

Technical Reports

On-Farm Trials

Ames On-Farm Trial: Heenah Mahyah Student Farm Herb Trial

Introduction

Although herbs have been used medicinally for thousands of years, worldwide use of herbs as a source of “natural” medicine is increasing. Recently, we have seen a dramatic increase in American consumer interest in these alternatives to synthetic drugs. Because of this interest, there is also a large demand for production information under U.S. growing conditions, particularly for organic conditions. Premiums for certified organic herbs range from 20 – 400%. Because synthetic fertilizers are not permitted in organic production, organic growers are interested in alternative sources of nitrogen and other nutrients for their crops. Some of these alternatives include compost from various feedstocks and fertilizers made from feathermeal, bone meal, and seaweed. Natural fertilizers are reported to help preserve soil structure and quality, and protect groundwater from toxic runoff/infiltration. In addition, soil amendments consisting of green and livestock waste products have been reported to mitigate vegetable disease and insect problems. Three medicinal herbs were selected for this trial and are described below.

***Echinacea purpurea* (L.) Moench**

Purple coneflower is a hardy herbaceous perennial with a branched or fibrous root and longer, dark purple ray petals that grow up to four feet tall (Bremness, 1994; Hobbs, 1995; Powell, 1995; Stuart, 1979). The tops and roots are used medicinally as an immune system stimulant (Hobbs, 1995). *E. purpurea* growth is greatest in well-drained soils with a pH of 5.5 - 7.0. Problems include powdery mildew and aster yellows, a mycoplasma-like organism (Powell, 1995).

***Echinacea angustifolia* De Candolle**

Narrow-leaved purple coneflower is an herbaceous perennial with a vertical taproot and shorter, purple ray petals which grows up to five feet in height (Bremness, 1994; Hobbs, 1995). *E. angustifolia* is native to central and southwestern United States and appears from mid-summer to early autumn (Stuart, 1979). The dried rootstock is used medicinally as an antiseptic (Stuart, 1979) and immune system stimulant (Bremness, 1994).

***Melissa officinalis* L.**

Lemon balm is a bushy herbaceous perennial with lemon-scented foliage (Bremness, 1994; Powell, 1995; Stuart, 1979). A native to central and southern Europe, lemon balm became widespread in northern temperate zones. Sandy, dry soil with a pH level of 6.5 - 7.5 is preferred for maximum growth, with more aromatic leaves produced in dry soil (Powell, 1995). Fresh or dried leaves are used medicinally as a carminative, a diaphoretic, an anti-spasmodic, or an anti-depressant agent (Bremness, 1994; Stuart, 1979).

Experimental design

The experiment consisted of a randomized complete block design with four replications of six treatments (control, 2 compost levels and 3 fertilizer levels) and three medicinal

herbs: *Echinacea purpurea*, *E. angustifolia* and *Melissa officinalis*. Each plot measured 15' x 15' (4.56 m x 4.56 m) with 16 plants per plot planted on 3 ft. x 3 ft. (0.91 m x 0.91 m) centers.

Materials and Methods

Plots previously planted to a cover crop of sorghum-sudangrass at the Heenah Mahyah Student Farm (HMSF) were used for this study. Soils were sampled on 15 May 2000 and 19 May 2000. Plots were cultivated for bed preparation on 15 May 1999. *Echinacea purpurea*, *Echinacea angustifolia* and *Melissa officinalis* seeds were planted in the Iowa State University Horticulture Department greenhouses on 20 January 1999. Transplants were set at 3 in. (7.6 cm) depth on 1 June 1999. Treatments were applied at the beginning of plant growth on 24 June 1999 and on 5 June 2000. The treatments were applied as follows: Midwestern Bio-Ag® (Blue Mounds, WI) feathermeal-based pellet fertilizer was applied at a rate equivalent to 50 lb N/acre (56 kg N ha⁻¹), 100 lb N/acre (112 kg N ha⁻¹) and 150 lb N/acre (168 kg N ha⁻¹). Composted turkey litter (Ultra-Gro®, Ellsworth, IA) with a chemical analysis of 2.2-2.8-1.5 N-P-K was applied at a rate equivalent to 50 lb N/acre (56 kg N ha⁻¹) and 100 lb N/acre (112 kg N ha⁻¹). No insecticides, fungicides, or herbicides were applied in keeping with certified organic standards. Weeds were managed through mechanical cultivation between rows until canopy closure, followed by an application of 6 in. (15.2 cm) organic oat straw mulch on each plot (10 June 1999 and 12 June 2000) and hand weeding when needed. Parameters measured for all plants per plot included: plant height, leaf number, flower number and insect number. In 1999, plants were sampled on June 12, 25 and 30, July 6, 13 and 22, August 11, September 11, October 23, and November 13. All leaves from 3 *M. officinalis* plants per plot (72 plants total) were harvested on November 13, 1999, before frost. *Echinacea* leaves and roots were harvested from 2 plants per plot (42 randomly selected plants) on November 13. In 2000, plants were sampled on June 9, 23 and 26, July 7, and 21 and August 4. *M. officinalis* was harvested on June 27 and 28 and September 21 before flowering; *Echinacea* leaves and roots were harvested on 21 September 2000. Measurements were subjected to analysis of variance and Fisher's PLSD test (SAS Institute, 1988).

