EFFECTS OF PLANTING DATE, FLAX VARIETY, AND CHEMICAL WEED MANAGEMENT TREATMENTS ON FLAX BIOMASS AND SEED YIELD

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Introduction

Flax (*Linum usitatissimum*) has been grown for seed in Oregon since approximately 1849. During the following decades, it was widely used as a first crop on newly cultivated land, but by 1939 production had become more limited (Hill, 1939). However, leading up to and throughout World War II, there was significant production of fiber flax in Oregon. Decreased fiber prices, combined with the labor-intensive process of harvesting fiber flax, led to the decline of Oregon fiber flax production during the 1950s. The last flax processing plant closed in the 1960s. Some limited production of flax grown for seed continues today.

Western Oregon cropping systems are dominated by grass grown for seed and small grains. Efforts to diversify with alternative broadleaf crops are ongoing. There has been renewed interest on the part of private industry in producing flax for both seed and fiber. One of the challenges with producing flax is re-evaluating best management agronomic practices for improved flax varieties. Weed management and other unknown factors (planting date, soil fertility management, harvest methods, etc.) are often cited as concerns by growers. Trials were conducted to assess weed control options in flax under western Oregon production conditions in response to this renewal of interest in flax grown for fiber and a continued modest interest in flax seed production.

Materials and Methods

Eight trials were conducted at the Oregon State University Hyslop Research Farm to assess crop safety and weed control efficacy of herbicides labeled for use in flax or herbicides we believed to have potential for use in flax. The experimental design of all studies was a randomized complete block with four replications. Two flax varieties were used in these studies. The variety 'Agatha' was bred for suitability as a fiber crop, and 'Linore' is a standard variety grown for seed in the Pacific Northwest. 'Agatha' and 'Linore' were planted in the fall and spring of the 2012 growing season and again in the fall and spring of the 2013 growing season. The 2012 trials were planted with a Nordsten seed drill, and the 2013 trials were planted with a flax planter that scatters seed in a row approximately 4 inches wide. All herbicide treatments were applied with a bicycle-wheeled sprayer calibrated to deliver 20 gpa. In the fall-planted trials, trifluralin was applied before planting. In 2012, trifluralin was incorporated by the planting equipment and hand raking. In 2013, it was incorporated by the planting equipment alone. Weed control efficacy and flax injury were evaluated visually. Flax biomass data was obtained by harvesting and drying 10.8 square feet of above-ground biomass. Flax seed was direct combined with a small plot combine. Data were analyzed using ANOVA and means separated by LSD.

Results

Fall planting of both varieties resulted in greater biomass and seed yield than did spring planting, indicating that flax is ideally suited to the wet, relatively warm winters of western Oregon (Tables 1–8). Both varieties responded similarly to herbicide treatments, regardless of planting date (Tables 1–8). Post-emergent applications of bromoxynil-MCPA delayed flax flowering and maturity by approximately one week (data not shown). None of the herbicides tested caused lasting significant flax injury except fluroxypyr-bromoxynil, which is labeled for use in small grains to control volunteer flax up to 4 inches tall (application rate of 0.48 lb ai/acre). Fluroxypyr-bromoxynil applied to less dense stands of volunteer flax at this higher rate and with a more appropriate timing (newly emerged volunteer flax) likely would provide good to excellent control of volunteer flax in grass and small grain crops. Trifluralin applications also caused injury to flax (reduced emergence), but this injury was no longer visible by flax harvest and resulted in only modest decreases in flax biomass and seed yield.

The presence of weeds in several of the studies allowed us to rate weed control efficacy of the herbicide treatments on various important weed species. For example, mesotrione applied post-emergent in 2012 controlled 93% of volunteer meadowfoam (Table 1). In spring-planted flax, pyrasulfotole-bromoxynil controlled 85 to 90% of sharp-point fluvellin in 2012 (Tables 3 and 4). Post-emergent applications of mesotrione controlled sharp-point fluevellin 60 to 74% in both years (Tables 3, 4, and 8). S-metolachlor applied pre-emergent one day following flax planting in 2012 controlled 100% of annual bluegrass and lady's mantle,

93 to 98% of ivy-leaved speedwell, and 85 to 87% of lesser seeded bittercress (Tables 5 and 6). In the same study, trifluralin applied pre-emergent controlled 93 to 95% of annual bluegrass, while post-emergent-applied mesotrione controlled 89 to 90% of lesser seeded bittercress (Tables 5 and 6).

