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Performance of grafted brinjal (*Solanum melongena* L) under different spacing and fertigation levels

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Abstract
The brinjal (*Solanum melongena* L.) variety COBH 2 was grafted on *Solanum torvum* and the grafts were planted in the field to standardize spacing and fertigation levels. A strip plot design was adopted with four levels of spacing (1 m x 1 m, 2 m x 1 m, 1.5 m x 1.5 m and 0.6 m x 0.6 m) and three levels of fertigation (75, 100 and 125 % RDF) replicated four times. After six months the plants were pruned to obtain ratoon crop which was maintained for four 4 months. The days taken for 50 per cent flowering and first harvest were nutrition and neither spacing nor interaction. The 75 and 100 per cent RDF were on par for early flowering (32.00 and 32.38 days in main crop; 16.88 and 17.00 days in ratoon crop); and early harvest (44.38 and 45.44 days in main crop; 34.38 and 35.56 days in ratoon crop) (Figure 1). The widest spacing (1.5 m x 1.5 m) recorded the highest fruit weight (67.44 and 63.71 g) and number of 269.44 and 136.71 fruits plant^{-1} in main and ratoon crops respectively. However, the closest spacing (1 m x 1 m) recorded the highest marketable yield of 98.47 and 57.91 t ha^{-1} in main and ratoon crop respectively. The highest fruit weight (69.79 and 65.96 g) was recorded under highest nutrition level (125 % RDF) in both main and ratoon crops. However, the maximum number of marketable fruits plant^{-1} (191.43 and 98.79 fruits plant^{-1}) and marketable yield ha^{-1} (87.24 and 44.79 t ha^{-1}) were observed under 100 per cent RDF. The treatment combination 1 m x 1 m + 100 per cent RDF recorded the highest marketable yield of 110.25 and 59.42 t ha^{-1} in main and ratoon crops respectively.

Keywords: Spacing, drip fertigation, brinjal grafts, earliness, yield parameters

1. Introduction
Grafting of brinjal cultivars on perennial and wild *Solanaceous* species was proved to increase the yield and availability period of the fruits (Lee, 1994; Carmina *et al*., 2011) [16]. The use of *S. torvum* as rootstock was reported to confer resistance to *Verticillium* wilt, *Fusarium* wilt, bacterial wilt and root knot nematode (Sebahattin *et al*., 2005) [28]; (King *et al*., 2008) [14]. Grafting is also high effective in ameliorating crop losses caused by adverse environmental conditions (Dietmar *et al*., 2010) [7].
The use of vegetable grafts will be most successful when complemented with sustainable farming system practices (Kubota, 2008) [15]. Among them, plant spacing is an important agronomic attribute since it is believed to have effects on light interception for photosynthesis which is the energy manufacturing medium using green parts of the plant. Also it affects rhizosphere exploitation by the plants (Ibeawuchi *et al*., 2008) [13]. Plant nutrition also plays an important role for enhancing yield of brinjal. Fertilizers applied under traditional methods are generally not utilized efficiently by the crop; while in drip fertigation nutrients are applied directly into the zone of maximum root activity and consequently fertilizer-use efficiency can be improved over conventional method of fertilizer application (Hebbar *et al*., 2004) [12].
However, according to Colla *et al.* (2006) [6] and Arao *et al*. (2008) [2], available information on spacing and nutrition for grafted plants is not sufficient for commercial cultivation. Therefore, this study was initiated with the aim to provide the results of field experiment on effect of spacing and spacing and drip fertigation on earliness and yield parameters in Brinjal (*Solanum melongena* L) grafted onto *Solanum torvum*.

2. Material and Methods
The experiment was carried out at the University Orchard, Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The study location is situated at 11° North latitude and 77° East longitude and at an elevation of 426.6 m above mean sea level. *Solanum torvum* was used as rootstock and the scion was Brinjal (*S. melongena* L.) F_1 Hybrid, COBH 2.
A strip plot design was adopted with four levels of spacing (S1: 1 m x 1m, S2: 2 m x 1 m, S3: 1.5 m x 1.5 m and S4: 0.6 m x 0.6 m) and three levels of fertigation (F1: 75 % RDF, F2: 100 % RDF and F3: 125 % RDF) replicated four times replicated four times.

