USE OF BACKPACK BOOM SPRAYERS FOR RAPID WEED CONTROL IN CACTUS PLANTATIONS AND USE OF PLASTIC TENTS TO STIMULATE WINTER NOPALITO PRODUCTION

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Our prior research with herbicides and cultivation of the wild Texas native *Opuntia lindheimerii* showed a nearly 10-fold increase in growth of well weeded plots over unweeded control plots (Felker and Russell, 1988). The soil-sterilant herbicides tebuthiuron (Spike) and hexazinone (Velpar) were the most effective herbicides in providing nearly year-long control. Other useful preemergence herbicides were simazine and diuron. Tebuthiuron and hexazinone must be used with extreme caution because they are very phytotoxic to nearly all other vegetation, including live oak (*Quercus virginia*) and mesquite (*Prosopis glandulosa*). Tebuthiuron or hexazinone could cause damage to live oak trees well outside cactus plots through root absorption. At the present time, no preemergence herbicides have been approved by the EPA and it would be a violation of federal law to use any of these herbicides in commercial cactus production.

Rapid, economical weed-control techniques are not only useful in a research setting but are absolutely essential to the economic production of nopalitos or fruit. More than one grower's field has been observed to be overgrown with weeds.

Due to preliminary results showing minimal phytotoxicity to older *Opuntia* growth from Roundup and the minimal long-term environmental effects of Roundup, we examined use of Roundup for weed control in *Opuntia*.

Because Roundup is not specified for use on cactus on the Roundup label, it is a violation of federal law to use Roundup for weed control in cactus plantations. However, Texas A&M University - Kingsville has been working with the USDA's group for registering pesticides for minor crops (IR4) to clear Roundup for use on cacti. The experiments have been done and the cactus samples sent for residue analysis. Monsanto has agreed to add cactus to the list, if the USDA residue tests show there is little Roundup residue on the cactus. In all likelihood, Roundup should be approved in 1995. If needed for commercial production before then, an emergency state registration could be requested.

The tests with Roundup for the USDA used a 80 hp farm tractor with a PTO-mounted pump applying 30 gallons of water per acre. To avoid spraying Roundup directly over the plants, the nozzles were hung from a spray boom using flexible plastic drop nozzles about 20 inches long. The nozzles were about 6 inches off the ground and were adjusted to spray the roundup on the "woody" base of the established cacti to kill weeds in this zone.

Most farmers only have 5- to 10-acre plots and, because it is difficult to drive over a hedge of cacti, it was also important to develop techniques for use of Roundup without a tractor.

The following objectives were important in developing a Roundup weed control system:

- Minimize the weight of water that must be carried and the number of fill-ups
- The applicator must be able to walk fast and cover a lot of area quickly
- Techniques should not damage young, newly planted cactus.

We chose to use a pressure-regulated Solo backpack sprayer with a boom attachment. The backpack sprayer has a pressure regulator and standard agricultural nozzle tips, therefore, a very professional, but inexpensive and flexible system can be built. The boom is similar to those used on standard farm equipment. A boom can be purchased from various suppliers but the cost is usually greater than $125 for a 5-ft boom. Nozzles that come with the Solo sprayer are high-volume nozzles that do not give a fan distribution. For these reasons, we fabricated a boom nozzle using 1/2 inch PVC pipe fittings with 3 nozzles spaced 20 inches apart (Figure 1).

Figure 1. Three-Nozzle Boom Sprayer and Single-Nozzle Boom Sprayer with Spray-Confining Bucket

The only difficult task was creating a system that allows quick exchange of boom sprayers and single-nozzle sprayers. This difficulty arose because the threads on the nipple of the pressure regulator used to connect the wand supplied with the Solo sprayer were not standard. To create a quick-couple:

- Obtain a 3/4 inch coupling with female ends of 14 threads/inch on both sides
- Connect this coupling to the male portion of the pressure regulator
- Insert a 3/4 to 1/2 inch reducer into the remaining end of the 3/4 inch coupling.
- Connect the 1/2 inch end of the reducer to a 1/2 inch brass pipe-thread to hose-thread adapter
- Connect a 1/2 inch hose connection from the wand to the pressure regulator. After this coupling is installed, a variety of booms and wands can be interchanged in seconds.

