University of Nebraska
Northeast Research & Extension Center
Haskell Agricultural Laboratory
57905 866 Road
Concord, NE 68728-2828

HASKELL AG LAB (FARM OPERATION) COORDINATES = LAT 42°22’52” LONG 96°57’91”

2007 Weed Science Reports

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Appendix A:

ABBREVIATIONS FOR HERICIDE APPLICATION METHODS

ABBREVIATION	**APPLICATION METHOD**
EPP	Early Preplant (before or after weed emergence)
BURN	Burndown (after weed emergence)
PPI	Preplant Incorporated
PRE	Preemergence
EPOST	Early Postemergence
POST	Postemergence
MPOST	Mid Postemergence
LPOST	Late Postemergence

ABBREVIATIONS USED FOR WEED SPECIES

ABBREVIATION		SPECIES
Grasses		Grasses (Check comments section for species present)
Broadlea		Broadleaf (Check comments section for species present)
Foxtail	(SETSP, SETSS)	Foxtail species (Green, Yellow)
Bromegra		Bromegrass
Grft	(SETVI)	Green foxtail
Yeft	(SETLU)	Yellow foxtail
Bygr	(ECHCG)	Barnyardgrass
Fisb	(CCHPA)	Field sandbur
Yens	(CYPES)	Yellow nutsedge
Blns	(SOLPT)	Black nightshade
Colq	(CHEAL)	Common lambsquarters
ERC		Eastern red cedar
Fibw	(CONAR)	Field bindweed
Fiht	((EQUAR)	Field horsetail
Kocz	(KCHSC)	Kochia
Fapa	(PANDI)	Fall Panicum
Puls		Purple loosestrife
P.pea		Partridgepea
Swcl	(MEUOF)	Sweet clover
Tamg	(PHBPU)	Tall morningglory
Tawh	(AMATU)	Tall waterhemp
Tams	(DESPI)	Tansy Mustard
Vele	(ABUTH)	Velvetleaf
Vema	(HIBTR)	Venice mallow
Wibw	(POLCO)	Wild buckwheat
Willow		Willow trees
Howe	(ERICA)	Horseweed (marestail)
Voco	(ZEAMX)	Volunteer Corn
Hverva		Hoary Vervain
Wragwe		Western Ragweed
Buckbr		Buckbrush
Sumac		Smooth Sumac
Mkwd	(ASCSY)	Common milkweed
Jpwd		Joepyeweed

Appendix B:

