NOT FOR PUBLICATION

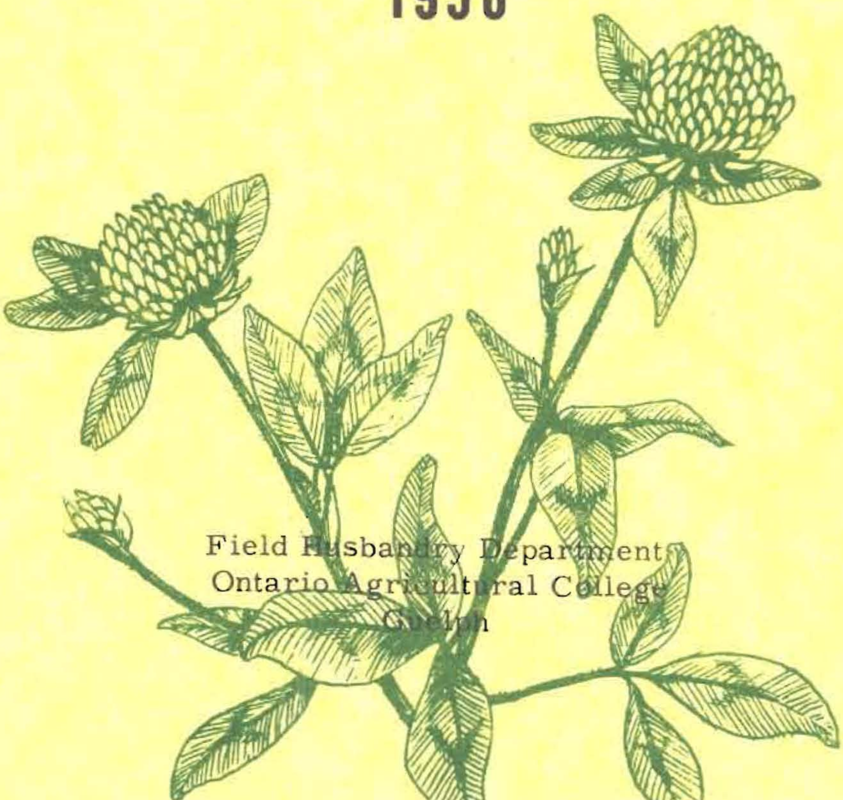
B. E. Twamley

PROGRESS REPORT

FORAGE CROP INVESTIGATIONS

HAY, PASTURE AND SEED PRODUCTION

1956



Field Husbandry Department
Ontario Agricultural College
Guelph

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FORAGE PROGRESS REPORT 1956

The data from all O.A.C. trials are compiled in this report for use of members of the Field Husbandry Department and those associated with the testing programs. Data from co-operative trials at Kemptville and Ridgetown are included in summary form so that all information will be collected to-gether for interpretive purposes.

This report is not complete but does contain the main data collected from current projects and those completed in 1956.

Red Clover vs. Ladino 1954. Composition of Mixtures
in Pounds per Acre

Mixture No.	Alf.	Red.	Lad.	Tim.	Orch.	Brome
1		9		5	3	
2		9		5		
3	6	4		5		
4	6	4		2	3	5
5	6	2	1	2	3	5
6	6		2	2	3	5
7	6	4		3	5	
8	6	2	1	3	5	
9	6		2	3	5	
10	6	4			5	7
11	6	2	1		5	7
12	6		2		5	7
13	6	4		3		7
14	6	2	1	3		7
15	6		2	3		7

Red Clover vs. Ladino 1954, tons of D.M. per acre

Mixture	1955 Hay June	1955 Aft. Aug.	1955 Aft. Sept.	1955 Hay + Aft. Total	1956 Hay June	1956 Aft. Aug.	1956 Aft. Sept.	1956 Hay + Aft. Total	2 Yr. Mean Hay + Aft. Total
Tim. + orch. + br.+									
Alf. + r.cl.	2.96	0.37	0.57	3.90	2.04	0.85	0.54	3.44	3.67
Alf. + r.cl.+Lad.	2.94	0.26	0.74	3.94	2.08	0.88	0.65	3.61	3.78
Alf. + Lad.	2.88	0.33	0.83	4.04	1.99	0.84	0.64	3.47	3.76
Tim. + orch. +									
Alf. + r.cl.	2.85	0.34	0.56	3.75	1.88	0.88	0.58	3.33	3.54
Alf. + r.cl.+Lad.	3.10	0.27	0.75	4.12	2.08	0.89	0.69	3.65	3.89
Alf. + Lad.	2.72	0.32	0.78	3.82	2.08	0.91	0.68	3.66	3.74
Orch. + br. +									
Alf. + r.cl.	2.99	0.45	0.58	4.02	1.82	0.87	0.57	3.26	3.64
Alf. + r.cl.+Lad.	2.77	0.35	0.69	3.81	1.83	0.92	0.64	3.39	3.61
Alf. + Lad.	2.82	0.25	0.69	3.76	1.92	0.92	0.67	3.51	3.62
Tim. + br. +									
Alf. + r.cl.	3.36	0.48	0.54	4.38	2.20	0.82	0.54	3.55	3.96
Alf. + r.cl.+Lad.	3.05	0.10	0.73	3.97	2.47	0.83	0.61	3.91	3.94
Alf. + Lad.	3.06	0.32	0.71	4.09	2.26	0.77	0.57	3.60	3.85
R.cl. + tim. + orch.	3.27	0.24	0.50	4.01	1.71	0.39	0.23	2.32	3.16
R.cl. + tim.	3.12	0.34	0.45	3.91	2.12	0.23	0.18	2.52	3.22
Alf. + r.cl. + tim.	3.05	0.23	0.63	3.91	2.43	0.82	0.57	3.82	3.87
L.S.D. (0.05)	0.28	N.S.	0.18	N.S.	0.17	0.12	0.07	0.27	0.41
(0.01)	0.38	N.S.	0.24	N.S.	0.22	0.16	0.09	0.36	0.55

Red Clover vs. Ladino 1954. Tons D.M. per acre.

Group No.	Association	1955 Hay June	1955 Aft. Aug.	1955 Aft. Sept.	1955 H + Aft. Total	1956 Hay June	1956 Aft. Aug.	1956 Aft. Sept.	1956 H + Aft. Total	2 Yr. Mean H + Aft.
	Legume Comparisons									
1	Alf. + r.cl. + grasses	3.04	0.41	0.57	4.02	1.99	0.85	0.56	3.40	3.70
2	Alf. + r.cl. + Lad. + grasses	2.96	0.27	0.73	3.96	2.12	0.88	0.64	3.64	3.80
3	Alf. + Lad. + grasses	2.87	0.31	0.75	3.93	2.06	0.86	0.64	3.56	3.74
	L.S.D. (0.05)	N.S.	N.S.	0.08	N.S.	0.07	N.S.	0.04	0.11	N.S.
	(0.01)	N.S.	N.S.	0.11	N.S.	0.10	N.S.	0.05	0.15	N.S.
	Grass Comparisons									
4	Tim.+orch.+br.+legs.	2.93	0.32	0.72	3.97	2.04	0.86	0.61	3.51	3.73
5	Tim.+orch.+legs.	2.89	0.31	0.68	3.88	2.01	0.89	0.65	3.55	3.73
6	Orch. + br. + legs.	2.86	0.35	0.65	3.86	1.86	0.90	0.62	3.38	3.62
7	Tim. + br. + legs.	3.15	0.33	0.66	4.14	2.31	0.80	0.57	3.68	3.92
	L.S.D. (0.05)	0.18	N.S.	N.S.	N.S.	0.09	0.06	0.04	0.13	0.23
	(0.01)	0.24	N.S.	N.S.	N.S.	0.12	0.08	0.05	0.17	0.30

Red Clover vs. Ladino 1954. Percent Legumes in Mixtures on a D.M. Basis in 1955.

Mixture	June hay				Aug. aft.				Sept. aft.			
	Alf.	r.cl.	Lad.	Tot.	Alf.	r.cl.	Lad.	Tot.	Alf.	r.cl.	Lad.	Tot.
Tim. + orch. + br. +												
Alf. + r.cl.	4	40	-	44	25	43	-	68	34	13	-	47
Alf. + r.cl. + Lad.	4	15	17	36	34	17	6	57	14	4	25	43
Alf. + Lad.	5	-	29	34	17	-	30	47	13	-	31	44
Tim. + orch. +												
Alf. + r.cl.	4	45	-	49	23	37	-	60	25	11	-	36
Alf. + r.cl. + Lad.	4	23	13	40	19	16	7	42	18	4	23	45
Alf. + Lad.	3	-	28	31	20	-	26	46	13	-	34	47
Orch. + br. +												
Alf. + r.cl.	7	47	-	54	20	47	-	67	27	13	-	40
Alf. + r.cl. + Lad.	3	18	19	40	18	16	13	47	15	4	27	46
Alf. + Lad.	4	-	32	36	17	-	17	34	14	-	27	41
Tim. + br. +												
Alf. + r.cl.	5	54	-	59	30	52	-	82	51	16	-	67
Alf. + r.cl. + Lad.	3	16	19	38	49	15	9	73	27	4	38	69
Alf. + Lad.	3	-	37	40	29	-	26	55	20	-	54	
R.cl. + tim. + orch.	-	47	-	47	-	43	-	43	-	22	-	22
R.cl. + tim.	-	41	-	41	-	83	-	83	-	35	-	35
Alf. + r.cl. + tim.	4	39	-	43	44	46	-	90	44	20	-	64

Red Clover vs. Ladino 1954. Percent Legumes in Mixtures on a D.M. Basis in 1956.

Mixture	June hay				Aug. aft.				Sept. aft.			
	Alf.	r.cl.	Lad.	Tot.	Alf.	r.cl.	Lad.	Tot.	Alf.	r.cl.	Lad.	Tot.
Tim. + orch. + br. +												
Alf. + r.cl.	34	11	-	45	69	7	-	76	65	2	-	67
Alf. + r.cl. + Lad.	22	1	10	33	34	1	24	59	26	2	28	56
Alf. + Lad.	11	-	15	26	24	-	33	57	21	-	34	55
Tim. + orch. +												
Alf. + r.cl.	35	15	-	50	64	8	-	72	54	2	-	67
Alf. + r.cl. + Lad.	14	2	14	30	37	1	24	62	25	2	32	59
Alf. + Lad.	9	-	16	25	18	-	30	48	19	-	35	53
Orch. + br. +												
Alf. + r.cl.	41	9	-	50	65	8	-	73	69	3	-	72
Alf. + r.cl. + Lad.	18	1	17	36	38	1	23	62	30	2	30	62
Alf. + Lad.	14	-	15	29	34	-	22	56	23	-	33	56
Tim. + br. +												
Alf. + r.cl.	33	5	-	38	78	7	-	85	88	3	-	91
Alf. + r.cl. + Lad.	11	1	9	21	44	1	22	67	45	2	37	84
Alf. + Lad.	10	-	10	20	30	-	30	60	35	-	51	86
R.cl. + tim. + orch.	-	20	-	20	-	40	-	40	-	32	-	32
R. cl. + tim.	-	23	-	23	-	62	-	62	-	31	-	31
Alf. + r.cl. + tim.	33	13	-	46	80	11	-	91	82	6	-	88

Red Clover vs. Ladino 1954. Percent Grasses in Mixtures on a D.M. Basis, 1955.

Mixture	June hay Tim.	June hay Orch.	June hay Br.	June hay Tot.	Aug. Total	Sept. aft. Tim.	Sept. aft. Orch.	Sept. aft. Br.	Sept. aft. Tot.
Alf. + r.cl. +									
Tim. + orch. + br.	27	25	4	56	32	2	47	4	53
Tim. + orch.	15	36	-	51	40	3	61	-	64
Orch. + br.	-	40	6	46	33	-	55	5	60
Tim. + br.	29	-	12	41	18	12	-	21	33
Alf. + r.cl. + Lad.+									
Tim. + orch. +br.	20	38	6	64	43	4	48	5	57
Tim. + orch.	24	36	-	60	58	4	51	-	55
Orch. + br.	-	53	7	60	53	-	49	5	54
Tim. + br.	43	-	19	62	27	12	-	19	31
Alf. + Lad. +									
Tim. + orch. + br.	24	37	5	66	53	4	48	4	56
Tim. + orch.	23	46	-	69	54	4	49	-	53
Orch. + br.	-	55	9	64	66	-	54	5	59
Tim. + br.	36	-	24	60	45	8	-	18	26
R.cl. + tim. + orch.	29	24	-	53	57	5	73	-	78
R.cl. + tim.	59	-	-	59	17	65	-	-	65
Alf. + r.cl. + tim.	57	-	-	57	10	36	-	-	36

Red Clover vs. Ladino 1954. Percent Grasses in Mixtures on a D.M. Basis, 1956.

Mixture	June hay				Aug.	Sept. aft.			
	Tim.	Orch.	Br.	Tot.	Total	Tim.	Orch.	Br.	Tot.
<u>Alf. + r.cl. +</u>									
Tim. + orch. + br.	7	38	10	55	24	1	31	1	33
Tim. + orch.	8	42	-	50	28	1	32	-	33
Orch. + br.	-	41	9	50	27	-	27	1	28
Tim. + br.	25	-	37	62	15	3	-	6	9
<u>Alf. + r.cl. + Lad. +</u>									
Tim. + orch. + br.	6	49	12	67	41	2	40	2	44
Tim. + orch.	14	56	-	70	38	1	40	-	41
Orch. + br.	-	50	14	64	38	-	37	1	38
Tim. + br.	35	-	44	79	33	6	-	10	16
<u>Alf. + Lad. +</u>									
Tim. + orch. + br.	14	50	10	74	43	1	43	1	45
Tim. + orch.	15	60	-	75	52	1	46	-	47
Orch. + br.	-	49	22	71	44	-	42	2	44
Tim. + br.	26	-	54	80	40	4	-	10	14
R.cl. + tim. + orch.	21	59	-	80	60	2	66	-	68
R.cl. + tim.	77	-	-	77	38	69	-	-	69
Alf. + r.cl. + tim.	54	-	-	54	9	12	-	-	12

Red Clover vs. Ladino 1954. Percent Total Legumes in Mixtures.

Mixture	1955						1956					
	June hay		Aug. aft.		Sept. aft.		June hay		Aug. aft.		Sept. aft.	
	Act.	Tr.	Act.	Tr.	Act.	Tr.	Act.	Tr.	Act.	Tr.	Act.	Tr.
Tim. + orch. + br. +												
Alf. + r.cl.	44	42	68	56	47	43	45	42	76	61	67	55
Alf. + r.cl. + Lad.	36	37	57	49	43	41	33	35	59	50	56	49
Alf. + Lad.	34	36	47	43	44	42	26	31	57	49	55	48
Tim. + orch. +												
Alf. + r.cl.	49	44	60	51	36	37	50	45	72	58	67	55
Alf. + r.cl. + Lad.	40	39	42	40	45	42	30	33	62	52	59	50
Alf. + Lad.	31	34	46	43	47	43	25	30	48	44	53	47
Orch. + br. +												
Alf. + r.cl.	54	47	67	55	40	39	50	45	73	59	72	58
Alf. + r.cl. + Lad.	40	39	47	43	46	43	36	37	62	52	62	52
Alf. + Lad.	36	36	34	36	41	40	29	33	56	49	56	49
Tim. + br. +												
Alf. + r.cl.	59	50	82	65	67	55	38	38	85	67	91	73
Alf. + r.cl. + Lad.	38	38	73	59	69	56	21	27	67	55	84	66
Alf. + Lad.	40	39	55	48	74	59	20	27	60	51	86	68
R.cl. + tim. + orch.	47	43	43	41	22	28	20	27	40	39	32	34
R.cl. + tim.	41	40	83	66	35	36	23	29	62	52	31	34
Alf. + r.cl. + tim.	43	41	90	72	64	53	46	43	91	73	88	70
L.S.D. (0.05)		6		14		9		7		5		6
(0.01)		8		19		12		9		7		8

Red Clover vs. Ladino 1954. Percentage of Total Legumes in Groups of Mixtures.

Group No.	Association	1955						1956					
		June Act.	hay Tr.	Aug. Act.	aft. Tr.	Sept. Act.	aft. Tr.	June Act.	hay Tr.	Aug. Act.	aft. Tr.	Sept. Act.	aft. Tr.
	Legume comparisons												
1	Alf. + r.cl. + grasses	52	46	69	56	48	44	46	43	76	61	75	60
2	Alf. + r.cl. +Lad.+grasses	39	39	55	48	51	46	30	33	63	52	65	54
3.	Alf. + Lad. + grasses	35	36	46	43	52	46	25	30	55	48	62	52
	L.S.D. (0.05)		4		5		N.S.		3		2		3
	(0.01)		6		8		N.S.		4		3		4
	Grass comparisons												
4.	Tim. + orch. + br. + legs.	38	38	57	49	45	42	35	36	64	53	59	50
5.	Tim. + orch. + legumes	40	39	49	44	43	41	35	36	60	51	60	51
6.	Orch. + br. + legumes	43	41	49	44	42	40	38	38	64	53	63	52
7.	Tim. + br. + legumes	46	43	70	57	70	57	26	31	71	58	87	69
	L.S.D. (0.05)		N.S.		7		5		4		3		3
	(0.01)		N.S.		9		7		5		4		4

Red Clover vs. Ladino 1954. Percent Alfalfa in Mixture.

Moisture	1955						1956					
	June hay		Aug. aft.		Sept. aft.		June hay		Aug. aft.		Sept. aft.	
	Act.	Tr.	Act.	Tr.	Act.	Tr.	Act.	Tr.	Act.	Tr.	Act.	Tr.
Tim. + orch. + br. +												
Alf. + r.cl.	4	11	25	30	34	36	35	36	69	56	65	54
Alf. + r.cl. + Lad.	4	11	34	36	14	22	22	28	34	36	26	31
Alf. + Lad.	5	13	17	24	13	21	11	19	24	29	21	27
Tim. + orch. +												
Alf. + r.cl.	4	11	23	29	25	30	35	36	64	53	65	54
Alf. + r.cl. + Lad.	4	11	19	26	18	25	14	22	37	37	25	30
Alf. + Lad.	3	10	20	27	13	21	9	18	18	24	18	24
Orch. + br. +												
Alf. + r.cl.	7	15	20	27	28	32	41	40	65	54	69	56
Alf. + r.cl. + Lad.	3	10	18	25	15	23	18	25	38	38	30	33
Alf. + Lad.	4	11	17	24	14	22	14	22	34	36	23	29
Tim. + br. +												
Alf. + r.cl.	5	13	30	33	51	46	33	35	78	62	[illegible]8	70
Alf. + r.cl. + Lad.	3	10	49	44	27	31	11	19	44	42	45	42
Alf. + Lad.	3	10	29	33	20	27	10	18	30	33	35	36
Alf. + r.cl. + tim.	4	11	44	42	44	42	33	35	80	63	82	65
L.S.D. (0.05)		N.S.		13		7		8		9		9
(0.01)		N.S.		17		10		11		12		13

Red Clover vs. Ladino 1954. Yield of Alfalfa in Mixtures in Tons D.M. per Acre.

Mixture	1955 June hay	1955 Aug. aft.	1955 Sept. aft.	1955 Total	1956 June hay	1956 Aug. aft.	1956 Sept. aft.	1956 Total	2 year mean Totals
Tim. + orch. + br. +									
Alf. + r.cl.	0.12	0.05	0.20	0.37	0.70	0.59	0.35	1.64	1.00
Alf. + r.cl. + Lad.	0.13	0.07	0.10	0.30	0.45	0.29	0.17	0.91	0.61
Alf. + Lad.	0.14	0.04	0.11	0.29	0.22	0.19	0.13	0.54	0.43
Tim. + orch. +									
Alf. + r.cl.	0.11	0.07	0.14	0.32	0.66	0.56	0.38	1.60	0.95
Alf. + r.cl. + Lad.	0.13	0.04	0.14	0.31	0.29	0.33	0.17	0.79	0.55
Alf. + Lad.	0.08	0.05	0.11	0.24	0.18	0.17	0.12	0.47	0.36
Orch. + br. +									
Alf. + r.cl.	0.21	0.07	0.16	0.44	0.73	0.56	0.39	1.68	1.06
Alf. + r.cl. + Lad.	0.09	0.08	0.11	0.28	0.33	0.35	0.19	0.87	0.57
Alf. + Lad.	0.11	0.04	0.09	0.24	0.27	0.31	0.15	0.73	0.49
Tim. + br. +									
Alf. + r.cl.	0.15	0.09	0.28	0.52	0.73	0.63	0.48	1.84	1.18
Alf. + r.cl. + Lad.	0.10	0.08	0.19	0.37	0.27	0.37	0.28	0.92	0.64
Alf. + Lad.	0.10	0.06	0.11	0.27	0.21	0.23	0.20	0.64	0.46
Alf. + r.cl. + tim.	0.11	0.09	0.27	0.47	0.80	0.66	0.46	1.92	1.18
L.S.D. 0.05	N.S.	N.S.	0.06	0.10	0.19	0.13	0.09	0.32	0.27
0.01	N.S.	N.S.	0.09	0.13	0.25	0.17	0.12	0.43	0.37

Red Clover vs. Ladino 1954. Yield of Alfalfa in Groups of Mixture.

Group No.	Association	1955 June hay	1955 Aug. aft.	1955 Sept. aft.	1955 Total	1956 June hay	1956 Aug. aft.	1956 Sept. aft.	1956 Total	2 year mean Totals
	Legume comparisons									
1	Alf. + r.cl. + grasses	0.15	0.07	0.19	0.41	0.71	0.58	0.40	1.69	1.05
2	Alf. + r.cl.+Lad.+grasses	0.11	0.07	0.14	0.32	0.34	0.33	0.20	0.87	0.59
3	Alf. + Lad. + grasses	0.11	0.05	0.11	0.27	0.22	0.22	0.15	0.60	0.43
	L.S.D. 0.05	N.S.	N.S.	0.03	0.07	0.10	0.06	0.04	0.16	0.14
	0.01	N.S.	N.S.	0.04	0.09	0.13	0.08	0.06	0.22	0.18
	Grass comparisons									
4	Tim. + orch. + br. + legs.	0.13	0.05	0.14	0.32	0.46	0.36	0.22	1.04	0.67
5	Tim. + orch. + legumes	0.11	0.05	0.13	0.29	0.38	0.35	0.22	0.95	0.62
6	Orch. + br. + legumes	0.14	0.06	0.12	0.32	0.44	0.41	0.25	1.10	0.70
7	Tim. + br. + legumes	0.12	0.08	0.19	0.39	0.40	0.41	0.32	1.13	0.76
	L.S.D. 0.05	N.S.	N.S.	0.03	0.08	N.S.	N.S.	0.05	N.S.	N.S.
	0.01	N.S.	N.S.	0.04	0.10	N.S.	N.S.	0.07	N.S.	N.S.

Red Clover vs. Ladino 1954. Yield of Total Legumes in Mixtures in Tons D.M. per Acre.

Mixture	1955 June hay	1955 Aug. aft.	1955 Sept. aft.	1955 Total	1956 June hay	1956 Aug. aft.	1956 Sept. aft.	1956 Total	2 year mean Total
Tim. + orch. + br. +									
Alf. + r.cl.	1.32	0.25	0.27	1.84	0.92	0.64	0.36	1.92	1.88
Alf. + r.cl. + Lad.	1.07	0.16	0.34	1.57	0.68	0.52	0.36	1.56	1.56
Alf. + Lad.	0.93	0.19	0.39	1.51	0.52	0.47	0.35	1.34	1.43
Tim. + orch. +									
Alf. + r.cl.	1.40	0.23	0.21	1.84	0.94	0.63	0.39	1.96	1.89
Alf. + r.cl. + Lad.	1.24	0.14	0.34	1.72	0.62	0.55	0.40	1.57	1.65
Alf. + Lad.	0.83	0.16	0.36	1.35	0.49	0.44	0.36	1.29	1.32
Orch. + br. +									
Alf. + r.cl.	1.63	0.33	0.24	2.20	0.91	0.63	0.41	1.95	2.07
Alf. + r.cl. + Lad.	1.13	0.24	0.34	1.71	0.65	0.57	0.39	1.61	1.66
Alf. + Lad.	1.02	0.10	0.29	1.41	0.56	0.52	0.37	1.45	1.43
Tim. + br. +									
Alf. + r.cl.	2.00	0.37	0.36	2.73	0.84	0.68	0.50	2.02	2.37
Alf. + r.cl. + Lad.	1.16	0.14	0.51	1.81	0.51	0.56	0.51	1.58	1.69
Alf. + Lad.	1.21	0.17	0.53	1.91	0.44	0.46	0.50	1.40	1.65
R.cl. + tim. + orch.	1.54	0.11	0.12	1.77	0.34	0.16	0.08	0.58	1.17
R.cl. + tim.	1.25	0.27	0.17	1.69	0.47	0.14	0.06	0.67	1.18
Alf. + r.cl. + tim.	1.32	0.20	0.40	1.92	1.12	0.75	0.48	2.35	2.13
L.S.D. 0.05	0.37	0.18	0.15	0.50	0.22	0.11	0.08	0.31	0.37
0.01	0.50	0.23	0.20	0.66	0.30	0.15	0.10	0.41	0.50

Red Clover vs. Ladino 1954. Yield of Total Legumes in Groups or Mixture.

