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Effect of rootstock age and growing conditions on success of softwood grafting in mango (*Mangifera indica* L.)

Navin Kumar, Arunima Tripathi, Deepti Patel and Anjali Shrivastav

Abstract
A field experiment was conducted at the Instruction Horticultural farm under Rajmohini Devi College of Agriculture and Research Station, Ambikapur, Sarguja, (C.G.) During the year 2021-22 with a view to study the "Effect of rootstock age and growing conditions on success of softwood grafting in mango (*Mangifera indica* L.)". The mango variety mallik a used to grown and treatment was replicated three times infactorial randomized block design. There were four rootstock age *e.g.*, 55, 65, 75 and 85 days old and two growing condition open and poly capping which were interaction effect of mango, in eight treatments *viz*., RA_1GC_1 (55 days age of rootstock under open condition), RA_1GC_2 (55 days age of rootstock under poly capping), RA_2GC_1 (65 days age of rootstock under open condition), RA_2GC_2 (65 days age of rootstock under poly capping), RA_3GC_1 (75 days age of rootstock under open condition), RA_3GC_2 (75 days age of rootstock under poly capping), RA_4GC_1 (85 days age of rootstock under open condition) and RA_4GC_2 (85 days age of rootstock under poly capping).The parameters i.e., days taken to sprouting, length of sprouts, number of leaves per grafting and leaf length were significantly superior in the treatment RA_2GC_2 (65 days old under poly capping). On the basis of above findings, treatment RA_2GC_2 (65 days old under poly capping) stand could be better performance first in position and RA_1GC_2 (55 days old under poly capping) stand in second order of preference. Therefore, it may be concluded that treatment RA_2GC_2 (65 days old under poly capping) may be prefer for best result in all the treatment.

Keywords: Rootstock age, grafting, mallika, growing condition, poly capping, open condition, sprouting

1. Introduction
Mango (*Mangifera indica* L.) is the national fruit of India and it is also known as the king of fruits. Mango is an evergreen fruit which grows well in regions. Tropical and subtropical, this crop belongs to *Anacardiaceae* family. The origin of mango is indo-Burma region. In India, mango occupies 2.29 million hectares of area and 20.44 million tones production 9.66 million tones hectares productivity during 2019-20. In Chhattisgarh, mango occupies an area of 76577 hectares with 465130 metric tons of production. (Anonymous 2020) [1].

Mango is very well-adapted to tropical and subtropical climates and it thrives well in almost all regions from the sea level to an altitude of 1500 metres. Mango can be grown successfully at a temperature ranges Between 24˚ to 27˚C. The tree is hardy in nature and it can endure even the temperature as high as 48˚C. It can grow successfully in low rainfall areas of as low as 25cm and as high as 375cm. Hence, there is a lot of scope for large scale planting of mango in the vast low rainfall areas of the country provided the temperature and soil are ideal for its growth.

Propagation is the way be which a new plant regenerates this can be done by both seed and vegetative method.

Seed propagation is the most common method of propagation, which do not produce true to type plants that have long gestation periods and produce irregular fruit sizes with inferior quality. Propagation by the asexual method is generally followed for successful cultivation. Mostly, mangoes are vegetatively propagated by inarching, veneer grafting, epicotyl grafting, Softwood grafting etc. (Karna and Varu 2018) [6].

Among different method softwood grafting has distinct advantages over other methods of vegetative propagation which is an efficient, economics; rapid method and grafts can be ready within a year. So, softwood grafting gives an excellence response in initial success with least possibility of mortality, better and uniform orchard establishments. (Ram and Pathak, 2006) [11]

The main requirement is to have vigour in the rootstock at the time of grafting.

You can achieve this by using a well-drained potting mix and attending to nutrition and pest and disease control. Do not graft rootstocks that are not vigorous. The size and age of the rootstock can vary considerably if it is vigorous. However, the most common stocks selected would be about 12 months old, 40-50 cm tall and up to 1 cm wide at a point about 20-30 cm above ground level. Field planted stocks can also be grafted after 6-12 months of growth. (Anonymous 2020) [1].

The propagation environment for grafting is the most important factor which plays a key role in success of grafting, The year-round fluctuation in temperature, relative humidity and sunlight results in varying degree of success in softwood grafting (Mange *et al*., 2017) [8].

