Sustainable Production of Cut Flowers

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A sustainable system of cultivation is one that requires minimum inputs from off the farm and is not dependent upon synthetic fertilizers or pesticides to produce a marketable crop.

Serious consideration of sustainable systems for the cultivation of cut flowers is important to commercial success because of increasing environmental regulation and chemical costs. Every year more chemicals are banned from use in agriculture, especially those for minor crops such as specialty cut flowers. Chemical companies lack the economic justification for the registration necessary for the use of chemicals on minor crops. Environmental law is shifting the cost of cleaning up pollution from agricultural chemicals to the producers and users of these chemicals. More farms in the future will be burdened with the cost of removing agricultural chemicals found in soils, water tables, runoff, or spray drift. In addition, many pesticides become less effective over time as their intended targets develop resistance and immunity to these measures. Decreasing soil fertility and plant vitality are also symptoms of less than adequate cultivation methods.

BIODYNAMIC METHOD

The foundation of Biodynamic production of cut flowers is the growing of a healthy fertile soil. Through the cultivation of biologically rich soils the production of healthy and disease- free plants is made possible. The need for toxic controls is dramatically reduced.

The Biodynamic method concentrates on practices that increase biological diversity in the soil. Soil sterilization and the application of synthetic fungicides and pesticides are incompatible with the Biodynamic method. Biodynamics approaches the farm as a living organism that needs to be cultivated by the farmer for optimum soil health.

The Biodynamic method is the oldest sustainable system of agriculture practiced in the western world today. The principles on which it is based were introduced by Rudolf Steiner in Austria during the 1920s. The method was later refined in the United States by Dr. Pfeiffer. In the late 1960s and early 70s Alan Chadwick further developed the method into the Biodynamic French intensive method of horticulture. Chadwick established a research facility and demonstration farm and garden at the University of California in Santa Cruz. The Biodynamic French intensive method is labor intensive and developed for small acreages and operations functioning without mechanical equipment.

Here & Now Garden has adapted these methods of horticulture to commercial floriculture production. Improved technologies are available today for the application of the Biodynamic method. Modern agriculture has developed specialized

tractors and bed shaping equipment, mechanical mulchers, reusable polypropylene mulch, computerized drip irrigation, and mechanical spraying, and injection systems.

SOIL AND COVER CROPS

Production fields should have a soil analysis defining soil structure, humus content, and chemical nutrient levels. The optimum soil is a sandy loam soil that is well-drained and has a high humus content. Specific deficiencies can be corrected through altering the content of the organic plant food mix and additives to the Biodynamic compost.

The current weed population and surrounding field populations should be analyzed for development of a weed control program. Specific cover crops can be chosen to discourage or eliminate weeds. Spring/summer sowings of buckwheat followed by overwintering with annual rye/vetch will eliminate joint-grass and dramatically reduce morning glory (*Convolvulus*). Sudan grass produces incredible quantities of vegetative matter to aid in building soil humus levels. In addition, Sudan grass has an extensive fibrous root system that is very valuable in healing the damaging effects of improper cultivation practices like the digging or sowing of crops in wet soils.

Cover crops are an excellent means of preparing the soil of cut flower production fields. It is possible to get as many as five different rotations of cover crops in a single year. Other excellent cover crops are crimson clover, fava beans, oats, and alfalfa. Cover crops are generally tilled in at peak flower before seed is set in the plants. Crops are generally mowed or flailed and then tilled in. The value of the cover crop is greatly diminished by leaving the mowed vegetative material on top of the field too long.

A year in a cover crop rotation can significantly improve both soil structure and biological activity in the soil. The latter is important if the use of fungicides and pesticides is to be avoided. Substantial quantities of plant material incorporated into the soil by tilling in cover crops promote the growth of abundant microorganisms in the soil. These microorganisms are 99.9% beneficial to plants. Many microorganisms are natural predators to the fungus and bacterial diseases of cut flowers. Properly prepared compost applied annually to the field is important in maintaining soil fertility and increasing microbial activity.

It is useful to visualize the amount of plant material produced by the farm that is exported. These bunches of cut flowers leaving the farm require that an equal amount of composted plant material be returned to the soil if the production system is to be sustainable. The production and application of compost must equal the mass of plant material exported, or the soil is being "mined" of its nutrients for the crops sold. Unless this material is replaced soil will lose fertility, stable humus levels will decline, and cultural problems will increase.

