



**Down to Earth:
Reports from the field**

Innovative Small Farmers' Outreach Program (ISFOP): East Central Region

Vegetable Grafting: An Introduction By Dr. Sanjun Gu

Grafting is an old practice with tree fruit. It is the act of joining two plants together. The upper part of the graft, the *scion*, becomes the top of the plant; the lower portion, the rootstock, becomes the root system or part of the trunk. Vegetable grafting (Fig. 1) came in much later. It first appeared in an ancient Chinese book when an experienced farmer was recorded to use more than six gourd plants (rootstocks) to support one gourd vine (scion) and harvested extra large gourds (birdhouse). Commercial grafting of vegetable plants began in Korea and Japan in the late 1920s when watermelon plants were grafted onto squash rootstocks for Fusarium wilt resistance. Eggplant was grafted onto scarlet eggplant (*Solanum integrifolium* Poir) in the 1950s. Since then, grafting has been adopted in Asia and Europe for various protected production systems including greenhouse and high tunnels. Currently, more than 95 percent of cucumbers and watermelons, and more than 54 percent of tomatoes grown in South Korea or Japan are grafted. In China, almost all cucumber and most tomato, watermelon and eggplant plants, are grafted for winter production in unheated solar plastic greenhouses or low-tunnels. In the Mediterranean region, grafting has been a major component of integrated management on soilborne diseases and increasing crop productivity. The number of grafted tomato plants was over 45 million in Spain and over 20 million in Morocco in 2004. In North America, there are about 40 million grafted hydroponic tomatoes in the British Columbia area and over 1250 acres of grafted tomatoes in Mexico.

In the United States, however, vegetable grafting has been an emerging technique but has become popular among small-scale farmers, especially with those who have high tunnels or a greenhouse. So far, research and demonstrations have been conducted at University of

Florida, North Carolina State University, The Ohio State University, University of Arizona and Lincoln University of Missouri. Although only a few Missouri farmers have included grafting in their vegetable production, Fahrmeier Farms in Lexington, Missouri began tomato grafting about 10 years ago with excellent results. This technique has been well accepted among Missouri extension horticulturists, thanks to a professional development program grant awarded to Lincoln University from the USDA Sustainable Agriculture Research and Education (SARE).

The benefits of vegetable grafting are prominent with intensive cropping systems such as in green-

houses and high tunnels. By carefully choosing appropriate rootstock varieties, grafted vegetable plants will have a more hardy root system that provides resistance to disease and cold weather, and enhances water and the ability to absorb minerals. The increased efficiency of nutrient and water absorption has been observed on most grafted vegetables and reduced fertilizer inputs have been reported on grafted cucurbits, a plant from the gourd family. Grafting can also be an alternative, in terms of soil-borne diseases, to methyl bromide which had been used extensively for soil fumigation but was banned completely in 2005. Grafting could be instrumental for organic and sustainable production of heirloom tomatoes. Grafting disease-susceptible heirloom tomatoes to resistant rootstocks is recommended for organic cultivation by researchers at North Carolina State University. For cucumber, watermelon and melon grafting, Fusarium wilt disease resistance has been a target in production. For tomatoes, grafting targets multiple diseases as detailed in (cont'd on page 4)



Figure 1. Insertion method of grafting shown on a watermelon plant.

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Beekeeping For Pleasure and Profit By Miranda Duschack

Beekeeping, once a common practice on farms, is again gaining in popularity. People across Missouri are trying their hand at keeping bees for pleasure and profit. Managed honeybees can benefit any farm or garden. The bees' pollination services will increase fruit set on cucurbits, strawberries, cherries and apples. Your honey harvest is a tasty, nutritious and profitable reward for successful management. Healthy hives will need to be divided annually to prevent swarming, so your stock will multiply naturally. Beekeeping can be highly satisfying, but because of its potential risks it takes thoughtful discernment before you begin. Consider the following:

- Are you or a family member allergic to honey bee venom? What is the severity of the allergy?
- Do you have a safe, private location for the beehives?
- Are you or a nearby neighbor spraying any pesticides that will kill the honeybees?
- Do you have the time to learn this skill?

On average, 30 percent of non-treated colonies die each year. What is your philosophy regarding treatments for mites and infections?

