OnLine Journal of Biological Sciences 1(8): 701-703, 2001

Seed Germination and Graft Compatibility of Wild *Solanum* as Rootstock of Tomato

[1]M. Ibrahim, [2]M. K. Munira, [1]M. S. Kabir, [1]A. K. M. S. Islam, [3]M. M. U. Miah
[1]Bangladesh Rice Research Institute, Gazipur, Bangladesh, [2](SPC), BADC, Gabtali, Dhaka,Bangladesh
[3]Agroforestry, Hajee Mohammed Danesh Agricultural College, Dinajpur, Bangladesh

Abstract: Eight wild *Solanum* namely, *S. sisymbriifolium, S. torvum, S. sanitwongsei, S. indicum, S. integrifolium, S. khasianum, S. surattense, S. insanum* and three *Solanum* amphidiploids of *S. melongena* "Uttara" x *S. integrifolium, S. melongena* "Dingaras Multiple Purple" (DMP) x *S. integrifolium* and *S. integrifolium* x *S. melongena* "Uttara" were tested using GA_3 pretreatment for their seed dormancy and seed germination rate along with their potentiality as rootstock of tomato at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. Influence of GA_3 treatment for germinating seed in most of the wild *Solanum* was not found effective except *S. sanitwongsei, S. surattense* and *S. integrifolium*. Among the rootstocks, *S. sisymbriifolium* performed better for yield and yield contributing characters in tomato that those of other wild relatives, their amphidiploids, and non-grafted plants.

Key words: Grafting, rootstock, wild *Solanum*, tomato.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) cultivation in Bangladesh is severely impaired by three important soil-borne pathogens viz. *Pseudomonas solanacearum, Fusarium oxysporum* and *Meloidogyne incognita*, the causal agent of bacterial wilt, fusarium wilt and root-knot nematode respectively and cause devastating damage of tomato (Ahmed and Hossain, 1985; Mian, 1986; Ali *et al.*, 1994). These are also the major limiting factors for tomato production throughout the world (Hinata, 1986). In Bangladesh, problems of these diseases are common in non-flooded high lands where solanaceous vegetables are grown continuously without crop rotation.. The average yield of tomato is 7.5 t ha^{-1} which is very low as compared to other tropical countries (Anonymous, 1996). This poor yield is mainly due to the use of low yielding varieties and improper cultural practices including poor disease management. In some cases 100% of the plants are found to die in kitchen gardens of Bangladesh due to wilt problem and root-knot may cause as much as 53-62% loss in fruit yield of tomato (Ali *et al.*, 1994). Early cultivation of tomato is also difficult due to high incidence of the wilt diseases (Ali *et al.*, 1994).

There are two traditional methods of controlling the soil-borne disease; I) Soil sterilization by chemicals, which is very expensive and not practical, and ii) Use of resistant varieties which are not available (Ali *et al.*, 1994). Some of non-tuberous wild *Solanum* species and their amphidiploids are reported to have high resistance against these diseases and compatible rootstock of tomato (McCammon and Honma, 1983; Ozaki 1985; Ali *et al.*, 1990 a, 1990 b, 1992 a, 1992 b). But transfer of these disease resistant traits from the wild to the tomato is very difficult due to intergeneric/interspecific cross incompatibility and hybrid sterility. Even genetic engineering has not been that successful or attempted. In some cases, amphidiploids produced by protoplast fusion are also sterile (SAIC, 1993). To avoid the problems of soil borne diseases grafting of tomato on resistant wild *Solanum* may be an effective technique especially where wilt and nematode problems are acute. This technique is being practiced in Japan since the 1930s (Matsuzoe *et al.*, 1990; Ali *et al.*, 1990a). Shetty and Reddy (1985) and Ali *et al.*, (1990a, 1990b) reported that *S. Sisymbriifolium* and *S. torvum* are effective rootstocks to control root-knot and wild disease.

But there are problems in raising of their seedlings. Most of them have very poor seed germination rate, have not uniformity in seed germination and also have strong seed dormancy. Many literatures reported that to break the dormancy and to give the uniformity in germination of the seeds of these rootstocks a treatment of gibberellic acid (GA_3) with 100 mg/l in water for 24 h is necessary. But this treatment is very expensive and difficult to practices at growers' level. Therefore, the objectives of this study were to standardize the seed germination of different wild *Solanum* and their interspecific hybrids and to evaluate the graft compatibility and yield performance of tomato with their wild relatives.