Group No.	Association	1955 June hay	1955 Aug. aft.	1955 Sept. aft.	1955 Total	1956 June hay	1956 Aug. aft.	1956 Sept. aft.	1956 Total	2 year mean Totals
	Legume comparisons									
1	Alf. + r.cl. + grasses	1.57	0.30	0.28	2.15	0.90	0.65	0.41	1.96	2.05
2	Alf. + r.cl. + Lad. + grasses	1.15	0.17	0.38	1.70	0.61	0.55	0.42	1.58	1.64
3	Alf. + Lad. + grasses	1.00	0.15	0.39	1.54	0.50	0.47	0.39	1.36	1.45
	L.S.D. 0.05	0.19	0.09	0.08	0.26	0.11	0.05	N.S.	0.15	0.19
	0.01	0.26	0.13	0.11	0.35	0.15	0.07	N.S.	0.20	0.25
	Grass comparisons									
4	Tim. + orch. + br. + legumes	1.11	0.20	0.33	1.64	0.71	0.54	0.36	1.61	1.62
5	Tim. + orch. + legumes	1.16	0.18	0.30	1.63	0.68	0.54	0.38	1.60	1.62
6	Orch. + br. + legumes	1.26	0.22	0.29	1.77	0.71	0.57	0.39	1.67	1.72
7	Tim. + br. + legumes	1.46	0.22	0.46	2.15	0.60	0.57	0.50	1.66	1.90
	L.S.D. 0.05	0.22	N.S.	0.10	0.30	N.S.	N.S.	0.05	N.S.	0.22
	0.01	0.29	N.S.	0.13	0.40	N.S.	N.S.	0.06	N.S.	0.29

Red Clover vs. Ladino 1954. **Number of Plants per Square Foot.**

Mixture	1955				1956						
	July		Sept.		May					Oct.	
	Alf.	R.cl.	Alf.	R.cl.	Alf.	R.cl.	Tim.	Orch.	Br.	Alf.	R.Cl.
Tim. + orch. + br. +											
Alf. + r.cl.	2.3	2.9	2.5	1.7	3.1	1.7	1.4	6.3	2.3	2.6	1.9
Alf. + r.cl. + Lad.	1.6	1.0	2.1	0.4	2.1	0.5	0.8	4.9	2.8	1.7	0.3
Alf. + Lad.	1.4	-	1.6	-	1.8	-	2.0	6.1	3.7	1.3	-
Tim. + br. +											
Alf. + r.cl.	2.3	3.3	3.9	2.4	3.8	1.4	3.0	-	6.0	3.2	1.3
Alf. + r.cl. + Lad.	2.6	1.5	2.4	0.6	2.7	0.2	3.2	-	6.2	2.0	0.3
Alf. + Lad.	1.3	-	1.8	-	1.6	-	2.8	-	5.0	1.4	-
L.S.D. 0.05	N.S.	1.1	1.2	0.4	N.S.	N.S.	1.5	N.S.	2.1	0.9	0.8
0.01	N.S.	1.6	1.6	0.6	N.S.	N.S.	2.1	N.S.	2.9	1.2	1.2
C.V.	43.4	24.8	32.7	34.2	41.7	58.3	45.6	19.6	32.9	29.1	13.5

Mixture Formulation 1954. Composition of Mixtures and Rates of Seeding

Mixture	Alfalfa	Red clover	Ladino	Timothy	Orchard	Brome
1	6	4	1	2	0	5
2	6	4	1	2	2	5
3	6	4	1	2	4	5
4	6	4	1	2	8	5
5	6	2	1	2	2	5
6	6	2	1	2	4	5
7	6	2	1	2	8	5
8	8	4	1	2	2	5
9	8	4	1	2	4	5
10	8	4	1	2	8	5
11	8	2	1	2	2	5
12	8	2	1	2	4	5
13	8	2	1	2	8	5
14	10	4	1	2	2	5

* lbs. per acre germinating 85% or more.

Mixture Formulation 1954. Yields of D.M. in tons/acre

Mix. No.	1955 June hay	1955 Aug. aft.	1955 Sept. aft.	1955 Aft. tot.	1955 Yr. Tot.	1956 June hay	1956 Aug. aft.	1956 Sept. aft.	1956 Aft. tot.	1956 Yr. Tot.	2 year average June hay	2 year average Aft. tot.	2 year average Yr. tot.
1	3.22	0.31	0.90	1.21	4.43	2.34	0.85	0.61	1.46	3.80	2.78	1.34	4.12
2	3.22	0.34	0.96	1.30	4.52	2.23	0.88	0.66	1.54	3.77	2.73	1.42	4.15
3	3.13	0.45	0.92	1.37	4.50	2.01	0.98	0.68	1.66	3.67	2.57	1.52	4.09
4	3.18	0.46	0.95	1.41	4.59	2.09	1.02	0.69	1.71	3.80	2.64	1.56	4.20
5	3.10	0.51	0.97	1.48	4.58	2.14	0.96	0.68	1.64	3.78	2.62	1.56	4.18
6	3.10	0.51	0.99	1.50	4.60	2.04	1.05	0.66	1.71	3.75	2.57	1.61	4.18
7	3.11	0.51	1.03	1.54	4.65	2.23	1.00	0.68	1.68	3.91	2.67	1.61	4.28
8	3.09	0.43	0.93	1.37	4.45	2.11	0.90	0.69	1.59	3.70	2.60	1.48	4.08
9	3.32	0.49	0.93	1.42	4.74	2.17	1.02	0.64	1.66	3.78	2.75	1.54	4.26
10	3.16	0.61	0.92	1.53	4.69	2.11	1.00	0.69	1.69	3.80	2.64	1.61	4.25
11	3.29	0.48	0.91	1.39	4.68	2.15	1.00	0.63	1.63	3.78	2.72	1.51	4.23
12	3.23	0.61	1.02	1.63	4.86	2.15	1.00	0.67	1.67	3.82	2.69	1.65	4.34
13	3.12	0.63	0.97	1.60	4.72	1.99	1.09	0.72	1.81	3.80	2.56	1.71	4.26
14	3.10	0.46	0.90	1.36	4.46	2.23	0.98	0.68	1.66	3.89	2.67	1.51	4.18

Mixture Formulation 1954. Yields of Groups in tons of D.M. per acre

Mean Mix. No.	June hay	Aug. aft.	Sept. aft.	aft. total	yr. total
			1955		
1	3.22	0.31	0.90	1.21	4.43
2,3,4	3.18	0.42	0.94	1.36	4.54
5,6,7	3.10	0.51	1.00	1.51	4.61
8,9,10	3.19	0.51	0.93	1.44	4.63
11,12,13	3.21	0.57	0.97	1.54	4.75
14	3.10	0.46	0.90	1.36	4.46
			1956		
1	2.34	0.85	0.61	1.46	3.80
2,3,4	2.11	0.96	0.68	1.64	3.75
5,6,7	2.14	1.00	0.67	1.68	3.81
8,9,10	2.13	0.97	0.67	1.65	3.78
11,12,13	2.10	1.03	0.67	1.70	3.80
14	2.23	0.98	0.68	1.66	3.89
			2 year average		
1	2.78	0.58	0.76	1.34	4.12
2,3,4	2.64	0.69	0.81	1.50	4.15
5,6,7	2.62	0.76	0.84	1.59	4.21
8,9,10	2.66	0.75	0.80	1.54	4.20
11,12,13	2.66	0.80	0.82	1.62	4.28
14	2.67	0.72	0.79	1.51	4.18

Mixture Formulation 1954. Percent Legumes in Mixtures

Mix. No.	June hay Alf.	June hay r.cl.	June hay Lad.	June hay Tot.	Aug. aft. Alf.	Aug. aft. r.cl.	Aug. aft. Lad.	Aug. aft. Tot.	Sept. aft. Alf.	Sept. aft. r.cl.	Sept. aft. Lad.	Sept. aft. Tot.
1	27	1	6	34	60	2	15	77	51	1	34	86
2	25	2	6	33	55	1	15	71	42	1	23	66
3	37	1	8	46	61	1	16	78	41	1	20	63
4	34	3	6	43	55	1	15	71	50	1	18	69

Mixture Formulation 1954. Percent Grasses in Mixtures

Mix. No.	June hay Tim.	June hay Orch.	June hay Br.	June hay Tot.	Aug. aft. Tim.	Aug. aft. Orch.	Aug. aft. Br.	Aug. aft. Tot.	Sept. aft. Tim.	Sept. aft. Orch.	Sept. aft. Br.	Sept. aft. Tot.
1	31	-	35	66	4	-	19	23	4	-	10	14
2	19	37	11	67	2	25	5	29	1	32	1	34
3	7	41	6	54	1	19	2	22	1	35	1	37
4	11	40	6	57	1	25	3	29	1	29	1	31

Mixture Formulation Trial, 1955

	No. in F.H. 29-4						No. in F.H. 29-5					
	4	5	6	13	14	15	2	5	8	11	14	4
	Lbs. per acre of mixture number											
	1	2	3	4	5	6	7	8	9	10	11	12
Alfalfa	6	6	6	6	6	6	6	6	8	8	10	6
Red Clover	4	2		4	2		4	2	4	2	4	4
Ladino		1	2		1	2	1	1	1	1	1	1
Timothy	2	2	2	3	3	3	2	2	2	2	2	2
Orchard	3	3	3				2	2	2	2	2	8
Brome	5	5	5	7	7	7	5	5	5	5	5	5

Mixture Formulation 1955

Yields of Mixtures in Tons D.M. per Acre, 1956

Mixture No.	June hay	Aug. aft.	Sept. aft.	aft. total	Yr. Total
1	3.01	0.83	0.69	1.52	4.53
2	2.64	0.85	0.75	1.60	4.24
3	2.62	0.93	0.84	1.77	4.39
4	2.80	0.83	0.66	1.49	4.29
5	2.86	0.83	0.73	1.56	4.42
6	2.61	0.91	0.82	1.73	4.34
7	2.82	0.98	0.78	1.76	4.58
8	2.96	0.84	0.75	1.59	4.55
9	2.91	0.91	0.76	1.67	4.58
10	2.62	0.85	0.76	1.61	4.23
11	2.93	0.86	0.74	1.60	4.53
12	2.70	0.80	0.72	1.52	4.22
Mean of 1, 2, 3	2.76	0.87	0.76	1.63	4.39
Mean of 4, 5, 6	2.74	0.86	0.74	1.59	4.35

Mixture Formulation 1955

Yields of Total Legumes in Lbs./Acre

Mixture No.	June hay	Aug. aft.	Sept. aft.	Aft. Total	Year Total
1	4763	1265	1070	2335	7098
2	3835	1163	1113	2276	6111
3	3882	1316	1233	2549	6431
4	4403	1453	1215	2668	7071
5	4630	1517	1336	2853	7483
6	3783	1593	1541	3134	6917
7	4332	1546	1075	2621	6953
8	4416	1270	1158	2428	6844
9	4416	1338	1146	2484	6900
10	4098	1298	1182	2480	6578
11	4437	1250	1076	2326	6763
12	4144	1218	1092	2310	6454
Mean of 1, 2, 3	4160	1248	1139	2387	6547
Mean of 4, 5, 6	4272	1521	1364	2885	7157

Mixture Formulation 1955

Percent Legumes in Mixtures 1956

Mixture No.	June hay				Aug. aft.				Sept. aft.			
	Alf.	R.cl.	Lad.	Tot.	Alf.	R.cl.	Lad.	Tot.	Alf.	R.cl.	Lad.	Tot.
1	45	34	-	79	60	17	-	77	71	6	-	77
2	47	23	3	73	55	8	5	68	64	2	8	74
3	68	-	6	74	57	-	14	71	54	-	19	73
4	43	36	-	79	66	21	-	87	84	8	-	92
5	46	30	5	81	71	13	7	91	72	6	14	92
6	66	-	6	72	67	-	21	88	77	-	17	94
7	39	33	5	77	60	11	8	79	54	7	8	69
8	38	29	7	74	61	7	7	75	61	4	12	77
9	47	25	4	76	61	9	4	74	69	2	5	76
10	57	15	6	78	63	8	5	76	70	1	6	77
11	42	30	4	76	60	8	5	73	66	2	5	73
12	37	35	5	77	58	12	6	76	60	5	11	76

Mixture Formulation 1955

Percent Grasses in Mixtures 1956

Mixture No.	June hay				Aug. aft.				Sept. aft.			
	tim.	orch.	br.	tot.	tim.	orch.	br.	tot.	tim.	orch.	br.	tot.
1	5	13	3	21	2	18	3	23	2	20	1	23
2	2	22	3	27	1	28	3	32	2	22	2	26
3	7	15	4	26	2	24	3	29	2	23	2	27
4	12	-	9	21	6	-	7	13	3	-	5	8
5	10	-	9	19	5	-	4	9	4	-	4	8
6	20	-	8	28	3	-	9	12	3	-	3	6
7	5	14	4	23	1	18	2	21	2	27	2	31
8	2	20	4	26	1	22	2	25	2	20	1	23
9	5	16	3	24	1	23	2	26	2	21	1	24
10	3	15	4	22	1	21	2	24	1	21	1	23
11	4	14	6	24	2	23	2	27	1	25	1	27
12	1	21	1	23	1	21	2	24	1	22	1	24

Recommended Hay-Pasture Mixtures 1954

Species	Composition in lbs. per acre of Mixture Number:											
	1	2	3	4	5	6	7	8	9	10	11	12
Alfalfa	5	4		6	4	6	5	5		5		6
R. Clover	5	5	9	4	3	4	3			4*	8	4
Ladino		1			1	1	1	1				
Alsike							1	2		1	2	
Birdsfoot Trefoil									5			
Timothy	2	2	5	2	5	2	3	5	5	8	8	5
Orchard	5	5	3	3	3	3	2					
Brome	5	5		5	5	5	5		5			
Meadow Fescue								3				
Reed Canary								4				

* late red clover

Table 1:- Recommended Hay-Pasture Mixtures 1954. Tons D.M./Ac. in 1955.

Mixture No.	Hay June 23	Aftermath			Seasonal Total
		Aug. 8	Sept. 8	Total	
4	3.14	0.38	0.66	1.04	4.18
6	2.99	0.33	0.70	1.02	4.01
9	1.59	0.08	0.11	0.19	1.78
10	3.30	0.34	0.60	0.94	4.24
11	3.51	0.13	0.40	0.53	4.04
12	3.26	0.34	0.59	0.93	4.18

Table 2:- Recommended Hay-Pasture Mixtures 1954. Tons D.M./Acre in 1956.

Mixture No.	Hay July 6	Aftermath Aug. 16*	Season Total
4	2.09	.96	3.05
6	2.08	.96	3.04
9	1.84	.68	2.52
10	2.40	.88	3.28
11	2.28	1.00	3.28
12	2.32	.92	3.24

* mixture 9 cut on Sept. 10

Recommended Hay-Pasture Mixtures 1954. Composition of D.M. in %, 1956

Mix.No.	Alf.	R.Clover	Lad.	B. Tref.	Tim.	Orch.	Brome
				Hay			
4	38.4	9.6	-	-	14.2	28.8	9.0
6	24.8	7.6	8.1	-	18.5	30.9	10.1
9	-	-	-	39.4	43.7	-	16.8
12	35.0	6.1	-	-	58.9		
				Aftermath			
4	78.2	8.2	-	-	1.9	8.2	3.5
6	62.4	2.5	15.2	-	2.0	13.2	4.6
9	-	-	-	84.4	4.4	-	11.2
12	88.8	3.7	-	-	7.5		

Hay-Pasture Mixtures at New Liskeard, 1955

Mixtures Seeded at New Liskeard

Species	Variety	Lbs./acre in mixture number							
		1	2	3	4	5	6	7	8
Alfalfa	Vernal	7	4	5	7	7		7	7
Red Clover D	Lasalle	2	2	2	3			3	3
S	Leon		2	2		3			
Alsike	Alon	1	1	1					
B. Trefoil	Empire						6		
Timothy	Medon	5	5	4	2	2	5	5	
Orchard	Oron				3	3			
Brome	Com.	7	7	4	5	5	5		10
Meadow Fescue	Mefon			3					

Hay-Pasture Mixtures, New Liskeard

Tons D.M./acre in 1956

Mixture No.	July 10	Aug. 31	Total
1	2.20	.93	3.13
2	2.20	.80	3.00
3	2.43	.92	3.35
4	2.36	.90	3.26
5	2.36	.82	3.18
6	2.16	.48	2.64
7	2.24	.84	3.08
8	2.14	.81	2.95

College Farm Plantings 1956

A. O.A.C. Farm

Field S_3

	(1)		(1)		
	Empire	8	Viking	8	(8 acres)
	Can. Brome	8	Can. Brome	8	

Hay + aftermath for sheep pasture or sheep pasture all season

Field Empire 8 + S-48 6 lbs.

Late cut hay + aftermath pasture for sheep (10 acres)

Field D1

Vernal	8
Lasalle	3
Ladino	1
Can. Brome	10 - broadcast on when oats 4-6"

Hay + aftermath pasture for dairy herd

Field 1A

Du Puits	5
Ladino	2
S-143	8

Irrigated pasture for dairy herd (4-5 acres)

B. Auld Farm

Field 2	Acreage
1. Vernal 10 lbs. + S-37 7 lbs.	3
2. " " + Frode 7 lbs.	3
3. " " + Can. Brome 10 lbs.	3
4. Can. Grimm 10 lbs. + Can. Brome 10 lbs.	3
5. Du Puits 10 lbs. + " " "	3
6. Vernal 10 lbs. + Lasalle 3 lbs. "	remainder field

Management: grass silage for 3, 4 and 5. Remainder as hay-pasture.

C. Kay Farm

Field E (10 acres)

	lbs./acre	
Can. Var. alfalfa	10	
S-123	3	
Dorset Marl.	3	This mixture seeded as result of mixing error.
S-100	$1\frac{1}{2}$	
S-48	8	

Field G (15 acres)

	lbs./acre
Vernal	10
Dorset Marlgrass Red Clover	3
S-100	$1\frac{1}{2}$
Can. Brome	10

Orchard Grass vs. Bromegrass in a Beef Pasture

R.P.O.: F.H. 13-2 Cooperative with Animal Husbandry

Objective: To compare brome grass and orchard grass as a grass for use in pasture mixtures for beef cattle. The main considerations in this experiment are: (1) yield of forage and of beef per acre and (2) effect of the grass species on the survival of the legume.

Procedure:

The trial was seeded at the Arkell farm using 3 replications each containing two three acre plots. The two mixtures are:

	lbs./acre		lbs./acre
Alfalfa	10	Alfalfa	10
Ladino	1.5	Ladino	1.5
White Dutch	1.5	White Dutch	1.5
Orchard	12	Brome	15

In 1955 seven steers averaging about 650 lbs. were placed in each plot on May 26 and kept there as long as there was pasture. The last group of steers was removed on July 5th. Growth ceased in early June because of drought and did not commence again until mid-August. The area was allowed to recover to strengthen the stand until late fall when it was grazed moderately. No record was made of pasture days or livestock gains during this late fall grazing.

In 1956, three steers averaging 676 lbs. were placed in each plot on June 9th and taken off September 26th. This was not sufficient steers to utilize the available pasture so that it was not possible to assess the beef production per acre from the two grasses in 1956. Data were obtained to compare the palatability of each mixture as measured by dry matter intake by the steers and by the relative gains per animal.

Measures of growth and consumption were taken at intervals throughout the season using the cage-strip method. Ten cages were placed in each three acre block. At each harvest date samples were taken under each cage and 10 strips were cut in the grazed area. The cages were then moved to a new site on the grazed area.

Five samples from each plot at each harvest date in 1955 and on June 7, 1956 were separated into their component species to determine the contribution of brome vs. orchard to the pasture yield and to study the effect of the grass on the legume.

Alfalfa stand counts were made in August, 1955 and September 1956 to observe the competitive effect of the two grasses on alfalfa survival.

Table 1:- Orchard vs. Brome in Beef Pasture. Growth and Consumption (tons D.M./ac.) in 1955 and 1956.

Growth Period	Growth		Consumption	
	Brome	Orchard	Brome	Orchard
1955				
Up to May	1.18	0.95	-	-
May 25 - June 14	0.31	0.65	0.20	0.41
June 14 - June 28	0.08	0.01	0.38	0.19
Total early season	1.57	1.16	1.03	0.60
June 28 - Sept. 12	0.64	0.73		
Sept. 12 - Oct. 19	0.07	0.23		
Total late season	0.71	0.96	N.M.*	N.M.*
Season Total	2.28	2.12		
1956				
Up to June 6	0.86	0.45	-	-
June 6 - June 21	1.47	1.20	.50	.28
June 21 - July 30	1.40	1.05	.60	.46
July 30 - Sept. 7	0.75	0.65	.44	.53
Sept. 7 - Oct. 16	0.30	0.36	.05	.19
Season Total	4.78	3.70	1.59	1.46
Percentage Consumed			33.2	30.9

* not measured.

Table 2:- Orchard vs. Brome in Beef Pasture. Beef Yields and Pasture Days per Acre in 1955 and 1956.

Year	Lbs. Beef per Acre		Lbs. Gain per Day		Total Pasture Days	
	Brome	Orchard	Brome	Orchard	Brome	Orchard
1955*	156	122	1.58	1.49	84	84
1956**	168	147	1.54	1.35	109	109
Difference	+28		+.14		0	

* up to July 5
** pasture not fully utilized

Table 3:- Orchard vs. Brome in Beef Pasture. Composition (%) of the Herbage and Alfalfa Plant Population.

	% of D.M.			No. Alfalfa Plants per Square Foot	
	May 25 1955	Oct. 19 1955	June 7 1956	Aug. 19 1955	Sept. 18 1956
Brome Mixture					
Alfalfa	37.5	20.1	21	11.3	3.5
Ladino	10.5	5.9	T		
Brome	41.9	74.0	77		
Weeds	10.1	0.0	2		
Orchard Mixture					
Alfalfa	29.5	4.0	16	7.0	1.4
Ladino	8.5	0.7	0		
Orchard	54.0	95.3	84		
Weeds	8.0	0.0	T		

Results:

Good stands of grass, alfalfa and white clover were obtained in all plots. During the early spring of the first crop year (1955) orchard grass growth was set back severely as the result of *Scolecotrichum graminis* coupled with frost injury. Heading of the orchard grass was sparse. The severe drought of 1956 caused growth to cease before mid-June and it did not commence regrowth until late summer. This reduced the seasonal yields and killed out the white clover in all areas except the low sections in the plots.

Growth was excellent in 1956. The grass growth was greater than could be utilized by the available steers so that much of the herbage matured and was left ungrazed.

The main information provided by this experiment is:

1. Brome grass was more compatable with alfalfa than orchard grass. This compatability was evidenced even in the first crop year where there were 11.3 alfalfa plants per square foot in the brome mixture and 7.0 in the orchard mixture. In addition the alfalfa plants

were more vigorous in the brome mixture.

2. Brome grass mixtures can be high yielding in the first harvest year. This is contrary to the opinion often held by farmers that brome does not produce well in the first year.
3. Brome grass is less subject to injury by frost, disease and poor soil drainage conditions than orchard grass. Orchard grass killed out severely in the poorly drained sections of the field during the 1955-1956 winter; brome did not kill out in similar areas.
4. The brome grass mixture outyielded the orchard grass mixture in dry matter production in both years. In 1956 the difference was one ton of dry matter per acre in favour of brome. This increase was in early season growth. In the latter part of the season orchard either equalled or outyielded brome at each cutting date each year.
5. Steers gained better on the brome mixture. The average daily gain per steer for the two years was 1.56 lbs. for brome and 1.42 for orchard. The steers on brome gained 28 lbs. more per head than those on orchard during the two years.
6. The increased gains per steer are probably related to dry matter intake. Steers on the brome mixture consumed more in both years than those on the orchard mixture. However, in the later summer and fall of 1956 consumption was greater in orchard than brome. Orchard grass produced more regrowth at this time of the year than brome and it is likely that this succulent growth was more palatable than the more mature brome grass. This suggests that both orchard and brome, used in separate mixtures might be valuable where full season pasture is required ie. where cattle are not ready to market until late summer or fall. This is not conclusive.

7. The differences in consumption found in this experiment suggest that palatability or acceptibility of a pasture may have an important bearing on the beef yield of a pasture.

