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Enhanced Graft-take Ratio and Quality of Grafted Tomato Seedlings by Controlling Temperature and Humidity Conditions

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Abstract. This study was conducted to enhance graft-take ratio and quality of grafted tomato seedlings by controlling temperature and humidity during the healing and acclimatization processes. Three temperature levels (20°C, 23°C, and 26°C) were carried out to determine optimum temperature on four rootstocks. In addition, twelve combinations of three relative humidity levels (70%, 80%, and 90%) and four temperature levels (17°C, 20°C, 23°C, and 26°C) were set up to evaluate the effect of relative humidity and temperature on the graft-take ratio of grafted seedlings. In the other hand, five relative humidity periods (H0, H1, H2, H3, and H4: 90% relative humidity for first 0, 1, 2, 3 and 10 days and afterwards relative humidity was reduced to 70%, respectively) were examined effect of relative humidity periods on the graft-take and quality of grafted seedlings. The higher graft-take ratios (84.0~87.4%) were showed at 23°C compared to 20°C and 26°C in all rootstocks. Graft-take ratios decreased and number of diseased plants increased at high temperature. The graft-take ratios increased with increasing relative humidity in all temperature levels on the 3rd and 7th day after grafting. However, increasing relative humidity significantly increased percent of diseased plants. The graft-take ratio reduced at (26°C) and (17°C) temperature under all relative humidity conditions. The graft-take ratio increased with increasing period of 90% relative humidity. Maximum graft-take ratios were observed in H2 and H3 treatments. Graft-take ratio decreased with increasing 90% relative humidity for 10 days (H4). Diseased plants had not been found in H0, H1, H2, and H3 treatments. Seedling quality was improved through increasing fresh and dry weight of root, compactness, and root morphology of tomato seedlings in H2 and H3 treatments. Therefore, high relative humidity (90%) for first 2 or 3 days and afterwards reduced low relative humidity (70%) at 23°C condition during healing and acclimatization promoted the graft-take and quality of grafted tomato seedlings.

Additional key words : acclimatization processes, relative humidity, rootstocks, plug seedlings, seedling quality

Introduction

Since grafting is considered an important technique for the sustainable production of fruit bearing vegetables in Korea, Japan and several European countries (Lee, 1994; Oda, 1995), the use of grafted tomato for commercial production has increased in the world in order to improve resistance to biotic and abiotic stresses (Lee and Oda, 2003; Rivero et al., 2003). Healing and acclimatization are very important processes that are necessary for grafted plants to survive (Lee and Oda, 2003). Temperature and humidity are the key environmental factors that influence the healing and acclimatization of grafted seedlings. In conventional culture, healing and acclimatization of the grafted plants are done in a tunnel that is made by plastic-film and shaded by cloth (Oda, 1999; Davis et al., 2008). During healing and acclimatization in the plastic tunnel, the relative humidity was controlled by closing and opening of plastic-film to prevent wilting of the scions. Changing environmental condition in the tunnel by day, night and seasons was the cause that affects the grafting success. However, recently healing and acclimatization have also been mechanized by development of the healing chambers (Oda, 1999). In healing chambers, higher survival rate, faster growth, and higher quality of grafted plants under highly controlled healing conditions were reported in some papers (Kim et al., 2001; Nobuoka et al., 2005).

Regarding temperature and relative humidity conditions during healing and acclimatization for grafted plants, Liang (1990) suggested that the suitable temperature for grafted watermelon post-grafting curing environment was 25~30°C. Mii et al. (1994) pointed out the appropriate curing envi-

