Sainfoin Forage and Seed Production Trials: 1991-1993[1]

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Introduction

Sainfoin (*Onobrychis viciifolia*) is a forage legume that was introduced into the US in 1786, but was only occasionally cultivated until the 1960's, when improved varieties allowed wider cultivation in adapted areas, primarily Montana and parts of western Canada. However, sainfoin has some properties that may make it better suited to certain situations than other common forage legumes such as alfalfa (*Medicago sativa*), clovers (*Trifolium* sp.), and birdsfoot trefoil (*Lotus corniculatis*). Sainfoin seems to be well-adapted to dry and calcareous soils, is winterhardy, maintains forage quality even after anthesis, and is resistant to the alfalfa weevil. Its main advantage over alfalfa is the fact that it is a non-bloating forage for livestock in both hay and fresh (grazed) forms. It produces a large amount of biomass in the spring before anthesis (or first cutting if produced for hay). However, sainfoin is susceptible to root and crown disease, does not grow well in acid, saline, or wet soils, tends to have low stand persistence over time, and regrows slowly after cutting. Thus, it competes best with other forage legumes such as alfalfa in regions where multiple cuts are not the norm.

Irrigated alfalfa yields very well in a pure stand in southern Oregon, and it seemed unlikely that sainfoin would be the preferred choice in this situation. However, it was desirable to learn whether sainfoin would grow well in this semi-arid region, as it may be useful in dryland mixes with forage grasses to take advantage of its non-bloating and drought-tolerant features. In addition, we also wanted to learn whether sainfoin seed production was a viable production option in this region.

The objective of this study was to measure forage and seed yield production of several sainfoin varieties under southern Oregon growing conditions.

1991 Study

Materials and Methods

The sainfoin cultivars used in this study were Eski (released by Montana St. Univ. Experiment Station in 1964), Melrose (licensed in Canada in 1969), Remont (released by Montana St. Univ. Experiment Station in 1971), and Renumex (released by New Mexico St. Univ. Experiment Station in 1977).

The 1991 study measured forage production only. The four sainfoin cultivars and two alfalfa varieties (Vernal and WL320, planted as a comparison to sainfoin) were planted in a split-plot design with four replications. An irrigation variable (irrigated or not) was the main plot, and cultivars were the subplots. Border areas and part-circle irrigation sprinklers were used to allow separation of irrigation treatments. Individual treatment plots were 5 ft by 24 ft in size, and the area cut for yield data was 3 ft by 20 ft.

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[1] Use of product common or brand names is for the convenience of the reader only and does not imply endorsement or registration of the products by the author or Oregon State University, nor criticism of other products not named.

All plots were planted by hand using a single row Planet Jr. type drill on April 18, 1991. The two alfalfa varieties were well-emerged by April 26, and all four sainfoin cultivars were well-emerged by April 29. Irrigation and rainfall amounts for the 1991 growing season are shown in Table 1.

Results & Discussion

Because 1991 was the seedling year, only one harvest for yield was made, on July 19. Yield results are shown in Table 2. To compare maturities of the cultivars, an estimate of flowering was made on July 18, just prior to the first harvest (Table 2).

Irrigation clearly enhanced the yield of all sainfoin and alfalfa cultivars, but it also accelerated the maturity of the sainfoin cultivars. As expected, Eski was the latest maturing cultivar. Renumex has both Eski and Remont in its parentage, but its flowering response and yield most closely resembled that of Remont.

1992 Study

Materials and Methods

The 1991 study was repeated in 1992, except that in 1992 the differential irrigation treatments were not applied, and thus any yield differences between irrigation treatments could be due to residual effects of the previous year's irrigation effects, but not due to any differences in 1992 irrigation. Rainfall and irrigation amounts for 1992 are shown in Table 3. Because the crop was well-established in 1992, plots were harvested for yield on three dates, May 1, June 24, and August 12, using the same equipment and procedures as in 1991 (Table 4).

In addition to the study planted in 1991, another study area was planted April 3, 1992. This area included the same four sainfoin cultivars as the 1991 planting, also arranged in a split plot design with four replications (but using a different randomization layout). Alfalfa treatments were not planted in 1992. It was laid out to allow two irrigation treatments as the main plots, and the four sainfoin cultivars as the subplots. However, in 1992, the entire area received the same irrigation as the 1991 study area, with no differential irrigation treatments (Table 3). The 1992 planting was not harvested to measure forage or seed yield in 1992, but was cut in mid-summer for bulk harvest.