The structure of the soil can be significantly improved by cover crops. The deep penetrating roots of some cover crops can shatter soil hard pans created by cultivation. The decomposed plant material tilled into the soil eventually becomes stable humus that improves the aeration and drainage of the soil thereby enhancing the nutrient-absorbing ability of the crops fine root hairs.

Cover crops should be tilled in before they dry out completely. The soil should be sprayed with a soil inoculant to speed the decomposition of the plant material and

establish beneficial soil microorganisms. Either the "Pfeiffer Field Spray" or BD Barrel Compost can be used. The time necessary for the soil to break down the vegetative matter can be reduced to as little as 2 to 3 weeks with these field sprays.

FERTILIZATION

Depending upon the requirements dictated from a soil analysis, generally the application of compost, manure, and organic plant fertilizer is necessary for optimum growth. Table 1 details the rate of application by soil fertility.

Perennial plants should be top-dressed each spring with 1/4 to 1/2 in. of ripened Biodynamic compost. Biodynamic compost is a specific kind of compost that requires 9 months to a year to break down and become fully stable for use. The specific compost most suited to cut flower production is the Pfeiffer recipe that is made from layering materials into a windrow pile 12 to 15 ft wide, 6 ft tall, and as long as is necessary to produce the quantity of compost necessary for production. This compost is comprised of dairy manure, soil, plant trimmings (from the fall clean-up), leaves or some highly carbonaceous plant material such as straw or spoiled hay. The materials are layered onto the pile to assure a carbon/nitrogen ratio of approximately 30 to 1. Soil additives are also incorporated into the compost to become stabilized for more efficient utilization by the plants. These additives are greensand, rock phosphate, oyster shell, and kelp. Approximately 50 lb of each additive is used per 25 tons of compost. The compost is treated with the six Biodynamic compost preparations to produce a balanced plant food and soil conditioner. The preparations are created through the controlled composting of specific herbs:

#502	Yarrow
#503	Chamomile
#504	Stinging nettle
#505	Oak bark
#506	Dandelion
#507	Valerian

This finished compost is rich in trace elements and the microflora necessary to produce a healthy soil capable of inhibiting fungus and viral diseases. An excellent description of making this compost is in Dr. E. Pfeiffer's book *Practical Guide to the Use of the Biodynamic Preparations*.

An organic plant food is banded into the bed where the cut flower plants will be planted when the bed is being shaped or it is worked into each planting hole for the plants as they are being planted. This balanced plant food is 4 parts seed meal, 1 part rock phosphate, 1/2 part kelp, and 1 part greensand. See Table 1 for an exact formulation to meet specific growing requirements.

TILLAGE

The intensive French Biodynamic method of horticulture includes an emphasis on deep cultivation and raised beds. Alan Chadwick observed that plants growing in land slides had increased growth. The tumbling action of a land slide produces an upper soil horizon with increased pore space between soil particles, better soil aeration, and increased root growth in plants. This resulted in increased production and plant vigor.

The intensive French Biodynamic method duplicates this environment with the double digging and raising of the plant beds. Raised beds increase plant growth and

flower production by increasing the area of the upper soil zone available for root growth. Mechanically produced raised beds can be constructed with tractor-mounted bedding equipment. In clay soils the intensive method calls for double-digging or deep non-soil horizon-mixing tilling of the soil. This can be accomplished mechanically with a articulating spader attachment on a tractor, such as the Celli spade cultivator. Here & Now Garden plants in 10 in.-high, 3 ft-wide raised beds.

PLANT SPACING

Most perennial cut flowers are planted 1.5 plants per lineal foot of bed in a matrix pattern. This gives each plant a 16-inch-diameter root zone. In perennial plantings this spacing produces a bed that is completely covered by the leaf canopy by the end of the second growing season. Most annual cut flowers are planted 2.5 plants per lineal foot of bed.

The utilization of matrix planting on raised beds significantly increases the number of plants that can be grown per acre. For example, in peony production, raised beds matrix planted result in 10,000 peony plants per acre compared to about 3000 plants per acre in row-cropped fields.

WEED CONTROL

The use of precision mulching in the cultivation of cut flowers seeks to reduce the area of the field available to weed growth through restriction of light to the soil. Woven polypropylene fabric is used to cover any field area not utilized by the plants.

