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EFFECT OF DIFFERENT SALINITY LEVELS ON LEAF AND FLOWERING ATTRIBUTES OF BRINJAL VARIETIES GRAFTED ON *SOLANUM TORVUM*

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ABSTRACT

The current experiment was conducted at College of Agriculture, Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) during the year 2020 and 2021. The pot experiment was laid out in Factorial Randomized Block Design (FRBD) which was replicated twice with two factors, *i.e.*, Grafts (on *Solanum torvum i.e.*, Phule Arjun, Phule Harit, Krishna and Manjari Gota by adopting cleft method) and Salinity levels (*i.e.*, Control, 2, 3, 4 and 5 dS m^{-1}). Among the different varieties grafted on *Solanum torvum* Phule Harit showed significantly superior performance for leaf area and number of flowers. However, number of leaves and minimum days to 50 per cent flowering was recorded in Phule Arjun. Among the different salinity levels minimum days required for 50 per cent flowering was observed at higher level of concentration. In interactions, Phule Harit grafted on *Solanum torvum* was found maximum for leaves at 3.00, 4.00 and 5.00 dS m^{-1}. While, Manjari Gota grafted on *Solanum torvum* was observed maximum for flowers at 3.00, 4.00 and 5.00 dS m^{-1}.

Key words : Brinjal, Egg plant, *Solanum torvum*, Salinity levels, Flowering and Leaf attributes.

Introduction

Brinjal is one of the widely distributed and cultivated species of solanaceae family. It is a native of India (De Candolle, 1984) and often known as poor man's vegetable throughout the world. In India, brinjal occupies an area of 0.73 million hectares with production of 12.98 million metric tons and productivity of 19.10 tons per hectare (Anonymous, 2022a). It is well distributed in Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, Maharashtra and Uttar Pradesh. Eggplant is a rich source of nutrients, low in calories and fats, contains mostly water, fiber, good source of minerals and vitamins and rich in total water-soluble sugars, free reducing sugars, amide proteins among other nutrients. Brinjal is valued for its medicinal properties, beneficial for diabetic patients and an excellent remedy for those suffering from liver complaints (Yarmohammadi *et al.*, 2021 and Sharma *et al.*, 2021).

Drought and salinity are the major environmental factors which reduces crop productivity of which salinity is detrimental in limiting plant growth and crop productivity (Schwarz *et al*., 2010). Salinity in soil or water is a serious threat to plant growth that prevents plants in achieving their genetic potential. Its annual damage is about 20 per cent of the world's crops grown under irrigation (Roy choudhury *et al*., 2013). Ongoing efforts to improve salt tolerance in brinjal using plant breeding, biotechnological approaches and other management practices have met with limited success due to genetic and physiological complexity of the traits involved in salt tolerance (Colla *et al*., 2010). Brinjal is moderately sensitive to salinity, consequently more attention is required in agricultural production of this crop with important rootstocks and its

varieties. Grafting offers an alternative to breeding and biotechnological approaches to rapidly enhance salt tolerance in vegetable crops (Keatinge *et al.*, 2014). Grafting is an integrative reciprocal process involves union of rootstock and scion together from two different plant parts to form a single, living plant (Kumar, 2011) therefore, both scion and rootstock influence salt tolerance of grafted plants (Etehadnia *et al*., 2008). The use of salt tolerant rootstocks has been suggested as a valid approach to enhance salt tolerance in many vegetable crops, particularly in Solanaceous and Cucurbitaceous crops (Colla *et al*., 2010). The main rootstocks are used for grafting brinjal is *Solanum torvum* and *Solanum xanthocarpum* (King *et al*., 2010). Thus, the study of selection of rootstock-scion combinations with enhanced tolerance to salinity requires a better understanding of rootstock influence on ion exclusion and biochemical changes. Though extensive research has been carried out to examine salt induced morphological, biochemical and physiological changes in brinjal (Akinci *et al.*, 2004), there is no research on the effect of salinity in grafted brinjal.