Honey sales are an easy way to profit financially from beekeeping. A well managed colony contains about 50,000 bees at its peak during late spring. The colony requires about 60 pounds of stored honey to survive the winter without supplemental feeding, but will store double or more than that poundage. Your honey harvest is this surplus. The average single colony honey harvest in Missouri is 60 pounds, although many beekeepers have reported 100-200 pound harvests per hive. The colony creates honey during nectar flows, when trees, shrubs and flowers are in bloom. Management increases during this time as

beekeepers add empty bee boxes, called supers, for bees to fill. The spring nectar flow lasts from late April to Memorial Day at the end of May, with the summer flow lasting until late June or July, when clover normally stops blooming. It is during these flows that the beekeeper harvests the bees' excess honey. The going rate for bottled, extracted honey on the direct market is \$6.00-\$8.00 per pound. Cut comb sells for upwards of \$10 for a 4-inch by 4-inch square.

The beginning beekeeper starts with two colonies. That way, if one is strong and the other weak, bees can be moved to shore up the failing population. At the start of April the beginner installs a package of bees into a brand new standard 10-frame hive of Langstroth design. Used equipment can harbor disease and chemical residues that may damage the colony and should be avoided. To ensure an early delivery date, the packaged bees and equipment must be ordered from retailers by the end of January. Assemble and paint the new hives by mid-March, so they are ready for the April installation. Pre-packed colonies come with about 3,000 bees and one queen. Over the course of the first spring and summer, the package of bees will become a colony and the population will grow into tens of thousands of bees.

Packages, unlike nucleus colonies, grow slower, giving the beginner the opportunity to witness development. Beginners are usually enthralled while observing the growth and social behaviors of the colony, and become 'hooked' on beekeeping. The initial investment for two new hives with supers and foundation, protective equipment such as suit, smoker, gloves as well as hive tool and the packaged bees, is around \$700.



Miranda Duschack with packaged bees

During the first year a colony started from package bees will build out wax comb on the foundation, grow in population and store honey for colony survival. Supplemental feeding will be required to assist in faster growth and at times when nectar is scarce, in order to prevent starvation. The goal for the first year is for the colony to build out the hive with comb, store honey for the winter and survive until spring. Do not expect to harvest honey the first year, but be prepared for second year harvests.

Local beekeepers' associations are an excellent resource for beginning beekeepers. Club members are eager to share their knowledge with a novice. Timely and informational presentations guide the audience through important topics relevant to the season, such as 'swarming' and 'fall inspections'. Meetings are a fine place to find helpful printed material, high quality bees, equipment and possibly even a mentor. Some clubs have portable extractors to loan or host extraction events for those without the equipment. Association membership fees are nominal and well worth the investment.

Looking Ahead By Janet Hurst and David Price

Many of you are busy starting seedlings with high hopes for this growing season. Now is the time to sit down with seed catalogues to see what is new and to reorder the old reliables you depend on each year. Be careful not to overestimate your needs or to get carried away when ordering your stock. Many of us are like a kid in a candy store when it comes to seeds! Make a list of needed supplies for seed starting such as pots, seed trays, lights, amendments, row cover, etc.

Speaking of soil, is it time for a new soil test? To properly amend your growing medium, a current test will ensure you are adding the required nutrients. Why not consider something new this year? Perhaps a trial of worm castings added to your soil blend. The interest in vermiculture (the cultivation of earthworms) grows daily. If you have raised beds, take a walk around the garden and see if there are repairs or replacements to be made. Look into alternative mulches such as free burlap coffee bags from St. Louis area roasters.

For those of you that have livestock on the farm, the less demanding hours of winter are ideal for mending fences or making repairs in barn lots and handling areas. This is also a time to cleanup debris and hazards that may have been overlooked last summer. Consider your pastures. Adding legumes to a grass-based pasture will mitigate the need for expensive nitrogen-based fertilizers. In Missouri, the middle of February is the perfect time to begin frost seeding legumes. Broadcasted red clover seed will work its way into the soil as the ground freezes and thaws throughout the late winter months.

Regarding your livestock, especially horses and large ruminants like cattle, move them to a 'sacrifice' paddock in the winter months. This way only one pasture will have to be re-worked in the spring and the other pastures will be ready for turnout after they green up. Speaking of spring turnout, don't forget to de-worm your animals before doing so. It is important to consider (*cont'd on page 3*)

The months of winter are a good time to reflect, to rest for a moment and to take stock of our plans for 2012. On the farm there are countless tasks to attend to during the first three months of the year.

