mango stone was sown in each poly bag in the month of June. The scion was selected from a healthy, matured mother tree which was free from pests and diseases. The scion was selected from non- flowering terminal shoot. The cultivar selected as a scion shoot was Kesar. The selected scion shoots were defoliated on the mother plant a week before detaching. A part of the petiole was kept intact on the selected terminal shoot. The scion shoots were collected during the early morning hours on the day of grafting. Shoots of pencil thickness, which were one season old and free from pests and diseases were selected. Healthy and disease-free rootstock seedlings were selected and softwood grafting was done on the same day of separation of scion from mother tree in the month of November. The graft union was wrapped firmly using a polythene strip of 200 gauge. The scion sticks were then covered immediately with polytube cover caps to maintain the microclimate and avoid desiccation of the scion and also to avoid the graft union from coming in contact with water. As per treatment, the grafted plants in different-sized poly bags were then shifted under different protected structures. A total of 600 healthy mango grafts were prepared at the rate of 120 grafts under each protected structure. Observations were recorded on three grafts per replication at monthly intervals up to 150 DAG. The collected data was analyzed using statistical methods outlined by Panse and Sukhatme (1985) and treatment means were compared using critical difference values at 5% level of significance. The observations recorded include the length of the scion (cm), the number of leaves per graft, the diameter of graft union (mm), success percentage and final survival percentage.

Length of scion (cm)

The length of scion was measured using a measuring scale from the point of graft union up to the shoot tip at monthly intervals up to 150 days after grafting and the mean was calculated.

Number of leaves per graft

The number of leaves per graft was counted manually after 30 DAG at monthly intervals up to 150 days after grafting from randomly selected grafted plants and the mean values were computed.

Diameter of graft (mm)

The diameter of the randomly selected observational grafts was measured using Vernier Calliper at monthly intervals up to 150 days after grafting and after computing the mean, it was recorded as the diameter of the graft in milli meter (mm).

Success percentage (%)

The success percentage was calculated by dividing the number of successful grafts by the total number of grafted rootstocks and expressing it as a percentage.

$$\text{Success percentage (\%)} = \frac{\text{Number of successful grafts}}{\text{Total number of grafted root-stock}} \times 100$$

Final survival percentage (%)

The final survival percentage was calculated at 150 DAG based on the number of survived grafts out of the total number of successful grafts.

$$\text{Final survival percentage (\%)} = \frac{\text{Number of survived grafts}}{\text{Total number of successful grafts}} \times 100$$

Results and Discussion

Length of scion (cm)

The length of the scion (12.43, 13.90, 15.27, 17.58 cm) was found to be significant at all stages of growth *i.e.*, 60, 90, 120 and 150 DAG respectively except at 30 DAG in polybag B_3 which was statistically at par with B_2. The increased soil volume in larger polybags likely contributed to enhanced nutrient availability, promoting scion elongation. These findings align with those reported by Adu-Berko *et al*. (2011) in cashew and Begum *et al.* (2021) in *Khaya anthotheca*.

At 30 and 60 DAG maximum length of scion (11.60, 12.52 cm) was recorded in S_2, which was at par with S_3 and S_1. However, at 90, 120 and 150 DAG maximum length of scion (14.12, 16.57, 19.90 cm) was noted in S_1 followed by S_2 and S_3. Maximum scion length under treatment S_1 and S_2 might be due to the fact that both the nets create a microclimate that is conducive to plant growth. Insect-proof nets maintain stable humidity levels and prevent sudden temperature fluctuations and green shade nets filter sunlight, preventing scorching and promoting balanced photosynthesis. The results of the experiment are in close agreement with those of Fatnassi *et al.* (2001), Tanny (2013), Sivudu *et al.* (2014) in mango and Mahmood *et al*. (2018).

The maximum length of scion (11.84 cm) at 60 DAG was recorded in S_3B_2 and S_2B_3, whereas, maximum (15.44, 17.22, 21.74 cm) length of scion at 90, 120 and 150 DAG, respectively was recorded in treatment combination S_1B_3. The variation in length of scion in different-sized poly bags and protected structures might be because, the favorable conditions such as temperature and high humidity prevailing inside the protected structure stimulate rapid callusing and early contact of cambial layers, which enables the graft to heal quickly and make a strong union ultimately leading to better strength and faster growth (Chander *et al*., 2016). The roots also nourish properly and the strong root system might have absorbed more nutrients from the soils thereby increasing the shoot length of scion on the grafted plants (Karna *et al*., 2018).