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
January										January
1	28	16	19	-	-	-	-	33	0.15	1
2	34	19	21	-	-	-	-	32		2
3	38	21	29	-	-	-	-	32		3
4	44	29	30	-	-	-	-	34		4
5	49	32	34	-	-	-	-	34		5
6	38	23	24	-	-	-	-	33		6
7	43	31	33	-	-	-	-	32		7
8	36	24	26	-	-	-	-	32		8
9	48	25	26	-	-	-	-	32		9
10	35	21	25	-	-	-	-	32		10
11	48	28	28	-	-	-	-	32		11
12	30	0	0	-	-	-	-	28		12
13	8	-2	1	-	-	-	-	24		13
14	12	2	13	-	-	-	-	26		14
15	16	-9	-9	-	-	-	-	27	0.32	15
16	3	-20	-19	-	-	-	-	26		16
17	10	-20	8	-	-	-	-	27		17
18	26	7	19	-	-	-	-	28		18
19	30	9	10	-	-	-	-	28		19
20	34	4	8	-	-	-	-	28		20
21	32	11	24	-	-	-	-	29	0.36	21
22	29	16	17	-	-	-	-	30		22
23	29	12	30	-	-	-	-	30		23
24	38	25	30	-	-	-	-	30		24
25	39	13	16	-	-	-	-	30		25
26	35	17	34	-	-	-	-	30		26
27	43	15	19	-	-	-	-	29		27
28	24	-9	-6	-	-	-	-	24		28
29	21	14	21	-	-	-	-	24		29
30	26	-5	-5	-	-	-	-	21		30
31	15	-5	-5	-	-	-	-	22		31
Avg/Total	**30**	**11**	**16**					**29**	**0.83**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
February										February
1	29	5	5	-	-	-	-	22	0.05	1
2	26	-5	-5	-	-	-	-	20		2
3	19	-12	-11	-	-	-	-	18		3
4	7	-13	-6	-	-	-	-	17		4
5	9	-5	4	-	-	-	-	20		5
6	13	12	12	-	-	-	-	22	1.00	6
7	29	5	6	-	-	-	-	22		7
8	14	5	9	-	-	-	-	22		8
9	16	-2	-2	-	-	-	-	24	0.17	9
10	13	-12	-12	-	-	-	-	24		10
11	29	-7	27	-	-	-	-	26		11
12	34	22	22	-	-	-	-	28		12
13	24	5	5	-	-	-	-	27	0.15	13
14	9	-15	-15	-	-	-	-	26		14
15	4	-15	-6	-	-	-	-	24		15
16	10	-7	9	-	-	-	-	24		16
17	41	14	18	-	-	-	-	24	0.15	17
18	32	12	15	-	-	-	-	27		18
19	39	15	33	-	-	-	-	29		19
20	46	27	28	-	-	-	-	30		20
21	47	22	23	-	-	-	-	30		21
22	49	23	24	-	-	-	-	31		22
23	41	31	31	-	-	-	-	31		23
24	47	34	34	-	-	-	-	32	0.04	24
25	36	24	24	-	-	-	-	32	0.90	25
26	29	16	20	-	-	-	-	32		26
27	39	9	9	-	-	-	-	32		27
28	30	25	27	-	-	-	-	31		28
Avg/Total	**27**	**8**	**12**					**26**	**2.46**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
March										March
1	32	27	27	-	-	-	-	31		1
2	32	20	20	-	-	-	-	31	0.15	2
3	26	11	11	-	-	-	-	31	0.15	3
4	25	5	23	-	-	-	-	31		4
5	45	23	23	-	-	-	-	31		5
6	29	12	12	-	-	-	-	31		6
7	36	14	21	-	-	-	-	31		7
8	28	22	28	-	-	-	-	31		8
9	46	32	35	-	-	-	-	35	0.15	9
10	52	29	38	-	-	-	-	37		10
11	55	31	32	-	-	-	-	40		11
12	63	41	41	-	-	-	-	41		12
13	72	44	47	-	-	-	-	44		13
14	72	35	35	-	-	-	-	38		14
15	45	29	31	-	-	-	-	38		15
16	52	19	23	-	-	-	-	35		16
17	40	31	31	-	-	-	-	37		17
18	47	31	31	-	-	-	-	40		18
19	57	37	37	-	-	-	-	42		19
20	53	27	28	-	-	-	-	38		20
21	50	45	49	-	-	-	-	45		21
22	70	28	28	-	-	-	-	45		22
23	55	31	34	-	-	-	-	49		23
24	74	34	55	-	-	-	-	51	0.12	24
25	69	56	56	-	-	-	-	54	0.34	25
26	73	45	45	-	-	-	-	54		26
27	81	41	41	-	-	-	-	52		27
28	64	54	55	-	-	-	-	55		28
29	76	58	59	-	-	-	-	55		29
30	64	45	46	-	-	-	-	57	1.10	30
31	67	47	49	-	-	-	-	50	0.76	31
Avg/Total	**53**	**32**	**35**					**41**	**2.77**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
April										April
1	54	33	33	--	--	--	--	44	1.36	1
2	61	36	38	--	--	--	--	46		2
3	57	36	36	50	50	48	48	43	0.35	3
4	38	18	18	48	48	49	49	36		4
5	36	18	19	49	45	48	45	37		5
6	37	17	17	45	44	45	44	35		6
7	31	15	18	44	42	45	43	34		7
8	35	12	20	42	40	45	40	36		8
9	40	17	19	40	40	40	40	39		9
10	50	36	36	40	40	40	40	39	0.05	10
11	42	32	32	39	39	39	39	37	0.58	11
12	36	30	30	40	40	40	40	38	0.07	12
13	46	24	25	38	38	38	38	41		13
14	53	27	39	43	39	42	42	44		14
15	57	27	38	44	44	42	40	48		15
16	70	39	40	47	42	45	42	54		16
17	80	42	43	49	46	46	43	55		17
18	67	39	40	50	49	47	47	55		18
19	69	41	41	43	40	49	49	55		19
20	69	44	45	51	51	49	49	57	0.10	20
21	78	63	63	54	51	51	49	62		21
22	85	55	58	57	54	54	51	59		22
23	68	42	42	57	55	54	54	56	0.25	23
24	69	42	47	40	40	40	40	52	1.10	24
25	61	46	46	58	55	51	51	49	1.30	25
26	49	42	42	55	53	52	52	53	0.67	26
27	64	39	44	46	43	43	43	55		27
28	71	41	57	56	54	55	52	59		28
29	79	51	61	54	52	54	54	65		29
30	92	55	57	59	55	55	52	69		30
Avg/Total	**58**	**35**	**38**	**48**	**46**	**47**	**46**	**48**	**5.83**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
May										May
1	92	54	55	61	59	56	55	67		1
2	71	41	43	61	59	58	58	64		2
3	73	48	52	60	58	56	56	61		3
4	65	55	57	59	58	55	55	61	0.07	4
5	76	65	67	60	58	58	58	62	0.50	5
6	76	60	61	61	60	59	56	62	0.75	6
7	70	59	61	60	59	59	59	61	0.10	7
8	67	47	49	61	60	60	60	61		8
9	76	47	51	64	61	60	59	63		9
10	82	51	55	65	64	61	59	68		10
11	85	49	52	67	64	64	60	70		11
12	83	54	60	69	64	65	64	70		12
13	89	61	69	68	64	65	64	71		13
14	92	69	69	66	65	64	64	73		14
15	86	52	52	69	65	65	64	66		15
16	65	41	46	64	62	65	62	64		16
17	70	34	39	67	64	67	64	64		17
18	72	52	53	64	62	61	61	68		18
19	82	58	58	65	64	62	61	70		19
20	87	58	60	66	62	65	61	73		20
21	86	64	64	69	65	65	62	73		21
22	86	64	64	68	65	65	65	70		22
23	79	59	60	69	68	65	65	68	1.05	23
24	74	51	51	70	67	64	62	63	0.20	24
25	67	43	48	69	65	68	65	62	0.10	25
26	71	49	59	67	64	69	64	66		26
27	68	41	59	69	64	67	63	65		27
28	72	49	61	65	64	64	62	68		28
29	80	67	67	67	64	65	65	67		29
30	75	64	65	67	67	65	65	64	0.90	30
31	75	49	51	67	65	65	65	64		31
Avg/Total	**77**	**53**	**57**	**65**	**63**	**63**	**61**	**66**	**3.67**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
June										June
1	76	56	57	67	65	65	65	63		1
2	69	52	58	67	65	67	64	62	0.15	2
3	72	56	62	69	68	67	65	63	0.17	3
4	75	56	59	69	65	65	65	65	0.70	4
5	78	47	51	70	68	69	68	66	0.12	5
6	76	61	62	72	68	69	65	69		6
7	89	60	62	69	68	68	68	71	0.05	7
8	80	46	49	70	68	69	68	69		8
9	72	50	64	71	65	69	65	70		9
10	85	61	70	69	66	67	65	75		10
11	91	67	68	73	69	70	69	78		11
12	89	65	68	75	71	70	69	77		12
13	87	68	69	70	71	69	68	73		13
14	73	66	67	75	72	72	70	73	0.15	14
15	84	63	65	75	72	70	72	74		15
16	85	64	71	75	72	72	71	77		16
17	92	67	68	78	75	74	71	77		17
18	88	70	70	74	74	72	72	76		18
19	81	52	55	76	71	72	71	72		19
20	82	56	61	75	72	72	72	76		20
21	90	66	70	76	74	74	70	76		21
22	87	65	66	75	74	73	73	77	0.55	22
23	87	67	68	80	75	76	75	78		23
24	80	60	65	80	75	78	74	78		24
25	85	66	68	79	75	76	75	80		25
26	92	71	72	79	78	78	75	81		26
27	87	63	67	82	78	78	74	81		27
28	82	55	56	83	76	79	75	79		28
29	76	49	58	80	76	78	74	79		29
30	80	54	63	79	74	76	75	79		30
Avg/Total	**82**	**60**	**64**	**74**	**71**	**72**	**70**	**74**	**1.89**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
July										July
1	81	55	65	79	74	76	73	79		1
2	83	64	65	79	74	74	73	78		2
3	85	67	68	78	74	76	74	81		3
4	89	61	65	80	76	75	75	82		4
5	91	59	62	83	75	78	75	83		5
6	90	64	65	81	74	79	75	85		6
7	91	67	68	85	74	80	71	85		7
8	96	65	70	83	79	79	76	85		8
9	96	64	66	83	69	86	69	84		9
10	85	64	66	84	78	80	76	81		10
11	80	48	50	83	75	79	75	78		11
12	83	56	59	82	76	78	75	79		12
13	82	49	55	80	79	78	76	80		13
14	85	55	69	79	75	78	76	83		14
15	90	56	62	81	75	78	75	82		15
16	85	60	61	82	76	79	76	84		16
17	93	63	69	83	79	80	78	86		17
18	98	70	75	84	81	80	79	86		18
19	92	68	68	83	79	80	78	81	1.60	19
20	83	59	61	84	79	80	78	80		20
21	82	62	66	80	77	79	76	81		21
22	83	69	69	80	77	75	75	83		22
23	90	69	69	82	80	76	75	86		23
24	90	70	71	82	72	79	76	87		24
25	89	69	70	83	80	80	86	86		25
26	91	69	69	82	80	79	79	87		26
27	93	69	71	83	80	80	86	88		27
28	87	66	66	83	80	80	78	85		28
29	85	66	70	80	79	78	78	84		29
30	85	63	65	89	80	81	79	84		30
31	86	64	65	82	79	80	76	84		31
Avg/Total	**88**	**63**	**66**	**82**	**77**	**79**	**76**	**83**	**1.60**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
August										August
1	86	67	70	81	79	79	79	84		1
2	89	67	68	83	79	80	79	85		2
3	88	58	59	84	78	86	79	80		3
4	83	59	70	78	76	78	75	80	0.14	4
5	93	71	72	80	78	79	78	82		5
6	85	68	70	84	80	80	79	78	0.10	6
7	85	69	72	80	80	80	78	75		7
8	80	68	70	80	79	78	78	73	0.14	8
9	76	68	69	80	78	79	78	79	1.31	9
10	90	67	70	81	79	79	76	76	1.80	10
11	90	67	70	80	80	79	79	82	0.80	11
12	93	68	70	83	80	80	79	79	0.05	12
13	83	66	68	83	80	79	78	79		13
14	91	70	70	83	79	81	79	83		14
15	86	71	72	82	81	81	79	82	0.15	15
16	90	70	71	81	80	81	80	82		16
17	82	69	72	82	79	80	78	78		17
18	76	67	69	80	80	80	79	78	0.05	18
19	89	71	74	80	79	79	78	81		19
20	87	67	70	80	79	79	76	78		20
21	86	61	63	81	79	78	76	77	0.65	21
22	87	63	69	80	79	78	78	72		22
23	71	63	65	80	75	78	74	71	2.00	23
24	77	58	59	75	76	74	75	71		24
25	76	54	62	75	74	74	73	72		25
26	78	61	65	75	74	75	74	74		26
27	83	70	71	75	74	73	72	79		27
28	91	68	68	75	73	75	73	77		28
29	84	61	62	79	76	75	74	73	0.37	29
30	75	52	53	75	72	73	73	73		30
31	78	54	56	78	74	75	74	75		31
Avg/Total	**84**	**65**	**67**	**80**	**78**	**78**	**77**	**78**	**7.56**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
Sept.										Sept.
1	81	55	61	77	75	77	77	75		1
2	84	62	63	75	74	76	74	76	0.15	2
3	85	60	60	76	72	74	72	75	0.05	3
4	87	59	60	78	74	75	72	76		4
5	89	64	65	75	75	75	72	78		5
6	84	67	68	77	73	75	74	75		6
7	78	68	68	76	75	75	73	75	0.05	7
8	78	47	49	78	74	76	74	71		8
9	78	51	52	74	72	73	72	66		9
10	61	45	47	74	74	74	74	62	1.10	10
11	63	47	48	74	68	73	68	61	0.11	11
12	68	46	41	70	65	69	68	63		12
13	77	41	57	70	67	69	66	66		13
14	65	36	36	68	65	66	66	61		14
15	59	32	35	65	65	65	63	57		15
16	61	45	47	64	62	65	62	63		16
17	77	51	67	65	64	65	64	71		17
18	89	65	67	69	65	67	61	69	0.12	18
19	75	44	45	69	67	67	67	65		19
20	75	48	63	70	67	68	67	70		20
21	90	68	72	70	71	68	65	71		21
22	78	39	40	70	64	69	64	66		22
23	86	48	60	67	66	68	64	71		23
24	89	68	69	70	69	68	68	70		24
25	67	49	50	71	68	69	68	63	0.14	25
26	66	41	42	70	65	68	65	61		26
27	74	44	46	67	64	67	65	63		27
28	77	34	36	64	63	65	63	63		28
29	80	62	63	63	63	65	63	65	1.00	29
30	83	62	64	65	64	63	62	64	0.05	30
Avg/Total	**77**	**52**	**55**	**71**	**68**	**70**	**68**	**68**	**2.77**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
Oct.										Oct
1	83	43	44	--	--	--	--	66	1.35	1
2	78	44	67	--	--	--	--	62		2
3	73	39	40	--	--	--	--	60		3
4	79	45	50	--	--	--	--	63		4
5	72	57	67	--	--	--	--	69		5
6	87	70	71	--	--	--	--	73		6
7	89	59	60	--	--	--	--	65		7
8	62	46	46	--	--	--	--	58	1.95	8
9	69	46	52	--	--	--	--	57		9
10	66	37	37	--	--	--	--	54		10
11	55	28	30	--	--	--	--	53		11
12	59	31	40	--	--	--	--	57		12
13	68	40	55	--	--	--	--	58	0.10	13
14	57	55	55	--	--	--	--	57	1.55	14
15	58	45	45	--	--	--	--	56	1.20	15
16	56	46	47	--	--	--	--	54	1.35	16
17	66	43	52	--	--	--	--	54	0.11	17
18	62	55	57	--	--	--	--	56	0.35	18
19	57	44	45	--	--	--	--	54	1.25	19
20	64	41	46	--	--	--	--	54		20
21	81	42	48	--	--	--	--	52		21
22	52	37	39	--	--	--	--	50		22
23	58	30	31	--	--	--	--	50		23
24	70	31	33	--	--	--	--	53		24
25	66	33	33	--	--	--	--	51		25
26	63	28	29	--	--	--	--	51		26
27	63	29	31	--	--	--	--	51		27
28	58	27	28	--	--	--	--	49		28
29	62	35	35	--	--	--	--	52		29
30	70	39	45	--	--	--	--	54		30
31	70	42	42	--	--	--	--	52		31
Avg/Total	**67**	**42**	**45**	**--**	**--**	**--**	**--**		**9.21**	