We fabricated two easily interchangeable wands for the Solo sprayer that used low-volume, commercial spray-tip nozzles (Figure 2). We used 8001 ss Tee Jet nozzles. The 80 stands for the 80 degree angle of the fan pattern below the nozzle, the 01 stands for 0.1 gallon/min spray (gpm) (at 40 psi) and the ss stands for stainless steel fabrication. The 0.1 gpm is the lowest-volume tip available. Stainless steel tips are required in this application because Roundup corrodes brass and galvanized materials.

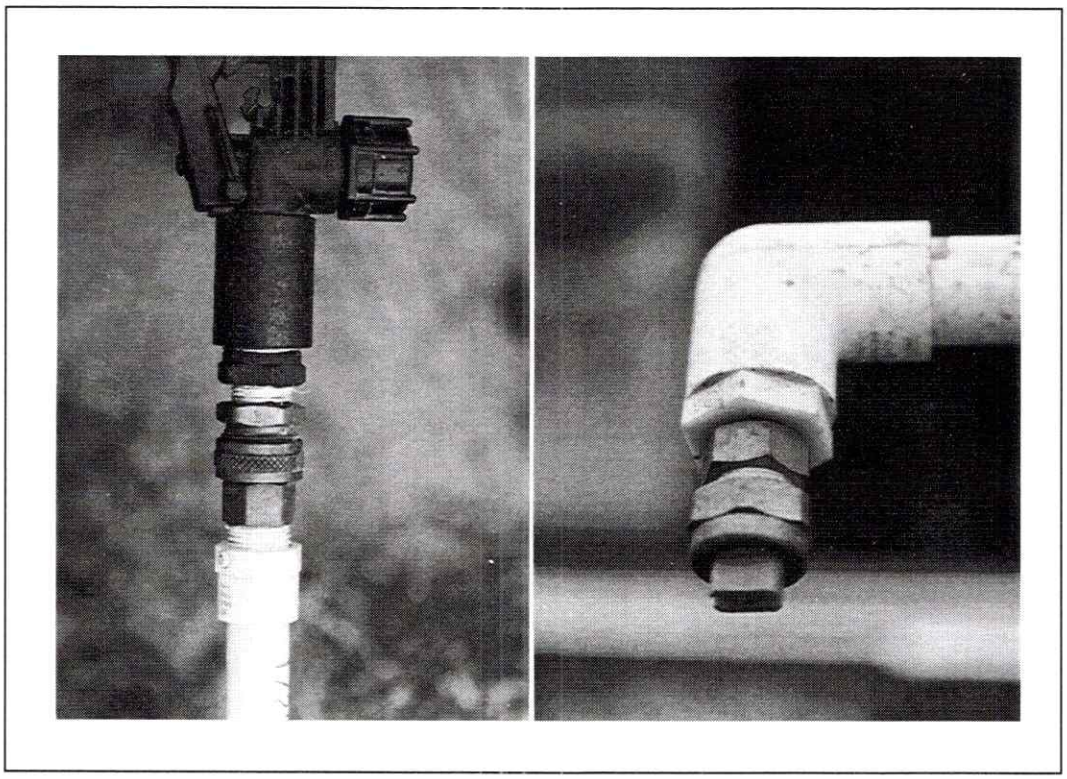

Figure 2. Detail of Quick Disconnect and Spray-Tip Nozzle

Each of the three nozzles can be assumed to cover 20 inches for a total swath of 60 inches (5 ft). If one walked continuously at 3 mph (15,840 ft/hr) this boom would cover 79,200 ft^2/hr or 1.8 acre/hr.

