

ORGANIC FARMING RESEARCH FOUNDATION

FINAL REPORT

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**IMPROVING THE QUALITY OF ORGANIC HERB PRODUCTION:
EVALUATION OF ORGANIC SOIL AMENDMENTS AND NATURAL MULCHES**

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1. Summary

Farmers interested in transitioning some or all of their land into organic production need information regarding the best management practices for these systems. Soil fertility and weed management strategies are imperative for optimum plant growth and yields. Current research in organic herb production at Iowa State University has included investigations into certified organic methods of fertilization and use of organic mulches for weed suppression. Although increased yields were obtained with vegetables (broccoli and green peppers) fertilized with composted turkey manure (UltraGro®, Ellsworth, IA), results with herb crops were not consistent. Compost increased herb leaf growth (Echinacea and lemon balm) but not root growth. Imported biological fertilizers also increased plant growth and yields, but did not provide any advantage over locally produced compost. This information was transferred through on-farm Field Days and workshops at Iowa State University. Organic medicinal herbs research plots were established in 2001 in a 2-3 year project to identify, through replicated trials, which organic mulches provide the optimum level of weed suppression, yields, and herbal quality. Preliminary results (first-year) demonstrate a significant effect from natural

mulches (flax mat, wool mat and oat straw), including yield increases and weed suppression. Comparisons of biochemical constituents and essential oil yields for both projects are underway at Iowa State University. Funding from the Organic Farming Research Foundation helped support analysis of the soil amendment component of this project, and establishment of the weed management component. Funding for completion of this research has been submitted for the 2002 grants program.

2. Introduction to Topic

As a consequence of surplus crops of commodity corn and soybeans in the Midwest, and the resulting low prices, an excellent opportunity exists for organic farmers to plant crops for high-value niche markets. Iowa farmers reported 150,000 acres of organic production to the Iowa Department of Agriculture and Land Stewardship (IDALS) survey in 1999. This figure reflects only acreage reported by those farmers who returned their survey; thus, many more acres are believed to go unreported. In addition to comparable yields with conventional systems, organic systems have been reported to produce more flavorful products and garner a 20-400% premium price in the marketplace. While a number of specialty crops have been explored, the potential for growing crops that provide health benefits, such as the medicinal herbs, *Hypericum*, *Echinacea* and catnip, has been little exploited. The European Union currently controls the majority share of essential oil products exported throughout the world, despite the fact that similar yields for these products can be obtained in the U.S. With prices reaching \$50 per ounce, the essential oil market offers a lucrative option for small- and mid-size growers. Many herbs, including *Echinacea purpurea*, can be sold at a 100% premium if grown organically. 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.

Because synthetic fertilizers and herbicides are not permitted in organic production, organic growers have a need for alternative sources of nutrients and weed management practices 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. In order to obtain premium prices for certified organic crops, farmers need scientifically validated information to help develop successful organic farming systems. In addition to production information, the majority of organic farmers surveyed expressed a need for improved marketing structures to strengthen their profitability. The overall market for organically grown herbs can be characterized as diverse in product and fragmented in distribution. The demand for products derived from organic herbs is expected to continue to grow. It is the challenge of the industry to assure a consistent stream of product that will satisfy the quality standards of the processors and the end-users.

These organic herb projects were established to integrate resources from two research institutions (Iowa State University and the University of Minnesota) and a farmer group (Organic Herb Producers Cooperative) working in organic herb production, processing, quality analysis, marketing and education, to address the problems of consistent herbal quality and distribution. The long-range goal of this project is to develop systems for organic medicinal herbs as profitable alternative crops, and to improve our understanding of the beneficial effects of herbs. The objectives of each particular project, which are the first steps toward the attainment of the long-range goal, are to critically assess the effects of field management systems on the herbal quality of organic medicinal herbs. A concomitant objective is technology transfer through Field Days and grower guidebooks to increase marketability of herb crops and improve growers' profitability.

Three medicinal herbs—purple coneflower (*Echinacea purpurea*), narrow-leaved purple coneflower (*E. angustifolia*), and lemon balm (*Melissa officinalis*)—were selected for soil amendment research and two others, catnip (*Nepeta cataria*) and St. John's Wort (*Hypericum perforatum*) were selected for weed management research based on discussions with the Organic Herb Producers Cooperative of Lakeville, Minnesota, and Community Development Services of Minneapolis, Minnesota. Information on these herbs is presented 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).

Catnip (*Nepeta cataria*) is indigenous to Eurasia and now found throughout much of North America (Simon et al., 1984). A member of the mint family (Lamiaceae), catnip is sold in feline products in pet stores. Catnip is also known as an herbal medicine in the

Ozark Mountains, for treating colds, their symptoms, and other ailments like diarrhea, colic, and cancer (Simon et al., 1984). Catnip leaves can be added to foods as a seasoning or in teas as a relaxant (Domokos et al., 1994). Like other mint species, essential oils can be obtained from the plant by steam distillation of leaves, flowers, and stems (Waller and Johnson, 1984). Among volatile constituents produced are two feline attractants, 4 α , 7 α , 7 α -nepetalactone and 4 α , 7 α , 7 α -dihydronepetalactone (Waller and Johnson, 1984), and other chemicals include sterols, acids, and tannins (Simon et al., 1984). Nepetalactones can comprise 1-2 mg/g of fresh weight of the plant (Waller and Johnson, 1984), though they can be readily volatilized by physical disturbance and exposure to sunlight after the plant tissue has dried. These compounds may possess antibacterial properties (Bourrel *et al.*, 1993).

St. John's Wort (*Hypericum perforatum*) is a flowering plant of the family Hypericaceae that is indigenous to the United States. St. John's wort has a long history of medicinal use for treating ailments as wide ranging as headache, rheumatism, and skin disorders (Kreitmair, 1950). Extracts from St. John's Wort can be purchased in many health food stores and are sought by individuals worldwide suffering from mild to moderate depression (Linde et al., 1996). St. John's Wort, contains a number of biologically active constituents, including chlorogenic acid, a broad range of flavonoids, naphthodianthrones, phloroglucinols, essential oils and xanthenes. The compounds of primary interest are hypericin and hyperforin. Though it is not understood what affects the concentrations of these molecules present in St. John's Wort extracts, it is clear that there is significant variation between genotypes in its natural product content, and that environmental factors can play a major role in their expression (Buter et al., 1998). Hypericin is a polycyclic quinone that comprises the dark pigment in St. John's Wort and other *Hypericum* species. Hypericin, hyperforin, and possible synergistic effects with the aforementioned biomolecules possess important and diverse types of biological activity (Duran and Song, 1986), with potential benefits in anti-viral and anti-cancer therapy (Diwu, 1995, Anker et al., 1995).