Weather Summary – Concord, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
Nov										Nov
1	53	25	26	--	--	--	--	47		1
2	61	36	37	--	--	--	--	48		2
3	55	21	22	--	--	--	--	44		3
4	68	29	35	--	--	--	--	48		4
5	69	39	40	--	--	--	--	47		5
6	48	20	21	--	--	--	--	41		6
7	42	18	20	--	--	--	--	41		7
8	65	27	28	--	--	--	--	43		8
9	52	20	22	--	--	--	--	44		9
10	61	21	34	--	--	--	--	46		10
11	63	33	38	--	--	--	--	49		11
12	73	36	42	--	--	--	--	46		12
13	55	30	39	--	--	--	--	45		13
14	64	36	37	--	--	--	--	45		14
15	51	21	22	--	--	--	--	41		15
16	50	26	29	--	--	--	--	44		16
17	64	29	33	--	--	--	--	48		17
18	55	34	35	--	--	--	--	44		18
19	52	36	41	--	--	--	--	45		19
20	63	34	35	--	--	--	--	43		20
21	46	26	26	--	--	--	--	37		21
22	30	14	19	--	--	--	--	33		22
23	27	9	14	--	--	--	--	31		23
24	41	22	22	--	--	--	--	34		24
25	45	21	26	--	--	--	--	35		25
26	53	21	23	--	--	--	--	36		26
27	43	11	13	--	--	--	--	33		27
28	34	24	26	--	--	--	--	32		28
29	35	15	20	--	--	--	--	31		29
30	32	10	11	--	--	--	--	30		30
Avg/Total	**52**	**25**	**28**	--	--	--	--	**41**	**0**	

Appendix C:

Weather Summary – Brunswick, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
April										April
1	61	35	--	--	--	--	--	47	.17	1
2	56	37	--	--	--	--	--	47	.31	2
3	47	20	--	--	--	--	--	43	.01	3
4	36	18	--	--	--	--	--	38		4
5	34	17	--	--	--	--	--	38		5
6	32	17	--	--	--	--	--	37		6
7	34	14	--	--	--	--	--	35		7
8	39	13	--	--	--	--	--	37		8
9	48	22	--	--	--	--	--	40		9
10	40	33	--	--	--	--	--	37		10
11	38	31	--	--	--	--	--	37		11
12	46	29	--	--	--	--	--	40		12
13	55	31	--	--	--	--	--	44		13
14	58	29	--	--	--	--	--	47		14
15	71	33	--	--	--	--	--	50		15
16	76	45	--	--	--	--	--	55		16
17	63	43	--	--	--	--	--	53		17
18	69	38	--	--	--	--	--	55		18
19	64	45	--	--	--	--	--	53	.11	19
20	78	47	--	--	--	--	--	56		20
21	81	57	--	--	--	--	--	61	.13	21
22	68	48	--	--	--	--	--	58	.64	22
23	67	41	--	--	--	--	--	55		23
24	54	46	--	--	--	--	--	51	1.51	24
25	49	44	--	--	--	--	--	48	.91	25
26	66	43	--	--	--	--	--	54		26
27	67	45	--	--	--	--	--	56		27
28	78	45	--	--	--	--	--	59		28
29	89	55	--	--	--	--	--	64		29
30	89	54	--	--	--	--	--	67		30
Avg/Total	**58**	**36**	**--**	**--**	**--**	**--**	**--**	**49**	**3.78**	

Weather Summary – Brunswick, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
May										May
1	68	50	--	--	--	--	--	65		1
2	72	43	--	--	--	--	--	63		2
3	64	44	--	--	--	--	--	58		3
4	74	55	--	--	--	--	--	61	.04	4
5	74	58	--	--	--	--	--	61	2.00	5
6	69	58	--	--	--	--	--	62	.01	6
7	67	51	--	--	--	--	--	61	.05	7
8	75	48	--	--	--	--	--	61		8
9	82	47	--	--	--	--	--	63		9
10	82	56	--	--	--	--	--	67		10
11	83	49	--	--	--	--	--	68		11
12	86	56	--	--	--	--	--	69		12
13	87	64	--	--	--	--	--	71		13
14	75	56	--	--	--	--	--	68	.02	14
15	62	44	--	--	--	--	--	63		15
16	69	43	--	--	--	--	--	62		16
17	72	35	--	--	--	--	--	62		17
18	79	55	--	--	--	--	--	65		18
19	85	58	--	--	--	--	--	68		19
20	84	59	--	--	--	--	--	69		20
21	81	63	--	--	--	--	--	69	0.1	21
22	73	56	--	--	--	--	--	66	.99	22
23	72	55	--	--	--	--	--	65	.09	23
24	66	47	--	--	--	--	--	63	.04	24
25	71	45	--	--	--	--	--	62		25
26	65	48	--	--	--	--	--	63	.16	26
27	66	44	--	--	--	--	--	60	.17	27
28	77	60	--	--	--	--	--	63		28
29	68	59	--	--	--	--	--	63	1.40	29
30	66	53	--	--	--	--	--	61	.78	30
31	70	52	--	--	--	--	--	62		31
Avg/Total	**74**	**52**	--	--	--	--	--	**64**	**5.76**	