Materials and Methods

The present experiment was conducted at College of Agriculture, Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the year 2020 and 2021. The experiment was laid out in Factorial Randomized Block Design (FRBD) with two replications (Table 1) and it consisted of two factors, *i.e.*,

Table 1 : Treatment details of experiment.

Factor A: Grafts	**Factor B: Salinity levels**
A_1: Phule Arjun grafted on *Solanum torvum*	B_1: Control
A_2: Phule Harit grafted on *Solanum torvum*	B_2: 2.00 dSm^{-1}
A_3: Krishna grafted on *Solanum torvum*	B_3: 3.00 dSm^{-1}
A_4: Manjari Gota grafted on *Solanum torvum*	B_4: 4.00 dSm^{-1}
	B_5: 5.00 dSm^{-1}

Treatment Combinations			
Tr. no.	**Details of treatment combinations**	**Treatment combinations**	**EC dSm^{-1}**
T_1	Phule Arjun grafted on *Solanum torvum*	A_1B_1	Control
T_2	Phule Arjun grafted on *Solanum torvum*	A_1B_2	2
T_3	Phule Arjun grafted on *Solanum torvum*	A_1B_3	3
T_4	Phule Arjun grafted on *Solanum torvum*	A_1B_4	4
T_5	Phule Arjun grafted on *Solanum torvum*	A_1B_5	5
T_6	Phule Harit grafted on *Solanum torvum*	A_2B_1	Control
T_7	Phule Harit grafted on *Solanum torvum*	A_2B_2	2
T_8	Phule Harit grafted on *Solanum torvum*	A_2B_3	3
T_9	Phule Harit grafted on *Solanum torvum*	A_2B_4	4
T_{10}	Phule Harit grafted on *Solanum torvum*	A_2B_5	5
T_{11}	Krishna grafted on *Solanum torvum*	A_3B_1	Control
T_{12}	Krishna grafted on *Solanum torvum*	A_3B_2	2
T_{13}	Krishna grafted on *Solanum torvum*	A_3B_3	3
T_{14}	Krishna grafted on *Solanum torvum*	A_3B_4	4
T_{15}	Krishna grafted on *Solanum torvum*	A_3B_5	5
T_{16}	Manjari Gota grafted on *Solanum torvum*	A_4B_1	Control
T_{17}	Manjari Gota grafted on *Solanum torvum*	A_4B_2	2
T_{18}	Manjari Gota grafted on *Solanum torvum*	A_4B_3	3
T_{19}	Manjari Gota grafted on *Solanum torvum*	A_4B_4	4
T_{20}	Manjari Gota grafted on *Solanum torvum*	A_4B_5	5

Grafts and Salinity levels. There were four varieties grafted on *Solanum torvum* and five levels of salinity. The seeds of *Solanum torvum* (Turkey Berry) used as rootstock and varieties/hybrids adopted and released for Maharashtra region has been selected as scions of brinjal *viz*., Phule Arjun (F_1), Phule Harit, Krishna (F_1) and Manjari Gota were obtained from Senior Vegetable Breeder, All India Co-ordinated Research Project (AICRP) on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra.

Total number of leaves were measured by counting each individual leaf at every 20 days interval after transplanting. The readings were taken from the tagged plants and average was worked out and expressed in numbers. The leaf area was taken on five leaves per plant were randomly selected at peak harvesting period and average leaf area was measured with the help of Leaf Area Meter and expressed in centimeter square (cm^2). Number of days required from transplanting to the date on which 50 per cent of the plants showed the flowering were counted. Total number of flowers per plant was recorded regularly from observational plants by counting of individual flower. Average was worked out and expressed in numbers. The data obtained during experiment were analyzed as per the standard statistical methods prescribed by Panse and Sukhatme (1985).