Birdsfoot Trefoil Mixtures 1954. Tons D.M. per Acre

Mixture	1955				1956				
	May 27	July 12	Sept. 7	Total	June 26	Aug. 15	Sept. 10	Total	2 year ave.
Empire + M. Fescue	1.25	0.98	1.17	3.40	2.20	1.38	-	3.58	3.49
+ Can. Brome	1.14	1.05	0.92	3.12	2.23	1.10	-	2.33	2.72
+ Orchard	0.83	0.52	1.00	2.35	1.51	1.38	-	2.89	2.62
+ Medon Timothy	1.19	0.97	1.09	3.25	2.23	1.26	-	3.49	3.37
~~+ T + O + B + F~~	~~1.42~~	~~0.82~~	~~1.01~~	~~3.25~~	~~2.40~~	-	-	-	-
+ T + O + B	0.99	-	0.98	-	1.77	-	-	-	-
+ T + O + F	1.12	0.66	1.09	2.87	1.83	-	-	-	-
+ O + B + F	1.06	-	1.02	-	1.94	-	-	-	-
Alf. + Emp. + T + B + F	1.30	1.02	1.19	3.51	2.48	1.35	.31	4.14	3.83
Alf. + R.Cl. + T + O + B	1.53	0.70	0.72	2.94	2.11	.93	.24	3.28	3.11

Birdsfoot Trefoil Mixtures 1954. Legume % in 1956

Mixture	June		August	
	Trefoil	Total Legume	Trefoil	Total Legume
Empire + M. fescue*	21.8	-	63.4	-
+ Can. Brome*	21.0	-	53.6	-
+ Orchard*	24.5	-	38.5	-
+ Medon Tim.*	14.0	-	60.8	-
Alf. + Emp. + T + B + F	4.2	37.7	5.6	72.6
Alf. + R.Cl. + T + O + B	-	37.8	-	55.7

* volunteer timothy in all mixtures

Pasture Irrigation Trial 1954. Increase in D.M. Yield Due to Irrigation

Mixture	Increase Over 1955 Season	Residual Measured in 1956				Increase Over 2 years
		June 12	July 20	Aug. 24	Season Total	
Ladino + Medon Timothy	+6340	-329	+498	-340	-171	6169
Ladino + Orchard	+4340	+661	+224	+256	+1141	5481
Ladino + Can. Brome	+5420	+ 7	+492	+140	+639	6059
Ladino + Orchard + Brome	+5140	+239	+399	+466	+1104	6244
Ladino + O + B + Fesc.	+4380	+573	+528	+212	+1313	5693
O + B + Fesc.	+2020	+853	+349	+654	+1856	3876
Ladino + W. Dutch + O + B	+4760	+198	+354	+328	+880	5640
Alf. + Lad. + W.D. + T + O + B + F	+3620	+444	+438	+381	+1263	4883
Mean	+4502	+331	+410	+262	+1003	5505

Pasture Irrigation Trial, 1954. Tons D.M. per Acre in 1956

Mixture	June 12	July 20	Aug. 24	Total
		Irrigated		
Ladino + Orchard	2584	1118	1926	5628
Ladino + Can. Brome	2243	1284	1810	5337
Ladino + Medon Timothy	1870	1420	1690	4980
Ladino + Orchard + Brome	2138	1274	1916	5328
Lad. + W. Dutch + O. + B.	1903	1256	1817	4976
Ladino + O. + B. + Fescue	2516	1394	1868	5778
Alf. + Lad. + W.D. + T. + O. + B. + F.	2396	1302	1978	5676
+ O. + B. + Fescue*	1414	724	1372*	3510
Mean	2133	1221	1797	5159
		Non Irrigated		
Ladino + Orchard	1923	894	1670	4487
Ladino + Can. Brome	2236	792	1670	4698
Ladino + Medon Timothy	2199	922	2030	5151
Ladino + Orchard + Brome	1899	875	1450	4224
Lad. + W. Dutch + O. + B.	1705	902	1489	4096
Ladino + O. + B. + Fescue	1943	866	1656	4465
Alf. + Lad. + W.D. + O. + B. + F.	1952	864	1597	4413
Ladino + O. + B. + Fescue*	561	375	718	1654
Mean	1802	811	1535	4148
Alfalfa + Brome	2599	1363	2189	6151

* Includes considerable volunteer white clover in 1956.

Effect of Row Spacings and Rates of Seeding Upon the Seed Yield of Orchard Grass and Timothy

R.P.O.: F.H. 14-3.

Objectives: As outlined in 1955 report.

Procedure: As outlined in 1955 report.

Results and Discussion:

(1) Timothy

The results with timothy are shown in Tables 1 to 5. The first table gives the number of seed stems produced per square foot of land area. The differences among row spacings were highly significant with the largest number of stems per unit area produced under the 14 inch row spacing.

Table 2 shows the head lengths produced under the various rates and spacings. The 28 and 35 inch row spacings produced the largest heads.

The seed yields shown in Table 3 were the same from all seeding rates in 1956. Rates of seeding were significant in the first production year in 1955. The seed yields from the various row spacings were significant in 1956, as in the previous year. The 7 inch spacing gave lowest yields of seed.

The different row spacings also produced highly significant differences among seed weights. The 35 inch rows produced the heaviest seed, the narrow 7 inch rows the lightest seed.

The establishment of the timothy seed in a clay-loam soil is given in Table 5. These data were not subjected to analysis.

(2) Orchard Grass

The results with orchard grass are shown in Table 6 to 11.

The stem counts at all rates and row spacings were much higher in 1956 than in the previous year. No differences were present among the rates of seeding used but highly significant differences were present among the row widths. The 14 and 21 inch row spacings gave the highest number of seed stems per unit area.

In the yield of seed produced, the 14 and 21 inch spacing gave the best results in 1956, the 7 inch spacing was the best in 1955. There were no differences among the rates of seeding a yield of seed in 1956. The medium rates were best in the previous year. The seed yields were almost twice as high in 1956 as in the first year of production.

In 1956 the highest seed weight was obtained from the heavier rates of seeding. In 1955, the reverse was the case. The weight of seed per head in Table 9 was not analized but there appears to be a greater weight of seed produced per head as the row spacing increased from 7 to 35 inches.

The establishment data in Table 10 and the height of the seedlings produced in Table 11 were not analized. There appeared to be no differences in germination or height among the rates of seeding or row widths used.

Summary:

(1) Rates of seeding did not effect the yield of seed obtained from stands of timothy and orchard grass in their second production year. Differences in seed yield were present among rates in the first year of production.

(2) Differences among row spacings were present with timothy and orchard grass. In seed yield and seed stem production the 14 inch row spacing gave the highest yield and stem number with both species. Row spacing differences were also present in 1955.

(3) Some of the other data collected showed differences among rates of seeding and row spacings with both timothy and orchard grass.

Table 1

Timothy - Stems per Square Foot

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	Rate Mean
2½	53.6	69.8	50.0	46.2	36.7	51.2
5	51.9	65.7	49.8	44.2	34.5	49.2
7½	54.1	62.8	47.5	46.5	38.6	49.9
10	57.9	61.4	46.0	41.8	37.5	48.9
Row Mean	54.4	64.9	48.2	44.7	36.8	49.8

Row Spacing (.05) 20.3
(.01) 27.5 C.V. 9.7%

Table 2

Timothy - Head Lengths in Cms.

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	Rate Mean
2½	6.6	6.8	7.3	7.0	7.1	7.0
5	6.5	6.9	6.7	7.1	6.9	6.8
7½	6.5	6.8	6.6	7.4	7.1	6.9
10	6.3	6.6	6.6	7.0	7.1	6.7
Row Mean	6.5	6.8	6.8	7.2	7.1	

Row Spacing (.05) 0.6 C.V. 4.3%

Table 3

Timothy - Seed Yield in Pounds per Acre

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	250.5	362.3	339.0	340.9	302.2	319.0	363.7
5	240.0	376.9	330.4	359.9	338.1	329.0	337.3
7½	231.1	355.6	348.7	353.2	318.1	328.0	343.5
10	253.6	349.4	325.5	374.5	320.3	324.6	321.3
1956 Row Mean	243.7	361.0	335.8	357.1	319.7	323.5	
1955 Row Mean	278.4	352.2	382.5	358.2	335.8		341.4

Row Spacing (.05) 98.7 C.V. 9.4%

Table 4

Timothy - Weight of 1,000 Seeds in Grams

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	.3453	.3556	.3640	.3613	.4016	.3632	.327
5	.3461	.3322	.3781	.3694	.4701	.3666	.327
7½	.3470	.3591	.3694	.3829	.3765	.3670	.327
10	.3469	.3571	.3717	.3678	.3793	.3646	.337
1956 Row Mean	.3463	.3510	.3708	.3673	.3911	.3653	
1955 Row Mean	.304	.318	.331	.352	.343		.330

Row Spacing (.05) .0140
(.01) .0190 C.V. 6.4%

Table 5

Timothy - Percent Establishment in Soil

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	66	64	76	67	70	69	62
5	77	67	74	81	70	74	60
7½	74	66	74	68	64	69	63
10	75	67	66	74	71	71	62
1956 Row Mean	73	66	73	73	69	71	
1955 Row Mean	65	63	63	57	61		62

Table 6

Orchard Grass - Stems per Square Foot

Rating Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	25.3	47.6	44.5	27.7	25.7	34.2	16.7
5	28.6	49.6	43.6	27.7	23.9	34.7	21.0
7½	26.4	54.4	44.6	27.6	24.2	35.4	21.2
10	28.6	48.9	42.4	25.1	25.3	34.0	21.0
12½	31.3	53.1	43.3	25.6	22.5	35.2	17.8
15	28.3	53.1	41.7	28.3	25.1	35.4	17.0
1956 Row Mean	28.1	51.1	43.3	27.0	24.5	34.8	
1955 Row Mean	38.4	22.7	13.3	11.8	9.3		19.1

Row Spacing (.05) 8.7 C.V. 11.1%
(.01) 12.7

Table 7

Orchard Grass - Seed Yield in Pounds per Acre

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	266.5	304.2	308.0	305.4	282.6	293.3	128.2
5	249.5	332.6	323.0	278.9	275.2	291.8	169.4
7½	272.7	335.1	326.6	292.2	258.1	296.9	181.3
10	273.4	347.0	312.2	303.9	258.6	299.0	172.9
12½	287.6	312.1	323.7	322.9	261.4	301.5	162.8
15	290.1	315.5	314.0	303.1	284.8	301.5	145.7
1956 Row Mean	273.3	324.4	317.9	301.1	270.1	297.4	
1955 Row Mean	216.2	196.0	139.6	129.5	118.9		160.0

Row Spacing (.05) 40.5 C.V. 9.8%

Table 8

Orchard Grass - Weight of 1,000 Seeds in Grams

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1956 Rate Mean
2½	1.085	0.993	1.018	1.065	1.130	1.058	1.253
5	1.018	1.017	1.049	1.088	1.101	1.054	1.254
7½	1.042	1.060	1.032	1.071	1.078	1.057	1.244
10	1.082	1.027	1.074	1.054	1.101	1.068	1.225
12½	1.117	1.108	1.088	1.102	1.089	1.101	1.229
15	1.098	1.105	1.068	1.127	1.098	1.099	1.211
1956 Row Mean	1.074	1.052	1.055	1.084	1.099	1.073	
1955 Row Mean	1.161	1.210	1.257	1.274	1.271		1.234

Rate Seeding (.05) .036 C.V. 5.3%

Table 9

Orchard Grass - Weight of Seed per Head in Grams

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean
2½	.245	.251	.245	.315	.366	.284
5	.208	.235	.322	.310	.283	.271
7½	.205	.251	.247	.289	.252	.249
10	.269	.207	.285	.276	.304	.268
12½	.254	.260	.327	.295	.296	.286
15	.221	.264	.315	.277	.335	.282
1956 Row Mean	.234	.245	.290	.294	.306	

Table 10

Orchard Grass - Percent Establishment in Soil

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	77.2	77.7	85.5	74.5	73.7	77.7	70.5
5	72.0	76.2	79.0	68.2	78.2	74.7	73.3
7½	72.2	81.5	75.7	81.0	71.7	76.4	71.3
10	79.7	72.7	81.5	68.7	78.2	76.2	74.7
12½	79.0	79.7	86.5	75.7	67.7	77.7	74.6
15	80.0	80.0	81.0	74.0	71.5	77.3	75.0
1956 Row Mean	76.7	78.0	81.5	73.7	73.5	76.7	
1955 Row Mean	75.3	73.0	74.5	73.3	72.8		73.5

Table 11

Orchard Grass - Seedling Height in Cms. 40 Days after Seeding

Rate Seeding lbs./ac.	Row Spacing (in.) 7	14	21	28	35	1956 Rate Mean	1955 Rate Mean
2½	9.2	9.6	9.5	9.5	10.0	9.6	9.2
5	9.1	9.0	9.1	10.2	9.7	9.4	9.3
7½	9.2	9.7	10.2	9.2	9.5	9.6	9.7
10	8.6	10.2	9.1	9.5	8.5	9.2	9.3
12½	9.4	9.2	9.9	9.2	10.4	9.6	9.3
15	9.6	9.5	9.2	10.2	10.4	9.8	9.9
1956 Row Mean	9.2	9.5	9.5	9.6	9.7	9.4	
1955 Row Mean	9.9	9.3	9.4	9.2	9.4		9.4

The Effect of Rate of Seeding and Row Spacing of an Oat Companion Crop Upon Forage Seedling Establishment

R.P.O.: F.H. 15-3.

Objectives: As outlined in 1954 report.

Procedure: As outlined in 1954 report with the exception that the hay-pasture mixture was changed to a mixture of alfalfa and bromegrass each of which were seeded at 10 lbs. per acre.

Results and Discussion:

In 1956 the oat companion crop lodged at heading time and it was necessary to cut it green in order to prevent the forage seeding from smothering. This, coupled with an extremely wet year, reduced the competition for the normal growth factors and consequently no stand differences were present in alfalfa. With bromegrass, however, significant differences in stand appeared among the various seeding rates, but these are difficult to associate with the seeding rate of the oat companion crop.

The vigor of the alfalfa plants, as measured by plant height at the heading time of the oats, showed that the height decreased with an increase in seeding rate. These differences, though not as great as in former years, showed again a decrease in plant height with an increase in rate of seeding of the oats. There were no differences in alfalfa height between the 7 and 14 inch drills.

As the rate of seeding of the oats in 1955 increased, the stand decreased and the hay data in 1956 showed the same trend. Significant differences were obtained in the first hay cutting among the rates where the oats were in 7 inch drills and also among the rates in the split analysis. The lighter the seeding of oats in 1955, the heavier the yield of hay in 1956.

The hay was composed of 25% orchard grass, 2% timothy, 12% brome, 24% red clover and 37% alfalfa. The grass and the red clover components in the hay followed the same downward trend as their stands when the seeding rate of oats was increased. The alfalfa component however, showed an inverse relationship and increased its amount in the hay with the increased rate of seeding, though its stand had decreased.

Summary:

1. The favourable establishment year of 1956 caused the alfalfa and brome seedings to produce excellent stands under all seeding rates of oats.
2. The oats were removed after heading because of lodging, thus no stand differences were present with alfalfa but differences were obtained with brome.
3. Hay yields in 1956 decreased with an increase in the rate of seeding of the oats used to establish the crop in 1955.
4. The specie components of the hay decreased with an increase in the rate of seeding of the oats with the exception of alfalfa which showed a direct relationship.

Rate of Seeding Oats on Stand and Hay Yields

Seeding Rate	Stand and Vigor 1956				Stand 1955		Composition 1956		Hay Yields 1956		
	Alfalfa Height cms.	Alfalfa	Brome	Total Stand	Total Legume	Total Grass	Percent Legume	Percent Grass	First Cut	Second Cut	Total
7" Drills 0	32.3	18.3	17.8	36.4	22.0	17.6	55.1	45.0	2.31	1.37	3.69
½	30.8	19.6	22.9	43.3	15.5	18.8	59.1	40.9	2.16	1.42	3.59
1	28.7	18.8	19.8	42.2	14.3	15.3	61.3	38.5	2.36	1.54	3.90
1½	28.5	19.3	18.3	3[illegible].3	12.4	15.7	61.3	38.6	2.29	1.43	3.73
2	28.4	20.7	21.8	41.9	8.4	14.3	57.2	42.7	1.97	1.34	3.32
2½	26.4	17.1	24.8	44.5	9.1	13.2	61.2	38.8	1.81	1.42	3.24
3	25.8	15.5	26.0	42.3	9.7	13.5	66.5	33.4	1.76	1.44	3.21
3½	27.3	19.6	21.7	41.6	10.7	11.2	67.2	32.6	2.02	1.28	3.31
4	24.6	21.7	17.5	40.0	8.9	11.5	63.9	36.0	1.58	1.38	2.97
L.S.D.		N.S.	2.9 3.9	N.S.	3.7	4.8			.50	N.S.	N.S.
C.V.		19.9	10.6	12.9	23.5	22.6			17.0	35.5	12.5
14" Drills ½	30.6	17.4	19.7	38.8	14.1	14.1	67.2	33.1	2.49	1.49	3.98
1	28.3	16.6	16.3	35.0	15.6	13.6	71.8	27.9	2.23	1.46	3.69
1½	28.5	17.4	18.7	38.3	16.6	14.4	65.4	35.2	2.45	1.47	3.92
2	28.0	17.0	17.3	38.9	14.8	12.8	61.7	39.1	2.37	1.53	3.80
Drill Width Mean ½	30.7	18.5	19.3	40.1	14.8	16.4	61.1	39.0	2.42	1.52	3.94
1	28.5	17.7	16.5	35.7	15.0	14.4	65.4	34.4	2.10	1.40	3.50
1½	28.5	17.4	16.9	36.0	15.5	15.0	63.3	36.8	2.11	1.44	3.55
2	28.2	18.7	17.1	39.8	11.6	13.5	61.5	38.6	1.97	1.45	3.42
L.S.D. Rates		N.S.	N.S.	N.S.	N.S.	N.S.			0.23 0.32	N.S.	0.35
C.V.		19.9	20.9	14.6	17.9	20.4			10.4	11.3	8.8
Mean ½-2 bu. Rate 7" Drill	29.1	18.4	16.9	38.0	12.7	16.3	59.2	40.7	1.92	1.42	3.34
14" Drill	28.8	17.7	18.0	37.7	15.7	13.7	65.2	34.8	2.38	1.49	3.87

The Effect of Rate of Seeding Oats and Fertility Levels Upon the Establishment of Alfalfa and Birdsfoot Trefoil with Bromegrass

R.P.O.: F.H. 33-12.

Objectives: The objectives of the study are to ascertain the effect of the following upon the establishment of alfalfa-brome and birdsfoot trefoil-brome mixtures.

(a) rate of seeding oat companion crop.

(b) 7 and 14 inch drill widths of the companion crop.

(c) low and high fertility levels

(d) soil types.

Procedure:

Alfalfa-brome and birdsfoot trefoil-brome were overseeded on plots where a companion crop of oats was seeded at 1, 1½ and 2½ bushels per acre in 7 inch drills and 1½ bushels in 14 inch drills. The low fertility rate was an application of 100 lbs. of 4-24-12 per acre, the high fertility rate was 300 lbs. of the same fertilizer. The soil types were a light sand at Hespeler, clay-loam at Guelph and a heavy clay at Brampton. The test was a modified split plot with four replications.

The test at Hespeler produced such a poor stand of oats, it was discarded. Stand counts were taken on the Guelph and Brampton tests in September. Six square foot samples were taken per plot at Brampton, four at Guelph.

Results and Discussion:

At Guelph, the alfalfa and brome established equally well under the low and high fertility rates. There were also no differences among the rates of seeding the oats with either species. At Brampton, however, the low rate in 7 and 14 inch drills established more plants of alfalfa than the heavy oat

oat rates. With brome at Brampton, the heavy fertilizer rate established more plants than the light rate.

The trefoil and brome established (table 2) equally well in 7 and 14 inch drills at Guelph and Brampton. There were also only small differences between fertility levels at the two locations with trefoil and brome.

Summary:

(1) In general, all species at both Guelph and Brampton established approximately same number of plants under the two fertility levels and the different rates and spacings of seeding oats.

(2) Bromegrass established approximately twice as many plants per square foot at Guelph as at Brampton.

Table 1

Rates and Fertility on Alfalfa-Brome-Plants per Square Foot

Location and Rate	Alfalfa			Brome		
	Low	High	Mean	Low	High	Mean
Guelph 1	13.2	10.2	11.7	16.6	17.1	16.8
1½	10.1	10.6	10.4	18.0	18.1	18.0
2½	9.7	11.6	10.6	17.3	18.7	18.0
1½-14	10.2	10.3	10.3	17.1	17.4	17.3
Mean	10.8	10.7		17.2	17.8	
Mean % estab.	22.5	22.3		60.7	62.9	
Brampton 1	10.3	10.5	10.4	7.9	10.2	9.1
1½	10.3	9.2	9.7	7.4	8.9	8.1
2½	8.9	9.4	9.2	8.8	8.0	8.4
1½-14	12.6	9.2	10.8	8.3	8.8	8.5
Mean	10.5	9.6		8.1	9.0	
Mean % estab.	21.8	20.0		28.6	31.8	
Guelph	C.V. - 20.3%; N.S.			C.V. - 19.1%; N.S.		
Brampton	C.V. - 9.9%; Rates 1.2			C.V.-17.4%;Fert.(.05)		

Table 2

Rates and Fertility on Birdsfoot Trefoil-Brome - Plants per Square Foot

Location and Spacing	Birdsfoot Trefoil			Brome		
	Low	High	Mean	Low	High	Mean
Guelph 7 inch	5.5	7.4	6.4	15.3	17.1	16.2
14 inch	6.4	5.5	6.0	14.8	19.4	17.1
Mean	5.9	6.4		15.0	18.2	
Mean % estab.	8.0	8.6		66.0	80.1	
Brampton 7 inch	10.8	10.0	10.4	7.6	7.1	7.3
14 inch	8.6	10.0	9.4	9.3	7.4	8.3
Mean	9.8	10.0		8.4	7.2	
Mean % estab.	13.2	13.5		37.0	31.7	

Companion Crop Management

R.P.O.: F.H. 33-14.

Objectives: To learn the most satisfactory manner of handling a companion crop on a new seedling in order to establish the best stand.

Procedure:

Oats at $1\frac{1}{2}$ bu. per acre and barley at 2 bu. were used as the companion crops and were overseeded with alfalfa and bromegrass, each sown at 10 lbs. per acre. The small seeds were harrowed after seeding. The companion crops were treated as shown in the table of results. All clipped plots were trimmed back to a height of six inches.

The plots were five feet wide and twenty-two feet long. Stand counts were made in September with four square foot counts per plot meaned for analysis. A randomized block design with four replications was used.

Results and Discussion:

Clipping of the companion crop reduced the stand of alfalfa. The best stand was obtained where no companion crop was used and with a companion crop of barley. With bromegrass, however, barley plots gave the poorest stand with no differences among the other management practices.

In this study, plots that were to be left for grain lodged soon after heading due to a heavy crop of straw. The lodging was so severe that all plots were mowed and the companion crop removed to prevent smothering of the new seedings.

Companion Crop Management - Plants per Sq. Foot

Management		Alfalfa Stand	Brome Stand	Total Stand
Oats cut 10" left		12.2	18.7	30.8
Oats cut 24" left		13.4	17.6	31.0
Oats cut 24" off		14.2	20.2	34.4
Oats grain		14.2	19.2	33.4
Oats 14" grain		15.0	20.2	35.2
Oats hay		13.7	21.4	35.1
Barley grain		17.4	13.4	30.9
No companion		20.2	20.2	40.3
Mean percent estab.		59.8	66.4	63.3
L.S.D.	(.05)	4.5	4.3	6.2
	(.01)	-	-	-
C.V.		20.4	15.6	12.4

Summary:

(1) Alfalfa established a thicker stand where no companion crop or barley was used than under oats clipped or left for grain.

(2) Bromegrass established a lower stand under barley than under any of the other treatments.

(3) Hay yields to be taken in 1957.

Methods of Seeding Alfalfa and Bromegrass

R.P.O.: F.H. 33-7.

Objectives: As outlined in 1955 report.

Procedure: As outlined in 1955 report.

Results and Discussion:

The stand establishment was discussed in the 1955 report. Differences were present.

Results obtained from the botanical separations of the hay from these stands in 1956 showed a high percent of grass in the mixture. Though six to eight times as many plants of alfalfa established as bromegrass, the latter species still occupied 25% of the mixture in the first cutting. This high percentage was produced from only two to three plants of brome per square foot.

The hay yields were not high from any of the methods but probably compare favourably with yields in the area. No differences were present in hay yields in either cuttings among the methods of seeding used.

Summary:

(1) Bromegrass, though it established poorly in 1955, made up approximately 25% of the hay component in 1956.

(2) The seeding methods used to establish the stand in 1955 did not effect the hay yields obtained in 1956.

