Evaluation of Medicinal Herb Species for Kansas

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Abstract

Before embarking on a new crop such as medicinal herb production, growers want to know what to expect in terms of plant survival, yield of tops and roots, and whether any significant insect pests or diseases are present. These screening trials have been conducted over three years on between 2 and 4 sites ranging from eastern to western Kansas to address these questions. Of the 5 annuals and 27 perennials screened so far, 18 were rated as "good" potential based on survival, vigor ratings and yield. Another 10 were rated as "medium," and had some limitations which might be overcome through improved cultural methods or varieties. Four species were rated as "poor" due lack of survival, severe insect or disease pest problems, winter survival, and/or lack of vigor under transplanted conditions. One of these, *Echinacea angustifolia*, might be improved through direct seeding, but other problems such as weed control are encountered in a direct seeding system.

INTRODUCTION

Medicinal herbs have been used to promote health for centuries, and have increased in popularity and sales in the last 10-20 years. Growth accelerated between 1994 and 1998, going from $1.6 billion in sales in the U.S. to nearly $4 billion (Brevoort 1998). Though prices for many herbs leveled off after 1999, and even has declined over the past 2-3 years, there is continued interest among established farmers, part-time farmers, and new farmers in growing medicinal herbs as part of their overall farm enterprise mix. Though some production information is available (see Kehler 1999, for example), little is published that can be applied to Kansas conditions, especially yield data.

These experiments began in the summer of 2000, with the overall goal to screen medicinal herbs as possible crops for Kansas, and Great Plains Region farmers in the U.S. The list of hundreds of possible herbs was narrowed down using the following criteria: 1) those that are likely to grow under our climatic conditions, 2) are currently popular in the mass market, OR 3) recommended by local herbalists.

MATERIALS AND METHODS

Two sites (Olathe and Wichita) were used for the screening trials in 2000, a third site (Hays) was added in 2001; and a fourth site (Colby) was added in 2002. The Horticultural Research Farm at Olathe is situated on silt loam soils, high in organic matter, with annual rainfall of 889 mm per year in Northeast KS. The J.C. Pear Horticultural Center in Wichita, located in South-central KS, is on a sandier soil with less average rainfall. In Hays, located in West-Central KS, has an annual rainfall of only about 635 mm. Colby is located in the Northwestern part of the state, also with annual rainfall of about 600 mm. Both Hays and Colby also have more evaporative demand, and potentially more wind. Drip irrigation is used at Colby and overhead irrigation is used at Wichita. The other sites receive hand watering at the time of transplanting.

Fifteen herb species and/or biotypes were screened in 2000, and an additional 15 were added in 2001, and a second year of data collected on the first set of plots. Another 5 species were added in 2002. A total of 38 accessions, including 36 species, and two sets of variety/biotype comparisons have been made at one or more sites over the 3 year period. Data collected includes % survival, biomass in the fall (tops and roots), plant

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vigor rating (1-5), insect pressure rating (1-5), and disease rating (1-5). The percent dry weight at the time of harvest, and growth stage (vegetative, flowering, seed) is also recorded. With few exceptions, all plots are replicated 4 times, and either 5 or 10 plants per plot were transplanted from greenhouse grown seedlings. Planting density changes from site to site, depending on site conditions and whether irrigation is available, and ranges from a spacing of 30 to 60 cm between plants. An attempt was made to achieve a plant spacing that would not limit yield.

Seeds were planted in commercial seedling starting mix in the greenhouse, and cold-wet stratified if the literature and/or past experience indicated that this treatment would enhance germination. Seedlings were raised in 3" pots in pro-mix, using only fish emulsion as the fertility source. The source of seeds was generally one of two or three reputable dealers of herb and/or native plant seeds. Plants were transplanted into the field in late May or early June each season, and fall evaluations and biomass harvest was obtained in late August through mid-September.

Fertility was supplemented at 3 of the 4 sites with compost added at the time of planting, and/or side-dressed after planting. Weed control was achieved through mechanical means; hay and fabric mulch, and hand weeding. Because many prospective herb growers are organic farmers, and the future trends predict more demand for organic production, all plots have been managed using practices that could be certified as organic by a commercial grower, though no attempt has been made to certify the research fields.

