GRAFTED TOMATO IN VIET NAM, FROM 0 TO 7,000HA/YEAR

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ABSTRACT

Bacterial wilt caused by Ralstoniasolanacearum can kill up to 100% of tomato plants. Growing tomatoes by grafted seedlings in which scions of normal tomato are grafted on resistant tomato rootstock can give 100% of plant resist to Ralstoniasolanacearum. From 2002 to 2004, The Institute of Agricultural Science for Southern Vietnam (IAS) studied and introduced this technology to Lam Dong farmers. So far, every year 6500-7000 hectares (ha) out of 7000-8000 ha tomatoes grown in Lam Dong, Viet Nam is using grafted seedlings. This brings to Viet Nam farmer a total profit of around 45-50 million USD/year. In Viet Nam, so far, there are around 80 tomato grafting seeding farms with an average area of 5,000m². On average, each farm can produce 3-4 million grafted tomato seedlings and get profit of 22,000 USD/year. Eighty percent of works in seedling farms are performed by machines. Hand grafted work done by labor workers using grafting tools (razor blades and latex-tubers) has the efficiency around 150-200 seedlings/hour.

Keywords: Grafting, Seedling, Tomato, Vietnam

INTRODUCTION

Tomato (Lycopersiconesculentum Mill.) is one of cash crops grown popularly in the world with an area of 4,582,438ha and production of 150,513,813tons (Indian Horticulture Database, 2011). In Vietnam (VN), annual area of tomato production is about 20,000ha. In the North, tomato is planted mainly in Red River Delta and in the South mainly in Lam Dong province. In which, only in Lam Dong province it is around of 6,500-7,000 ha/year. Tomato is often damaged by many kinds of insects and diseases, in which, Bacterial wilt (Ralstoniasolanacearum) is considered the most serious one because it can spread out fast and can damage almost 70-80% even 100% of plants. In Vietnam, the damage caused by Bacterial wilt is reported in technical guide as one of the few diseases that can make tremendous lost and is difficult to control. Still now, there is no chemicals can control it. Using resistant varieties and doing crop rotation are recommended. However, in real world practices, there are no highly resistant varieties available in markets and rotation showed no effectiveness. Big efforts were made to find suitable methods or solutions to control this disease but in vein. By now, grafting a tomato scion onto a rootstock of a resistant egg-plants or tomato is still the best solution.

With the assistance of AVRDC, grafting tomato was introduced into VN from 2002. In order to have 7,000-8,000ha grafted tomato each year, the researchers in the Institute of Agricultural Science for Southern Vietnam (IAS) in the Southern part of VN and the Fruit and Vegetable Research Institute (FAVRI) in the Northern VN together worked with farmers modified AVRDC’s techniques a lot. In 2012, AVRDC conducted a survey to assess impact of grafting in VN and generate useful information (Genova, 2013). This paper provides information on implementation of grafting techniques in VN with focusing on Lam Dong province where the area of grafted tomatoes cover more than 90% of grafted tomato of whole nation.

Research

From 2002 to 2003, 3 experiments using tomato varieties that resist to Ralstoniasolanacearum were carried out by IAS in Ho Chi Minh City and in Lam Dong province. The purpose of these experiments was to find out good varieties for using as rootstock. Seven tomato varieties were used as rootstock to graft with normal varieties. The
experiments showed that 98-100% of plants that grafted with rootstock of HW7996 (from AVRDC) resist to \textit{R. solanacearum}. Grafted tomatoes can give the yield of 70-80 tons/ha in Lam Dong, making an increase of 50% in yield compared to non-grafted tomatoes. In the North Viet Nam, during 2006-2007, FAVRI conducted some experiments and found EG203 egg-plant (from AVRDC) is good rootstock for grafting tomato to overcome water-loging and bacterial wilt the major constrains in tomato production there.

\textbf{Implementation}

Lam Dong, a province in highland, South Vietnam, with the average temperatures between 20-25°C all year-round, it is the largest tomato production area in Vietnam, providing around 360,000 tons/year to the market. Lam Dong is a agricultural province where vegetables production has been developed for 60-70 years, and this is why bacterial wilt became the most serious disease. Bacterial wilt could destroy 100% of farmers' harvest. Therefore, Lam Dong was chosen to usethegrafting technique first.

From 2004, grafting technique and growing grafted tomato seedlings were introduced to the farmers. The technique was transferred to the farmers efficiently. In 2007, 100% tomato growers in the area have applied this technique to a total area of 3,500-4,000ha. Year by year, the tomato production in Lam Dong sustainably increased. From 2010 to date, in 2016, the total tomato plantation doubled to 7,000ha and 100% of these plantations grow grafted seedlings. (Vinh, Ngo Quang, 2006)

Beside Lam Dong, some provinces in the South VN such as Tien Giang, Vinh Long, Tra Vinh also adopted this technique and the total growing area is around 100-200ha/year; and provinces in the North VN such as Bac Ninh, Bac Giang, Hanoi, Hung Yen, Hai Duong with the growing area of 300-500ha/year.

