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Ndereyimana Assinapol
M. Sc student, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

S Praneetha
Professor (Hort), Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

V Rajasree
Asst. Professor (Hort), Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Correspondence
S Praneetha
Professor (Hort), Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Performance assessment of grafted brinjal for shoot and fruit borer infestation (*Solanum melongena* L)

Ndereyimana Assinapol, S Praneetha and V Rajasree

Abstract
Investigations were carried out in brinjal (*Solanum melongena* L.) grafts to evaluate the effect of spacing and fertigation levels on shoot and fruit borer infestation. 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), three levels of fertigation (75, 100 and 125% RDF) and replicated four times. After six months of planting the plants were pruned to obtain ratoon crop which was maintained for four 4 months. The lowest shoot borer (8.61 and 7.86 per cent) and fruit borer (9.66 and 8.20 per cent) infestations were recorded under widest spacing as compared to the closest; while the lowest nutrition level (75 per cent RDF) recorded the lowest shoot borer (7.74 and 7.01 per cent) and fruit borer (8.91 and 8.21 per cent) infestations in main and ratoon crops respectively. It was concluded that the shoot and fruit borer infestation reduced with increased spacing and with decreased nutrition level.

Keywords: spacing, fertigation, brinjal grafts, shoot and fruit borer infestations, marketable yield

Introduction

Brinjal (*Solanum melongena* L.), is a staple vegetable also known as Aubergine, Eggplant or Guinea squash and is one of the commonly grown species in the family *Solananceae* (Kantharajah and Golegaonkar, 2004) [10]. It is an economically important crop in Asia, Africa and in many sub-tropics and it is also cultivated in some warm temperate regions of the Mediterranean and South America (Das *et al*. 2010) [4].

Brinjal production by using grafts is high effective in ameliorating crop losses caused by soil borne diseases aggravated by successive cropping and adverse environmental conditions (Dietmar *et al*. 2010) [5]. However, the use of grafting as an integrated pest management tool to manage biotic stress will be most successful when complemented with sustainable farming practices (Kubota, 2008 [11], Frank *et al*. 2010) [7]. Plant spacing and nutrition are the important agronomic attributes since they contribute to the plant growth and health which in turn affect production capability.

The key pest responsible for deterioration of quality and quantity in brinjal is shoot and fruit borer, *Leucinodes orbonalis* Guen (Pyralidae: Lepidoptera). It causes up to 70 per cent yield loss by boring into the young tender shoots and fruits (Bhavani *et al*. 2009) [3]. Thus, any package of production technology of brinjal needs to be evaluated for its impact on the incidence of this pest. Likewise, the present article will give in detail about the results of the study carried out to evaluate the different spacing and fertigation levels on incidence of shoot and fruit borer.

Material and Methods

The study was carried out at the Department of Vegetable Crops, University Orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the year 2011-12. Study location 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 -ootstock and Brinjal (*S. melongena* L.) F_1 Hybrid, COBH 2 (Coimbatore Brinjal Hybrid 2 released from Tamil Nadu agricultural University, Coimbatore*)* was used as scion.

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.

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. Twenty five 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 for four months.

Under each plot ten healthy plants were selected and the data were recorded for total number of shoots and fruits per plant, fruit weight, number of marketable fruits per plant, marketable yield per plant, marketable yield per hectare.

Out of which total number of shoots and fruits affected by borer were calculated and the shoot and fruit borer infestation percentages were obtained. Analysis of variance was performed for all the recorded data (after arc sine transformation) by using *M Stat-C* software package to evaluate the statistical difference of treatment means where the level of significance was set at $p<0.05$.

