H o r t i c u l t u r a l E n g i n e e r i n g
Volume 13 No. 3 May 1998

NEW JERSEY NURSERY & GREENHOUSE FILM 1998 RECYCLING PROGRAM

New Jersey's 1997 nursery & greenhouse film recycling demonstration was viewed as a success. However, in order to have a more successful program in 1998, growers must maintain a high quality control program when removing the film and preparing it for storage or delivery to the regional collection sites. Through the demonstration program we learned ways to collect, bale and market the film. Now we must move forward to implement measures to improve the program. In order to market the film, we must be able to provide an ample supply of quality material. Grower cooperation is imperative in order to continue the success and future of the program. Below are steps which MUST be followed for the 1998 film recycling program.

QUALITY CONTROL:

- Film should be cut just above the lathe board in order to insure that no staples or wood is commingled with the film.
- The film MUST be rolled. For ease of handling, the film should be rolled up as soon as it is removed from the structure. The rolled film must be no wider than 4-5 feet (like a sausage). It may be necessary to cut the length of the film for ease of handling.
- The bundled film MUST be tied and ONLY the same type of film in the roll should be used to tie it. DO NOT use twine, wire, non-nursery/greenhouse film, etc. If anything other than nursery/ greenhouse film is used to tie the bundled film, the load will be rejected (see sketch for bundling procedure options A & B).

Recycling Continued

- Every step should be taken to avoid Film picking up excess soil when the film is removed from the structures, rolled, stored or prepared for delivery to the regional collection site.
- Only nursery and greenhouse film will be accepted at the regional collection sites. No bags, mulch film, shrink film, stretch film, or ground cover film will be accepted.
- Film MUST be free of foreign material: lathing, wood, staples, paper, stone, saran tape, etc. Any loads which contain material other than nursery or greenhouse film will be rejected by the approved collection sites.

STORING THE FILM OVER THE WINTER FOR FUTURE OFF-SITE RECYCLING:

New Jersey has one collection period, namely during the spring/early summer months. Collection dates may vary by region.The rolls of film can be stored over the winter and delivered to the collection sites during the next regionally scheduled collection period. 1999 collection times and regional collection sites have not been established. In order to assure that the material will maintain its quality over the winter months, the steps listed below must be followed.

- The rolls can not be in contact with the soil or placed on stone. They must be stored on a concrete pad or on pallets.
- Storing the film on soil or stone will increase the chance of soil or stones contaminating the load of film when it is prepared for delivery to the regional collection site.
- The best place to store the rolls of film is inside a building. However, if an area of a building can not be designated for this purpose, the material can be stored out-

Film Recycling Continued

side if it is covered. In order to eliminate the accumulation of water in the rolls, they MUST be covered with some type of tarp or plastic. The film which is removed from the structures can be used to cover the rolled film and the covering can then be bundled and tied and recycled when the material is delivered to the regional collection site. If a tarp or non-greenhouse/nursery film is used to cover the rolls, it must be removed prior to delivery of the rolls of film to the collection site.

- ♦ All quality control measures outlined earlier must be followed.

TRANSPORTATION:

- ♦ Film may be transported to the collection sites by the grower or a commercial contractor. If a trash dumpster is used to transport the rolls of film, remember that only nursery and greenhouse film is allowed - no other plastic material or refuse. If there are any contaminants in the load, the entire load may be rejected by the regional collection site.
- ♦ A solid waste transport permit from the New Jersey Department of Environmental protection **IS NOT r**equired to transport recyclable materials to the collection site.

ADDITIONAL QUESTIONS CONTACT:

- ♦ Karen Kritz, New Jersey Department of Agriculture (609) 984-2506
- ♦ AT Plastics 1-800-661-3606

1998 APPROVED COLLECTION SITES

ATLANTIC COUNTY

Atlantic County Utility Authority, 6700 Delilah Road, Egg Harbor, (609) 272-6902. **Prior to delivery of the film, all growers *MUST* call the Authority to establish an account with them.**

Hours of Operation: Monday-Friday 7:00 a.m.-5:00 p.m.
Tipping Fee: $10 per ton
Drop-off Requirements:

- Material must be free of debris, wood, and soil.
- Film should be bundled into manageable sizes for ease of unloading and baling.
- If grower chooses to tie bundles (not required), the tie MUST be made of greenhouse film.

BERGEN COUNTY

All American Recycling, 210 Clifton Blvd., Clifton, (973) 778-8280. Call for directions.