Results & Discussion

Forage yield results for the three 1992 harvest dates, taken from the 1991 planting area, are shown in Table 4. To see if any residual effects of the 1991 irrigation treatments remained, the results were analyzed as a split plot design as they had been in 1991, even though the same amount of irrigation was applied to all plots in 1992.

For the first harvest, it was interesting to see that the sainfoin yield was greater for the plots that had not been irrigated in 1991, but the reverse was true for alfalfa. In subsequent harvests, the "irrigated" treatments had a greater yield in 1992 for both sainfoin and alfalfa. Even though the first harvest makes up a large portion of the annual yield, especially for sainfoin, the pattern for the annual total was similar to that of the second and third cuttings, with the "irrigated" treatments yielding more than the "non-irrigated" treatments due to the larger advantage in those plots in the latter two cutting dates. Reasons for the yield advantage in the "non-irrigated" treatment for the first cutting of sainfoin cannot be definitively explained. It may be that in 1991 the non-irrigated sainfoin plants established a deeper and larger root system which allowed them to take better advantage of water and nutrients in the fall of 1991 and spring of 1992 (note the dry weather in spring of 1992, Table 3), after which the ready availability of irrigation water eliminated this advantage, but no clear answer is possible given the data.

1993 Study

Materials and Methods

In 1993, both the 1991 and 1992 plantings received uniform irrigation applications (Table 5). Forage was harvested for yield determination on April 29 in the 1991-planted trial only. The 1992 planting was not cut for hay, but was allowed to grow until seed harvest later in the summer. To harvest seed, both trial areas were swathed using a tractor side-mounted sickle bar mower on August 9. Seed from individual plots was combined on August 25 using a Hege 125C plot combine. The seed was fairly clean, but some additional cleaning was done on a desktop sized Clipper cleaner before yield calculations were made.

Results & Discussion

To verify that there were no lingering effects from the 1991 differential irrigation treatments, the forage yield data from the April 29 was subjected to the split plot design analysis of variance. The irrigation treatment effect was not close to being statistically significant, and so all subsequent analysis was done using a randomized complete block design with eight replications, ignoring the existence of the original irrigation treatment.

In the 1991 planting area, the yields of the two alfalfa varieties were significantly greater than the four sainfoin cultivars (Table 6). In fact, the yield advantage for alfalfa was much greater in 1993 than it had been in 1992. This suggests that reported observations about sainfoin's limited stand persistence may have begun occurring by the third year in this experiment.

In terms of sainfoin seed production, it is interesting that the seed yield for all four cultivars was greater in the 1991 planting than in the 1992 planting, even though the 1991 planting had been cut for hay on April 29 and had to regrow from its base before producing flowers and seed structures. The data does not show precisely why this occurred, but it could be a function of more branching on the regrowth after the hay harvest, or perhaps older sainfoin plants just tend to produce more branches and flowering stalks than the younger plants.

When comparing cultivar differences, the sainfoin seed yields followed similar patterns for the two planting dates, with one exception. Renumex produced the least seed of all four sainfoin cultivars in both trials. Eski produced more seed than Renumex, and Melrose in turn produced more than Eski (not all differences were statistically significant). Remont did not follow the same pattern both years, producing the greatest seed yield in the 1991-planted trial, but the second lowest seed yield in the 1992-planted trial. Dependable seed production has sometimes been a problem in traditional sainfoin growing areas, and these yields compare favorably with reported seed yields. It may be that SW Oregon may be a better place to produce sainfoin seed even if the forage yields do not compete well with alfalfa in this region.

1994 Study

Materials and Methods

In 1994 the two trials were managed to further examine the effect of early season forage harvest on subsequent seed harvest. Originally, both trials had been laid out in a split plot design with and irrigation variable as the main plot treatment. However, differential irrigation was applied to the 1991 planting only in 1991, and irrigation in the 1992 planting had always been uniform (no irrigation variable applied). Thus, in 1994 the existing randomization was used to test the effect of early season forage harvest on later seed yield by taking an early season forage harvest on May 24 in the plots previously designated as the “non-irrigated” treatment, while not taking any forage harvest in the previously designated “irrigated” plots. Thus the trials both had a split plot design, with spring forage harvest (or not) being the main plot, and cultivars the sub plot, (as before). The May 24 forage harvest was done with a tractor-mounted sickle bar mower, and individual plot yields were not determined. For seed harvest, all plots in both experiments were swathed on August 11, and seed was combined on August 22 using the Hege 125C combine as in 1993 and cleaned as before. Seed was not collected from the alfalfa plots.