Weather Summary – Brunswick, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2" Depth Soil Temp Max °F	2" Depth Soil Temp Min °F	6" Depth Soil Temp Max °F	6" Depth Soil Temp Min °F	Weather Station Auto 4" Soil Temp Max °F	Precip Inches	Date
June										June
1	70	54	--	--	--	--	--	62	.16	1
2	66	52	--	--	--	--	--	61	.12	2
3	76	53	--	--	--	--	--	63		3
4	78	56	--	--	--	--	--	65	.07	4
5	78	48	--	--	--	--	--	64		5
6	86	61	--	--	--	--	--	65	.36	6
7	76	51	--	--	--	--	--	65	.01	7
8	71	44	--	--	--	--	--	62		8
9	82	53	--	--	--	--	--	63		9
10	90	62	--	--	--	--	--	68		10
11	88	66	--	--	--	--	--	71		11
12	82	66	--	--	--	--	--	71		12
13	72	65	--	--	--	--	--	69	1.56	13
14	80	62	--	--	--	--	--	69	.01	14
15	85	62	--	--	--	--	--	70		15
16	88	64	--	--	--	--	--	72		16
17	85	67	--	--	--	--	--	72		17
18	79	59	--	--	--	--	--	70	.13	18
19	83	56	--	--	--	--	--	66	.03	19
20	90	57	--	--	--	--	--	69		20
21	86	65	--	--	--	--	--	71	.13	21
22	87	64	--	--	--	--	--	72	.01	22
23	84	64	--	--	--	--	--	73		23
24	88	61	--	--	--	--	--	73		24
25	91	67	--	--	--	--	--	75		25
26	83	64	--	--	--	--	--	75		26
27	82	58	--	--	--	--	--	73		27
28	77	54	--	--	--	--	--	71		28
29	81	51	--	--	--	--	--	71		29
30	82	55	--	--	--	--	--	72		30
Avg/Total	**82**	**59**	--	--	--	--	--	**69**	**2.59**	

Weather Summary – Brunswick, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
July										July
1	84	57	--	--	--	--	--	72		1
2	85	65	--	--	--	--	--	73		2
3	93	67	--	--	--	--	--	75		3
4	90	60	--	--	--	--	--	76		4
5	92	59	--	--	--	--	--	75		5
6	92	64	--	--	--	--	--	77		6
7	100	65	--	--	--	--	--	79		7
8	94	68	--	--	--	--	--	79		8
9	86	61	--	--	--	--	--	78		9
10	79	56	--	--	--	--	--	77		10
11	83	52	--	--	--	--	--	77		11
12	80	57	--	--	--	--	--	75	0.62	12
13	83	53	--	--	--	--	--	76		13
14	89	65	--	--	--	--	--	82		14
15	89	60	--	--	--	--	--	81	.04	15
16	91	58	--	--	--	--	--	81		16
17	95	68	--	--	--	--	--	85	.01	17
18	92	67	--	--	--	--	--	84	1.11	18
19	85	61	--	--	--	--	--	79	.01	19
20	82	59	--	--	--	--	--	79		20
21	86	69	--	--	--	--	--	82		21
22	91	70	--	--	--	--	--	84		22
23	94	69	--	--	--	--	--	87		23
24	91	70	--	--	--	--	--	88		24
25	91	70	--	--	--	--	--	87		25
26	93	70	--	--	--	--	--	86		26
27	86	66	--	--	--	--	--	85		27
28	81	62	--	--	--	--	--	81		28
29	84	61	--	--	--	--	--	81		29
30	86	67	--	--	--	--	--	84		30
31	87	69	--	--	--	--	--	82		31
Avg/Total	**88**	**63**	**--**	**--**	**--**	**--**	**--**	**80**	**1.87**	

Weather Summary – Brunswick, NE 2007

Date	Air Temp Max °F	Air Temp Min °F	Air Temp OBS °F	2” Depth Soil Temp Max °F	2” Depth Soil Temp Min °F	6” Depth Soil Temp Max °F	6” Depth Soil Temp Min °F	Weather Station Auto 4” Soil Temp Max °F	Precip Inches	Date
August										August
1	87	65	--	--	--	--	--	80	.02	1
2	85	62	--	--	--	--	--	81		2
3	81	61	--	--	--	--	--	77	0.6	3
4	93	69	--	--	--	--	--	81	.03	4
5	87	65	--	--	--	--	--	82		5
6	83	70	--	--	--	--	--	79	.01	6
7	83	68	--	--	--	--	--	80		7
8	79	66	--	--	--	--	--	77	.17	8
9	93	65	--	--	--	--	--	81	.52	9
10	86	65	--	--	--	--	--	76	.03	10
11	94	67	--	--	--	--	--	81		11
12	80	66	--	--	--	--	--	77	0.04	12
13	93	64	--	--	--	--	--	79		13
14	87	70	--	--	--	--	--	82		14
15	89	70	--	--	--	--	--	80	.20	15
16	82	66	--	--	--	--	--	78	.09	16
17	75	62	--	--	--	--	--	73		17
18	90	67	--	--	--	--	--	76	.04	18
19	81	64	--	--	--	--	--	79		19
20	90	64	--	--	--	--	--	79		20
21	89	59	--	--	--	--	--	78	.20	21
22	70	61	--	--	--	--	--	70	.64	22
23	76	60	--	--	--	--	--	70	.90	23
24	74	55	--	--	--	--	--	69		24
25	78	52	--	--	--	--	--	70		25
26	87	64	--	--	--	--	--	72		26
27	92	70	--	--	--	--	--	77		27
28	76	63	--	--	--	--	--	74	.01	28
29	75	55	--	--	--	--	--	73		29
30	79	54	--	--	--	--	--	73		30
31			--	--	--	--	--			31
Avg/Total			--	--	--	--	--			

BUILDING A RESEARCH FLAMER. Stevan Z. Knezevic, Logan Dana*, Jon E. Scott and Santiago Ulloa. Associate Professor, Research Technician, Research Technologist, and Graduate Research Assistant, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Weed flaming can be an additional tool for weed control options in organic cropping systems. There are several commercial flamers available for use in agronomic crops with the cost ranging from $6,000 to $15,000 depending on the number of rows the flamer covers. However, most of the commercial flamers are physically too large to be effectively utilized in small research plots. Therefore, as part of a larger study, the objective of this project was to build a relatively inexpensive and smaller research-type flamer for flaming weed and crop species at various growth stages. As a result, the three types of flamers were built, including two types for broadcast flaming (1.2 m and 3 m wide) and one for intra-row flaming that can cover three to five crop rows planted 76cm apart. Custom designed main frame was built to be interchangeably used with each flamer type, while a three-point-hitch allowed mounting on a tractor or ATV. Square steel tubing of different sizes (2.5-5.6cm) was utilized for building the main frame, which allowed to easily adjust burner height, burner angle, distance between burners to fit the crop row width, and the flame direction (inter or intra-row). There are also two pressure gauges (low and high) to control propane pressures ranging from 70 to 620 kPa (10-90 PSI). Propane application rate (kg ha^{-1}) was regulated by a combination of propane pressure and application speed. For example, using a driving speed of about 6 km/hour (4MPH), the propane rates can vary from 12 to 93 kg ha^{-1}(3-20 GPA). Burners were purchased at the cost of about $100 per burner, while the overall cost of material (eg. steel tubing, propane tank, valves, electronic safety solenoids, two pressure regulators, hose) ranged from $2,000-$3,000 depending on the flamer (sknezevic2@unl.edu).

WEED TOLERANCE TO FLAMING. Stevan Z. Knezevic and Santiago Ulloa*. Associate Professor and Graduate Student Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Organic producers rank weeds as the most important pests that limit their crop production. In order to optimize propane use as a weed control tool, the objective of this study was to collect a baseline data on weed tolerance to broadcast flaming. Field studies were conducted in 2007 utilizing six rates of propane and ten major weed species in northeast Nebraska, including: Venice mallow (*Hibiscus trionum*), waterhemp (*Amaranthus rudis*), field bindweed (*Convolvulus arvensis*), kochia (*Kochia scoparia*), Ivyleaf morning-glory (*Ipomoea hederacea*), velvetleaf (*Abutilon theophrasti*), redroot pigweed (*Amaranthus retroflexus*), barnyardgrass (*Echinocloa crus-galli*), green foxtail (*Setaria viridis*) and yellow foxtail (*S. glauca*). The propane rates included: 0, 12.1, 30.9, 49.7, 68.5 and 87.22 kg/ha (0, 2.5, 6.5, 10.5, 14.4 and 18.4 gal/a). Flaming treatments were applied utilizing an ATV mounted flamer moving at a constant speed of 6.5 km/hour (4 MPH). Species response to propane rates were described by log-logistic models based on relative dry matter for each weed species. Overall response to flame varied among the species, growth stages and propane rate. Broadleaf weeds were more susceptible to flames than grasses. Propane rate of 50-70 kg/ha provided 90% control of most broadleaf species. Although, 70-90 kg/ha provided 80% control of grasses, none of the propane rates provided 90% control. Flaming has a potential to be used effectively in organic agriculture (sknezevic2@unl.edu).