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ronment for grafted tomato seedlings was 20~30^oC for temperature, more than 80% for relative humidity, and 50~70% shading of the daylight. Nishiura (1999) also proposed the air temperature, relative humidity, and light and dark interval period as 25~28^oC, 90%, 12 h respectively for the healing and acclimatization of grafted tomato seedlings. Chang et al. (2003) suggested that the survival rate and quality of grafted seedlings were promoted if the relative humidity in the acclimatization chamber was maintained at 80~90%. In contrast, Jang et al. (2009) reported that the growth of grafted peppers was greater under low temperature and low relative humidity conditions. The low relative humidity (65%) and light condition at 25^oC during healing and acclimatization promoted the graft-take of grafted seedlings. Although there is general consensus that controlling of temperature and humidity is required for successful grafting of herbaceous plants. However, there is not so much information on control of relative humidity period for grafted tomato seedlings. Oda (1999) just suggested that keeping the grafted plants at about 30^oC temperature and with more than 95% relative humidity for three days of healing promotes the survival ratio and then the relative humidity was lowered and the light intensity increased. Therefore, the objective of this study was conducted in order to enhance graft-take ratio and quality of grafted tomato seedlings through controlling temperature and humidity during the healing and acclimatization period.

Materials and Methods

1. Plant material and growing scions and rootstocks

In all experiments, seeds of tomato varieties were sown in the 128-cell plug trays (Bumnong. Co., Ltd, Korea) containing commercial growing substrate (BM2, Berger Group Ltd, Canada). Twenty- three days after sowing, the seedlings were used for grafting. During the plastic house, seedlings were watered daily or as required. One week after sowing, seedlings were fertilized at overhead irrigation twice a week with Wonder Grow fertilizers (Chobi Co., Ltd, Korea).

2. Grafting method and healing and acclimatization process

Splice grafting method was undertaken. After placing the scion on the rootstock, ordinary grafting clips were used to fix the grafted position tightly together (Lee and Oda, 2003). Rootstocks and scions with similar stem diameters were chosen to increase the grafting success. After grafting, grafted plants were placed in healing chambers for 10 days. Healing chambers were also equipped with an autocontrol air conditioning system for healing the grafting. Light intensity was approximately 30 $mmol \cdot m^{-2} \cdot s^{-1}$ provided by fluorescent lamps. Relative humidity and temperature were set up with different values for the individual purpose of each experiment.

3. Temperature and humidity treatments

Three experiments were performed. The effect of temperature and rootstocks on the graft-take ratio was examined by treating grafted tomato seedling with three temperature levels (20^oC, 23^oC, and 26^oC) on four rootstock cultivars (“Kanbarune”, “B-Blocking”, “Magnet”, and “Solution”). In this experiment, “Super-Top” cultivar was used as scion and relative humidity was maintained at 85~90%.

The effect of relative humidity and temperature on the graft-take ratio was examined by treating grafted tomato seedlings with three relative humidity levels (70%, 80% and 90%) on four temperature conditions (17^oC, 20^oC, 23^oC, and 26^oC). “Myrock” cultivar was used as scion while “Support” cultivar was used as rootstock for this experiment.

The effect of humidity period on graft-take ratio and quality of grafted tomato seedlings was studied by treating grafted tomato seedlings with five treatments of humidity period H0 (70% relative humidity for 10 days), H1 (90% relative humidity for first one day and then relative humidity was reduced to 70% for next 9 days), H2 (90% relative humidity for first two days and then relative humidity was reduced to 70% for next 8 days), H3 (90% relative humidity for first 3 days and then relative humidity was reduced to 70% for next 7 days), H4 (90% relative humidity for 10 days). “Unicorn” cultivar was used as scion and rootstock “Self-grafted” and temperature was maintained at 23^oC for this experiment. After 10 days in the healing chamber, grafted seedlings were transferred to plastic house in natural condition for 5 days. The grafting clips were removed 2 days after plants were out of the healing chamber.