The recommended dose of fertilizer (RDF) adopted was 200:150: 100 kg of N: P: K ha^{-1}. Drip lines were laid to cover entire area of the field and planting was done in *kharif* season during June 2011 by using forty days old, vigourous and healthy grafts. 75 per cent of P was given as basal application along with 25 t ha^{-1} farm yard manure. 25 per cent of P was given along with N and K through fertigation in equal splits from third week after planting. Fertilizers applied through fertigation were in the form of NPK 19:19:19, Mono Ammonium Phosphate (12:61:0), Potassium nitrate (13:0:45) and urea. Recommended cultural practices were followed. After six months the plants were pruned to obtain ratoon crop which was maintained four 4 months. The data were recorded for days to 50 per cent flowering, days to first harvest, fruit weight, number of marketable fruits per plant, marketable yield per plant, marketable yield per hectare.

Analysis of variance was performed for all the recorded data by using *M Stat-C* Software package and the level of significance was set at $p<0.05$. LSD test was conducted for pairwise comparisons of means.

3. Results and Discussion

3.1 Effect of spacing and fertigation levels on days to 50 per cent flowering and first harvest in brinjal grafts

The days taken to 50 per cent were significantly affected by fertigation levels and neither spacing nor interaction. The results are presented in figure 1.

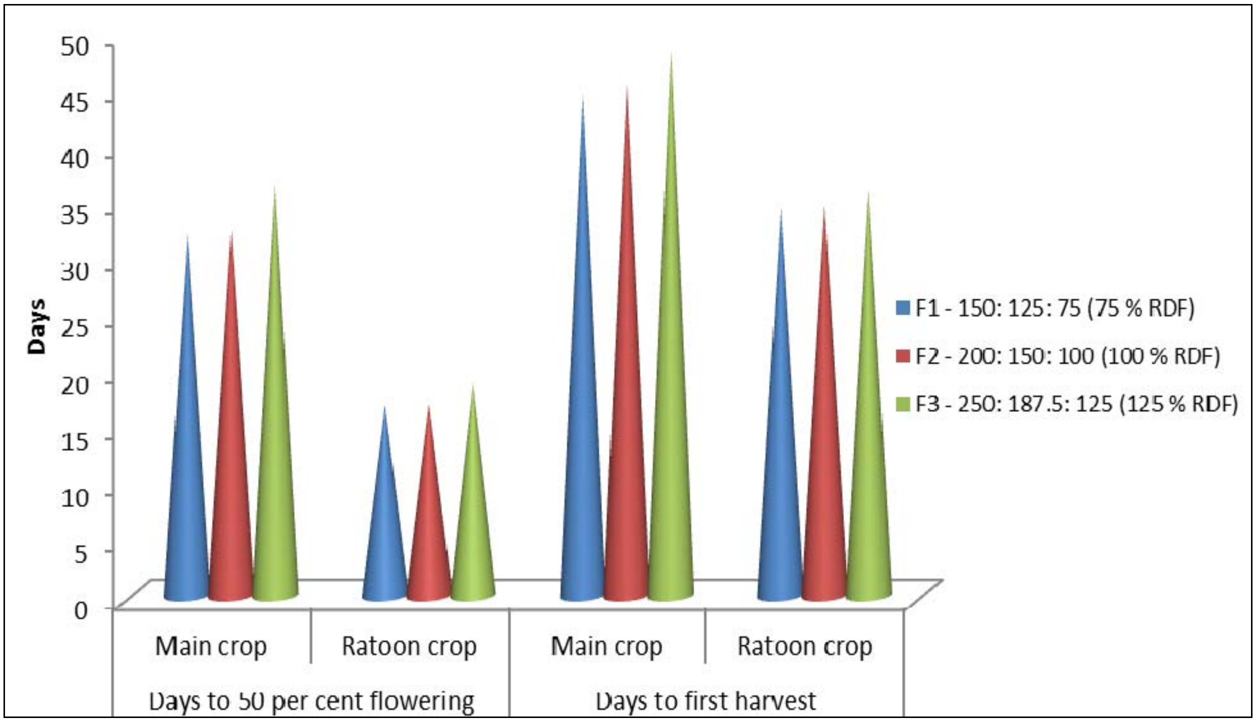

Fig 1: Effect of fertigation levels on days to 50 per cent flowering and first harvest in brinjal grafts