Results and Discussion

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 and Figure 1). 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). 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) and Anburani *et al.* (2003) [13] 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) [20] observed in brinjal that the highest yield per hectare was obtained at closest spacing. Mishriky and Alphonse (1994) 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) opined that the magnitude of yield is influenced by plant population and its distribution pattern, which are important for getting maximum

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	62.11	174.71	10.99	60.01	93.81	5.55
CV (%)	0.90	3.85	3.92	1.29	2.73	4.39

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

economic yield from a given field area. Comparable results were also obtained by Saggam and Yazgan (1995) and Ganesan and Subbiah (2003) 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) [20] in brinjal and Gare (2002) [9] 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) [12]. 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) [16], Naik *et al.* (1996) [15] and Prabhu *et al.* (2003) [19] also reported in brinjal that the fruit size and weight increased with increasing levels of N and P.

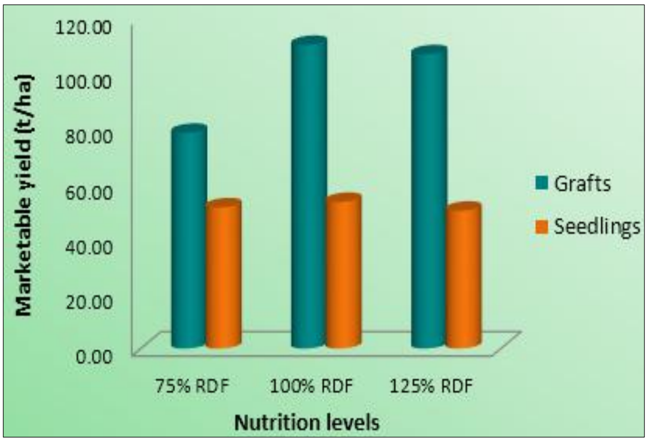

Fig 1: Marketable fruit yield in brinjal grafts and seedlings

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).

Effect of spacing and fertigation levels on shoot and fruit borer infestation

The shoot borer infestation was influenced by spacing and fertigation levels while their interaction was not significant in both main and ratoon crops. The lowest shoot borer infestation (8.61 and 7.86 per cent) was recorded under widest spacing (1.5 m X 1.5 m) which was on par with 2 m x 1m (9.06 per cent) in main crop. Application of 75 per cent RDF recorded the lowest shoot borer infestation (7.74 and 7.01 per cent in main and ratoon crops respectively). The mean values recorded for this parameter were 9.61 and 8.67 per cent in main and ratoon crops respectively (Table 2).

The fruit borer infestation was also influenced by spacing and nutrition, but their interaction was significant only in ratoon crop. The lowest fruit borer infestation was recorded by 1.5 m X 1.5 m spacing (9.66 and 8.20 per cent) which was on par with 2 m x 1m only in main crop (10.28 per cent). Application of 75 per cent RDF recorded the lowest infestation (8.91 and 8.21 per cent in main and ratoon crops respectively). The interaction 1.5 m x 1.5 m recorded the lowest fruit borer infestation (6.88 per cent) and the highest infestation was recorded under 0.6 m x 0.6 m + 125 per cent RDF).

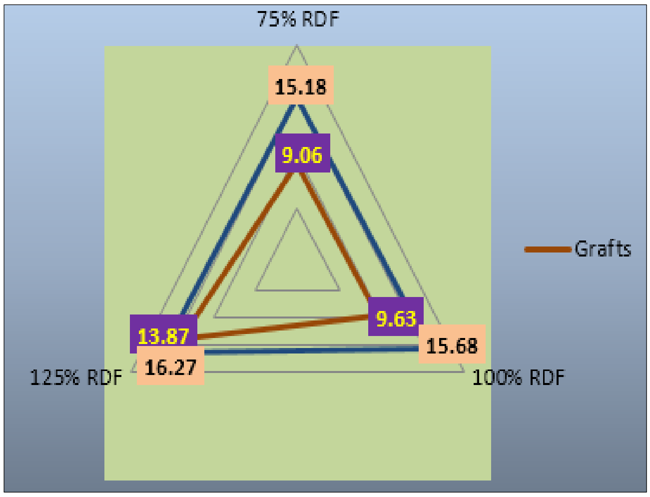

Fig 2: Fruit borer incidence in brinjal grafts and seedlings

The mean values recorded for this parameter were 11.11 and 9.56 per cent in main and ratoon crops respectively (Table 3).