Results and Discussion

The data on leaf parameters namely, number of leaves per plant, leaf area, days for 50 per cent flowering and number of flowers per plant of brinjal under the influence of different salt concentrations was furnished in Tables 2-4. In pooled mean, among grafts, significantly the highest number of leaves per plant had recorded in Phule Arjun at 20, 40, 60, 80, 100, 120, 140, 160 and 180 DAT (8.25, 12.83, 17.69, 21.24, 23.74, 27.32, 31.04, 33.46 and 34.27, respectively). Whereas, significantly the lowest number of leaves per plant was observed in Krishna at 20 DAT (6.14); Manjari Gota at 100, 160 and 180 DAT (18.40, 20.47 and 18.80, respectively) and Phule Harit at 40, 60, 80, 120 and 140 DAT (8.86, 12.13, 15.78, 19.59 and 20.62, respectively) grafted on *Solanum torvum*. The maximum leaf area (106.55 cm^2) was found in Phule Harit grafted on *Solanum torvum*. Whereas, significantly the minimum leaf area (39.56 cm^2) was observed in Manjari Gota grafted on *Solanum torvum*. Phule Arjun grafted on *Solanum torvum* was recorded minimum days required for 50 per cent flowering (31.39) and the maximum days to 50 per cent flowering was recorded in Phule Harit grafted on *Solanum torvum* (39.85 days). Flowering is earlier in the self-rooted plants as compared

Fig. 1 : Effect of different salinity levels on leaves of brinjal varieties (Phule Arjun, Phule Harit, Krishna and Manjari Gota) grafted on *Solanum torvum*.

to grafted plants which might be due to the fact that grafting caused stress and delayed flower formation. As grafted plants needs time to acclimatize in field condition where formation of graft union delays the early establishment of plant which may affect the reproductive organs without effecting vegetative growth in the grafted plants at early stages, later, grafted plants significantly influenced the flowering because of wild habit and vigorous root system of rootstock as wild cultivars have gregarious flowering nature. Vigorous plants by grafting extended the growth period and luxurious growth and delayed flowering. The highest number of flowers per plant (30.49) was noted in Manjari Gota grafted on *Solanum torvum*. Whereas, significantly the lowest number of flowers per plant (26.00) was recorded in Krishna grafted on *Solanum torvum*. The rootstock-scion combination may alter number of hormones produced in grafted plants which resulted in maximum number of flowers in grafted plants than non grafted plants. The present study gets ample support from the work of Khah *et al.* (2006); Mohamed *et al.* (2012) and Kumar *et al.* (2016), Rathod (2017), Sabatino *et al.* (2019), Ulas *et al.* (2021) Musa *et al.* (2020) and Sarswat *et al.* (2020).

Under the different salt concentrations, the highest number of leaves per plant was found in control at 60, 80, 100, 120, 140, 160 and 180 DAT (18.49, 22.47, 25.96,

Table 2 : Effect of different salinity levels on number of leaves per plant of brinjal varieties grafted on *Solanum torvum.*