3. Objectives

- Address the key questions of management and processing of organic medicinal herbs through research and demonstration trials on-farm and at University stations.
- Identify, through biochemical analysis, the key medicinal constituents of target herbs for the purpose of standardization as a marketing tool.
- Develop production and processing guides to promote market development of organic herbs.
- Promulgate technology transfer of organic herb production and marketing strategies through the establishment of on-farm and institutional demonstration sites, annual Field Days, and new crop training programs for extension staff, growers, and buyers.

4. Materials and Methods

Effect of Soil Amendments on Organic Medicinal Herbs

The organic herb research project was established at Iowa State University in 2000 in

consultation with Renne Soberg and the Organic Herb Producers Cooperative of Lakeville, Minnesota, Todd Thompson of Organic Alliance/Community Development Services, Minneapolis, Minnesota, and Erica Renaud, Organic Research Farm Manager, Frontier Natural Products Cooperative, Norway, Iowa.

Plots previously planted to a cover crop of sorghum-sudangrass at the Heenah Mahyah Student Farm (HMSF) at Iowa State University, Ames, Iowa, were selected for the soil amendment component of this project. Soils were sampled on 15 May 2000 and 19 May 2000. Plots were cultivated for bed preparation on 15 May 1999. *E. purpurea*, *E. angustifolia* and *M. 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).

Effect of Mulch Treatments on Organic Medicinal Herbs

An experiment was established in 2001 to investigate the use of natural mulches as a weed management strategy in 2-3 years of organic herb production. The experimental site was selected on land that was previously in an alfalfa-grass fallow area and is beginning the transition to a certified organic designation. The land is a uniformly sloped Nicollet fine sandy loam soil at the Iowa State University Horticulture Research Station, in Gilbert, Iowa (USDA hardiness zone 5a; lat. 42°3'N). Plots were arranged in a randomized complete block design, consisting of four blocks (replications), 2 medicinal herb species, catnip (*N. catari*) and St. John's Wort (*Hypericum perforatum* 'Helos'), and five weed management treatments. Treatments consist of the following: a nonwoven wool mat (sheep raised in Minnesota), a flax straw mat (FlaxTech™, Rock Lake, ND), organic oat straw (from the certified organic Iowa State University Neely-Kinyon Farm), a hand weeded (positive) control, and a weedy (negative) control. Field dimensions are 29 x 36-m. Each experimental unit consists of three rows of plants, 0.9 m apart, with two outer rows planted as buffers. There are 17 plants per row spaced 0.46 m apart. All three

mulch treatments extend 23 cm beyond either side of the rows to provide a weed management zone across the row. The oat straw was placed at a 10-cm depth in the rows.

Seeds were started in plastic trays in the Iowa State University greenhouse using a commercial organic germination mix on 10 March 2001. Four-week-old plants were transplanted into a 4 x 4-cm cell seedling tray containing commercial organic potting mix, and three weeks later into 6 x 6-cm Fertil Pots®. A total of 2,176 plants were transplanted into the Gilbert field on 13 June 2001 using a one-row mechanical transplanter adapted for herb plants. Soil samples were taken from the field on 29 May 2001.

Hand-weeding was employed in the positive control plots every 2 weeks during the growing season. Mechanical cultivation between the mulched areas of the rows (46 cm between each mulch treatment) occurred twice during the growing season. The mulches will remain in place throughout the 2-3 years of the experiment. At the beginning of the second growing season, the plants that have died will be counted and noted, and will be replaced. An additional amount of oat straw will be added when needed to maintain a 10-cm depth.

Plant, weed and mulch measurements

Scientific methods and instruments are utilized to collect data on herb and weed growth and yields. Mulch effects on the immediate environment (temperature light, moisture) and interaction with herb plants are also determined. Data are collected from the middle row of each experimental unit. Detailed measurements were collected in 2001 and will continue to be collected for two growing seasons (2001-2002) with the potential for additional measurements in 2003.