Irrigation was managed uniformly for both trial areas. Precipitation and irrigation amounts for 1994 are shown in Table 7.

Results & Discussion

Seed yields in 1994 overall were quite a bit less than they had been in 1993 (Table 8). This may have been due to the hotter, drier weather experienced in 1994, such that irrigation could not supply the evapotranspiration need of the crop (compare Tables 5 & 7). The stand age and lack of persistence may have also been a factor, as growth and flowering did not seem to be as vigorous or dense in 1994 as they had been previously.

In 1994, the seed yield exhibited different patterns for the 1991 planting compared to the 1992 planting. For the 1991 planting, the cultivars that were not cut in the spring tended to have a greater yield than where the cultivars had been cut in the spring (Table 8). Conversely, for the 1992 planting the cultivars that were cut in the spring tended to have greater yields than the same cultivars that were not cut. The cultivar “Remont” was the exception to this pattern for both planting dates. However, in all cases, the differences (between cut in spring or not cut) were not statistically significant, despite the consistent pattern.

In 1993, we had observed that the 1991 planting (cut in spring) tended to have a greater yield than the 1992 planting (not cut in spring), although the experiment was not designed in way that could statistically compare these two situations. In 1994, the exact opposite situation occurred, such that the seed yield was greater for the 1992 planting where it had not been cut in the spring compared to the 1991 planting that was cut in the spring. Again, the possible interactions between stand age and spring cutting effect could not be sorted out by this experiment. Therefore, a recommendation regarding the benefit or detriment of taking a spring forage harvest in areas of a planned seed harvest cannot be made based on these data.

Overall Conclusions and Recommendations

The drought-tolerant and non-bloating aspects of sainfoin may make it a good forage choice for some dryland grazing situations. Forage yields in SW Oregon were slightly less than alfalfa the first year, and for the first cutting the second year, but in later cuttings and in subsequent years the forage yield for sainfoin decreased dramatically compared to alfalfa. These trials confirmed sainfoin's reputation to produce good yields for the first cutting each year, but also confirmed its tendency to persist poorly after the first couple growing seasons.

However, SW Oregon may be a good area to produce sainfoin seed. The Rogue Valley is well-adapted for many types of seed crops, and its isolation from production areas of many crops often simplifies production methods such as need for isolation. Also, local growers currently have the equipment and expertise to produce such crops. The effect of taking a first cutting for hay on subsequent seed yield was inconclusive. Both benefit and detriment to seed yield were observed for this practice for different stand ages and harvest years. If sainfoin seed production is pursued commercially, further testing should be done to better understand the effect of spring forage harvest on later seed yield.

Table 1. Irrigation and rainfall amounts for the sainfoin trial, 1991. Southern Oregon Research and Extension Center, Medford, OR.*

		Irrigated Treatment Areas	
Time Period	Rainfall (inch)	Total Applied (inch)	[Irrigation Events]
April 1 – April 18 (pre-planting)	2.14	0	[0]
April 19 – May 31	2.18	1.8	[1]
June 1 – July 19 (1st Harvest)	1.84	2	[1]
July 19 – Sept 30 (end of season)	0.25	11.4	[3]
Seasonal Total	6.41	15.2	[5]

*Non- irrigated treatments areas received no irrigation, only natural rainfall.

Table 2. Forage yield on July 19 and percentage of plants in bloom on July 18, 1991 for four sainfoin and two alfalfa cultivars grown with or without irrigation. Southern Oregon Research and Extension Center, Medford, OR.

	Oven-Dry Yield (lb/acre)		Percent in Bloom on July 18	
Cultivar	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated
Eski	1004	633	4.2	1
Melrose	1140	855	15	7
Remont	1119	815	47.5	23.8
Renumex	1106	756	45	16.2
Vernal	1345	900	1.5	1.5
WL320	1692	958	3.5	3.5
	Analysis of Variance: $LSD_{0.05}$ Calculation			
Between Irrigation Treatments =	172		2.1	
Between Cultivars =	144		5.6	

Table 3. Irrigation and rainfall amounts for the sainfoin forage trials, 1992. Southern Oregon Research and Extension Center, Medford, OR.