The 75 and 100 per cent RDF were on par for early flowering (32.00 and 32.38 days in main crop; 16.88 and 17.00 days in ratoon crop); and early harvest (44.38 and 45.44 days in main crop; 34.38 and 35.56 days in ratoon crop) (Figure 1). The reason for which spacing did not affect significantly the days to 50 per cent flowering and first harvest could be that, at the initial stage up to the first harvest, there was no competition for space among different spacing levels. Similar results were also recorded by Birbal *et al*. (1995) [4] in okra and Saggam and Yazgan (1995) [25] in tomato.

Plants receiving 125 per cent RDF took longer periods for 50 per cent flowering and first harvest. This may be attributed to the influence of higher level of nitrogen in delaying initiation of flowering due to prolonged vegetative phase (Rajangam, 1991) [23]. Similar results were found by He and Chen (1996) [11] in tomato and Suthar *et al.* (2005) in brinjal.

3.2 Effect of spacing and fertigation levels on yield parameters in brinjal grafts

Spacing, fertigation levels and their interaction significantly affected yield parameters viz., fruit weight, number of marketable fruits per plant, marketable yield per plant and per hectare in both main and ratoon crops (Table 1, Figure 2).

Table 1: Effect of spacing and fertigation on yield parameters in brinjal grafts

Treatment	Main crop			Ratoon crop		
	Fruit weight (g)	Number of marketable fruits plant^{-1}	Marketable yield plant^{-1} (kg plant^{-1})	Fruit weight (g)	Number of marketable fruits plant^{-1}	Marketable yield plant^{-1} (kg plant^{-1})
Factor A: Spacing (S)						
S1-1m x1 m	61.12c	173.24b	10.36c	60.21c	95.85c	5.56c
S2-2m x 1m	64.90b	233.31a	14.82b	62.06b	119.88b	7.23b
S3-1.5m x 1.5m	67.44a	243.30a	16.07a	63.71a	126.32a	7.84a
S4-0.6x 0.6m	54.99d	48.96c	2.71d	54.07d	33.20d	1.58d
CD (*P* = 0.05)	0.49	16.68	1.12	1.03	5.00	0.23
Factor B: Fertigation						
F1- 75% RDF	53.71c	163.76b	8.87b	52.45c	89.16c	4.58b
F2- 100% RDF	62.85b	191.43a	12.23a	61.63b	98.79a	6.12a
F3- 125% RDF	69.79a	168.94b	11.87a	65.96a	93.49b	6.05a
CD (*P* = 0.05)	0.81	10.05	0.69	1.59	3.92	0.30
Interaction (S x N)						
S1F1	52.11i	162.92e	8.42e	51.21g	88.26h	4.29e
S1F2	62.17e	190.50d	12.30d	61.22d	105.83f	6.26d
S1F3	69.09c	166.32e	12.38d	67.22ab	93.45g	6.14d
S2F1	56.14g	217.23c	12.09d	54.79f	115.68e	6.11d
S2F2	65.74d	258.61a	17.49b	64.84c	124.20bc	7.83b
S2F3	72.82b	224.10bc	17.398b	66.55b	119.75d	7.74b
S3F1	59.06f	229.25b	13.40c	57.16e	121.34cd	6.71c
S3F2	68.90c	267.72a	18.92a	66.75b	130.23a	8.47a
S3F3	74.37a	232.93b	18.35a	68.19a	127.41ab	8.34a
S4F1	47.54j	45.64f	2.17g	46.64h	31.34i	1.23g
S4F2	54.61h	48.88f	2.67f	53.71f	34.90i	1.66f
S4F3	62.83e	52.39f	3.29f	61.86d	33.35i	1.85f
CD (*P* = 0.05)	0.83	10.00	0.60	1.15	3.81	0.36
Grand mean CV (%)	62.11 0.90	174.71 3.85	10.99 3.92	60.01 1.29	93.81 2.73	5.55 4.39