6. 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
P	424 ppm
K	619 ppm

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

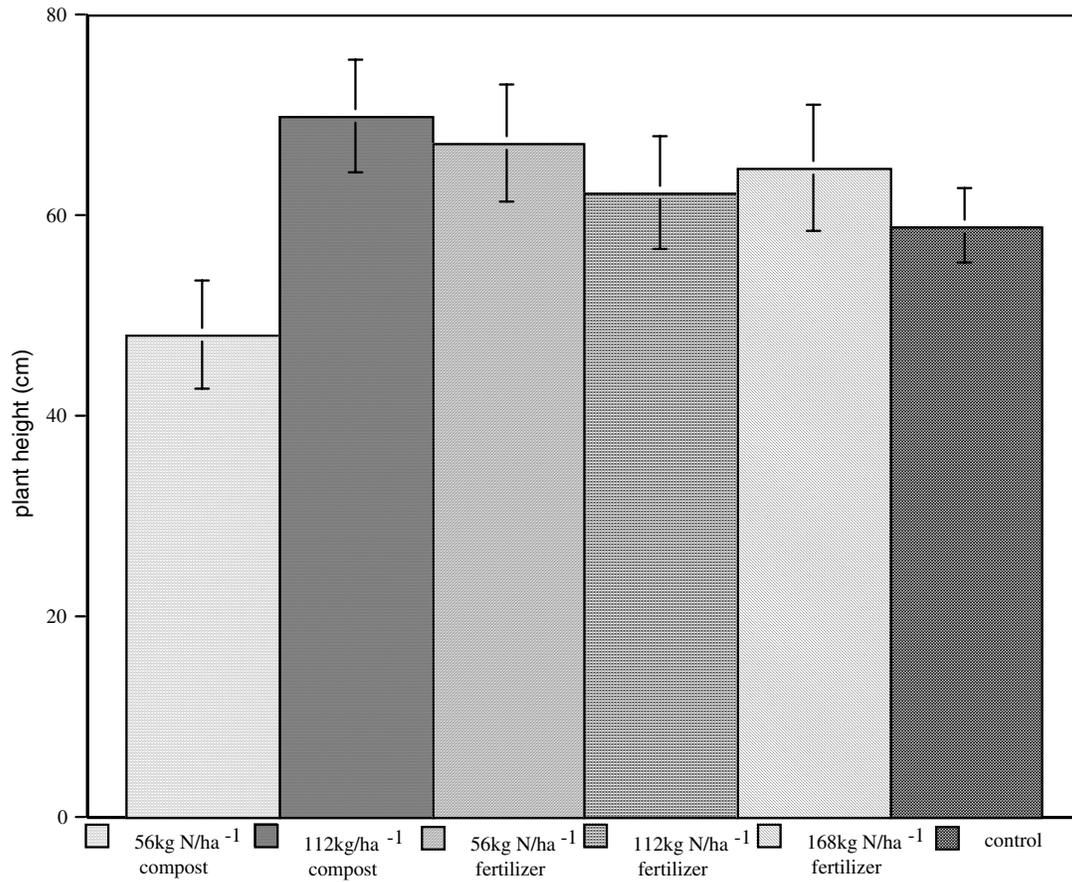


Figure: 2 *Melissa officinalis* Plant Height (cm) 1999

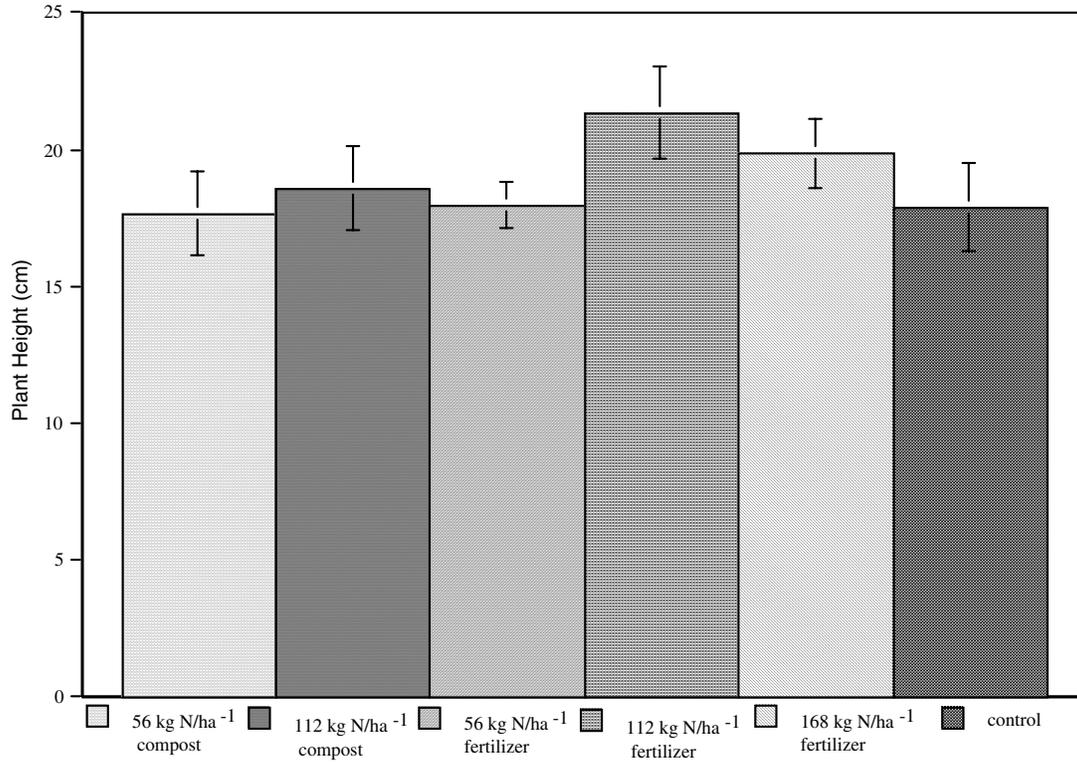
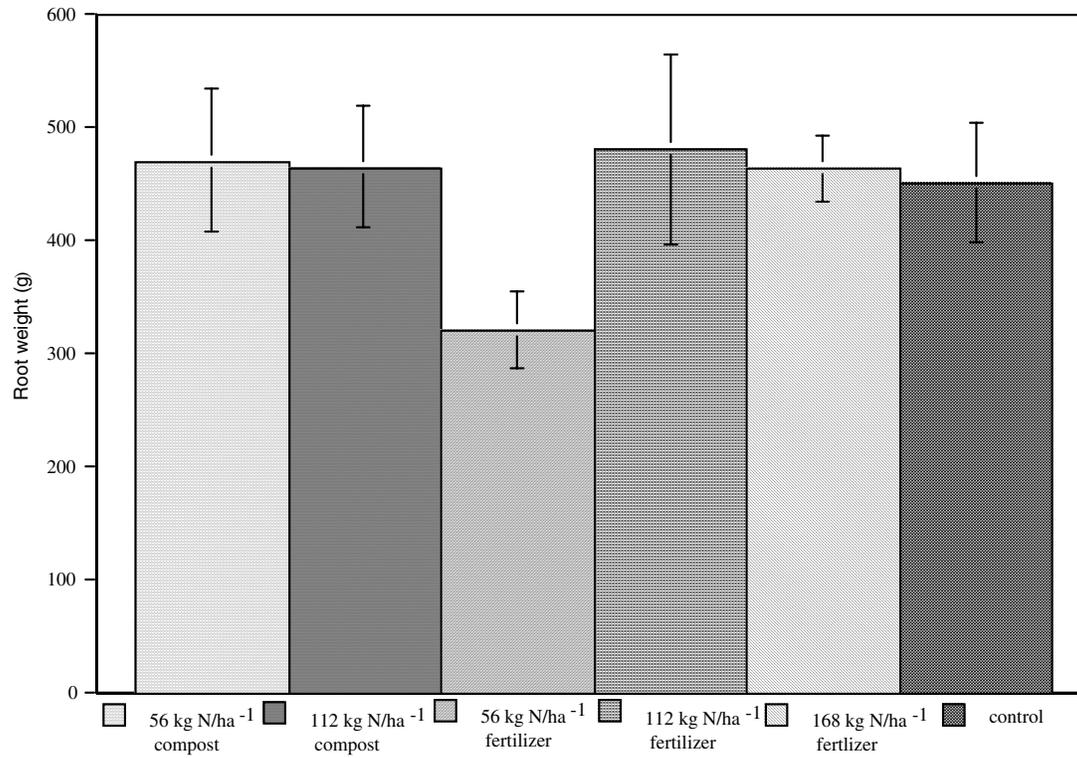


