Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 13, No. 3, p. 63-72, 2018
http://www.innspub.net

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RESEARCH PAPER

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Effect of grafting season, rootstocks and seedling age on success of stone grafting and pigments synthesis in Sindhri leaves

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Article published on September 13, 2018

Key words: Chlorophyll, Epicotyl grafting, Grafting season, Mango, Seedling age.

Abstract

Mango (*Mangifera indica* L.) is a highly cross-pollinated and allopolyploid in nature. It is mandatory to keep such fruit plants true-to-type through asexual techniques. A preliminary study was conducted with hypothesis that season and age of seedlings rootstock could be effective to improve the success rate of stone grafted seedlings and synthesis of chlorophyll in fresh leaves. For experimental purpose freshly extracted stones of commercial mango cultivars; Sindhri, SB Chaunsa, Dusehri, Sufaid Chaunsa, Anwar Retual, Retual Late No. 12 and Desi stones were planted in polyethylene bags containing the potting media to observe the performance of different age (10, 15, 20 and 25 days after emergence) seedling rootstocks with specific scion of Sindhri in three seasons (August, September and October).Results confirmed that October is the best season for Sindhri stone grafting on seedlings rootstock of Sindhri, SB Chaunsa and Sufaid Chaunsa having epicotyl age of 10 days. However, sprouting of 1st leaf in Sindhri was best where grafting was done in August. A significant improvement in chlorophyll a (75.9%), chlorophyll b (73.0%) and total chlorophyll (74.7%) validated the effectiveness of August season for stone grafting of Sindhri on seedlings of Retual Late 12. However, on the basis of highest success rate (68.3%) of Sindhri on SB Chaunsa, it is concluded that October is the best season for stone grafting of Sindhri.

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Introduction

Among various fruit trees propagation techniques, grafting is considered one of the bestapproach for vegetative propagation (Bally, 2006). Comparative to other methods of propagation, grafting is less expensive and required small time frame for establishment of an orchard (Alam *et al*., 2006). In past, many researchers documented the technique of grafting as bench grafting, seedling grafting and epicotyl grafting (Kashyap *et al*., 1989). However, nowbench grafting, seedling grafting and epicotyl graftingare cumulatively termed as stone grafting (Alam *et al*., 2006).

In recent times, continuously changing socio-economic status in all over the world to achieve the aim of high yield of fruit, intensified cultivation has increased the use of rootstock tremendously to establish an orchard by stone grafting (Pinto *et al*., 2018). A successful grafting depends upon the type of rootstock and scion which is used for the purpose of propagation. It is an established fact that the role of rootstock always remains remarkable for survival, productivity and dwarfing of any grafted fruit (Mng'omba *et al*., 2008). Technical skills and knowledge about grafting techniques also played an imperative role to make a graft successful (Akinnifesi *et al*., 2008). However, the selection of an appropriate rootstock of desirable characters is a major necessity for the success of any stone graft (Simons, 1987). Besides desirable characteristics bearing rootstock, variation in temperature and humidity of environment also directly affect the success of any stone graft (Ram, 1997).

Comparative to other characteristics, the most desirable attribute of any rootstock includes; rapid growth (in height and diameter) that significantly decreased the waiting period. When the alignment of scion and rootstock cambium tissues become successful than cambium tissues divide readily and make a firm union between rootstock and scion (Pina and Errea, 2005). The division of cambium tissue to form a firm union validate the success of graft and its proper propagation(Pina and Errea, 2005).