2. Materials and Methods

The field experiment was conducted at the Horticultural research farm, Department of Horticultural, RMD Collage of Agriculture Research Station, Ambikapur (C.G.). Ambikapur is located at 23°12′N 83°2′E. It has an average elevation of 623 metres (2078 feet). The district is spread over a forest-rich area of 22,237km². Most of the district's terrain is forested and hilly. Natural resources include bauxite, forest products and paddy crops. The major contribution of the rainfall comes from South Western disturbances in Arabian sea which accounts for 1000-1050mm of rainfall in the region.

Softwood grafting is a commercially adopted method of vegetative propagation. Generally, in mango, the ideal time for softwood grafting is June to September with high atmospheric humidity. The key factor for successful vegetative propagation is the descent. Non-flowering side the shoots of the current season's growth (3-5 months old lateral shoots) were selected. A rootstock about 55, 65, 75 and 85 days aged of old rootstock with a similar diameter was used. Lower leaves were removed from rootstock. After the grafting operation, extra or off shoots arising from the dormant buds of the rootstock were removed regularly. As a preventive measure against insect pest and diseases, spraying with insecticide and fungicide was followed in a routine schedule. For this, Sumithion 2ml/liter of water and Dithane M-45 @ 2gm/litre of water were sprayed at 7-10 days intervals from three to four weeks after grafting and continued up the last date of recording final data. The data on different parameter were recorded at 15 days interval except for days taken to sprouting.

Results and Discussion

Data pertaining to attributes influenced by various treatments has been given in table 1, 2, 3 and 4 and fig 1.1 (a) & (b), 1.2(a) & (b), 1.3(a) & (b) and 1.4(a) & (b).

Minimum day taken for sprouting was observed in treatment RA_2 *viz*., 65 days old (12.99 days) which was significantly superior to other rootstock age and the growing condition poly capping (GC_2) recorded minimum days (14.29 days), whereas treatment combination RA_2GC_2 *viz*., 65 days old under poly capping (12.17 days) indicate that, minimum day taken for sprouting, and the maximum days taken to sprouting was recorded RA_4GC_1 (85 days old under open field) (17.50 days). Also, similar results were reported by Chaudhary *et al*., (2017) [4] and Kaur and Malhi (2006) [7] analyzed the effect of age of root stock on the performance of epicotyl grafting in mango. Based on the results of two years study, it can be concluded that epicotyl grafting in mango was found to be most successful in terms of bud sprouting growth and survival percent when performed on 7 days old seedling rootstock (17.39% increase in percent success) over 9 days old seedling rootstock.

The observation with respect to length of sprout (cm) were recorded for rootstock age at 90 DAG 65 days old (RA_2) produced significantly highest length of sprout (6.63cm) and the growing condition poly capping (GC_2) produced highest length of sprout (5.79cm). while the interactions between rootstock age and growing condition was found significantly higher in treatment combination RA_2GC_2 viz., 65 days old under poly capping (7.10cm) whereas the lowest length of sprout (cm) was recorded under RA_4GC_1 (85 days old under open field) condition (3.83cm). The results obtained in the present study are supported by the works of Naik *et al*., (2018) [9]. Studies were conducted to observe the effect of longer scions of 21 cm resulted in significantly higher percentage of successful grafts survival, maximum height of grafted plant and length of sprout than shorter ones whereas it showed significantly minimum number of leaves graft days taken for first sprouting and days taken for last sprouting.

The number of leaves per grafting was recorded for rootstock age at 90 DAG, 65 days old (RA_2) produced significantly highest number of leaves (9.83 cm), and for growing condition poly capping (GC_2) recorded highest number of leaves per grafting at 90 DAG (9.39). The interactions between rootstock age and growing condition was found significant in treatment combination RA_2GC_2 *viz*., 65 days old under poly capping (10.33), whereas the lowest number of leaves per grafting was recorded under RA_4GC_1 (85 days old under open field) condition (7.67). Similar result was also reported by Thutte *et al*., (2020) [12] and Beshir *et al*., (2019) [3]. The present investigation it can be concluded that the polyhouse with foggers condition had shown significantly superior performance in relation to percentage of graft success, growth and survival percentage of mango grafts.