Figure: 3 *Echinacea purpurea* Root Harvest Fresh Weight 1999



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

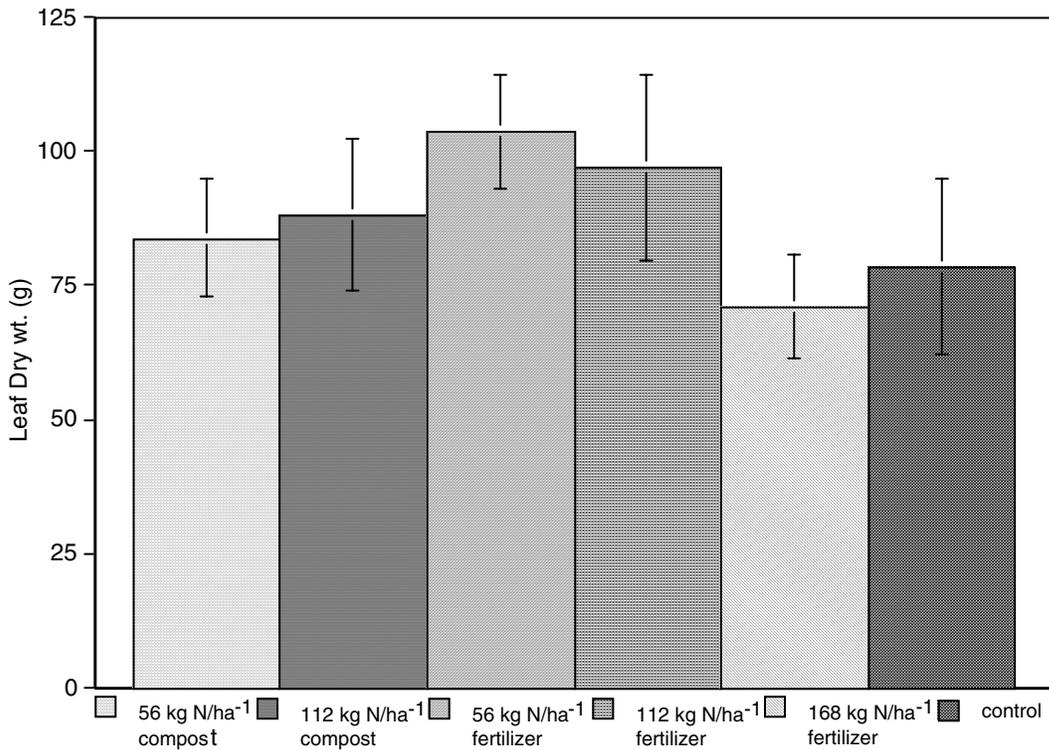
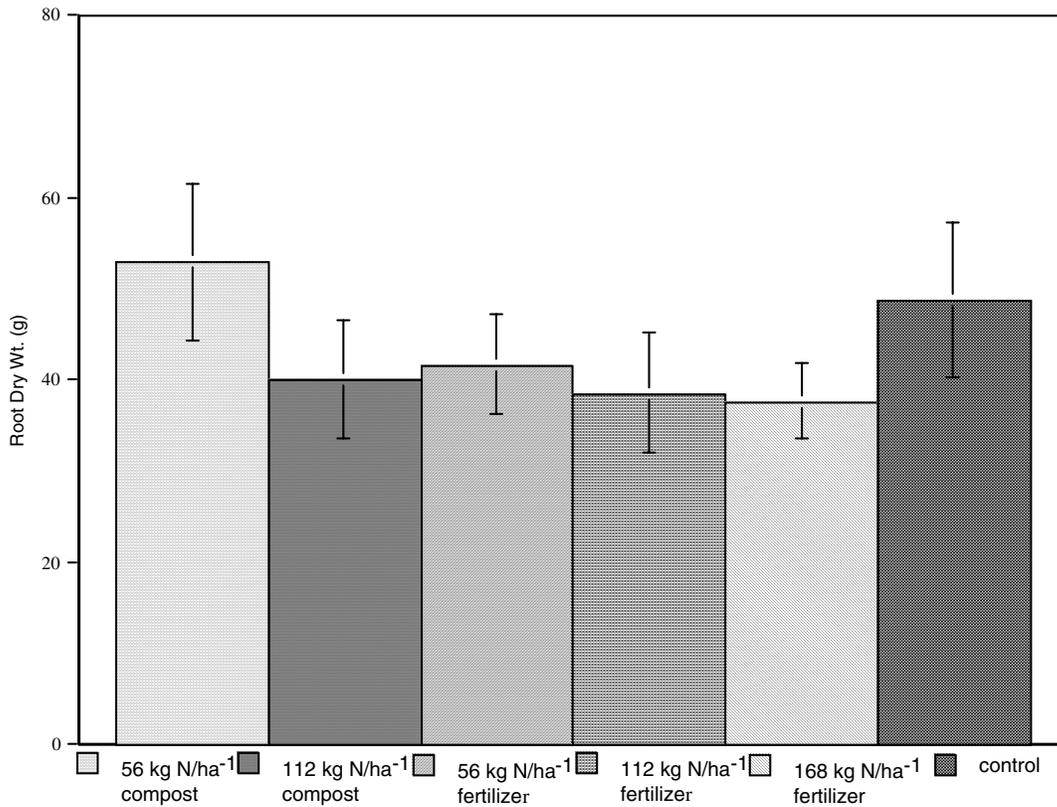


Table 2. Soil characteristics of *Echinacea purpurea* plots with organic fertilizer and compost treatments at the HMSF Organic Herb Trial, 2000.

