Vegetable Grafting

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For thousands of years various fruit industries around the world have been grafting trees to deal with many production problems like diseases, vigor, soil pests, and environmental effects. Commercial grafting of vegetables has only started recently, even though it has been documented in Japanese writing many centuries earlier. The practice is very popular in Southeast Asia. Last year, it was estimated that 20% of China's watermelon was produced from grafted plants and South Korea and Japan produced about 700 million seedlings each. However, since the early 1990's, vegetable grafting has been gaining steady popularity in the Middle East, Western Europe, and more recently in the US for several reasons. In Europe in 2009, Spain was the leading user with an estimated 129 million plants, followed by Italy with 47 million and France with 28 million plants. In the US, it is estimated that 40 to 45 million grafted plants were grown in 2005.

A comprehensive review of the practice has recently been published in the journal Scientia Horticulturae (volume 127, December, 2010). Studies have shown that stocks of certain vegetables have excellent tolerance to soil-borne diseases like Fusarium, Verticillium, Phytophthora, namatodes, and many other pests. Certain stocks have also been shown to provide some protection from viruses. Studies in Arizona showed that "Olympic Gold" muskmelon grafted onto interspecific squash hybrid 'Tetsukabuto' were more resistant to pythium and to root knot nematodes than non-grafted plants. Similarly in North Carolina, an experiment with heirloom tomatoes grafted on CRA 66 and Hawaii 7996 rootstocks resulted in complete control of bacterial wilt in an infected field compared to non-grafted plants. In a third trial under an organic system, heirloom tomatoes were grafted onto 'Maxifort' (De 'Ruiter) and 'Robusta' (Bruinsma) rootstocks to control races 1, 2 of Fusarium. Both rootstocks provided either complete control or delay of the infection. The benefit of having pest resistant stocks is very important to vegetable production, especially under high tunnels, hydroponic, and organic systems.

Another benefit to grafting is to increase vigor and early production. The previous studies on heirloom tomato in North Carolina also showed that plants grafted on 'Maxifort' (De 'Ruiter) in a field that has been in constant tomato production for 12 years had higher biomass production than on non-grafted plants. These studies suggest that grafting of tomato on certain rootstocks can compensate for lack of crop rotation. The same benefit has also been shown in grafted watermelon plants. Grafting has also been shown to increase yield of some vegetable varieties. Researchers from Korea and Japan have reported increases of 25 to 50% in yield of grafted tomato, melons, pepper, eggplant, and watermelon compared to non-grafted plants. The increase in yield was attributed mainly to increases in vegetative growth, reduction in pest pressure, and less deformed fruits.

Other reported benefits of grafting include increased resistance to low and high temperatures, better nutrient uptake, improved tolerance to drought and flooding, improved water use efficiency, enhanced tolerance to high soil pH and high salt stress. Particularly important is the use of rootstocks to resist low soil moisture like figleaf gourd rootstock that has been used commercially to increase the tolerance of watermelon, cucumber, melon, and summer squash to low soil temperature. Hobbyists have used the technique to graft tomato, eggplant and pepper on potato and to graft Chinese cabbage and cabbage on radish in order to produce several related vegetables on one plant.

Economic cost

In 2010, Rivard and his colleagues (HortTechnology, volume 20) examined the economic cost of producing grafted tomato plants under an organic system in North Carolina and under a conventional system in Pennsylvania. They found that the cost of producing grafted plants in NC was 59 cents compared to $1.25 in Pennsylvania, while the cost of non-grafted plants was 13 cents in NC and 51 cents in PA. A breakdown of the cost showed that grafting supplies account for about 37%, seed about 45%, labor about 12%, and miscellaneous expenses about 10%. Their conclusion was that the cost of producing grafted plants is affected by the availability of seed stocks and grafting supplies rather than by labor to graft the plants.

Currently, a limited number of commercial rootstocks are available for watermelon, melon, tomato, eggplant, bell pepper, and cucumber. It is expected that the seed cost and grafting supplies will decline as the demand increase.

Grafting techniques

Most of the grafting techniques are similar to those used in tree fruit production. The process involves selecting the right rootstock/scion combination, the grafting technique, healing or callusing, and acclimation of the grafted plants. Most commercial grafting is done by hand, but the technology for automated grafters is advancing very rapidly.

Currently there are at least two companies that produce automatic grafters. The three most common methods for grafting vegetables are splice, tongue, and cleft. Splice grafting is preferred by commercial growers, while tongue grafting is used mostly by hobbyists. Clift grafting is used mostly for tomato, pepper and eggplant. After grafting the plants need to be healed and acclimated. Healing is usually done by enclosing the grafted plants in a sealed chamber in a warm and partially shaded place (70 to 75°F) for 5 to 7 days. After the callus has formed and the wounded surfaces are healed, plants may be put under a mist system or placed under a clear plastic cover for acclimation.

In conclusion, vegetable grafting is moving closer to becoming an accepted practice for commercial vegetable production. It has many advantages, but lack of information about the systems and the cost is still high for many growers.