Results and Discussion

In 1999, significant differences were observed in treated plots compared with the control plots. Soil analysis (Table 1) revealed a high level of P and K in the selected fields. The addition of the biological fertilizer or the compost significantly increased plant height in *Echinacea purpurea* (Figure 1). Plant height did not differ between the biological fertilizer and the compost plots using similar rates of 50 lb N/acre (56 kg N ha⁻¹) and 100 lb N/acre (112 kg N ha⁻¹). The 100 lb N/acre (112 kg N ha⁻¹) fertilizer treatment resulted in the tallest *M. officinalis* plants (Figure 2); however, the differences were not significant. In the first year of growth, the application of a biological fertilizer or compost did not significantly increase root growth in *Echinacea purpurea* (Figure 3).

Table 1. Pre-plant soil characteristics at the HMSF Organic Herb Trial, 1998.

Soil Characteristic	Amount
Organic Matter	3.7%
pH	6.6
Buffer pH	6.9

Figure: 1 *Echinacea purpurea* plant height (cm) 1999

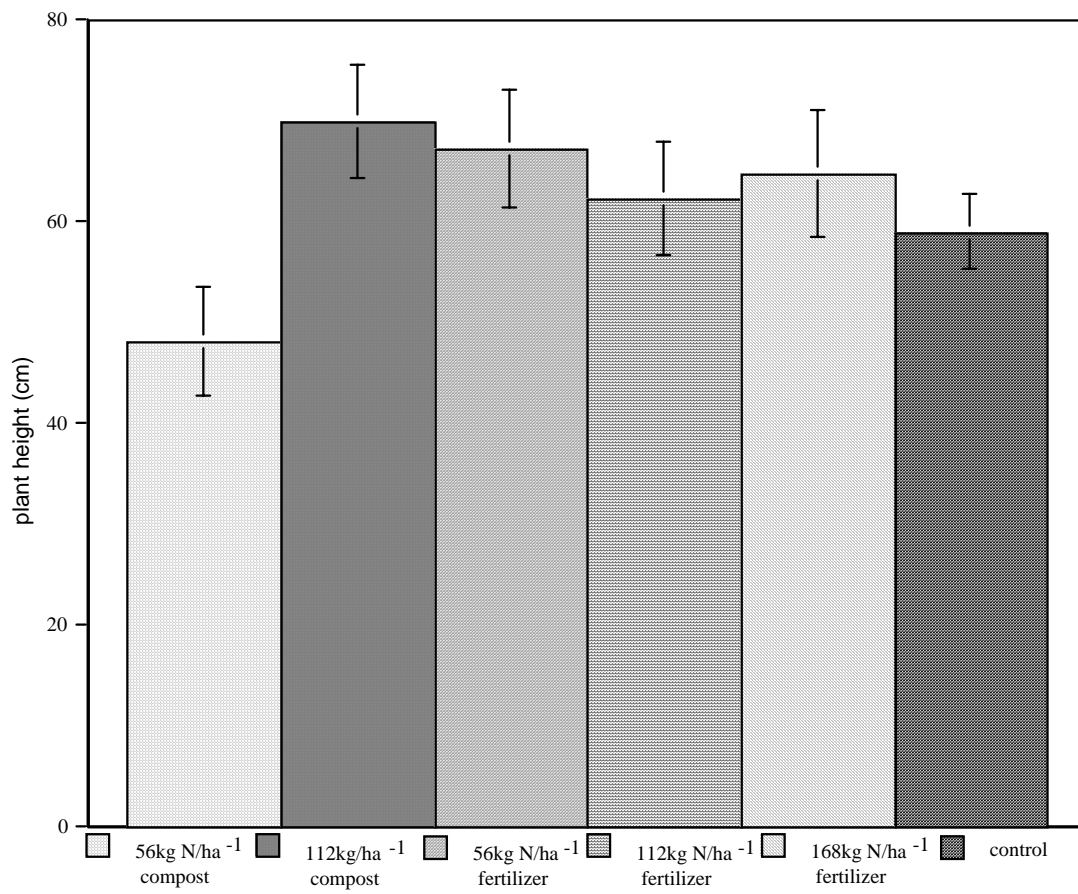


Figure: 2 *Melissa officinalis* Plant Height (cm) 1999

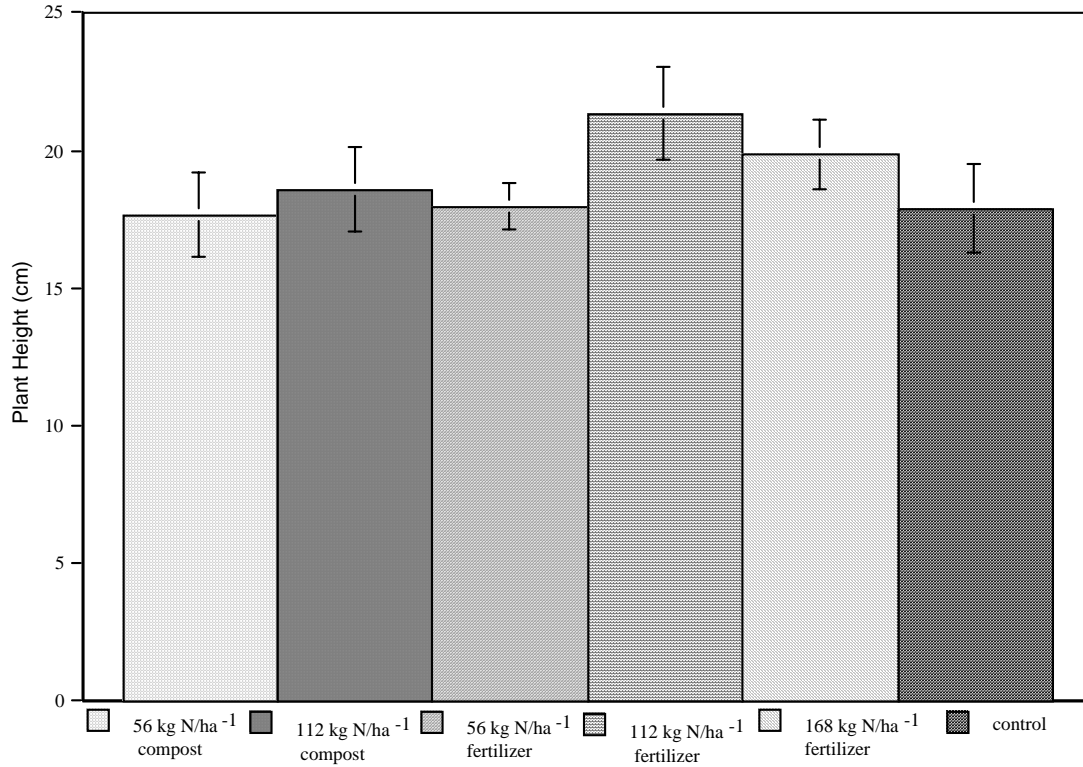
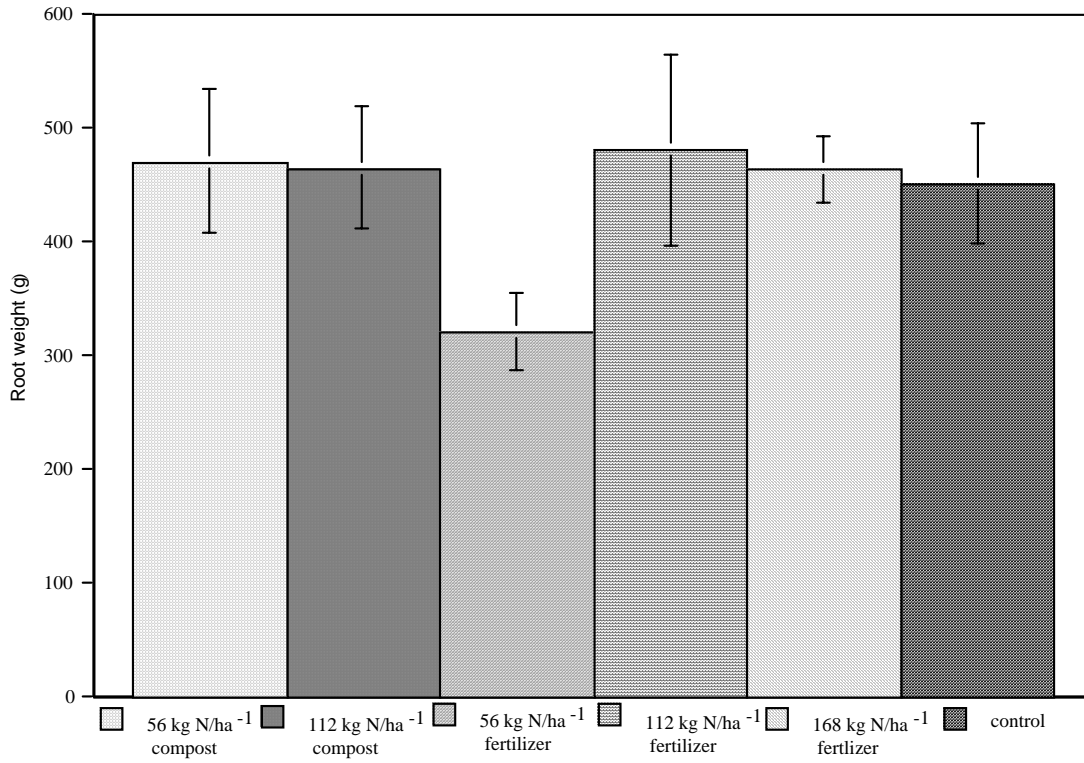


Figure: 3 *Echinacea purpurea* Root Harvest Fresh Weight 1999



In 2000, significantly greater *E. purpurea* leaf dry matter was harvested from the 50 lb N/acre (56 kg N ha⁻¹) organic fertilizer plots than the 150 lb N/acre (168 kg N ha⁻¹) organic fertilizer plots (Figure 4). This result does not correlate with the soil data (Table 2) which indicated a significantly higher level of soil nitrate in the 150 lb N/acre (168 kg N ha⁻¹) plots. It may suggest that fertilization with 50 lb N/acre (56 kg N ha⁻¹) may be optimal for plant growth, and greater N addition does not result in an increase in yield. The same trend was apparent for root dry weight (Figure 5), although the difference was not significant.