Mango is cultivated all over the world due to its economic and nutritional value, exotic, fruit elegance and flavour appeal (FAO, 2013; Anees *et al*.,2011). Pakistan is one of major producer of Mango (Alexander, 1989). Due to its dietary fiber, taste, smell and carbohydrates mango is considered the king of fruits (Kumar *et al.,* 2017). Mango has both polyembryonic (apomictic) and monoembryonic seed (Bally, 2006). For its propagation both zygotic (sexual) and nucellar (asexual or maternal) parts can be used. However, it is documented fact that through nucellar seedling as rootstock, uniform fruit orchard can be achieved more easily comparative to zygotic seedlings (Xiang and Roose, 1988; Garcia *et al*., 1999; Ruiz *et al*., 2000). So far, a large number of work has been documented on use of grafting techniques for the propagation of mango but little information is available regarding the effect of seedlings age and appropriate season for successful stone grafting of mango. Therefore, the current study was designed with novelty and aim to find the best age and season of stone grafting to propagate mango in the semi-arid zone of south Punjab Pakistan. It is hypothesized that the appropriate age of seedling rootstock and season could be effective for the success of stone grafting of Sindhri.

Material and methods

Study site description

The study was conducted at mango nursery of Mango Research Institute, Old Shujabad Road, Multan. The site of the experiment was 30°09'12.0"N and 71°26'43.1"E with 126 m elevation from sea level and 186.6 mm annual precipitation.

Seed collection and sowing

For the collection of seeds, mangoes were purchase from local fruit market of Multan on July 2017.Total 50 seeds were freshly extracted from each variety and sown for germination. Disease-free seeds were sown in iron germination trays (1 x 1 m size) having

growing medium with the composition; sugarcane Baggase + silt +coconut fiberina ratio of 65:30:5 (w/w) respectively.

Irrigations and management

Standard irrigation and plant protection measures were adopted as and whenever needed. The seeds were kept in such a way to avoid overlap each other in the tray and well space to each other to facilitate the germination process.

Grafting practice

Grafting was practice on seedlings with the help of a sharp surgical blade instead of a traditional budding knife.

Grafted season and seedlings age

Grafting was done in August, September and October 2017 when the age of seedlings was 10, 15, 20 and 25 days.

Rootstock and scion

Seven different root stocks of variable sizes were used to examine the success of stone graft. The root stock seedlings included; Sindhri, SB Chaunsa, Dusehri, Anwar Retual, Sufaid Chaunsa, Retual Late 12 and Desi. However, scion of Sindhri was used for grafting.

Design of experiment and climatic conditions

The experiment was conducted by following a randomized complete block design with three replicates. The average nocturnal temperature and humidity of August, September and October were taken from Central Cotton Research Institute meteorological station (30°12'N and 71°28'E; 123 m above sea level) which is given below;

Month	Maximum Temperature	Minimum Temperature	Relative Humidity
August	39-34	32-26	92%
September	38-32	31-22	59%
October	36-30	21-18	100%

Photosynthetic pigments in leaves

For determination of chlorophylla, chlorophyllb and total chlorophyll in fresh mango leaves, 0.1gof leaves were cut from the shoot. After that leaf was crushed in 5mlof80% acetone solution until it becomes a paste. When leaf samples become a thick pastethen the final volume was made10mL with 80% acetone. In the end, the samples were filtered with What man filter paper No.42. For determination chlosrophylla, chlorophyll b and total chlorophyll, absorbance was noted at 645 and 663 nm wavelength on a spectrophotometer. Final calculations were made by using formulas of Arnon (1949):

$$\text{Chlorophyll a (mg g}^{-1}) = \frac{12.7(\text{OD } 663) - 2.69\ (\text{OD } 645)\ V}{1000\ (W)}$$

$$\text{Chlorophyll b (mg g}^{-1}) = \frac{22.9\ (\text{OD } 645) - 4.68\ (\text{OD } 663)\ V}{1000\ (W)}$$

Where V = final volume made
W = gram of fresh leaf sample
f.wt. = fresh weight.

However, total chlorophyll was calculated by the addition of chlorophylla and chlorophyll b.

Statistical analysis

For statistical analysis standard statistical procedure of Steel *et al.*, (1997).Three factorial ANOVA was applied by using Statistix 8.1 software for calculation of significance of seedlings age and season on the success of stone grafting. All the treatments means were compared by the tukey's test at $p \leq 0.05$.