Bed tops are covered with the most porous material available to allow adequate water and air to the soil. Soil will not turn anaerobic under woven polypropylene as it does under black plastic. The mulch must restrict light to weed seeds but allow the soil to breathe.

When the beds are formed the soil has been worked to a fine tilth and is weed-free. These beds are then covered with a highly porous, woven-polypropylene weed barrier. Plant holes 6-in. square are burned into the 3 ft-wide weed barrier arranged in the matrix pattern described earlier. The paths of the beds are covered with a U.V. inhibited woven polypropylene. This material is commonly used under containers in nurseries and can withstand tractor and foot traffic while allowing some air and water penetration.

The top of the bed is then mulched with a 1- to 2-in. layer of horse manure/wood shavings. This mulch is spread with a tractor mounted mulcher capable of mulching 4 or more acres of raised bed in a single day. The polypropylene weed barrier prevents weed germination on most of the bed, and the layer of horse bedding mulch smothers weeds in the uncovered planting holes. The perennial plants can easily break through this mulch and crowd out any weeds. The bed tops require weeding 3 to 4 times annually to remove small wind-borne weed seeds that attempt to establish in soil of the planting holes in the weed barrier. The amount of weeds that germinate in this area is small and two persons weeding by hand can clean a 2-acre field in a day. Weeds are eliminated using this method without herbicides.

The weed barrier remains on the bed for 2 to 3 seasons until the perennial plants establish themselves and the crowns begin to crowd the planting hole. By the third growing season the plants have established a heavy leaf canopy that will cover the entire bed and out compete most weeds. Depending upon the quality of the weed barrier purchased the useful life can exceed 10 years.

Table 1. General fertilizer program per crop per 100 square feet. (Assuming no soil test is performed. It is best to perform a soil test, especially for a garden of 500 square feet or more—see bottom of page.). (Printed with permission of Ecology Action, 2225 El Camino Real, Palo Alto, California 94306).

Functions	Sources (one for each function)	1st & 2nd year (Assuming poor soil)	3rd & 4th year (or 1st or 2nd year in average soil)	5th year (or 1st year good soil)	Maintenance (Every year thereafter[1])	Add to soil (Before or after double-dig)
Nitrogen*						
2.5%	Alfalfa meal	16.0 lb	10.5 lb	5.0 lb		After
12.0%	Blood meal[2]	3.5 lb	2.5 lb	1.25 lb		
9.75%	Fish meal	4.0 lb	2.25 lb	1.25 lb		
12.0%	Hoof & horn	3.5 lb	2.5 lb	1.25 lb		
7.2%	Soy meal	5.5 lb	3.5 lb	1.75 lb		
Phosphorus	Bone meal	4-5.0 lb	2.0 lb	2.0 lb	2.0 lb	After
	Phosphate rock	10.0 lb	5.0 lb	3.0 lb		
	Soft phosphate	10.0 lb	5.0 lb	3.0 lb		
Potash & trace minerals	Kelp meal[3]	1.0 lb	1.0 lb	1.0 lb	0.25 lb	After
	Wood ash[4]	2.0 lb	1.0 lb	1.0 lb	1.0 lb	
	Granite	10.0 lb	5.0 lb	3.0 lb		
Microbiotic life, humus, multiple nutrients	Compost[5] (or manure)	8.0 ft^3 (each crop[6])	8.0 ft^3	8.0 ft^3	8.0 ft^3	After, for best results[7]
Calcium	Eggshells[4]	2.0 lb	1.0 lb	as available up to ½ lb		After
	Oyster shell	2.0 lb	1.0 lb			

* Nitrogen = (% of protein) - 6.25. The first and second year amounts will provide 0.4 lb pure nitrogen per 100 ft^2.

[1] Beginning with the 6th year your legumes, compost crops, and recycled plant materials (in the form of compost) can provide most of your nitrogen, phosphorus, and potash. Double-check this periodically with a soil test.

[2] Do not plant for 2 weeks if using more than 3 lb blood meal per 100 ft^2. It can burn the plants during this time since it releases nitrogen rapidly at first.

[3] For trace minerals: kelp is up to 33% trace minerals.

[4] Save your own.

[5] Top priority in typical adobe soil. Breaks up clay, improves drainage, releases nutrients, and lowers pH.

[6] Eight cubic feet will cover 100 ft^2, 1 in. deep; 2 ft^3 will cover 100 ft^2, 1/4 in. deep. You can substitute manure for compost the first year if you do not have a ready supply of compost.