The mean followed by the same letter not different at p = 0.05

The plants spaced by 1.5 m x 1.5 m recorded the highest fruit weight (67.44 and 63.71 g) and number of fruits plant^{-1} (243.30 and 126.32) in main and ratoon crops respectively (Table 1). Since the widest spaced plants had lowest competition for soil nutrients and light, it was most likely that they would produce more and bigger sized fruits (Sanches *et al*. 1993) [27]. The overlapping of plants at the closest spacing might have resulted in the inter-competition of light and soil nutrients leading to low fruit performances when compared to the wider spaced plants. Similar findings were also reported by Nanthakumar and Veeraraghavathatham (1999) [21] Anburani *et al.* (2003) [1] and Carmina *et al.* (2011) [5] in brinjal.

The closer spacing (1 m x 1 m) recorded the highest marketable yield (98.47 and 52.84 t ha^{-1}) in main and ratoon crops respectively (Figure 2). This could be attributed to the highest number of plants per hectare. Similarly, Reddy *et al*. (1990) [24] observed in brinjal that the highest yield per hectare was obtained at closest spacing. Mishriky and Alphonse (1994) [18] reported in bell pepper cv. California Wonder, number of fruits and yield per plant were decreased in closer spacing however total yield per hectare was increased. Singh and Saimbhi (1998) [26] opined that the magnitude of yield is influenced by plant population and its distribution pattern, which are important for getting maximum economic yield from a given field area. Comparable results were also obtained by Saggam and Yazgan (1995) [25] and Ganesan and Subbiah (2003) [9] in tomato.

The highest fruit weight (69.79 and 65.96 g) was recorded under highest nutrition level (125 % RDF) in main and ratoon crops respectively (Table 1). This could be attributed to the fact that the nitrogen up to certain level increases shoot and leaf growth, which would have helped in the synthesis of greater amount of carbohydrates and more efficient protein synthesis to the developing fruits and that may have resulted in increased number of cells as well as elongation of individual cells. This in turn might have enhanced the size of the fruits. Similar findings were also quoted by Reddy *et al.* (1990) [24] in brinjal and Gare (2002) [10] in chilli. Phosphorus as an important constituent of nucleoproteins is involved in high energy transfer compounds such as adenosine diphosphate and adenosine triphosphate and plays a key role in energy transfer in the metabolic processes. The potassium up to certain level would have also encouraged better utilization of assimilates through efficient transport to the developing fruits which acts as active sinks in brinjal (Marschner, 1995) [17]. In fact, the essential elements, particularly the primary nutrient elements N, P and K are supplied to plants to increase crop production. Nandekar and Sawarkar (1990) [20], Naik *et al*., (1996) [19] and Prabhu *et al.* (2003) [22] also reported in brinjal that the fruit size and weight increased with increasing levels of N and P.

The highest number of 191.43 and 98.79 marketable fruits plant^{-1} and marketable yield of 87.24 and 44.79 t ha^{-1} were observed under 100 per cent RDF in main and ratoon crops respectively (Table 1, Figure 2).