Results

Success Rate

Both main and interactive effects of grafting season (S),rootstocks (V)and seedlings age (D) differ significantly for success rate of stone grafting in mango. Comparative to 15, 20 and 25 days of seedlings, the success rate was significantly high in 10 days old seedlings. Similarly, most of the seedlings of mango were successfully stone grafted in October comparative to September and August. For success rate of stone grafting, seedlings of Sindhri, SB Chaunsa and Sufaid Chaunsagr afted at the age of 10

days in September and October were statistically alike to each other but performed significantly best among all the varieties. It was noted that Sindhri, SB Chaunsaand Desi performance was significantly better compared to Deshei, Sufaid Chaunsa, Anwar Retual and Retol 12 in 25 days old seedlings for success rate of stone grafting. Deshei, Sufaid Chaunsa, Anwar Retual and Retual Late 12 remained statistically alike to each other when grafted in August and September at the age of 25 days. However, the performance of Anwar Retual remained significantly better as compared to Retual Late 12 when grafted in October at the age of 25 days. Maximum increase of 68.3% in the success rate of stone grafting was observed in 10 days old seedling of SB Chaunsa and Sindhri as compared to Desi grafted in October.

Table 1. Three factorial analysis of variance.

Attributes	Sources	df	SS	MS	F	P
Success rate of grafted stone	Days	3	30526.9	10175.6	3070.97	***
	Season	2	1883.9	941.9	284.27	***
	Varieties	6	8051.6	1341.9	404.99	***
	Days × Season	6	85.8	14.3	4.31	***
	Days × Varieties	18	10285.1	571.4	172.45	***
	Season × Varieties	12	271.1	22.6	6.82	***
	Days × Season × Varieties	36	429.5	11.9	3.60	***
	Error	168	556.7	3.3		
1st Leaf Sprout	Days	3	462.36	154.12	178.98	***
	Season	2	2322.72	1161.36	1348.68	***
	Varieties	6	214.63	35.77	41.54	***
	Days × Season	6	15.82	2.64	3.06	***
	Days × Varieties	18	55.56	3.09	3.58	***
	Season × Varieties	12	188.72	15.73	18.26	***
	Days × Season × Varieties	36	111.18	3.09	3.59	***
	Error	168	144.67	0.86		
Chlorophyll a (mg g^{-1})	Days	3	0.0110	0.00366	1.18	ns
	Season	2	1.9113	0.95564	309.02	***
	Varieties	6	7.2457	1.20762	390.50	***
	Days × Season	6	0.0080	0.00134	0.43	ns
	Days × Varieties	18	0.3346	0.01859	6.01	***
	Season × Varieties	12	0.0904	0.00753	2.44	***
	Days × Season × Varieties	36	0.0955	0.00265	0.86	ns
	Error	168	0.5195	0.00309		
Chlorophyll b (mg g^{-1})	Days	3	0.00506	0.00169	1.23	ns
	Season	2	0.87472	0.43736	319.09	***
	Varieties	6	3.35702	0.55950	408.21	***
	Days × Season	6	0.00352	0.00059	0.43	ns
	Days × Varieties	18	0.16058	0.00892	6.51	***
	Season × Varieties	12	0.04565	0.00380	2.78	***
	Days × Season × Varieties	36	0.04277	0.00119	0.87	ns
	Error	168	0.23027	0.00137		
Total Chlorophyll (mg g^{-1})	Days	3	0.0309	0.01030	1.21	ns
	Season	2	5.3718	2.68591	315.61	***
	Varieties	6	20.4665	3.41108	400.82	***
	Days × Season	6	0.0219	0.00365	0.43	ns
	Days × Varieties	18	0.9579	0.05322	6.25	***
	Season × Varieties	12	0.2636	0.02196	2.58	***
	Days × Season × Varieties	36	0.2647	0.00735	0.86	ns
	Error	168	1.4297	0.00851		

First Leaf Sprout

Both main and interactive effects of S, V and D differ significantly for 1st leaf sprout in stone grafted mango. Comparative to 15, 20 and 25 days of seedlings, 1st leaf sprout was significantly high in 10 days old seedlings. Similarly, most of the seedlings of mango showed 1st leaf sprout which were grafted in August comparative to September and October. For 1st leaf sprout, all varieties seedlings grafted at the age of 20 and 25 days in August were statistically alike to each other.