4. Data collection and analysis

All grafted seedlings were evaluated for signs of graft failure on the 3rd and 7th day after grafting. Diseased plants were evaluated on the 10th day after grafting. Grafted seedlings on the 15th day after grafting were harvested for analysis of growth characteristics. Seedling height (cm) and number of leaves of grafted seedlings were measured. Leaf area (cm^2) was measured by leaf area meter (Area meter, Delta-T, UK). Leaf chlorophyll content was measured by using a chlorophyll meter (Minolta, SPAD-502, Japan). Fresh and dry weights of shoot and root were measured. Dry weight of shoot and root were taken through oven-dry method at 80°C for 72 h until constant weight achieved. T/R ratio (shoot dry weight/root dry weight ratio) and compactness (shoot dry weight/stem length) were calculated. The root morphology was analyzed with HP1100 scanner equipped with the WIN MAC RHIZO V 2009c program (Regent Instruments INC., Canada). The roots were detached from their shoots and then placed in a tray (15 cm × 30 cm) with water. The water served to separate out the roots and keep them moist. The parameters of total root surface area, total root length, average root diameter, and number of root tips were determined by the program.

The experimental design was a split-plot for first and second experiments. Temperature was the main plot and rootstock variety was the sub plot in first experiment. Humidity was the main plot and temperature was the sub plot in second experiment. Third experiment was arranged in completely randomized design. In each replication, one 128-cell plug tray with 64 plants was measured. For the statistical analysis of growth parameters, ten seedlings per treatment from each replication were randomly selected. Data were analyzed using SAS v.9.3 software (SAS Institute Inc., Cary, NC, USA). Mean separations were calculated using Duncan's multiple range test at $P \leq 0.05$.

Results

1. Effect of temperature on graft-take ratio and diseased plants in four rootstock varieties

On the 3rd day after grafting, the graft-take ratios were decreased at 20°C and 26°C compared with 23°C in all rootstock cultivars except B-Blocking. But the graft-take ratios were not statistically different among temperature levels and cultivars. However, 7 days after grafting, graft-take ratios significantly decreased at 20°C and 26°C temperatures in all rootstock cultivars. The higher graft-take ratios (84.0~90.0%) were observed at 23°C temperature compared with 20°C and 26°C temperatures (64.6~83.4% and 64.6~78.0%, respectively). In each temperature levels, there was no significant difference in graft-take ratio among different rootstock cultivars. From the 3rd to 7th day after grafting, high percentage of graft failure was observed in B-Blocking (28.2%) and Kanbarune (16.6%) at low temperature (20°C), whereas high percentage of graft failure of Magnet (20.0%) and Solution (16.6%) was observed at high temperature (26°C) (Table 1).

Table 1. Effect of temperature on graft-take ratio and diseased plants of the four rootstock cultivars.

Temperature	Rootstock cultivars	Graft-take ratio (%) after grafting		Percent of diseased plants (%)	Final graft-take ratio (%)
		3 days	7 days		
20°C	Kanbarune	91.4 bcd[x]	75.4 d	0.0 f	75.3 c
	B-Blocking	92.8 abc	64.6 e	5.3 c	59.3 f
	Magnet	89.4 b-e	83.4 c	2.0 ef	81.3 b
	Solution	78.0 gh	74.0 d	3.4 c-e	70.6 d
23°C	Kanbarune	94.0 ab	87.0 abc	0.0 f	87.0 a
	B-Blocking	90.0 b-e	90.0 a	2.6 de	87.4 a
	Magnet	98.6 a	88.6 ab	3.0 cde	85.3 ab
	Solution	87.4 c-f	84.0 bc	0.0 f	84.0 ab
26°C	Kanbarune	75.0 h	68.6 e	4.6 cd	64.0 e
	B-Blocking	82.6 fg	78.0 d	8.6 b	69.4 d
	Magnet	84.6 ef	64.6 e	12.0 a	52.6 g
	Solution	86.0 def	69.4 e	10.6 ab	58.7 f
Significance					
Temperature (T)		NS[y]	*	**	**
Cultivars (C)		NS	NS	NS	NS
C × V		NS	NS	*	*

[x]Mean separation within columns by Duncan's multiple range test at $P = 0.05$.
[y]NS, *, ** indicates Non-significant; significant at $P \leq 0.05$ and $P \leq 0.01$, respectively.