Number of leaves per graft

Significantly, maximum (9.61, 11.28, 12.42, 14.64) number of leaves was recorded in treatment B_3 (8×12"). Whereas, minimum number of leaves (9.27, 10.40, 12.09, 13.93) was recorded in B_1. A well-developed root system contributes for better uptake of nutrients and water from the soil, increased formation of amides, amino acids, proteins, lipids, hormones and other organic substances (Amar Singh, 2003). In larger polybag sizes, the increased

Table 1 : Influence of different sizes of poly bags and protected structures on length of scion and (cm) and number of leaves of mango graft.

Treatments	Length of scion (cm)					Number of leaves				
	30 DAG	60 DAG	90 DAG	120 DAG	150 DAG	30 DAG	60 DAG	90 DAG	120 DAG	150 DAG
A. Polybag										
B_1	11.38	12.25	12.95	14.42	16.41	7.38	9.27	10.40	12.09	13.93
B_2	11.34	12.27	13.12	14.67	16.68	7.72	9.51	10.81	12.37	14.29
B_3	11.48	12.43	13.90	15.27	17.58	7.67	9.61	11.28	12.42	14.64
F test	NS	Sig	Sig	Sig	Sig	NS	Sig	Sig	Sig	Sig
SE(m) ±	0.09	0.04	0.14	0.16	0.20	0.11	0.03	0.06	0.09	0.11
CD at 5%	-	0.11	0.42	0.46	0.58	-	0.08	0.17	0.27	0.32
B. Protected structures										
S_1	11.47	12.47	14.12	16.57	19.90	7.87	9.70	11.64	13.09	15.71
S_2	11.60	12.52	13.97	15.92	17.90	7.80	9.63	11.55	12.90	15.33
S_3	11.56	12.36	13.91	15.21	17.56	7.48	9.61	11.12	12.61	15.19
S_4	11.18	11.92	12.12	12.74	13.55	7.27	9.26	9.62	10.92	11.24
S_5	11.19	12.33	12.50	13.49	15.35	7.53	9.10	10.23	11.94	13.98
F test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)	0.12	0.05	0.19	0.21	0.27	0.14	0.03	0.07	0.12	0.14
CD at 5%	0.35	0.15	0.54	0.60	0.77	0.41	0.11	0.22	0.35	0.41
Interaction (A x B)										
S1B1	11.29	12.35	13.54	16.01	18.66	7.83	9.68	11.27	12.84	14.54
S2B1	11.78	12.45	13.48	15.62	17.43	7.69	9.63	11.22	12.41	14.73
S3B1	11.60	12.25	13.29	13.86	17.15	7.56	9.56	10.34	12.10	15.09
S4B1	11.15	11.77	11.98	13.69	14.42	6.81	8.68	9.24	11.43	11.68
S5B1	11.08	12.21	12.47	12.94	14.40	7.00	8.80	9.93	11.68	13.64
S1B2	11.53	12.41	13.39	16.49	19.65	7.78	9.67	11.55	12.76	16.00
S2B2	11.17	12.44	13.73	15.18	17.54	8.08	9.71	11.35	12.97	14.87
S3B2	11.84	12.31	13.65	15.62	17.21	7.50	9.60	11.10	12.76	15.41
S4B2	11.00	12.08	12.25	12.38	13.04	7.40	9.52	9.82	11.44	11.71
S5B2	11.20	12.11	12.61	13.68	15.96	7.87	9.05	10.23	11.93	13.48
S1B3	11.61	12.62	15.44	17.22	21.74	8.01	9.76	12.10	13.68	16.61
S2B3	11.84	12.67	14.70	16.98	18.98	7.63	9.56	12.07	13.30	16.39
S3B3	11.24	12.54	14.79	16.14	18.31	7.37	9.68	11.93	12.97	15.08
S4B3	11.41	11.91	12.14	12.17	13.19	7.60	9.60	9.79	9.91	10.33
S5B3	11.30	12.41	12.41	13.86	15.96	7.74	9.46	10.55	12.22	14.82
F test	NS	Sig	Sig	Sig	Sig	NS	Sig	Sig	Sig	Sig
SE(m)	0.21	0.09	0.32	0.36	0.46	0.25	0.06	0.13	0.21	0.25
CD at 5%	-	0.26	0.94	1.04	1.31	-	0.19	0.38	0.62	0.71

soil volume provides more nutrients, resulting in vigorous graft growth which supports the findings of Singh (1998) in bhalia, Ilyas *et al*. (2014) in kinnow and Abera *et al*. (2018).