The observation with respect to leaf length (cm) was recorded for rootstock age at 90 DAG, 65 days old (RA_2) significantly highest leaf length (cm) (14.28cm) and for growing condition poly capping (GC_2) recorded highest leaf length at 90 DAG (12.8cm). The interactions between rootstock age and growing condition were found significant at 90 DAG significantly highest in treatment combination RA_2GC_2 *viz*., 65 days old under poly capping (16.27 cm), whereas the lowest leaf length (cm)was recorded under RA_4GC_1(85 days old under open field) condition (9.33cm). Similar result was also found by Naik. *et al*., (2018) [9] studied the age of rootstock for softwood grafting in jackfruit experiment was laid out on Factorial Completely Randomized Design (FCRD) with three replications. On comparing the performance of different age of rootstocks used, 30 days old rootstock gave successful grafts and improved growth parameters. Physiological parameters also showed positive response in 30 days old rootstock.

Table 1.1a: Individual effect of rootstock age and growing condition on days taken for sprouting

Treatments	Days taken for sprouting
A. Rootstock age	
RA_1 = 55 days old	13.66
RA_2 = 65 days old	12.99
RA_3 = 75 days old	15.99
RA_4 = 85 days old	16.83
SEm ±	0.44
CD (P=0.05)	1.34
B. Growing Condition	
GC_1 = Open field	15.45
GC_2 =Poly capping	14.29
SEm ±	0.31
CD (P=0.05)	0.95

Table 1.1b: Interaction effect of rootstock age and growing condition on days taken for sprouting

Interaction (RA x GC)	Days taken for sprouting
RA_1GC_1	14.17
RA_1GC_2	13.17
RA_2GC_1	13.81
RA_2GC_2	12.17
RA_3GC_1	16.32
RA_3GC_2	15.67
RA_4GC_1	17.50
RA_4GC_2	16.17
SEm ±	0.62
CD (P=0.05)	NS

Table 1.2a: Individual effect of rootstock age and growing condition on length of sprout (cm)

Treatments	15 day	30 day	45 day	60 day	75 day	90 day
A. Rootstock age						
RA_1 = 55 days old	3.15	3.66	4.51	5.18	5.54	6.23
RA_2 = 65 days old	4.00	4.50	5.00	5.51	6.01	6.63
RA_3 = 75 days old	1.96	2.41	3.08	3.63	4.08	4.68
RA_4 = 85 days old	1.83	2.25	2.83	2.80	3.65	3.98
SEm±	0.15	0.14	0.04	0.09	0.008	0.06
CD (P=0.05)	0.47	0.44	0.14	0.28	0.02	0.20
GC_1 = Open field	2.34	2.79	3.42	3.97	4.39	4.97
GC_2 = Poly capping	3.13	3.62	4.29	4.59	4.25	5.79
SEm ±	0.11	0.10	0.03	0.06	0.006	0.04
CD (P=0.05)	0.33	0.31	0.09	0.20	0.01	0.14

Table 1.2b: Interaction effect of rootstock age and growing condition on length of sprout (cm)

Interaction (RA x GC)	15 day	30 day	45 day	60 day	75 day	90 day
RA_1GC_1	2.50	3.00	4.20	4.77	5.26	6.10
RA_1GC_2	3.80	4.33	4.83	5.60	5.83	6.37
RA_2GC_1	3.50	4.00	4.50	5.03	5.50	6.17
RA_2GC_2	4.50	5.00	5.50	6.00	6.52	7.10
RA_3GC_1	1.77	2.17	2.67	3.27	3.66	3.80
RA_3GC_2	2.17	2.67	3.50	4.00	4.50	5.57
RA_4GC_1	1.60	2.00	2.33	2.83	3.15	3.83
RA_4GC_2	2.07	2.50	3.33	2.77	4.16	4.13
SEm ±	0.22	0.20	0.06	0.13	0.01	0.09
CD (P=0.05)	NS	NS	0.19	0.40	0.03	0.29

Table 1.3a: Individual effect of rootstock age and growing condition on number of leaves per grafting

Number of leaves per grafting						
Treatments	**15 day**	**30 day**	**45 day**	**60 day**	**75 day**	**90 day**
A. Rootstock age						
RA_1 = 55 days old	4.49	5.83	6.01	6.83	8.11	9.78
RA_2 = 65 days old	4.84	6.00	6.50	6.95	7.85	9.83
RA_3 = 75 days old	3.54	4.77	4.83	5.16	6.45	8.54
RA_4 = 85 days old	2.83	4.17	4.28	4.83	6.01	8.00
SEm±	0.07	0.02	0.009	0.04	0.14	0.07

