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Plant Nutrition for Greenhouse Crops

October 20, 2009

9:30-3:30

Publick House, Sturbridge, MA

UMass Extension, University of Connecticut, and Northeast SARE will sponsor an educational program providing practical information on plant nutrition for greenhouse crops. Sheila Graham of Plant Products Co. and Lela Kelly of Dosatron Co. will talk on water-soluble fertilizers, determining ppm, and fertilizer injectors. The topics of organic fertilization and water testing will be discussed by Doug Cox of UMass. Fred Hulme of Scotts Co. will speak on controlled fertilizers and Brian Krug of UNH and Rich McAvoy of UConn will cover identifying and correcting nutritional problems. Registration is $40 per person, including lunch. For more information contact Tina Smith (tsmith@umext.umass.edu) or Doug Cox (dcox@pssci.umass.edu).

Photoperiod and Bedding Plants

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Many growers are using photoperiod manipulation to control the flowering of bedding plants and other annuals and also as a method of energy conservation. In most cases bedding plant growers use photoperiod to shorten crop time. Many species of common annuals are known to respond to photoperiod and they are classified into five response groups (Table 1).

Bedding plants are either long-day, short-day, or day neutral in response to photoperiod. Some long-day species are "obligate" (or "qualitative") long-day plants meaning that they **require** daylengths **longer** than a certain critical length in order to flower. Other long-day species are "facultative" (or "qualitative") long-day plants. These plants initiate flowers under any daylength, but flower earlier with long-days. Snapdragon, sunflower, salvia, and petunia are some of the important long-day annual species.

Like long-day species, short-day plants have either an obligate or a facultative response to photoperiod; the former type **requires** a daylength **shorter** than a certain critical daylength while the latter type flowers under **any** daylength, but **earlier** with short days. African marigolds, cosmos, celosia, and zinnia are important short-day species.

The flowering of day neutral species is not affected by photoperiod. Geranium, impatiens, and begonia are examples of day neutral species.

It should be noted that there is some disagreement about the photoperiod response of certain species. For example, sometimes African marigolds (*Tagates erecta*) are classified as facultative, rather than obligate short-day plants as in Table 1 (Figure 1). Also, some varieties of French marigold (*T. patula*), like 'Naughty Marietta' (Figure 2), seem to be facultative short-day instead of day neutral plants as in Table 1. Zinnia (Figure 3) may or may not respond to short days.

There can be considerable variation in response to photoperiod among varieties of the same species. For example, the 'Lady', 'Galore', and 'Jubilee' series of marigold show a facultative response to short days, but the 'Inca', 'Antigua', 'Discovery', and 'Excel' series do not, and are day neutral varieties. Also, some dwarf Red Salvia varieties are day neutral, others are long-day plants, and some tall varieties are short day plants (Koranski, 1997).The main point is that growers using photoperiod may see photoperiod responses that don't always match what is expected.

Figure 1. 'First Lady' marigold flowers faster under short-day conditions. Note that the long-day plant is larger.

Figure 2. 'Naughty Marietta' marigold is a facultative short-day plant and it flowers faster under short-days (left) than long-days (right). Note that the long-day plant is larger.

Figure 3. Some zinnias are not greatly affected by photoperiod.

Controlling photoperiod

Generally, short-day plants flower when the daylength is **shorter** than 11 hours and long-day plants will flower when the daylength is **longer** than 14-16 hours (Warner, 2006). Keep in mind, however, that the critical daylength is likely to be somewhat different for each species. A traditional blackcloth system is used to shorten daylength. The amount of area covered by black cloth can be small because many species are treated for only 2-3 weeks in the seedling stage. Cloth is pulled at 4 PM and removed at 8 AM, daily.

Daylength is increased for long-day plants by continuous or cyclical night-lighting with incandescent bulbs 4-6 hours each night or by daylength extension with HPS lamps. A minimum of 10 footcandles of light intensity is necessary for night-lighting systems.