The different protected structures significantly influenced the number of leaves per graft at all the stages of growth i.e., 30, 60, 90, 120, 150 DAG and was found to be maximum (7.87, 9.70, 11.64, 13.09, 15.71) in treatment S_1, which was followed by S_2 and S_3. The difference in number of leaves might be due to favourable climatic conditions inside insect proof net and green shade net as compared to polytunnel and open conditions. The increased leaf count observed under the insect-proof net could be attributed to the reflective properties of the white-colored net. White surfaces tend to scatter and diffuse light, resulting in a more uniform distribution of light intensity across the plant canopy. This enhanced light availability may contribute to greater leaf production.

Table 2 : Influence of different size of poly bags and protected structures on diameter of graft (mm), success percentage and final survival percentage.

Treatments	Diameter of graft (mm)					Success percentage (%)	Final survival percentage (%)
	30 DAG	60 DAG	90 DAG	120 DAG	150 DAG		
A. Polybag							
B_1	6.14	6.33	6.53	6.76	6.80	62.00 (52.42)	72.86 (59.39)
B_2	6.22	6.44	6.71	6.88	6.90	61.50 (52.04)	72.30 (59.26)
B_3	6.40	6.67	6.92	7.06	7.15	65.00 (54.41)	73.02 (59.62)
F test	Sig	Sig	Sig	Sig	Sig	NS	NS
SE(m) ±	0.06	0.06	0.06	0.05	0.06	1.52	1.08
CD at 5%	0.17	0.18	0.18	0.17	0.17	--	-
B. Protected structures							
S_1	6.40	6.71	7.03	7.19	7.29	79.16 (63.27)	86.74 (68.67)
S_2	6.45	6.64	6.85	7.09	7.19	76.66 (61.31)	85.62 (67.72)
S_3	6.22	6.56	6.83	6.96	7.04	72.50 (58.47)	84.31 (66.68)
S_4	6.08	6.18	6.34	6.47	6.52	40.83 (39.65)	61.13 (51.50)
S_5	6.13	6.32	6.55	6.78	6.80	45.00 (42.09)	45.83 (42.55)
F test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)	0.07	0.08	0.08	0.07	0.08	1.96	1.40
CD at 5%	0.22	0.23	0.23	0.21	0.23	5.61	4.00
Interaction (A x B)							
S1B1	6.17	6.35	6.51	6.69	6.81	80 (63.78)	85.77 (67.86)
S2B1	6.22	6.27	6.50	6.71	6.82	75 (60.08)	85.35 (67.47)
S3B1	6.15	6.50	6.67	6.86	6.90	72.5 (58.42)	83.58 (66.10)
S4B1	6.09	6.23	6.42	6.57	6.60	40.00 (39.15)	60.83 (51.28)
S5B1	6.08	6.30	6.56	6.98	7.10	42.50 (40.65)	48.75 (44.25)
S1B2	6.42	6.85	7.16	7.37	7.40	75.00 (60.61)	86.35 (68.35)
S2B2	6.34	6.60	6.80	7.19	7.29	75.00 (60.61)	86.60 (68.51)
S3B2	6.24	6.45	6.89	6.95	7.00	70 (56.92)	85.24 (67.40)
S4B2	6.05	6.11	6.20	6.27	6.31	40.00 (43.54)	64.58 (53.59)
S5B2	6.12	6.19	6.50	6.61	6.70	47.50 (43.54)	38.75 (38.43)
S1B3	6.60	6.95	7.43	7.52	7.66	82.5 (65.44)	88.09 (69.79)
S2B3	6.80	7.05	7.24	7.37	7.45	80 (63.78)	84.92 (67.19)
S3B3	6.26	6.73	6.92	7.08	7.16	75.00 (60.61)	84.10 (66.53)
S4B3	6.14	6.20	6.39	6.57	6.66	42.50 (42.09)	58.00 (49.62)
S5B3	6.20	6.45	6.60	6.75	6.84	45.00 (42.09)	50.00 (44.98)
F test	NS	NS	Sig	Sig	Sig	NS	NS
SE(m)	0.13	0.14	0.14	0.13	0.14	3.40	2.4
CD at 5%	-	-	0.40	0.38	0.40	-	-

*Figures in parenthesis are arc sine transformed values.

Anushma *et al*. (2014) also had similar results in jamun. The result of the experiment is in line with that of Mahmood *et al*. (2018) and Gaurav *et al*. (2016) .

Significantly, maximum (9.76, 12.10, 13.68, 16.61 at 60, 90, 120, 150 DAG) number of leaves were noted in treatment combination S_1B_3, which was significantly superior over all treatment combinations. The combined use of protected condition and large polybag sizes significantly influenced the number of leaves. The accelerated and sturdy formation of graft union, coupled with enhanced nutrient absorption, is likely responsible for the observed increase in leaf count per graft. The result of the experiment is in line with the findings of Thakre (2016) in acid lime.