Factors	Treatment Details	Number of leaves per plant (Pooled mean)								
		20 DAT	40 DAT	60 DAT	80 DAT	100 DAT	120 DAT	140 DAT	160 DAT	180 DAT
Factor A: Grafts										
A_1	Phule Arjun grafted on *Solanum torvum*	8.25	12.83	17.69	21.24	23.74	27.32	31.04	33.46	34.27
A_2	Phule Harit grafted on *Solanum torvum*	6.23	8.86	12.13	15.78	17.49	19.59	20.62	23.44	23.68
A_3	Krishna grafted on *Solanum torvum*	6.14	11.26	16.37	19.76	22.00	26.84	29.55	29.30	27.08
A_4	Manjari Gota grafted on *Solanum torvum*	7.86	10.90	14.86	16.70	18.40	20.59	21.80	20.47	18.80
	SE (m) ±	**0.386**	**0.746**	**0.221**	**0.340**	**0.198**	**0.227**	**0.376**	**0.365**	**0.325**
	C.D at 5 %	**1.150**	**2.223**	**0.658**	**1.014**	**0.592**	**0.677**	**1.121**	**1.089**	**0.969**
Factor B: Salinity levels										
B_1	0 dS m^{-1}	7.33	12.31	18.49	22.47	25.96	31.42	34.44	36.92	36.71
B_2	2.00 dS m^{-1}	7.79	10.99	16.48	19.83	22.14	27.43	30.30	31.83	29.27
B_3	3.00 dS m^{-1}	6.59	10.13	14.66	18.60	20.13	21.99	24.20	24.39	24.46
B_4	4.00 dS m^{-1}	6.80	10.99	14.10	16.50	18.05	19.50	21.00	21.69	21.75
B_5	5.00 dS m^{-1}	7.10	10.41	12.58	14.44	15.77	17.58	18.83	18.51	17.60
	SE (m) ±	**0.431**	**0.834**	**0.247**	**0.380**	**0.222**	**0.254**	**0.420**	**0.408**	**0.363**
	C.D at 5 %	**NS**	**NS**	**0.736**	**1.134**	**0.662**	**0.757**	**1.254**	**1.218**	**1.084**
A x B: Interactions										
T_1	A_1B_1	7.44	13.07	19.44	26.50	28.88	33.32	38.50	41.13	43.88
T_2	A_1B_2	8.82	12.32	19.32	22.57	27.38	31.13	33.63	36.75	39.07
T_3	A_1B_3	7.38	12.38	17.69	21.01	23.13	26.13	31.25	33.25	34.25
T_4	A_1B_4	7.69	12.25	16.63	19.94	21.57	24.38	28.32	31.44	32.69
T_5	A_1B_5	9.94	14.13	15.38	16.19	17.76	21.63	23.50	24.75	21.44
T_6	A_2B_1	7.44	9.83	15.88	21.07	25.13	28.63	27.38	33.38	35.82
T_7	A_2B_2	6.51	8.88	12.82	17.75	19.59	23.26	24.74	27.50	26.50
T_8	A_2B_3	5.38	7.75	11.38	14.19	15.07	16.50	18.50	20.50	20.51
T_9	A_2B_4	6.26	8.94	10.94	13.57	14.57	15.13	16.00	18.25	18.13
T_{10}	A_2B_5	5.59	8.92	9.63	12.32	13.13	14.44	16.50	17.59	17.44
T_{11}	A_3B_1	6.69	12.75	21.13	21.82	25.00	35.07	41.38	43.00	42.25
T_{12}	A_3B_2	6.19	10.82	17.69	21.94	23.26	32.75	37.50	38.63	27.75
T_{13}	A_3B_3	6.32	11.63	16.07	23.13	24.57	26.32	27.00	25.38	25.07
T_{14}	A_3B_4	5.57	11.69	13.94	16.90	19.74	21.07	21.63	21.25	21.94
T_{15}	A_3B_5	5.94	9.44	13.01	15.00	17.44	19.01	20.25	18.25	18.38
T_{16}	A_4B_1	7.75	13.61	17.50	20.51	24.82	28.69	30.50	30.19	24.88
T_{17}	A_4B_2	9.63	11.94	16.09	17.07	18.36	22.57	25.32	24.46	23.75
T_{18}	A_4B_3	7.28	8.76	13.51	16.07	17.75	19.01	20.07	18.44	18.00
T_{19}	A_4B_4	7.69	11.07	14.88	15.62	16.32	17.44	18.07	15.81	14.26
T_{20}	A_4B_5	6.94	9.14	12.32	14.26	14.75	15.25	15.07	13.44	13.13
	SE (m) ±	**0.862**	**1.667**	**0.493**	**0.760**	**0.444**	**0.508**	**0.841**	**0.817**	**0.727**
	C.D at 5 %	**NS**	**NS**	**1.471**	**2.267**	**1.323**	**1.514**	**2.507**	**2.435**	**2.168**

DAT- Days After Transplanting; NS-Non-Significant.