Some ways to use photoperiod

The first example, the inspiration for this article, was a mistake I made two years ago growing annual and bedding plant specimens for my herbaceous plants course. I needed to have specimens ready to view by the last week in January and therefore I had to start seeds during November. Obviously this is the time of year when daylength is shortest. I normally use what amounts to daylength extension with HPS lamps, lighting the plants daily from 6 AM to 8PM (14 hour day) beginning at germination, but one year I forgot to start the lighting system. The result was early-flowering and too short short-day plants like marigolds, celosia, cosmos, and some zinnia types; they were poor examples of what the plants would be like in the landscape. Also, long-day petunias were very compact (but nicely branched) and developed no flowers until it was almost too late to use in class. Using daylength extension to creates long days for **very early** crops would have built larger plants and **slowed** the flowering of short-day plants, but speeded up the flowering of long-day species.

A second example, related to the first, concerns the flowering of facultative short-day African marigolds. The critical daylength for these plants is about 11 hours. In New England, if the seed is sown before 15 February natural short days will accelerate flowering with the result being what I observed in my "mistake". On the other hand, if seed is sown after 20 February when daylength is longer than the critical daylength flowering will be delayed and the plants will grow tall. Black cloth is needed here. This applies to the 'Lady', 'Galore', and 'Jubilee' series mentioned earlier.

A third example is the prevention of "ugly buds" on early crops of greenhouse grown sunflowers for cutting (Wien, 2009). Sunflowers are facultative short-day plants and when they are planted under natural short days the plants finish short, flower early, and develop many small "ugly buds" crowding the terminal flower bud. Three weeks of long days (16 hours) delayed flowering 18 days, nearly doubled plant height, doubled terminal flower size, and prevented the formation of "ugly buds".

Finally, most growers using photoperiod control on annuals do so to shorten crop time and perhaps save some energy by being able to delay seeding/planting. This approach is used with success on long-day species. Plugs are provided with long days by night-lighting beginning during the last two weeks before transplanting until flower buds become visible after transplanting. Night-lighting is not needed after early April when days become naturally long. This method was described by Eric Runkle of Michigan State University in his talk "Energy Efficient Crop Production Strategies" presented at the 2008 New England Greenhouse Conference. He showed a 27 day reduction in the time to flower of petunia 'Fantasy Pink Morn' through the use of long days.

References

Kornaski, D. 1997. Ask Dr. Kornaski. *Grnhse. Prod. News*, June issue, page 6.

Warner, R.M. 2006. Supplemental lighting on bedding plants – Making it work for you. *OFA Bull.* No. 899.

Wien, C. 2009. No more ugly buds! *The Cut Flower Quar.* 21(1):56.

Table 1. Photoperiodic response groups for numerous annual bedding plants[z].

Obligate Long-Day Plants	
Ammi majus	Asperula
Bachelor's Buttons (*Centaurea*)	Catananche
China Aster (*Callistephus*)	Dill
Flax (*Linum*)	*Fuchsia* x *hybrida*
Gazania	Ipomopsis
Lavatera	Legousia
Leptosiphon	Limnanthes
Lobelia	Love-in-the-Mist (*Nigella*)
Monkey Flower (*Mimulus*)	Nierembergia
Primrose (*Oenothera*)	Petunia ('Purple Wave')
Platystemon	Rudbeckia
Strawflower	Sweet Pea (*Lathyrus*)
Tuberous begonia (*Begonia* x *tuberhybrida*)	
Facultative Long Day Plants	
African Daisy (*Dimorphothica*)	Ageratum
Basil	Calendula
Collinsia	*Dianthus chinensis*
Linaria	Mexican sunflower (*Tithonia*)
Pansy (*Viola*)	Petunia (Grandiflora types)
Phacelia	Reseda
Salpiglossus	Blue Salvia
Snapdragon	Statice
Sunflower	
Obligate Short-Day Plants	
Mina Vine	Hyacinth Bean
African Marigold (*Tagetes erecta*)	
Facultative Short-Day Plants	
Celosia	Cosmos
Creeping Zinnia (*Sanvitalia*)	Globe amaranth (*Gomphrena*)
Hiemelis begonia	Moonflower (*Ipomea*)
Morning Glory (*Pharbitis*)	Signet marigold (*Tagetes tenuifolia*)
Zinnia (*Zinnia elegans*)	
Day-Neutral Plants	
Amaranthus	*Asclepias curassavica*
Balsam (*Impatiens balsamina*)	Wax begonia (*Begonia* x *semperflorens*)
Carpanthea	Centranthus
Cleome	Cobea
Dianthus barbatus	French marigold (*Tagetes patula*)
Geranium	Common Impatiens
Nemophila	New Guinea impatiens
Oxypetalum	Stock
Verbascum	Narrow-leaved Zinnia (*Zinnia angustifolia*)

