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Compatibility of brinjal (*Solanum melongena* L.) varieties grafted on *Solanum torvum* Sw. at different dates

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Abstract

The present investigation conducted on grafting in brinjal during monsoon season of 2018 with the major objectives of this investigation to study the compatibility of brinjal varieties and suitable time for grafting when grafted on *Solanum torvum* at four different dates. The observation of scion rootstock was recorded before and after grafting. The variety Phule Arjun were reported minimum days to germination, days taken to reach grafting stage and highest germination percentage when sowed for 1st September grafting dates. It also reported the minimum days taken to graft healing, days to sprouting and transplanting when grafted at 1st August. Significantly highest grafting success was noted in Phule Arjun and Krishna grafted at 1st August and 1st September. Whereas, it was lowest recorded in Phule Harit grafted at 15th July. From the results obtained can be concluded that Phule Arjun and Krishna more compatible with *Solanum torvum* when grafted at 1st August and 1st September took minimum days for graft healing, sprouting, transplanting and highest grafting success.

Keywords: Rootstocks, scion, solanum torvum, compatibility, brinjal

Introduction

Brinjal (*Solanum melongena* L.) is an important horticultural crop of Solanaceae family. Which is widely cultivated in Asia, Africa, and subtropics (India, Central America), even in some warm temperate regions (Mediterranean area, South of the USA) (Sihachakr *et al.* 1993)^[25]. India contributes for an area of 7.36 million ha and production of 12777 MT to the global production with productivity 18.90 MT/ha and ranks second to China. Brinjal covers 8.14% of total vegetable area and produces 9% of total vegetable production in India. In India it is well distributed in Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra and Uttar Pradesh. West Bengal rank first in production having area 163.15 thousand hectare with production of 3027.75 MT/ha and accounting 23.69% shares in production. Whereas, Maharashtra having area 22.488 thousand hectare with 429.91 MT/ha production and accounting 3.36% shares in production. (Anon, 2020)^[1].

Nowadays grafting is regarded as a rapid additive tool to the relatively slow breeding methodology which aimed to increasing environmental stress tolerance of fruit vegetables in short duration. Cultivation of vegetable grafts permits not only pest resistance and high yields but also ameliorates crop losses caused by adverse environmental conditions. It has also been observed that grafting Brinjal on wild species affects various physiological processes of a plant which in turn provide better opportunity to survive well and perform better in adverse climatic conditions. The use of vegetable grafts will be most successful when complemented with sustainable farming system practices (Kubota, 2008)^[11]. Grafting imprints resistance to pathogenic agents and soil pests, tolerance to abiotic stress factors, improves water and nutrient absorption and increases the graft vigor (King *et al.*, 2010; Lee, 1994)^[10, 15].

Grafting of eggplant cultivars on perennial and wild Solanaceous species was proved to increase yield and availability period of the fruits (Gisbert *et al.*, 2011; Lee, 1994)^[5, 15]. *Solanum torvum* Sw., a native of western tropics and India, exhibits resistance to a wide range of soil pathogens such as *Verticillium dahliae*, *Ralstonia solanacearum*, *Fusarium oxysporum* and root knot nematodes (Bletsos, 2003; Gousset *et al.*, 2005; Bagnaresi *et al.*, 2013)^[3, 6, 2] as well as being tolerant to abiotic stresses (Savvas *et al.*, 2010)^[23].

Solanum torvum Sw. is the rootstock commonly used for grafting, especially in the most intensive protected cultivation. However, its use has been limited due to lack of rapid and homogeneous synchronized seed germination. Studies have shown that grafting can affect yield and fruit quality in eggplant (Gisbert *et al.*, 2011; Sabatino *et al.*, 2018)^[5, 21]. The grafting itself and the prevalence of particular type of commercial rootstocks influence vegetable fruit quality and partially storability (Kyriacou *et al.*, 2017)^[14]. They also reported that grafting significantly affects morphometric traits, textural characteristics, sweetness and acidity, as well as functional compounds in eggplant. The aim of this study was to investigate and evaluate the compatibility of brinjal variety grafted on *Solanum torvum* and suitable time for grafting.