Table 2. Effect of grafting season, rootstocks and seedling age on chlorophyll a (mg g^{-1}) synthesis in leaves of stone grafted Sindhri.

Mango Varieties	Days	Aug	Sep	Oct	ME (D × V)	ME (V)	Aug	Sep	Oct
		IE (D × V × S)					IE (S × V)		
Sindhri	10	0.57	0.46	0.45	0.50 $^{E-H}$	0.45 ^{D}	0.54 ^{E}	0.44 $^{F-H}$	0.36 ^{HI}
	15	0.54	0.42	0.35	0.44 $^{F-H}$				
	20	0.53	0.45	0.31	0.43 ^{GH}				
	25	0.53	0.44	0.34	0.43 $^{F-H}$				
SB Chaunsa	10	0.58	0.49	0.36	0.48 $^{E-H}$	0.45 ^{D}	0.56 ^{E}	0.45 ^{FG}	0.35 ^{I}
	15	0.56	0.43	0.33	0.44 $^{F-H}$				
	20	0.58	0.49	0.38	0.48 $^{E-H}$				
	25	0.52	0.40	0.32	0.41 ^{H}				
Dusehri	10	0.55	0.46	0.40	0.47 $^{E-H}$	0.47 ^{D}	0.56 ^{E}	0.45 ^{FG}	0.38 $^{G-I}$
	15	0.56	0.39	0.32	0.42 ^{GH}				
	20	0.54	0.44	0.39	0.46 $^{F-H}$				
	25	0.59	0.52	0.42	0.51 $^{E-H}$				
Anwar Retual	10	0.83	0.69	0.52	0.68 ^{D}	0.77 ^{B}	0.89 ^{A}	0.77 ^{C}	0.65 ^{D}
	15	0.95	0.85	0.75	0.85 ^{AB}				
	20	0.98	0.83	0.73	0.84 ^{AB}				
	25	0.82	0.72	0.59	0.71 ^{CD}				
Sufaid Chaunsa	10	0.95	0.75	0.60	0.76 $^{B-D}$	0.79 ^{B}	0.92 ^{A}	0.79 ^{BC}	0.65 ^{D}
	15	0.92	0.82	0.59	0.78 ^{BC}				
	20	0.95	0.80	0.66	0.80 $^{A-C}$				
	25	0.86	0.80	0.73	0.80 $^{A-C}$				
Retual 12	10	0.95	0.85	0.77	0.86 ^{AB}	0.87 ^{A}	0.95 ^{A}	0.87 ^{AB}	0.79 ^{BC}
	15	0.96	0.87	0.83	0.89 ^{A}				
	20	0.92	0.83	0.75	0.83 ^{AB}				
	25	0.95	0.90	0.82	0.89 ^{A}				
Desi	10	0.68	0.52	0.47	0.60 ^{E}	0.58 ^{C}	0.67 ^{D}	0.49 ^{EF}	0.42 $^{F-I}$
	15	0.66	0.48	0.41	0.57 $^{E-G}$				
	20	0.67	0.50	0.42	0.58 ^{EF}				
	25	0.66	0.47	0.37	0.56 $^{E-H}$				
	ME (S)	0.73 ^{A}	0.61 ^{B}	0.51 ^{C}					

Means sharing different letters are significantly different ($p \leq 0.05$). Non-significant values have no lettering.
ME = indicates main effect; IE = interactive effect.