Percentage of diseased plants increased significantly with increasing temperature to 26°C during the healing and acclimatization processes in all rootstock cultivars. High percentage of diseased plants of the all rootstock cultivars was found at (26°C). Therefore, final graft-take ratio at 26°C was affected by percentage of diseased plants. High final graft-take ratios (84.0-87.4%) were showed at (23°C) temperature in all rootstock cultivars. The final graft-take ratios were not statistically different among rootstock cultivars at (23°C) temperature, whereas there were statistically different on graft-take ratio among different rootstock cultivars at 20°C and 26°C (Table 1).

2. Effect of humidity on graft-take ratio and diseased plants in different temperature levels

The graft-take ratios increased with increasing from 70% to 80% relative humidity in different temperature conditions on the 3rd and 7th day after grafting. However, there was no significant different between 80% and 90% relative humidity with graft-take ratio in different temperature condition. From the 3rd to 7th day during the healing and acclimatization processes, percentage of graft failures was significantly greater at 70% relative humidity (10.5~28.9%) than 90% relative humidity (7.7~12.5%) and 80% relative humidity (2.3~12.1%) in all temperature levels. The lowest percentage of graft failure was obtained at 80% relative humidity with 23°C temperature and afterwards at 90% relative humidity with 23°C temperature, and at 90% relative humidity with 20°C temperature. High temperature (26°C) and low temperature (17°C) were reduced graft-take ratio in all relative humidity levels. The higher graft-take ratios were also observed at 23°C temperature compared to other temperature levels in all relative humidity conditions (Table 2).

Increasing relative humidity significantly increased percentage of diseased plants during the healing and acclimatization processes. The low percentage of diseased plants (0.0~5.5%) was found at 70% relative humidity condition, whereas high percentage of diseased plants (5.5~14.1%) was found at 90% relative humidity condition. High diseased plant was the cause that reduced final graft-take ratio of grafted tomato under 90% humidity condition. The highest (88.2%) final graft-take ratio was observed at 80% relative humidity with (23°C) and afterwards 90% relative humidity with (23°C), 90% relative humidity with (20°C) (Table 2).

3. Effect of humidity period on graft-take ratio and quality of grafted tomato seedlings

Graft-take ratios were considerably high (83.0-100.0%) by all relative humidity periods. The graft-take ratio increased with increased period of 90% relative humidity condition. However, maximum graft-take ratios (100.0%)

Table 2. Effect of humidity on graft-take ratio and diseased plants in different temperature levels.

Humidity	Temperature	Graft-take ratio (%) after grafting		Percent of diseased plants (%)	Final graft-take ratio (%)
		3 days	7 days		
90%	17°C	88.3 bcd	75.8 bc	8.6 c	67.2 cd
	20°C	86.7 cd	78.9 b	5.5 de	73.4 bc
	23°C	96.1 a	88.3 a	14.1 a	74.2 b
	26°C	72.7 f	64.8 d	9.4 c	55.5 e
80%	17°C	82.8 de	74.2 bc	3.9 e	70.3 bcd
	20°C	85.2 cde	73.1 bc	6.3 d	64.8 cd
	23°C	95.3 ab	92.9 a	4.7 de	88.3 a
	26°C	71.3 f	61.7 d	11.7 b	50.0 ef
70%	17°C	72.7 f	43.7 f	0.0 f	43.8 f
	20°C	78.9 ef	64.8 d	0.0 f	64.8 d
	23°C	91.4 abc	71.9 c	1.6 f	70.3 bcd
	26°C	63.6 g	53.1 e	5.5 de	47.7 f
Significance					
Humidity (H)		**[y]	**	**	NS
Temperature (T)		**	**	NS	*
H × T		**	**	*	*

[x]Mean separation within columns by Duncan's multiple range test at $P = 0.05$.
[y]NS, *, ** indicates Non-significant; significant at $P \leq 0.05$ and $P \leq 0.01$, respectively.