Table 2: Effect of spacing and fertigation on shoot borer infestation in brinjal grafts

Treatments	Shoot borer infestation (%)	
	Main crop	**Ratoon crop**
Factor A: Spacing (S)		
S1-1 m x 1 m	9.95(18.36)b	8.99 (17.37)ab
S2-2 m x 1 m	9.06(17.36)c	8.03 (16.41)bc
S3-1.5 m x 1.5 m	8.61(17.21)c	7.86 (16.23)c
S4-0.6 m x 0.6 m	10.81(18.77)a	9.82 (18.22)a
CD (P=0.05)	0.39	1.02
Factor B: Ferigation (F)-NPK kg ha^{-1}		
F1-150: 125: 75 (75% RDF)	7.74 (16.66)b	7.01 (15.32)c
F2-200: 150: 100 (100% RDF)	9.54 (18.26)a	8.78 (17.21)b
F3-250: 187.5: 125 (125% RDF)	11.54 (18.85)a	10.24 (18.64)a
CD (*P*=0.05)	0.57	1.01
Interaction (S x N)		
S1F1	8.03 (17.32)	6.93 (15.25)
S1F2	9.86 (18.71)	9.16 (17.60)
S1F3	11.97 (19.04)	10.89 (19.26)
S2F1	7.18 (16.14)	6.38 (14.63)
S2F2	9.07 (18.13)	8.37 (16.82)
S2F3	10.92 (17.79)	9.32 (17.78)
S3F1	6.67 (15.64)	6.32 (14.55)
S3F2	8.54 (16.98)	8.09 (16.52)
S3F3	10.62 (19.00)	9.17 (17.63)
S4F1	9.10 (17.55)	8.40 (16.84)
S4F2	10.68 (19.21)	9.48 (17.92)
S4F3	12.65 (19.55)	11.58 (19.89)
CD (*P*=0.05)	NS	NS
Grand mean	9.61(17.92)	8.67 (17.06)
CV (%)	9.23	3.37

Figures in parentheses indicate arc sine transformed values
The means followed by the same letter are not significantly different

Table 3: Effect of spacing and fertigation on fruit borer infestation in brinjal grafts

Treatments	Fruit borer infestation (%)	
	Main crop	**Ratoon crop**
Factor A: Spacing (S)		
S1-1 m x 1 m	11.33(19.59)ab	9.62 (18.01)b
S2-2 m x 1 m	10.28(18.63)b	9.34 (17.74)bc
S3-1.5 m x 1.5 m	9.66(18.01)b	8.20 (16.58)c
S4-0.6 m x 0.6 m	13.17(21.23)a	11.07 (19.41)a
CD (P=0.05)	2.17	1.38
Factor B: Nutrition(N) - NPK kg ha^{-1}		
F1-150: 125:75 (75% RDF)	8.91 (17.31)c	8.21 (16.61)c
F2-200: 150:100 (100% RDF)	11.14 (19.44)b	9.10 (17.53)b
F3-250: 187.5:125 (125% RDF)	13.28 (21.34)a	11.35 (19.67)a
CD (*P* = 0.05)	1.99	0.21
Interaction (S x N)		
S1F1	9.06 (17.49)	8.35 (16.79)fgh
S1F2	9.63 (19.43)	8.64 (17.09)efg
S1F3	13.87 (21.86)	11.86 (20.14)ab
S2F1	8.10 (16.53)	7.47 (15.86)gh
S2F2	10.19 (18.62)	9.36 (17.82)def
S2F3	12.55 (20.73)	11.19 (19.54)abc
S3F1	7.46 (15.83)	6.88 (15.20)h
S3F2	9.59 (18.03)	7.64 (16.04)gh
S3F3	11.93 (20.19)	10.07 (18.50)cde
S4F1	11.03 (19.37)	10.17 (18.59)bdce
S4F2	13.69 (21.71)	10.77 (19.16)abcd
S4F3	14.78 (22.60)	12.26 (20.48)a
CD (P=0.05)	NS	1.61
Grand mean	11.11 (19.364)	9.56 (17.93)
CV (%)	4.41	0.68

The means followed by the same letter are not significantly different.
Figures in parentheses indicate arc sine transformed values.