Diameter of graft (mm)

The diameter of graft was found to be maximum (6.40, 6.67, 6.92, 7.06, 7.15 mm at 30, 60, 90, 120, 150

DAG, respectively) in polybag B_3, which was statistically at par with B_2. The variation in graft diameter may be attributed to the presence of a well-developed root system in large polybags, which enhance nutrient and water absorption from the soil. Soil in the smaller polybags becomes compacted and can affect number of leaf growth as well as diameter of the graft, which supports the findings of Abera *et al.* (2018), Haldankar *et al.* (2014) in mango and Begum *et al.* (2021) in *Khaya anthotheca*.

At 30 DAG maximum (6.45 mm) diameter of graft was recorded in S_2 followed by S_1 (6.40 mm). Whereas at 60, 90, 120 and 150 DAG the diameter of the graft was recorded to be maximum (6.71, 7.03, 7.23 and 7.29 mm, respectively) in S_1. The observed variation in graft diameter across different protected structures can be attributed to the favorable microclimate conditions within these structures. Specifically, factors such as temperature and relative humidity create an environment conducive to increased meristematic activity. The results of the experiment are in line with the findings of Mahmood *et al.* (2018) and Mditshwa *et al.* (2019).

Maximum diameter (7.43, 7.52, 7.66 mm at 90, 120, 150 DAG) of the graft was recorded in S_1B_3. The observed graft diameter appears to be influenced by the cumulative interaction of two key factors. Quick and strong graft union formation due to moderate temperature and high humidity, coupled with enhanced nutrient uptake by the roots likely contributes to maximal graft diameter. The result of the experiment is in line with the findings of Thakre (2016) in acid lime.

Success percentage (%)

The success percentage for different-sized poly bags was found to be non-significant in different-sized poly bags. Similar findings were noted by Haldankar *et al.* (2014) for mango grafts.

Regarding protected structures significantly, the maximum success percentage (79.16%) was observed, when mango grafts were kept under treatment S_1, which was at par with treatment S_2 (76.66%) and S_3 (72.50%). Whereas minimum success percentage was observed in treatment S_4 (40.83%) and S_5 (45%). The varying success percentages could be attributed to the significant influence of temperature and humidity on graft union formation. Temperature plays a crucial role in graft union formation by influencing callus development. This favorable climate during the study likely contributed to successful graft unions. The outcome of the investigation aligns with the research conducted by Mahesh *et al.* (2017) on mango.

The interaction effect of different size of poly bags and protected structures on success percentage was found to be non-significant.

Final survival percentage (%)

The final survival percentage for different-sized poly bags was found to be non-significant at 150 DAG. The sizes of the poly bag did not influence the final survival of the mango grafts. The successful union of rootstock and scion contributes for survival of the grafts. The results are in line with the findings of Haldankar *et al.* (2014) in mango.

Regarding protected structures significantly, the maximum final survival percentage (86.74%) was observed under treatment S_1 followed by treatment S_2 (85.62%) and S_3 (84.31%) whereas the minimum final survival percent was observed in treatment S_4 (61.13%) and S_5 (45.83%). These observations conform with the fact that shade, humid, and warm conditions after grafting might have resulted in increasing the survival percentage of grafts as reported by Islam *et al.* (2004) in mango and Ghosh *et al.* (2017) in sapota. Least graft survival was noticed in the polytunnel and open conditions. Polytunnels create a microclimate with higher temperatures and reduced air exchange. The extreme heat and excessive humidity might have stressed the grafts, affecting their survival. The results of the experiment conform with the findings of Manga *et al.* (2017) in guava.

The interaction effect of different size of poly bags and protected structures was found to be non-significant at 150 DAG.

Conclusion

The choice of poly bag size can impact the growth performance of the grafts. Optimizing polybag size is crucial for successful grafting and subsequent plant growth. Larger polybags offer advantages in terms of nutrient availability, scion length, and overall vigour. As we strive for sustainable horticulture practices, understanding the impact of poly bag size becomes increasingly relevant. Selecting the appropriate protected structure based on the season of grafting is critical for the successful growth of grafts. Protected structures create an environment conducive to successful grafting and subsequent growth of the grafts. In summary, the combination of insect-proof net and large polybag size creates an optimal micro-environment for mango grafts. It balances leaf production, stem elongation and overall plant health, ultimately contributing to successful grafting outcomes.

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