Table 3. Effect of humidity periods on the graft-take ratio and growth of grafted tomato seedlings.

Treatments	Graft-take ratio (%)	Percent of diseased plants (%)	Plant height (cm)	Stem diameter (mm)	No. of leaves	Leaf chlorophyll content (SPAD)	Leaf area (cm^2)
H0	83.0 c[x]	0.0 b	7.07 b	3.06 a	4.75 a	40.58 a	19.9 a
H1	89.0 b	0.0 b	7.27 ab	3.04 a	4.80 a	44.97 a	19.9 a
H2	100.0 a	0.0 b	7.28 ab	3.02 a	4.70 a	46.62 a	19.4 a
H3	100.0 a	0.0 b	7.26 ab	3.08 a	4.90 a	42.17 a	19.7 a
H4	92.0 b	1.5 a	7.87 a	3.03 a	4.90 a	41.34 a	20.4 a

[x]Mean separation within columns by Duncan's multiple range test at $P \leq 0.05$ (n = 10).
H0 70% relative humidity for10 days
H1 90% relative humidity for first 1 day and then relative humidity was reduced to 70% for next 9 days
H2 90% relative humidity for first 2 days and then relative humidity was reduced to 70% for next 8 days
H3 90% relative humidity for first 3 days and then relative humidity was reduced to 70% for next 7 days
H4 90% relative humidity for10 days

Table 4. Effect of humidity periods on fresh and dry weight of shoot and root, T/R ratio, and compactness of tomato seedlings.

Treatments	Fresh weight (g)		Dry weight (g)		T/R ratio	Compactness[y] ($mg \cdot cm^{-1}$)
	Shoot	Root	Shoot	Root		
H0	1.982 a[x]	0.350 b	0.126 a	0.030 b	5.713 a	16.802 b
H1	2.015 a	0.369 ab	0.128 a	0.030 b	5.508 a	18.584 a
H2	2.071 a	0.359 ab	0.128 a	0.033 ab	5.840 a	18.663 a
H3	2.050 a	0.385 a	0.127 a	0.037 a	5.326 a	19.183 a
H4	2.054 a	0.388 a	0.132 a	0.035 a	5.312 a	16.772 b

[x]Mean separation within columns by Duncan's multiple range test at $P \leq 0.05$ (n = 10).
[y]Compactness is the values of the plug dry weight divided with the plug height.

were observed at 90% relative humidity condition for first 2 and 3 days (H2 and H3, respectively). Moreover, graft-take ratio (92.0%) decreased with increasing 90% relative humidity for 10 days during the healing and acclimatization period. The lowest graft-take ratio (83.0%) was observed in 10 days under 70% relative humidity condition. In the other hand, diseased plant had not been found at treatments for first 0, 1, 2 and 3 days under 90% relative humidity condition (Table 3).

Stem diameter, leaf number, leaf chlorophyll content, leaf area, fresh and dry of shoot did not exhibit any significant difference among relative humidity periods. However, difference relative humidity periods affected on plant height, fresh and dry weight of root. The tallest plant height (7.87 cm) was recorded at 90% relative humidity for 10 days (H4), whereas plant height (7.07 cm) decreased at 70% relative humidity for 10 days (H0). The higher fresh and dry weights of root were observed at H3 and H4 treatments. Different relative humidity periods did not affect on T/R ratio of grafted seedlings. However, seedlings treated with 90% relative humidity for first 1, 2, 3 days were significantly more compact than those of other treatments (Table 4).