RESULTS AND DISCUSSION

General results expected were that plants native to Kansas and the Great Plains would be potentially viable crops for medicinal herb producers. Initial interest among Kansas growers was in Echinacea production, as its use and harvest as a commercial crop can be dated back to at least 1894 (Bartholomew 1998). Some research has been done on this crop previously, looking at germination requirements and raised bed production in Kansas (Smith-Jochum and Albrecht 1988), and studies from throughout the US have been summarized by Li (1998). Quite a lot is known about the distribution and historic use of native Echinacea species in the Great Plains (Kindscher 1989). However, detailed yield data is still lacking for this herb, as well as for the dozens of other herb/crops that could be grown in the Great Plains. In addition, economic analyses are lacking, with the exception of occasional studies such as Falk et al. (1999). More data are needed on survival, yield, and also potential price for herbs as crops, before they will be adopted by farmers as viable crops.

Other plants that are native to the Great Plains in our trials included yarrow (*Achillea millefolium*), Butterfly Milkweed (*Asclepias tuberosa*), and Joe Pye Weed (*Eupatorium purpureum*). Several introduced, but naturalized species were also expected to do well. Interestingly, these expectations were not always supported by the data. The species screened at each of the four sites are summarized in Table 1. The percent survival, vigor rating, and overall evaluation of each species is presented in Table 2.

Survival

Of the 32 species compared in the first two years of this trial, 4 had less than 50 % survival of transplants at the end of the first growing season, and were borage, *Echinacea angustifolia*, dandelion, and red clover. Previous experience with these crops indicates that better success may have been obtained by direct seeding some of these, rather than using transplants. Some perennials, including white sage, feverfew, mullein and evening primrose, seemed to winter-kill at all three sites. Since primrose is a biennial, and the marketed portion is usually the seed, this presents a problem for this crop. For crops like white sage, feverfew and mullein, first year plants could be harvested, and the crop treated like an annual. Another group of perennials had acceptable stands in year 1, but fell below the 50 % survival point during year 2, which would limit yield. These were butterfly milkweed, Chinese milkvetch, *Monarda didyma* 'Panorama Red Shades," and *Echinacea angustifolia*. With the exception of the *Monarda*, these are often higher value

in the market, and might still be worth a growers' time to establish and harvest, though as multi-year crops, continued stand lost would be a problem.

Vigor Ratings

Vigor ratings were scored in both the spring and the fall, and indicate how "adapted" a particular plant was to it's site and climate. Of the 34 accessions, only 2 rated below a 2.5 on a 5 point (5=high) scale in the fall ratings averaged across sites, and 10 rated below 2.5 in the spring (3 of those had winter-killed, data not shown). Thus, most of the plants chosen for this trial were at least somewhat adapted to Kansas growing conditions. Ironically, the *Echinacea angustifolia* was the species that had the lowest average vigor rating in both year 1 and 2 of this trial, and it is native to this area of the Great Plains.

Insect and Disease Damage Ratings

Ratings were scored in the fall, and 11 accessions scored 2.0 or higher, indicating significant damage and/or feeding by insects on a 1-5 scale (with 5 being the most damage, data not shown). Disease ratings also showed 11 accessions with a 2.0 or higher. Of these, 8 were affected by Aster Yellows, a common disease in the floriculture industry. The 3 *Echinacea* species were most affected, with the % infection rate as measured by plants with visual symptoms at the end of the second year at one of the sites as 25 % for *E. angustifolia*, 26 % for *E. pallida*, and 99 % for *E. purpurea*. Interestingly, the infection rate for the *E. purpurea* was also high in the first year, and yet the plants were still alive in year 2, so mortality from the disease wasn't as high as expected.

Yield or Biomass

Shoots and roots were collected in the fall of each year, washed, weighed fresh, and then sub-samples were weighed fresh and dry to obtain % dry weight. Of the 34 accessions screened so far, 16 are marketed as root crops, 19 the tops (stems and leaves) are marketed, and in 4 only the floral portion is used. Data are presented for the tops (Table 3) and roots (Table 4) of the appropriate species, and floral plants have been left out of the data set for now. Floral medicinal plants are also probably not feasible in Kansas, especially for a mass market, due to the high cost of labor for harvesting.