Figure: 4 *Echinacea purpurea* Leaf Harvest Dry Weight 2000

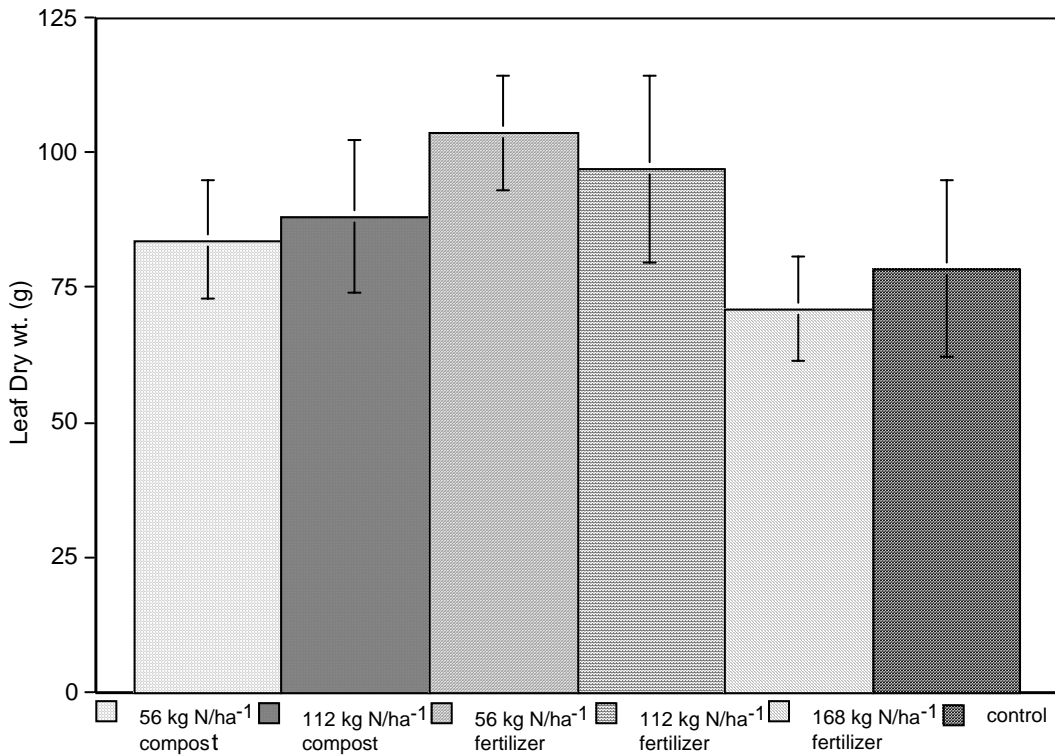
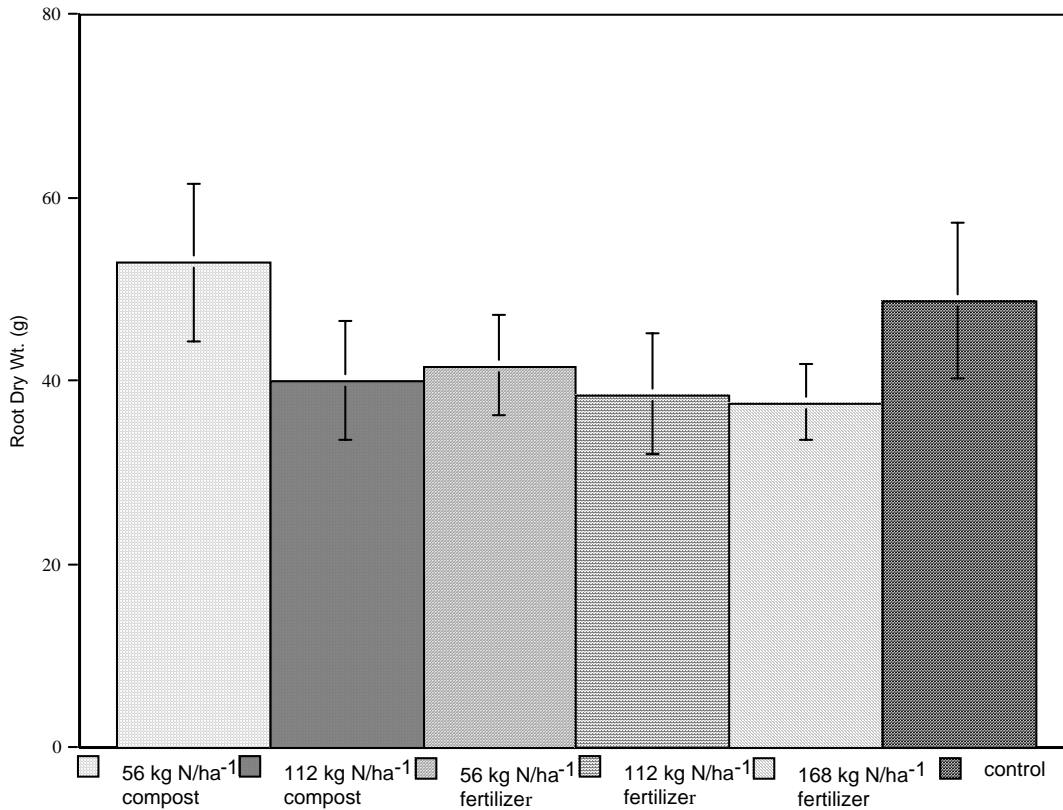


Table: 2 Soil characteristics of *Echinacea purpurea* plots with organic fertilizer and compost treatments at the HMSF Organic Herb Trial, 2000.