A 3.2 gallon (12.1 liter) backpack sprayer containing a 2% solution (8.2 ounces, or about 1 cup (242 ml) of Roundup covers half an acre in half an hour. This 2% solution produces top die-back of all weed species but will not permanently kill bermuda grass. At a cost of $48/gallon when Roundup is purchased in 2.5 gallon containers, this is a herbicide cost of $6.15/acre. Assuming a labor rate of $5/hr, the cost to treat an acre is $10 labor plus $6.15 for the Roundup. In the spring of the year during the rainy season it may be necessary to apply Roundup every 3 weeks.

The use of Roundup with a 5 ft boom sprayer controls weeds between rows, but is not effective around the base of small plants or to kill the weeds directly in the rows. Fortunately, the backpack sprayer can be quickly adapted for use in these two applications.

When it is desirable to kill weeds near the base of cactus greater than 3 cladodes tall, a wand with a single 8001 ss nozzle can be used. It is only necessary to hold the nozzle about 8 inches off the ground and 12 inches from the cactus and to walk down the rows at 3 mph, applying a 2% Roundup solution. Roundup has no apparent effect when applied to the base of mature cactus.

While Roundup causes little damage when applied to the base of mature cactus, it causes scarring and necrotic lesions when it comes in contact with actively growing young cladodes. Therefore, a physical barrier to prevent the Roundup from coming in contact with immature cactus must be employed. This is accomplished by placing the nozzle inside of an inverted 5 gallon plastic nursery container. The outer portion of the nozzle is unscrewed, the male portion of the nozzle tip pushed through a small hole in the inverted bottom of the bucket, and the female portion of the nozzle replaced from the bottom. Thus, all of the spray is inside the inverted bucket. It is possible to move the bucket along side new young cladodes to spray Roundup on adjacent weeds without the spray touching the cladodes.

Use of Plastic Tents to Stimulate Growth of Nopalitos and Prevent Frost Damage

The most cold hardy of all the spineless *Opuntia* species, *O. ellisiania*, produces nopalitos only in the spring. In contrast, the Texas A&I 1308 cactus produces nopalitos almost anytime the temperatures is greater than about 70 °F. In contrast, this clone is very susceptible to frost damage. We have grown this variety at Texas A&M Kingsville in a large unheated greenhouse with only a single layer of plastic and had no damage from the freeze of 1989 when temperatures outside the greenhouse reached 10 °F.

Thus, to create high temperatures and continuous growth in the winter and to protect this cactus from frost damage, it is useful to grow the Texas A&I 1308 nopalito clone under 6 ft wide, 3 ft tall plastic tunnels. The 6 ft wide tunnels should be separated by 6 to 8 ft wide alleys to permit carts or pick-up trucks to move between the beds during harvest.

This method provides earlier production for the spring nopalito season and protects the cactus from freezing in winter.

On the surface, it appears simple enough to construct these small plastic tunnels. However, we have been putting plastic over individual plants from 1985 through 1991 and have had many problems with high winds from Texas "northers" blowing the plastic off or rainfall puddling on the roof and causing the tunnels to collapse. Only after adapting the Mexican system have we been able to solve both the wind and the rain problems.

The basic concept is to place plastic hoops about 6 ft apart, tie them together with polypropylene string, and cover the hoops with greenhouse plastic. The hoops are created as follows. A 20-foot section of 3/8 inch concrete-reinforcing rod (rebar) is cut into two 10 ft sections. The 10 ft sections are used to form half of an ellipse about 6 ft wide and 3 ft tall as shown in Figure 3. To keep the hoops rigid and erect, they are tied together with three strands of polypropylene rope (available very inexpensively from stores that sell supplies for hay balers).

After the hoops are covered with the plastic sheeting, the polypropylene string is used to secure the plastic on the hoops. This is accomplished by tying the plastic at the base of one hoop and then crossing diagonally over the top of the tunnel to the base on the other side of the adjacent hoop. Thus a criss-crossed pattern will evolve over the top of the plastic. In high winds this prevents the individual 6 ft long sections of plastic from joining together in one large 100 ft wave that would tear the plastic off the hoops.