CD (P=0.05)	0.23	0.08	0.02	0.13	0.44	0.22
B. Growing Condition						
GC_1 = Open field	3.60	4.75	5.14	5.48	6.81	8.65
GC_2 = Poly capping	4.25	5.63	5.67	6.39	7.40	9.39
SEm±	0.05	0.02	0.006	0.03	0.10	0.05
CD (P=0.05)	0.16	0.06	0.01	0.09	0.31	0.16

Table 1.3b: Interaction effect of rootstock age and growing condition on number of leaves per grafting

Interaction (RA x GC)	15 day	30 day	45 day	60 day	75 day	90 day
RA_1GC_1	4.33	5.33	5.67	6.38	8.00	9.33
RA_1GC_2	4.66	6.33	6.35	7.26	8.23	10.23
RA_2GC_1	4.35	5.67	6.33	6.57	7.35	9.33
RA_2GC_2	5.33	6.33	6.67	7.33	8.35	10.33
RA_3GC_1	3.41	4.33	4.33	4.66	6.23	8.41
RA_3GC_2	3.69	5.22	5.33	5.67	6.67	8.67
RA_4GC_1	2.33	3.67	4.23	4.33	5.67	7.67
RA_4GC_2	3.33	4.67	4.33	5.33	6.35	8.33
SEm ±	0.10	0.04	0.01	0.06	0.20	0.10
CD (P=0.05)	0.32	0.12	0.03	NS	NS	0.32

Table 1.4a: Individual effect of rootstock age and growing condition on leaf length (cm)

Leaf length (cm)						
Treatments	**15 day**	**30 day**	**45 day**	**60 day**	**75 day**	**90 day**
A. Rootstock age						
RA_1 = 55 days old	2.64	4.83	7.16	8.71	11	13.11
RA_2 = 65 days old	3.00	5.38	7.83	10.18	12.38	14.28
RA_3 = 75 days old	1.96	4.14	4.51	6.01	7.7	9.78
RA_4 = 85 days old	1.78	2.93	4.4	3.98	7.48	9.66
SEm±	0.01	0.11	0.08	0.08	0.13	0.11
CD (P=0.05)	0.02	0.33	0.24	0.26	0.41	0.36
B. Growing Condition						
GC_1 = Open field	2.06	4.08	5.28	5.51	8.67	10.62
GC_2 = Poly capping	2.63	4.56	6.67	8.93	10.6	12.8
SEm±	0.007	0.07	0.05	0.06	0.09	0.08
CD (P=0.05)	0.02	0.23	0.17	0.19	0.29	0.25

Table 1.4b: Interaction effect of rootstock age and growing condition on leaf length (cm)

Interaction (RA x GC)	15 day	30 day	45 day	60 day	75 day	90 day
RA_1GC_1	2.26	4.26	6	6.37	9.5	11.4
RA_1GC_2	3.03	5.4	8.33	11.07	12.5	14.83
RA_2GC_1	2.5	4.4	6.43	8.17	10.27	12.3
RA_2GC_2	3.5	6.37	9.23	12.2	14.5	16.27
RA_3GC_1	1.86	4.83	4.47	5.77	7.57	9.47
RA_3GC_2	2.06	3.47	4.57	6.27	7.83	10.1
RA_4GC_1	1.63	2.83	4.23	1.77	7.37	9.33
RA_4GC_2	1.93	3.03	4.57	6.2	7.6	10
SEm±	0.01	0.15	0.11	0.12	0.19	0.16
CD (P=0.05)	0.04	0.47	0.35	0.38	0.58	0.5