Treatment	Moisture (%)	pH	Total C ppm	NH ₄ -N ppm	NO ₃ -N ppm
control	19.0	6.5	26791	4.0	7.0
compost 56kg N/ha ⁻¹	18.2	6.8	26056	2.0	8.0
Compost 112 kg N/ha ⁻¹	18.9	6.6	24219	2.6	6.3
Fertilizer 56kg N/ha ⁻¹	19.1	6.5	27341	2.1	5.0
Fertilizer 112 kg N/ha ⁻¹	17.6	6.2	28358	2.0	8.6
Fertilizer 168 kg N/ha ⁻¹	18.1	6.6	28512	4.3	12.7

Figure: 5 *Echinacea purpurea* Root Harvest Dry Weight 2000



For *E. angustifolia*, significant treatment effects were found for leaf and root fresh weight and for leaf dry weight. Plants in the 100 lb N/acre (112 kg N ha⁻¹) fertilizer treatment were significantly greater than all other treatments (Figure 6). This does not correlate with the soil data (Table 3) which shows significantly less soil nitrate in the 100 lb N/acre (112 kg N ha⁻¹) fertilizer treatment than in the 150 lb N/acre (168 kg N ha⁻¹). No other soil parameters, which could account for the additional growth, were significantly greater in the 100 lb N/acre (112 kg N ha⁻¹) plots. No significant differences were found between treatments in *E. angustifolia* root dry weight (Figure 7). Differences were more readily apparent in above-ground plant parts, perhaps a reflection of differential growth between above and below ground. After a third or fourth year of root growth, differences may have become more apparent below ground.

