Agronomic Research On Commercially Important Herbs

Jazeem Wahab and Greg Larson
Canada-Saskatchewan Irrigation Diversification Centre,
Outlook Saskatchewan

Introduction

Natural products are becoming increasingly popular as food flavouring and cosmetic and as health supplements in Europe and North America. Presently, the herb and spice industry is expanding very rapidly in Canada, and Saskatchewan is one of the provinces in the forefront. To address the needs of this developing industry, the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) has expanded the herb research and development program with the objective of developing cost effective and labour saving production practices for commercial scale production of important herbs. This project is being conducted with financial support from the Canada-Saskatchewan Agri-Food Innovation Fund and with market directions from the Saskatchewan Herb and Spice Association.

The main goals of the CSIDC's herb research and development program include (i) evaluating the adaptability of promising herbs to Saskatchewan growing conditions, (ii) developing labour saving management practices for mechanized commercial production, (iii) comparing the effects dryland and irrigated production on yield and quality, and (iv) identifying appropriate production and harvest methods to increase yield and improve quality. The herb species included in the agronomic studies include *Echinacea angustifolia*, feverfew, German chamomile, milk thistle, stinging nettle, and St John's wort. Many other aromatic, culinary, and medicinal herbs are also being evaluated in observational plots. Preliminary results from the various studies on *Echinacea angustifolia* conducted at the CSIDC are summarized in this paper.

Materials and Methods

Field trials are being conducted to develop suitable agronomic practices for both direct seeded and transplanted *Echinacea angustifolia* for dryland and irrigated production. Field plots were established during the 1997 and 1998 growing season. The direct seeded tests were established with a 'Fabro' plot seeder using stratified seed (seeds mixed with moist sand and stored in a refrigerator for four weeks prior to seeding). Transplanting was done using a Water-wheel Planter. A plant spacing of 60 cm (between-row) and 30 cm (within-row) was utilized for all tests except for the plant density studies with the transplanted crop. For the plant population studies, plant populations were adjusted by varying the within-row spacing while maintaining the between-row spacing constant at 60 cm.

The 1999 growing season received 280 mm of rain compared to the 60-year average of 237 mm from April through September. For the irrigation trials, only 75 mm of supplemental irrigation was applied to maintain the soil moisture status at approximately 50% Field Capacity.

The harvested roots were dried in a forced-air drier at 35 to 40°C prior to yield estimation.

***Direct Seeding Studies**:*

Seeding rate and row spacing effects of on yield and quality under dryland and irrigated production: The treatments included five seeding rates (60, 90, 120, 150, 180 seeds/m^2) and two row spacings (41, 61 cm). The trial was established in 1997. The field plots were laid out as 3 x 2 factorial in a RCBD with four replications. Separate tests were established for dryland and irrigated production.

Fertilizer response study under irrigation: The treatments included two nitrogen rates (50, 100 kg N/ha), two nitrogen application times (spring only, spring and fall: ½ & ½), and two phosphorus rates (50, 100 kg P_2O_5/ha). The trial was established in 1997. The field plots were laid out as a 2 x 2 x 2 factorial in a RCBD with four replications. A seeding rate 120 seeds/m^2 and a row spacing 61 cm was utilized to establish the crop.

***Transplanting Studies**:*

Interactive effects of nitrogen, phosphorus and harvest age on root yield: Two nitrogen rates (50, 100 kg N/ha), two nitrogen application times (spring, Spring and fall: ½ & ½), and two phosphorus rates (50, 100 kg P_2O_5/ha) were evaluated. Trials were established in 1997 and 1998. Field plots were laid out as a 2 x 2 x 2 factorial in a RCBD plus a no fertilizer check with four replications. Yield responses were studied for a one and two year crops.

Spacing and fertilizer effects on root yield for dryland and irrigated production: Two within-row plant spacings (15, 30 cm); three nitrogen levels (0, 75, 150 kg N/ha), two phosphorus levels(0, 60 kg P_2O_5/ha) were evaluated under irrigation and dryland. The trial was established in 1997. Field plots were laid out as 2 x 3 x 2 factorial in a RCBD with four replications for the different water treatments.

Results and Discussion

Direct Seeded Echinacea angustifolia

Inherent seed dormancy and the requirement of light for germination renders *Echinacea* a difficult crop for direct seeding. Consequently, *Echinacea* is generally produced using transplants. Raising *Echinacea* from transplants requires high capital and labour inputs. These studies examined the feasibility of direct seeding *Echinacea angustifolia* with the objective of reducing transplanting costs.

When direct seeded, the plant stand ranged between 9.4% to 14% of the original seeding rates in the different tests.

The overall yields under dryland was higher compared to irrigation (Table 1). This is likely due to the better soil conditions where the dryland plot were located and minimal moisture stress experienced during the 1999 growing season. Under dryland, the lowest seeding rate of 60 seeds/m^2 produced the lowest dry root yield (876 kg/ha) and increasing seeding rate produced higher root yields (Table 1). The highest yield (2089 kg/ha) was recorded for the 180 seeds/m^2 seeding rate. In the irrigation test, seeding rate had no effect on dry root yield and ranged from 1013 kg/ha for 90 seeds/m^2 to 1263 kg/ha for 180 seeds/m^2. Row spacing (41, 61 cm) had no effect on dry root under both dryland and irrigated

production (Table 1).

Table 1. Seeding rate and row spacing effects on plant stand and dry root yield for direct seeded *Echinacea angustifolia* grown under dryland and irrigation: two-year crop.