This agronomic and weed management information should be evaluated by growers and industry to determine whether flax production has a role to play in crop diversification strategies in western Oregon. For a list of herbicide products currently labeled for use in flax production, refer to the flax chapter in the *Pacific Northwest Weed Management Handbook*, which is updated annually. Further studies are needed, including those designed to "rediscover" agronomic requirements for improved varieties of flax. Among these would be more refined studies on determination of optimum flax planting dates and seeding rates as well as those designed to determine optimum flax fertility requirements.

References

Hill, D.D. 1939. *Seed-Flax Production in Oregon*. Oregon Agricultural Experiment Station Circular 133.

Table 1. Weed control, crop injury, dry biomass, and seed yield of 'Agatha' flax planted November 2, 2011.[1]

			Meadowfoam	Flax		
			5/25/2012	5/25/2012	7/27/2012	8/23/2012
	Rate	Date applied	Control	Injury	Dry biomass	Seed yield
	(lb ai/a)		(%)		(lb/a)	(bu/a)
Check	—	—	0 c	0 d	6,806 a	17.6 b
Trifluralin[2]	0.75	11/2/11	30 bc	0 d	7,358 a	21.2 ab
s-metolachlor	1.43	11/2/11	20 bc	9 bc	7,021 a	19.5 ab
Pendimethalin	1.42	11/2/11	45 abc	0 d	8,370 a	23.0 a
Mesotrione	0.094	11/2/11	50 abc	0 d	8,155 a	20.2 ab
Mesotrione	0.094	4/24/12	93 a	9 bc	6,377 a	19.2 ab
Fluroxypyr-bromoxynil	0.32	4/24/12	70 ab	75 a	3,127 b	7.0 c
Bromoxynil-MCPA	0.35	4/24/12	65 ab	13 b	6,500 a	18.4 b
Clopyralid	0.25	4/24/12	0 c	5 cd	8,247 a	18.2 b

[1]Means followed by the same letter are not significantly different ($P = 0.05$).
[2]Preplant incorporated.

Table 2. Crop injury, dry biomass, and seed yield of 'Linore' flax planted November 2, 2011.[1]

			Flax		
			5/25/2012	7/19/2012	7/19/2012
	Rate	Date applied	Injury	Dry biomass	Seed yield
	(lb ai/a)		(%)	(lb/a)	(bu/a)
Check	—	—	0 b	6,224 a	30.7 b
Trifluralin[2]	0.75	11/2/11	3 b	5,978 a	30.1 b
s-metolachlor	1.43	11/2/11	0 b	6,960 a	34.2 ab
Pendimethalin	1.42	11/2/11	0 b	7,419 a	36.5 a
Mesotrione	0.094	11/2/11	1 b	6,592 a	36.5 a
Mesotrione	0.094	4/24/12	6 b	5,978 a	29.2 b
Fluroxypyr-bromoxynil	0.32	4/24/12	41 a	5,519 a	20.6 c
Bromoxynil-MCPA	0.35	4/24/12	1 b	6,561 a	32.2 ab
Clopyralid	0.25	4/24/12	0 b	6,592 a	33.1 ab

[1]Means followed by the same letter are not significantly different ($P = 0.05$).
[2]Preplant incorporated.