Figure: 6 *Echinacea angustifolia* Leaf Harvest Dry Weight 2000

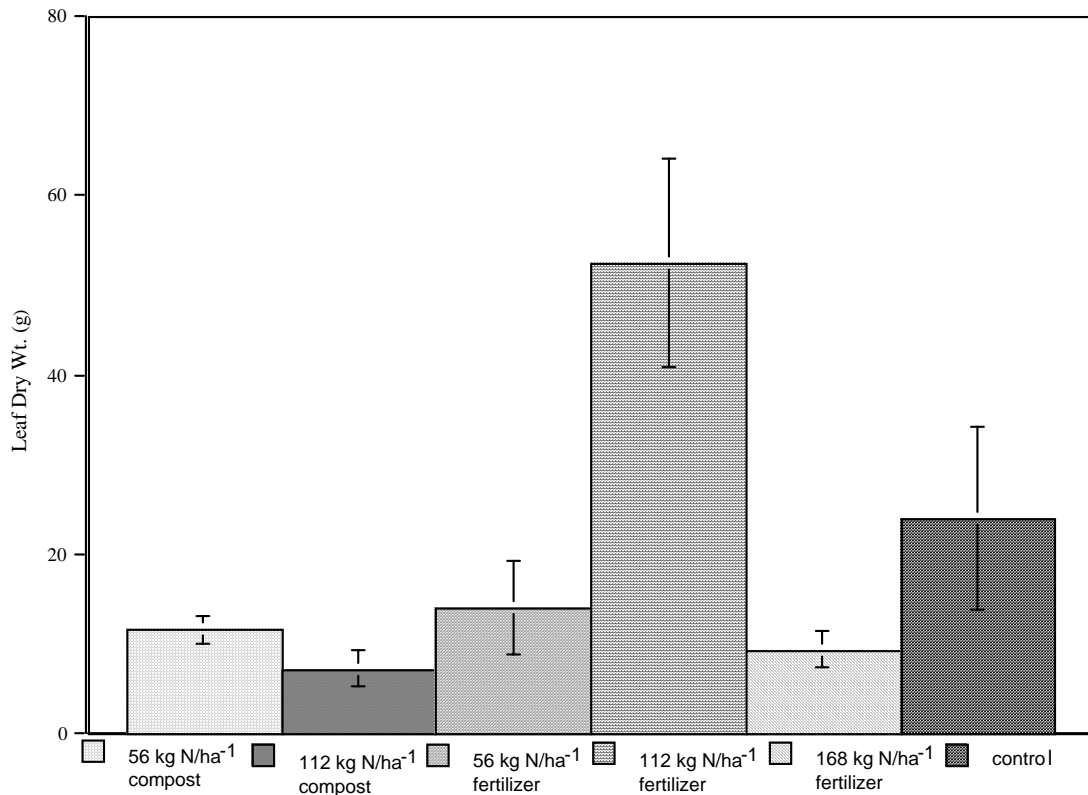


Figure: 7 *Echinacea angustifolia* Harvest Dry Root Weight 2000

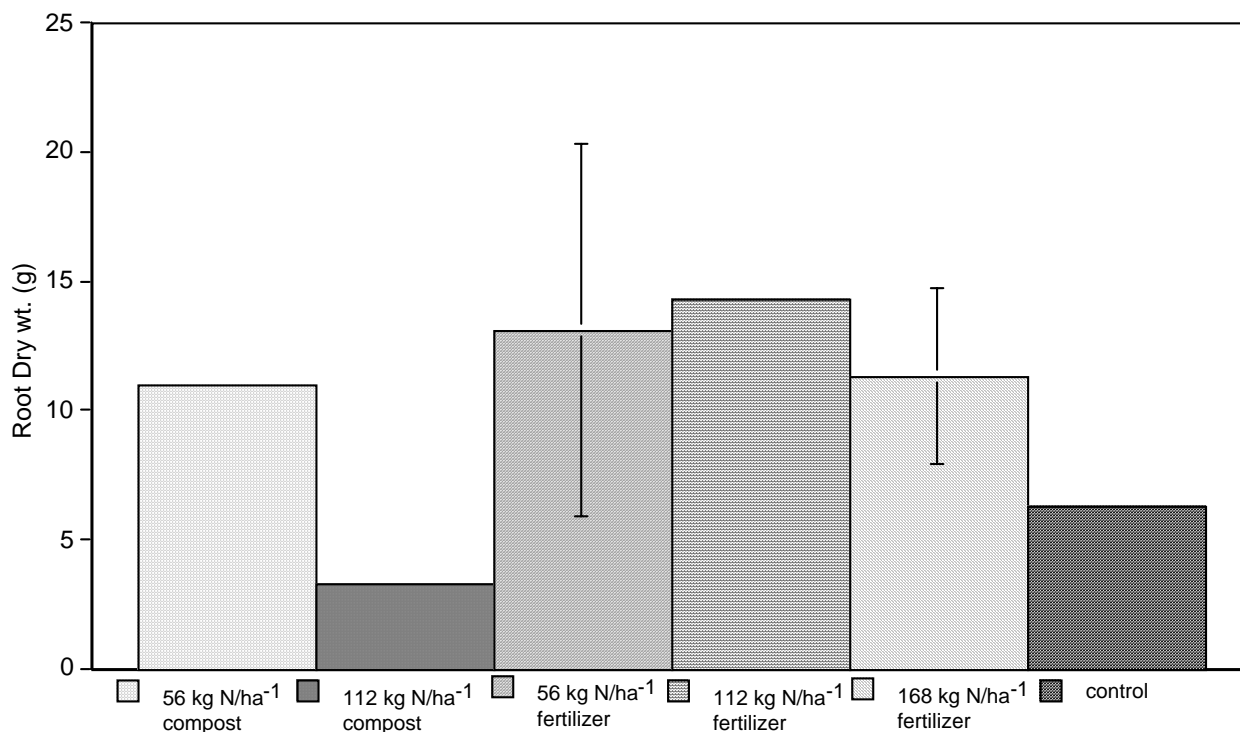


Table 3. Soil characteristics of *Echinacea angustifolia* plots with organic fertilizer and compost treatments at the HMSF Organic Herb Trial, 2000.

Treatment	% moist	pH	total C ppm	NH ₄ -N ppm	NO ₃ -N ppm
control	17.0	6.5	25151	3.7	8.8
compost 56kg N/ha ⁻¹	16.9	6.5	28031	2.4	6.6
Compost 112 kg N/ha ⁻¹	18.4	6.7	28103	3.3	4.7
Fertilizer 56kg N/ha ⁻¹	15.5	6.5	28544	3.9	5.4
Fertilizer 112 kg N/ha ⁻¹	17.9	6.6	27844	3.2	3.9
Fertilizer 168 kg N/ha ⁻¹	19.4	6.6	28585	3.1	11.3

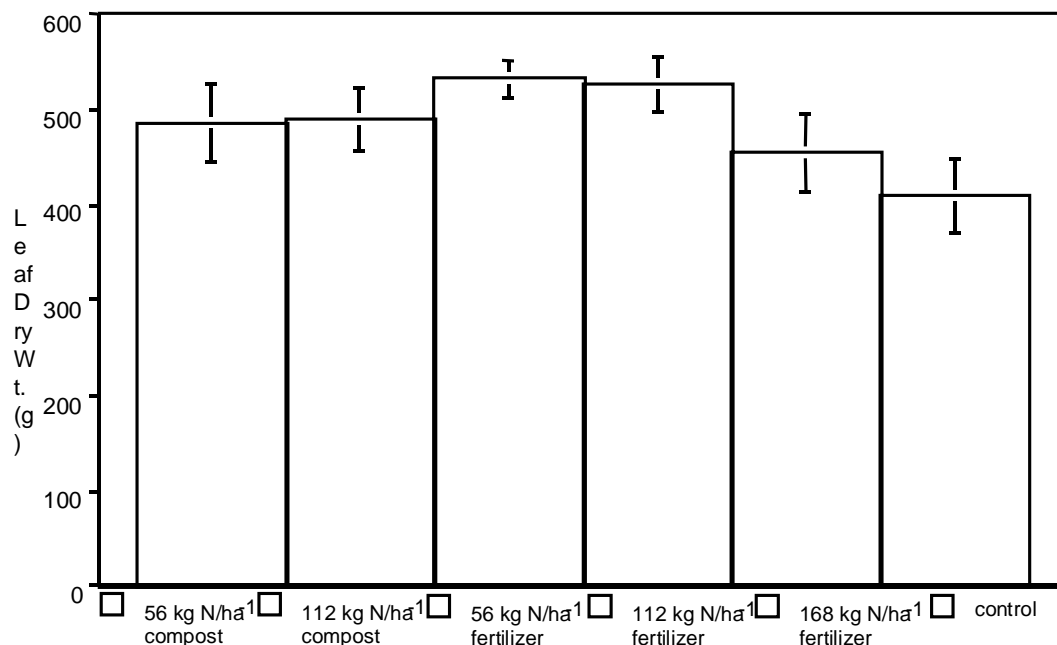
Lemon balm (*M. officinalis*) plants in the compost treatments produced significantly greater fresh weight than the control in 2000. The organic fertilizer treatments of 50 lb N/acre (56 kg N ha⁻¹) and 100 lb N/acre (112 kg N ha⁻¹) also yielded significantly higher than the control. Although the fertilizer treatment of 150 lb N/acre (168 kg N ha⁻¹) yielded higher than the control, the difference was not statistically significant. Significant differences between organic fertilizer treatments were also observed. The 50 lb N/acre (56 kg N ha⁻¹) treatment yielded higher than the 100 lb N/acre (112 kg N ha⁻¹) which in turn yielded higher than the 150 lb N/acre (168 kg N ha⁻¹) treatment. Dry weight data