Root morphology responses to different relative humidity periods are given in Fig. 1. Total root surface, total root length, and number of toot tips were significantly in difference relative humidity treatments. However, there was no significant difference among difference relative humidity treatments on average root diameter of grafted seedlings. The highest total root surface area was observed at relative humidity period of H3 treatment while the highest total root length and number of root tips were observed at relative humidity period of H2 treatment.

Discussion

Increased grafting success requires close contact between scion and rootstock vascular bundles, rootstock and scion compatibility, and proper environmental conditions to facilitate rootstock and scion union (Davis et al., 2008). Although other reports showed that different rootstock varieties, which related this to the diversity in number of vascular bundles, could reduce graft-take ratio of grafted plant (Traka-Mavrona et al., 2000; Aganon et al., 2002; Heidari et al., 2010). However, in first study, our data suggested that graft-take ratio was not affected by different rootstock varieties. These results agree with results of Oda et al.

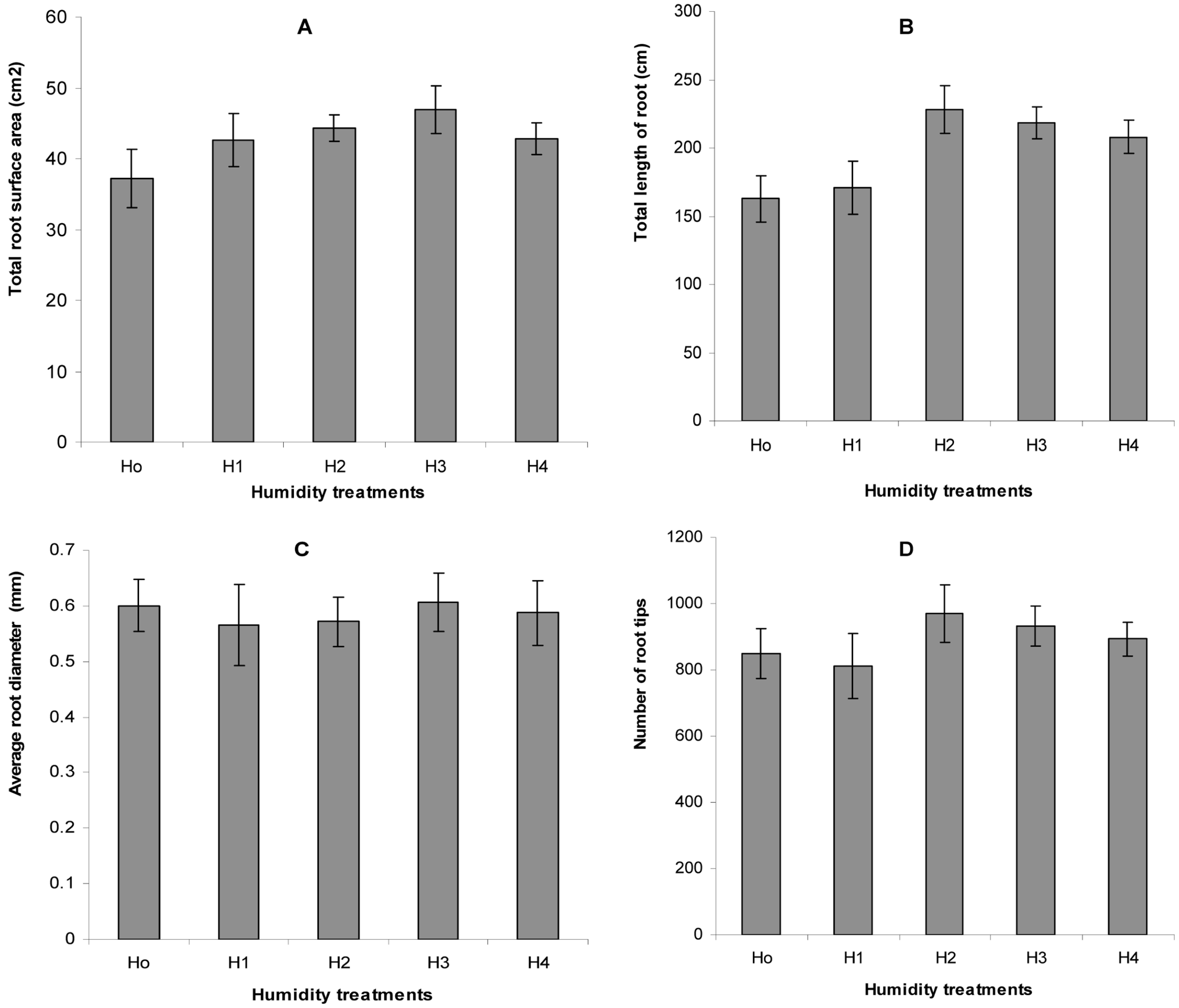

Fig. 1. Effect of humidity periods on root morphology of grafted tomato seedlings. Total root surface area (A), Total root length (B), Average root diameter (C), and total root tip number (D) of tomato seedlings. Vertical bars represent ± SD of means n = 10.

(1993) who did not find difference in survival rate between cucumber grafted onto *C. maxima* and *C. moschata*. Salehi et al. (2009) also suggested that survival rate was not affected by the number of vascular bundles in hypocotyls of rootstocks and the difference between hypocotyls diameters may not be the only reason for the lower survival rate. In this study, the graft-take ratios were not statistically different among the different rootstock cultivars but graft-take ratios were affected by temperature levels on the 7th day and final day after grafting. The present study showed that, the high graft-take ratios (84.0~87.4%) were observed at (23^{o}C) temperature condition. In addition, the final graft-take ratios were not statistically different among the different rootstock cultivars at (23^{o}C) temperature, whereas there were statistically different on graft-take ratio among the different rootstock varieties at 20^{o}C and 26^{o}C. These results suggested that 23^{o}C temperature is suitable condition for tomato seedlings during the healing and acclimatization processes.