[z] Warner, R.M. 2006. Supplemental lighting on bedding plants – Making it work for you. *OFA Bull.* No. 899.

Organic Fertilizers and Soilless Media Show Promise

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Greenhouse operators are showing great interest in “organic” or “green” growing practices and the possibility of becoming “certified organic”. Elimination of chemical pesticides, adoption of IPM methods, and the use of biorational insect and disease control methods are important steps toward reaching the goal of being organic. However, growers must also seek alternatives to current growing media which contain chemical starter fertilizers and wetting agents and the use of traditional water-soluble chemical fertilizers. The results of this study are intended to help growers with less than an acre of greenhouse space who wish to transition from traditional growing media and fertilizers to organic alternatives.

At the present time only a few commercial soilless media are approved by the National Organic Program (NOP) or the Organic Materials Review Institute (OMRI). Sungro Horticulture and Fafard have several organic formulations of peat-lite media containing no chemical fertilizers or wetting agents. Some in the organic community object to the use of sphagnum peat moss in horticulture, but the Sungro and Fafard mixes are approved for use in organic plant production at this time.

Compost is an obvious choice as an alternative to peat-containing media. Historically many types of compost have proven successful for growing greenhouse crops. However, widespread use of compost has been limited by the lack of long-term availability of large quantities of consistent product.

The only widely available water-soluble fertilizer approved by NOP and OMRI is liquid fish fertilizer (fish emulsion). Liquid fish fertilizer has a very low NPK analysis (2-4-1), a rather thick consistency, and some users object to its odor. However, it has the advantage of being compatible with most equipment and systems growers already use to apply water-soluble fertilizer. It can be successfully used to fertilize plants including greenhouse tomatoes irrigated using a drip system (Mello and Mello, 2007).

Another approach to fertilizing greenhouse plants organically, is to incorporate bulk fertilizers like dried blood, bone meal, and rock phosphate in the medium before planting. Of course this way of fertilizing limits the control of nutrition as the plants grow unlike water-soluble fertilizers. However, one interesting formulation has been developed by John Biernbaum of Michigan State University (Biernbaum, 2006). It consists of a peat- or compost-based medium amended with a commercial alfalfa meal-based 3-1-5 fertilizer as the source of nutrients. Birenbaum, in his trials, successfully grew a variety of bedding plants in this growing medium without applying any other fertilizer.

This study with marigolds is part of a larger, ongoing project supported by the New England Greenhouse Conference and the New England Florist Credit Association Endowment which will evaluate several commercial organic growing media, liquid fish emulsion fertilizer, the Biernbaum formulation, and alfalfa pellets for growing bedding plants and other annuals. This project is intended to help small- and medium-sized growers produce annual plants using commercial organic growing media, liquid fish fertilizer, or an alfalfa meal amended peat-lite medium.