revealed significantly higher yields in the 50 lb N/acre (56 kg N ha⁻¹) and 100 lbs N/acre (112 kg N ha⁻¹) organic fertilizer treatments compared with the control. Although the compost treatments also yielded higher than the control, the results were not statistically significant. The increase in yield obtained with the addition of 100 lb N/acre (112 kg N ha⁻¹) compared with 50 lb N/acre (56 kg N/ha⁻¹) was only 5 grams. This has important ramifications for farmers when yield benefits are not obtained with additional fertilization.

Table: 4 Soil characteristics of *Melissa officinalis* plots with organic fertilizer and compost treatments at the HMSF Organic Herb Trial, 2000.

Treatment	% moist	pH	total C ppm	NH ₄ -N ppm	NO ₃ -N ppm	Fe ppm	S ppm
control	18.7	6.4	30071	3.7	9.1	274	12.9
compost 56kg N/ha ⁻¹	19.2	6.5	30314	2.4	4.4	235	11.0
Compost 112 kg N/ha ⁻¹	19.6	6.6	28512	2.2	6.8	218	9.7
Fertilizer 56kg N/ha ⁻¹	16.2	6.7	26065	4.4	9.3	219	11.4
Fertilizer 112 kg N/ha ⁻¹	15.7	6.8	30190	3.1	6.9	252	14.8
Fertilizer 168 kg N/ha ⁻¹	16.8	6.6	27586	3.5	13.1	330	16.8

Figure: 8 *Melissa officinalis* Leaf Harvest Dry Weight 2000



Conclusions

The addition of compost as a soil amendment should not be confused with a synthetic fertilizer addition. The long-term benefits of compost to the soil-plant system in terms of improving soil structure through the addition of organic matter, soil moisture retention, and soil microbial activity may exceed benefits derived from the supply of plant nutrients alone. A study of the long term effects of compost addition and varying rates and types of compost would prove beneficial to organic farmers and gardeners in choosing the optimum conditions for organic vegetable and herb production. In addition, the interaction between cultivar and response to compost appears to be significant and warrants further investigation.

Impact of the Results

It is difficult to separate the impacts of all LCSA projects from each other. Overall impacts are outlined below. Specific impacts to the *Soil Amendments* project include that approximately 7,000 people were made aware at Field Days and presentations about the benefits of compost and other sustainable and organic agricultural practices. The farmers involved in these trials have adopted sustainable practices of soil testing and applying compost when needed.

I. Output Indicators

Generating Basic Information

- Number of research/demonstration plots established to develop sustainable/organic systems: 13
- Number of research/extension publications in sustainable/organic horticulture/agronomy: 15
- Number of grants to supplement research and demonstration efforts: 12

Engagement/Application

- Number of producers utilizing sustainable/organic practices: 353
- Number of acres in certified organic production: 150,000
- Number of Community Supported Agriculture projects (CSAs) active: 35
- Number of diversified or alternative community marketing systems or alliances established: 5
- Number of trained or updated key agricultural professionals in sustainable agriculture: 35
- Number of educational meetings, field days, workshops, one-on-one contacts, phone contacts: 268
- Number of mass media dissemination and direct teaching events: 7

II. Outcome Indicators:

- Percentage improvement in soil quality as a result of sustainable/organic practices: 10%
- Percentage reduction of harmful contaminants (excess nutrients and toxic chemicals) in Iowa waterways and groundwater: 44%
- Percentage new products (out of total market) for the value-added market: 2%
- Percentage income increase for family farmers from adoption of sustainable/organic practices:
(Long-range determination underway in 2000)

Publications with Information from this Project:

(* represents availability on the Web)

Delate, K. 2001. Using an agroecological approach to farming systems research. Accepted for HortTechnology (#1413)

*Rossiter, C. and K. Delate. 2001. Effect of Organic Treatments on Tomato Yield. Iowa State University Allee Research and Demonstration Farm Progress Report, College of Agriculture, Iowa State University, Ames, IA..