It was noted that 25 days old Sindhri, Deshei, Anwar Retual, Sufaid Chaunsa and Desi grafted seedling performed significantly better than 10 days old seedlings in September and October. However, the performance of Desi and Sufaid Chaunsa remained significantly best as compared to Anwar Retual when grafted in August at the age of 10 and 15 days. Maximum increase of 26.0% in 1st leaf sprout was observed in 25 days old seedling of Desi as compared to Anwar Retual grafted in August.

Photosynthetic Pigments

Main effect of S and V were significant but the main effect of D remained non-significant for chlorophyll a, band total synthesis in grafted mango seedlings. However, the interaction of D × V and S × V also remained significant for the synthesis of chlorophyll a,b and total chlorophyll in grafted mango seedlings. It was observed that all mango varieties which were grafted in August performed significantly best compared to September and October grafted

seedlings for the synthesis of chlorophyll a, chlorophyllb and total chlorophyll. Among all varieties, Retual Late 12 performed significantly best for the synthesis of chlorophyll a, b and total chlorophyll. Anwar Retual, Sufaid Chaunsa and Retual Late 12 remained statistically alike to each other but differ significantly best as compared to all other varieties grafted in August for the synthesis of chlorophyll a, chlorophyll b and total chlorophyll.

Table 3. Effect of grafting season, rootstocks and seedling age on chlorophyll b (mg g^{-1}) synthesis in leaves of stone grafted Sindhri.

Mango Varieties	Days	Aug	Sep	Oct	ME (D × V)	ME (V)	Aug	Sep	Oct
		IE (D × V × S)					IE (S × V)		
Sindhri	10	0.39	0.34	0.31	0.35 $^{F-I}$	0.31 ^{D}	0.37 ^{F}	0.31 ^{GH}	0.24 ^{I}
	15	0.37	0.28	0.23	0.29 $^{G-I}$				
	20	0.36	0.31	0.21	0.29 ^{HI}				
	25	0.35	0.30	0.23	0.29 ^{HI}				
SB Chaunsa	10	0.39	0.33	0.25	0.32 $^{F-I}$	0.31 ^{D}	0.38 ^{F}	0.31 ^{GH}	0.24 ^{I}
	15	0.38	0.29	0.22	0.30 $^{G-I}$				
	20	0.39	0.34	0.26	0.33 $^{F-I}$				
	25	0.36	0.27	0.22	0.28 ^{I}				
Dusehri	10	0.38	0.31	0.27	0.32 $^{F-I}$	0.32 ^{D}	0.38 ^{F}	0.31 ^{GH}	0.26 ^{HI}
	15	0.38	0.27	0.22	0.29 ^{HI}				
	20	0.37	0.30	0.27	0.31 $^{G-I}$				
	25	0.40	0.35	0.28	0.35 $^{F-I}$				
Anwar Retual	10	0.56	0.47	0.36	0.46 ^{E}	0.52 ^{B}	0.61 ^{AB}	0.52 ^{D}	0.44 ^{E}
	15	0.64	0.58	0.51	0.58 $^{A-C}$				
	20	0.66	0.56	0.49	0.57 $^{A-C}$				
	25	0.56	0.49	0.40	0.48 ^{DE}				
Sufaid Chaunsa	10	0.64	0.51	0.41	0.52 $^{C-E}$	0.53 ^{B}	0.62 ^{AB}	0.54 ^{CD}	0.44 ^{E}
	15	0.63	0.56	0.40	0.53 $^{B-D}$				
	20	0.64	0.55	0.45	0.55 $^{A-C}$				
	25	0.58	0.55	0.50	0.54 $^{A-D}$				
Retual 12	10	0.64	0.58	0.53	0.58 ^{AB}	0.59 ^{A}	0.64 ^{A}	0.59 ^{BC}	0.54 ^{CD}
	15	0.65	0.59	0.57	0.60 ^{A}				
	20	0.63	0.56	0.51	0.57 $^{A-C}$				
	25	0.65	0.61	0.56	0.61 ^{A}				
Desi	10	0.46	0.35	0.32	0.38 ^{F}	0.36 ^{C}	0.45 ^{E}	0.33 ^{FG}	0.28 $^{G-I}$
	15	0.45	0.33	0.28	0.35 $^{F-H}$				
	20	0.45	0.34	0.29	0.36 ^{FG}				
	25	0.45	0.32	0.25	0.34 $^{F-I}$				
	ME (S)	0.49 ^{A}	0.42 ^{B}	0.35 ^{C}					

Means sharing different letters are significantly different ($p \leq 0.05$). Non-significant values have no lettering. ME = indicates main effect; IE = interactive effect.