Material and Methods

Present investigation was conducted at the farm of All India Co-ordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment conducted in Kharif 2018. Seeds of rootstock sowed one month before the scion seeds. To overcome the problem of uneven germination, the rootstock seeds sown in 102 cells pro-trays containing sterilized coco-peat. The rootstock seedling took 60 to 65 days and scion seedlings ready for grafting in 25-30 days after sowing. Four cultivated varieties like Manjari Gota, Phule Harit, Krishna (F₁) and Phule Arjun (F₁) were grafted onto *Solanum torvum* rootstock by using cleft grafting method. This is most commonly method used for solanaceous crops. With a razor blade, rootstocks were cut below the cotyledon and a longitudinal cut was made 1.5 cm. Scions were pruned to 1-3 leaves and the lower stem was cut into a tapered wedge to place inside the depth cut of the rootstock. After insertion, graft unions were joined with silicon clip to improve stability, reduce chance of infection and ensure vascular contact. For grafting used 17 to 19 mm stem girth seedlings of both scion and rootstocks. Grafting were carried out morning and evening hours in moist chambers made up with transparent polythene of 100 micron thickness. After grafting seedlings were immediately placed in grafting chamber for nine days. Grafting chamber were covered with black polythene for two days and seedlings were placed in dark. This process was carried out to ensure high grafting success. Maintain relative humidity of 85-95% for five days to allow the graft union to heal, then light was gradually increased and relative humidity was decreased. Then the seedlings were transferred to the normal nursery where healing process was allowed for one weeks before they were transplanted. Before the transplanting seedlings were grown under natural light conditions for two to three days. During the whole crop cycle, air temperature and relative humidity inside the graft chamber was recorded daily presented in table 1. Ten seedling were selected and tanged from each replication and observation were recoded given below.

A. Rootstock and Scion parameters

1. Days taken for Germination

The observation was recorded at everyday by visual observation and average days taken for germination were expressed.

2. Days taken to reach grafting stage

Observation was recorded based on seedling height, number of leaves and days required to reach correct stage of grafting.

3. Germination (%)

Hundred seed were sowed in pro-trays containing coco-peat. The observation was recorded by counting emergence of seedling by visual observation.

$$\text{Germination (\%)} = \frac{n}{N} \times 100$$

Whereas, n= number of seeds that were germinated, N: total number of seed in each experiment.

B. Observation of grafted plant

1. Days taken for graft healing

The observation was recorded after 3 days of grafting by removing the grafting clips and average days were noted.

2. Days taken to sprouting

The observation was recorded at everyday by visual observation and the number of sprouted seedlings were counted and average days were expressed.

3. Days taken to attain transplanting

The observation was recorded by counting day required for transplanting from grafting and mean days required for days taken to attain transplanting was worked out.

4. Graft success (%)

Graft success was recorded at 5th, 10th and 15th days after grafting and on the day transplanting, 7th, 14th and 30th day after transplanting based on wilting of the grafts at healing region. It is calculated by number of plants died to the total number plants multiplied by hundred and it is expressed in percentage.

Statistical analysis

The experiment was conducted in two Factorial Randomized Block Design (FRBD). 5x4 FRBD consisting of five treatments (one rootstocks R0: *Solanum torvum* and four varieties V₁: Manjari Gota, V₂: Phule Harit, V₃: Krishna and V₄: Phule Arjun) and four sowing dates (rootstock seed was sowed 60 days before the grafting dates and scion seed sown 1 month before grafting date). 4x4 FRBD consists of four grafting dates (D₁: 15th July, D₂: 1st August, D₃: 15th August and D₄: 1st September) and four scion varieties (V₁: Manjari Gota, V₂: Phule Harit, V₃: Krishna and V₄: Phule Arjun) which were replicated tree times. The data obtained during experiment were analyzed as per the statistical methods prescribed by Panse and Sukhatme (1985)^[18] to obtain valid conclusion.