In second study, increasing relative humidity significantly increased graft-take ratios in different temperature levels. This study agrees with result of Kim et al. (2001) who suggested that it is necessary to control the humidity at higher than 90% for suppressing the evapotranspiration of grafted seedlings and thus enhancing the graft-taking of grafted seedlings. However, increasing relative humidity significantly increased percent of diseased plants during the healing and acclimatization period. High diseased plant was caused that reduced final graft-take ratio of grafted tomato under high humidity condition. Therefore it is important to control relative humidity period in order to increase graft-take ratio by reducing diseased plant during the healing and acclimatization processes.

Once grafting is performed, it is important to increase the chances for vascular bundles of the scion and rootstock to come into contact (Oda et al., 1994), by maximizing the area of the cut surfaces that are spliced together, and by pressing the spliced cut surfaces together. Therefore, controlling relative humidity period during healing and acclimatization is also critical for the survival and growth of grafted seedling. Oda, (1999) also suggested that after grafting, keeping the grafted plants at more than 90% relative humidity for three days of healing promotes the survival ratio and then the relative humidity is reduced. On the other hand, histological analysis suggested that the transport activities of vasculature were recovered at 3 days and that auxin modulated the vascular reconnection at 2 days after grafting (Yin et al., 2012). So, high relative humidity in first 2 or 3 days is the very important for the scion into contact with the rootstock. In our third experiment, maximum graft-take ratios (100.0%) were observed at 90% relative humidity condition for first 2 and 3 days (H2 and H3, respectively). In addition, diseased plants had not been found in first 2 and 3 days at 90% relative humidity. The results showed that controlling relative humidity was very important to enhance maximum graft-take ratio of grafted tomato and to decrease percent of diseased plants during the healing and acclimatization period. In addition, seedling quality was improved through increasing fresh and dry weight of root, compactness, and root morphology of tomato seedling in first 2 and 3 days under 90% relative humidity condition. Our result agrees with results of Chiu et al. (1999) who suggested that the survival rate and quality for grafted seedlings kept in the acclimatization chamber with 90% humidity, 25~28^{o}C temperature and 12h light and dark interval period for 3 days after grafting were better than those seedlings for traditional culture in the under protected cover in the field.