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

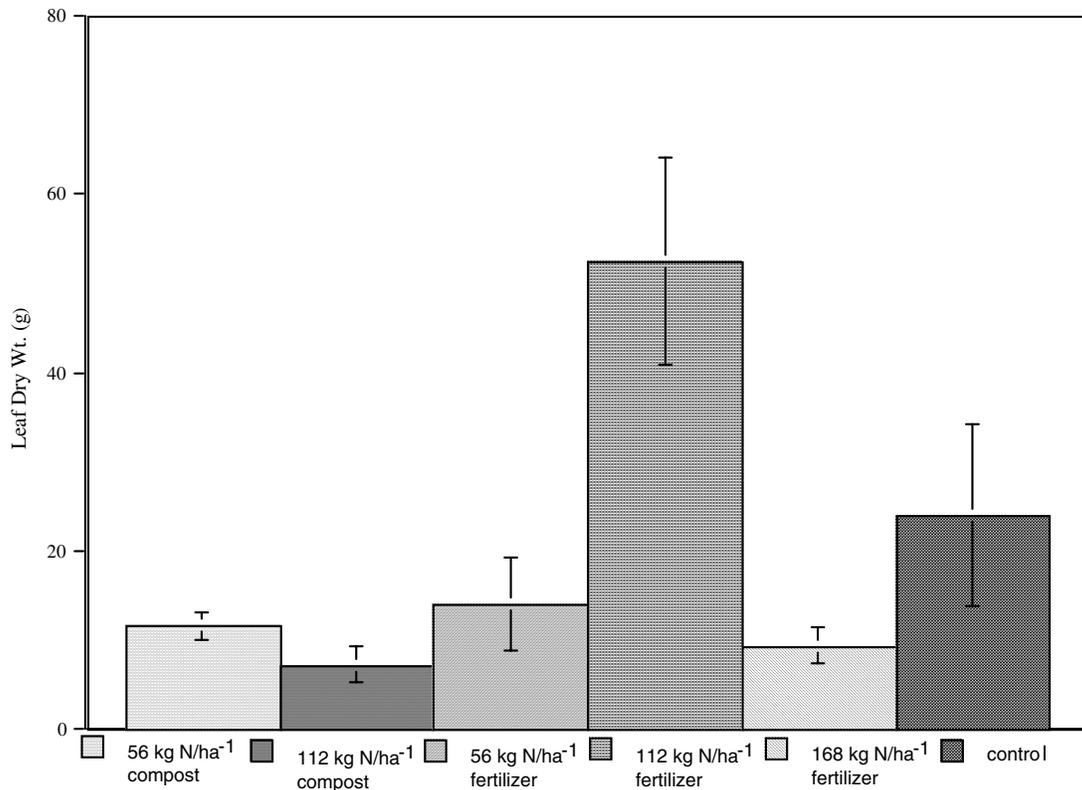


Figure: 7 *Echinacea angustifolia* Harvest Dry Root Weight 2000

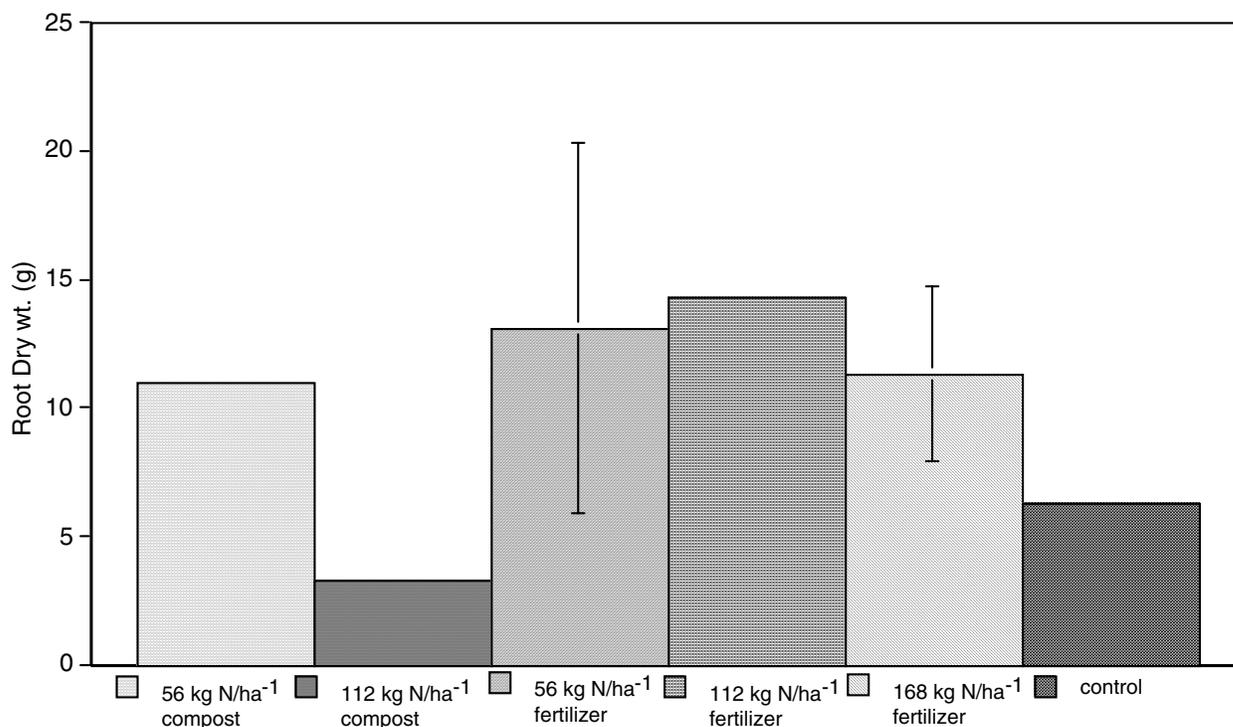


Table 3. Soil characteristics of *Echinacea angustifolia* plots with organic fertilizer and compost treatments at the HMSF Organic Herb Trial, 2000.