Materials and Methods

Standardization of seed germination technique of wild *Solanum*: 1000 seeds of eight wild *Solanum* species namely *S. sisymbriifolium, S. torvum, S. sanitwongsei, S. indicum, S. integrifolium, S. khasianum, S. surattense, S. insanum* and three *Solanum* amphidiploids of *S. melongena* "Uttara" x *S. integrifolium*, "DMP" x *S. integrifolium* and *S. integrifolium* x *S. melongena* "Uttara" were considered as experimental materials. Half of seeds of each variety were treated with GA_3 solution with 100 mg/l in water and rest half were treated with tap water as control for 24 h at room temperature. Seedbed was prepared using well decomposed cow dung to obtain a desirable tilth. Seeds of each treatment were sown in 4 alternate 1m long parallel line on the surface level of the seedbed making about 2 cm line depth and then a very thin cover was made with sandy soil. Irrigation and weeding were done when necessary. Data were collected on rate of germination once after every 7 days and continued up to 6 weeks.

Graft compatibility and yield performance of tomato: Five rootstocks namely, *S. sisymbriifolium, S. torvum, S. sanitwongsei, S. indicum, S. integrifolium*, and three *Solanum* amphidiploids of *S. melongena* "Uttara" x *S. integrifolium*, "DMP" x *S. integrifolium* and *S. integrifolium* x *S. melongena* "Uttara" were used as experimental materials. Tomato line TM0126 (already released as BARI tomato 3) was used as scion and also used as non-grafted control. Thirty five days old tomato seedlings were grafted on fifty days old rootstocks following standard procedures by Ali *et al.* (1994).

The experiment was laid out in Randomized Complete Block

Table 1. Seed germination percentage of wild *Solanum* species as influenced by GA_3

Solanum species	First week		Second week		Third week		Fourth week		Germination increased over GA^3 treatment (%)	Germination increased over control (%)
	GA_3	Control	GA_3	Control	GA_3	Control	GA_3	Control		
S. melongena "Uttara" x *S. integrifolium*[a]	12.22	9.78	21.11	27.33	21.56	27.78	21.56	27.78	6.22	-
S. melongena "DMP"x *S. integrifolium*[a]	10.91	10.22	20.00	25.78	20.36	26.22	20.36	26.22	5.86	-
S. integrifolium x *S. melongena* "Uttara"[a]	9.56	9.11	19.33	16.56	22.22	21.11	22.22	21.11	-	1.11
S. insanum	10.44	11.78	21.56	34.44	24.22	35.30	24.22	35.30	11.08	--
S. sisymbriifolium	49.32	49.11	67.56	84.22	67.56	36.44	67.56	86.44	18.88	-
S. surattense	20.00	12.22	46.67	30.00	47.33	31.11	47.33	31.11	-	16.22
S. indicum	9.18	5.11	13.11	12.89	13.33	15.78	13.33	15.78	2.45	-
S. integrifolium	45.56	25.33	60.00	46.78	60.00	49.78	60.00	49.78	-	10.22
S. sanitwongsei	11.11	0.67	29.11	5.67	44.22	11.33	48.22	14.22	-	34.00
S. khasianum	3.11	6.89	8.44	14.22	9.55	14.44	10.00	15.11	5.11	-
S. torvum	0.00	0.00	2.44	3.56	14.67	16.89	15.11	17.78	2.67	-

a = Amphidipliod

Table 2. Effect of different wild *Solanum* rootstocks on yield contributing characteristics in tomato.

Solanum species	Days to first flowering**	Days to first fruit set**	Number of fruits/truss*	Days to first fruit maturity**	Plant height first harvesting* (cm)	Plant height lastharvesting* (cm)
Non-grafted plants	83.98c	92.19c	3.10b	142.30b	71.69a	74.17a
S. melongena "Uttara" x *S. integrifolium*[a]	88.56bc	98.21b	3.49a	147.30a	54.02c	55.09c
S. melongena "DMP" x *S. integrifolium*[a]	89.47ab	98.56b	3.09b	146.00a	53.28c	54.69c
S. integrifolium x *S. melongena* "Uttara"[a]	87.29bc	97.16bc	3.08b	146.80a	53.84c	54.86c
S. sisymbriifolium	93.45a	103.12a	3.19ab	146.80a	60.80b	63.59b
S. torvum	87.98bc	95.49bc	3.02b	146.10a	51.93c	53.72c
S. sanitwongsei	89.53ab	99.70ab	3.08b	148.10a	53.43c	54.67c
S. indicum	91.04ab	100.60ab	3.28ab	149.00a	53.25c	54.20c
S. integrifolium	88.82ab	100.20ab	3.47a	146.40a	58.22b	59.97b

a = Amphidiploid. *,** = Significant at 5% and 1% level, respectively.
Values in each column followed by same letter(s) are not significantly different.

Table 3: Effect of different wild *Solanum* rootstocks on yield, fruit characteristics, grafting success and disease prevalence in tomato.