In September grafted seedlings, Sufaid Chaunsa and Retual Late 12 gave significantly best results compared to all other varieties for the synthesis of chlorophyll a and b. However, for total chlorophyll Anwar Retual, Sufaid Chaunsa and Retual Late 12 remained statistically alike to each other and performed best for the synthesis of chlorophyll a, b and total chlorophyll. Maximum increase in chlorophyll a (75.9%), chlorophyll b (73.0%) and total chlorophyll (74.7%) was noted in Retual Late 12 as compared to Sindhri which were grafted in August.

Discussion

In the current study, mango seedlings which were stone grafted in October showed significantly better success rate compared to August and September was might be due to more active vegetative phase in October season due to the optimum intake of nutrients. Islam *et al.*, (2004) suggested that in

suitable environmental conditions the cell divisionbecome fast in grafted seedlings. This quick division of cells helped alotin the rapid callus formation and intermingling of vascular bundles in rootstock and scion.Sadhu, (2005) argued that it is optimum temperature and humidity of environment that play an imperative role in the success of stone grafting in mango.Furthermore, results of current study confirmed that 10 and 15 days old epicotyl of seedlings performed significantly best regarding the success of stone grafting of Sindhri scion.Gagandeep and Malhi, (2006) also noted that younger epicotyle of 7 days performed significantly better compared to old epicotyls of 15 days in Mango.

Table 4. Effect of grafting season, rootstocks and seedling age on total chlorophyll (mg g^{-1}) synthesis in leaves of stone grafted Sindhri.

Mango Varieties	Days	Aug	Sep	Oct	ME (D × V)	ME (V)	Aug	Sep	Oct
		IE (D × V × S)					IE (S × V)		
Sindhri	10	0.96	0.80	0.76	0.84 $^{F-I}$	0.76 ^{D}	0.91 ^{E}	0.75 $^{F-G}$	0.61 ^{HI}
	15	0.91	0.70	0.58	0.73 $^{G-I}$				
	20	0.89	0.76	0.52	0.72 $^{G-I}$				
	25	0.88	0.73	0.57	0.73 $^{G-I}$				
SB Chaunsa	10	0.97	0.82	0.61	0.80 $^{F-I}$	0.76 ^{D}	0.94 ^{E}	0.76 ^{FG}	0.58 ^{I}
	15	0.95	0.72	0.55	0.74 $^{G-I}$				
	20	0.97	0.83	0.64	0.81 $^{F-I}$				
	25	0.88	0.68	0.53	0.70 ^{I}				
Dusehri	10	0.93	0.77	0.67	0.79 $^{F-I}$	0.78 ^{D}	0.94 ^{E}	0.76 ^{FG}	0.64 $^{G-I}$
	15	0.94	0.66	0.54	0.71 ^{HI}				
	20	0.91	0.73	0.66	0.77 $^{F-I}$				
	25	0.99	0.87	0.70	0.85 $^{F-I}$				
Anwar Retual	10	1.39	1.16	0.88	1.14 ^{E}	1.29 ^{B}	1.50 ^{AB}	1.29 ^{C}	1.09 ^{D}
	15	1.59	1.42	1.27	1.43 ^{AB}				
	20	1.64	1.39	1.22	1.42 $^{A-C}$				
	25	1.38	1.20	0.99	1.19 ^{DE}				
Sufaid Chaunsa	10	1.59	1.25	1.01	1.28 $^{C-E}$	1.32 ^{B}	1.54 ^{A}	1.33 ^{BC}	1.09 ^{D}
	15	1.55	1.38	1.00	1.31 $^{B-E}$				
	20	1.59	1.35	1.11	1.35 $^{A-C}$				
	25	1.44	1.35	1.23	1.34 $^{A-D}$				
Retual 12	10	1.59	1.43	1.30	1.44 $^{A-C}$	1.46 ^{A}	1.59 ^{A}	1.45 $^{A-C}$	1.33 ^{C}
	15	1.61	1.47	1.40	1.49 ^{A}				
	20	1.55	1.39	1.26	1.40 $^{A-C}$				
	25	1.60	1.52	1.38	1.50 ^{A}				
Desi	10	1.15	0.87	0.79	1.01 ^{F}	0.97 ^{C}	1.12 ^{D}	0.83 ^{EF}	0.70 $^{F-I}$
	15	1.11	0.81	0.68	0.96 $^{F-H}$				
	20	1.12	0.83	0.71	0.98 ^{FG}				
	25	1.10	0.79	0.63	0.95 $^{F-I}$				
	ME (S)	1.22 A	1.03 B	0.86 C					