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 (168kg 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

Effect of Mulch Treatments on Organic Medicinal Herbs

Analysis of effects from mulching, including mulch effects on weed populations (species), soil temperature and moisture under mulches, radiation below and above mulch layer, and light transmittance through mulches are currently undergoing analysis. Analysis of weed biomass has demonstrated a positive effect from mulching (Table 5). All mulches significantly reduced weed biomass at the end of the growing season compared with the controls. Catnip yields were significantly greater in the flax mat treatment. There were no significant differences in yields between wool mat and oat straw treatments. Yields and weed populations in mulched plots equaled hand-weeded plots, demonstrating the value of mulches in reducing weed pressure and labor to maintain adequate weed control. Biochemical analysis of catnip is currently underway with Dr. Joel Coats in the Entomology Department at Iowa State University. *Echinacea* and *Hypericum* analysis will be conducted in Dr. George Kraus' lab in the Chemistry Department at Iowa State University in 2002.

Table 5. Weed biomass in mulch treatment plots, Organic Herb Trial, 2001.

Species	Treatment	Mean Dry Wt. (g) ± SE ^z
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Catnip	Oat straw	611.06 ± 135.04a
Catnip	Wool mat	255.65 ± 63.24a
Catnip	flax mat	69.48 ± 40.11a
Catnip	Control+	35.97 ± 35.97a
Catnip	Control-	1667.7 ± 259.77b
St. John's Wort	Oat straw	525.82 ± 144a
St. John's Wort	Wool mat	192.05 ± 188.07a
St. John's Wort	Flax mat	117.3 ± 74.39a
St. John's Wort	Control+ ^y	8.6 ± 3.8a
St. John's Wort	Control- ^y	1130.47 ± 154.61b

^zTreatments followed by same letter are not significantly different.

^yControl+ refers to plots hand-weeded throughout the growing season; control- refers to those not hand-weeded.

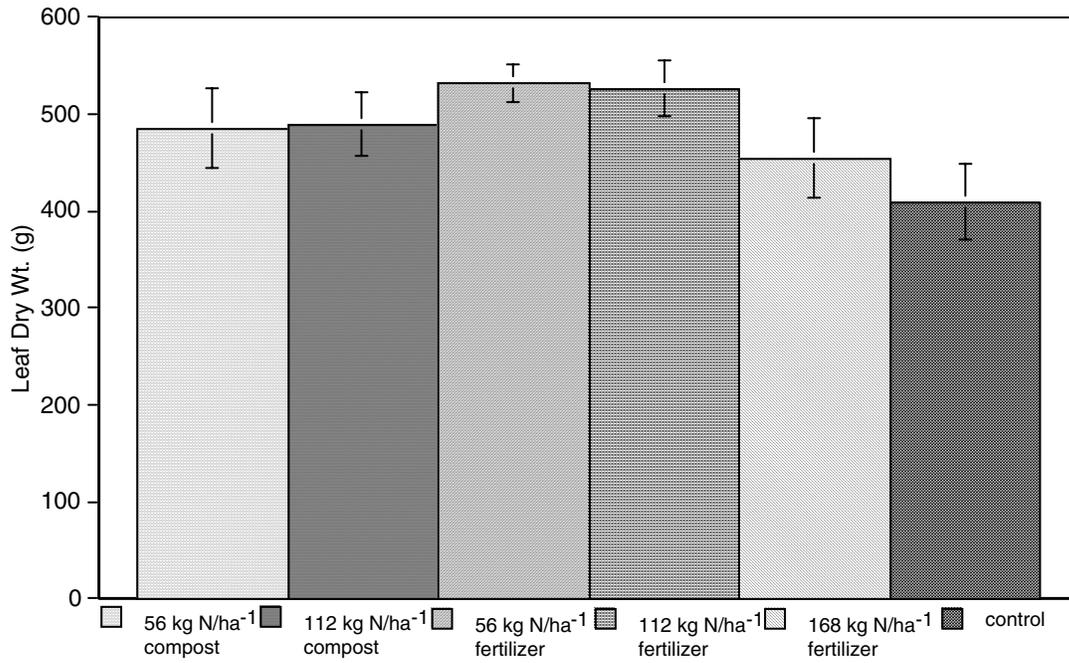
Table 6. Catnip dry weight yields, Organic Herb Trial 2001.

Treatment	Mean Dry Wt. (g) ± SE ^z
Flax mat	31.675 ± 6.19a
Oat straw	21.75 ± 3.16b
Wool mat	18.81 ± 2.28b
Control+ ^y	20.64 ± 1.77b
Control- ^y	9.57 ± 1.71c

^zTreatments followed by same letter are not significantly different.

^yControl+ refers to plots hand-weeded throughout the growing season; control- refers to those not hand-weeded.

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. We have determined that the focus of our organic herb research in 2001-2003 will be on catnip and St. John's Wort, based on market demand and the need for production research.

7. Impact of the Results–Education and Outreach:

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 in the three years of this work. 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%
5. 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)

One graduate student was partially supported by this grant in 1998-99 (Angela Biggs), and another student, Lisa Duppong (2000-2002), continues the initial herb work in her M.S. in Agronomy today. Other students were employed on this grant to support the vegetable compost studies.

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

*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.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. 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.

Delate, K. and V. Lawson. 1999. Evaluation of Organic Soil Amendments for Certified Organic Pepper Production. Horticulture Research Report, Dept. of Horticulture, ISU, Ames, IA.

Delate, K. 1997. Organic Agriculture. Integrated Crop Management Conference Proceedings, November 17, 1997, Iowa State University, Ames, IA.

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:

3. Arranging speakers (ten Iowa State University professors and eleven farmers);
4. Developing a resource manual (700 pages);
5. Arranging an all-Iowa organic meal for the final session;
6. Developing a corresponding web page where PowerPoint presentations were translated for the web;

7. Developing testing materials, student project development and grading; and
8. 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 the 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. .

Literature Cited:

- Altieri M.A., J. Trujillo, M. Astier, P Gersper, and W. Bakx. 1991. Low-input technology proves viable for limited-resources farmers in Salinas Valley. *California Agriculture* 45:20-22.
- Altieri, M. A. 1995. *Agroecology*. Westview Press, Boulder, CO.