Seeding Methods on Establishment and Hay Yields

	1955 Stand		1956 Hay Comp.		1956 Hay Yds.-Tons		
Method of Seeding	Alfalfa Plants Sq./Ft.	Brome Plants Sq./Ft.	% Alfalfa	% Brome	1st Cut	2nd Cut	Total Yield
Grain drill and harrow	12.6	2.3	81.0	19.0	2.00	.91	2.95
Grain drill pack before	20.2	2.2	86.0	14.0	1.97	.98	2.94
Grain drill pack after	16.3	2.2	75.7	24.3	1.97	.94	2.90
Grain drill pack before & after	20.2	3.0	72.8	27.2	1.95	.90	2.86
Brillion seeder	21.8	0.8	97.6	2.4	1.86	.89	2.75
Band seeder	14.7	2.5	79.6	20.4	1.72	.88	2.63
Band seeder pack after	16.1	2.6	83.0	17.0	1.63	.92	2.75
L.S.D. (.05)	3.2	0.9			N.S.	N.S.	N.S.
(.01)	4.2	1.2					
C.V.	17.9	40.6			8.2	7.4	5.0

Methods of Seeding with a Grain Drill

R.P.O.: F.H. 33-8

Objectives: To learn the most satisfactory method of establishing a mixture of alfalfa and bromegrass with the common grain drill.

Procedure: The bromegrass component of the mixture was mixed with oats and in all cases seeded through the grain box. The oat companion crop was sown at 2 bushels per acre, the brome at 8.6 pounds. The alfalfa was seeded through the grass seed box at 10 pounds per acre.

The plot size was approximately 40 feet long and a drill width wide. The test was laid out in a randomized block design with four replications. The oats were harvested for grain and the stand counts were taken in September. Six square foot samples were taken per plot, counted and meaned for analysis.

Results and Discussion:

The results with alfalfa indicated that this species established better where some form of coverage of the seed took place. Higher stands were obtained where alfalfa was broadcast in front of the hoes and where packing or harrowing took place. The low stand obtained where the oats were seeded at the regular depth may be due to the seed falling in the deep furrow openings caused by the hoes and the seed later being covered to deeply with soil washed in from rains.

The brome established a good stand where it was seeded shallow. When planted at the regular depth of 2½ inches with oats, the stand was reduced considerably. The poor stand obtained

Methods of Seeding with Grain Drill - Plants Sq. Foot

Method		Alfalfa Stand	Brome Stand	Total Stand
Before hoe, shallow		10.5	4.7	15.4
After hoe, shallow		8.5	8.1	16.8
After hoe, shallow, pack		10.1	8.3	19.6
After hoe, shallow, harrow		10.9	8.5	19.4
After hoe, regular		5.0	5.1	10.6
With oats, shallow		8.4	7.1	15.8
With oats, regular, harrow		10.1	4.7	15.4
Band, shallow		7.4	7.3	14.8
Mean percent estab.		14.8	27.6	19.1
L.S.D.	(.05)	2.4	1.1	3.1
	(.01)	3.3	1.5	4.4
		18.8	10.4	13.0

from the first method shown in the table was caused from difficulty encountered in setting the drill to sow at a uniform shallow depth. Packing or harrowing, also improved the stand of bromegrass.

Summary:

1. Band seeding alfalfa gave the poorest stand. Forms of coverage improved the stand of this species.

2. Bromegrass established poorly when seeded with oats planted at the regular depth of seeding the oat crop.

Band Seeding Forage Crops

R.P.O.: F.H. 33-13.

Objectives: To study the effect of banding alfalfa and bromegrass seeds over fertilizer in combination with other seeding practices upon establishment.

Procedure: Alfalfa and bromegrass were banded directly over a fertilizer application of 250 pounds of 4-24-12 per acre. The band seeding of these species was coupled with other treatments shown in the table. The oats were seeded at 2¼ bushels, the brome at 9.6 pounds and the alfalfa at 10 pounds per acre.

Plant measurements were made during the summer in some plots and stand counts (six square foot samples per plot) were made in September.

Results and Discussion:

Banding alfalfa did not increase the stand. This method coupled with packing or wide spacing gave about the same stand as where the alfalfa was broadcast and harrowed. The brome component established more plants where the oats were in wide drills or where no oats were planted. Harrowing after banding brome also improved the stand over banding alone.

There were little differences in the height of the alfalfa plants among the treatments when measured at the first of August.

Band Seeding - Plants per Sq. Foot

Method	Alfalfa	Brome	Total Stand	Alfalfa plant height - cms.
Band 1"	8.4	5.4	13.9	
Band 2"	9.9	5.1	15.0	
Band ½" below	8.8	5.8	14.6	29.7
Band harrow	9.3	7.9	17.2	
Band pack	10.3	6.0	16.3	
Band 16 drills	10.5	8.1	18.6	23.6*:25.9**
Band no oats	10.5	11.5	22.0	26.2
Broadcast harrow	12.5	6.3	18.7	
Mean percent estab.	20.9	25.7	22.6	
L.S.D. (.05)	N.S.	2.2	4.8	
L.S.D. (.01)		3.0	-	
C.V.	21.2	21.3	19.3	

* oat row
** no oats

Summary:

(1) Band seeding did not increase the establishment of alfalfa.

(2) Brome that was banded without a companion crop or that was harrowed after banding gave more plants than where banded alone with oats.

Seedbed Firming and Seed Coverage

R.P.O.: F.H. 33-15

Objectives: To learn if firming a seedbed is necessary in order to establish alfalfa and bromegrass and if better stands are obtained where the seed has been lightly covered.

Procedure:

Similar to that outlined under F.H. 33-7 in the 1954 report. All seedings were made with a companion crop of oats seeded shallow at 2¼ bushels per acre. A John-Deere grassland drill was used. Plots were approximately 40 feet long and one drill width wide. The bromegrass was seeded with the oats at 9.6 lbs. per acre, the alfalfa through the grass-seed box at 10 lbs. per acre.

The methods as listed in the table were carried out by using a cultipacker light sections of stiff-tooth harrows, logging chains and a band seeding attachement. The stand counts were taken in late September after the oats were harvested for grain. Six square foot samples were taken per plot, counted and meaned for analysis. The experimental design was a randomized block with four replications.

Results and Discussion:

The results obtained with the alfalfa component in 1956 indicated that firming the soil both before and after seeding give the highest establishment. This agrees with results obtained in F.H. 33-7 in 1954.

Seed Bed Firming and Coverage on Plants Per Square Foot

Methods		Alfalfa Stand	Brome Stand	Total Stand
Pack before		11.2	6.7	17.9
Pack after		13.3	7.9	21.2
Pack before and after		16.2	7.9	24.0
Pack before harrow after		15.2	8.4	23.6
Harrow		12.7	7.2	19.9
Band		9.9	7.9	17.9
Chains		10.5	6.2	16.7
Check		10.3	7.8	18.1
Mean percent estab.		25.8	27.3	26.4
L.S.D.	(.05)	2.9	N.S.	3.7
	(.01)	4.0		5.0
C.V.		16.1	14.8	12.6

Band seeding gave poor results which also agrees with all previous tests. Covering with chains or leaving the alfalfa uncovered gave similar results to band seeding.

With bromegrass there were no differences among the methods in establishment.

Summary:

(1) Both alfalfa and bromegrass established satisfactory stands. Firming and covering both before and after seeding was advantageous with the alfalfa.

(2) No differences in the establishment of brome were present among the methods used.

Spring Seeding Forage Crops on Winter Wheat

R.P.O.: F.H. 33-16.

Objectives: To determine the best methods of establishing forage species on winter wheat in the early spring.

Procedure: The study is as divided into four small tests as follows:

(1) Seed rate of alfalfa test. In this study, alfalfa was seeded on wheat in plots in a randomized block test with 4 reps. The rates of seeding ranged from 8 to 16 lbs. at 2 lb. intervals. The seed was broadcast by hand in late March. Six square foot counts were taken per plot in October and meaned for analysis.

(2) Mulching test. Alfalfa was seeded on winter wheat in March at 12 lbs. per acre. This seeding was mulched previously with straw at $\frac{1}{2}$, 1 and 2 ton rates and with a light application of manure. These four mulching treatments were in a randomized block design with four replications. Six square foot counts were taken in October.

(3) Date of seeding alfalfa test. This test was started in 1956 but not completed due to unfavourable weather in the spring. Alfalfa was to be broadcast and drilled in early March, late March and mid April.

(4) Specie observation. Several forage species used in hay and pasture seedings were seeded on winter wheat in March. Each specie was replicated four times and counts were taken in October.

Results and Discussion:

(1) Alfalfa established well on winter wheat in 1956. The abundance of moisture throughout the season gave good stands of alfalfa even at low seeding rates.

(2) In the mulching study, there were no differences among the stands produced under straw, manure or where no mulch was used. This may have been due to favourable weather for establishment.

(3) No results in 1956.

(4) Alfalfa established a good stand on wheat. The plants were, however, only small to medium in size and not as vigorous as the red clover plants. This latter species not only produced a very thick stand but the plants were large in size and vigorous in appearance. Birdsfoot trefoil established a fairly thick stand but unlike red and alfalfa, many plants were extremely small with only two or three leaves on them.

Timothy established many plants per square foot but were quite small in size. Orchard appeared to establish the best of the grasses with strong vigorous plants. Meadow fescue, though it did not establish was thick a stand as orchard, also had very strong vigorous plants. Brome established the poorest stand of all the grasses. The plants were of medium size, however, and also had stooled considerably.

Spring Seeding Forage Crops on Winter Wheat

Plants per Square Foot

Rate Seeding	Alfalfa	Mulching	Alfalfa	Specie Establishment	
Rate	Stand	Mulch	Stand	Species	Stand
8 alfalfa	13.7	½ ton straw	18.7	Alfalfa - 12	20.5
10 alfalfa	16.8	1 ton straw	16.0	Red Clover - 10	27.0
12 alfalfa	19.9	2 ton staw	17.9	Trefoil - 10	13.0
14 alfalfa	23.7	manure	21.5	Timothy - 8	14.1
16 alfalfa	25.1	check	18.0	Orchard - 10	13.0
10 red clover	30.3			Brome - 15	3.0
				M. Fescue - 10	9.6
L.S.D. (.05)	8.6		N.S.		
(.01)	11.9		-		
C.V.	26.3		17.0		

Summary:

(1) Alfalfa established good stands on winter wheat in 1956 at all rates of seeding.

(2) Mulching alfalfa with straw or manure did not improve the stand.

(3) Most species seeded on winter wheat established good stands in 1956 with the exception of bromegrass.

Midsummer Seedings of Alfalfa and Bromegrass

R.P.O.: 33-9.

Objectives: To learn if alfalfa and bromegrass can be successfully established during the mid-summer on fallow and stubble land and the method of seeding best suited to mid-summer establishment.

Procedure: Alfalfa and bromegrass were seeded on fallow land that had been kept worked to control weeds. Seedings were made on June 15, July 15 and August 15. Plots were also seeded on August 15 on stubble land from which a copy of oats had been harvested. This stubble ground was disced after grain harvest to prepare a seedbed. Three methods of seeding including broadcast and harrow, broadcast and pack and band seeding were used at each date of seeding. A split plot design with four replications was used, and alfalfa and brome were each seeded at 10 pounds per acre.

Results and Discussion:

No results in 1956. The test was discontinued in July because continuous wet weather made further seedings impossible.

Fall Seeding Forage Crops on Winter Wheat

R.P.O.: F.H. 33-10.

Objectives: To ascertain the best methods of establishing forage crops on winter wheat in the fall.

Procedure: This study in 1956 was divided into two parts, one test with alfalfa and bromegrass, another with birdsfoot trefoil and timothy.

(1) Alfalfa-brome test. On September 1 alfalfa and bromegrass were seeded at 10 pounds each per acre with 1.5 bushels of winter wheat. The methods of seeding included banding in narrow and wide drill rows of wheat, seeding with the wheat, harrowing to cover and spring seeding.

A randomized block design with four replications was used. Stand counts will be taken after wheat harvest in 1957.

(2) Trefoil-timothy test - Birdsfoot trefoil 7 pounds and timothy 5 lbs. were seeded with winter wheat at 1.8 bushels in mid-September. The methods used and test design were similar to those used with alfalfa and brome. Wide and narrow drill spacings of wheat, banding, broadcasting, harrowing and spring seeding methods were included.

Results and Discussion:

No results in 1956. Stand counts to be taken after wheat harvest in 1957.

Management Practices on New Seedings

R.P.O.: F.H. 33-11.

Objectives: To ascertain the effect of some fall management practices upon the establishment, survival and yield of an alfalfa-bromegrass mixture.

Procedure:

The alfalfa and bromegrass were seeded in the spring with a companion crop of oats. The oats were mixed with brome and seeded at $2\frac{1}{4}$ bushels per acre, the brome at 9.6 lbs. and the alfalfa at 10 lbs. The oats were harvested for grain after which the plots were treated as shown in the table. The first series were clipped three days after the oats were harvested, the second series 15 days. Six square foot samples were counted and meaned for analysis of the stand establishment, 28 days following the second series of clippings.

Results and Discussion:

The alfalfa stand showed no differences among the management treatment applied. The brome established fewer plants where fertilizer was applied after clipping. The voluntary oats, however, on these plots were much thicker and they may have caused some brome thinning. They did make the brome seedlings more difficult to distinguish and some plants may have been overlooked during the counting process.

Management Practices on Establishment
Plants per Sq. Foot

Management		Alfalfa Stand	Brome Stand	Total Stand
Clip early left		8.0	5.0	13.0
Clip early remove		8.0	5.7	13.7
Clip early, remove, fert.		7.8	4.2	12.6
Clip late left		8.3	5.8	14.2
Clip late remove		8.5	5.2	13.7
Unclipped		6.8	5.4	12.9
Mean percent estab.		16.4	19.2	17.7
L.S.D.	(.05)	N.S.	1.3	N.S.
	(.01)	-	-	-
C.V.		17.0	13.0	12.8

Summary:

(1) All management practices gave similar results on alfalfa establishment. The fertilizer application depressed the brome stand.

(2) Hay yields and stand counts will be taken in 1957.

Mixtures for Ditch Bank Control

R.P.O.:

Objectives:

To observe the establishment, growth and cover produced by different species and mixtures on ditch banks at Brampton.

Procedure:

Fertilizer was applied to the clay sub-soil on the ditch bank at approximately 1,000 pounds per acre. This was partially worked into the soil with a small cultivator. The seed of the mixtures was sown by hand on top of the rough soil on April 29, 1955. Light coverage was made with a hand rake. Each mixture was seeded in duplicate.

The mixtures, species and seeding rates used are shown in the table. Mulches and companion crop seedings were made at the time of seeding the small seeds.

In the early spring of 1956, approximately 400 pounds of 4-24-12 was applied to all plots.

Observations:

There were considerable differences in the initial establishment of the various species. Some species such as bluegrass and crown vetch established very poorly, while birdsfoot trefoil and red top started reasonably well but had thinned considerably by the following year. Notes taken in mid-July 1956 are summarized as follows:-

Mix. 1 - This complex mixture looked superior to most of the others tried. The red fescue and perennial rye were quite thick. The white dutch clover was good especially near the top of the bank.

Mix. 2 - Again red fescue and perennial rye stood out. Sweet clover gave good growth. The addition of timothy was to no advantage.

Mix. 3 - Red fescue and perennial rye were excellent on the top and slopes of the banks.

Mixtures and Seeding Rates

Mixture No.	Components	Seeding Rate Ac.
Mix. 1	White dutch clover Creeping red fescue Canada blue Red Top Perennial ryegrass	2 25 7 7 15
Mix. 2	Same as mix. 1 plus Timothy Sweet clover	 10 10
Mix. 3 Mix. 4 Mix. 5 Mix. 6 Mix. 7 Mix. 3-7	Creeping red fescue Canada blue Red top Meadow fescue Brome Perennial rye with each	50 25 25 50 75 15
Mix. 8	Crown vetch Perennial rye Creeping red fescue	10 15 25
Mix. 9	Birdsfoot Trefoil Perennial rye Creeping red fescue	15 15 25
Mix. 10 Mix. 11 Mix. 12 Mix. 13 Mix. 14 Mix. 15	Mix. 1 plus no mulch no companion Mix. 1 plus straw mulch Mix. 1 plus manure mulch Mix. 1 plus oats 2 bu. and straw Mix. 1 plus oats at 4 bu. Mix. 1 plus winter wheat at 4 bu.	as above as above as above as above as above as above

Mix. 4 - Canada blue did not establish well nor persist. The perennial rye growth was satisfactory.

Mix. 5 - Red top established poorly and though it persisted, the cover was much too open. The perennial rye, satisfactory.

Mix. 6 - Meadow fescue gave excellent growth and did well near the top and steep sides of the bank. It could be falted for being too open. It suppressed perennial rye growth.

Mix. 7 - Brome established and grew well but tended to produce a somewhat open cover. It suppressed the perennial rye growth completely by the second year.

Mix. 8 - The red fescue in this mixture was very good. There were only a few scattered plants of crown vetch, one with bloom.

Mix. 9 - Birdsfoot trefoil looked poor. It produced only a few scattered plants. On the bank with the northern exposure it killed completely. The red fescue with it appeared to be taking over.

Mixtures 10-15 - The mulch of manure appeared to be superior to all other combinations tried. It produced thick stands especially of the grasses. White dutch, perennial rye, red fescue and red top looked particularly good under this mulch. These same species established well where a straw mulch was used. The straw mulch was superior to no mulch or oats or wheat companion crops. Oats seeded at 4 bushels was superior to oats plus straw or winter wheat. The latter was the poorest of the treatments tried. Only a few scattered plants of perennial ryegrass persisted under the oat and wheat companion crops.

Summary -

1. Creeping red fescue, perennial ryegrass, bromegrass, meadow fescue, and white dutch clover ranged in that order as ditch bank cover crops.

2. Mulching with manure improved the stand of the species listed. Straw mulches were also beneficial.

EIGHTH ANNUAL REPORT

OF THE

LEGUME RESEARCH COMMITTEE

IN

ONTARIO

Ontario Agricultural College

Guelph, Ontario

March, 1956

SEQUENCE OF REPORTS BY DEPARTMENTS

REPORT OF THE DEPARTMENT OF AGRICULTURAL ECONOMICS TO THE

LEGUME RESEARCH COMMITTEE IN ONTARIO

March 1956

Abstract

Canadian production of alfalfa, alsike and sweet clover seed in 1955 was estimated to be slightly lower than in 1954. Red clover seed production was estimated as 32 percent larger than the 1954 crop. Since 1954 production of alfalfa, red clover and sweet clover was below normal, the 1955 crop was also one of the smallest in recent years. Alsike seed production has held fairly constant since 1951 at which time a marked increase in production took place in Alberta.

Ontario production of alfalfa and red clover seed in 1955 was larger than in 1954 whereas alsike and sweet clover production continued to decline.

A wide variation and generally poor yields were typical of the 1955 yield estimates reported by 49 farmers in Haldimand, Peel and Simcoe counties. Exceptionally dry weather during July and August was the most frequent reason given for the poor yields.

Report
on
Production of Legume Seeds 1955

Alfalfa

Production of alfalfa seed in Canada in 1955 is estimated at 3.7 million pounds which is the smallest crop since 1936. (The average annual production of alfalfa seed in Canada for the period 1945-54 was 10.4 million pounds.) A poor crop in Saskatchewan and extensive frost damage in Saskatchewan, Alberta and the Peace River District of British Columbia were the main factors accounting for the low production.

Production in Ontario at 1 million pounds in 1955 is up about 30 percent over 1954 as a result of some exceptionally good yields and up about 10 percent over the ten year average (1945-54).

United States production of alfalfa seed during the past year is estimated as the largest on record. Since this seed is readily available to Canadian importers it has had a depressing effect on prices.

Alsike

Canadian production of alsike seed in 1955 is estimated at 7.5 million pounds. This crop is practically unchanged from that of 1954 although 44 percent larger than the ten year average (1945-54). About 99 percent of the Canadian production originated in Alberta and the Peace River District of British Columbia.

While United States produced the second smallest crop on record, Europe is reported to have had a larger crop than in 1954. Thus prices are expected to be about the same as last year.

Ontario production is estimated at 50,000 pounds or 15,000 pounds less than in 1954.

Red Clover

Canadian production of red clover seed is estimated at 6.7 million pounds or 32 percent larger than 1954. Nevertheless this is 18 percent smaller than the ten year average (1945-54) and is one of the smallest crops in recent years. Yields of the double-cut type in Ontario were adversely affected by the dry weather in July and August and were lower than normal but larger than in 1954. In spite of these unfavourable conditions 42 percent of the Canadian production originated in Ontario.

Prices are generally lower than in 1954.

Sweet Clover

Estimated production of sweet clover in Canada in 1955 is 13.9 million pounds. This represents 87 percent of 1954 production and 81 percent of the ten year average (1945-54).

Ontario production was slightly lower than the 1954 crop and accounted for only about 6 percent of the Canadian output.

Prices are expected to be somewhat lower than in 1954.

Report on Yields of Legume Seed in Haldimand, Peel and Simcoe Counties 1955

Forty-nine of the ninety-three questionnaires mailed to farmers in Haldimand, Peel and Simcoe counties were returned. Fourteen of these reported no acreage of red clover, alfalfa or alsike left for seed in 1955. This left thirty-five farmers who intended to harvest either red clover or alfalfa seed. Only twenty-four of these were successful in harvesting some seed. Dry weather during July and August seemed to account for the poor seed yields in 1955.

The large amount of variability in the small number of yield estimates that were obtained made meaningless any average that might be calculated from them. The range in the yield estimates was as follows:

	Alfalfa		Red Clover	
	No. of estimates	Range (pounds per acre)	No. of estimates	Range (pounds per acre)
Haldimand	16	0 - 235 [x]	6	0 - 32
Peel	3	0 - 166	5	0 - 160
Simcoe	0	-	13	0 - 180

[x] This yield was reported by Mr. Robert Anderson, R.R.#3, Caledonia from a 5 acre field. It is the largest yield of alfalfa ever reported to us from this county. Mr. Anderson has described the method of handling this field but was unable to explain the exceptional yield.

LEGUME RESEARCH COMMITTEE

ABSTRACT OF 1955 PROGRESS REPORT

APICULTURE DEPARTMENT

PART II NECTAR SECRETION INVESTIGATIONS - R. W. Shuel

Further work was done on the relationship of nectar secretion to mineral nutrition, with special reference to the the effects of phosphorus and potassium in red clover. The levels of supply of nitrogen, phosphorus, and potassium all have important effects on nectar secretion which can be correlated with such aspects of plant development as fresh or dry weight, flower size, and carbohydrate composition. Plants achieving maximal vegetative growth are generally poor nectar plants, both nectar yield per flower and flower number being sub-optimal. An overabundance of nitrogen reduces nectar yield, apparently through promotion of excessively vigorous vegetative growth and reduction of free sugar in the tissues. A low level of phosphorus is beneficial for nectar secretion but not for flower production, especially if the ratio of phosphorus to potassium is very low. A high level of phosphorus reduces secretion severely, though it favours abundant flower production. Too little potassium reduces nectar secretion, too much depresses flowering and promotes excessive vegetative growth. High potassium consistently reduces nectar concentration.

The experiments summarized herein were designed to reveal specific effects of the mineral elements on nectar secretion and related processes, rather than to provide the basis for fertilizer recommendations. The latter might vary considerably with soil type and location. It has been found, too, that the most favourable levels of the mineral elements vary with species. In general it might be stated, however, that fertilizer additions designed to produce moderately vigorous but not maximal vegetative growth, and good flower production, should promote good nectar crops.

The relationship of quantity and composition of nectar secreted by excised flowers cultured in vitro was also studied. Of ten common sugars tested, sucrose gave for higher nectar yields than any other sugar, although many of the other sugars were equally well assimilated by the flower. Most of the sugars supplied to the flowers were transformed in the process of secretion, and sucrose usually appeared in the nectar. These results suggest that secretion is a metabolic activity of considerable complexity. As such it may be amenable to a form of external control other than nutritional.

LEGUME RESEARCH COMMITTEE IN ONTARIO

1955 PROGRESS REPORT

APICULTURE DEPARTMENT

PART I

POLLINATION INVESTIGATIONS

M. V. Smith

S.A.E. Farm Single Cut Red Clover Pollination

On June 15th a colony of honeybees was moved to the S.A.E. farm and placed beside a small area of single cut red clover which had been set out in plots for testing the effect of minor elements on seed production. A total of 80 plots (20 plot blocks replicated 4 times) each trimmed to 16' x $2\frac{1}{2}$' gave a total area of bloom of less than 1/10 acre. Thus one colony of bees should provide ample pollination.

The clover was fairly well out in bloom when the bees were moved in. A survey of the plots before the bees were released showed that no honeybees were present on the plots at 10.00 a.m. At 1.15 p.m. the honeybees from this colony were quite active on the blossoms.