In conclusion, the graft-take ratio and seedling quality were improved by controlling of environmental factors such as temperature and humidity during healing and acclimatization period. On the other hand, diseased plant had not been found when relative humidity was controlled. Therefore, high relative humidity (90%) for first 2 or 3 days and afterwards reduced low relative humidity (70%) at 23^{o}C temperature condition during healing and acclimatization promoted the graft-take and seedling quality of grafted tomato.

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토마토 공정묘의 접목활착율과 묘소질 향상을 위한 접목 활착실내의 적정 온 · 습도 조건 구명

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적 요. 토마토 접목순화장치 개발을 위한 기초실험의 일환으로 대목의 종류 및 활착실내의 온습도가 접목활착율에 미치는 영향을 조사하였다. 접목활착실의 온도는 23°C > 17°C > 20°C > 26°C 순으로 초기 활착율과 최종활착율이 높은 것으로 조사 되었으며, 상대습도는 높을수록 활착율은 양호한 결과를 나타냈다. 단 상대습도가 90% 이상 처리구에서는 곰팡이병에 의한 이병주 발생도 같이 증가하는 경향을 나타냈다. 대목의 종류에 따른 초기활착율은 'Kanbarune'의 26(± 1)°C와 'Solution'의 20(± 1)°C를 제외하고는 대목의 종류와 관계없이 모든 온도 처리구에서 83% 이상 양호한 활착율을 보였으나, 최종 활착율에서는 처리 온도간에 뚜렷한 유의적 차이를 나타내, 23(± 1)°C에서만 대목의 종류와 관계없이 85%에서 90%전후의 활착율을 보였고, 20(± 1)와 26(± 1)°C에서는 65~75% 정도로 활착율이 저하되었다. 특히, 27(± 1)°C에서는 이병주의 증가로 건묘생산율은 모든 대목처리구에서 65% 이하였다. 일반적으로 알려져 있는 고온기 접목활착 최적온도인 23(± 1)°C에서는 대목의 종류에 따른 건묘생산율은 84~88% 전후로 대목 품종간 유의적 차이는 없었다. 접목활착실내 상대습도 조건에 따른 최종 접목활착율은 초기 2~3일간은 상대습도를 90%로 유지하고 나머지 7~8일간은 75% 정도로 유지하는 처리구에서 100% 접목활착 성공율을 나타냈고, 전기간 90%로 유지한 처리구와 1일 90%, 9일간은 75%로 유지한 처리구에서는 90%전후의 성공률을 나타냈다. 전반적으로 높은 상대습도 유지기간이 길수록 초기 활착율은 증가하는 경향을 보였으나, 고습도에서 장기간 묘를 양생할 경우, 곰팡이병 발생 등으로 최종 건묘생산율은 감소하므로, 초기 2~3일간만 90% 전후로 유지하고 나머지 구간은 75% 전후로 유지하는 것이 고온기 토마토 접목 활착율 향상을 위한 바람직한 조건이라 판단되었다. 각 처리간 묘소질에는 큰 차이를 나타내지 않았으나, 전반적으로 활착율이 양호했던 처리구에서 묘소질이 타 처리구에 비해 상대적으로 좋았으며, 이러한 경향은 특히 근권부의 형태적 특성을 조사한 결과에서 명료하게 나타났다. 이상의 결과 고온기 토마토 활착실내의 환경관리는 23도 전후의 온도에서 80(±5)%의 상대습도로 관리하는 것이 건묘생산에 적합할 것으로 판단되었다.

추가 주제어 : 순화과정, 상대습도, 대목, 플러그 육묘, 묘소질