How the plants were grown

Seeds of ‘First Lady’ marigold were sown in plug trays on 18 February 2009. On 11 March seedlings were transplanted to 4-inch pots filled with either Fafard 3B, Fafard Organic FOF#30, and Sunshine Organic Planting Mix SOPM. The three mixes are soilless peat-based media but they do not conatin chemical sater fertilizer or wetting agent. Fafard Organic FOF#30 is the organic version of 3B and contains Perdue Organic Fertilizer as a starter charge and no wetting agent. Sunshine SOPM is the organic version of Sunshine Mix #1 and contains yucca extract as a wetting agent. The media were tested prior to planting for pH, EC, NO_3-N, NH_4-N, P, K , and Ca (Table 1).

Table 1. Soil test results prior to planting.

	Fafard 3B	**Fafard Organic**	**Sunshine Organic**
pH	6.2	5.5	6.5
Soluble salts (mS/cm)	1.52	1.46	0.73
NO_3-N (ppm)	29	6	7
NH_4-N	0	8	0
P	2	35	0
K	110	141	5
Ca	56	118	106
Mg	71	135	146

Plants were fertilizer with either Plantex 20-2-20 chemical fertilizer (200 ppm N), Neptune's Harvest Organic Fish (emulsion) Fertilizer 3-1-5 (2.2 fl. oz./gal.), Planet Natural alfalfa pellets 5-1-2 (35 oz./ft^3), or the fish fertilizer and alfalfa pellet treatments together. The alfalfa pellets (similar in appearance to wood pellets and often used as animal feed when fortified with molasses) were incorporated in the growth media before planting. Liquid fertilizers were applied at nearly every watering.

Plants were harvested on 8 May at which time foliar height (height measured to the uppermost leaves), flower height (height measured to the top of the first flower bud), first flower bud diameter, and shoot dry weight were measured.

Results

At harvest plants fertilized with chemical fertilizer, fish fertilizer, or fish fertilizer and alfalfa pellets were difficult to tell apart from each other regardless of growth medium. However, the plants fertilized with alfalfa pellets alone were chlorotic and had noticeably smaller leaves than plants in the other treatments. These differences in appearance between plants fertilized with alfalfa pellets alone and the other treatments are clearly apparent (Figures 1 and 2).

Table 2 shows the "main effects" of fertilizer and growth medium on marigold growth; there were only a couple of interactions between the two factors. Plants fertilized with chemical fertilizer were tallest, had the most developed first flower bud, and accumulated the most shoot dry weight. Plants fertilized with fish fertilizer of the combination of fish and alfalfa pellets were, from a statistical standpoint inferior to the chemical fertilizer treatment, but the actual differences were very small and of limited practical importance.

Figure 4. The left plant was fertilized with alfalfa pellets alone.

The plants fertilized with alfalfa pellets alone were obviously nutrient deficient, but oddly they were as tall as the chemical treatment and taller than the fish fertilizer and fish + alfalfa pellets treatment. However, first flower buds were much smaller and the plants accumulated much less shoot dry weight than the other treatments.

Plants grown with Fafard 3B were the tallest and accumulated the greatest dry weight. The two organic soilless media produced comparable levels of growth to each other except that Sunshine Organic plants accumulate significantly less dry weight.

Table 2. 'First Lady' marigold growth as affected by fertilizer and growth medium.

	Foliar hgt. (cm)	Flower hgt. (cm)	Bud dia. (mm)	Shoot dry weight (gm)
Fertilizer type				
Chemical 20-2-20	26.5a[z]	32.2a	56.8a	12.8a
Fish emulsion	25.4b	30.3b	49.7b	11.9b
Alfalfa pellets	26.6a	32.7a	34.2c	9.1c
Fish + alfalfa	25.6b	30.9b	52.3a	11.5b
Growth medium				
Fafard 3B	26.7a	32.3a	50.2a	12.6a
Fafard Organic	25.7b	31.1b	50.1a	11.2b
Sunshine Organic	25.5b	31.0b	44.5b	10.2c

[z]Means followed by different letters within fertilizer or growth medium are statistically different at P=0.01.