Daily pollinator counts were taken on 10 plots throughout the whole of the blooming period - except for several days when weather interfered. All counts were taken in the early afternoon when insect activity should have been at its peak. The data from these counts are summarized in tabular form below:

Pollinator Counts on Single Cut Red Clover
(Total of 13 Counts Taken June 15 - 29)

Plot No.	1	3	5	7	9	11	13	15	17	19	Totals	%
Honeybees	15	16	13	19	14	19	15	10	7	19	147	48.0
Bumblebees	1	3	2	1	1	3	1	1	1	1	15	4.9
Other Wild Bees	21	16	10	8	17	17	13	13	14	15	144	47.1
Totals	37	35	25	28	32	39	29	24	22	35	306	100

The following conclusions can be drawn from the above pollinator counts.

1. Honeybees and wild bees were present in approximately equal numbers and comprised the bulk of the pollinators present. The honeybees were more active on the blossoms than the wild bees (Andrenids and Holictids).

2. Bumblebees comprised less than 5 per cent of the total pollinator population, and almost all bumblebees observed were queens. Only one worker was recorded on June 28th. At this time of the year bumblebee population is at a low ebb and cannot be counted upon to assist appreciably in the pollination of single cut red clover.

3. No significant difference in pollinator populations was apparent between plots.

4. Honeybee pollinators were no more numerous on plot 1 (beside the hive) than on plot 19 (50 yards distant from the hive).

5. Although pollinating insects were reasonably active throughout the whole of the blooming period, the populations were not particularly high. An average of 2.7 pollinators was present per plot. This works out to an average of .61 pollinators per square yard. One bee per square yard is usually considered as adequate for red clover pollination.

Fluorescent Marker Tests on Honeybee Foraging Dispersal

Tests planned to study the dispersal and range of foraging honeybees on second cut red clover had to be abandoned due to the drought and subsequent poor growth of this crop.

Bumblebees for Light Panel Pollination

Other investigators have reported that bumblebees can be successfully used for controlled cross-pollination in enclosed chambers. A nest of Bombus griseocollis taken on June 10th was placed in a growth chamber at the Botany Department on June 13th in an effort to see how they would behave in the presence of red clover bloom.

The nest was rather small, consisting of a queen, 12 workers and 15 brood cells. Within an hour of introduction several workers were seen to emerge from the nest, circle the nesting box and work on the clover heads. During the subsequent 10 days, one or two bumblebees could be seen on the blossoms on most occasions when the chamber was visited. However, the bees did not get sufficient nectar or pollen from the relatively few blossoms available to maintain themselves and had to be given supplementary feed. During this period 6 workers died and were replaced by 5 new bees which emerged in the nest. The queen, however, ceased laying and the nest gradually dwindled away, so after 10 days the nest was moved outside in hopes that it would recover. The queen promptly absconded and the nest died.

The clover plants in this chamber were used for root rot studies and the heads were not harvested for seed. However, it is interesting to note that bumblebee workers were active under these artificial conditions. This suggests that growth chamber tests might be used to compare the efficiency of bumblebee and honeybee pollinators on a crop such as red clover.

PART II

REPORT ON NECTAR SECRETION INVESTIGATIONS

R. W. Shuel

I. MINERAL NUTRITION STUDIES

The relationship of nectar secretion to nitrogen, phosphorus, and potassium nutrition has been studied in leguminous and non-leguminous species. In 1953 nitrogen effects were reported on, in 1954 N, P and K effects on snapdragon. The present report deals with the effect of phosphorus and potassium supply on secretion in red clover, and a summary of our nutrition work to date. We have attempted to relate nutritional effects on secretion to other phases of the plant economy, rather than treating them as isolated phenomena.

Red Clover Experiments

Plants of a clonal population were grown in sand cultures supplied with phosphorus at 10, 40, and 160 ppm (denoted as P_1, P_2, and P_3, respectively) and potassium at 8, 45, and 180 ppm (denoted as K_1, K_2, and K_3, respectively). A constant level of nitrogen (102 ppm) was used. Although it would have been desirable to vary the nitrogen level as well, not enough space was available for more than 10 treatments. The effects of nitrogen had already been established. A reasonably high level of supply of nitrogen was adopted in this study in order to avoid nitrogen limitations on plant growth. The levels of phosphorus and potassium selected were within a range expected to support normal growth and development. No gross symptoms of deficiency or toxicity appeared.

Results

Experimental results are tabulated in Tables I, II, and III. Table I contains data on growth, flowering, and nectar secretion, Table II the results of chemical analyses of plant tissue, and Table III factorial effects of phosphorus and potassium on the various factors listed in Table I.

Considerable variation appeared with respect to date of maturation. High phosphorus accelerated flowering, high potassium retarded it. As a result plants in the low-phosphorus group of treatments matured too late to be assayed for nectar at the same time as plants in the other treatment groups. This necessitated a separate analysis of data from low-phosphorus treatments, with the loss of a direct comparison between the low-phosphorus and the intermediate and high-phosphorus results. An indirect comparison of low and high-phosphorus groups was made possible by the fact that plants of the P_2K_3 treatment flowered continuously over the whole sampling period and could thus be included in statistical analyses of both early and late groups. Growth and nectar data for this group are entered twice in Table I, once for the early and once for the late part of the nectar sampling period. The ratio P_2K_3 (early)/P_2K_3(late) was used as a factor to adjust the observed results of one late group for comparison with the early group. Values adjusted in this manner have been entered in Table III in parentheses, indicating that 'F' values are not applicable to them, and that the confidence limits for comparison with the means of the other treatments are not known. In the analysis of potassium effects, both linear and quadratic components were calculated. The magnitude of the quadratic component is a measure of departure from linearity. The quadratic component is included for phosphorus only in cases where the data for the 3 phosphorus levels could be analyzed together. When only the intermediate and high levels were comparable, the linear effect alone could be inferred.

Several indices of nectar yield have been included in the Tables. Nectar volume and sugar weight yields were calculated on the basis of yield per 100 florets, as well as yield per inflorescence. As each floret contains a nectary, yield per floret is the quantity of greatest physiological significance. The volume of nectar per floret is a criterion of the availability of nectar to a foraging insect and hence is of significance as a determinant of pollination. Nectar concentration affects the attractiveness of nectar to the bee. Its importance is difficult to assess as it is subject to wide daily variation with fluctuating humidity. Total potential nectar yield per plant is the product of mean yield per inflorescence and average inflorescence number. It is a measure of the potential honey crop and also of the potential seed yield as it is mediated by nectar secretion.

The concentration of the mineral elements in the plant tissue paralleled their concentration in the source of supply (Table II). Plants grown at the highest level of phosphorus contained more potassium than plants in the lower-phosphorus groups. Various phases of growth and flower production were influenced by phosphorus and potassium supply (Tables I, III). The weight of the root system was directly proportional to potassium supply and inversely proportional to phosphorus supply. The correlation coefficient between root weight and molal ratio of K to P in the shoot tissue was +0.806, closely approaching significance at the 0.1 per cent level. Shoot weight was related directly to supply of K and in a curvilinear manner to P level. The most prolific flowering occurred at the intermediate level of both elements, the least at the lowest level of phosphorus and the highest level of potassium. The largest flower heads occurred at the intermediate level of potassium and the lower and intermediate levels of phosphorus. Floret number was closely related to head length. Staminal tube length varied inversely with phosphorus supply, but with a significant departure from linearity in the case of potassium.

Volume and weight yields of nectar were substantially reduced at the highest P level (Table III). Values for the late-flowering group adjusted for comparison with the other groups, 34.9 µl and 19.6 mg., respectively, suggest that nectar yields at the lowest P concentration were at least as good as those at the intermediate. The first increment of potassium gave a large increase in nectar volume at all levels of phosphorus; the second increment had little effect on nectar volume but reduced nectar concentration considerably.

The pattern of variation in tissue carbohydrate composition with P and K nutrition is not always clear-cut. It may be summarized as follows: Variation in reducing sugar followed no consistent trend and variation in starch was slight. The intermediate-phosphorus group was higher in sucrose than the high-phosphorus group. Within these two groups sucrose content increased with increasing potassium supply. Plants of the P_1K_1 and P_1K_2 treatments were high in all carbohydrate fractions; results for P_1K_3 plants were anomalous, probably because of a difference in stage of maturity at the time of harvest.

Nectar yield per floret was related to tissue sucrose content and head size. When the anomalous P_1K_3 treatment was excluded from the correlation, a multiple correlation coefficient "R" of 0.959, significant past the 1 per cent level, was obtained. The high order of this correlation indicates that a large percentage of the variation in nectar yield could be accounted for in terms of tissue sucrose content and head size. Sucrose content and head size were not in themselves closely correlated.

A high level of potassium consistently reduced nectar concentration. This effect appeared to be independent of potassium effects on volume of nectar.

The relationships between mineral nutrition and vegetative growth, head size, sucrose content and nectar yield may be summarized as follows: The first increment of potassium gave a large increase in growth at the two lower levels of phosphorus, a large increase in head weight and nectar yield in all cases, and a large increase in sucrose content only at the P_2 level. The second increment of potassium gave a relatively small increase in vegetative growth and nectar yield, a large increase in tissue sucrose at the P_2 and P_3 levels, and a large decrease in head weight at the P_3 level. The first increment of phosphorus gave an increase in vegetative growth only at the two highest levels of K. Effects of this increment on head weight, sucrose, and nectar production are confounded with time and weather effects and are therefore difficult to interpret. The second phosphorus increment had little effect on vegetative growth at the K_1 level, but caused a reduction in vegetative growth at the K_2 and K_3 levels. The second phosphorus increment had little effect on vegetative growth at the K_1 level, but caused a reduction in vegetative growth at the K_2 and K_3 levels. This second addition was accompanied by a general decrease in head weight, tissue sucrose content, and nectar yield at all levels of K.

The intermediate levels of both P and K were best for flower production. The overall nutritional effects on total yield of nectar per plant are the resultant of the separate effects on nectar secretion and flower production. Plants supplied with the intermediate levels of P and K had the highest nectar potential. Less phosphorus resulted in poor flower production, more phosphorus reduced nectar secretion. The lowest potassium concentration was sub-optimal for both flower development and secretion, while the highest potassium concentration favoured vegetative development at the expense of flower production.

The variability in staminal tube length evident in Table III should be remarked upon, as it may affect the ability of the honeybee to reach the nectar column. High levels of phosphorus reduced staminal tube length, whereas high levels of potassium increased it, though in a non-linear manner. A similar effect of potassium has been noted elsewhere. It is conceivable that improvement in nectar yield may sometimes be nullified by increases in staminal tube length. It is now believed that the bee is capable of withdrawing most of the nectar from the red clover floret provided it can reach the meniscus of the column with its tongue. Capillary movement of nectar up the wall of the tube enables the bee to obtain nectar which would otherwise be beyond its reach. Any adverse effect of an increase in staminal tube length would thus depend on whether this increase removed the nectar meniscus beyond the reach of the bee's tongue.

Fairly complete data on the general influence on nectar secretion of nitrogen, phosphorus, and potassium supply have now been obtained both in leguminous and non-leguminous plants. These may be summarized as follows:

1. The amount of nectar secreted <u>per flower</u> is correlated with certain characteristics of plant development, i.e., vegetative growth, flower size, and carbohydrate composition. These characteristics can be altered by adjusting the level of nitrogen, phosphorus and potassium taken up by the plant. The amount of nectar which a <u>plant</u> is capable of producing depends on the average volume of nectar secreted per flower and the number of flowers produced. The volume of nectar secreted per flower affects the attractiveness of the flower to the foraging insect; the amount which the plant is capable of producing governs the feasibility of placing colonies of bees in the field.

2. In general, plants of maximal vegetative growth are poor nectar yielders. Both nectar per yield per flower and flower number are sub-optimal.

3. An overabundance of nitrogen reduces nectar yield, apparently through promotion of excessive vegetative growth and reduction of free sugar in the tissues. A low level of phosphorus is beneficial for nectar secretion, but not for flower production, especially if

the ratio of phosphorus to potassium is very low. A high level of phosphorus, however, reduces secretion to a marked degree. Too little potassium reduces nectar secretion, too much reduces flowering. High potassium consistently reduces nectar concentration.

4. The best absolute levels of the three elements varies with species. The experiments reported herein were designed to reveal individual effects of the mineral elements rather than to provide a basis for fertilizer recommendations. They do indicate that levels of the 3 mineral elements likely to produce moderately vigorous but not excessive vegetative growth, and good flower production, are most satisfactory from the standpoint of the nectar crop.

5. High levels of phosphorus drastically reduced the root system in red clover, a condition obviously undesirable from the standpoint of cropping and overwintering.

TABLE I

PLANT GROWTH AND NECTAR YIELD DATA I
AT VARIOUS LEVELS OF PHOSPHORUS ANI

Treatment		Mean Shoot Dry Wt. g.	Mean Root Dry Wt. g.	Date of First Flower	Mean Head No.	Mean Head Wt. mg.	Mean Florets per Head	Mean Staminal Tube Length mm.	N Ne Vo 100
P_1K_1		43.5	31.7	4 July	32	976	104.4	9.34	21
P_1K_2		65.5	41.1	4 July	31	1209	123.7	9.28	29
P_1K_3		70.5	40.8	9 July	24	1071	125.1	9.10	28
P_2K_3(Late)						1092	110.2		29
P_2K_1		41.5	18.8	29 June	33	1005	116.1	8.87	23
P_2K_2		74.3	29.9	26 June	55	1126	108.1	9.25	33
P_2K_3(Early)		83.0	35.6	27 June	51	1115	114.7	9.18	38
P_3K_1		47.4	18.1	25 June	51	981	108.6	8.73	22
P_3K_2		50.0	21.3	27 June	53	1103	116.1	9.20	29
P_3K_3		59.5	33.9	1 July	33	945	97.2	9.15	27
LSD	.05	12.4	8.8		11.9	59.1	6.91	0.171	2.
P_1	.01	16.4	11.8		16.0	78.3	9.02	0.226	2.
P_2&P_3	.05	12.4	8.8		11.9	85.7	8.95	0.171	4.
	.01	16.4	11.8		16.0	112.0	11.05	0.226	5.

TABLE I

PLANT GROWTH AND NECTAR YIELD DATA IN RED CLOVER
AT VARIOUS LEVELS OF PHOSPHORUS AND POTASSIUM

Treatment	Mean Shoot Dry Wt. g.	Mean Root Dry Wt. g.	Date of First Flower	Mean Head No.	Mean Head Wt. mg.	Mean Florets per Head	Mean Staminal Tube Length mm.	Mean Nectar Vol. per 100 Florets µl	Mean Nectar Conc. %	Mean Sugar per 100 Florets mg.	Mean Sugar Wt. per Inflor. mg.	Potential Nectar Sugar per Plant mg.
P_1K_1	43.5	31.7	4 July	32	976	104.4	9.34	21.40	67.8	19.43	20.28	476
P_1K_2	65.5	41.1	4 July	31	1209	123.7	9.28	29.75	61.5	23.53	29.44	669
P_1K_3	70.5	40.8	9 July	24	1071	125.1	9.10	28.70	62.4	23.56	29.66	522
P_2K_3(Late)					1092	110.2		29.30	60.8	23.34	25.86	
P_2K_1	41.5	18.8	29 June	33	1005	116.1	8.87	23.35	49.7	14.70	14.65	483
P_2K_2	74.3	29.9	26 June	55	1126	108.1	9.25	33.90	48.1	19.60	18.75	1031
P_2K_3(Early)	83.0	35.6	27 June	51	1115	114.7	9.18	38.30	45.1	20.62	18.95	966
P_3K_1	47.4	18.1	25 June	51	981	108.6	8.73	22.30	48.1	13.35	12.29	627
P_3K_2	50.0	21.3	27 June	53	1103	116.1	9.20	29.20	48.7	17.11	16.20	859
P_3K_3	59.5	33.9	1 July	33	945	97.2	9.15	27.80	44.4	14.64	12.95	686
LSD .05	12.4	8.8		11.9	59.1	6.91	0.171	2.41	1.4	2.74	3.49	
P_1 .01	16.4	11.8		16.0	78.3	9.02	0.226	2.95	1.9	3.62	4.66	
P_2&P_3 .05	12.4	8.8		11.9	85.7	8.95	0.171	4.50	2.2	2.59	3.59	
.01	16.4	11.8		16.0	112.0	11.05	0.226	5.91	2.8	3.42	4.72	

TABLE II

CHEMICAL ANALYSES OF RED CLOVER SHOOT TISSUE
WITH VARIOUS P - K TREATMENTS

Treatment	N	P	K	Reducing Sugar	Sucrose	Total Sugar	Starch	Total Carbohydrates
P_1K_1	1.95	0.084	0.77	3.15	1.87	5.02	19.7	24.7
P_1K_2	2.14	0.108	1.92	3.34	1.78	5.12	20.6	25.7
P_1K_3	1.88	0.099	3.05	2.98	1.24	4.22	10.7	14.9
P_2K_1	2.51	0.394	0.57	1.84	1.03	2.87	13.2	16.1
P_2K_2	2.17	0.330	1.32	2.11	1.69	3.80	14.6	18.4
P_2K_3	1.77	0.314	2.68	1.80	2.07	3.87	14.9	18.8
P_3K_1	2.41	0.635	0.82	2.11	0.92	3.03	13.8	16.8
P_3K_2	2.46	0.650	3.57	2.15	1.07	3.22	12.9	16.1
P_3K_3	2.20	0.544	5.12	3.29	1.57	4.86	14.6	19.5

TABLE III

FACTORIAL EFFECTS OF PHOSPHORUS AND POTASSIUM ON GROWTH AND NECTAR YIELD IN RED CLOVER

Factor	Mean Shoot Dry Wt.	Mean Root Dry Wt.	Mean Head No.	Mean Head Fresh Wt.	Mean Florets Per Head	Staminal Tube Length	Mean Nectar Vol. per 100 Florets	Mean Nectar Sugar Conc.	Mean Nectar Sugar per 100 Florets	Potential Nectar Sugar Yield per Plant
	g.	g.		mg.		mm.	µl	%	mg.	mg.
P_1	60.0	37.8	28.9	(1123)	(117.8)	9.24	(34.85)	(47.4)	(19.62)	(556)
P_2	66.2	28.1	46.2	1083	113.0	9.10	31.67	47.7	18.31	827
P_3	52.3	24.4	45.5	1009	104.0	9.02	26.35	47.0	15.03	724
K_1	44.2	22.8	38.4	993	112.3	8.99	22.73	48.8	14.03	555
K_2	63.2	30.8	46.3	1114	112.1	9.24	31.40	48.4	18.35	945
K_3	70.9	36.8	36.0	1032	105.6	9.14	32.90	44.6	17.63	826
"F" Values										
P_l	4.67*	30.06***	24.62***	8.79**	5.27*	18.44***	16.45***	1.03	18.80***	
P_q	11.36**	2.07	9.77**			0.63				
K_l	59.06***	32.07***	0.52	1.64	4.31*	10.00**	40.02***	27.41***	15.21***	
K_q	3.51	0.19	9.77**	15.10***	1.30	17.42***	6.64*	6.21*	9.96**	
PK	4.14**	1.42	5.97**	4.07*	8.46**	9.20**	7.78**	1.13	3.31*	

Statistical Significance   *** 0.1% level
(l - linear component)   ** 1% level
(q - quadratic ")   * 5% level

II. STUDIES OF NECTAR SECRETION IN EXCISED FLOWERS

Studies of the relationship of sugar supply to quantity and composition of nectar secreted by snapdragon flowers cultured *in vitro* were continued. The concentration at which the nectar was secreted was almost identical with the concentration of the sugar solution taken up by the flower. Secretion was tested on a number of sugars including sucrose, glucose, fructose, maltose, lactose, galactose, xylose, mannose, sorbose, and raffinose. Nectar yield in sucrose cultures was from 40 to 250 per cent higher than yield from cultures of the other sugars, although many of the other sugars were assimilated as readily as sucrose. Paper chromatograms revealed sugar transformations in nectar of flowers cultured on sucrose, glucose, fructose, maltose, lactose, galactose, mannose, and raffinose, but not in flowers supplied with xylose or sorbose. In most cases some sucrose was secreted. Nectar from flowers supplied with glucose or fructose, for instance, contained more sucrose than glucose or fructose. These data indicate that secretion is a metabolic activity involving participation of enzyme systems. As such it may be amenable to external control by means other than nutritional.

PART III

ALFALFA POLLINATION IN KERN COUNTY, CALIFORNIA

G. F. Townsend

The week of July 3rd, 1955, was spent in Kern County, California, about 150 miles north of Los Angeles. This Valley is possibly one of the richest agricultural areas in the United States. It is 50 miles square, and is operated under irrigation. The main crop has been cotton, but since the cotton acreage is now limited many are turning to alfalfa seed production. The alfalfa acreage has expanded considerably in the last two to three years, now consisting of more than 70,000 acres. Most of the seed is of certified varieties.

Since large quantities of sprays are applied by aeroplane, there are practically no wild pollinating insects in this Valley - at least none were observed.

In order to provide for pollination of the alfalfa Valley Pollination Service, a limited company, has been set up to organize the beekeepers. The Manager is Mr. Charles B. Reed, a beekeeper operating on his own about 2500 colonies of bees. This Organization contracts for bees among the beekeepers and also contracts for acreages for pollination among the farmers. This year upwards of 80,000 colonies of bees are being placed in approximately 40,000 acres of alfalfa by this Organization alone. The gross turnover for pollination will be upwards of one-half million dollars. This Organization has been built up only over the last two to three years and has proven so satisfactory to both the farmers and the beekeepers that it has expanded beyond anything ever anticipated.

Organization of the Valley Pollination Service

The Organization is set up in the centre of the seed growing area near Bakersfield, and consists of the Manager, an office assistant, and a supervisor. The supervisor is a college graduate, and carries on a certain amount of individual research to determine the better methods of handling the bees. They also employ two inspectors, whose duties are to examine 10 per cent of the colonies placed in the fields as a guarantee to the farmer that colonies of suitable strength are being used for the pollination work. If the colonies do not come up to standards the contract permits the Organization to refuse payment for their use. The Manager spends a good part of the winter and spring period lining up colonies of bees and fields to be pollinated.

Contracts are signed both with the beekeeper and with the farmer. These contracts stipulate the strength of colonies to be used and the conditions under which they will be delivered. The Organization is empowered to collect the moneys for the pollination service and distribute the same on a pro rata basis as received, any losses being distributed over the whole group. The contract with the farmer stipulates that he must not spray while the bees are in the field, that he must assist in providing locations for the bees, etc. The rental fee is $5.50 per colony plus one cent per pound of seed produced over 600 pounds per acre, with a maximum of $7.50 per colony. The contract also states the minimum number of colonies which the farmer agrees to accept in his fields. Additions in numbers of colonies can be made at later dates.

A complete check is kept on all of the farmer's fields by aeroplane, so that the bees may be moved in at the most important time. The bees are moved into the fields progressively, the feeling being that better use of the bees is made in this way and better pollination received. Plans are made from two to four or five days ahead for delivery of bees into each field according to their condition and development of the flowers. The beekeeper is contacted and when he arrives at the station with his load of bees his delivery instructions are given. A temporary office during the height of the season is located at each end of the Valley, so that the beekeepers entering either from the north or south can pick up their instructions without covering too much distance. The loads of bees usually arrive about midnight, or later, and a man is kept on hand all during the night at this season of the year to assist the beekeepers in reaching the proper fields. At the height of the season, thirty or more truck loads a night are entering the Valley. The Manager has a car telephone so that he may keep in contact with the farmers, his office and the beekeeper at all times.

With an organization of this type good public relations are kept between the beekeeper and the farmer, many serious problems are avoided, and each is assured of the best possible use of bees. It avoids serious price cutting which usually reflects in the use of poor colonies, and any losses are shared equally over the whole group.

The Use of the Bees in the Field

The bees are placed in the field progressively every 7 days until 2 to 3 colonies per acre have been established. The bees are first moved into the field when half to three-quarters bloom is noticed, and the bees are placed first in the sections of the field which are in heaviest bloom. They are placed in groups, starting 250 feet in from the edge of the field and every 500 feet throughout the field. Drives are marked across each field 500 feet apart and a group of 10 to 15 colonies is dropped at every 500-ft. location.

We are often asked why we cannot obtain satisfactory tripping of alfalfa by honeybees in Ontario. By closely observing the conditions in California for this week period, at the height of the season, I am fairly well convinced that it is a combination of plant physiology plus proper use of bees. Most areas in California are very short of pollen and when the bees are moved into the field they are almost on the verge of pollen starvation and therefore must work the alfalfa in order to feed the developing larvae. Under these conditions even when a large quantity of pollen was available in an adjoining field of corn the bees still worked alfalfa plants for pollen, and in so doing tripped every blossom visited. By placing up to 3 colonies per acre a large population of bees is obtained in the field. Up to 10 bees to the square yard were recorded. Under most conditions accidental tripping will amount to 1 per cent of the blossoms visited, thus even the nectar gatherers will trip a large percentage of the blossoms. The physiology and cultural practice under which the plants were grown seemed to play a great part in whether or not the plants were tripped by honeybees.