Solanum species	Fruits yield/ Plant (kg)*	Fruit yield/ ha. (ton)*	pH of fruits*	Soluble solid (%)	Grafting success (%)	Plant infested (%)
Non-grafted plants	2.05bc	48.89bc	4.31d	4.46ab	-	26.67
S. melongena "Uttara" x *S. integrifolium*[a]	2.54ab	60.40ab	4.38cd	4.05b	90	13.34
S. melongena "DMP" x *S. integrifolium*[a]	2.27abc	54.13abc	4.68a	4.52ab	90	10.01
S. integrifolium x *S. melongena* "Uttara"[a]	2.12bc	50.48bc	4.48abcd	4.10b	92	13.33
S. sisymbriifolium	2.75a	65.40a	4.39cd	4.61ab	86	6.69
S. torvum	2.05bc	48.81bc	4.63ab	4.06b	78	6.68
S. sanitwongsei	1.68c	40.26c	4.58abc	4.60ab	92	0.03
S. indicum	1.79c	42.70c	4.42bcd	4.32b	90	16.67
S. integrifolium	2.09bc	49.48bc	4.57abc	4.94a	75	10.00

a = Amphidiploid. * = Significant at 5% level.
Values in each column followed by same letter(s) are not significantly different.

Design (RCBD) and individual plot was 3 x 1.4m^2 in size having plant to plant and row to row distances of 60 cm and 70 cm respectively, accommodating 10 plants. Manure and fertilizer were applied as per recommendation of Rashid (1983). Support was given to each seedling by bamboo stick. All axillary shoots from rootstocks were removed. Weeding and irrigation was done as and when needed. Data were recorded from ten randomly selected plants per plot on days to first flowering, days to first fruit set, number of fruits per truss, days to first fruit maturity, plant height at first and last harvest, fruit yield per plant and per hectare, pH of fruits, percent of soluble solid, percent success of grafting, prevalence of virus disease-like symptoms and wilt, number of trusses per plant, number of flowers per truss, number of flowers per plant, number of fruits per plant, percent of fruit setting rate and individual fruit weight.

Results and Discussion

Standardization of seed germination technique of wild *Solanum* : The maximum percent of seed germination was found in *Solanum sisymbriifolium*, both in GA_3 and control treatment of 68% and 86% on second and third week from seed sowing respectively which was very similar to *S. integrifolium* in GA_3 treatment (Table 1). Lower percent of seed germination was found in *S. khasianum* both in GA_3 and control treatment. *S. torvum* took long time to germinate and had poor germination even after GA_3 treatment. Percent of seed germination of three amphidiploids and *S. insanum* in GA_3 and control treatments were more or less similar. The highest increase in germination rate due to control over GA_3 treatment was found in *S. sisymbriifolium* (18.88%) followed by *S. insanum*, *S. melongena* x *S. integrifolium*, "DMP" x *S. integrifolium*, *S. khasianum*, *S. torvum* and *S. indicum* and the highest increase in germination rate due to GA_3 over control treatment was found in *S. sanitwongsei* (34%) followed by *S. surattense*, *S. integrifolium* and *S. integrifolium* x *S. melongena* "Uttara" (Table 1).

Seed treatment with GA_3 had no mentionable effect over control for germination in all wild *Solanum* and the amphidiploids. Considering uniformity of seed germination

there were no remarkable difference between the GA_3 and control treatments of all wild *Solanum* and the amphidiploids.

Graft compatibility and yield performance of tomato with their wild relatives: Plants grafted on different rootstocks differed significantly from non-grafted plants in respect of days to first flowering, days to first fruit set, days to first fruit maturity and grafted plants required more time than non-grafted plants (Table 2). It is a common phenomenon for delayed flowering, fruit setting and fruit maturity due to grafting shock of the scion. Similar results were reported by Matsuzoe *et al*. (1990), Ali *et al*. (1994) and Ibrahim (1996). The total number of fruits per truss were statistically differ but varied within a narrow range of 3.02 to 3.49. Ibrahim (1996) also observed similar results. Significant effects were observed at plant height and the maximum plant height at first and last harvesting were observed in the non-grafted plants and the plants grafted on *S. sisybbriifolium* performed the second highest (Table 2). Ibrahim (1996) observed the same results on non-grafted plants. Significant difference were observed among the plants on grafted and non-grafted conditions in respect of fruit yield per plant and fruit yield per hectare (Table 3). The maximum fruit yield was recorded in plants grafted on *S. sisymbriifolium* (65.40 t ha^{-1}). Matsuzoe *et al*. (1990) and Ibrahim (1996) observed the same results. Plants grafted on *S. sisymbriifolium* performed more or less better in pH of fruits and percent of soluble solid. Matsuzoe *et al*. (1990) and Ibrahim (1996) observed the same results. Seventy eight to 92% success of grafting was observed on different rootstocks. Ali (1993) observed 70 to 95% success of grafting generally when tomato plants were grafted on non-tuberous wild *Solanum*. There was a little effect in success of grafting with the change of rootstocks. Higher disease prevalence was recorded in non-grafted plants as compared to other grafted ones as wild *Solanum* species are probably resistant to the viruses coming from soil (Table 3). Reduced disease incidence in grafted plants as compared to non-grafted ones were also reported by Peregrine *et al*. (1992), Ali *et al*. (1994), Mian *et al*. (1995) and Ibrahim (1996). Grafting had no significant effect on number of trusses per plant, number of flowers per truss, number of flowers per plant, number of fruits per plant, percent of fruit setting rate and individual fruit weight.