Figure 5. Marigolds growing in Sunshine Organic Planting Mix fertilized (L to R) with chemical 20-2-20, fish fertilizer, alfalfa pellets alone, fish fertilizer + alfalfa pellets. In terms of appearance, Fafard 3B and Fafard Organic Mix produced the same results.

Conclusions

Overall I think the results of this study were positive and the organic materials showed promise. Since this was the first experiment in this project the main objectives were to determine the overall responses to the treatments and to use the results to establish levels of fish and alfalfa fertilizers for use in future experiments with marigold and other plants. Since there is almost no readily available information on the levels of fish and alfalfa fertilizers to use, you've got to start somewhere! So it's likely that applying higher levels of fish fertilizer or alfalfa pellets will produce better results.

I chose the alfalfa pellet application level based on recommendations in Birenbaum's (2006) study. He, however, used an alfalfa meal (rather than pellet) fertilizer called Bradfield Organics "Luscious Lawn & Garden" 3-1-5 fertilizer which I was unable to get in February. Many readers who operate garden centers will recognize the Bradfield Organics brand. I intend to use it and the pellets in future work.

Marigold responses to growth medium, especially shoot dry, may have been due to the differences in nutrient levels at planting (Table 1). Fafard 3B had a much higher NO_3-N level at planting than the organic media and finished with the most shoot dry weight. Also, Sunshine Organic, which produced plants with the least dry weight, had very low P and K levels and a much lower EC level at planting compared to the other two media. Although starter fertilizers are supposed to last only 2 or 3 weeks, it's surprising how much impact on future growth they can have if their levels are low during the time after transplanting when the young plants not watered with fertilizer very frequently.

References

Biernbaum, J. 2006. Greenhouse organic transplant production. Illinois Organic Conference, 12 January 2006. 13 pages.

Mello, A. and L. Mello. 2007. Organic fertilization of greenhouse tomatoes by drip irrigation. *Floral Notes* 19(6):2-3.

Two New "Black" Ornamental Peppers Heading to Market

Stephanie Yao, USDA Agricultural Research Service

Ornamental plant enthusiasts now have more pepper varieties to add to their gardens. The Agricultural Research Service (ARS) has entered into a license agreement with McCorkle Nurseries, in Dearing, Ga., for propagation and distribution of these eye-catching peppers.

The new plants, 'Midnight Creeper' and 'Solar Eclipse,' are the latest in a line of ornamental pepper varieties released by ARS. They were created by geneticist John Stommel of the ARS Genetic Improvement of Fruits and Vegetables Laboratory and Rob Griesbach, a former researcher with the ARS Floral and Nursery Plants Research Unit, both in Beltsville, Md.

Best used as bedding plants, 'Midnight Creeper' and 'Solar Eclipse' are particularly striking due to their dark purple to black coloring. Once a novelty, these colors are now standard elements to consider in garden design. Black foliage provides long-lasting color in short-season climates and year-round color in warmer climates.

'Midnight Creeper' has purple flowers and produces fruit that's black when immature, but red when mature. Attractive in mass plantings as a dense ground cover, the plant is unique in that it grows outward instead of upward like other pepper plants. In contrast, 'Solar Eclipse' is tall, bushy and prized for its striking black foliage, providing a novel foundation for garden designs. The plant produces very few flowers and fruit when grown under summer field conditions, contributing to its season-long usefulness.

Taste evaluations for 'Midnight Creeper' and 'Solar Eclipse' indicated that the fruit are "extremely hot" and "very hot," respectively. However, because the plants are intended for ornamental use, Scoville ratings - measures used to verify a pepper's pungency - were not determined.

Stommel and Griesbach's research on ornamental peppers has dual benefits. The research provides new, interesting cultivars for consumers while also laying a foundation for anthocyanin research to help create plant colors that the ornamental industry and consumers enjoy. Anthocyanins are water-soluble pigments that give fruit, leaves, flowers, stems, and roots their color. They also protect the plant from damaging ultraviolet sunlight and act as antioxidants when eaten.

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