Hours of Operation: Monday-Friday 8:00 a.m.-5:00 p.m., Saturday by appointment only
Tipping Fee: None
Drop-off Requirements:

- Film must be either folded, rolled or baled.
- If grower chooses to tie bundles (not required), the tie MUST be made of greenhouse film.
- No excessive dirt contamination, wood, rope, twine or other foreign materials allowed.

Additional Services: Roll-off or trailer services are available anywhere in the state at a fee determined on a case-by-case basis. Call Global Commodities, (201) 796-5100, for more details.

BURLINGTON COUNTY

Burlington County Resource Recovery Facility Complex, Burlington-Columbus Road, Mansfield, (609) 499-5300. **Prior to delivery of the film, all growers *MUST* call the Complex to establish an account with them.**

Burlington County Continued

Hours of Operation: Monday-Friday 7:00 a.m.-4:00 p.m., Saturday 7:00 a.m.-noon
Tipping Fee: $10 per ton
Drop-off Requirements:

- Film must be rolled into manageable bundles and tied securely with the same film.
- Film which is dirty or not properly prepared will be rejected.

CUMBERLAND COUNTY
Cumberland County Solid Waste Complex, Jesse Bridge Road, Deerfield, (609)825-3700. **Prior to delivery of the film, all growers *MUST* call the Authority to establish an account with them.**

Hours of Operation: Monday-Friday 7:30 am-3:30 pm, Saturday by appointment only
Tipping Fee: $10 per ton
Drop-off Requirements:

- Film must be rolled into manageable bundles.
- If grower chooses to tie bundles (not required), the tie MUST be made of greenhouse film.
- Material must be free from all debris and foreign material including, but not limited to, wood, shrink wrap and nails.
- Film which is dirty or not properly prepared will be rejected.

COMMENTS MADE BY NJ SECRETARY OF AGRICULTURE ARTHUR BROWN ANNOUNCING THE PROGRAM

Last year's three-month film recycling pilot project kept almost 450,000 pounds of film, about 45 percent of the total film used by Garden State growers, out of landfills.

Secretary Brown continued

"Finding ways to recycle or re-use agricultural plastics has been a continuing NJDA priority. We began this program as pilot project last year and it was extremely successful," Brown said. "This year we will be able to underwrite a portion of the recycling effort and expand the program thanks to a $25,000 grant from NJDEP," Brown added. Grant funds will be distributed to the approved collection sites based on the volume of film they collect and recycle from New Jersey growers only. Grants will not be provided for film collected by out-of-state growers.

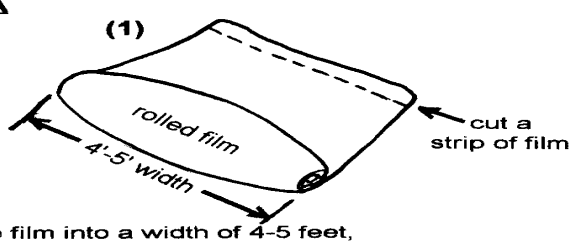
Brown stressed the need for good quality control when growers bundle the film. "Last year the biggest stumbling block we had to overcome was the amount of dirt in the film. We worked with growers and our other partners in the project to develop clear guidelines for this year's participants to follow as they remove and bundle the film," Brown said. "The guidelines (outlined in this artlcle) will insure that the film is as clean as possible, thereby providing the recycling market with quality material."

NEW ENGLAND GREENHOUSE CONF
October 19 thru 21, 1998

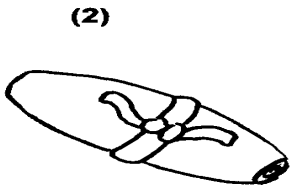
This year's new location is at the
Centrum Center in
Worcester, Mass.
Contact Larry Carville at PO Box 117
Vernon, CT 06066-0117

NURSERY & GREENHOUSE FILM BUNDLING PROCEDURE

OPTION A

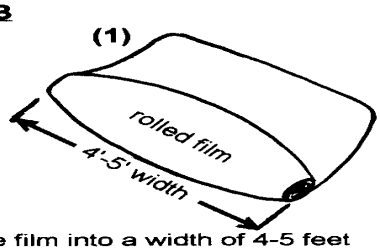


(1) Fold the film into a width of 4-5 feet, roll the film up and then cut off a strip of film from the end of the roll...

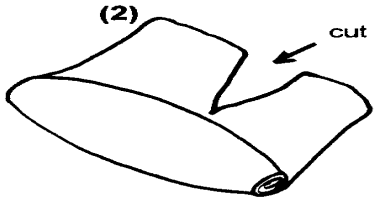


(2) and use the strip of film to tie the bundle.