Handling of the Bees

Pollination would be practically impossible without some type of assistance in moving, as at this time of year the colonies are some times quite heavy. With rising costs of operation, especially for labour, the beekeepers in California have developed special loaders for moving their bees, and where it formerly required two or three men now one man can load 100 colonies of bees, as well as move and unload them. Without these loaders large scale pollination of this type would be impossible. The loaders are of a boom type, mounted on the frame of a truck floor so that the boom can pass through 360 degrees over the top of the truck. There is a hand-operated hydraulic levelling machine to raise and lower the boom as well as level it in both directions. At the end of the boom is a clamp to take hold of the colonies and push button electric control operated from battery and motor to both raise and lower the colony as well as run it along the track.

The colonies are loaded at dusk, moved during the night, and unloaded after daylight in the morning. The operators sleep beside their load, after arriving at destination, using cots and sleeping bags. The truck loaders have yellow lights at the centre and back in order to see and yet not attract the bees. All of the truck bodies are flat, with hooks every 6 inches, and the colonies are tied on by ropes. No screens of any type are used, except that a plastic screen is carried with the load in case of breakdown, in which case the screen would be placed over the load and tied down to avoid bees escaping on to the road. This plastic screen is of the fly screen mesh type made of plastic lumite, with heavy type canvas sewn at the edges.

Cultural Practices in Handling the Alfalfa

The water supply in this area is practically all by sprinkler irrigation. In many cases the alfalfa does not receive any water after May, although others carry on the practice of giving sufficient water to bring the alfalfa into bloom, allowing it to dry up sufficiently to set a crop of seed, and then bringing on another set of bloom. It seems, however, that those who are operating under the most economical conditions are those who are watering only up until May and then taking one set of seed from the plants.

The alfalfa is planted in rows 32 to 48 inches apart, and is weeded by hand the first year. During the second year in most cases the stands are thinned by removing every other row, and sometimes in the third year a further removal is made of every other row.

They have found that wherever there is rank growth or solid block seeding even though the plants are visited by bees there is very little seed produced and most of the blossoms strip off. Some of the best sets of seed and some of the fields which were yielding the highest crops of seed were those which were very thin.

Temperature and humidity seem to play some part in the tripping of the bloom in that best tripping and least stripping seem to take place at 90 to 95°F. with a low humidity.

In observing the pollen-gathering bees, it was found that they never gathered pollen on the areas of lush growth or heavy planting; that they always seemed to work the non-succulent areas, the upright plants, and the sparse plantings; and these areas also were the ones which had the greatest amount of tripping and the most seed on the plants.

Harvesting

Most of the fields are defoliated and direct combined with pickup prongs spaced to pick up between the rows. Some are windrowing with no defoliant, using a special windrower which picks up the plants and sets them on end in rows, with very little shattering to the plant.

An attempt is being made to grow some birdsfoot trefoil and their plan is to windrow this on a roll of paper so that any pods bursting or cracking will leave the seed on the paper and this will be picked up by the combine as it progresses up the field.

Varieties of Seed

There are a number of varieties of seed being grown but they include mainly ranger and naragansett, but there is available a fairly large acreage of vernal of certified variety.

Miscellaneous

One thing was noticed particularly, and that was that the salt content of the soil in this area was very high. It is necessary to leach it out down to a certain level before plants will grow satisfactorily, but it was wondered at the time of observation as to whether or not the salt left did not play some part in the seed yeild.

LEGUME RESEARCH COMMITTEE

PLANS FOR 1956

APICULTURE DEPARTMENT

POLLINATION INVESTIGATIONS

Further work should be carried out on the use of honeybees in the pollination of alfalfa, as it is quite possible that more satisfactory methods for their use could be developed. This work, however, cannot be carried out until suitable fields are available.

NECTAR SECRETION INVESTIGATIONS

1. Mineral Nutrition - A study of the effect of boron on nectar secretion in red clover is in progress. The outcome of this experiment will determine the next step in nutrition investigations. Experiments with varying calcium and magnesium supply are expected to be undertaken soon, as there have been indications that these elements may be significant in nectar secretion.

2. Other Work - Work with auxins and enzyme inhibitors will be continued to gain further information on the basic mechanism of secretion. In addition to evidence that plant growth substances can alter nectar yield when supplied externally, there are indications from studies with one species that a mechanism connected with development of the reproductive organs exerts some control over the amount of nectar secreted.

LEGUME RESEARCH COMMITTEE

Abstract

Department of Bacteriology

--1955--

I. Physiology of Rhizobium

Fundamental studies were continued on the root nodule bacteria. Washed cells of *Rhizobium meliloti* were found to deaminate glycine and the L- and D- isomers of various amino acids but did not carry out decarboxylation of histidine or glutamic acid. Peptides of glycine and L- and D-leucine are readily utilized as soil nitrogen sources by these bacteria. While resting cells of these organisms require amino acids for growth in a synthetic medium, these acids may be replaced by an ammonia-forming compound, plus certain organic acids. No significant differences have yet been found between effective and ineffective strains of *Rhizobium meliloti*.

II. Grassland vs. Legume Systems of Farming

A survey of Essex and Kent farms for the presence of Azotobacter species revealed low populations of the organisms in grassland soils and only slightly higher counts in cultivated soils. High counts of Azotobacter were obtained from O.A.C. fertilized plots.

Populations of Azotobacter were not established under greenhouse conditions in a soil to which was added P.K. lime and plant residues. Azotobacter survived in similar soils seeded to sugar beets, but high populations were not established.

Soil seeded to alfalfa inoculated with legume bacteria supported a better yield of oats than soil seeded to orchard grass and inoculated with Azotobacter. The orchard grass did not promote Azotobacter growth and the numbers actually declined. The establishment of Azotobacter in certain soils appears to be dependent upon definite fertilizer requirements and abundance of available carbohydrates.

III. Mutational Studies of Rhizobia

An attempt was made to isolate mutant cultures of the root nodule bacteria resistant to saturated solutions of various seed protectants. By a series of selective steps several mutants of *Rhizobium meliloti* and *Rhizobium trifolii* were isolated which were found to possess an increased resistance to Phygon and Leytosan. No mutants however were isolated which showed resistance to Arasan.

LEGUME RESEARCH COMMITTEE

Report 1955

Department of Bacteriology

I. Physiology of Rhizobia

a) Deamination and decarboxylation of amino acids

Washed intact cells of an effective strain of *Rhizobium meliloti* were found to oxidatively deaminate glycine and the L- and D- isomers of a number of different amino acids. Experimental techniques involved the use of the Warburg microrespirometer and radioactive isotopes. Quantitative data were difficult to obtain because of the presence of associated reactions such as transamination and ammonia assimilation. Glyoxylic acid, produced by removal of the glycine amino group was isolated as the corresponding dinitrophenylhydrazone.

Microrespirometer studies revealed that under the experimental conditions employed no anaerobic decarboxylation of glutamic acid or histidine could be detected.

b) Transamination

Cell-free extracts of rhizobia synthesized glutamic acid from α-ketoglutaric acid when glycine, L-histidine, D-aspartic acid or D-valine acted as amino group donors. This supplemented previous work where it was found that L-aspartic acid, L-valine, L-alanine and L-leucine could serve as donors. In addition, acetone-dried cells formed alanine from D-aspartic acid and pyruvate, but only in small amounts.

c) Racemization

Alanine racemase activity was detected in cell-free extracts and acetone-dried cells, but racemization of aspartic and glutamic acids did not occur. These studies involved the use of D-amino acid oxidase and L-glutamic acid decarboxylase as analytical tools. It may be concluded, therefore, that the L-glutamic acid previously detected in mixtures containing D-aspartic and α-ketoglutaric acids, may have been produced by a series of three coupled reactions involving racemization and L- and D-amino acid transamination.

d) Utilization of peptides

Two effective and one parasitic strain of *Rhizobium meliloti* brought about partial hydrolysis of a number of di- and tripeptides containing glycine and L- and D-leucine. Stimulatory effects beyond that calculated on the basis of complete peptide degradation were observed in many instances and explained on the basis of transpeptidation. Inhibition in media containing peptides of glycine + D-leucine was traced to an antagonistic effect between the two amino acids after liberation. Although the ineffective and effective strains of rhizobia differed in several ways, the most interesting feature was the stimulation of the growth of the ineffective organism by D-leucylglycine, a compound which was decidedly inhibitory to the other two strains.

e) Utilization of organic and inorganic nitrogen sources by rhizobia

The requirement of an amino acid for the growth of washed cells of Rh. meliloti could be satisfied by ammonium, nitrate, or nitrite ions, but only in the presence of certain non-nitrogenous organic acids of importance in the Kreb's cycle. Since α-keto-glutaric acid was extremely active in this respect it was postulated that amino acids were synthesized from ammonia and this acid. The enzyme responsible for this reaction, L-glutamic acid dehydrogenase, was found in the organism but aspartase, another enzyme important in ammonia "fixation", was not detected. Purines and pyrimidines could substitute for ammonia, nitrate or nitrite because they are potential ammonia-formers. No differences between effective or ineffective strains of rhizobia were found in these studies, but a new synthetic medium has been formulated for excellent growth of these organisms.

II. Grassland vs. Legume Systems of Farming

Experiments were containued to determine the extent to which the use of grass with applications of P.K., lime and plant residues will encourage the growth and nitrogen fixing ability of the non-symbiotic Azotobacter in comparison with inoculated legumes.

a) Colony counting

It has been determined that Azotobacter colonies appearing on agar plates, after the "soil sprinkle" counting method has been carried out, follow the Poisson distribution. A control chart showed that Azotobacter counts using a series consisting of five replicate plates could be made with an accuracy of 96%.

b) Survey

Surveys were continued for Azotobacter populations on grassland and cultivated soils on farms in Essex and Kent counties. In general the counts were low, ranging from zero to several hundred colonies per gram of soil. However, the cultivated soils showed slightly higher Azotobacter counts than soils under sod. These latter soils had a pH of less than 6.0 and the results may be because of this acid reaction. Several experimental plots at O.A.C. were sampled each month during 1955 and examined for Azotobacter. Some of the plots yielded very high populations of this organism, probably owing to the application of various fertilizers and/or a slightly alkaline pH (7.6).

c) Influence of P.K., lime and plant residues on Azotobacter

Brantford silt loam, low in the above materials, was used in greenhouse studies. Straw and corn stalks, together with P.K. and lime were added to pots of this soil, and all pots except controls were inoculated several times with Azotobacter chroococcum. In spite of high applications of P.K. and lime, Azotobacter could not be established in these soils. There was an indication, however that the effect was due to an inadequate energy source since a slight increase in the numbers of Azotobacter occurred in those pots containing corn stalks toward the end of the experiment.

A second series of experiments was carried out in the greenhouse using Brantford silt loam and Brookston clay. Various fertilizer treatments were used (P.K. + lime, P.K. + corn stalks, P.K. + N), some of the pots were inoculated with Azotobacter chroococcum, and all pots seeded to sugar beets. It was believed that these plants would increase the carbohydrate content of the soil and aid in the establishment of a high Azotobacter population. The Azotobacter cells survived throughout the experiment and in some of the fertilized pots a slight increase in count was observed. However, there was no correlation between the weight of sugar beets at harvesting and the Azotobacter population. Therefore the establishment of Azotobacter in soils is a very difficult procedure unless definite fertilizer treatments are applied, and particularly a supply of available carbohydrate.

A check crop of oats was seeded to the above pots to determine any beneficial influence of Azotobacter on soil fertility. The final results are not yet available, but preliminary data indicate that no definite beneficial influence has been exerted.

In a final experimental series certain pots containing Brantford silt loam were fertilized with P.K. and lime, while others remained unfertilized as controls. Alfalfa, inoculated with an effective strain of Rhizobium meliloti (R_{21}) was seeded to half the pots, and orchard grass, inoculated with Azotobacter chroococcum, was seeded to the other half. There was no indication that the orchard grass promoted Azotobacter growth. In fact, periodic counts showed a rapid decline in Azotobacter numbers throughout the experimental period. This may be a result of competition between bacteria and plants for available oxygen, nutrients etc. A check crop of oats seeded to all the pots showed no increase in the weight of dry matter of the harvested plants owing to Azotobacter inoculation. As was expected, the yield of oats from the alfalfa pots was higher than that obtained from the orchard grass pots.

III. Mutational Studies on Rhizobia

The gradient-plate technique has been used for the isolation of mutants of the alfalfa organism, *Rhizobium meliloti* and the red clover organism, *Rhizobium trifolii*, which are resistant to certain chemicals used to protect leguminous seed. Major consideration was given to 2,3-dichloro-1,4 naphthoquinone (Phygon), phenylmercuriurea (Leytosan) and Bis (dimethylthiocarbamyl) disulphide (Arasan). These compounds have a low solubility in water. The objective was to obtain cultures of root-nodule bacteria which could grow in the presence of saturated solutions of these seed protectants. For practical purposes, resistance to these concentrations would be "absolute resistance".

a) Phygon

This chemical was the least toxic to rhizobia of the three seed protectants. Some strains were found to be naturally resistant to saturated solutions of Phygon. Two strains tested, which were sensitive to Phygon, readily mutated to show a stepwise increase in resistance. *Rh. meliloti* 107 required three mutational steps and *Rh. trifolii* 205 took five mutational steps to yield cultures resistant to saturated solutions of Phygon.

b) Leytosan

All strains of rhizobia tested were highly sensitive to Leytosan. A series of three selective steps sufficed to isolate mutants of *Rh. meliloti* and *Rh. trifolii* which showed a four-fold and eight-fold increase, respectively, in resistance to Leytosan. A much higher level of resistance must still be obtained before these strains would reach absolute resistance.

c) Arasan

All cultures were moderately sensitive to Arasan. Owing to its wide-spread use as a seed-protectant, this chemical received special emphasis. Nevertheless, repeated attempts have thus far failed to yield a single mutant showing resistance to Arasan.

LEGUME RESEARCH COMMITTEE

Proposed Programme for 1956

Department of Bacteriology

I. Physiology of Rhizobia

Fundamental studies on the physiology of the legume root nodule bacteria will be continued. These are necessary for the detection of differences between effective and ineffective strains, for the clarification of the nitrogen fixation process, and for the rapid production of large quantities of soybean organisms for legume inoculant purposes.

(a) - Determination of the nutritional requirements of the slow growing soybean bacteria.

(b) - Determination of the reason for the apparent dependence of resting rhizobia on an external supply of amino acids.

(c) - To trace the superficial pathways of amino acid synthesis in rhizobia using radioactive compounds.

II. Mutational Studies of Rhizobia

Mutational studies on rhizobia will be continued in an attempt to isolate mutants resistant to saturated solutions of various seed-protectant chemicals. Greenhouse tests with various mutants, together with leguminous plants, damping off fungi and the seed protectant chemicals will be conducted. It is hoped to provide a system wherein the fungicide and legume inoculant can be added to the seed simultaneously without danger of the protectant killing the rhizobia or impairing their activity.

III. Efficiency of Rhizobium spp.

(a) Testing of R. meliloti on alfalfa

In view of the increasing popularity of newer varieties of alfalfa such as "Vernal" and "de Puit", it is planned to test O.A.C. strains of the alfalfa root nodule bacteria for effectiveness and infectiveness on these new varieties.

(b) Testing Birdsfoot Trefoil culture

Reported inability of trefoil to be successfully inoculated unless double amounts of inoculant are used will be investigated by testing O.A.C. trefoil inoculant under greenhouse and possibly field conditions.

ROOT ROT OF CLOVERS

by

L. V. Busch

Dept. of Botany

During the past year a special effort was made to determine the role that P & K played in the root rot complex found in red clover in Ontario. It had been noticed previously that red clover plants growing in the light chamber at 18 hours photoperiod frequently exhibited root rot symptoms similar to those found in the field, while similar plants growing at 12 to 14 hours, at which interval they remained vegetative, rarely were affected. It was decided to study the effects of different levels of P & K on root development and deterioration of red clover plants growing at 18 hours in the light chamber. Four levels of nutrient were chosen. High P & K, low P & K, minus P & minus K. With the first few experiments non-sterilized soil was used and no root rot organisms were added. However, a serious infestation of root-rot nematodes made soil sterilization mandatory and it was necessary to add root rot organisms to each pot.

It was shown that in sterilized soil without the addition of root rot organism the roots of plants, deficient in potassium, which had been growing in a reproductive state, were considerably reduced in size, when compared to plants receiving adequate amounts of K. The roots of all plants were essentially the same size at the commencement of the experiment. None of the plants however showed root-rot symptoms. However, when root rot cultures were introduced to a similar set of plants those plants which were growing at minus K or low K exhibited the root rot symptoms, while plants with sufficient potassium, did not. It would appear therefore that any practice which tends to keep the plants in a vegetative stage, will also help prevent root rot.

In addition to investigating the effects of P & K on root rot, some effort was made to determine the damage caused by fall pasturing of alfalfa plants. Four stations were located in a two year old hay field, October 15, 1954. The alfalfa plants were counted in two adjacent square yard plots at each station, one plot was caged in each case and the other left open. From the time the cages were applied until freeze up the field was pastured whenever the top growth warranted. The plots were recounted May 11 when the growth was several inches high. From the table it will be noted that in three cases survival in the non-pastured area was considerably greater than on the adjacent pastured plots. The difference in results obtained at station #2 was possibly due to the fact that this area was covered by a heavy ice layer for the greater part of the winter.

Station	Cage		Open	
	Fall	Spring	Fall	Spring
1.	57	20	47	6
2.	48	3	34	3
3.	37	25	34	11
4.	51	34	45	14
total of 1, 3, & 4	145	79	126	31

Alsike Pollen Studies

A Report to the Legume Research Committee in Ontario

B.R. Irvine

ABSTRACT

For each set of growing conditions, whether in the growth chamber or in the field, there is a separate maximum seed yield potential. How close this approaches maximum reproductive capacity depends on the environmental conditions present. To date, no satisfactory means of identifying plants growing in the growth chamber and in the field under identical conditions exists, whether vegetative growth or reproductive response is the criterion. The possibility that the growing conditions of the Alsike plant would be reflected in the behaviour of the pollen is the phase being studied. The ability of pollen to germinate under standard conditions and its growth rate has been investigated for twenty different nutrients. On the completion of calibrating the Cartesian Diver Microrespirometer differences in respiration of pollen prior to germination, at the time of germination, and during pollen tube elongation will be sought. When extraction procedures have been standarized, the auxin content of pollen from plants growing in the twenty nutrients will also be investigated.

Plans For 1956

It is Intended to Continue the Present Line of Research

ALSIKE POLLEN STUDIES

A Report to the Legume Research Committee in Ontario

B.R. Irvine
Botany Department

INTRODUCTION

Alsike clover plants grown under certain environmental conditions have a greater ability to set and produce seed than when grown under less favourable ones. The maximum ability to produce seed, or the maximum reproductive capacity has been reported as 27 gms. of seed per plant for Alsike clover. This figure was obtained under known levels of temperature, humidity, light, soil composition and nutrition. Altering any one of these factors from the level known to give maximum reproductive capacity results in a lower seed yield. In the growth chambers these reductions in seed yield can be measured and the cause determined. In the field only certain factors can be measured. For instance there is no way to control the reduction caused by unfavorable photoperiod, or temperature. Therefore when conducting studies on maximum seed yield in the field, our maximum seed yield will be reduced to a value much lower than the reported 27 grams per plant. Assuming the maximum yield in the growth chambers to be 100%, and the reduction in yield due to the additive effects of photoperiod and temperature to be 50% then the best yeild we could expect would be 13.5 grams of seed per plant other factors being optimum.

By studying soil composition, drainage, and fertilizer requirements of the plant in the field it is hoped to measure the effect they have on maximum reproductive capacity. If this can be done it should be possible by proper combinations of the above factors to bring seed yields up to the theoretical maximum for particular sets of conditions.

From previous reports to this committee, various methods have been used in trying to equate the results of the total environmental conditions in the field and in the growth chamber. Some of these methods were:

1. seed yield, comparable plants would have comparable seed yield.
2. chemical analysis (total analysis of the plant or of plant parts), plants under treatment in the growth chamber would have consistent differences in composition which could be identified in the field and
3. measurements of plant parts, green weight, dry weight, number of flower heads, florets or reproductive shoots. None of these means of comparing plants could be used with confidence, most differences being small and variable. Since differences in the ability of pollen from different plants and sites to affect seed-set have been noted in cherry, pear and apple orchards it seemed adviseable to study the effect of environmental changes on the parent plant on the ability of the male gametophyte to fertilize the egg nucleus in the embryo sac of alsike clover. For these studies, Alon a commercial variety of clover has been used. Two main lines of research have been followed in this problem. The first, is the ability of the plant to produce pollen that is viable, has high germination and a good growth rate of the pollen tube. These conditions are attributes necessary for high seed-set. Although the amount of pollen produced by the plants was ample the percentage germination varied, not only among the treatments but within treatments. Table 1 is a comparison of germination of pollen collected on the 13th of March, 1955, the 17th of May, 1955, and the 18th of October, 1955. Results from the last experiment were higher and more consistent than those from the first two collections. This could be due to the fact that a different chamber was used in the latter experiment.

Table 1. The % germination of alsike pollen when the nutrient level of the parent plant was varied.

Conc. of PandK	10:1:1	1:1:1	1:10:10	Ratio $1:10^2:10^2$	$1:10^3:10^3$	$1:10^4:10^4$
1000	0	50	60	68	82	83
100	0	84	73	80	78	—
10	94	72	80	72	0	—
1	88	71	73	63	—	—
0.1	—	62	71	47	—	—

From the above table it can be seen that:

1. The proper ratio of N,P, and K for the germination of the maximum number of pollen grains shifts as the intensity of nutrition varies.

2. Under high intensities of inorganic nutrition, the lower N is in comparison to P and K, the better the germination.

3. As the intensity decreases, higher and higher proportions of N are required to maintain a high percent of pollen germination.

4. Below some critical concentration of N, P, and K which appears to be around a PK concentration of 1, the effect of ratio on pollen germination reverses so that greater quantities of P and K are again required to maintain pollen germination.

5. The maximum pollen germination, 94% was obtained at a moderate nutritional intensity.

All pollen was germinated on a medium consisting of 10% sucrose, 5 p.p.m. boron, and 0.75% agar.

Growth rate of the pollen tube has been measured for some of the nutrient treatments, their curve plotted, and the following relationships appeared.

1. Growth rates of pollen tubes from pollen developed on plants receiving the same ratio of N,P and K have the same slope.
2. The higher the intensity of nutrition, the greater the relative growth rate within a single ratio.
3. The maximum rate of pollen tube growth occurs in the first half hour and the rate remains steady after about two hours.
4. The slope and shape of the growth rate curve is distinctive for each ratio over the range that has been surveyed.

Attempts to determine on a quantitative basis the amount of auxin in pollen has met with little success. None of the extraction proceedures tried have yielded measureable amounts of auxin as determined by the avena coleoptile test.

Techniques

Twenty different nutrient solutions have been tested on Alsike clover grown in the light panels. Each solution varying in N,P and K levels was repeated in triplicate making a total of 60 plants in an experiment. Growth of each plant was recorded, as well as the time of flowering and the number of flowers produced. Five florets was collected from each plant and counts made on the ratio of germinated to non-germinated grains. A small hive of bees was placed in the panel and left there for a period of two weeks. In approximately three weeks time the seed was ready to be collected. The seed from each plant was cleaned by hand, screened to eliminate small seed, and weighed.

As far as respiration studies of pollen are concerned little work has been reported in the literature. Any measurements made were done in the Warburg using a relatively large sample of pollen. It would be difficult to obtain large quantities of pollen for all the treatments to be studied moreover the relatively large sample size would likely mask any measureable differences. The Cartesian Diver Respirometer as conceived and elaborated by Linderstrøm-Lang appears ideal for a study of pollen respiration since it deals with very small quantities. This equipment works best with gas volume changes of the order of 0.01 micro litres per hour, and has an accuracy of 0.001 micro litres. Therefore it is hoped to measure respiration of a single pollen grain once the technique has been mastered. This equipment is being made and calibrated in the Cytology Laboratory. The divers used have a volume of from 1 to 10 micro litres. Pipettes used to fill the divers must be calibrated to deliver 0.4 to 1 micro-litre quantities. These pipettes are filled and expelled in the normal manner. The neck of the diver has an internal diameter of 1 millimeter, and is about 10 millimeters long. This necessitates the construction of a special apparatus for lowering and raising the pipette without touching the sides of the diver neck. Construction and calibration of this equipment is almost completed.

SUMMARY

For each set of growing conditions, whether in the growth chamber or in the field, there is a separate maximum seed yield potential. How close this approaches maximum reproductive capacity depends on the environmental conditions present. To date, no satisfactory means of identifying plants growing in the growth chamber and in the field under identical conditions exists, whether vegetative growth or reproductive response is the criterion. The possibility that the growing conditions of the Alsike plant would be reflected in the behaviour of the pollen is the phase being studied. The ability of pollen to germinate under standard conditions and its growth rate has been investigated for twenty different nutrients. On the completion of calibrating the Cartesian Diver Micro-respirometer differences in respiration of pollen prior to germination, at the time of germination, and during pollen tube elongation will be sought. When extraction procedures have been standarized, the auxin content of pollen from plants growing in the twenty nutrients will also be investigated.