Table 3. Weed control, crop injury, dry biomass, and seed yield of 'Agatha' flax planted April 18, 2012.[1]

			Sharp-point fluvellin	Flax		
			7/9/2012	7/9/2012	8/13/2012	8/13/2012
	Rate	Date applied	Control	Injury	Dry biomass	Seed yield
	(lb ai/a)		(%)		(lb/a)	(bu/a)
Control	—	—	0 d	0 b	1,977 a	9.9 ab
s-metolachlor	1.43	4/18/12	25 cd	3 b	1,740 a	7.8 bc
Pendimethalin	1.42	4/18/12	48 bc	0 b	2,046 a	11.3 a
Mesotrione	0.094	4/18/12	43 bc	0 b	2,255 a	10.2 ab
Mesotrione	0.094	6/13/12	68 ab	0 b	1,986 a	10.2 ab
Fluroxypyr-bromoxynil	0.32	6/13/12	0 d	79 a	359 b	0.4 d
Bromoxynil-MCPA	0.35	6/13/12	0 d	0 b	1,765 a	7.2 bc
Clopyralid	0.25	6/13/12	13 d	0 b	2,137 a	6.0 c
Pyrasulfotole-bromoxynil	0.241	6/13/12	85 a	3 b	1,796 a	7.3 bc

[1]Means followed by the same letter are not significantly different ($P = 0.05$).

Table 4. Weed control, crop injury, dry biomass, and seed yield of 'Linore' flax planted April 18, 2012.[1]

			Sharp-point fluvellin	Flax		
			7/9/2012	7/9/2012	8/13/2012	8/13/2012
	Rate	Date applied	Control	Injury	Dry biomass	Seed yield
	(lb ai/a)		(%)	(%)	(lb/a)	(bu/a)
Control	—	—	0 d	0 c	1,298 a	12.7 bc
s-metolachlor	1.43	4/18/12	0 d	0 c	1,825 a	14.8 abc
Pendimethalin	1.42	4/18/12	30 c	0 c	2,030 a	17.8 a
Mesotrione	0.094	4/18/12	23 cd	0 c	1,972 a	18.5 a
Mesotrione	0.094	6/13/12	60 b	0 c	1,837 a	16.0 ab
Fluroxypyr-bromoxynil	0.32	6/13/12	0 d	60 a	561 b	1.9 d
Bromoxynil-MCPA	0.35	6/13/12	0 d	0 c	1,774 a	13.7 bc
Clopyralid	0.25	6/13/12	8 d	0 c	2,003 a	10.9 c
Pyrasulfotole-bromoxynil	0.241	6/13/12	90 a	10 b	1,273 a	12.0 bc

[1]Means followed by the same letter are not significantly different ($P = 0.05$).

Table 5. Weed control, crop injury, dry biomass, and seed yield of 'Agatha' flax planted November 11, 2012.[1]

			Annual bluegrass	Lady's mantle	Lesser-seeded bittercress	Ivy-leaved speedwell	Flax		
			2/18/2013	2/18/2013	3/19/2013	3/19/2013	Injury	Dry biomass	Seed yield
	Rate	Date applied	Control				3/19/2013	8/14/2013	8/27/2013
	(lb ai/a)		(%)				(%)	(lb/a)	(bu/a)
Check	—	—	0 b	0 c	0 c	0 c	0 c	12,161 a	18.0 a
Trifluralin[2]	0.75	10/11/12	95 a	48 ab	0 c	75 ab	70 b	10,299 a	18.8 a
s-metolachlor	1.43	10/12/12	100 a	100 a	87 a	93 a	0 c	11,513 a	14.1 a
Pendimethalin	1.42	10/12/12	75 a	5 bc	33 bc	73 ab	0 c	12,991 a	18.8 a
Mesotrione	0.094	10/12/12	25 b	20 bc	68 ab	50 abc	0 c	11,149 a	18.6 a
Mesotrione	0.094	2/4/13	0 b	11 bc	90 a	65 ab	0 c	10,481 a	17.0 a
Fluroxypyr-bromoxynil	0.32	2/4/13	0 b	15 bc	40 abc	68 ab	95 a	1,558 b	6.5 b
Bromoxynil-MCPA	0.35	2/4/13	0 b	5 bc	68 ab	63 ab	0 c	10,057 a	15.9 a
Clopyralid	0.25	2/4/13	0 b	0 c	0 c	10 bc	0 c	11,534 a	18.1 a

[1]Means followed by the same letter are not significantly different ($P = 0.05$).
[2]Preplant incorporated.