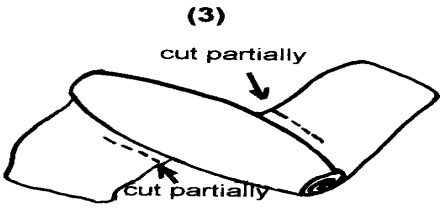
OPTION B



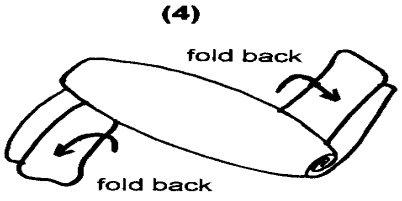
(1) Fold the film into a width of 4-5 feet and roll the film into a bundle...



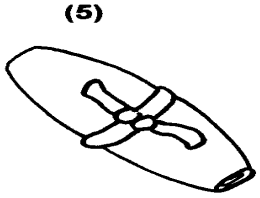
(2) cut the film down the center (the length of the cut will be determined by the diameter of the bundle)...



(3) roll one side of the cut film back under the bundle, cut the film partially (approx. half way)...



(4) fold both pieces of the film back...



(5) and tie the bundle.

15th International Lettuce Conference and Leafy Vegetable Crops Workshop Atlantic City, New Jersey September 23-26, 1998

The 15th International Lettuce Conference and Leafy Vegetable Crops Workshop will be held at the Holiday Inn Hotel, Boardwalk, 111 South Chelsea Avenue, Atlantic City, New Jersey on September 23-26, 1998. The advance registration deadline for this exciting conference is July 1, 1998. Registrants who mail their intentions after July 1, 1998 will receive a surcharge.

Dr. Wesley Kline is conference coordinator and can be reached at; →

15th Conference continued

Dr. Wesley Kline Leafy Vegetable Conference, 291 Morton Avenue, Millville, New Jersey 08332, USA.

An advance registration packet includes, hotel registration information, a preliminary program, travel information, registration form and information and guidelines on submitting summaries of presentations to be given at the meetings. Dr Stephen Garrison is handling the summaries which are restricted to two pages. These summaries are to reach Dr. Garrison by August 1, 1998 at; The Rutgers Horticultural Research and Extension Center, 121 Northville Rd. Bridgeton, New Jersey 08302

ETHICS IS PRACTICAL

Each fall I teach a session in our senior design course for our undergraduate engineering students entitled ETHICS. Ethics comes from the Greek word, ***ethikos*** meaning, the science of moral duty, broadly, the science of ideal human character and moral principles, quality or practice.

Ertas and Jones, in the book, Engineering Design Process, by Wiley 1993, define ethics as follows: "The science or doctrine of the sources, principles, sanctions, and ideals of human conduct and character; the science of the morally right."

In the course I tell the students that character always leads to conduct. I further state that ethics are ***caught*** more than ***taught***. Many people believe that a young person's ethical standards and outlook are established at a young age under the influence of family, church, friends and school teachers and the outlook cannot be changed or influenced significantly at the young adult stage in life when entry level is made into the University. However, others contend that ethics needs to be applied to the college curriculum and students need to become aware of its importance.

"Ethics have historically been linked to philosophy and religion — peripheral to the core academic interests of most engineers and scientists. Yet, it is not always recognized that ethical lapses have enormous economic consequences for employers and often tragic personal consequences for the individual involved. In a real sense, ethics in a technological society is practical and ethics training has tangible value for corporations and businesses. A reputation for integrity is a business asset and its opposite can literally become a liability."

F. Peter Boer,Executive Vice President
W.R. Grace and Co.

Let me know if you agree or disagree
Your Editor

ON-FARM AGRICHEMICAL HANDLING FACILITIES

Safe Handling and storage of agricultural chemicals require serious attention to health and environmental concerns. Improper storage and handling of pesticides can cause severe illness and potential environmental problems. A well-designed storage and handling system is necessary to prevent and to deal with personal emergencies, fires, spills and contamination.

On-Farm Agrichemical Handling Facilities, NRAES - 78 is a publication from the Northeast Regional Agricultural Engineering Service and discusses important considerations for growers who are contemplating or need to contemplate planning and constructing a pesticide storage facility.

This 22 page publication includes two appendixes: one is a plan for a post-frame chemical storage building, and the other is a list of companies that distribute equipment for storage or containment of chemicals. Also included are one table, seventeen figures, conversion factors and a list of publications for further reading on the subject.