Results and Discussion

Rootstock and Scion parameters

The mean data pertaining on effect of different dates of sowing on days taken to germination (DTG), germination percentage (GP) and days taken to reach grafting stage (DTRGS) in Brinjal varieties and rootstock depicted in Table 2. Significantly lowest days taken for germination (8.33), days taken to reach grafting stage (33.73) and highest germination was recorded in seed sown for D₄: 1st September. Whereas, highest days for germination (11.07), days to reach to grafting stage (39.13) and lowest germination percentage (71.27%) was noted in seed sown for D₁: 15th July. The variety V₄: Phule Arjun noted minimum days for germination (6.00), days taken to reach grafting stage (28.17) and highest germination (84.75%). However, highest days taken for germination (21.25), days taken to reach grafting stage

(62.67) and lowest germination (59.50%) was recorded in R₀: *Solanum torvum*. The interaction effect of date and rootstock or varieties recorded significantly lowest days for germination (5.00), days to reach grafting stage (26.33) and highest germination percentage (88.33%) was reported in D₄V₄. However, highest days for germination (23.33), days to reach grafting stage (68.33) and minimum germination (55.67%) was reported in treatment D₁R₀.

The temperature played an important role in germination of seed. At very high temperature, the rate of germination was strictly prohibited and caused cell and embryos death. Seedling establishment rate was also reduced (Rajatha *et al.*, 2018) [19]. *Solanum torvum* took maximum days for germination this may be due to species character. It is a wild species which may be having hard seed coat and prolonged seed dormancy that may result in erratic, poor and late germination. This results was line with Gisbert *et al.*, (2011) [5] and Rathod (2017) [20]. In addition to Kumar *et al.*, (2016) [13] also revealed that *Solanum torvum* Swartz is a highly vigorous relative of eggplant but its poor, irregular and erratic germination due to long dormancy in seeds limits practicability as rootstock.

Seed germination is an important criteria in crop production. Brinjal is a warm-season crop. The optimum temperature for brinjal seed germination ranges from 22-30°C. In the present investigation rootstocks and scion seed sowed at different dates and observed that temperature was critical factor which affect the germination. It was reported the germination percentage in the range of 80% to 85% in F₁ hybrids (Krishna and Phule Arjun) and varieties (Manjari Gota and Phule Harit) showed the minimum germination percentage i.e. 65% to 72% in both season. The rootstock *Solanum torvum* is wild in nature and seed germination is an important concern when using materials of wild species or exotic species as rootstock. Seeds of a number of wild *Solanum* species are known to emerge slowly and about 30 days can be needed to attain germination with percentage rates that vary between 15% and 50% in *S. insanum* L. *S. torvum* *S. integrifolium*, *S. surattense*, *S. khasianum*, *S. sanitwongsei* and in hybrids of *S. melongena* x *S. integrifolium* (Ibrahim *et al.*, 2001) [8]. Fasted germination was showed in variety Phule Arjun obviously resulted in minimum number of days to reach the grafting stage. Our results were line with Rathod (2017) [20] who exhibited the minimum days to reach grafting stage in brinjal hybrid Mahyco-9.

Grafted plant Parameters

The mean data pertaining on effect of different dates of grafting on days taken to graft healing (DTGH), Days taken to sprouting (DTS), days taken to transplanting (DTT) and graft success (%) in brinjal varieties depicted in Table 3. Significantly lowest days taken for graft healing (4.56), sprouting (8.27), transplanting (18.97) and highest graft success (94.42%) was reported in D₂: 1st August. While, highest days taken for graft healing (5.91), sprouting (9.43), transplanting (20.17) and lowest graft success (84.23%) was reported in D₁: 15th July. Among the four varieties Phule Arjun showed significantly lowest days for graft healing

(4.23), sprouting (7.96), transplanting (18.62) and recoded highest graft success (94.17%). However, highest days for graft healing (5.75), sprouting (9.66), transplanting (20.62) and lowest grafting success was reported in (85.89%) var. Manjari Gota. The interaction effect of dates of grafting variety showed significantly lowest days for graft healing (3.57), sprouting (7.24), transplanting (17.91) and highest grafting success (97.78%) was reported in treatment D₂V₄. Whereas, highest days taken for graft healing (6.25) was noted in D₁V₁. The interaction D₃V₁ showed highest days for graft sprouting (9.77) and graft transplanting (20.82). However, interaction D₁V₁ recorded lowest graft success (78.11%).

