By grouping crops according to certain variables, you can increase production efficiency and reduce the number of problems encountered.

By Ryan Warner

Grouping crops can save you money

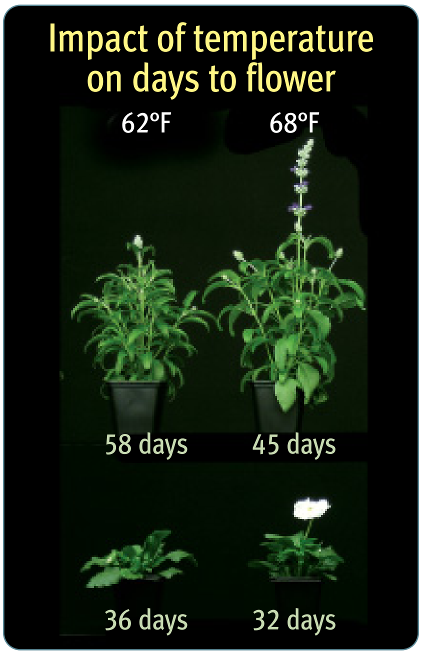
ONE OF THE GREAT CHALLENGES that greenhouse growers face is the incredible diversity of crops produced in a single operation. Each crop may have its own optimal set of environmental conditions (temperature, photoperiod or nutritional requirements). Even though you may not be able to provide the optimal environment for each crop, you can create a few separate environments. By appropriately grouping crops, you can increase production efficiency and reduce the number of problems.

When deciding which crops should be grown together, your first priority should be to consider the factors that determine crop timing. The two biggest factors determining crop timing are temperature and light environment, most importantly photoperiod.

Temperature effects

The rate of development of a plant (the leaf unfolding rate) is a function of temperature. As temperatures increase, the leaf unfolding rate increases. If the temperature exceeds the maximum temperature, plants experience stress and leaf unfolding rate declines.

Given the high costs of fuel, many growers are tempted to reduce the greenhouse temperature to save money on fuel. Because the rate of crop development is dependent on



Growing temperatures impact days to flower for *Salvia farinacea* 'Strata' (top) and pansy 'Delta Pure White' (bottom).

temperature, reducing temperatures increases production time of all crops. However, some crops will be more severely delayed than others.

Reducing temperatures from 68°F to 62°F increased time to flower of *Salvia farinacea* by 13 days. This same temperature drop only increased days to flower of pansy by four days.

For crops that are severely delayed by lower temperatures, reducing the growing temperature may actually increase total fuel costs for producing that crop. You are better off growing these crops warmer so they are in the greenhouse for a shorter period.

Photoperiod effects

The light environment also has a huge impact on crop timing.

General growing temperatures

Low-temperature plants

(60˚F to 68˚F)

Abutilon, ageratum, ajuga, alstroemeria, alyssum, anemone, aquilegia, argyranthemum, bidens, bellis, brachyscome, bracteantha, browallia, calibrachoa, centaurea, cyclamen, dianthus, diascia, echinacea, flowering kale, foxglove , gazania, geranium (ivy), geranium (seed), heuchera, lamiastrum, lamium, lobelia (annual), marigold (all types), matthiola (stock), nasturtium, nemesia, oenothera, osteospermum, oxalis, pansy, penstemon, petunia (upright), phlox, sanvitalia, schizanthus, snapdragon, viola

High-temperature plants

(68˚F to 75˚F)

Angelonia, anisodontea, begonia (fibrous), begonia (tuberous), celosia, cleome, coleus, colocasia, cosmos, Cuphea rosea, dracena (spikes), fuchsia, gerbera, gomphrena, gypsophila, helianthus, helichrysum, heliotrope, hibiscus, impatiens, ipomoea, lantana, lavender, millet, nicotiana, New Guinea impatiens, pentas, petunia (spreading), perilla, pepper, ornamental pepper, plectranthus, portulaca, salvia, scaevola, scoparia, scutellaria, stobilanthes, sutera (bacopa), tomato, torenia, verbena, vinca, vinca vine

Photoperiodic classification of annuals

Obligate long-day plants

Ammi, asperula, callistephus, catananche, centaurea, dill, fuchsia, gazania, ipomopsis, lathyrus, lavatera, legousia, leptosiphon, limnanthes, linum, lobelia, mimulus, nigella, nierembergia, oenothera, petunia, platystemon, strawflower

Facultative long-day plants

Ageratum, basil, calendula, collinsia, dianthus, dimorphothica, linaria, pansy, petunia (grandiflora), phacelia, reseda, salvia, snapdragon, statice, sunflower, tithonia

Obligate short-day plants

Mina vine, hyacinth bean, African marigold

Facultative short-day plants

Celosia, cosmos, gomphrena, ipomea, morning glory, sanvitalia, signet marigold, zinnia

Day-neutral plants

Amaranthus, carpanthea, centranthus, cleome, cobea, nemophila, oxypetalum, stock, verbascum

Many bedding plants are photoperiodic, meaning that flowering is induced by a particular photoperiod or daylength.