This excellent publication was written by Dr. David Ross, Extension Agricultural Engineer of the University of Maryland, and John Bartok, Extension Specialist Emeritus of the University of Connecticut. It can be purchased for $6.00 a single copy, plus a shipping fee of $3.50 within the US. The publication is available from:

NRAES
Cooperative Extension
152 Riley-Robb Hall
Ithaca, NY 14853-5701

All major credits cards are honored. For information about quantity discounts or ordering the publication call 607 255 7654 or they can be reached by fax at 607 254 8770.

e-mail address is nraes@cornell.edu

Energy Considerations for Greenhouse Heating

William J. Roberts Director CCEA
Bioresource Engineering Department, Rutgers University, New Brunswick, NJ 08903

The purpose of a greenhouse heating system is to replace energy lost from the greenhouse when outside temperatures are lower than desired in the greenhouse growing area. Ideally the system should have a variable output capable of matching the changing heat load caused by the outside weather conditions.

Heat is transferred by conduction, convection and radiation. Conduction is the direct transfer from one surface to another such as from an electric stove element to a teapot resting upon it. Convection is the mixing of one parcel of fluid with another such as occurs in water in the teapot. The energy is supplied to the teapot by conduction but the transfer that occurs in the water is by convection. Convection is also the greatest mode of heat transfer from a radiator. Warm water within the radiator heats the surface which in turn heats the air adjacent to the surface. The warmed air rises and heat transfer begins as convection causes the cold air to replace the warm air and be warmed in the process. Although it is popularly called a radiator a better term would be convector.

Radiation transfer depends upon the fourth power (T^4) of the temperature differences and is important when heat sources are at a high temperatures such as an open flame or a fireplace. At night, the greenhouse represents a fireplace as it radiates to the very cold clear sky. Polyethylene film greenhouse glazing is transparent to radiation heat transfer. Glass and some other plastics

Energy Considerations Continued

exhibit this characteristic in a much more limited way. This night-time radiation heat loss can represent as much as 25 percent of the total heat loss for a double-filmed polyethylene greenhouse. Condensation droplets on either or both of the two layers of film can appreciably reduce the radiation portion of the heat loss.

Infrared inhibitors are being successfully added to greenhouse polyethylene films and giving a significant decrease in the radiation portion of the heat loss. Simpkins, at Rutgers, under tests with similar greenhouses covered with conventional film and IR treated film, found that at least a 10% savings could be realized with IR greenhouse glazing. IR polyethylene greenhouse glazing is a popular choice for growers today. The added price of the three-year film is more than offset by the energy savings possible. For a year-round production facility the additional cost is normally made up in the first growing season.

The heat loss from a greenhouse depends upon three parameters: (1) The surface area of the greenhouse, (2) the location of the greenhouse and crop to be grown and (3) the greenhouse glazing. Two of these are readily determined and the third is an approximation depending upon the glazing and its condition. Losses to the soil are usually negligible and not included because the temperature difference between the greenhouse and the soil is so small.

The heat loss in Btu/hour is calculated by multiplying the surface area of the greenhouse by the greatest expected temperature difference between inside and outside and the heat transfer coefficient of the glazing material.

Energy Considerations cont

The surface area of a greenhouse can be readily measured. Temperature differential (delta T) is determined by weather bureau records or experience for a certain location for lowest outside temperature and the lowest night-time temperature desired for the crop being grown, usually determined by the grower. The heat transfer coefficient, U, depends upon many variables but for normal design practice, the following are used and are listed below the equation.

$$Q = U (A) (Ti - To)$$

Q = Size of heating unit required in BTU/hr
U = Heat transfer coefficient in BTU/hr/sq ft/deg F^o temp diff
A= Surface area in square feet.
(Ti - To) = Night temp inside required for the crop - lowest expected outside temperature for the greenhouse location.

Single glazed structures, U = 1.2 BTU/hr/square foot/^{o}F temperature difference.
Double glazed structures, U = 0.8 BTU/hr/square foot/^{o}F temperature difference.
Thermal screened double glazed, U = 0.5 BTU/hr/sq foot/^{o}F temperature difference.
Glass with thermal screen U = 0.8 BTU/hr/square foot/^{o}F Temperature difference.