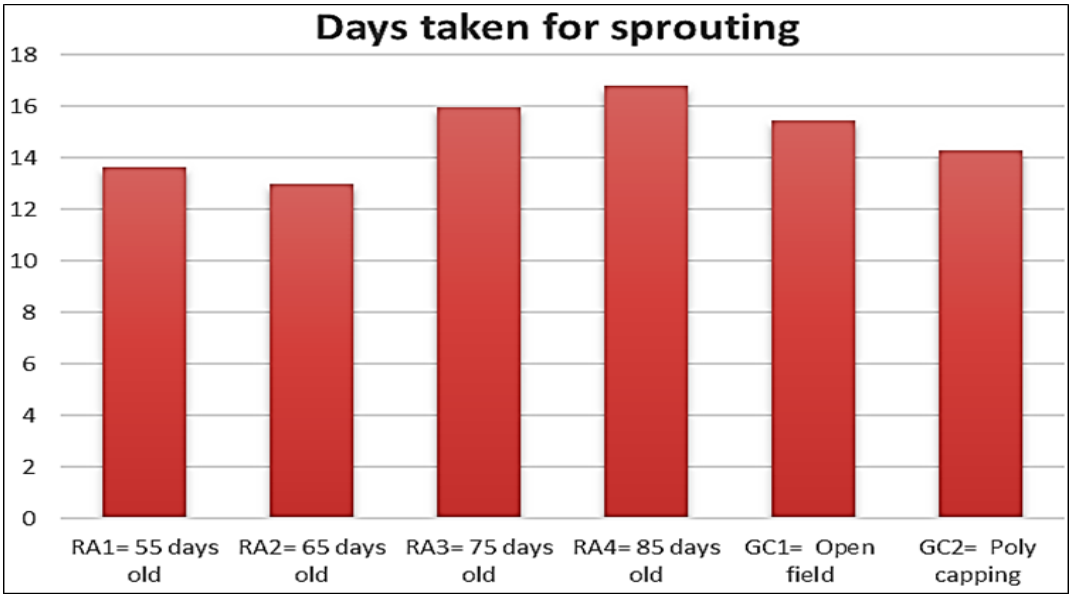

Fig 1.1a: Individual effect of rootstock age and growing condition on days taken for sprouting

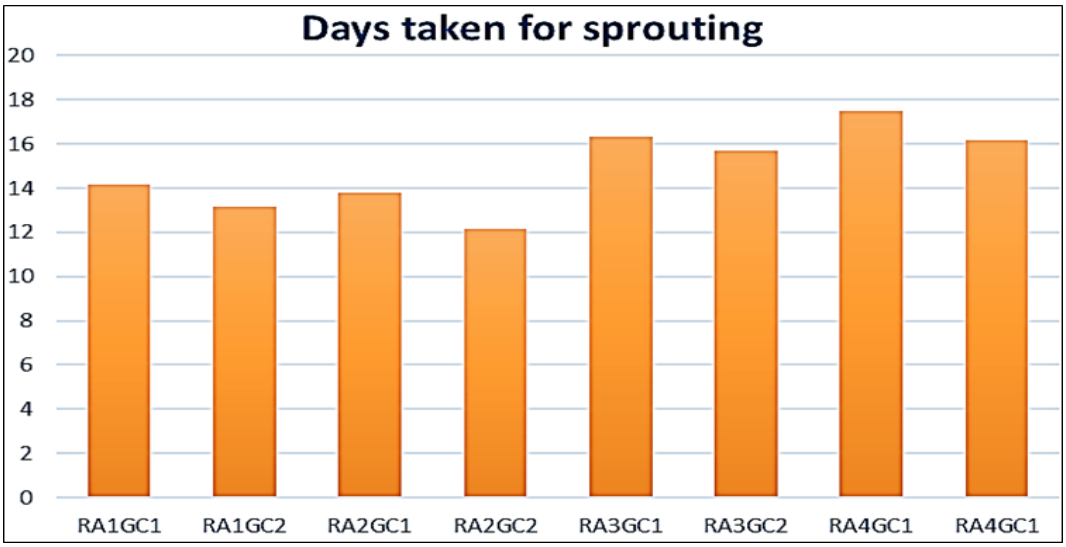

Fig 1.1b: Interaction effect of rootstock age and growing condition on days taken for sprouting