These results showed significant difference between main and ratoon crops for shoot and fruit borer infestation in brinjal grafts. The highest infestation (9.61 per cent in shoots and 11.11 per cent in fruits) was noticed in main crop (*kharif* season) as against 8.67 and 9.56 per cent respectively in ratoon crop. This could be attributed to the fact that in *kharif* season, the weather condition affected the efficacy of phytosanitary treatments. Mote (1976) [14] studied the seasonal incidence of shoot and fruit borer and reported that even though the incidence of the pest was noticed in all the seasons, intensity of the pest was much more in *kharif*, followed by *rabi* and summer seasons. Shobharani and Nandihalli (2004) [23] reported that the incidence of shoot and fruit borer was more severe during *kharif* season than *rabi*.

The highest incidence of shoot and fruit borer was noticed in closer spacing as compared to the wider spacing in both main and ratoon crops. This might be due to the fact that in closer spacing, the insect would be able to find refuge and escape to the pesticide treatment and natural enemies. Also the microclimate inside the canopy of closer spaced plants would be encouraging the insect development. These results are fall line with the findings of FAO (2003) [6], where wider spacing and fertilizer use as per recommended rate contributed to the reduction of incidence of shoot and fruit borer in brinjal.

In both main and ratoon crops, the highest incidence of shoot and fruit borer was noticed under highest nutrition level (125 per cent RDF). This could be due to more succulence caused by excessive fertilizer which predisposed the shoots and fruits to be easily attacked by the borer. Similar to this, Batal *et al.* (1994) [2] opined that excessive N fertilization increased crop susceptibility to pests and decreased marketing quality. Patnaik *et al.* (1998) [18] reported that use of balanced fertilizer decreased the fruit damage.

Conclusion

Based on the results of this study, it was found that the brinjal grafts grown under 1 m x 1 m spacing and applied with 100 per cent RDF (200:150:100 kg NPK ha^{-1}) recorded the highest fruit yield (110.25 t ha^{-1} and 52.42 t ha^{-1}) in both main and ratoon crops. The results of plant spacing and fertigation levels had significant effect on shoot and fruit borer infestation in brinjal grafts. The wider spaced plants applied with higher nutrition level recorded the lower shoot and fruit borer infestation and vice-versa in both main and ratoon crops of brinjal grafts. Therefore, it is required to follow the standardized plant spacing and nutrition (1 m x 1 m spacing and applied with 100 per cent RDF (200:150:100 kg NPK ha^{-1}) properly while cultivating brinjal grafts so as to limit the shoot and fruit borer infestation at the economically acceptable level.