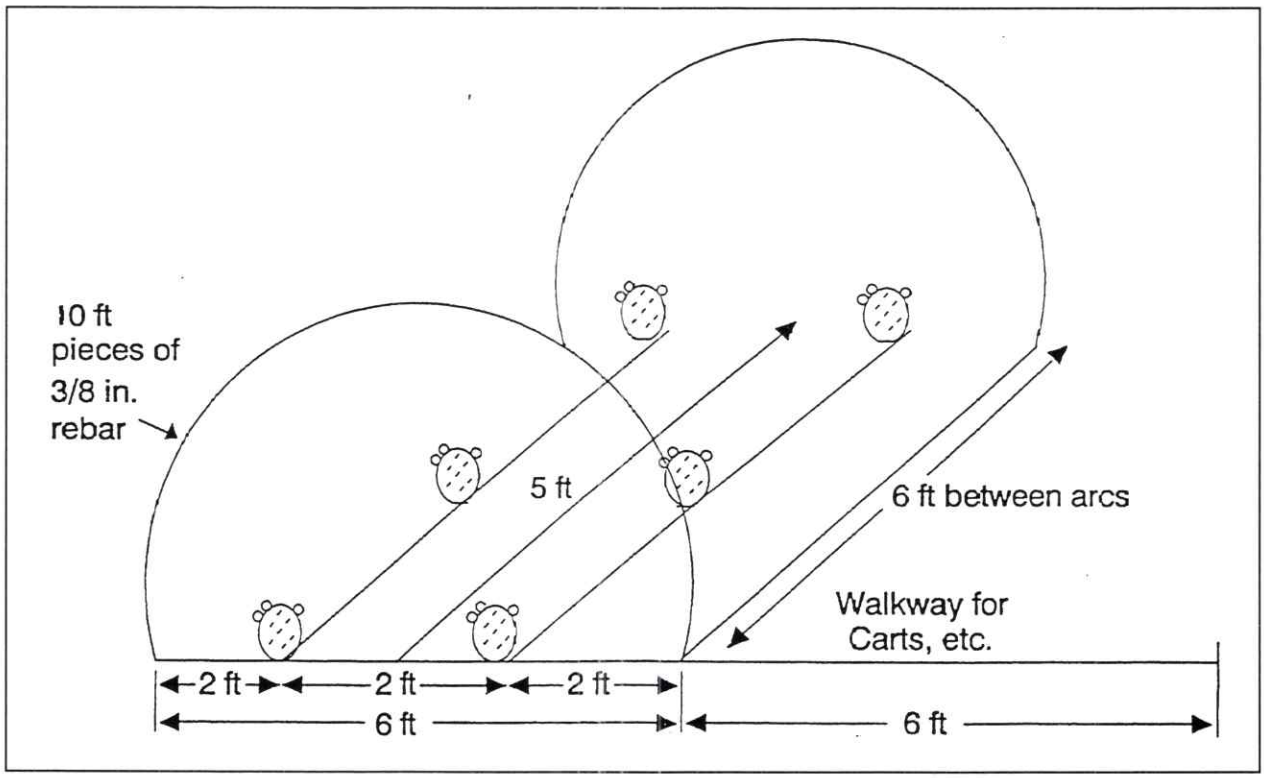

Figure 3. Nopalito Production in Plastic Tunnels

Planting stock of our vegetable variety 1308 is in short supply and expensive; therefore, it is necessary initially to use a wider spacing. As the first plants grow larger and fill in the empty spaces, more dense plantings can be used. Because the nopalitos are hand-picked and the tonnage per acre can be very high, it is necessary to have alleys for access to the plantings.