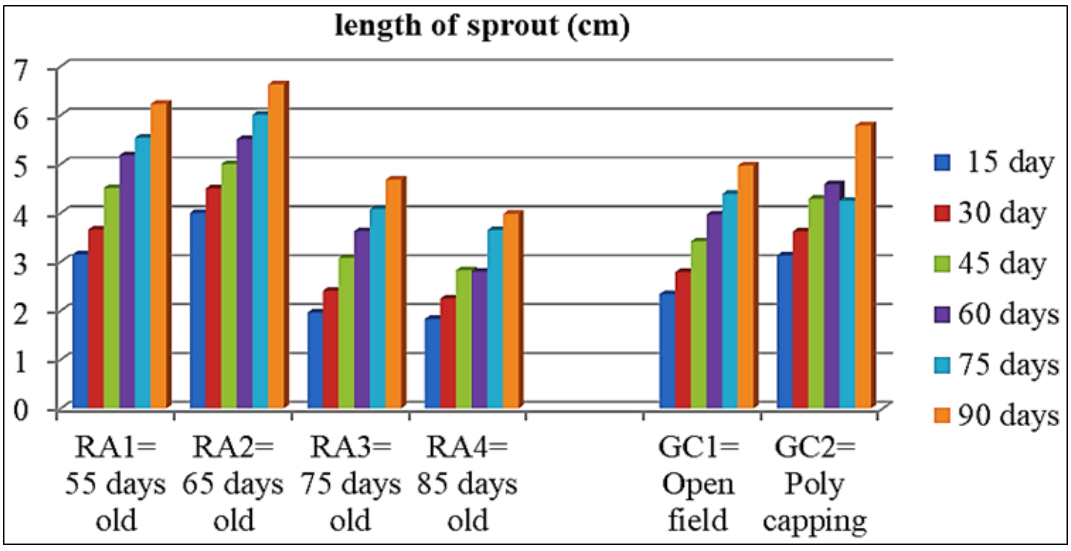

Fig 1.2a: Individual effect of rootstock age and growing condition on length of sprout (cm)

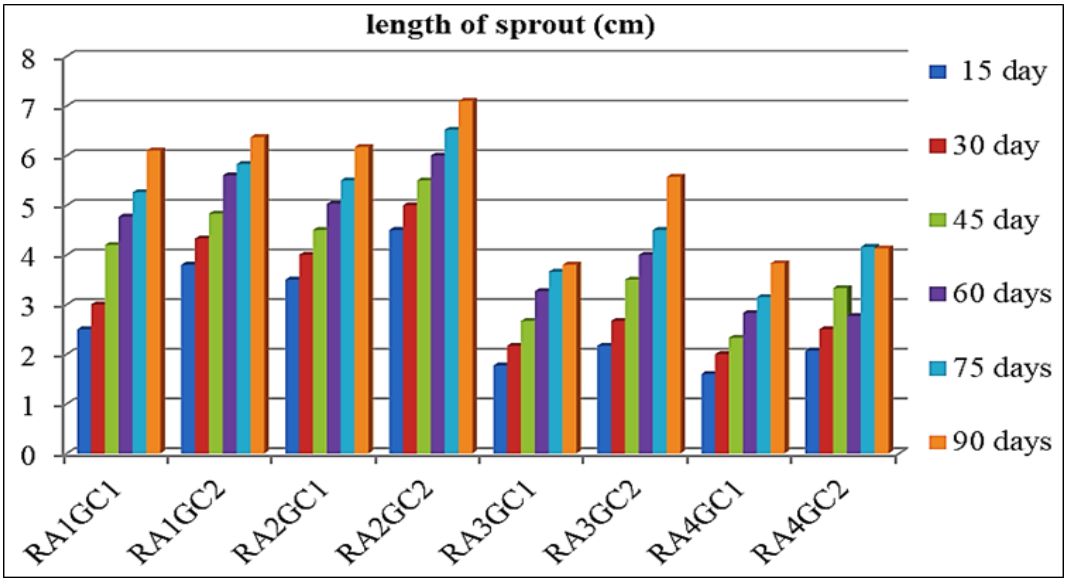

Fig 1.2b: Individual effect of rootstock age and growing condition on length of sprout (cm)