CROP TOLERANCE TO FLAMING. Stevan Z. Knezevic*, and Santiago Ulloa. Associate Professor and Graduate Student Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828.

Flaming can be an additional tool for weed control in organic cropping systems. However, tolerance of major crops must be determined in order to optimize proper use of flame. Therefore, objective of this study was to collect a baseline information on crop tolerance to broadcast flaming. Field experiments were conducted during summer of 2007 utilizing six rates of propane and six crops including: field corn (*Zea mays*), sorghum (*Sorghum halepense*), soybean (*Glycine max*), sunflower (*Helianthus annuus*), alfalfa (*Medicago sativa*) and red clover (*Trifolium pratense*). The propane rates applied were 0, 12.1, 30.9, 49.7, 68.5 and 87.22 kg/ha (0, 2.5, 6.5, 10.5, 14.4 and 18.4 gal/a). Flaming treatments were applied using a constant speed of 6.5 km/hour (4MPH). Species response to propane rates were described by log-logistic models based on visual estimates of crop injury. Overall response to flame varied depending on the species, growth stage and propane rate. Corn and sorghum were more tolerant than the broadleaf crops. Soybean and sunflower were severely injured when flamed at early growth stages (VE-VC), however they could tolerate more heat at later stages (V9-R1). Alfalfa and red clover were the most susceptible to flaming regardless of the growth stage. Perennial crops such as alfalfa and clover may show more tolerance to flaming in their 2nd or 3rd year of growth. Of all crops tested, broadcast flaming has the most potential for use in field corn and sorghum. More research is needed to evaluate flaming procedures (eg. positioning of the flame) in other grass-type crops, and various broadleaf crops (sknezevic2@unl.edu).

DOSE RESPONSE CURVES OF KIH-485 FOR WEED CONTROL IN CORN. Stevan Z. Knezevic, Jon E. Scott* and Peter Porpiglia, Associate Professor and Research Technologist, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828, and Researcher, Kumia America, White Plains, New York.

KIH-485 is a new herbicide under development. Field studies were conducted in 2006 and 2007 at Brunswick and Concord to describe and compare dose response curves for KIH-485 at three soil types (eg. 1%OM, 2%, and 3% OM) for control of green foxtail, field sandbur, large crabgrass, velvetleaf and tall waterhemp. Dose response curves were fit, and ED90 values (effective dose that provides 90% weed control) were determined utilizing the **R** and *drc* software package. Corn showed excellent tolerance to KIH-485, as there was no crop injury at any of the rates tested at medium and heavy soils. There was crop injury at sandy soil (<1%OM) at 2X and 3X rates due to cold-wet spring in 2007 only.
Generally, an increase in OM resulted in higher ED90 values for all weed species. Based on the 2006 data, the ED90 (90% control) for green foxtail was 115 g ai/ha for soils with 1% OM, while 300 g ai/ha was calculated for soils with 3% OM. Similar response was observed for other weed species. The proposed label rate for KIH might be between 200-250 g ai /ha, which would provide excellent control of most weed species for at least first four weeks of the growing season on soils up to 3% OM. Based on the 2006 data, at 28 DAT field sandbur was controlled with 228 g ai/ha on soils with 1% OM, green foxtail with 115g and 121g ai/ha on soils with 1% and 2% OM, as well as velvetleaf and tall waterhemp on soils with 3% OM with 189 g ai/ha and 240 g ai/ha. Most soils in Nebraska contain no more than 3% OM, thus the KIH has a good potential for PRE use in corn as it provided excellent early season control of our major weed species (sknezevic2@unl.edu).

UTILIZING **R** SOFTWARE PACKAGE FOR DOSE RESPONSE STUDIES: THE CONCEPT AND DATA ANALYSIS. Stevan Z. Knezevic, Jens C. Streibig, and Christian Ritz, Associate Professor, Haskell Ag. Lab., University of Nebraska, Concord, NE, 68728-2828, and Professor and Post Doc, Royal Veterinary and Agricultural University (KVL), Copenhagen, Denmark **.**

Advances in statistical software allow both standard and more complex statistical methods for non-linear regression analysis of dose response curves to be carried out conveniently by non-statisticians. One such statistical software is the freely available program **R** with the *drc* extension package. The *drc* package can: (1) simultaneously fit multiple dose-response curves, (2) compare curve parameters for significant differences, (3) calculate any point along the curve as the response level of interest, commonly known as an effective dose (eg. ED30, ED50, ED90), and determine its significance, (4) generate graphs for publications or presentations. We believe that when it comes to dose response data, the *drc* package has advantages over many currently available statistical software programs for non-linear regression analysis. Therefore, our objectives are to: (1) provide a review of few common issues in dose response curve fitting, (2) facilitate the use of up-to-date statistical techniques for analysis of dose response curves and (3) invite further debate on the subject (sknezevic2@unl.edu).

Flaming: Potential New Tool for Weed Control in Organically Grown Agronomic Crops

Stevan Knezevic[1] and Santiago Ulloa[2]

Abstract

Field experiments were conducted during summer 2007 to determine a baseline information on crop and weed tolerance to broadcast flaming utilizing different rates of propane. The species evaluated were: maize (*Zea mays*), sorghum (*Sorghum halepense*), soybean (*Glycine max*), sunflower (*Helianthus annuus*), barnyardgrass (*Echinocloa crus-galli*), green foxtail (*Setaria viridis*), velvetleaf (*Abutilon theophrasti*) and redroot pigweed (*Amaranthus retroflexus*). The propane rates applied were 0, 12.1, 30.9, 49.7, 68.5 and 87.22 kg/ha. Species response to propane rates were described by log-logistic models. Overall response to flame varied depending on the species, growth stage and propane rate. Broadleaf weeds were more susceptible to flames than grasses. Field maize and sorghum were less susceptible, while soybean and sunflower were severely injured. Of all crops tested, broadcast flaming has the most potential for use in field maize. However, more research is needed to evaluate flaming procedures (eg. positioning of the flame) in other grass-type crops, and various broadleaf crops.

Introduction

There is an increased interest in organic production among farmers and industries in the United States. This interest is based on the increasing consumer demand for organic foods (Johnson 2005). Organic producers rank weeds as their number one problem (Walz, 1999). Hand weeding and cultivation are the most popular physical methods for weed control utilized by organic growers. However, hand weeding had become cost prohibitive, while repeated cultivation increases the chance of soil erosion and promotes emergence of new weed flushes (Wszelaki *et al.* 2007; Reimens *et al.* 2007). In addition, there are only few organic herbicides approved for use in organic production, and they are cost prohibitive. Therefore, there is a need to evaluate various alternative and integrated methods of weed control. The use of propane for flame weeding could be one of the alternative control methods for weed control in organically grown field crops in United Sates.

During flaming process, the heat from the flame is transferred to the plant tissues increasing the thermal energy of the plant cells (Lague *et al.* 2000) and resulting in coagulation of cell proteins if the temperature is above 50C (Parish 1990). Furthermore, exposing plant tissue to a temperature of about 100C for a split second (eg. 0.1 second) can result in cell membrane rupture (Pelletier *et al.* 1995; Morelle 1993), resulting in loss of water and plant death (Rifai *et al.* 1996).

In order to optimize use of flame, as a weed control tool, the biologically effective dose (ED) of propane for control of major weed species and tolerance of major crops must be determined. Depending on the desired level of weed control, or tolerable crop injury level, a propane dose could be selected to either control the weed, or reduce its growth thereby offsetting its competitive ability against the crop. Goal of our experiments in 2007 was to develop a baseline information on crop and weed tolerance to broadcast flaming. The specific objective was to develop dose response curves for propane on several major weeds and field crops in Nebraska.