THE IPM CORNER: Importance of Pollination in the Vegetable Garden/Small Farm

By Dr. Jaime Piñero, LUCE State Extension Specialist—Integrated Pest Management

Close to seventy-five percent of the flowering plants on earth rely to some degree on pollinators in order to set seed or fruit. Therefore, understanding, providing, enhancing, and managing habitat for pollinating insects is a very important component of food production. We are well into the fall so the following information will become useful for next spring.

What is pollination and why is it important? Pollination is the transfer of pollen within a flower or between flowers and is needed for many plants to produce fruits.

For the vegetables we grow for leaves (lettuce, spinach, cabbage) and roots (beets, carrots, radishes), pollination is not important. But the vegetables we grow for fruit, or seeds (melons, corn), pollination is almost always needed. The pollination process in all beans, peas, and tomatoes is called self-pollination because the transfer of pollen takes place within the individual flowers without the aid of insects or wind. However, many crops such as cucurbits (e.g., squash, pumpkins, melons, cucumbers) have the male and female organs in separate flowers on the same plant and therefore insects are needed to transfer pollen from male flowers to female flowers while going from flower to flower, collecting nectar and pollen. In general, the more bee visits per flower, the

greater the number of seeds per fruit, the larger the size of the fruit, and the smaller the number of irregularly shaped fruit. Poorly shaped fruit (cucumbers, watermelons, tomatoes) may result from incomplete pollination but also from temperature extremes and poor plant nutrition status. Also, many insects that visit flowers as adults also provide pest control for crop plants.

What are the most common pollinating insects? Bees (honey bees, native bees, bumble bees, sweat bees) are the most important group of pollinators. Flies are important pollinators of strawberries, and for onion and

carrot seed, whose flowers are not a favorite of managed bees. Wasps, butterflies, and moths can also aid in pollination, but to a lesser degree.

How can I enhance pollination in my garden? Since pollinating insects are so important in the garden, it is important to consider them when choosing and applying insecticides. Choose insecticides that are least toxic to bees, and apply them late in the day when bees are not actively working in the garden. A patch of suitable flowers quickly becomes a magnet for butterflies, bees, flies, and beetles that aid in pollination of adjacent plants. The following advice comes from the Xerces Society (<http://www.xerces.org>), an international non-profit organization that protects

wildlife through the conservation of invertebrates and their habitat:

Use local native plants. Research suggests native plants are four times more attractive to native bees than exotic flowers. In gardens, heirloom varieties of herbs and perennials can also provide good foraging.

Choose several colors of flowers. Flower colors that particularly attract native bees are blue, purple, violet, white, and yellow.

Plant flowers in clumps. Flowers clustered into clumps of one species will attract more pollinators than individual plants scattered through the habitat patch. Where space allows, make the clumps four feet or more in diameter.

Include flowers of different shapes. Bees are all different sizes, have different tongue lengths, and will feed on different shaped flowers. Consequently, providing a range of flower shapes means more bees can benefit.

Have a diversity of plants flowering all season. By having several plant species flowering at once, and a sequence of plants flowering through spring, summer, and fall, you can support a range of bee species that fly at different times of the season.

Where can I buy seeds? Information on where to get seeds, and for the types of native plant seeds that are available and suitable for Missouri can be provided by Dr. Nadia Navarrete-Tindal (Navarrete-TindalN@LincolnU.edu), State Extension Specialist—Native Plants.

Native plants should be your first choice to help our native bees!

Looking Ahead...(continued from page 2)

strategies to prevent illnesses (i.e., grass tetany, founder, bloat, and/or colic) that can be caused by an abrupt transition from a winter diet of stored forages to the lush grasses of spring. Grass tetany (a calcium deficiency) is especially prevalent in cattle, goats and sheep. To manage against this illness, provide access to a mineral supplement that is high in magnesium. Magnesium is often deficient in immature spring grasses and essential in preventing grass tetany. Consider offering free-choice hay to the animals to prevent discomfort and sickness as they make the transition to spring pasture. As the season progresses and the forages become more nutrient rich, the animals will wean themselves off of the hay and mineral.

Winter is the time to create an overall business and marketing plan. Think of your business plan as that type of instrument:

a virtual mapping system to guide your decisions and keep you heading in one direction. In the heat of the moment, or the summer as the case may be, it is easy to get swept away by the demands placed on time and labor. A few hours putting numbers together, calculating expenses versus sales will be time well spent. Remember to run your farm as a business and to pay yourself a living wage.