Departments of Botany and Soils

Phasic Development and the Nutrient Uptake of Red Clover

by

R.O. Bibbey and J.W. Ketcheson

ABSTRACT

The growth and nutrient uptake of vegetative and reproductive red clover at 2 P levels was studied on clonal plants growing in Burford loam under photoperiods of 14 and 20 hours, in artificially illuminated growth chambers. P uptake at the early-full bud (rapid growth) and full bloom stages of development of the reproductive plants, and corresponding ages of vegetative plants was measured by P^{32} application over a 72 hour period.

Results showed that the fertilized, vegetative plants were higher in root weight and P and K uptake than other treatments. The nutrient uptake appeared to be associated with root development. P level in the soil affected P levels in the plant tops but did not affect either root growth or K uptake. Both nutrient uptake and growth patterns appeared to be established shortly after the application of fertilizer or initiation of photoperiod. The relationship of these findings to the physiology of the plant and field practice is discussed.

Red Clover in Southern Ontario is normally vegetative in growth from the time it emerges the first-season until early May of the second. From May until fall it is usually reproductive.

The question arises as to whether this crop accumulates its nutrient elements during its earlier vegetative growth and redistributes them during reproductive development, or whether there is continuous uptake of nutrients throughout its life cycle. A study in this field offered an opportunity for a fuller understanding of the physiology of the clover plant, as well as possible key information to the fertilizer practice of this crop.

Growth response and nutrient uptake of vegetative and reproductive clover plants, therefore, was studied, using different fertilizer levels to observe the long time effect, and P^{32} to study short term uptake at specific growth stages.

Growth Procedures

Clonal red clover plants, 4th pass from a single plant selected from Delaware red clover, were used throughout this study. The plants were grown in Burford loam in 2 gallon glazed pots, first in the greenhouse, and then in the artificially illuminated growth panels in the Department of Botany. They were maintained at a 14 hour photoperiod until a vigorous vegetative plant was established, then, following a period of lower temperature and enforced drought, half of the plants were forced into reproductive development by a 20 hour photoperiod.

Pertinent data regarding growth of the experiment plants are listed below:

20, July/1955.	Crowns from 3rd pass plants, sectioned and cuttings planted in coarse sand following a "Auxone" (rooting compound) dip. Maintained in greenhouse.
1, Sept.	Transplanted in soil-sand-peat mixture in 4 inch pots.
3-5, Oct.	Transplanted to Burford loam in 2 gallon glazed pots.
22, Oct.	Moved to Light Panels. 14 hour photoperiod.
12, Nov.-5 Dec.	Minimal moisture, low temperature (60°F. $\pm$ 5°F.)
5, Dec.	Field capacity moisture, normal temperature (70°F. $\pm$ 5°F.)
12, Dec.	Separated into 14 and 20 hour photoperiods.
19, Dec.	Soil of half of plants in each photoperiod fertilized with phosphorus at rate of 80 ppm. P. (368 lb. P_2O_5/ac.)

The plants were watered with distilled water and brought to the field capacity of the soil once each week. Additional waterings of uniform amounts of water for each plant in each panel were given when necessary. Sprays of D.D.T. and Aromite were used at intervals, and 2 plants were sprayed with nicotine sulphate to control aphids.

Volatilized S. was used to control mildew. Other than some effect by mildew on the vegetative plants at the first sampling, pests were not a factor in this study.

Notes were taken at intervals, and once stem elongation started every 3 days until completion of the experiment. Plants were moved at least twice a week to overcome position effect within the panel. The two panels had similar light intensities from single 400 watt Westinghouse JH1 mercury arc bulbs supplemented by 4, 60 watt tungston lights. While temperatures fluctuated somewhat, an attempt was made to balance the "degree-hours" between the panels.

Four glass rods were inserted 4 inches into the soil in each pot. These rods were later extracted, and both the fertilizer and tracer P injected into the hole using a syringe with a 4 inch needle. It was felt that in this way the P. would be uniformly applied to the root zone with minimum physical injury to the roots.

Four plants were sampled for analysis on the date of initial fertilization (Dec. 19). P^{32} was added to 4 fertilized and 4 unfertilized plants from each photoperiod at the rapid growth stage of the reproductive plants, i.e. from the very early bud to full bud stage, and to 5 plants at each of the two fertilities and photoperiods at the full flower stage. The plants were harvested 72 hours after treatment, at least 11½ hours after initiation of light for the day. During this 72 hours plants were brought to the field capacity of the soil each day, and the amount of water noted. Tops were separated from roots, roots were washed from the soil, fresh and dry weights taken and the material submitted for analysis.

One gram of dried, ground plant material was dry ashed at 525° (with an intermediate nitric acid treatment) and taken up in hydrochloric acid solution. Aliquots were analysed for phosphorus colorimetrically by the molybdivanodate method and for potassium by flame photometry. The P^{32} activity of the sample was determined with a solution Geiger detector tube and scaler. Activities were expressed on basis of total weight of plant material per pot, of total phosphorus per pot, and as per unit of plant material, and per unit of phosphorus.

Results

Growth Responses

The photoperiods of 14 and 20 hours were successful in producing strongly vegetative and strongly reproductive plants, respectively. The 14 hour, vegetative plants had little or no crown shoot development and leaves were from 8-9 inches in height. One week after switching half of the plants maintained at 14 hours to 20 hours the plants appeared less leafy. At 18 days all 20 hours plants showed crown shoot development and leaves, in general, had assumed a more upright habit of growth. (Figures 3 and 4). At 4 weeks these plants were in the early bud stage, and at 7 weeks in full flower. (Table 1.) Since the experimental material was of clonal origin, plants within a treatment were very uniform in appearance.

No particular responses of the vegetative plants distinguished the growth of the fertilized from the unfertilized. On the other hand, differences in growth habits were apparent between reproductive plants at the two fertility levels. These are shown in the data presented in Table 1.

Response from the fertilizer was first noted 18 days after application, when treatment differences in the length of the king shoots were noted. It would appear that the main fertilizer response was at this early stage, since an initial 3 day "boost" from the fertilizer at this time was maintained fairly uniformly through to flowering.

A second response initiated by the fertilizer at this early stage was an increase in proportion of crown shoots that responded to the photoperiod. This resulted in more strongly reproductive plants with less vegetative growth at their base, (Figure 5) as well as greater uniformity in flowering.

It should be noted that the above fertilized vs. unfertilized reproductive responses of the clover plants were very uniform for 8 out of the 9 plants in each category. One of the fertilized plants, however, reacted similar to the unfertilized group in growth habits, time of flowering, and P^{32} uptake, even though it was normal in weight and phosphorus content for its fertilized group. Similarly one of the unfertilized plants acted in the same manner as the unfertilized. Since for unknown reasons these plants exceeded the 4X mean deviation value in certain characteristics, they were eliminated from the statistics in Table 8 as well as the growth data in Table 1.

Dry Weights

Data respecting dry weights are presented in Tables 2, 3 and 6, for samplings at fertilization, full bud and full bloom sampling dates, respectively, and shown graphically in Figure 7.

It will be noted that root weights did not vary greatly between full bud and full bloom, while top weights in all treatments increased markedly. With little root variation, total dry weights would, by necessity, follow closely to top weights. Extending the curves for total weights as established by the full bud and full bloom samplings they are found to meet at a point about 18 days after application of the fertilizer. It was noted above that differences in length of king shoots of the 20 hour plants were first observable about this time, with average lengths of 4.6 and 3.3 inches for the fertilized and unfertilized plants respectively.

The curves also suggest that the developmental pattern for these plants, and as will be shown later the nutrient-uptake pattern, was established shortly after the application of the fertilizer.

At both bud and flowering sampling dates, tops of the unfertilized reproductive plants outyielded other treatments. This, in part, is probably because these plants were more leafy than the fertilized reproductive counterparts. Fertilized vegetative plants outyielded the unfertilized. While there was no significance between treatment root weights, the fertilized vegetative roots were consistently higher in weight than other treatments. Vegetative roots as a class were significantly higher in weight than reproductive roots, while there was no difference between the roots from the fertilized vs. unfertilized plants.

Phosphorus Uptake

The total phosphorus uptake per plant along with phosphorus percentage and yield of dry matter is given in Tables 3 and 6. These apply to the bud stage and bloom stage, respectively, and are broken down into roots and tops in each case. Corresponding values for representative plants harvested at the time the phosphorus fertilizer was applied are given in Table 2.

From these Tables, it is evident that total phosphorus uptake is highest in fertilized plants in a vegetative condition. The increase for fertilized reproductive plants over unfertilized plants is about one-third that for corresponding vegetative plants.

Vegetative-fertilized	-	44.9 mgms P.
" -Unfertilized	-	29.8 " "
Difference		15.1xx " "
Reproductive-fertilized	-	34.3 " "
-Unfertilized	-	28.5 " "
Difference	-	5.8xx " "

These increases are due to higher phosphorus percentages in the case of tops and whole plants, and to both higher percentages and higher yields of dry matter in the case of roots.

A plot of phosphorus pick-up with time shows all treatments to be fairly constant as to rate. Vegetative plants are higher than reproductive plants and the fertilized vegetative plants show the highest rate. It appears in each case that the differential in phosphorus level is established early in the experimental period. While the rate of uptake for vegetative roots follows a similar pattern to that in tops, reproductive roots show a declining rate. The ratio of total phosphorus in tops to that in roots is higher for reproductive plants than for vegetative plants.

Reproductive plants	- bud stage	2.36
	- bloom stage	2.60
Vegetative plants	- bud stage	1.69
	- bloom stage	1.29

Phosphorus-32 Uptake

The uptake of phosphorus-32 over a 72-hour period is given in Table 5 and 8 for the bud and bloom stages respectively. The values given are counts per minute in plant material following an initial soil application equivalent to 15 x 10^4 counts per minute per pot, of carrier free phosphorus-32.

In general the highest uptake of isotope occurs in roots. Unfertilized plants are much higher than fertilized plants.

The significant point in connection with the short period uptake is found in the activity per milligram of total phosphorus.

Bud stage	- vegetative-fertilized	-	375 counts/mgm P
	" -unfertilized	-	971 " / " "
	reproductive-fertilized	-	359 " / " "
	" -unfertilized	-	951 " / " "
Bloom stage	- vegetative-fertilized	-	237 " / " "
	" -unfertilized	-	767 " / " "
	reproductive-fertilized	-	241 " / " "
	" -unfertilized	-	784 " / " "

The similarity between vegetative and reproductive plants in the fertilized group and again in the unfertilized group suggests a parallelism in P^{32} for the two growth conditions. Thus at both the bud stage and the bloom stage, the 72-hour uptake rate bears the same relation to the overall uptake in both the reproductive and vegetative plants.

The sharp decrease in counts for fertilized plants is considered to be, at least in part, due to increased dilution of the isotope in the soil. Phosphorus-32 tracer atoms distribute themselves amongst stable phosphorus-31 atoms in the soil and the two are considered to be taken up concurrently in proportion to their concentrations. Since there is more phosphorus-31 relative to phosphorus-32 in the fertilized soil, the concentration of the latter in fertilized plants should be basically less. There was no evidence in this study to relate transpiration to P^{32} uptake.

Potassium Uptake

The uptake of potassium together with potassium percentage is given in Tables 2, 4 and 7 for fertilization bud and bloom stages, respectively.

Again the vegetative plants exhibit the higher uptake. This increase appears to be a consequence of higher percentage values in the tops and higher dry matter levels in roots.

Phosphorus fertilizer treatments do not appear to influence the potassium percentage in the plant. Any change in total uptake therefore is a result of change in total dry matter; and there appears to be no interaction between these two elements.

Total uptake of potassium per unit of root weight is similar for all treatments and conditions of growth.

	Total K. mgms.	Root Wt. gms.	Total K/Root Wt.
Bud Stage			
Vegetative-fertilized	127.1	6.5	19.6
" -unfertilized	102.3	5.7	17.9
Reproductive-fertilized	92.9	4.6	20.2
" -unfertilized	99.0	4.8	20.6
Bloom Stage			
Vegetative-fertilized	145.8	6.4	22.9
" -unfertilized	120.0	5.8	20.7
Reproductive-fertilized	98.1	4.6	21.5
" -unfertilized	114.2	5.2	21.8

A plot of the uptake of potassium by tops and roots with time illustrates a parallelism between fertilized and unfertilized vegetative plants. The lower rate of uptake in the fertilized reproductive plant reflects its reduced dry matter yield in favour of reproductive development.

The roots of all plants show a decline in potassium percentage, and consequently in potassium uptake, between the bud and bloom stages. This decline appears to be in favour of increased top content. This is particularly true in the case of reproductive plants where the ratio of potassium in tops to that in roots is 7.2 and 7.7 for the bud and bloom stages respectively. The corresponding ratios for vegetative plants are 5.8 and 4.7.

Discussion

In this study an attempt was made to inter-relate nutrient uptake and phasic development of the clover plant. In a number of aspects this was successful. For example, plants maintained in a vegetative condition by means of short photoperiod was shown to pick-up larger quantities of P and K from the soil than plants in a reproductive condition. Similarly, growth responses with respect to photoperiod and fertility levels appeared to initiate nutrient up-take patterns that persisted to full bloom. While P uptake of the roots responded to type of growth, P uptake of the tops was related to both type of growth and soil P levels. Percent K in both roots and tops was closely related to phasic development, with probably at least part of the effect being the comparison of K content of leafy plants vs stemmy plants. K uptake was found to be closely related with root weight, which in turn was found to be related to phasic development.

The tracer data indicates that the rate of P uptake at either the full bud or flowering stage was similar to the rate of uptake established over a period of time. Unfortunately large fluctuations in activity among the heavy P^{32} feeders statistically mask differences among the lesser feeders. There was, however, a strong tendency for higher P^{32} uptake in vegetative plants, and P^{32} activity of vegetative roots was significantly higher than that of reproductive roots. Dilution effects complicate conclusions in relation to fertility levels.

It is surprising that the total weights of the 20-hour plants did not appreciably exceed those of the 14 hour plants since these plants had 6 hours more light per day or about 350 total hours of additional photosynthetic potential. No explanation is offered, but the results do suggest further investigation into the photosynthesis-phasic growth field.

These developmental-nutrient uptake relations are of particular interest in relation to the physiology of the clover plant. Earlier reports to this committee by Riddell and Bibbey have shown that cambial activity of the root, with its subsequent phloem potential, was related to phasic development. This coupled with the weight increases recorded in this study suggests that the vegetative condition results in increased carbohydrate movement to the roots, a condition generally recognized in terms of fall development.

If nutrient uptake is closely related to the root, as this study suggests, it may be tied in with increased absorbing surface - a growth response to increased carbohydrates etc. from the top, and/or to a greater metabolic activity within the root - also a possible response from increased carbohydrates etc. Since there was little gain in root weight between the full bud and bloom samplings it would appear that increased metabolic activity was a major factor.

Findings in this study suggest that soil application of P fertilizer would be used more efficiently by clovers in vegetative condition. Field practices that encourage a vigorous first year plant should also encourage increased uptake of nutrients, which in turn would be available for redistribution within the plant during the second season. The possibility of clover fertilization after removal of the nurse crop might be further investigated. The data would also support the early fall application of fertilizers to perennial legumes.

In addition to increased nutrient uptake the findings also suggest further emphasis on nutrient balance. The strong reproductivity of the high P plants would suggest an increased possibility of this type of plant dying out after first cut during the second year. In other words, the strongly reproductive response of the crown shoots left little regrowth potential in terms of undeveloped shoots. There would appear to be nutrient-photoperiodic-varietal balance of which the field research worker should be cognizant.

Key to Figures on next page.

Figure 1. 14 hr. red clover plants on Dec. 13 when 20 hour photoperiods were established.

Figure 2. Technique for application of P^{32}.

Figure 3. Clover plants 17 days after establishment of reproductive photoperiod.

Figure 4. 14 hr. red clover plants the same age as those in Fig. 3.

Figure 5. Left, unfertilized plant; right, fertilized plant, showing growth differences.

Figure 6. Reproductive plants at the early bud (rapid growth stage).

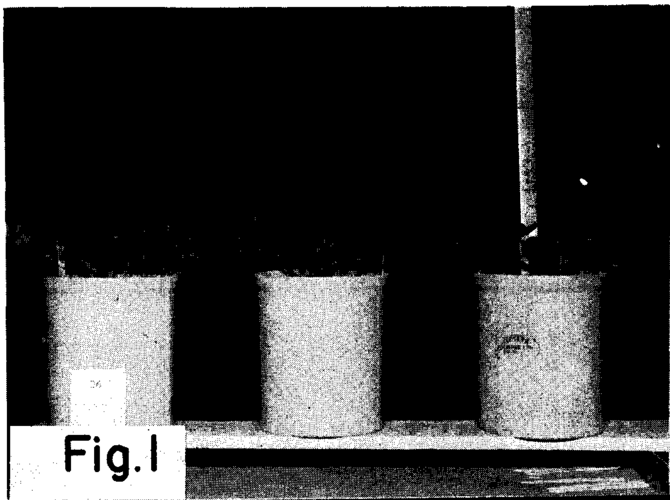

Fig. 1

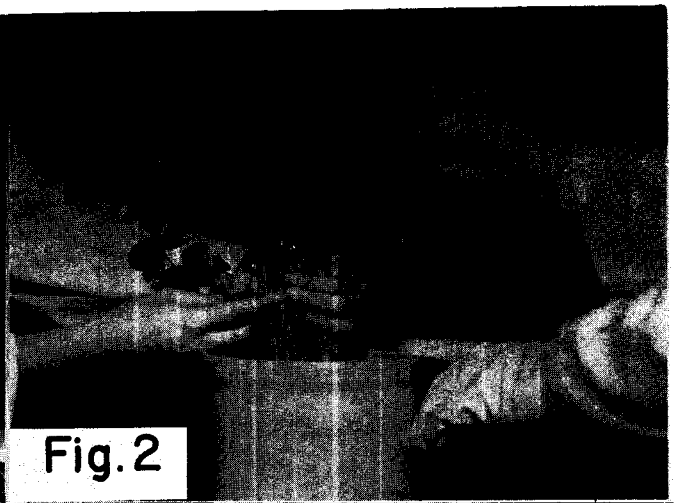

Fig. 2

Fig. 3.

Fig. 4.

PHASIC DEVELOPMENT AND NUTRIENT UPTAKE

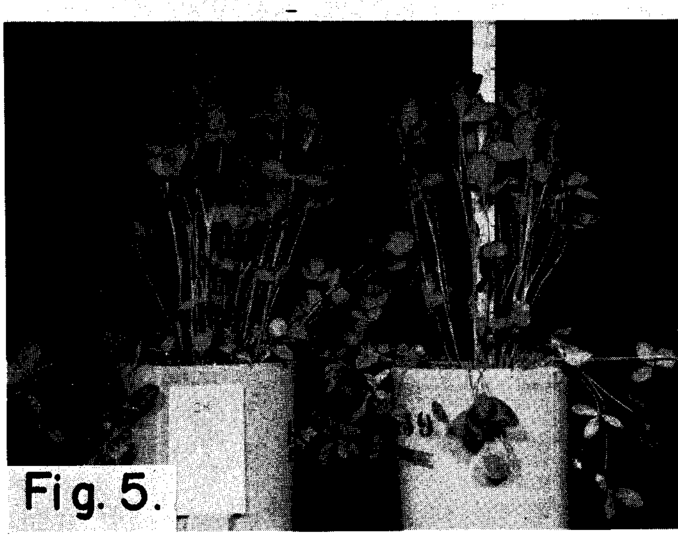

Fig. 5.

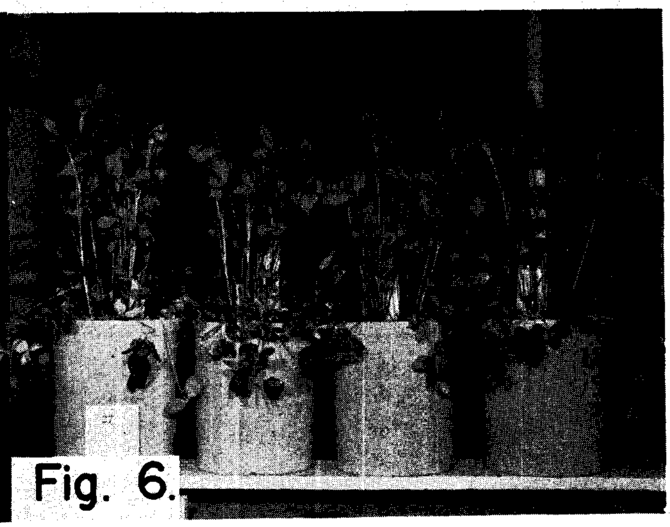

Fig. 6.

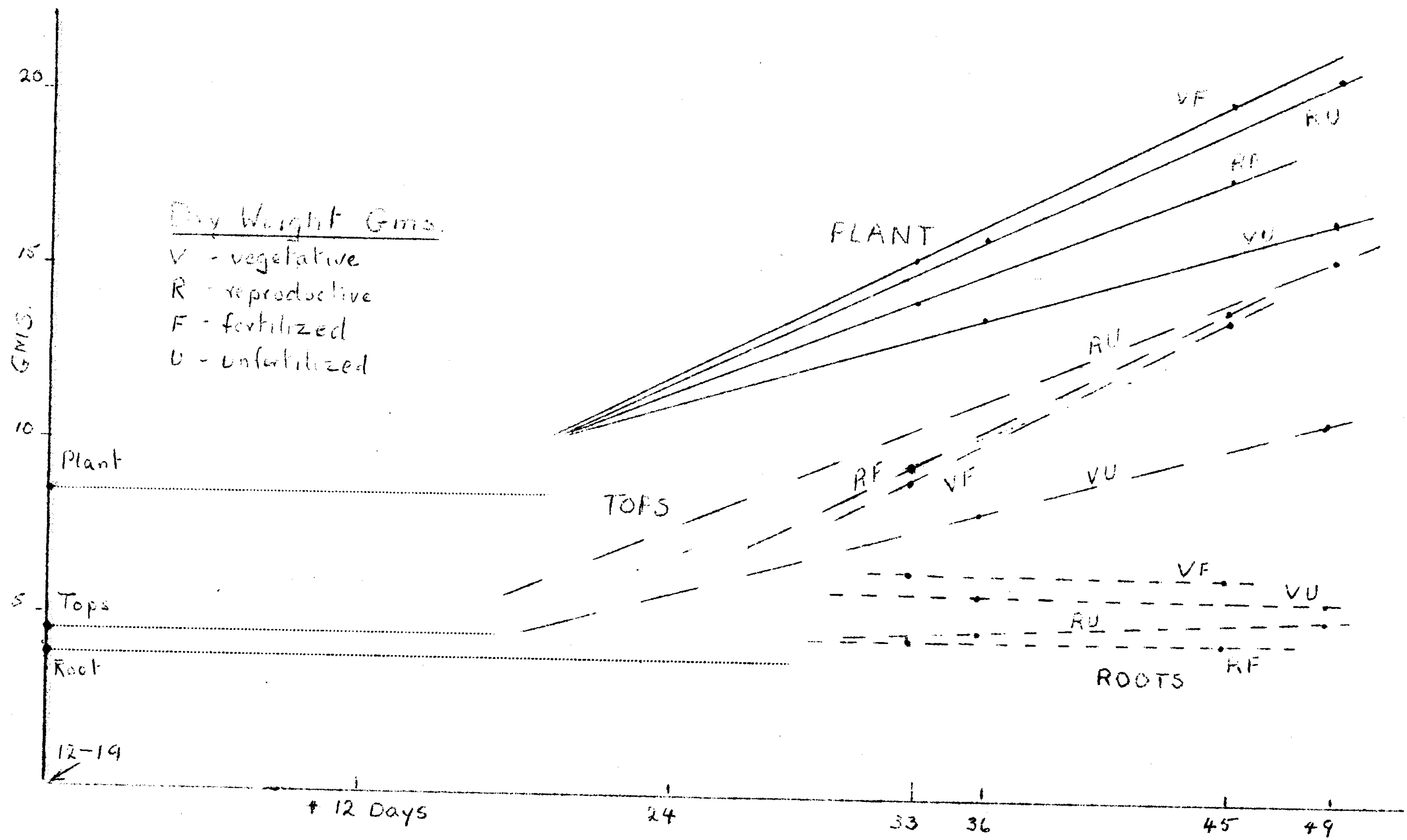
Dry Weight Gms.
V - vegetative
R - reproductive
F - fertilized
U - unfertilized
GMS.
20
15
10
5
Plant
Tops
Root
12-19
12 Days
24
33
36
45
49
PLANT
VF
RU
RF
VU
TOPS
RU
RF
VF
VU
ROOTS
VF
VU
RU
RF

Table 1. Growth Data of Fertilized and Unfertilized Reproductive Red Clover. Means of 8 plants per treatment.