In commercial nurseries, the grafted seedlings are usually placed in specially constructed tunnels within which the temperature is maintained at 24°C and relative humidity 100% (Nobuoka *et al.*, 1997) [17]. In present investigation the optimum temperature and high humidity was recorded at D₂: 1st August in grafting chamber. It be might be better union of vascular tissues at the graft union takes place. Rathod (2017) [20] was reported similar results in brinjal. The treatment D₂V₄ reported minimum days for sprouting because of early graft union and it might be due to the favorable temperature and humidity. The treatment D₂V₄ showed minimum days for graft healing and sprouting obviously resulted in minimum number of days for transplanting.

Grafting success depends on several factors that include graft union and graft compatibility, combination of scion and rootstock (Kawaguchi *et al.*, 2008) [9], Seedling age, post grafting management, size of scion and rootstock, culture condition, grafting method, tissue and structure differences, physiological and biochemical characteristics, growing stage of rootstock and scion, phytohormone and the environment which play a major role (Davis *et al.*, 2008) [4]. The success of grafting is also dependent upon the weather conditions and it varies from region to region within a season. The seasonal influence could be ascribed to the influence of prevailing temperature and humidity (Tamilselvi, 2015). Eggplant is grafted mainly by cleft or tube grafting techniques (Lee, 1994; Bletsos *et al.*, 2003; Miguel *et al.*, 2007) [15, 3, 16]. In the present investigation four eggplant varieties was grafted on *Solanum torvum* at different dates by cleft grafting, to find the better time and better combination for the grafting. It was reported the highest grafting success (97.78%) on 1st august grafted Phule Arjun. It might be due to favorable temperature and humidity in the grafting chamber. Successful grafting (compatibility between scion and rootstock) was due to cell division in the scion and rootstock at the graft union (dedifferentiation and redifferentiation of the callus tissue), followed by rapid connection between the vascular bundles of the scion and rootstock and subsequent secondary growth of the scion (Shehata *et al.*, 2000) [24]. Among the four eggplant varieties hybrid (Phule Arjun and Krishna) form early callus and better compatibility than varieties (Manjari Gota and Phule Harit). The findings are in accordance with those obtained by Gisbert *et al.*, (2011) [5], Kumar *et al.* (2017) [12], Hoza *et al.* (2017) [7], and Sabatino *et al.*, (2019) [22] in eggplant.

Table 1: Temperature and humidity recorded in grafting chamber

15th July					15th August				
Days	Temperature		Humidity		Days	Temperature		Humidity	
	Max	Min	Max	Min		Max	Min	Max	Min
1	33.2	25	99	65	1	31.2	23.3	99	74
2	33.4	25.2	98	68	2	30.3	22.4	99	73

3	32	24.6	97	62	3	31.6	24.4	98	77
4	32.2	25.3	94	50	4	29.3	20.4	98	60
5	32.3	24	92	45	5	30.5	21.4	96	52
6	32.7	25	93	51	6	32.2	22.3	98	53
7	33.8	21.3	97	40	7	29	22.1	97	41
8	32.3	26.9	94	35	8	29.1	20.1	94	45
9	34.1	24.2	92	30	9	27.1	19.8	95	44
Mean	32.89	24.61	95.11	49.56	Mean	30.03	21.80	97.11	57.67
1st August					1st September				
1	29.3	20.1	99	77	1	26.3	20.1	99	72
2	29.4	21.1	99	75	2	27.9	20.1	99	74
3	29.1	19.5	99	78	3	27.5	20.8	99	74
4	28.4	19.7	94	65	4	27.3	19.4	98	63
5	28.2	19	95	62	5	28.9	21.3	99	60
6	28.5	21.2	93	51	6	30.8	21.4	98	42
7	30.4	20.2	97	40	7	30.2	20.9	97	37
8	31.3	21.6	94	55	8	30.4	21	94	35
9	31.2	20.3	92	52	9	34.9	22.3	95	28
Mean	29.53	20.30	95.78	61.67	Mean	29.36	20.81	97.56	53.89

Table 2: Effect of date and rootstock or varieties on days taken to germination (DTG), germination percentage (GP) and days taken to reach grafting stage (DTRGS)