Data are presented as grams per plant. This can be converted to per acre yield with the following assumptions; average density of 5 ft^2 per plant, or 8712 plants per acre (3528 plants/ha). For herbs, yield goals might be in the range of 500, 1000, or 2000 lb/acre (560, 1120, 2240 kg/ha), which translates to 26, 52, and 104 g/plant. This rule of thumb allows one to assess if this is a low, medium, or high yielding herb. If a potential grower also knows the current going price in the marketplace, they can use these yield figures to estimate gross profit, and then deduct anticipated growing costs, to come up with a reasonable budget with which to plan.

CONCLUSIONS

Potential herb growers need data on which to base their decisions such as potential yield, cost of production, and potential price. These screening trials are intended to generate data that will help growers know which herbs are adapted to their region of Kansas, know which species might be susceptible to insects or diseases, and provide realistic yield figures with which to develop budgets. In some cases, specific varieties or bio-types of herbs are compared. Future work needs to continue to compare available varieties of adapted herbs, harvest established herbs over several years, and continue to screen new herbs that have promise as crops for this region. Larger field-scale trials with direct seeding and mechanized harvest would be beneficial collaborations for the future with farmer-growers.

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Tables

Table 1. Herbs in the KSU Trials-Locations Tested.

		Location			
Species	**Common Name**	**Olathe**	**Wichita**	**Hays**	**Colby**
Achillea millefolium	Yarrow	X	X		X
Althea officinalis	Marshmallow	X	X	X	X
Articum lappa	Burdock	X	X	X	X
Asclepias tuberosa	Butterfly Milkweed	X	X		X
Astragalus membranaceus	Chinese Milkvetch	X	X	X	X
Borago officinalis	Borage	X	X		X
Calendula officinalis	Calendula	X	X	X	X
Echinacea angustifolia	Narrow leaf coneflower	X	X	X	X
Echinacea pallida	Pale purple coneflower	X	X		X
Echinacea purpurea	Purple coneflower	X	X	X	X
Eupatorium perfoliatum	Boneset	X	X	X	
Eupatorium pupureum	Joe Pye Weed	X	X		X
Glycyrrhiza glabra	Licorice (European)	X	X	X	X
Glycyrrhiza uralensis	Chinese Licorice	X	X		
Hypericum perforatum	St. John's Wort	X	X		X
Lespedeza capitata	Round head lespedeza	X	X		
Matricaria recutita	German Chamomile	X	X	X	X
Monarda didyma	"Panorama Red Shades" bergamot	X			
Monarda fitulosa	Wild bergamot	X	X		X
Oenothera biennis	Evening Primrose	X	X	X	
Origanum vulgare	Oregano	X			
Rumex acetosa	Sorrell	X	X	X	X
Salvia apiana	White Sage	X	X		X
Scutellaria lateriflora	Skullcap	X		X	X
Silybum marianum	Milk Thistle	X	X	X	X
Stevia rebaudiane	Stevia		X	X	
Tanacetum parthenium	Feverfew	X	X	X	X
Taraxacum officinale	Dandelion	X	X	X	X
Trifolium pratense	Red Clover	X	X	X	X
Urtica dioica	Nettles	X	X	X	X
Valeriana officinalis	Valerian	X	X	X	X
Verbascum thapsis	Mullein	X	X	X	X
Verbena hastata	Blue Vervain	X	X		

Table 2. Percent Survival (until the end of the first growing season for the annuals), vigor ratings, and preliminary evaluation of suitability for Kansas growing conditions.