Table 6. Weed control, crop injury, dry biomass, and seed yield of 'Linore' flax planted October 11, 2012.[1]

			Annual bluegrass	Lesser-seeded bittercress	Ivy-leaved speedwell	Flax		
			2/18/2013	3/19/2013	3/19/2013	Injury	Dry biomass	Seed yield
	Rate	Date applied	Control			3/19/2013	8/14/2013	8/14/2013
	(lb ai/a)		(%)			(%)	(lb/a)	(bu/a)
Check	—	—	0 b	0 c	0 b	0 c	9,106 a	23.7 a
Trifluralin[2]	0.75	10/11/12	93 a	0 c	15 ab	35 b	9,530 a	27.9 a
s-metolachlor	1.43	10/12/12	100 a	85 a	98 a	0 c	7,689 a	26.7 a
Pendimethalin	1.42	10/12/12	93 a	41 b	93 a	0 c	9,166 a	26.2 a
Mesotrione	0.094	10/12/12	69 a	85 a	90 a	0 c	9,470 a	26.2 a
Mesotrione	0.094	2/4/13	1 b	89 a	95 a	0 c	9,389 a	21.0 a
Fluroxypyr-bromoxynil	0.32	2/4/13	12 b	36 b	31 ab	90 a	2,995 b	13.2 b
Bromoxynil-MCPA	0.35	2/4/13	0 b	66 ab	51 ab	0 c	8,438 a	24.8 a
Clopyralid	0.25	2/4/13	0 b	0 c	19 ab	0 c	7,730 a	25.4 a

[1]Means followed by the same letter are not significantly different ($P = 0.05$).
[2]Preplant incorporated.

Table 7. Crop injury, dry biomass, and seed yield of 'Agatha' flax planted March 13, 2013.[1]

			Flax		
			Injury	Dry biomass	Seed yield
	Rate	Date applied	6/11/2013	9/11/2013	9/13/2013
	(lb ai/a)		(%)	(lb/a)	(bu/a)
Check	—	—	0 d	3,462 a	4.0 a
s-metolachlor	1.43	3/18/13	0 d	3,774 a	4.7 a
Pendimethalin	1.42	3/18/13	0 d	3,426 a	5.0 a
Mesotrione	0.094	3/18/13	0 d	3,515 a	4.7 a
Mesotrione	0.094	5/31/13	24 b	3,337 a	3.9 a
Fluroxypyr-bromoxynil	0.32	5/31/13	65 a	2,052 a	0.1 b
Bromoxynil-MCPA	0.35	5/31/13	10 c	3,872 a	4.9 a
Clopyralid	0.25	5/31/13	0 d	3,212 a	3.4 a

[1]Means followed by the same letter are not significantly different ($P = 0.05$).

Table 8. Weed control, crop injury, dry biomass, and seed yield of 'Linore' flax planted March 18, 2013.[1]

			Sharp-point fluvellin	Prostrate knotweed	---------- Flax ----------		
			--------- Control ---------		Injury	Dry biomass	Seed yield
	Rate	Date applied	7/8/2013	7/8/2013	6/11/2013	9/11/2013	9/13/2013
	(lb ai/a)		---------- (%) ----------		(%)	(lb/a)	(bu/a)
Check	—	—	0 b	0 b	0 c	4,140 a	12.1 a
s-metolachlor	1.43	3/18/13	31 b	75 a	0 c	4,202 a	14.29 a
Pendimethalin	1.42	3/18/13	48 ab	100 a	0 c	3,738 a	13.44 a
Mesotrione	0.094	3/18/13	35 b	100 a	0 c	4,327 a	13.66 a
Mesotrione	0.094	5/31/13	74 a	50 ab	18 b	3,480 a	12.46 a
Fluroxypyr-bromoxynil	0.32	5/31/13	25 b	100 a	40 a	2,391 b	1.027 b
Bromoxynil-MCPA	0.35	5/31/13	10 b	75 a	15 b	3,613 a	10.31 a
Clopyralid	0.25	5/31/13	13 b	0 b	0 c	3,096 ab	10.39 a

[1]Means followed by the same letter are not significantly different ($P = 0.05$).