*Delate, K. 2000. Organic Agriculture. Submitted as PM publication to Extension Communications. Expected release date: 8/2001

*Delate, K. 2000. Soil Management for Organic Farmers. Submitted as PM publication to Extension Communications. Expected release date: 8/2001

- *Delate, K. and D. Muenchrath. 2000. Organic Farming Systems. Cropping Systems Management and Crop Ecology-Agronomy 531. Department of Agronomy, Iowa State University, Ames, IA.
- Delate, K.M. 2000. Organic Agriculture. Encyclopedia of Pest Management , Professor David Pimentel (ed.), Cornell University, Marcel Dekker Press, New York (In press: publication date 1/01)
- Delate, K.M. 2000. The Sustainability of Organic Production: A Model for Rural Development. World Bank Sustainable Agriculture Conference, April 10, 2000, Iowa State University, Ames, IA.
- Delate, K.M. and J. Boes. 2000. Managing Your Organic Crops for Optimum Returns. Integrated Crop Management Conference Proceedings, November 29, 2000, Iowa State University, Ames, IA.
- * Delate, K. and V. Lawson. 2000. Evaluation of Soil Amendments and Cover Crops for Certified Organic Pepper Production. Horticulture Research Report, Dept. of Horticulture, ISU, Ames, IA.
- *Delate, K., V. Lawson and C. Cambardella. 2000. Evaluation of Organic Soil Amendments for Certified Organic Vegetable and Herb Production. Annual Report for the Leopold Center for Sustainable Agriculture, LCSA, ISU, Ames, IA.
- * Delate, K. 1999. Targeting the Premium Market: Organic Crops for Iowa. Integrated Crop Management Conference Proceedings, November 17, 1999, Iowa State University, Ames, IA.
- *Delate, K. and V. Lawson. 1999. Evaluation of Organic Soil Amendments for Certified Organic Vegetable and Herb Production. Annual Report for the Leopold Center for Sustainable Agriculture, LCSA, ISU, Ames, IA.
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Education and Outreach:

K. Delate made 197 presentations on organic production, agroecological research, and organic marketing to an audience of approximately 10,000 people from 1998-2000. This included the development of 17 slide shows and 4 publications to use at such meetings. The fact sheets have been submitted to become permanent numbered Extension publications. Twenty-five Field Days, where this project was discussed, were held from 1998 to 2000 to an audience of approximately 1,650 Iowa and Midwest producers/Extension staff. Included in these Field Days were the development of full-color fact sheets and media packages. Field Days were held at the Heenah Mahyah Farm herb trial in 1998 and 1999; the Muscatine Island Farm in 1998, 1999 and 2000; and at the One Step at a Time Farm in 1998, 1999 and 2000, where a total of 240 people participated in a discussion of trial results with K. Delate and cooperators. Other Extension activities around this research are discussed below.

Producer/Extension Workshops

Composting for Organic Producers Workshop

At the invitation of the Planning Committee of the Upper Midwest Organic Farming Conference, I organized a 6-hour composting workshop on March 18, 2000, that consisted of faculty from the University of Wisconsin and Iowa State University and growers engaged in compost operations. Over 400 people attended these sessions and gained valuable information on compost composition and utilization.

TOOLBOX TRAINING FOR ORGANIC AGRICULTURE

On August 22-23, 2000, a tri-state training on organic agriculture was held in Greenfield and Orient, Iowa. This training focussed on organic principles and practices for 35 Extension specialists in Iowa, Missouri, and Wisconsin. Efforts in this activity included contacting appropriate administrators in other states, securing arrangements for speakers (including seven Iowa State University professors and seven farmers), arranging hotel and meeting rooms, meal orders/delivery, and conducting a pre- and post-test to measure course effectiveness.

ORGANIC CROP PRODUCTION IOWA COMMUNICATION NETWORK (ICN) COURSE

In the fall of 1999, I developed the first Organic Crop Production ICN course for Extension and ISU university credit (AGRON/HORT 494X) for Spring semester 2000. The total attendance for the course was 168 participants, including 24 ISU students. Efforts for the course included the following:

- Arranging speakers (ten Iowa State University professors and eleven farmers);
- Developing a resource manual (700 pages);
- Arranging an all-Iowa organic meal for the final session;
- Developing a corresponding web page where PowerPoint presentations were translated for the web;
- Developing testing materials, student project development and grading; and
- Evaluation of the course.

This course will be repeated in 2002, based on the amount of requests from producers and Extension staff. From this course, eight videotapes have been produced and have been distributed to more than fifty recipients. An Organic Agriculture Gateway webpage was created with assistance from the Brenton Center. Completion of the webpage is anticipated in January 2002.

Upper Midwest Organic Farming Intensive Workshop

Based on request from organic farmers and agricultural professionals in the Midwest, a six-hour workshop was organized for March 23, 2001, in La Crosse, Wisconsin. I was responsible for a course on "Resources for Organic Farmers" that included publications, video tapes, farmer contacts, and organizations supporting organic producers in terms of funding and research initiatives. My course involved Extension personnel from the Universities of Minnesota and Wisconsin, along with agricultural professionals from lending agencies. Regional attendance was estimated at 400 participants.

Iowa Fruit and Vegetable Growers Association Organic Workshop

On February 11, 1999, over 100 people attended the first Organic Fruit and Vegetable Workshop I organized for the IFGVA annual conference in Cedar Rapids. In addition to arranging for seven professor- and producer-speakers, an all-organic meal was organized for the event, which allowed involvement of farmers with the conference participants. Since this event, I have spoken at all IFGVA annual conferences, and organized an Organic Workshop for the February 24, 2000, meeting.

Cooperative Efforts:

We gratefully acknowledge the help of Jan Libbey and Tim Landgraf of One Step at A Time CSA, and the staff at the Muscatine Island Research Farm, USDA National Soil Tilth Lab (Cindy Cambardella and lab); the diagnostic labs. in Agronomy, and Horticulture; George Kraus (Chemistry) and Frontier Herbs (Norway, IA) for their efforts, advice and support. .

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