		Preliminary Evaluation					
		Survival (%)		Vigor Rating		Rating	Limitation
Species	**Common Name**	**Yr 1**	**Yr 2**	**Yr 1**	**Yr 2**		
Annuals							
Borago officinalis	Borage	50	-	3.7	-	M	harvest?
Calendula officinalis	Calendula	83	-	3.7	-	M	harvest?
Matricaria recutita	German Chamomile	72	-	3.2	-	M	harvest?
Silybum marianum	Milk Thistle	63	-	3.2	-	M	direct seed?
Stevia rebaudiane	Stevia	95	-	4.2	-	G	
Perennials							
Achillea millefolium	Yarrow 'Proa'	78	nd	4.5	nd	G	
Althea officinalis	Marshmallow	94	nd	4.5	nd	G	
Articum lappa	Burdock	55	nd	4.2	nd	M	survival
Asclepias tuberosa	Butterfly Milkweed	72	49	3.1	3.0	M	
Astragalus membranaceus	Chinese Milkvetch	54	41	3.1	4.1	M	survival
Echinacea angustifolia	Narrow leaf coneflower	49	24	1.8	1.7	P	survival, low vigor
Echinacea pallida	Pale purple coneflower	89	56	2.8	3.3	M	
Echinacea purpurea	Purple coneflower	87	48	3.1	2.7	M	aster yellows
Eupatorium perfoliatum	Boneset	88	78	3.5	4.8	G	
Eupatorium pupureum	Joe Pye Weed	88	75	4.0	5.0	G	
Glycyrrhiza glabra	Licorice	89	89	3.5	3.6	G	invasive?
Glycyrrhiza uralensis	Chinese Licorice	73	69	3.3	4.0	G	invasive?
Hypericum perforatum	St. John's Wort	75	73	3.1	4.5	G	
Lespedeza captiata	Round head lespedeza	73	72	3.5	4.5	G	
Monarda didyma	"Panorama Red Shades" bergamot	53	13	2.5	1.3	P	survival
Monarda fitulosa	Wild bergamot	77	67	3.7	4.2	G	
Oenothera biennis	Evening Primrose	75	0	4.2	nd	P	survival
Origanum vulgare	Oregano	100	nd	4.1	nd	G	
Rumex acetosa	Sorrell	94	nd	3.4	ne	G	invasive?
Salvia apiana	White Sage	98	0	4.4	nd	G	treat as an annual
Tanacetum parthenium	Feverfew	90	9	3.5	2.9	G	treat as an annual
Taraxacum officinale	Dandelion	48	nd	3.4	nd	G	
Trifolium pratense	Red Clover	48	nd	3.5	nd	M	direct seed
Urtica dioica	Nettles	63	nd	3.4	nd	G	
Valeriana officinalis	Valerian	72	nd	2.8	nd	P	disease in 2nd year
Verbascum thapsis	Mullein	70	9	3.9	nd	G	treat as an annual
Verbena hastata	Blue Vervain	92	nd	4.6	nd	G	

nd=data not available, will be harvested in year 2.
G=good, M=medium, P=poor.

Table 3. Average Dry Weight (across sites) of Plant Tops Harvested in the Fall (g/plant).

Species	**Common Name**	**Year 1**	**Year 2**
Achillea millefolium	Yarrow 'Proa'	99	nd
Althea officinalis	Marshmallow	146	nd
Articum lappa	Burdock	34	nd
Borago officinalis	Borage	69	-
Echinacea purpurea	Purple coneflower	20	88
Eupatorium perfoliatum	Boneset	15	311
Eupatorium pupureum	Joe Pye Weed	51	347
Lespedeza captiata	Round head lespedeza	6	61
Monarda didyma	"Panorama Red Shades"	2	3
Monarda fitulosa	Wild bergamot	25	56
Origanum vulgare	Oregano	48	nd
Rumex acetosa	Sorrell	9	nd
Salvia apiana	White Sage	64	-
Stevia rebaudiane	Stevia	52	-
Tanacetum parthenium	Feverfew	23	43
Taraxacum officinale	Dandelion	5	nd
Urtica dioica	Nettles	45	nd
Verbascum thapsis	Mullein	83	-
Verbena hastata	Blue Vervain	81	nd

Table 4. Average Dry Weight (across sites) of Plant Roots Harvested in the Fall (g/plant).

Species	**Common Name**	**Year 1**	**Year 2**
Althea officinalis	Marshmallow	86	nd
Articum lappa	Burdock	27	nd
Asclepias tuberosa	Butterfly Milkweed (Reg)	2	39
Asclepias tuberosa	Butterfly Milkweed (Clay)	2	46
Astragalus membranaceus	Chinese Milkvetch	1	25
Echinacea angustifolia	Narrow leaf coneflower	1	9
Echinacea pallida	Pale purple coneflower	5	35
Echinacea purpurea	Purple coneflower	4	26
Eupatorium perfoliatum	Boneset	14	231
Eupatorium pupureum	Joe Pye Weed	10	253
Glycyrrhiza glabra	Licorice	5	53
Glycyrrhiza uralensis	Chinese Licorice	5	52
Oenothera biennis	Evening Primrose	12	-
Taraxacum officinale	Dandelion	19	nd
Urtica dioica	Nettles	16	nd
Valeriana officinalis	Valerian (standard)	12	-