Means sharing different letters are significantly different ($p \leq 0.05$). Non-significant values have no lettering.
ME = indicates main effect; IE = interactive effect.

They suggested that better continuity of sap between young epicotyle and scion due to proper translocation of solutes played an imperative role in the success of stone grafting (Chakrabarty and Sadhu 1989).

It was also observed that the synthesis of chlorophyll was significantly high in such seedlings leaves in which grafting was done in August. This improvement in the synthesis of chlorophyll a, chlorophyll b and total chlorophyll was might be due to better intake of nutrients and water in Aug due to optimum temperature as compared to October when temperature was low.Gunjate, (1989) also reported similar kind of results and argued that optimum

temperature plays an important role in the better growth of grafted seedling. According to Anwar *et al.*, (2011)mango plants showed the best growth and gave maximum yield when nutrients are applied after harvest in August.

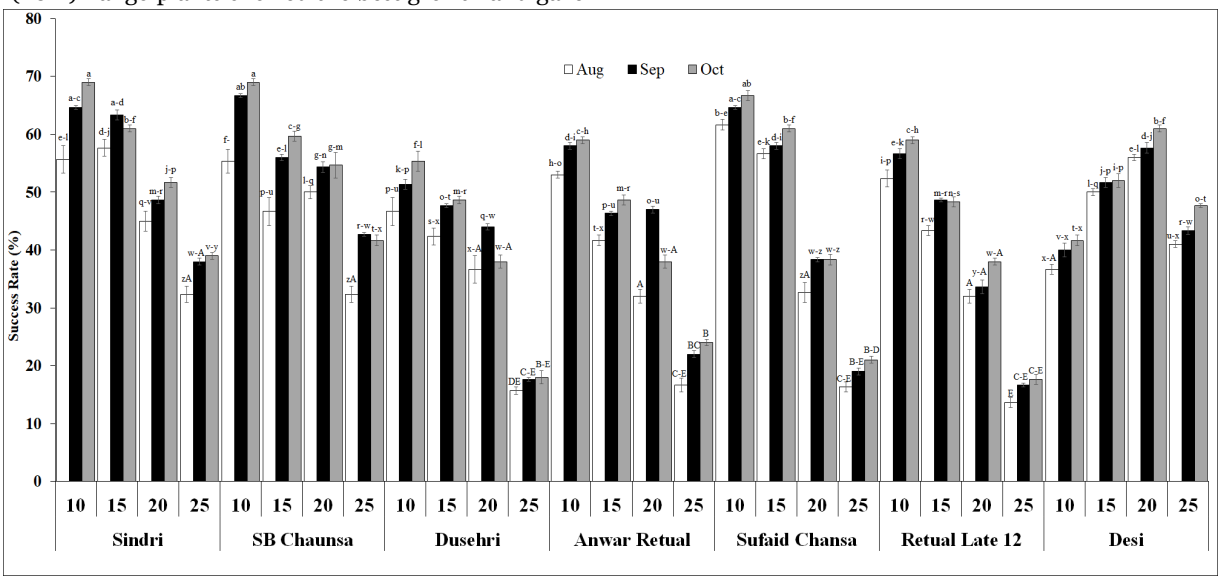

Fig. 1. Effect of grafting season, rootstocks and seedling age on success rate of stone grafting of Sindhri