How are your bookkeeping skills? A calendar placed strategically for recording planting dates, yields, frost and other important facts will serve you well for years to come. Record your sales each week and make notes of customer requests. Next year, take a look at these notes and you will have a better idea of what to grow, how much to grow and anticipated yields. Collect addresses and

emails to build your marketing base. A quick email to your customers will let them know what products you have available, what markets you will be attending, etc. People want to know about what is going on at the farm, so this is a great opportunity to keep them in the loop!

Continued educational programs abound with our Innovative Small Farmers' Program workshops and the Missouri Beginning Farmers' Program. These events provide educational opportunities to learn new techniques and to meet other farmers. Often a fresh idea will strike a chord, providing a new focus for your operation.

Check out these websites for more information: <http://beginningfarmers.missouri.edu/> www.missouribeginningfarming.blogspot.com

ISFOP

If you are a small farmer and need information, please contact an ISFOP Farm Outreach Worker (FOW). FOWs live and work in your community. They can provide information on ways to better manage your resources, reduce expense and increase income. They can also provide information on other programs and resources that may increase your income and the overall quality of life for your family.

You are eligible to participate if:

- ☑ Your family lives on a farm, rural or urban.
- ☑ Farm products or income from the farm are necessary for you to live where you do.
- ☑ Your family provides the management and most of the labor for your farm.
- ☑ Your total annual family income is less than \$50,000.

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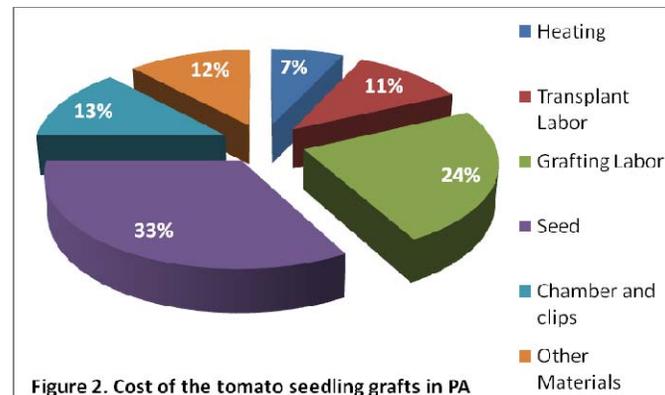
Vegetable Grafting ... (continued from page 1)

Table 1. Rootstock and Disease Resistance in Tomatoes

Rootstock	TMV	Corky Root	Fusarium Wilt (Race 1&2)	Verticillium Wilt	Root-knot Nematode	Bacterial Wilt	Southern Blight
Beaufort	R	R	R	R	MR	S	HR
Maxifort	R	R	R	R	MR	S	HR
TMZQ702	R	S	R	R	MR	HR	?
RST-04-105	R	S	R	R	MR	HR	MR
Big Power	R	R	R	R	MR	S	HR

TMV: Tobacco Mosaic Virus; R: Resistance; HR: High Resistance; MR: Moderate Resistance; S: Susceptible

Table 1. Grafting vegetable seedlings involves extra investment in materials (rootstock seeds, grafting tools, heeling chamber, etc.) and labor. Grafted tomato transplants cost 40 to 50 cents more per plant. The labor input is not as high as one would imagine. About 24 percent of the total cost for farmers without any experience in grafting (Fig. 2) will be reduced to about 15-17 percent after some practice. These additional costs will be easily compensated by the profit increase associated with increased yield and quality. Yield of grafted tomatoes could be increased by 9.4 tons (or 752 more boxes) per acre or a \$9,014 profit increase (assuming \$12 per box). This translates to a profit increase of \$1.88 per plant. In the case of watermelon, a grafted transplant costs about 50 cents more than an ungrafted one which translates to a \$700 additional cost per acre.



The return, however, would be at least 12.6 percent more than the ungrafted if Fusarium wilt is a problem.

Please note that grafting is not for all vegetables. It is more applicable to fruiting vegetables and some vining vegetables such as tomato, watermelon, melon and cucumber.

Grafting vegetables is not a complicated technique. Look for future articles on specific grafting methods for tomato, cucumber, melon, watermelon, pepper and eggplant.



Cleft grafting method shown on a pepper seedling.