Materials and Methods

Field trials were conducted in 2007 at the Haskell Ag Lab in north east Nebraska, and will be repeated in 2008 and 2009. Field site was cultivated on June 15. Seeds of 17 crop and weed species were planted on June 29, as a single row for each species, using push-type planters. In this manuscript we are reporting data for four crop and four weed species, including: field maize (*Zea mays*), sorghum (*Sorghum halepense*), soybean (*Glycine max*), sunflower (*Helianthus annuus*), barnyardgrass (*Echinocloa crus-galli*), green foxtail (*Setaria viridis*), velvetleaf (*Abutilon theophrasti*) and redroot pigweed (*Amaranthus retroflexus*). Volunteer weeds were controlled by hand weeding. Field was irrigated as needed to obtain uniform species emergence.

All species were treated with broadcast flaming. Flaming was conducted utilizing a custom built flamer mounted on a four-wheeler, which was driven across all 18 rows of test species. Flamer produced open flames utilizing propane as source of combustion. There were four burners (LT 2x8) (Flame Engineering, 2007) placed 30 cm apart. Burners were positioned 18 cm above soil surface and angled at 30˚ to the soil. Flamer was calibrated on June 19th, 2007 at 24C and 59% relative humidity. Flaming treatments were applied using a constant speed of about 6 km/h. Varying propane pressures included: 0, 68.9, 206.8, 344.7, 482.6 and 620.2 kPa, corresponding to 0, 10, 30, 50, 70 and 90 PSI, or the rates of propane of 0, 12.1, 30.9, 49.7, 68.5 and 87.22 kg/ha, respectively.

Experiment was set-up as a randomized complete block design with six treatments (propane rates) and three replications. Each plot was 7.6 by 2.1 m, with 18 different species planted in each plot in 38cm row spacing. Visual ratings of percent weed control, or crop injury, was conducted at approximately 3 hours, 1 day after treatment (DAT), 3DAT, 7DAT and 14DAT, and it was based on a scale from 0 to 100 (where 0 = no injury and 100 = plant death). In this manuscript, however, only data collected at 1DAT and 14DAT were presented. Dry matter data was also collected at 14 DAT, but not reported in this manuscript.

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Whole experiment was repeated utilizing the same procedures and planting the exact set of plant species on July 6th. There was no significant difference between the two identical experiments, based on data analysis in SAS, thus data was combined and the means further analyzed utilizing regression analysis.

Data were fit to a log-logistic function with four-parameter (Knezevic et al. 2007):

$$f(x) = c + \frac{d - c}{1 + \exp\left(b(\log(x)) - e\right)}$$

Where *c* is the lower limit, *d* is the upper limit, *b* is the slope and *e* is the value of *x* also known as ED50. Curve fitting was done by non-linear regression using the least square method. All statistical analysis and graphs were performed with **R** program utilizing the Dose Response Curves (*drc*) statistical addition package (Knezevic et al. 2007). The values of ED50, ED80 (80% control) and ED90 (90% control) were determined from the curves and utilized as a measure of the level of weed control by flaming. The ED90 is a standard parameter widely utilized to describe weed response to herbicides (Knezevic et al. 2007). Nevertheless, in organic cropping systems a goal of 90% control might be challenging to achieve. It should be noted that physical control methods (eg. flaming, cultivating) may not be as efficient as conventional chemical methods. For this reason, ED50 and ED80 rates were obtained (Table 1). Crop tolerance to flaming was compared among species utilizing values for ED5 (5% injury), ED10 (10% injury) and ED20 (injury) for each species.

Results and Discussion

<u>Weed control by flaming:</u>

In general, the level of weed control was influenced by the species, their growth stage at the time of flaming, and propane rate. Overall, grasses were harder to control than broadleaf species. Barnyardgrass and green foxtail required higher rates of propane than velvetleaf and pigweed (Figure 1). About 182 kg/ha and 153 kg/ha was needed to obtain 90% control (ED 90) in barnyardgrass and green foxtail, respectively. In contrary, only 53 kg/ha and 67 kg/ha of propane was needed to reach ED90 in velvetleaf and pigweed, respectively (Table 1). Similarly, Wszelaki et al. (2006) reported that grasses were more tolerant to flaming than broadleaf species. Such difference is likely a result of the physical position of the species' growing point at the time of flaming. Growing point in broadleaf species was above the ground, thus exposed to the flame. In contrary, growing point in grassy species during early growth stages was below soil surface, thus protected from the flame (Ascard 1995).

Growing point positioning at the time of flaming also impacts the way plant responded during the period of 2 weeks after flaming. In grassy species that were flamed at earlier growth stages (eg. growing point was below soil surface) there was significant difference between visual control ratings at 1 DAT and 14 DAT, indicating that grassy species can recover from flaming injury and continue to grow pass the 14 DAT rating. That was the case for both barnyardgrass (Figure 1a) and green foxtail (Figure 1b), resulting in significantly different curves for 1 DAT compared to 14 DAT (Figure 1a and 1b). Both grassy species were able to recover at about 30DAT (data not shown). In broadleaf species that were flamed at early stage, there was no much difference between visual control ratings at 1 DAT and 14 DAT, indicating that velvetleaf (Figure 1c) and pigweed (Figure 1d) did not recover after flaming, resulting in their complete control.

Furthermore, plant height can also cause differential response after flaming, especially in grassy species. The level of control of 83 cm tall barnyardgrass (flowering stage) did not differ between 1DAT and 14DAT, resulting is similar curves (Figure 1a), suggesting that barnyardgrass might be sensitive to flaming at the flowering stage. On the other hand, the level of control of 51 cm tall green foxtail (flowering stage) was lower at the 1DAT than 14 DAT, resulting in significantly different curves (Figure 1b). Green foxtail leaves remained green for the first 3 DAT, then turned brown and died. Despite the fact that the flamed leaves died, there was much new leaf growth from tillers and the plant continued to grow by 30 DAT. Such species response to flaming is not unique. We observed similar response in wheat that was flamed at the flowering stage, resulting in severe stunting, but the stem remained green and tillers produced new leaves to support plant growth (Knezevic and Ulloa, unpublished data).

However, it is also important to notice that the plant height did not significantly impact the level of propane needed to obtain 80%, or 90%, of weed control in two out of four weed species. For example, both, the 6 cm and 83 cm tall barnyardgrass was controlled at the 80% level with about 110 kg/ha (Table 1). Similarly, both the 4 cm and 20 cm tall pigweed was controlled at the 80% level with about 45 kg/ha (Table 1). However, higher rate of propane was needed to control taller velvetleaf (Table 1). In contrary, lower rate of propane was needed to control taller green foxtail, which may indicate that green foxtail is more sensitive to flaming at the flowering stage. Such information can be useful for developing strategies for timing flaming operations to control green foxtail.

It is important to notice large difference between the ED80 and ED90 values, especially for grassy weeds at both growth stages of flaming. For example, 102 kg of propane per ha was needed to obtain 80% control of barnyardgrass compared to 182 kg/ha needed for 90% control. It is indicating that 80% more propane was required to get only 10% increase in barnyard control. Similar response was observed for green foxtail, and to some extent in velvetleaf and pigweed.

<u>Crop tolerance to flaming:</u>

Several studies have investigated the effect of flaming on weeds (Ascard 1994, 1995; Lague et al. 1997). We believe that our study is one of the first that evaluated the effects of broadcast flaming in agronomic crops.

In our study, crops were less susceptible to flaming than weeds. It is likely a result of the crop size (eg. plant height) at the time of flaming (Table 2). Most crops were much larger than weeds, as crops emerged earlier and grew faster, particularly during the first 3-4 weeks of growth (data no shown).

Field maize and sorghum were more tolerant to flames than soybean and sunflower. The ED20 for maize was 57 while ED20 for sunflower was 46 kg/ha (Table 2). About 20% injury in soybean was achieved with 44 kg/ha. Sunflower was the most susceptible crop, a rate of 25 kg/ha was sufficient to reach ED 20 (Table 2). Soybean and sunflower, flamed at early stages (VC and VE), did not survive propane rates above 68 kg/ha, both died.