\textbf{Profit and household incomes}

In 2012, AVRDC surveyed 225 tomato farmers in Lam Dong and 75 tomato farmers in Red River Delta to evaluate the impact of grafting on their incomes and activities. The results of the survey showed that in 2007, 100% tomato farmers in Lam Dong province and in 2012 15% farmer in Red river delta adopted the use of grafted seedlings. Total sales of farmers using grafted tomato reach to 31,300 USD/ha and only 11,534 USD/ha for farmers rewnon-grafted tomato. Farmers grew grafted tomato seedings had a significantly higher revenues of 15,751 USD/ha compared to farmers grew non-grafted tomato. The benefit-cost ratio is 4.6 for grafted tomato and 3.5 for non-grafted tomato.
Table 1. Estimated effect of tomato grafting on net profits in Lam Dong province

<table>
<thead>
<tr>
<th>Item</th>
<th>Lam Dong province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption rate</td>
<td>100%</td>
</tr>
<tr>
<td>Yield (tons/ha)</td>
<td>73.3</td>
</tr>
<tr>
<td>Tomato price (USD/kg)</td>
<td>0.186</td>
</tr>
<tr>
<td>Total cost (in USD/ha)</td>
<td>6,617</td>
</tr>
<tr>
<td>Total profit (in USD/ha)</td>
<td>6,520</td>
</tr>
<tr>
<td>Total area under tomato production (ha, 2011)(^a)</td>
<td>6,388.0</td>
</tr>
<tr>
<td>Total profit from grafting (million USD)(^b)</td>
<td>41.7</td>
</tr>
</tbody>
</table>

\(^a\) Agro–Forestry Department, General Statistics Office, Vietnam
\(^b\) Foreign exchange rate in August 2012 (VND/USD) = 20,703.4
(source: An impact assessment of AVRDC’s tomato grafting in VN-AVRDC)

Based on average revenues of 13,138 USD/ha, average production costs of 6,617 USD, and an estimated tomato area of 6,388 ha (only in Lam Dong), total profit was higher by USD 41.7 million compared to the situation if the same land area had been cultivated with non-grafted tomatoes.

**Tomato grafted seedling farms in Lam Dong Province**

In Lam Dong so far, there are about 80 grafting tomato farms with the mean land area being nearly half a hectare. 85% operators had already attended vegetable grafting training. All operators use Vimina (Hawaii 7996) as rootstock and Anna as scion, which were priced around 145-169 USD and 1,879 USD per kilogram of seed, respectively. All nursery operators confer and discuss with each other at least twice a year to set the price of seedlings for farmers. Grafted seedlings were sold at an average price of 0.030 USD per seedling, giving operators a mean profit of 0.006 USD per seedling, which was nearly twice the profit from non-grafted tomato seedling of 0.0035 USD per seedling.

In seedling farms of Lam Dong province, nowadays around 80% of works have been replaced by machines. In which, machines are used for processing media, spraying chemical, spraying fertilizer, sowing seeds and transferring materials and seedlings. In order to sow seeds, farmers may used single auto-machine or combination of machines to full fill media and sowing seeds. All seedling farms use plastic house with platform that 70-80 cm above ground to arrange seedling trays. In general, a 5,000 m\(^2\) seedling farm operator requires 1.2 auto-seeders and 1.5 trucks. In each seedling farm, 10 to 50 labors works ongrafting every day. Each labor can graft 150-200 plants/hour with ratio of success around 98-100%. A 10-15 grafting-labors' farm can produce 0.3-0.4 million grafted seedlings/month estimated 3.4-4 million grafted seedlings/year, and get benefit of 500 million VND/year (24,000 USD).

**Grafting technique**

There are some technical instructions for grafting introduced by authors: Black et al. (2003), Harold (2003), Vinh, Ngo Quang (2006), Richard MacAvoy (2005), Cary Rivard and Frank Louws (2008), Vern Grubinger, Paramount Seeds and others. In general, all technical process is similar, only some points are different. Below is techniques of IAS, Vietnam, modified from AVRDC and it is being applied successfully in large area of 80 farms from 2007 till now (2016), producing around of 3.5-4.0 million grafted seedlings each farm annually. Normally, cut the rootstock above cotyledon at a 45º angle. Cut the scion stem at 45º angle also, slightly above the first true leaf. Slide a 13-mm-long latex tube (2.0-mm-inner diameter) over the scion stem. Push the scion about halfway into the tube. Slide the scion (now fitted with the latex tube) over the rootstock seedling stem. Make sure that the cut angles of the scion and rootstock stem are parallel. Gently push the scion and rootstock together. The tube will stay on the seedling until it naturally hardens, splits, and falls off in the field.

During grafting duration, spray very fine drop water every 10-15 minutes on grafted seedlings until they are moved into shade room. Grafted seedlings will be in the shaded room for 3 first days with temperature of around 20-25°C, humidity of around 80-90% relate humidity (RH), and light of 10-20% natural light. The grafted seedlings may wilt initially but will become upright within three days. From the 4th day after grafting, begin the
hardening process by raising light and reduce humidity (30-50% natural light, 75-80% RH, 22-27°C). Maintain these conditions for 4 days. From the 8th day toward, grafted seedlings should be maintained in normal condition of non-grafted seedlings (20-30°C, 60-70% HR, 70-80% natural light). Nine days after grafting, apply DAP (18-46-0) fertilizer of 0.4–0.5%. In general, grafted seedlings can be transplanted 12 days post operations.

CONCLUSION

After 14 years (2002-2016), Viet Nam’s grafted tomato plantation area increased from zero ha/year to 7,000 ha/year. Researchers and farmers in Viet Nam have good experiences in development of tomato grafting. We are willing to share to anyone who is interested in this subject. In our case, it clearly shown that planting grafted tomato seedlings is an excellent solution to control bacterial wilt. The technology can be applied widely in most of tomato growing areas where bacterial disease causes problems. One important thing for those places under unfavorable temperature conditions (too cold or too hot) is to conduct some studies to create suitable temperatures and humidities for grafting rooms or houses. HW7996 is a variety highly tolerant to *Ralstonia solanacearum*. It should be introduced and used widely.

REFERENCES

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