Seeding rate (seeds/m^2)	Dry root yield (kg/ha)	
	Dryland	Irrigation
60	876	1147
90	1090	1013
120	1448	1459
150	1352	1103
180	2089	1263
Row Spacing (cm)		
41	1272	1218
61	1457	1177
ANOVA		
Source		
Seeding rate (R)	**(580)	ns
Row spacing (S)	ns	ns
S x R	ns	ns
C.V. (%)	41.3	29.1

** and ns indicate significance at P<0.01 level of probability and not significant respectively.
Value within parenthesis is LSD estimates at 5.0% significance

.

Application of 50 kg N/ha produced 1137 kg/ha of dry root (Table 2). Adding 100 kg/ha nitrogen produced 17% higher root yield than 50 kg N/ha . Applying nitrogen once only in the spring or as two equal split applications in the spring and fall had no effect on root yield. Applying 100 kg P_2O_5/ha produced 1473 kg/ha dry root that was 48% higher than 50 kg P_2O_5/ha of applied phosphorus.

Transplanted Echinacea angustifolia

Harvesting *Echinacea angustifolia* during the third year produced on average 49% higher dry root yield than harvesting the crop in the second year (Table 3). Nitrogen rate, method of nitrogen application, or phosphorus rates did not affect dry root yield during the two harvest stages.

The overall dry root yield under dryland production was 1992 kg/ha compared to 1886 kg/ha for irrigated production (Table 4). Wider 60 x 30 cm plant spacing, i.e. 55,500 plants/ha, produced 1196 kg/ha of dry root under dryland and 1320 kg/ha under irrigation. Doubling the plant population by reducing the within-row spacing to 15 cm produced 133% higher yield under dryland and 86% higher yield under irrigation. Application of fertilizer nitrogen or phosphorus had no effect on root yields both under dryland and irrigated production conditions.

Table 2. Nitrogen and phosphorus effects on dry root yield of direct-seeded *Echinacea angustifolia* harvested three year after seeding: two-year crop.

Treatment		Dry root yield (kg/ha)
Nitrogen rate	50 kg N/ha	1137
	100 kg N/ha	1331
Nitrogen time of application	Spring	1228
	Spring & fall	1239
Phosphorus rate	50 kg P_2O_5/ha	995
	100 kg P_2O_5/ha	1473
ANOVA		
Source		
Nitrogen rate (N)		*(230)
Nitrogen Applic. (A)		ns
Phosphorus rate (P)		***(230)
N x A		ns
N x P		ns
A x P		ns
N x A x P		ns
C.V. (%)		23.9

***, *, and ns indicate significance at P<0.001, 0.05 levels of probability and not significant respectively.
Values within parentheses are LSD estimates at 5.0% significance.

Table 3. Nitrogen and phosphorus effects on dry root yield of transplanted *Echinacea angustifolia* harvested at two and three years after planting

Treatment		Dry root yield (kg/ha)	
		Year-2	Year-3
Nitrogen rate	50 kg N/ha	723	1111
	100 kg N/ha	725	1031
Nitrogen time of application	Spring	659	1135
	Spring & fall	789	1007
Phosphorus rate			
	50 kg P_2O_5/ha	693	1148
	100 kg P_2O_5/ha	755	993
No fertilizer check		831	1280
ANOVA			
Source			
Nitrogen rate (N)		ns	ns
Nitrogen Application (A)		ns	ns
Phosphorus rate (P)		ns	ns
N x A		ns	ns
N x P		ns	ns
A x P		ns	ns
N x A x P		ns	ns

C.V. (%)	42.4	42.0

ns indicate non-significant treatment effects.

Table 4. Plant spacing, nitrogen and phosphorus effects on dry root yield for transplanted *Echinacea angustifolia* grown under dryland and irrigation.

Treatment		Dry root yield (kg/ha)	
		Dryland	Irrigation
Spacing	15 cm	2787	2451
	30 cm	1196	1320
Nitrogen	0 kg N/ha	2136	1822
	75 kg N/ha	1997	1946
	150 kg N/ha	1842	1889
Phosphorus	0 kg P_2O_5/ha	2020	1906
	60 kg P_2O_5/ha	1964	1865
ANOVA			
Source			
Spacing (S)		***(331)	***(309)
Nitrogen (N)		ns	ns
Phosphorus (P)		ns	ns
S x N		ns	ns
S x P		ns	ns
N x P		ns	ns
S x N x P		ns	ns
C.V. (%)		28.2	27.8

*** and ns indicate significance at P<0.001 level of probability and not significant respectively. Values within parentheses are LSD estimates at 5.0% significance.

Summary

It was shown that *Echinacea angustifolia* can be established through both direct-seeding and transplanting. While direct-seeding, the seeding rate should be adjusted to compensate for the low germination and stand establishment. Favourable rainfall conditions during the 1999 growing season resulted in comparable yields between dryland and irrigation. The dry root yield in the test plots were quite variable and the coefficients of variation for individual tests were also high. This is likely due to variable root growth characteristic of individual plants.

Harvesting Echinacea angustifolia during the third year produced on the average double the yield than harvesting in the second year. The dry root yield during third year ranged between 1500 to 2000 kg/ha for the direct-seeded crop and between 1200 to 2800 for the transplanted crop. Higher yields were obtained at the higher plant density of 111,000 plants/ha, i.e. 60 x 15 cm spacing compared to a plant population of 55,500/ha (i.e. 60 x 30 cm spacing).

Application of nitrogen and phosphorus for the direct seeded crop increased yields but had no effect for the transplanted crop.