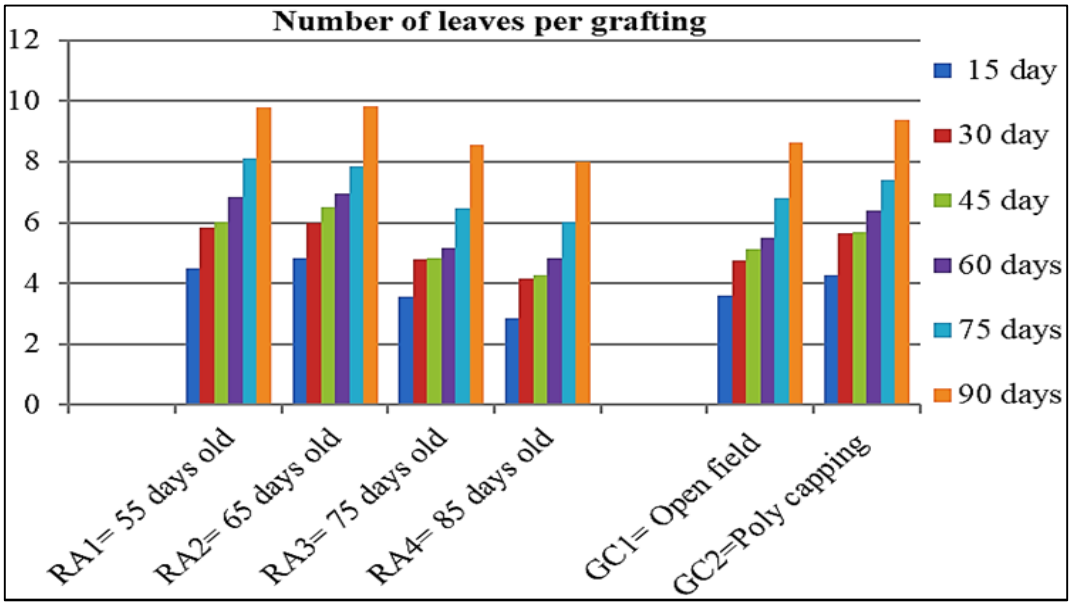

Fig 1.3a: Individual effect of rootstock age and growing condition on number of leaves per grafting

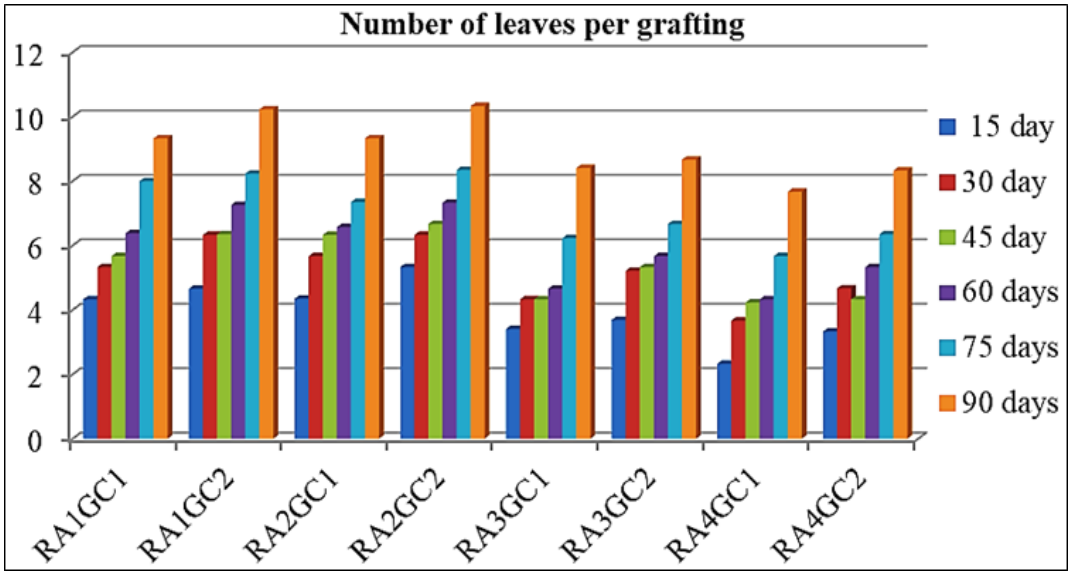

Fig 1.3b: Interaction effect of rootstock age and growing condition on number of leaves per grafting