With any mathematical equation if we want to minimize the value on one side of the equation we need to minimize the values on the other side of the equation. In this case we want to minimize heat loss on one side of the equation because that minimizes cost. The three parameters on the other side of the equation are temperature difference, surface area and the heat transfer coefficient. Two of the three of these we can change. The surface area is usually fixed with a particular size of greenhouse. The heat transfer coefficient can vary from 1.2 for single glass to 0.5 for double glazing with a thermal screen. The temperature difference can also be reduced if the crop is being grown on a heated floor. In this case the actual temperature of the greenhouse itself can be lower because the crop is growing on a warm floor and the microclimate at the floor is warmer than at the 6 foot level. Reducing the setting of the thermostat without changing the growing conditions of the crop is a way of reducing energy use by the greenhouse. The difference in scenario D and E in Table 1 illustrate the quantity of energy which can be saved.

The program developed by the author several years ago to predict heating loss uses the equation above and assumes the following. It predicts an average daily temperature by dividing the monthly degree day base by the number of days in a month and therefore determines the degree-days per day. Subtracting this figure from 65 gives the daily average temperature. The model assumes that the difference between the desired set point and the daily average temperature is the average temperature difference for the 24 hour period. The model multiplies the thermal heat transfer coefficient times the surface area times the average temperature difference for 24 hours and determines a total number of BTU required for the month. Dividing this number by 100,000 the btu/gallon available from #2 fuel oil gives the quantity of oil

Energy Considerations continued
amount of oil required in gallons assuming an efficiency of 71.5% for the combustion process. The model asks for the oil price per gallon and so the answer is given in dollars per month or dollars per square foot per year. The solar input during the day is assumed to be 15% of that needed and this is also credited in the model.

Examining a typical one acre installation gives the following results tabulated for easy comparison. The greenhouse is 192 by 210 feet with 12 foot sidewalls.

Table 1

Scenario	Gallons of oil	gallons per sq foot	Heating plant	Savings in Gallons
A	69,000	1.71	187 horsepower	
B	48,810	1.24	135 horsepower	20,190 29%
C	46,000	1.14	124 horsepower	23,000 33%
D	31,615	0.78	86 horsepower	37,385 54%
E	24,651	0.61	86 horsepower	44,349 65%

Scenario A Single Glass all around, (roof and side walls)
Scenario B Single Glass all around with internal overhead thermal screen
Scenario C Double poly roof with polycarbonate side walls
Scenario D Double poly roof with polycarbonate side walls with overhead thermal screen
Scenario E Same as D but with floor heating added with a 5 F lower setpoint temperature

Comparing A and B shows the value of a thermal screen for a glass house.
Comparing A and C shows the difference in double glazing versus single glazing.
Comparing C and D shows the value of a thermal screen for a double poly house.
Comparing D and E shows the value of floor heating and a thermal screen for a double poly house

The value of floor heating in the program is accounted for by lowering the set point 5 degrees Fahrenheit without any penalty on the crop production system in terms of time or performance. This has been verified for many crops through years of experience.

"Environmental Control of Greenhouses" E 213, available from your editor at modest cost gives other design parameters for heating, ventilating and cooling greenhouses. NRAES #3, Energy Conservation for Commercial Greenhouses, gives specific information on other energy saving measures helpful to the greenhouse operation. **"Soil Heating Systems for Greenhouse Production, E208"** is a design manual for installing floor heating in a greenhouse.

The installation of thermal screens in greenhouses has been a good energy saving device with rapid payback of less than five years in most cases. Retrofitting existing some greenhouse designs has been difficult and expensive for some growers. Most new installations are installing them because they also provide late spring, summer and early fall cooling opportunities and many growers are most excited about this option.

New Jersey Annual Vegetable Meeting
January 19 -21, 1999
Atlantic City New Jersey

This extraordinary annual meeting is sponsored by the Vegetable Growers' Association of New Jersey, Inc. and Rutgers Cooperative Extension, Rutgers the State University of New Jersey and The New Jersey Department of Agricutlure.

Each year this meeting features one of the best trade shows and programs on the entire east coast.

Make plans now to exhibit at the show, be a part of the program or schedule your attendance at the meetings. You will be glad you did.

Additional information concerning the exhibtion is available from:

Phil Traino, Executive Secretary
at 609 985 4382.

Greenhouse Design and Environmental Control Short Course

January 11-12, 1999

This short course features one and one half days of technology transfer and a one-half day tour to several state-of-the-art greenhouse operations. Topics for study and discussion include, greenhouse heating and cooling, space utilization, glazing choices, crop production systems, irrigation systems and design of floor heating systems. Additional information is available from your editor or from The Office of Continuing Professional Education 732 932 9271.

Catch us on the internet: Website Address
http://cook.rutgers.edu/~roberts/

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