Long-day plants flower when the daylength exceeds a certain critical length (and the night is less than a critical length). Plants need daylengths of 14-16 hours (night lengths less than eight to 10 hours) to flower.

Short-day plants flower when the daylength is less than a certain critical length (and the night length exceeds some critical length). Generally, crops need photoperiods of 11 hours or less (night length greater than 13 hours) to flower.

Day-neutral plants do not flower in response to daylength.

Because it is the length of the night that a plant measures, long-day plants can be induced to flower by turning lights on for four or more hours in the middle of the night (known as night-interruption or mum lighting), traditionally from 10 p.m. to 2 a.m. Plants need to be exposed to approximately 2 micromoles per square meter per second (about 10 footcandles) for night-interruption lighting to be effective.

Within the long-day and short-day plant classification, crops can be further categorized as having an obligate or facultative photoperiod response. Plants with an obligate photoperiod response must be grown under that photoperiod for flowering to occur. Plants with a facultative photoperiod response will eventually flower under any photoperiod, but will flower much earlier if produced under the appropriate photoperiod.

Nutrition effects

After crops are grouped based on the environmental variables, you can create subgroups based on general nutrition requirements that are measured by electrical conductivity and growing medium pH.

Electrical conductivity (EC). To maintain different nutrition levels between plant groupings, you can either have multiple fertilizer injectors set up to deliver different feed rates or alternate between fertilizer and clear water for crops with lower nutrition requirements. Check your fertilizer injector regularly. Many EC problems are simply due to clogged or malfunctioning fertilizer injectors.

Growing medium pH. Growing medium pH determines whether or not nutrients in the medium are available for plant uptake. Nutrients must be in solution to be taken up by the roots; different nutrients are only soluble over a particular pH range.

Precautions. While each plant may have slightly different nutritional

Relative nutrient requirements of greenhouse crops

Light electrical conductivity

(1:2 dilution of 0.26 to 0.75 mS/cm)
(SME of 0.76 to 2.0 mS/cm)
(PourThru of 1.0 to 2.6 mS/cm)

Aconitum, African violet, ageratum, anemone, anigozanthus, asclepias, aster, astilbe, balsam, begonia (fibrous, hiemalis, rex and tuberous), bracteantha, caladium, calceolaria, calla lily, celosia, cineraria, coleus, cosmos, cyclamen, freesia, geranium (seed), gerbera, gloxinia, impatiens, marigold, New Guinea impatiens, orchids, pansy, plugs, primula, salvia, streptocarpus, snapdragon, zinnia

Medium electrical conductivity

(1:2 dilution of 0.76 to 1.25mS/cm)
(SME of 1.5 to 3.0 mS/cm)
(PourThru of 2.0 to 3.5 mS/cm)

Angelonia, alstroemeria, alyssum, arygeranthemum, bidens, brachyscome, bougainvillea, calendula, calibrachoa, carnation, centaurea, cleome, clerodendrum, coleus, crossandra, dahlia, delphinium, dianthus, diascia, dusty Miller, exacum, fuchsia, geranium (vegetative), helichrysum, hibiscus, hydrangea, ipomoea, Jerusalem cherry, kalanchoe, lantana, lily, lobelia, morning glory, nemesia, ornamental kale, ornamental pepper, osteospermum, oxalis, petunia, phlox, platycodon, ranunculus, rose, sanvitalia, scaevola, schizanthus, sunflower, sutera (bacopa), torenia, verbena, vinca vine

Source: *Adapted and expanded from PourThru Nutritional Monitoring Manual by Brian Whipker, William Fonteno, Todd Cavins and Doug Bailey, 3rd edition, 2000. Published by North Carolina State University.*

needs, most nutritional problems are simply due to poor EC or medium pH management. Purchasing a pH/electrical conductivity meter is one of the wisest investments you can make. Regular soil testing and using graphical tracking to monitor pH and EC levels can avoid nutritional problems before they occur.

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