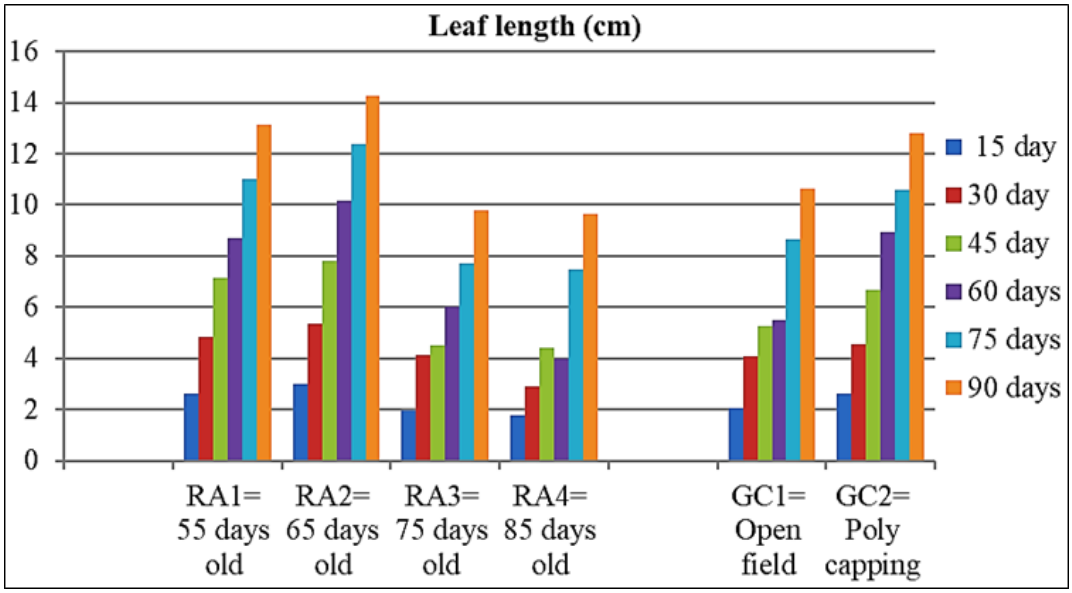

Fig 1.4a: Individual effect of rootstock age and growing condition on leaf length (cm)

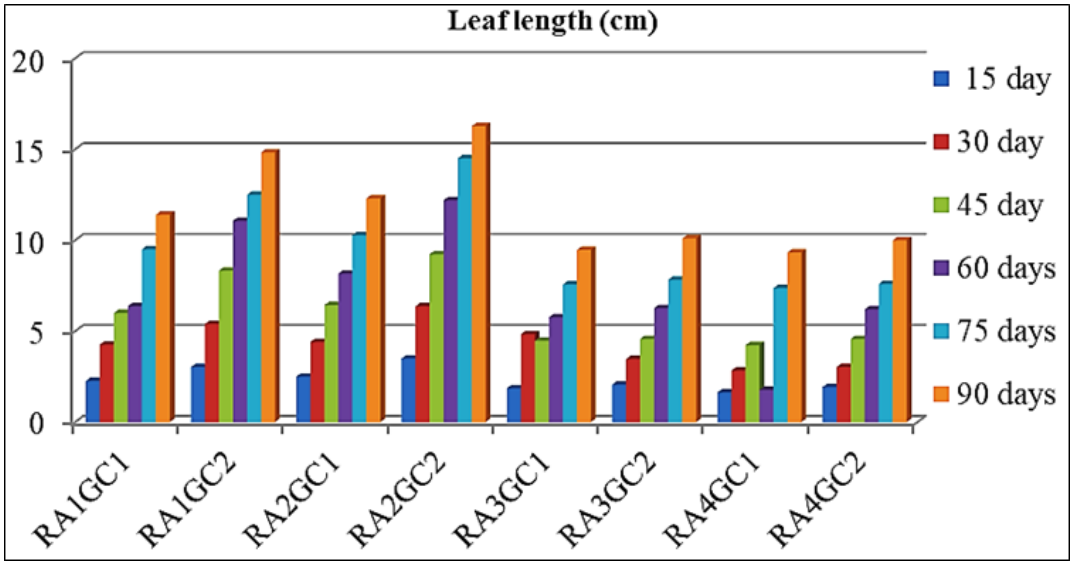

Fig 1.4b: Interaction effect of rootstock age and growing condition on leaf length (cm)

3. Conclusion

The parameters i.e., days taken to sprouting, length of sprouts, number of leaves per grafting and leaf length were significantly superior in the treatment RA_2GC_2 (65 days old under poly capping).

On the basis of above findings, treatment RA_2GC_2 (65 days old under poly capping) stand could be better performance first in position and RA_1GC_2 (55 days old under poly capping) stand in second order of preference. Therefore, it may be concluded that treatment RA_2GC_2 (65 days old under poly capping) may be prefer for best result in all the treatment.

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