- Astier, M. 1990. Developing low-input energy saving vegetables cropping systems for small farmers in Salinas Valley. Association of Community Based Education (ACBE), Washington D.C.
- Astier, M., P.L. Gersper, and M. Buchanan. 1994. Combining legumes and compost: A viable alternative for farmers in conversion to organic agriculture. *Compost Science and Utilization* 2:80-87.
- Bawden, R.J. 1990. Of agriculture and systems agriculture: Systems methodologies in agricultural education. In: *Systems theory applied to agriculture and the food chain*, pp. 305-323. J.G.W. Jones and P.R. Street (eds.), Elsevier Applied Science, London.
- Bertalanffy, L. 1973. *General systems theory: Foundations, Developments, Applications*. 4th edn. G. Braziller, New York.
- Bourne, J. 1999. The organic revolution. *Audubon* (March-April): 64-70.
- Bremness, L. 1994. *Herbs*. DK Publishing, New York.
- Brumfield, R.G., A. Rimal, and S. Reiners. 2000. Comparative cost analyses of conventional, integrated crop management, and organic methods. *HortTechnology* 10(4): 785-793.
- Brumfield, R.G., F.E. Adelaja, and S. Reiners. 1993. Economic analysis of three tomato systems. *Acta Hort.* 340: 255-260.
- Brusko, M. 1989. What really happens when you cut chemicals. *New Farm* (May/June): 19.
- Cambardella, C.A. 1994. Temporal dynamics of particulate organic matter N and soil nitrate N with and without an oat cover crop. *Bull. Ecol. Soc. Am.* 75:30.
- Cambardella, C.A. and E. T. Elliott. 1992. Particulate organic matter changes across a grassland cultivation sequence. *Soil Sci. Soc. Am. J.* 56:777-783.
- Cambardella, C.A. and E. T. Elliott. 1993. Carbon and nitrogen distribution in aggregates from cultivated and native grassland soils. *Soil Sci. Soc. Am. J.* 57:1071-1076.
- Chambers, R., A. Pacey, and L.A. Thrupp. 1989. *Farmer first: Farmer innovation and agricultural research*. Intermediate Technology Publications. Bootstrap Press, New York.
- Chase, C. and M. Duffy. 1991. An economic comparison of conventional and reduced-chemical farming systems in Iowa. *Amer. Jour. Alter. Agri.* 6(4): 168-173.
- Creamer, N. G. 1999. An evaluation of summer cover crops as weed suppressive mulches in vegetables. *Organic Farming Research Foundation Bulletin* 6: 14-16. OFRF, Santa Cruz, CA.
- Delate, K.M. 1999. Evaluation of organic soil amendments for certified organic pepper production. *Annual Fruit and Vegetable Progress Report, 1998*. Iowa State University, Ames, IA.
- Delate, K.M. and C. Cambardella. 1999. Comparison of organic and conventional rotations at the Neely-Kinyon Long-Term Agroecological Research (LTAR) site-First year results. *Iowa State University Armstrong Research and Demonstration Farm Progress Report, College of Agriculture, Iowa State University, Ames, IA.*
- Delate, K.M. and C. Cambardella. 2000. Comparison of organic and conventional rotations at the Neely-Kinyon Long-Term Agroecological Research (LTAR) site-Second year results. *Iowa State University Armstrong Research and Demonstration Farm Progress Report, College of Agriculture, Iowa State University, Ames, IA.*

- Delate, K.M. and J. DeWitt. 1999. Organic focus groups in Iowa. Leopold Center for Sustainable Agriculture Annual Report, LCSA, Iowa State University, Ames, IA.
- Delate, K.M. and V. Lawson. 2000. Evaluation of organic soil amendments and cover crops for certified organic pepper production. Annual Fruit and Vegetable Progress Report, 1999. Coop. Ext. Serv., Iowa State Univ., Ames, IA.
- Delate, K.M. and V. Lawson. 2001. Evaluation of organic soil amendments and cover crops for certified organic pepper production. Annual Fruit and Vegetable Progress Report, 2000. Coop. Ext. Serv., Iowa State Univ., Ames, IA.
- Delate, K.M., and C. Cambardella. 2001. Comparison of organic and conventional rotations at the Neely-Kinyon Long-Term Agroecological Research (LTAR) site-Third year results. Iowa State University Armstrong Research and Demonstration Farm Progress Report, College of Agriculture, Iowa State University, Ames, IA.
- Dent, J.B. 1993. Potential for systems simulation in farming systems research. In: System Approaches for Agricultural Development, pp. 325-339. F.W.T. Penning de Vries, P. Teng and K. Metselar (eds.). Kluwer Academic Publishers, Germany.
- Dyck, E., M. Liebman, and M.S. Erich. 1995. Crop-weed interference as influenced by a leguminous or synthetic fertilizer nitrogen source: I. Doublecropping experiments with crimson clover, sweet corn, and lambsquarters. *Agric., Ecosys. and Environ.* 56 (1995): 93-108.
- Elton, C.S. 1946. Competition and the structure of ecological communities. *Journal of Animal Ecology* 15:54-68.
- Greene, C. 2000. Organic agriculture gaining ground. *Agricultural Outlook* (April): 9-14. USDA-ERS, Washington, D.C.
- Hartman Group. 2001. Natural Sensibility, Typification of the New Wellness Consumer. Vol. 3(2). Hartman Group, Bellevue, WA.
- Hasey, J.K., R.S. Johnson, R.D. Meyer, and K. Klonsky. 1997. An organic versus a conventional farming system in kiwifruit. *Acta Hort.* 1:223-228.
- Heartland Organic Marketing Cooperative. 2001. Organic grain prices. Stuart, IA.
- Hildebrand, P.E. 1990. Farming systems research--extension. In: *Systems Theory Applied to Agriculture and the Food Chain*, pp. 131-143. J.G.W. Jones and P.R. Sprent (eds.) Elsevier Applied Science, London.
- Hobbs, C. 1995. *Echinacea: the immune herb!* Botanica Press, Santa Cruz, CA.
- Høgh-Jensen, H. 1998. Systems theory as a scientific approach towards organic farming. *Biological Agriculture and Horticulture* 16:37-52.
- IDALS (Iowa Dept. of Agriculture and Land Stewardship). 2000. Annual survey on organic production. Des Moines, IA.
- Kelly, W.C. 1990. Minimal use of synthetic fertilizers in vegetable production. *HortScience* 25: 168-169.
- Lampkin, N.H. and S. Padel. 1994. Organic farming and agricultural policy in Western Europe: An overview. In: *The economics of organic farming: An international perspective*, pp. 437-454. P. Midmore and N.H. Lampkin (eds.), CAB International, Wallingford, UK.
- Laszlo, E. 1983. *Systems Science and World Order*. Pergamon Press, New York.
- Lichtenberg, E., J.C. Hanson, A.M. Decker, and A.J. Clark. 1994. Profitability of legume cover crops in the mid-Atlantic region. *J. Soil Water Cons.* 49: 582-585.