		Irrigated Treatment Areas	
Time Period	Rainfall (inch)	Total Applied (inch)	[Irrigation Events]
April 1 – May 1 (1st Harvest)	0.9	0.8	[1]
May 2 – June 24 (2nd Harvest)	1.69	4	[2]
June 25 – Aug. 12 (3rd Harvest)	1.84	4	[1]
Aug. 13 – Sept 30 (end of season)	2.04	6.8	[2]
Seasonal Total	4.77	15.6	[6]

Table 4. Forage yield of four sainfoin and two alfalfa cultivars on four harvest dates in 1992. Southern Oregon Research and Extension Center, Medford, OR.*

	Oven-Dry Yield (lb/acre)							
	1st Harvest (May 1)		2nd Harvest (June 24)		3rd Harvest (August 12)		Annual Total	
Cultivar	Irrigated	“Non-Irrigated”	Irrigated	“Non-Irrigated”	Irrigated	“Non-Irrigated”	Irrigated	“Non-Irrigated”
Eski	3441	4076	1563	1123	1738	1179	6742	6377
Melrose	3619	4355	1950	1384	2505	1541	8074	7280
Remont	3859	4087	1657	1255	2308	1862	7825	7204
Renumex	4096	4213	1698	1509	2195	1804	7989	7525
Vernal	4134	3218	2174	1972	3616	2309	9924	7500
WL320	4102	3344	2829	2108	4245	3737	11,176	9188
	Analysis of Variance: $LSD_{0.05}$ Calculation							
Between Irrigation Treatments =	213		196		317		695	
Between Cultivars =	358		294		440		838	

*All plots received the same irrigation in 1992. The “Non-Irrigated” treatment refers to the previous year’s management.

Table 5. Irrigation and rainfall amounts for the sainfoin trials in 1993. Southern Oregon Research and Extension Center, Medford, OR.

Time Period	Rainfall (inch)	Irrigated Treatment Areas Total Applied (inch)	[Irrigation Events]
April 1 – April 29 (Forage Harvest)	3.12	0	[0]
April 30 – June 30	7.09	3.2	[1]
July 1 – Aug. 9 (Seed Harvest)	0.42	4.4	[1]
Aug. 10 – Sept 30 (end of season)	1.26	4.4	[1]
Seasonal Total	11.89	12.0	[3]

Table 6. Forage yield for the 1991 planting and both seed and forage yields for the 1992 plantings, collected in 1993. Southern Oregon Research and Extension Center, Medford, OR.

Cultivar	Oven Dry Forage Yield (lb/acre) Harvested April 29 1991 Planting	Seed Yield (lb/acre) Harvested August 9 1991 Planting	1992 Planting
Eski	1793	303	231
Melrose	2054	350	332
Remont	1824	425	223
Renumex	2101	248	155
Vernal	3386	---	---
WL320	3791	---	---
$LSD_{0.05}$	367	106	63

Table 7. Irrigation and rainfall amounts for the sainfoin trials in 1994. Southern Oregon Research and Extension Center, Medford, OR.

Time Period	Rainfall (inch)	Total Applied (inch)	[Irrigation Events]
April 1 – April 30	2.14	0	[0]
May 1 – May 24 (Forage Harvest)	2.18	1.8	[1]
May 25 – June 30	1.84	2	[1]
July 1 – Aug. 11 (Seed Harvest)	0.25	11.4	[3]
Aug. 12 - Sept. 30 (End of Season)			
Seasonal Total	6.41	15.2	[5]

Table 8. Seed yield collected in 1994 for the 1991 and 1992 plantings, after being cut for forage in the spring or not. Southern Oregon Research and Extension Center, Medford, OR.[a]

	Seed Yield (lb/acre)			
	1991 Planting		1992 Planting	
Cultivar	Spring Cut	Not Cut	Spring Cut	Not Cut
Eski	20	39	40	38
Melrose	77	93	111	80
Remont	18	16	42	55
Renumex	28	34	83	65
$LSD_{0.05}$ between cutting treatments =[b]	25		37	
$LSD_{0.05}$ between cultivars =[b]	28		46	

[a] Plots receiving the spring cut treatment were cut on May 24. All plots were swathed for seed harvest on August 11.

[b] No treatments were close to being statistically significant at P= 0.05; LSD values given for comparison of relative differences only.