Considering easy seed production and germination, lower disease prevalence on grafted plants and for high yield, *S. Sisymbriifolium* can be considered as a good rootstock for tomato production.

Reference

Ahmed, H. U. and M. M. Hossain, 1985. Crop disease survey and establishment of herbarium at BARI, Final Report. Plant Pathol. Div. Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, pp: 107.

Ali, M., N. Matsuzoe, H. Okubo and K. Fujieda, 1990a. In-vitro introduced *Solanum* amphidiploids as rootstocks of eggplant and tomatoes. J. Japan. Soc. Hort. Sci., 2: 256-257.

Ali, M., M. A. Quadir, H. Okubo and K. Fujieda, 1990b. Resistance of eggplants, its wild relatives and their hybrids to different strains of *Pseudomonas solanacearum*. Scientia Hortic., 45: 1-9.

Ali, M., H. Okubo and K. Fujieda, 1992a. Production and characterization of *Solanum* amphidiploid and their resistance to wilt. Sci. Hort., 181-196.

Ali, M., N. Matsuzoe, H. Okubo and K. Fujieda, 1992 b. Resistance of non-tuberous *Solanum* to root- knot nematode. J. Japan. Soc. Hort. Sci., 60: 921-926.

Ali, M., 1993. Workshop on Research and Development of Vegetable Crops, 9-10 March, 1993. Institute of Postgraduate Studies in Agriculture (IPSA), Salna, Gazipur, Bangladesh.

Ali, M., M. Z. Alam and A. M. Akanda, 1994. Grafting: A technique to control soil-borne diseases of tomato and eggplant. IPSA-JICA publication No. 4. Institute of Postgraduate Studies in Agriculture (IPSA), Salna, Gazipur, Bangladesh, 10p.

Anonymous, 1996. Year Book of Agricultural Statistics of Bangladesh 1994. BBS Statistics Division, Ministry of Planning, Dhaka, pp: 20.

Hinata, K., 1986. Eggplant (*Solanum melongena* L.). In: Y. P. S. Bajaj (Ed.), Biotechnology in Agriculture and Forestry, Springer Verlag, Berlin, Heidelberg, 2: 363-370.

Ibrahim, A. K. M., 1996. Potentiality of wild *Solanum* as rootstock of tomato. A thesis submitted for M. S. degree to the Institute of Postgraduate Studies in Agriculture (IPSA), Salna, Gazipur, Bangladesh, 1-3pp.

Matsuzoe, N., M. Ali, H. Okubo and K. Fujieda, 1990. Growth behaviour of tomato plants grafted on wild relatives of *Solnum melongena*. J. Japan. Soc. Hort. Sci., 59: 358-359.

McCammon, R. K. and S. Honma, 1983. Morphological and Cyto genetic analysis of an interspecific hybrid eggplant *Solanum melongena* x *S. torvum*. Hort. Sci., 18: 894-895.

Mian, I. H., 1986. Plant parasitic nematodes associated with some crop species in Bangladesh. Bangladesh J. Plant Pathol., 2: 7-13.

Mian, I. H., M. Ali and R. Akter, 1995. Grafting of *Solanum* rootstocks to control root knot of tomato and bacterial wilt of eggplant. Bull. Inst. of tropical Agric., 18: 41-47.

Ozaki, K., 1985. Pathogenic specialization of *Pseudomonas solanacearum* in Solanaceous plants. Abstract of the 13th meeting of plant bacterial disease. Phytopathol. Soc. Japan, pp: 1-6.

Peregrine, W.T.H. and K. Ahmad, 1992. Grafting: A simple technique for overcoming bacterial wilt. Tropical Pest Management, 28: 71-76.

Rashid, M. M., 1983. Sabjibiggan (in Bangali). Bangla Academy, Dhaka, Bangladesh, pp: 137-155.

SAIC., 1993. Growing wilt free tomato. Newsletter. A publication of the SAARC Agriculture Information Center (SAIC), Dhaka, Bangladesh, 3: 6.

Shetty, K. D. and P. P. Reddy, 1985. Resistance in *Solanum* species to root knot nematode (*Meloidogyne incognita*). Indian J. Nematol., 15: 230.