[7] Except for the first double-dig, when it is usually added before.

To revitalize an old lawn: Use 1.5 lb hoof and horn meal, 2 lb bone meal, and 1 lb kelp meal per 100 ft^2. Apply in spring and water well twice a week for 2 weeks. You should see results in 6 weeks.
Fruit trees: Use two heaping tablespoons alfalfa meal per foot of height, up to 2 lb of bone meal per full grown tree, and a light sprinkling of kelp meal (up to 1.4 lb per full-grown tree) around the drip line. Apply in spring when leaves first start to appear and water in well.
Citrus trees: Same as fruit trees with the addition of 5 to 8 lb phosphate rock to full-grown trees once every 3 to 5 years. Line the planting hole with crushed red rock for a long-lasting source of iron.
Soil testing service: Timberleaf, 5569 State Street, Albany, Ohio 45710.

Fields irrigated with a drip irrigation system will water only the planted area of the field and dramatically reduce weed growth in other areas. This can produce a significant reduction in weeding costs.

All tractor paths are sown in a permanent cover of perennial low-growing grasses and white clover. These paths are mown and the clippings collected for compost. A 2-ft-tilled swath is maintained around the sections of the production fields covered with polypropylene mulch. This prevents invasion of weeds by runners into the poly-mulched area.

FIELD HYGIENE

A field free of weeds will have less competition for water and plant nutrients. To avoid problems associated with monocropping, cut flower fields should be interspersed by species. If some crop diversity can be maintained on the farm and weed populations are kept in check, the incidence of viral diseases and pest infestations is dramatically reduced. At the end of the season all perennial plants are mowed down to the ground and this plant material is removed and composted. The beds are then top dressed with 1/4 to 1/2 in. of Biodynamic compost and then mulched with the 1 to 2 in. of horse bedding. This fall clean-up and top dressing is important for control of disease. Many future disease problems are eliminated by the removal and composting of potential pathogens. The application of finished compost (and plant food as necessary) increases soil microbial activity which inhibits remaining pathogens. The removal of weeds eliminates competing plants and possible hosts of more pathogens. As long as specific crops are kept in small units on a diversified farm, the field will not be a reservoir for the production of cut-flower specific pests.

WATERING

Cut flowers benefit from precise watering. Although many perennial cut flowers can be observed sustaining tremendous amounts of neglect around many old houses, the plants do produce more flowers and grow healthier with proper watering. The ideal watering system is one that allows both overhead and drip irrigation. The drier the foliage during the flowering season, the lower the incidence of fungal diseases and botrytis. Drip systems delivering water only to the roots are ideal. Overhead watering is an efficient way to foliar feed and apply prophylactic sprays to prevent botrytis and powdery mildew.

FUNGUS AND BOTRYTIS CONTROL

Fungus and viral infections are controlled first by proper soil cultivation and secondly by proper stimulation of plant growth. The extensive effort placed in soil preparation and compost application are to foster the development of plants that are naturally resistant to infection. The BD Field Spray 500 (composted horn manure) is used in early spring to stimulate healthy root growth. In the early summer BD spray 501 (quartz) is utilized to inhibit fungus and virus disease and stimulate leaf growth and plant vitality. Small quantities of these sprays are required for large areas. Four gallons will treat 2 acres.

It is unwise to overfeed cut flower plants with nitrogen. The resulting fleshy growth is highly susceptible to fungus and viral infections and more prone to insect predation.

Botrytis is of particular concern for many cut flowers in the Pacific Northwest.

Botrytis damage has been prevented by utilization of the Biodynamic method. Two efforts are required: enhancing the plants resistance to the incubation of the*Botrytis* spores, and encouraging microbial activity in the soil to draw fungal activity away from plant foliage.

The resistance of plant foliage to fungus and*Botrytis* infection can be increased by foliar feeding every 10 days during cold wetweather in early spring. The leaves of the plants are wetted with a foliar spray of kelp and BD preparation 508 (*Equisetum arvense*). One ounce of chopped dry equisetum is required to make about 4 gal of 508 tea which is sufficient for 2 acres of thick foliage. The 508 is diluted into 50 gal of the kelp/fish spray and applied at the same time. These sprays can also be injected into overhead irrigation for easy application.