During winter season October to December, combined effect of light and temperature significantly decreased photosynthesis conducted by chlorophyll (Adams *et al.* 2001; Oquist and Huner 2003). Leegood, (1995) argued that low temperature adverselyaffects the Calvin cycle in plants rather than n light absorption and electron transport played an important role in photosynthesis carried out as a result of light absorption by chlorophyll.

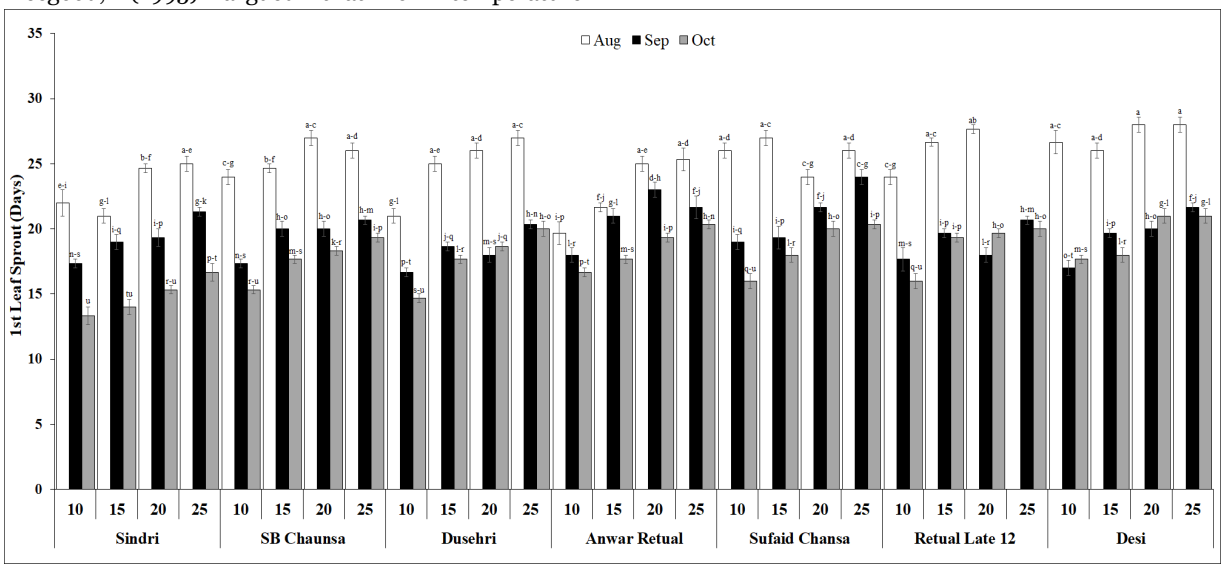

Fig. 2. Effect of grafting season, rootstocks and seedling age on 1st leaf sproutin stone grafted Sindhri.

Conclusion

On the basis of results, it is concluded that stone grafting is more successful in October. Epicotyl age of 10 days is most suitable but 15 days epicotyl is also successful on Sindhri, SB Chaunsa and Sufaid Chaunsa seedlings to get maximum success in stone grafting to propagate Sindhri variety of Mango. In case of chlorophyll a, chlorophyll b and total

chlorophyll synthesis August is the most suitable time for stone grafting of Mango. However, further investigation is yet suggested to explore why August is better for better synthesis of chlorophyll.

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