The cost for covering 100 ft long sections is about $0.75 per lineal foot. This estimate is based on use of a 10 ft section of 3/8 inch rebar for the hoops with a cost of $2.25 for each 20 ft section. With hoops spaced 6 ft apart, 18 pieces at $1.10 each are required for each 100 ft long section ($19.80). Three-year 6 mil plastic sheeting of dimensions 20 ft by 100 ft can be obtained from greenhouse suppliers for $106. Since a 10 ft by 100 ft section is needed, the cost would be $53 per 100 ft. Polypropylene binder twine for hay bales can be had for $25 per 20,000 lineal feet. Because about 700 ft of string are necessary to criss-cross the hoops and to tie the hoops together, this is a cost of about $1 for the twine. Thus, the cost for 100 lineal ft of plastic tunnel is $53 for plastic, $20 for the rebar hoops, and $1 for the string for a total cost of $74 per 100 ft. There would be about 36 alternating 6 ft wide cactus beds and alleys per acre for a materials cost of $2,664 per acre. We have used the three-year, 6 mil plastic for over 6 years on the roof of a greenhouse and thus there should be no problem in reusing the plastic for a minimum of four years. The rebar should be resuable for about 7 years. If it were desirable to use a drip irrigation system, this cost would be considerably greater.

With dense plantings, Mexican growers have achieved yields of 80,000 to 100,000 lb/acre. To obtain these high yields, Mexican growers used 175 semi-dry tons of cow manure per acre and provided partial irrigation. With the lower planting density used here, a production of about 20,000 lb/acre should be possible. When favorable rainfall occurred, Mr. Robert Mick of Sinton obtained 50 cladodes from a single planted cladode in one year. Since there are about 10 eating size nopalitos/lb (7 for planting size/lb) and about 50 pads were obtained from each pad that was planted, about 5 lb of nopalitos were obtained per plant. With a plant spacing of 2 ft by 5 ft (4,356 plants/acre) the first year production estimate is about 21,780 lb acre.

The retail price is about $0.90/lb. If the farmer can obtain a price of about $0.45/lb his gross revenues would be about $9,801/acre. We estimate that a person whose wages cost the employer $5.75/hr can pick 70 lb/hr for a harvesting cost of $0.082/lb. Thus, gross sales minus harvesting costs would be $8015/acre. These sales would therefore be sufficient to pay for the costs of the plastic and hoops in the first year and still make a considerable profit.

The market for Texas A&M 1308 nopalitos looks promising but needs considerable development. Food brokers have reported that about 40,000 lb of nopalitos cross the border daily during Lent at Laredo. Nopalitos are available through a large part of the summer at grocery stores in Kingsville. University faculty members have reported seeing nopalitos for sale in Cinncinnati, Ohio, East Lansing, Michigan, and Corvallis, Oregon.

Summary

The primary problems with development of the nopalito industry are (1) weed control, (2) frost protection, and (3) marketing. We believe the weed-control and frost-protection devices described here are economical and cost effective. Thus, market development is the last major requirement. The ever increasing demand for nopalitos must not be taken for granted. Development of a substantial land base to provide nopalitos must be developed along with a coordinated plan for market development through contacting wholesale and retail brokers.

There appear to be two general types of markets, (1) a low-volume (several hundred pounds per week) but high-priced ($1/lb) specialty market for extremely high quality and uniform nopalitos and (2) a much larger market (several thousand pounds per week) at a lower price (about $0.55/lb) for grocery stores. In considering which market to approach, one must consider the fixed monthly overhead and costs to deliver small quantities of nopalitos.

In 1993, there were only several farmers with several acres each. Additional farmers are necessary to put in small acreages to provide further test markets as well as to multiply the material for larger scale plantings. The Texas Prickly Pear Council is working hard to jointly develop a market for this new vegetable crop. If you would like to participate in this development, please call Peter Felker at (512) 595-3966.

References

Felker, P., and C. Russell. 1988. Effects of herbicides and cultivation on the growth of *Opuntia* in plantations. *Journal of Horticultural Science* **63:** 149-155.