31.42, 34.44, 36.92 and 36.71, respectively). While, the lowest number of leaves per plant was observed in 5 dS m^{-1} at 60, 80, 100,120,140,160 and 180 DAT (12.58, 14.44, 15.77, 17.58, 18.83, 18.51 and 17.60, respectively). The maximum leaf area was found in the control was 107.49 cm^2. While, minimum leaf area (64.41 cm^2) was observed in 5 dS m^{-1}. High salinity also causes smaller leaves, a reduction in intercellular spaces (empty and non-empty

Table 3 : Effect of different salinity levels on leaf area (cm^2) in brinjal varieties grafted on *Solanum torvum*.

Factors	Treatment details	Leaf area (cm^2)
A_1	Phule Arjun grafted on *Solanum torvum*	97.53
A_2	Phule Harit grafted on *Solanum torvum*	106.55
A_3	Krishna grafted on *Solanum torvum*	88.36
A_4	Manjari Gota grafted on *Solanum torvum*	39.56
	SE (m) ±	**0.235**
	C.D at 5%	**0.702**
B_1	0 dS m^{-1}	107.49
B_2	2.00 dS m^{-1}	93.66
B_3	3.00 dS m^{-1}	78.08
B_4	4.00 dS m^{-1}	71.37
B_5	5.00 dS m^{-1}	64.41
	SE (m) ±	**0.263**
	C.D at 5 %	**0.785**
T_1	A_1B_1	120.21
T_2	A_1B_2	107.68
T_3	A_1B_3	94.18
T_4	A_1B_4	86.12
T_5	A_1B_5	79.49
T_6	A_2B_1	135.12
T_7	A_2B_2	120.11
T_8	A_2B_3	100.45
T_9	A_2B_4	90.61
T_{10}	A_2B_5	86.46
T_{11}	A_3B_1	115.59
T_{12}	A_3B_2	98.29
T_{13}	A_3B_3	87.04
T_{14}	A_3B_4	74.84
T_{15}	A_3B_5	66.07
T_{16}	A_4B_1	59.06
T_{17}	A_4B_2	48.55
T_{18}	A_4B_3	30.68
T_{19}	A_4B_4	33.90
T_{20}	A_4B_5	25.62
	SE (m) ±	**0.526**
	C.D at 5 %	**1.569**

spaces between cells) and a decrease in the number of chloroplasts. The leaves have thickened and liquefied (Shannon, 1994). The highest number of flowers per plant (32.90) was observed in the control. The minimum number of flowers per plant (22.24) was recorded in 5 dS m^{-1}. The result of the present investigation is in accordance with the finding of Uddin *et al.* (2016), in which increased salt concentration at root zone up to certain extend may increase the number of flowers, but if it is too higher levels may drastically affect on flower number. The minimum days required for 50 per cent flowering was recorded in 5 dS m^{-1} (30.96 days). While, significantly maximum days to 50 per cent flowering was found in the control (40.52 days).

Among the treatment combinations, the maximum number of leaves were recorded in Krishna grafted on *S. torvum* with control at 60, 120, 140 and 160 DAT (21.13, 35.07, 41.38 and 43.00, respectively) and Phule Arjun grafted on *S. torvum* with control at 80,100 and 180 DAT (26.50, 28.88 and 43.88, respectively). Whereas, significantly the lowest number of leaves per plant was recorded in the Phule Harit grafted on *Solanum torvum* with 5 dS m^{-1} at 60, 80, 100 and 120 DAT (9.63, 12.32, 13.13 and 14.44, respectively) and Manjari Gota grafted on *Solanum torvum* with 5 dS m^{-1} at 140, 160 and 180 DAT (15.07,13.44 and 13.13, respectively). Phule Harit grafted on *S. torvum* with control was recorded significantly the maximum leaf area (135.12 cm^2). Phule Harit grafted on *Solanum torvum* was proved to be maximum for leaf area at 3.00, 4.00 and 5.00 dS m^{-1} (100.45 cm^2, 90.61 cm^2 and 86.46 cm^2, respectively). Whereas, significantly the lowest leaf area was observed in Manjari Gota grafted on *Solanum torvum* with 5 dS m^{-1} (25.62 cm^2). Grafting increased both leaf area and leaf number. More leaf area means more photosynthesis potential, which helps to maintain vigour and achieve potential yield (Hartmann *et al.*, 2002). The minimum days to 50 per cent flowering (27.24) were noted in Phule Arjun grafted on *S. torvum* with 5 dS m^{-1}. However, the maximum days to 50 per cent flowering was noted in Manjari Gota grafted on *S. torvum* with control was 43.51 days. Manjari Gota grafted on *S. torvum* with control