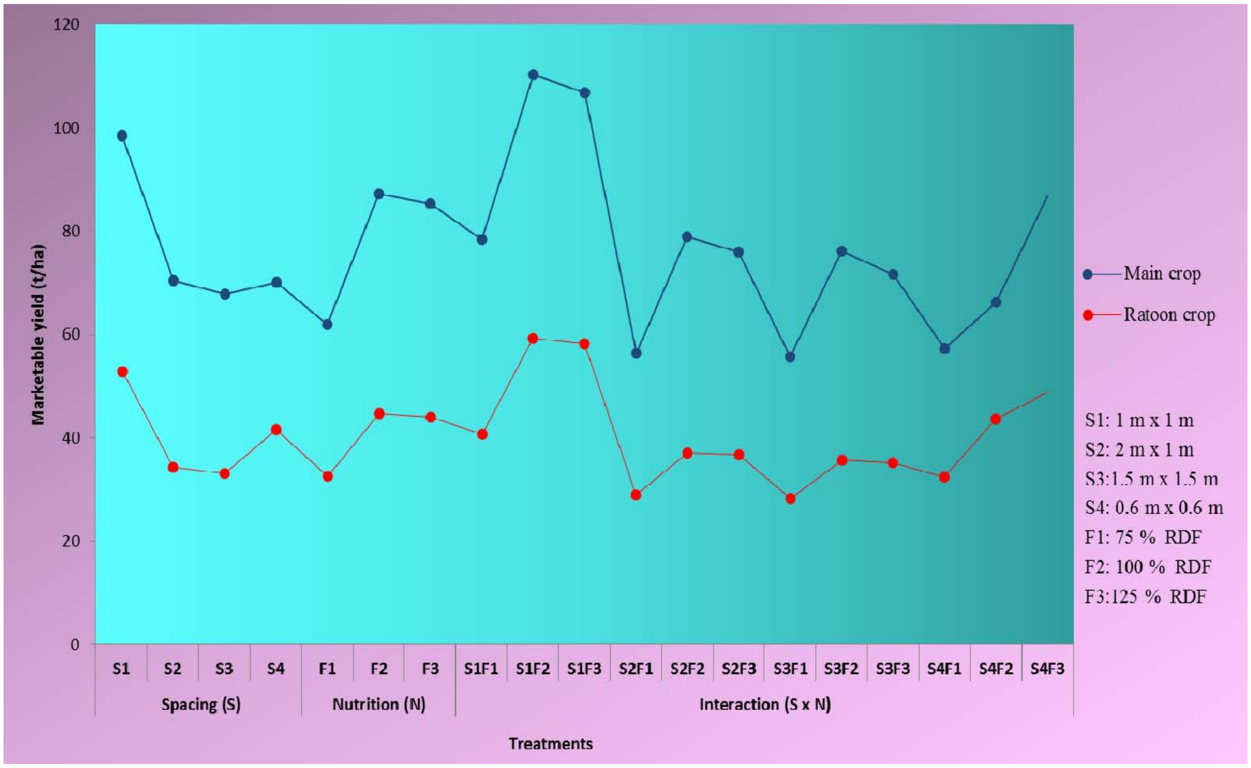

Fig 2: Influence of spacing and fertigation on marketable yield in brinjal grafts

The superiority of 100 over 125 per cent RDF for these parameters could be attributed to the fact that that excess fertilizer application, mainly nitrogen, is associated with vigorous vegetative growth and extended duration for flower bud appearance, leading to the reduction in potential number of fruits per plant. Batal *et al.* (1994) [3] and Everaarts (1994) [8] opined that excessive nitrogen fertilization may increase crop susceptibility to pests, diseases and physiological disorders, and will not always ensure that marketing yield is increased. Similar results were found by Birbal *et al.* (1995) [4] in okra, He and Chen (1996) [11] in tomato and Suthar *et al.* (2005) [29] in brinjal.

4. Conclusion

The study on standardization of spacing and fertigation in brinjal grafts revealed that the 1 m x 1 m spaced plants applied with 100 per cent RDF recorded lowest number days to 50 per cent flowering (31.50 and 16.50 days), days to first harvest (45.50 and 33.25 days) as well as the highest fruit yield (110.25 t ha^{-1} and 52.42 t ha^{-1}) for both main and ratoon crops. Therefore, cultivation of brinjal grafts under 1 m x 1 m spacing along with 100 per cent RDF (200:150:100 kg NPK ha^{-1}) through drip fertigation can be adopted for commercial cultivation.

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