Crop species also differed in their response after flaming. Field maize was the only crop that had more injury at 1DAT than 14DAT in both growth stages (V2 and V7), resulting in different curves for 1DAT and 14DAT (Figure 2a). This indicates that field maize was able to recover after flaming. In fact, maize was not killed by any of the propane rates tested in the study (data not shown). Similar response was observed in sorghum (Figure 2b). Soybean had more injuries at 1DAT than at 14 DAT but only at early stage of growth (VC), resulting in different curves between the 1DAT and 14DAT (Figure 2c), which may indicate that the VC soybean was able to recover from injuries. However, closer examination of the curves showed that soybean recovered only in the low rates of propane, while the rates above 60 kg/ha killed the crop. There was no difference in curves at the later stages in soybean indicating that soybean was not able to recover from flaming injuries. There was no difference in sunflower injuries between 1 DAT and 14 DAT when flamed at VE stage (Figure 1d), resulting in crop kill. However, when sunflower was flamed at V9 there was more injury at 1DAT than at 14 DAT, indicating that later emerging sunflower was able to survive flaming treatments.

Level of crop injury was impacted by the plant height in all species except in field maize. Both, 6cm and 33 cm field maize had 20% injury with about 60 kg/ha (Table 2). However, 3 cm tall sunflower had 20% injury with 25 kg of propane per hectare compared to 50kg/ha for 23 cm tall plants, indicating that taller sunflower had more tolerance to flaming. Reason for such response might be that the growing point of a taller sunflower (23cm) was positioned above the flames, as the flaming torches were placed at 18cm above soil surface. Thus, allowed 23 cm tall sunflower to survive flaming operation, while the 3 cm tall sunflower was completely killed.

In contrary, there was a reduction in ED5, ED10 and ED20 values for sorghum and soybean with the increase in their size, indicating that taller sorghum and soybean were less tolerant to flaming. It is possible that the injuries in taller soybean resulted in much water loss, and plants were not able to recover. Such hypothesis needs to be tested.

Conclusions

Based on the first year of data, broadleaf weeds and broadleaf crops were more susceptible to flaming than grassy species. About 42kg/ha and 50 kg/ha was needed obtain 80% control of velvetleaf and pigweed, respectively. Higher rates of propane were needed to obtain 80% control of barnyardgrass and green foxtail at 14DAT. Despite the fact that there was 80% control of grassy species at 14DAT, there was no complete kill of barnyardgrass and green foxtail as the plants were able to continue growing several weeks after flaming. From practical standpoint, flaming has a potential to be utilized as a tool to control velvetleaf and pigweed species. Even though, there was no complete kill of barnyardgrass and green foxtail, flaming provided early season control of both species by severely reducing their growth, and thereby offsetting their competitive ability against the crop.

It is important to notice large difference in propane rates needed to obtain 80% compared to 90% weed control levels, especially for grassy weeds. It is suggesting that organic producers need to take into account not only the level of weed control but also the economics of control when making weed management decisions

Crop susceptibility to propane rates varied among the specie and growth stages. Maize and sorghum were less susceptible at the very early stages likely because their growing point was below soil surface at the time of flaming. Soybean was more tolerant to flaming at the VC stage, likely due to the fact that cotyledons may have had enough food reserves to overcome loss of some surface area from flaming. Such hypothesis needs to be tested. In contrast, sunflower was less tolerant at the V2 stage, than V9 stage.

Of all crops tested, broadcast flaming has the most potential for use in field maize. Temporary injury of as much as 20% in field maize was obtained with about 60 kg of propane per ha, which was sufficient to provide control of velvetleaf and pigweed. Further studies are needed to determine the level of yield reduction in maize due to 20% injury levels.

Plant response to flaming for each the species evaluated in this study was unique. Plants from the same family and with similar morphological characteristics presented different response (e.g. maize and sorghum). Therefore, the ED values obtained in this experiment for field maize may not be applicable to other types of maize, including pop-corn, seed maize or silage maize.

All crops we tested had various levels of susceptibility to flaming. Therefore, the only way to control weeds without causing any crop injury is to minimize crops exposure to the flames. Results of this study suggested that there is a potential for utilizing flaming as one of the tools for weed control, especially in the grassy type crops (eg. maize). However, more research is needed to evaluate flaming procedures (eg. positioning of the flame) in other grass-type crops, and various broadleaf crops. For example, flaming inter-row space, or positioning flames below the crop canopy (eg. away from crop's growing point) might be much safer in broadleaf crops. Studies are needed to test such hypothesis.

Propane flaming is not an individual practice for non-chemical weed control (Johnson 2004). However, it has potential to be used in organic agriculture, it could be repeated as needed during the growing season, or could be integrated with other non-chemical weed management strategies.

Acknowledgements

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Table 1. Dose of propane needed to obtain 50%, 80% and 90% weed control, as indicated by the respective ED values (standard errors), based on visual ratings at 14 DAT and a function of crop growth stage and plant height.

Specie	Growth Stage	Plant high (cm)	Effective dose of propane (kg/ha)		
			ED 50(SE)	ED 80(SE)	ED 90(SE)
Barnyardgrass	4 L	6	38 (4)	102 (16)	182 (44)
	Flowering	83	42 (4)	110 (19)	194 (50)
Green foxtail	5 L	3	51 (4)	102 (15)	153 (35)
	Flowering	51	29 (4)	77 (13)	134 (35)
Velvetleaf	5 L	5	28 (3)	42 (5)	53 (10)
	7 L	18	38 (2)	56 (5)	72 (8)
Pigweed	3 L	4	30 (2)	50 (5)	67 (10)
	Flowering	20	35 (2)	42 (4)	47(6)

Table 2. Dose of propane that resulted in 5%, 10% and 20% crop injury, as indicated by the respective ED values (standard errors), based on visual ratings at 14 DAT and a function of crop growth stage and plant height.

Specie	Growth Stage	Plant high (cm)	Effective dose of propane (kg/ha)		
			ED 5(SE)	ED 10(SE)	ED 20(SE)
Field maize	V 2	6	35 (11)	44(10)	57 (7)
	V 7	33	31 (15)	43(14)	63 (9)
Sorghum	V 2	5	22 (12)	32(12)	46 (9)
	V 9	76	9 (5)	14(6)	23 (6)
Soybean	VC	5	26 (9)	34(9)	44 (7)
	R 1	46	12 (6)	16(6)	22 (6)
Sunflower	VE	3	15 (4)	19 (4)	25 (4)
	V 9	23	17 (10)	29 (11)	49 (9)

Fig. 1 Propane dose response curves for control of four weed species based on visual control ratings at 1DAT and 14DAT after flaming. Each data point represent a mean of 6 replications n=6. Data was fitted to log-logistic equations with four parameters.