References

1. Anburani A, Manivannan K, Shakila A. Integrated nutrient and weed management on yield and yield parameters in brinjal (*Solanum melongena* L.) cv. Annamalai. Pl. Archives. 2003; 3(1):85-88.
2. Batal KM, Bondari K, Granberry DM, Mullinix BG. Effects of source, rate and frequency of N application on yield, marketable grades and rot incidence of sweet onion (*Allium cepa* L. cv. *Granex-33*). Hort. Sc. 1994; 69:1043-1051.
3. Bhavani B, Rao NV, Rao CVN. Evaluation of integrated management practices for the control of shoot and fruit borer, *Leucinodes orbonalis* in brinjal. Pestology. 2009; 33(4):42-44.
4. Das S, Mandal AB, Hazra P. Genetic diversity in brinjal genotypes under Eastern Indian conditions. Indian J. Hort, 67 (special issue), 2010, 166-169.
5. Dietmar S, Youssef R, Giuseppe C, Venema JH. Grafting as a tool to improve tolerance of vegetables to abiotic stresses: Thermal stress, water stress and organic pollutants. Sci. Hort. 2010; 127:162-171.
6. FAO. Inter country programme for integrated pest management in vegetables in South and South-East Asia. Eggplant integrated pest management: An ecological guide. Rome, Italy, 2003, 177.
7. Frank JL, Rivard CL, Kubota C. Grafting fruiting vegetables to manage soil borne pathogens, foliar pathogens, arthropods and weeds. Sci. Hort. 2010; 127:127-146.
8. Ganesan M, Subbiah VR. A Case study on increasing tomato productivity in a Low cost naturally ventilated Greenhouse with different spacing. JRD Tata Ecotechnology Centre. M. S. Swaminathan Research Foundation, 2003.
9. Gare BN. Effect of spacing and fertilizer on yield of rainfed chilli in sub-montagne zone of Maharashtra. JMaharashtra Agrl. Univ. 2002; 25(3):270-271.
10. Kantharajah AS, Golegaonkar PG. Somatic embryogenesis in eggplant. Rev. J Sci. Hortic. 2004; 99:107-117.

11. Kubota C. Use of Grafted Seedlings for Vegetable Production in North America. Acta Hort. 2008; 770:21-26.
12. Marschner H. Mineral nutrition of higher plants. 2nd ed, Acad. Press, 1995, 436-460.
13. Mishriky JF, Alphonse M. Effect of nitrogen and plant spacing on growth, yield and fruit mineral composition of pepper (*Capsicum annuun* L). B. Fac. Agric, Univ. of Cairo. 1994; 45(2):413-433.
14. Mote UN. Seasonal incidence and chemical control of brinjal shoot and fruit borer (*Leucinodes orbonalis*). Veg. Sci. 1976; 3:128-130.
15. Naik LB, Prabhakar M, Doijode SD. Effect of nitrogen on growth, seed yield and quality of brinjal (*Solanum melongena* L.). Ann. Agric. Res. 1996; 17(4):419-421.
16. Nandekar DN, Sawarkar SD. Effect of plant nutrients (NPK) on different varieties of bringal (*Solanum melongena* L). Orissa J of Hort. 1990; 18(1-2):1-5.
17. Nanthakumar S, Veeraraghavathatham D. Effect of integrated nutrient management on growth parameters and yield of brinjal (*Solanum melongena* L.) cv. PLR-1. South Indian Hort. 2000; 48(1-6):31-35.
18. Patnaik HP, Singh DN, Mohapatra S. Effect of NPK fertilizers on the incidence of shoot and fruit borer, (Leucinodes orbonalis Gueen.) in brinjal under insecticidal protection. Orissa J Hort. 1998; 26:56-60.
19. Prabhu M, Veeraraghavathatham D, Srinivasan K. Effect of nitrogen and phosphorus on growth and yield of brinjal hybrid COBH-1. South Indian Hort. 2003; 51(1-6):152-156.
20. Reddy PN, Madager BB, Abbasshussan L. Investigation on varietal performance, spacing and fertilization on bringal (*Solanum melongena* L). Mysore J Agric. Sci. 1990; 22(4):490-492
21. Saggam N, Yazgan A. Effects of planting densities and number of trusses, yield and quality of tomato grown under unheated high plastic tunnel. Acta Hort. 1995; 412:258-267.
22. Sanches VM, Sundstrom FJ, Long NS. Plant size influences bell pepper seed quality and yield. Hort. Sci. 1993; 28(8):8009-811.
23. Shobharani M, Nandihalli BS. Role of Bt and *Trichogramma chilonis* Ishii in the management of potato shoot borer, *L. orbonalis* Guene. The Andhra Agri. J. 2004; 50:508-509.
24. Singh H, Saimbhi. Effect of plant spacing in brinjal (*Solanum melongena* L.). A review. Punjab vegetable growers. 1998; 33:11-14.