Plants should be scouted daily for *Botrytis*. Infected plant parts are pruned, collected, and sent to the landfill. These prunings are not burned since*Botrytis* can spread in smoke. If botrytis erupts to a problem level despite these preventative measures, a copper sulfate spray can be used as a control method to limit the infestation to an economically acceptable level.

After the crop has died back for the season, all the plants are mowed to the ground and the dead plant material is composted in treated compost piles. This field sanitation is an important element in control of fungus diseases.

INSECT PEST CONTROL

Flea beetle (*Epitrix*, various species) and cucumber beetle (*Acalymma vittatum* or *Diabrotica undecimpunctata*) are the primary insect pests that can do extensive damage to the flower buds during formation. The beetles chew the edges of the flower or they bore into the bud slightly. Scouting of the field is necessary to determine if the beetle populations are reaching damaging levels. Long periods of warm weather can increase the beetles to levels where the damage affects the crop. One or two applications of pyrethrum or Rotenone sprays can reduce populations enough to harvest undamaged crops. Timing of these sprays is critical to their effectiveness. The most productive time to spray is early afternoon when beetle activity is highest. These control methods should be used sparingly because populations of beneficial insects are also reduced by these broad spectrum insecticides.

In a well-established Biodynamic operation high populations of beneficial insects often develop without artificial introduction. Parasitic enemies of cucumber beetles include a tachina fly,*Celatoria setosa*, a braconid wasp, *Syrrhizus diabroticae*, and a nematode,*Howardula benigna*. The most important predator of cucumber beetles is a soldier beetle, *Chauliognathus pennsylvanicus*.

Insect, disease, and weeds are visible symptoms challenging the grower to understand what part of the farm organism is weak or out of balance. Changes in cultural methods, elimination of habitat, introduction of biological controls, or specific application of biologically derived pesticides are all acceptable methods to maintain economic production and continue building a sustainable ecological growing operation.

RESOURCES

General information and publication list:

- Biodynamic Farming and Gardening Association, P.O. Box 550, Kimberton, Pennsylvania 19442 (215) 935-7797.

- Biodynamic preparations are commonly made by experienced Biodynamic farmers, or produced cooperatively by local Biodynamic groups. The preparations are available for purchase from: Josephine Porter Institute, P.O. Box 133, Woolwine, Virginia 24185. (The Institute is a non-profit service to encourage the use of Biodynamic preparations. They can accommodate small orders and have a subscription service to supply greater quantities on a scheduled basis for larger operations. Annual cost of preparations for a 10-acre farm is under $200.)

OTHER REFERENCES

- Jeavons, J. 1974. How to Grow More Vegetables. Ten Speed Press, P.O. Box 7123, Berkeley, California 94707. (This is an excellent primer on the Biodynamic French Intensive Method.)
- Woven Polypropylene: Dewitt Company, Highway 61 South, RR3 Box 338, Sikeston, Missouri 63801.

"The Future" Question-Answer Period

Casey Van Vloten: Did you have contracts already established with various locations or is it hit-and-miss in terms of demand for your product?

Paul Sansone: There are no contracts in the cut flower market, world-wide. You have a customer list that you FAX out availabilities to the night before and then either they call you or you call them and secure the sale in the morning. Everything is completely speculative.

Casey Van Vloten: Do you lose much with this system? Do you have to throw much away by guessing and missing?

Paul Sansone: I don't (knock on wood). We are very aggressive in our marketing and when we see a market go down we look elsewhere. This year, peonies would be a great example. Oregon peonies came on the market at the same time as those from New Jersey and the Great Lakes, which are the three major peony-producing areas in the United States. Normally, we are separated by over a two-month period, so the market was completely glutted. Another grower that I market with had $60,000 worth of product that he threw away and he's been growing for 20 years and had never had more than a couple thousand dollars of lost product. We contacted buyers in Japan and Hong Kong who we had not sold to before and we sold 25% of our production into those new markets. So, sometimes it's how quick you can move.

Kristin Yanker-Hansen: Have you ever considered developing your inoculants or are they available through Rodales for the home gardener? How does the cut flower industry get flowers out of the garden with so little insect damage?

Paul Sansone: The preparations themselves are available through the Biodynamic Association to retail people and the home gardener can buy enough to do a little pile in the backyard. On the commercial level, there's a Josephine Porter Institute that now has subscription services for nurseries and farms. They are dealing with farms as large as 2000 acres where they'll supply preparations and inoculants on a