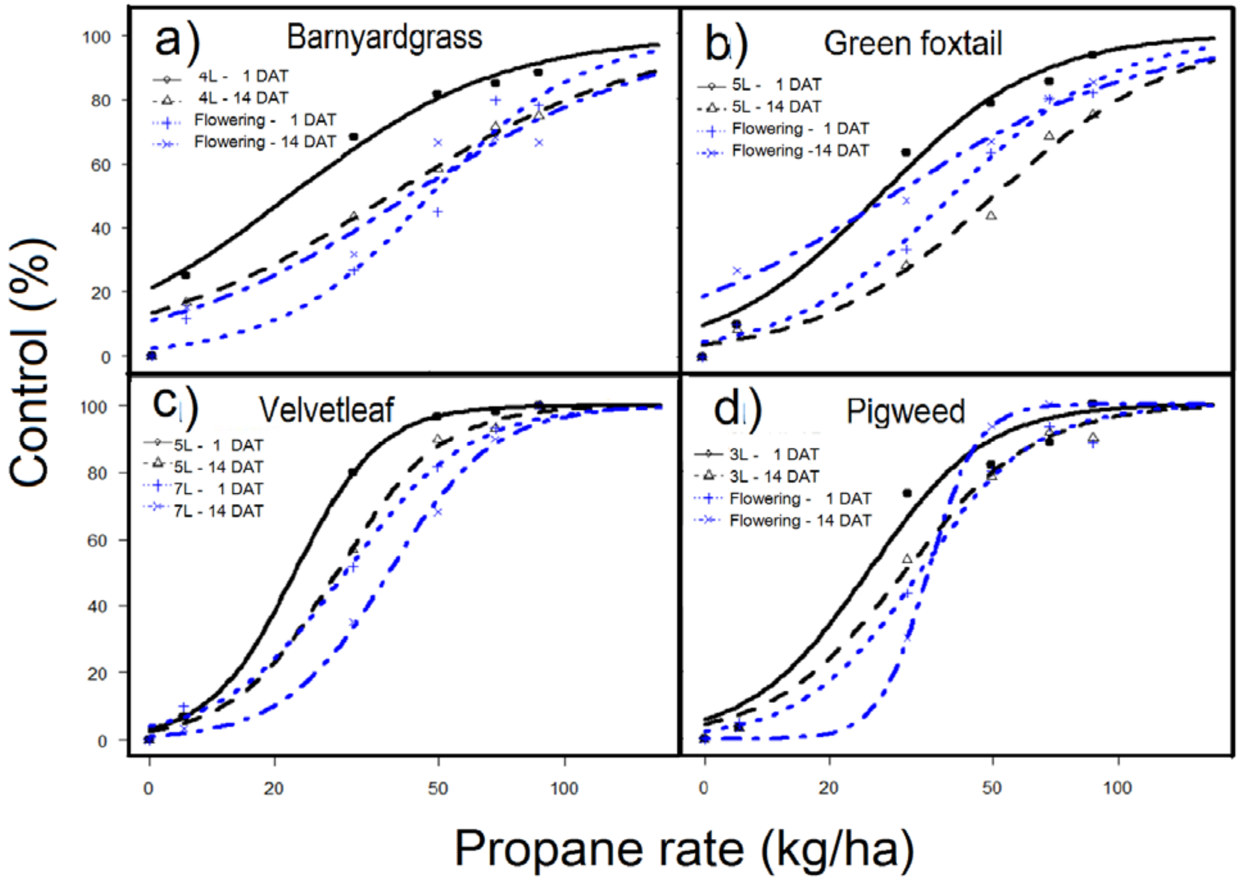
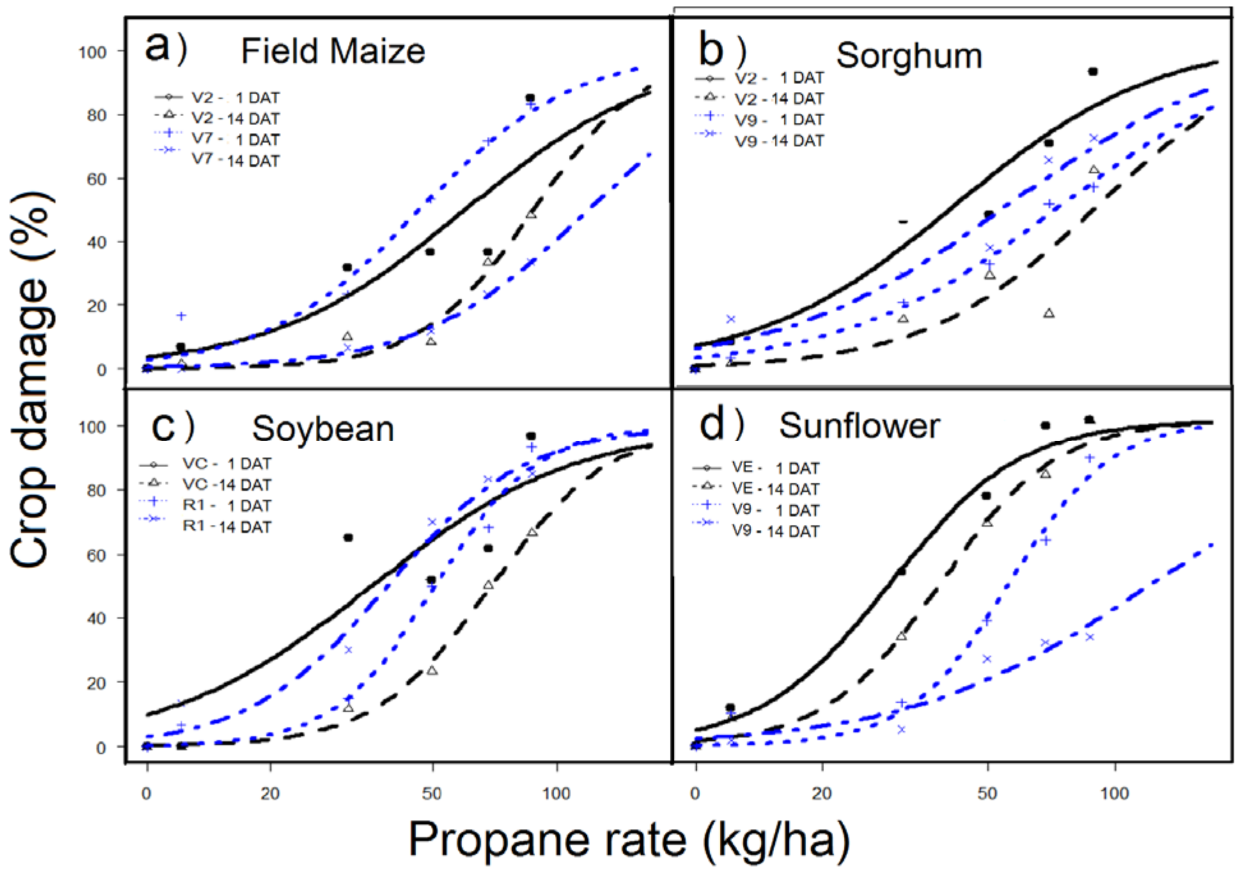


Figure 2. Propane dose response curves for four field crops based on visual injury ratings at 1DAT and 14DAT after flaming. Each point represent the mean of 6 replications n=6. Data were fitted using log-logistic equations with four parameters.



Integrated management of purple loosestrife

Stevan Knezevic, Doug Smith,
Ralph Kulm, Don Doty, Mick Goodrich, Rod Stolcpart and Dick Kincaid

Introduction:

Purple loosestrife (Lythrum salicoria), a wetland weed, is a noxious weed in Nebraska. It was introduced to North America from Europe in the 1800's and made a slow invasion of wetlands and waterways across the Great Lakes region into the Prairie states including Nebraska. It is estimated that about 12,000 acres of Nebraska's wetlands are infested with this plant, mostly along the main rivers. Therefore, there is a need to find a way to stop the spread of this highly competitive species. This weed interferes with various levels of the ecosystem and economy, thus there is a need to test various methods of its control and to increase public awareness of the adverse impact of this noxious weed.

This weed is one tough plant and no magic solution is immediately available. A single control measure cannot provide long term, sustainable, management of this weed therefore an integrated management approach is required. Therefore the overall goal of this long-term study (10 years, started in 2000) is to obtain data on evaluating several weed control methods under Nebraska conditions and to use such data for control recommendations and developing a public awareness program.

Specific objectives: There are three specific objectives of this study:

1. To evaluate performance of several aquatic type herbicides for control of purple loosestrife.
2. To evaluate several non-chemical control methods (e.g. mowing, disking, and replacement species)
3. To start public awareness programs through development of UNL publications and holding public meetings around the state.

Herbicide evaluations:

Herbicides alone may not provide long term control of this weed, however they are a necessary part of an integrated approach to stop the expansion of currently infested acres. They can also be used to spray roadsides and ditches. Therefore a total of 6 herbicides and their mixes will be tested at two application rates. Herbicide application will be conducted around the flowering time of the weed, which is believed one of the most vulnerable stages to control a perennial weed species.

Experimental design: RCBD with 15 treatments and 3 replications. Treatments are randomized in a 6 x 2 factorial arrangement of 6 herbicides and 2 herbicide doses. The list of herbicides will include: Rodeo at 4 & 6 pts/acre, 2,4-D at 2.5 & 5 pts/acre, Garlon 3A at 3 & 5 pts/acre, Arsenal at 4 & 6 pts/acre, Escort at 2 & 4 oz/ acre, Krenite at 3 & 5 gall/acre, and a "economical" mixes of Garlon 3A at 3pts + 2,4-D at 2.5pts, and Escort at 1 pt.+ 2,4-D at 2.5pts. There will be also unsprayed control (see protocol within following pages).

These studies are being conducted in 2000-20010 on four locations along the Niobrara, Missouri and North Platte rivers in Holt, Brown, Buffalo and Dixon counties, the most severely infested areas in Nebraska.