Table 4 : Effect of different salinity levels on flowering parameters of brinjal varieties grafted on *Solanum torvum.*

Factors	Treatment details	Days to 50 per cent flowering (Pooled mean)	Number of flowers per plant (Pooled mean)
A_1	Phule Arjun grafted on *Solanum torvum*	31.39	27.79
A_2	Phule Harit grafted on *Solanum torvum*	39.85	26.05
A_3	Krishna grafted on *Solanum torvum*	36.86	26.00
A_4	Manjari Gota grafted on *Solanum torvum*	35.84	30.49

Table 4 continued...

Table 4 continued...

	SE (m) ±	**0.300**	**0.158**
	C.D at 5 %	**0.895**	**0.471**
B_1	0 dS m^{-1}	40.52	32.90
B_2	2.00 dS m^{-1}	39.10	30.15
B_3	3.00 dS m^{-1}	35.20	27.33
B_4	4.00 dS m^{-1}	34.16	25.30
B_5	5.00 dS m^{-1}	30.96	22.24
	SE (m) ±	**0.336**	**0.177**
	C.D at 5 %	**1.001**	**0.527**
T_1	A_1B_1	34.54	33.95
T_2	A_1B_2	33.12	31.53
T_3	A_1B_3	31.21	27.23
T_4	A_1B_4	30.87	25.28
T_5	A_1B_5	27.24	20.69
T_6	A_2B_1	41.89	28.38
T_7	A_2B_2	40.80	27.13
T_8	A_2B_3	39.64	26.32
T_9	A_2B_4	38.83	24.75
T_{10}	A_2B_5	38.12	23.69
T_{11}	A_3B_1	42.13	33.91
T_{12}	A_3B_2	40.98	30.44
T_{13}	A_3B_3	37.08	26.00
T_{14}	A_3B_4	34.93	22.19
T_{15}	A_3B_5	29.19	17.44
T_{16}	A_4B_1	43.51	35.37
T_{17}	A_4B_2	41.52	31.52
T_{18}	A_4B_3	32.86	29.78
T_{19}	A_4B_4	32.02	28.67
T_{20}	A_4B_5	29.29	27.14
	SE (m) ±	**0.671**	**0.353**
	C.D at 5 %	**2.001**	**1.054**

was recorded significantly the highest number of flowers per plant (35.37). Whereas, significantly the lowest number of flowers per plant (17.44) were recorded in Krishna grafted on *Solanum torvum* with 5 dS m^{-1}.

Conclusion

The experiment was showing that significant differences in leaf number, leaf area, number of flowers per plant and 50 percent flowering in various scion and rootstock combinations and salinity levels. Phule Arjun grafted onto *Solanum torvum* recorded the highest number of leaves at various growth stages, mainly under non-saline (control) and mild saline conditions (3.00, 4.00 dS m^{-1}), while Phule Harit revealed the largest leaf area, representative varietal influence. Salinity stress especially reduced both leaf number and leaf area, with the lowermost values recorded at 5 dS m{ ¹, highlighting salinity's suppressive effect on leaf growth and development. Particularly Phule Arjun and Krishna on S. torvum, maintained better vegetative growth under control and low salinity. These research findings propose that

grafting, particularly under saline conditions, significantly enhance the vegetative growth attributes like as leaf number and leaf area, which are most important for crop vigor and yield potential.

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