- Liebhardt, W.C., R.W. Andrews, M.N. Culik, R.R. Harwood, R.R. Janke, J.K. Radke, and S.L. Rieger-Schwartz. 1989. Crop production during conversion from conventional to low-input methods. *Agron. J.* 81:150-159.
- Liebman, M. and E. Dyck. 1993. Crop rotation and intercropping as strategies for weed management. *Ecol. Appl.* 3:92-122.
- Lockeretz, W., G. Shearer, and D.H. Kohl. 1981. Organic farming in the corn belt. *Science* 211:540-547.
- MacRae, R.J., S.B. Hill, G.R. Mehuys, and J. Henning. 1993. Farm-scale agronomic and economic conversion from conventional to sustainable agriculture. *Advances in Agron.* 43: 155-198.
- Maynard, A.A. 1994. Sustained vegetable production for three years using composted animal manures. *Compost Science and Utilization* 2:88-96
- Miller, P.R., W.L. Graves, W.A. Williams, and B.A. Madson. 1989. Covercrops for California agriculture. University of California, Division of Agriculture and Natural Resources, UC-Davis, CA.
- National Organic Standards Board (NOSB). 1995. NOSB Annual Meeting, April 1995. United States Dept. of Agriculture, Washington, D.C.
- Niggli, U. and W. Lockeretz. 1996. Development of research in organic farming, pp. 9-23. In: *Fundamentals of organic agriculture*. Inter.Fed. Org. Ag. Move. (IFOAM) (eds.). IFOAM, Switzerland.
- Norgaard, R.B and T.O. Sikor. 1995. The methodology and practice of agroecology. In: *Agroecology*, pp. 21-40. M. Altieri (ed.). Westview Press, Boulder, CO.
- Organic Farming Research Foundation. Santa Cruz, CA.
- Organic Trade Association (OTA). 2001. OTA Newsletter. OTA, Greenfield, MA.
- Powell, E. 1995. *From seed to bloom: how to grow over 500 annuals, perennials & herbs*. Garden Way Publishing Book, Pownal, VT.
- Reganold, J.P., J.D. Glover, P.K. Andrews, and H.R. Hinman. 2001. Sustainability of three apple production systems. *Nature* 410: 926-929.
- Reiners, S. 1993. Nutritional quality of organically grown vegetables. *HortTechnology* 3 (3): 363.
- SAS Institute. 1988. *SAS procedures guide*. SAS Institute, Inc., Cary, N.C.
- Simon, J.E. 1993. New crop introduction: exploration, research and commercialization of aromatic plants in the new world. *Acta Horticulturae*. 331: 209-221.
- Spedding, C.R. 1979. *An introduction to agricultural systems*. Elsevier Applied Science Publishers, New York.
- Stanhill, G. 1990. The comparative productivity of organic agriculture. *Agric. Ecosys. Environ.* 30: 1-26.
- Stuart, M. Ed. 1979. *The encyclopedia of herbs and herbalism*. Orbis Publishing, London.
- Stute, J.K., and J.L. Posner. 1995. Legume cover crops as a nitrogen source for corn in an oat-corn rotation. *J. Prod. Agri.* 8: 385-390.
- Teasdale, J.R. 1993. Interaction of light, soil moisture and temperature with weed suppression by hairy vetch residue. *Weed Sci.* 41: 46-51.
- Temple, S. R. O. A. Somasco, M. Kirk and D. Friedman. 1994. *CA Ag.* 48: 14-19.
- USDA-NOP. 2000. National Organic Program final rule. *Federal Register*, December 21, 2000.

- van der Werf, E., J. Kariuki, and D.D. Onduru. 1997. Methodological issues in comparative agro-economic on-farm research assessments of organic versus conventional farming techniques. *Biological Agriculture and Horticulture* 14:53-69.
- Vogtmann, H. 1990. Research structure in biological farming: general view, justification, development. In: *Biological farming in Europe*. REUR Technical Series, 12. Proceedings of the Expert Consultation. FAO; Bern, Switzerland, pp. 41-47.
- Walz, E. 1999. Final results of the 3rd biennial national organic farming survey. National
- Wander, M.M., S.J. Traina, B.R. Stineer, and S.E. Peters. 1994. Organic and conventional management effects on biologically active soil organic matter pools. *Soil Sci. Soc. Am. J.* 58: 1130-1139.
- Wang, S.H.L., V.I. Lohr, and D.L. Coffey. 1984. Spent mushroom compost as a soil amendment for vegetables. *J. Amer. Soc. Hort. Sci.* 109:698-702.
- Zerger, U. and H. Bossel. 1994. Comparative analysis of future development paths for agricultural production systems in Germany. In: *The economics of organic farming: An international perspective*, pp. 317-327, P. Midmore and N.H. Lampkin (eds.), CAB International, Wallingford, UK.

**Budget Report for "Organic Amendments" segment
LCSA project 99-50**

Year	Budgeted	Spent	Major Category of Spending
1998	\$12,500	12,500	Salaries for Graduate Student, and Hourly Student Employees
1999	\$12,500	12,500	Salaries
2000	\$12,500	12,500	Salaries
TOTAL DIRECT COSTS	\$37,500	37,500	Salaries
Other Funders	Organic Farming Research Foundation (\$5,000 in 2001)	USDA-IFAFS (\$50,000 in 2001)	