Treatment	Observation of rootstock and scion		
	DTG	GP %	DTRGS
D1: 15th July	11.07	71.27	39.13
D2: 1st Aug	10.73	73.87	36.40
D3: 15th Aug	8.93	75.47	34.73
D4: 1st Sept	8.33	78.27	33.73
S.Em. \pm	0.15	0.36	0.22
CD at 5%	0.44	1.02	0.64
Variety and Rootstock			
R0: <i>Solanum torvum</i>	21.25	59.50	62.67
V1: Manjarigota	7.50	71.75	30.83
V2: Phule Harit	7.67	70.42	29.75
V3: Krishna	6.42	84.08	28.58
V4: Phule Arjun	6.00	84.75	28.17
S.Em. \pm	0.17	0.38	0.25
CD at 5%	0.50	1.10	0.72
Interaction			
D1R0	23.33	55.67	68.33
D1V1	8.67	68.67	34.33
D1V2	9.33	67.67	32.67
D1V3	7.33	82.33	30.33
D1V4	6.67	82.00	30.00
D2R0	22.33	62.00	62.33
D2V1	8.67	71.00	31.00
D2V2	8.67	70.00	29.67
D2V3	7.33	83.00	29.67
D2V4	6.67	83.33	29.33
D3R0	20.33	65.00	61.00
D3V1	6.67	72.00	29.33
D3V2	6.33	71.00	29.00
D3V3	5.67	84.00	27.33
D3V4	5.67	85.33	27.00
D4R0	19.00	67.67	59.00
D4V1	6.00	75.33	28.67
D4V2	6.33	73.00	27.67
D4V3	5.33	87.00	27.00
D4V4	5.00	88.33	26.33
S.Em. \pm	0.35	0.80	0.50
CD at 5%	0.99	2.29	1.44

Table 3: Effect of date and varieties on days taken to graft healing (DTGH), Days taken to sprouting (DTS), days taken to transplanting (DTT) and graft success (%)

Treatment	Observation of grafted plant			
	DTGH	DTS	DTT	Graft Success %
D1: 15th July	5.91	9.43	20.17	84.23
D2: 1st Aug	4.56	8.27	18.97	94.42

D3: 15th Aug	4.98	8.88	19.64	88.89
D4: 1st Sept	4.63	8.44	19.19	92.75
S.Em.±	0.06	0.12	0.13	0.42
CD at 5%	0.17	0.36	0.37	1.21
Variety				
V1: Manjarigota	5.75	9.66	20.62	87.21
V2: Phule Harit	5.70	9.20	19.86	85.89
V3: Krishna	4.40	8.20	18.87	93.03
V4: Phule Arjun	4.23	7.96	18.62	94.17
S.Em.±	0.06	0.12	0.13	0.42
CD at 5%	0.17	0.36	0.37	1.21
Interaction				
D1V1	6.25	9.74	20.71	79.93
D1V2	6.08	9.55	20.18	78.11
D1V3	5.73	9.36	20.03	88.89
D1V4	5.57	9.08	19.74	90.00
D2V1	5.37	9.71	20.48	92.22
D2V2	5.40	8.58	19.24	91.11
D2V3	3.90	7.57	18.23	96.55
D2V4	3.57	7.24	17.91	97.78
D3V1	6.13	9.77	20.82	86.67
D3V2	5.80	9.55	20.21	85.55
D3V3	4.07	8.17	18.84	91.11
D3V4	3.93	8.03	18.70	92.22
D4V1	5.23	9.43	20.45	90.00
D4V2	5.53	9.12	19.79	88.78
D4V3	3.90	7.72	18.38	95.56
D4V4	3.87	7.48	18.15	96.67
S.Em.±	0.12	0.25	0.26	0.85
CD at 5%	0.35	0.71	0.74	2.45

Conclusion

The present study showed that *Solanum torvum* was more compatible with var. Phule Arjun when grafted on 1st August. It was reported significantly lowest days for graft healing, graft sprouting and days taken to reach grafting stage. The variety Phule Arjun also took the minimum days for germination, days taken for grafting stage and highest germination percentage when sown for the 1st September grafting date.

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