Date	Fertility	Reproductivity[1]	Ht. longest shoot. ins.	No. shoots 1-3 ins.	No. shoots 3-6 ins.	No. shoots 6-12 ins.	No. shoots over 12 ins.	Flowering No. shoots in class 1	2	3	4	5	6	7
12-30	F	1	1.9	5	-									
	UnF	1	1.8	5.1										
1-6	F	2.0	4.6	4.6	3.1	0.2								
	UnF	1.6	3.3	7.6	1.0	-								
1-9	F	2.1	5.6	3.4	4.6	0.5								
	UnF	1.9	3.9	6.8	2.8	-								
1-12	F	2.1	8.4	2.9	2.4	3.0		0.1						
	UnF	2.0	6.2	4.2	4.6	1.1		-						
1-15	F	2.8	10.3	2.5	0.6	5.5		2.5						
	UnF	2.4	8.4	4.2	2.6	3.6		0.9						
1-18	F	3.0	13.9	1.6	0.9	3.9	1.9	3.6	0.4					
	UnF	2.9	10.5	3.6	1.8	5.1	0.2	2.4	-					
1-21	F	3.5	17.1	1.8	0.8	2.8	3.0	3.1	1.6	0.5				
	UnF	3.0	13.9	3.9	1.2	4.0	1.8	3.5	0.5	-				
1-24	F	3.8	20.5	2.2	0.8	1.0	5.5	1.8	2.5	1.5	0.2	0.2		
	UnF	3.2	17.0	3.6	0.5	3.1	3.6	2.9	2.9	0.5	-	-		
1-27	F	4	21.5	2.2	0.5	0.5	5.5	0.8	1.8	2.0	1.0	0.4	0.2	
	UnF	3.2	18.5	3.0	0.0	3.2	4.0	4.2	1.5	0.2	0.2	-	-	
1-30	F	4	23.0	2.5	0.2	1.0	6.0	0.5	0.5	0.5	1.5	1.2	2.2	0.2
	UnF	3.4	21.8	3.8	0.0	2.0	5.8	3.0	2.0	1.5	0.8	0.2	0.2	-
2-2	F	4	23.8	2.2	0.0	0.5	6.2	0.0	1.0	0.0	0.5	0.5	4.0	1.0
	UnF	3.4	23.6	3.8	0.8	1.2	6.5	1.8	1.8	1.2	1.5	0.2	1.0	0.2

[1] Class 0 = vegetative 1 sl. reproductive 2 moderately 3 strongly 4 very strongly

[2] Flowering Class 1 = very early bud 2 early bud 3 full bud 4 early flower 5 medium flower 6 full flower 7 past flower.

Table 2. Phosphorus and Potassium content and dry weight of red clover plants on day of fertilization. Mean of 4 plants.

	Phosphorus			Potassium	
	Dry wt. gms.	%	mg.	%	mg.
Tops	4.7 ± .4	.170 ± .007	7.88 ± .633	1.27 ± .063	59.16 ± 6.26
Roots	4.0 ± .3	.209 ± .004	8.32 ± .49	.65 ± .032	27.58 ± 1.05
Plant	8.7 ± .7	—	16.20 ± 1.12	—	86.75 ± 7.11

Table 3. Dry weight and P uptake by vegetative and reproductive red clover plants at two different fertility levels. Reproductive plants in the full bud (rapid growth) stage of development. Mean of four plants per treatment.

	Tops			Roots			Whole Plant		
	Dry wt. (gm.)	% P	P[1] (mg.)	Dry wt. (gm.)	% P[1]	P (mg.)	Dry wt. (gm.)	P (mg.)	
14 hr. Fertilized (Vegetative)	9.0	.274	24.5	6.5	.315	20.4	15.4	44.9	
14 hr. Unfertilized (Vegetative)	8.1	.198	16.0	5.7	.247	13.8	13.8	29.8	
20 hr. Fertilized (Reproductive)	9.6	.239	22.9	4.6	.252	11.4	14.2	34.3	
20 hr. Unfertilized	11.3	.162	18.2	4.8	.214	10.3	16.0	28.5	
F value	14.2[xx]	104[xx]	37.4[xx]	3.27	6.61[xx]	16.3[xx]	2.15	36.9[xx]	
L.S.D. 5%	1.09	.015	2.0	1.52	.052	3.5	2.2	3.9	
L.S.D. 1%	1.53	.020	2.8	2.13	.073	4.9	3.1	5.5	

[x] F value significant [xx] highly significant

[1] mg. P the mean of 4 plants and does not necessarily equal dry wt. x percent

Table 4. Dry weight and K uptake by vegetative and reproductive red clover plants at two different fertility levels. Reproductive plants in the full bud (rapid growth) stage of development. Mean of four plants per treatment.

	Tops			Roots			Whole Plant		
	Dry wt. (gm.)	% K	K[1] (mg.)	Dry wt. (gm.)	%K	K[1] (mg.)	Dry wt. (gm.)	K (mg.)	
14 hr. fertilized (vegetative)	9.0	1.01	90.6	6.5	.41	26.5	15.4	127.1	
14 hr. unfertilized (vegetative)	8.1	.96	77.4	5.7	.44	25.0	13.8	102.3	
20 hr. fertilized (reproductive)	9.6	.80	76.6	4.6	.36	16.3	14.2	92.9	
20 hr. unfertilized (reproductive)	11.3	.72	80.6	4.8	.42	20.2	16.0	99.0	
F value	14.2^{xx}	12.0^{xx}	2.94	3.27	1.5	4.9^{x}	2.15	5.25^{x}	
L.S.D. 5%	1.09	.122	11.8	1.52	.09	6.5	2.2	13.7	
L.S.D. 1%	1.53	.171	16.5	2.13	.12	9.2	3.1	19.2	

x F value significant, xx highly significant.

[1] mg K the mean of 4 plants and does not necessarily equal dry weight. x percent.

Table 5. Phosphorus-32 activity (counts per minute) of vegetative and reproductive red clover plants of two fertility levels at 72 hours following application of isotope. Reproductive plants in the early bud - full bud (rapid growth) stage of development. Mean of 4 plants per treatment.

	Tops			Roots			Whole Plant				
	Activity per gm.	Activity per top	Total P per top (mg.)	Activity per gm.	Activity per root	Total P per root (mg.)	Wt. of plant (gm.)	Activity per plant	Total P per plant (mg.)	Activity per mg. Total P	H_2O[2] used (ml.)
14 hr. Fertilized (vegetative)	807	7245	24.5	1459	9607	20.4	15.4	16,850	44.9	375	
14 hr. Unfertilized (vegetative)	682	5606	16.0	4027	23,330	13.8	13.8	28,940	29.8	971	486
20 hr. Fertilized (Reproductive)	833	7992	22.9	953	4308	11.4	14.2	12,300	34.3	359	
20 hr. Unfertilized (Reproductive)	802	9027	18.2	3738	18,064	10.3	16.0	27,090	28.5	951	695
F value	1.1	4.8[x]	37.4[xx]	14.6[xx]	7.0[xx]	16.3[xx]	2.15	4.7[x]	36.9[xx]	8.9[xx]	38.2[xx]
L.S.D. 5%	N.S.	2030	2.0	1260	9,850	3.5	2.2	11,000	3.9	346	—
L.S.D. 1%	N.S.	2850	2.8	1769	13,800	4.9	3.1	16,000	5.5	487	—

[x] F value signigicant. [xx] highly significant.

[1] Isotope equivalent to 15 x 10^4 counts per min. applied per pot. Treatment period 72 hrs.

[2] H_2O transpired by plant and evaporated by soil during 72 hr. P^{32} treatment period.

Table 6. Dry weight and phosphorus uptake by vegetative and reproductive red clover plants at two different fertility levels. Reproductive plants in the full bloom stage of development. Mean of 5 plants per treatment.

	Tops			Roots			Whole Plant		
	Dry. wt. (gm.)	%P	P (mg.)	Dry wt. (gm.)	%P	P (mg.)	Dry wt. (gm.)	P (mg.)	
14 hr. Fertilized (Vegetative)	13.56	.282	38.14	6.36	.364	22.77	19.9	60.9	
14 hr. Unfertilized (vegetative)	10.92	.214	23.32	5.79	.313	18.07	16.7	41.4	
20 hr. Fertilized (reproductive)	13.24	.226	29.86	4.57	.291	12.65	17.8	42.5	
20 hr. Unfertilized (reproductive)	15.61	.164	25.54	5.23	.188	9.75	20.8	35.3	
F value	7.4 XX	78.7 XX	13.2 XX	2.0	21.15 XX	51.8 XX	3.4 X	23.4 XX	
L.S.D. 5%	2.1	.016	5.34	NS	.048	2.40	3.1	6.8	
L.S.D. 1%	2.9	.022	7.36	NS	.067	3.30	4.2	9.3	

X F value significant. XX highly significant.

Table 7. Dry weight and potassium uptake by vegetative and reproductive red clover plants at two fertility levels. Reproductive plants in the full bloom stage of development. Mean of 5 plants per treatment.

	Tops			Roots			Whole Plant		
	Dry wt. (gm.)	% K	K (mg.)	Dry wt. (gm.)	%K	K (mg.)	Dry wt. (gm.)	K (mg.)	
14 hr. Fertilized (Vegetative)	13.56	.91	124.5	6.36	.34	21.3	19.9	145.8	
14. hr. Unfertilized (Vegetative)	10.92	.91	98.8	5.79	.36	20.9	16.7	120.0	
20 hr. Fertilized (Reproductive)	13.24	.65	86.0	4.57	.28	12.1	17.8	98.1	
20 hr. Unfertilized (Reproductive)	15.61	.65	101.2	5.23	.24	13.1	20.8	114.2	
F value	7.4^{xx}	22.4^{xx}	3.4^{x}	2.0	2.65	8.0^{xx}	3.4^{x}	4.7^{x}	
L.S.D. 5%	2.1	.095	26.1	NS	NS	5.2	3.1	27.3	
L.S.D. 1%	2.9	.131	36.0	NS	NS	7.2	4.2	37.7	

^{x} F value significant. ^{xx} highly significant.

Table 68 Phosphorus 32 activity (counts per minute) of red clover plants after application of isotope at the full bloom stage, and H_2O used during treatment period[2]. Mean of 5 plants per treatment.

	Tops			Roots			Whole Plant				
	Activity per gm.	Activity per top	Total P per top(mg.)	Activity per gm.	Activity per root	Total P per root(mg.)	Wt. of plant (gm.)	Activity per plant	Total P per plant (mg.)	Activity per mg. total P	H_2O[2] used (ml.)
14 hr. Fertilized (Vegetative)	509	6842	38.14	1218	7320	22.77	19.9	14,170	60.9	-237	622
14 hr. Unfertilized (Vegetative)	808	9045	23.32	3960	22,690	18.07	16.7	31,740	41.4	767	646
20 hr. Fertilized (reproductive)	438	5910	29.86	911	4,380	12.65	18.2	10,290	42.5	241	747
20 hr. Unfertilized (reproductive)	743	12,040	25.54	2926	16,000	9.75	21.7	28,040	35.3	784	827
F value	4.5^{x}	4.4^{x}	13.2^{xx}	17.6^{xx}	19.9^{xx}	51.8^{xx}	4.9^{x}	12.6^{xx}	23.4^{xx}	18.3^{xx}	10.2^{xx}
L.S.D. 5%	257	3950	5.34	1045	5600	2.40	2.9	8,900	6.8	219	90
L.S.D. 1%	357	5480	7,36	1450	7860	3.30	4.1	12,400	9.3	304	124

1 Isotope equivalent to 15×10^4 counts per min. applied per pot. Treatment period 72 hrs.

2 H_2O transpired by plant and evaporated by soil during 72 hr. P^{32} treatment period.

LEGUME RESEARCH COMMITTEE
IN ONTARIO

ENTOMOLOGICAL INVESTIGATIONS

- Progress Report for 1955 -

Department of Entomology and Zoology
Ontario Agricultural College
Guelph, Ontario.

DEPARTMENT OF ENTOMOLOGY AND ZOOLOGY

ABSTRACT of 1955 Investigations on Forage Legumes

The Haldimand County Co-operative Alsike Seed Project was completed. The 6-acre field was managed according to directions provided by the Committee. Yield was determined from 30 square-yard samples which were processed by the Field Husbandry Department. The mean yield was 285.27 lbs./ac. or 4.75 bu.

Nymphal Spittlebug Field Control Tests were conducted in Haldimand and Wellington counties. Blocks in Haldimand sprayed with Isotox Spray No. 20 (lindane 20%) at the rate of .25 lb. of actual toxicant per acre in 8.8 and 17.6 gallons of spray, at 40 lbs. pressure gave increases in yield of 1.75 and .60 tons respectively of fresh-cut forage. Blocks in the Wellington field were sprayed with Isotox Spray No. 20 at .25 lb. and heptachlor at .5 lb. actual toxicant per acre in 30 gals. of spray at approximately 100 lbs. pressure. Yields (dry matter in tons/ac.) determined from samples processed by the Field Husbandry Department, were approximately 2.2 tons from both treated and untreated areas.

Nothing was done in 1955 on the Alfalfa Seed Production Project in the Upper Bruce Peninsula.

During 1955, the Department of Entomology and Zoology continued investigations on several aspects of legume seed and forage production.

1. <u>Haldimand County Co-operative Alsike Seed Project</u>. This project, begun in 1954, was completed in 1955.

2. Several field tests (Haldimand and Wellington counties were conducted on the Control of <u>Spittlebug Nymps in Forage Crops</u>.

3. <u>Alfalfa Seed Production Project in the Upper Bruce Peninsula</u>.

4. A field of seed alsike was service-sprayed for insect control for the Department of Field Husbandry.

<u>Haldimand County Co-Operative Alsike Seed Project</u>

1954 - 1955

A re-statement of what appeared in the 1954 Report is as follows:

Mr. Gordon Skinner arranged with Alex Hedley and Sons (R. R. No. 2, Canfield; Lot 5, Conc. 1 North, Twp. of Cayuga) to co-operate on this project. Mr. Hedley formerly produced quantities of the crop.

Soil samples were taken by J. C. Bryant (Soils Department). The results of the analyses are given below.

Texture	O.M.	NO_3	Phosphate		Potash		Lime Requ't Factors				SO_4	Cl
			Water soluble	Dilute acid soluble	Water soluble	Replaceable	pH	CO_3	Ca	Mg		
		65		70		500+	6.2		1600	160		

The fertilizer recommendations based on these analyses (T. J. Heeg) were: 3 - 18 - 0 at 500 lb./ac.

or

11 - 48 - 0 at 200 lb./ac.

The Bacteriology Department provided the necessary powdered inoculant; R. Fulkerson (F. Hueb.) provided the alsike seed and suggestions for the seed-bed preparation and seeding as follows:

"Seed alsike at rate of 8-9 lbs. per acre. Mix inoculant with seed according to directions and immediately prior to seeding. The companion crop of oats or barley should be seeded lightly, preferably 1 to 1½ bushels per acre. A firm seed-bed is desirable and the land should be harrowed or packed following seeding. The seed has been treated with Arasan which may help in establishment".

On May 20, 3100 lbs. of 3-18-0 fertilizer were applied and oats (1 bu./ac.) and alsike were sown. This was later than advisable but the condition of the soil was excellent. The field was cultipacked 1½ days after sowing. The cover crop got away to a good start but a very dry spell set in about June 24 and lasted until mid-August. The oats yielded 40 bu./ac., the alsike catch did not appear to be promising.

On January 14, 1955 a letter from the co-operator indicated "catch disappointing...................dry spell apparently too much for it."

Visited field on April 26. Appearance more promising than expected. Higher parts well covered for most part; lowest areas bare; portions in between only fair. Considered adequate for our purposes if square yard samples to be taken.

By June 2, blossoming had started and <u>Miccotrogus</u> weevils were taken by sweeping. Sprayed in evening, applying approximately 200 gals. of Methoxcide 50 (Niagara Brand Methoxychlor 50% w.p.) at 100 lbs. pressure and 1 1/3 lbs. of actual toxicant per acre.

Twelve colonies of bees (courtesy of the Department of Apiculture) were placed at the edges of the field on June 3. These were left in place for the duration of the blossoming period.

On July 2, R. Fulkerson took 30 square-yard yield samples. As might be expected from such an uneven stand, there was much variation in the samples. The table below gives the calculated yield per acre in lbs. per sample.

Sample No.	Sample No.	Sample No.
1 - 255.0 lbs./ac.	11 - 537.8	21 - 297.7
2 - 208.0	12 - 346.8	22 - 298.8
3 - 375.6	13 - 378.8	23 - 257.7
4 - 390.5	14 - 340.4	24 - 173.9
5 - 404.4	15 - 272.1	25 - 344.6
6 - 266.8	16 - 300.9	26 - 152.6
7 - 244.3	17 - 276.3	27 - 310.5
8 - 242.2	18 - 276.3	28 - 214.5
9 - 341.4	19 - 280.6	29 - 218.7
10 - 216.6	20 - 140.8	30 - 194.2

Mean - 285.27 lbs./ac. or 4.75 bu./ac.

Control of Spittlebug Nymphs in Forage Crops

Field tests for spittlebug control were conducted on two farms, one in Haldimand and the other in Wellington county. Several insecticides were used.

Murray Coverdale farm, R. R. No. 1, Cayuga, on Highway 3 4 miles east of Cayuga. Blocks of an 8-acre field of third year alfalfa were sprayed on May 16 with Isotox Spray No. 20 (20% lindane), which contains 1.65 pounds of lindane per U.S. gallon. The rate of application was .25 lb. of actual toxicant (approximately 1 Imp. pint) per acre in (a) 8.8 gallons and (b) 17.6 gallons of spray at a pressure of approximately 40 lbs. The sprayer was a home-assembled, tractor-mounted, power take-off job with a 30-foot boom. Satisfactory coverage and effective spittlebug control were obtained. On June 20, 4 square-yard samples from the treated and check plots were taken and weighed fresh.

	A Blocks (West End) (.25 lbs. act. tox. per acre in 8.8 gals. spray)		B Blocks (East-central) (.25 lbs. act. tox. per acre in 17.6 gal. spray)	
	Check	Treated	Check	Treated
	3.0 lbs. fresh-cut	4.4 lbs.	4.0 lbs. fresh-cut	4.1 lbs. fresh-cut
	2.4	3.1 fresh-cut	3.3	3.9
	2.9	3.6	3.2	3.0
	3.3	3.4	2.8	3.3
Mean	2.90	3.62	3.32	3.57

The calculated tonnages per acre on a fresh-cut basis are as follows:

7.02 tons/ac.	8.77	8.05	8.65
Increase 1.75 tons		.60 tons	

Whether these differences were significant was not determined.

Bruce Fletcher farm, on Highway No. 6, one-half mile north of Marden. Two blocks (2.18 and 1.92 acres respectively) in a 10-acre field of grass-legume forage were sprayed on May 30 for spittlebug nymph control. The owner's tractor and the Department's high-pressure Farquhar Iron Age sprayer equipped with a 21-foot boom were used for application. On Block A (2.18 acres) lindane was applied at the rate of ¼ lb. actual toxicant per acre in approximately 30 gals. of spray at 90-100 lbs. pressure; on Block B (1.92 acres) heptachlor at the rate ½ lb. actual toxicant was applied in the same manner and under the same conditions as the lindane.

On June 27, samples were obtained for yield data. Each consisted of a strip of forage 2½ feet wide and a minimum length of 13 feet and their fresh-cut weights varied from 10.2 to 25 lbs. At the Field Husbandry Department an aliquot of each sample was weighed and dried and then weighed again. From these data the dry weight per plot in pounds and per acre in tons were calculated.

As can be seen in the table, the mean tonnages of dry matter per acre from the treated and check areas are so similar that further analysis is unnecessary.

Conclusions. In the Fletcher field the spittlebug population must not have been large enough to interfere with plant growth nor to warrant spraying. The Coverdale situation was somewhat different but the results were so erratic that their reliability is questionable.

It is very difficult if not impossible to examine a field in early May and forecast what its spittlebug population is or is going to be. Yet this is when the treatment should be applied in order to obtain maximum results with a minimum of damage from equipment.

Alfalfa Seed Production Project in the Upper Bruce Peninsula

D. H. Pengelly

In 1954 Mr. R. Bartley of Dyer Bay was approached as to the possibility of having a few acres of his land seeded down to alfalfa according to the specifications laid down by the Ontario Agricultural College. He was very willing but at the time was uncertain as to when reseeding would be done. Fortunately, because of adverse weather, he did not carry out his plans in 1955 but will do so in 1956.

Treatment	Plot No	Fresh cut wgt. of sample	Area of sample sq. feet	Aliquot Weight Fresh-cut	Aliquot Weight Dried	Percentage Dry Matter	Wgt. dry matter per plot	Tonnage dry matter per acre
Check	1	19.8 lb.	47.5	804 g.	225 g.	27.98 %	5.50 lb.	2.52
	2	15.3	51.3	862	263	30.51	4.66	2.00
	3	17.7	45.0	837	243	29.03	5.13	2.50
	4	15.0	63.3	946	310	32.77	4.92	1.70
	5	15.5	53.8	790	255	32.28	5.00	2.02
	6	20.6	49.3	866	245	28.29	5.84	2.62
							Mean	2.22
Lindane	1	17.5	40.0	699 g	176 g	25.18 %	4.41 lb.	2.41
	2	17.8	64.3	792	237	29.92	5.33	1.80
	3	10.2	33.1	850	259	30.47	3.11	2.04
	4	16.0	42.5	786	222	28.24	4.51	2.30
	5	16.7	39.5	802	215	26.81	4.47	2.48
	6	15.7	42.5	836	243	29.07	4.57	2.34
							Mean	2.22
Heptachlor	1	17.8	50.0	908 g	263 g	28.96%	5.14 lb.	2.24
	2	17.6	48.0	845	252	29.82	5.24	2.39
	3	17.3	43.8	915	254	27.76	4.80	2.39
	4	16.0	50.0	892	259	29.04	4.64	2.02
	5	14.0	58.8	845	262	31.01	4.34	1.61
	6	25.3	56.3	950	255	26.84	6.77	2.61
							Mean	2.21

&

PROPOSED PROGRAMME FOR 1956

Department of Entomology and Zoology

Land Needs - None; will make arrangements with growers.

Personnel - 1 student assistant (part-time only)

Equipment and Materials - Some insecticides only
Transportation necessary for Bruce County and other work.

Estimated Expenses

Supplies	100.00
Transportation etc.	$1150.00
	$1250.00

Projects:

A. Spittlebug Control - only if a farm or farms, which had heavy populations and suffered damage in 1956, can be located.

B. Clover Root Borer Control - This insect in New York State is considered the most destructive pest of red clover. Injury consists of tunnels throughout the tap root. Various root rot organisms invade these injuries and shorten the life of the plant by reducing its vigour and winter hardiness. Comtrol calls for an insecticidal treatment in early May on red clover that will be harvested for the first time. The treatment of old stands is largely wasted effort.

C. Alfalfa Seed Production - 1. A 10-acre field which has always had a good supply of native pollinating insects will be re-sown to alfalfa in 1956. Two acres will be seeded with Vernal and this area will be used in future studies of harmful insects, insecticide work if necessary and also to provide information on the seed yield that can be produced in the presence of adequate pollinating insects.

2. Surveys will be continued in an effort to find other areas where there are large numbers of native bees and where alfalfa seed might be produced successfully.

D. Bird's-foot Trefoil - Studies will be conducted on the native pollinators of Bird's-foot Trefoil whenever possible. Some trefoil is grown in the Dyer Bay area and studies would be concurrent with alfalfa pollination work.

E. Service Function for Other Departments - Insect control where necessary.

LEGUME RESEARCH COMMITTEE IN ONTARIO, 1955

Control of Insects Attacking Clovers and Alfalfa in Southwestern Ontario

Compiled by H. B. Wressell

Entomology Laboratory
Chatham, Ontario

During the summer of 1955, Mr. K. G. Davey of the Chatham Entomology Laboratory had two small experiments under way. One experiment had for its object a study of the contact toxicity of Perthane to adults and nymphs of the meadow spittlebug, *Philaenus leucophthalmus* (L.). The insecticide was applied by means of a Peet-Grady atomizer, the insects being confined in a spray tower. Each determination of the L.D.$_{50}$ involved exposure of groups of 20 nymphs or adults to sprays of different concentrations. One group of 20 was used as a check--no Perthane being used. As a further test, late nymphs were injected with small amounts of Perthane ranging from 0.13 to 16.5 micrograms. It was established that both contact and injection toxicity are greater for adults than for large nymphs. For small nymphs the contact toxicity is nearly five times greater than for adults.

A second experiment involved the growing of seedling alfalfa plants in the greenhouse and spraying them with heptachlor for phytotoxicity. No conclusions were possible in this study because it was evident that all the plants, including the checks, suffered a severe reduction in growth brought about by factors other than the insecticide heptachlor.

STUDIES BY CHATHAM ENTOMOLOGY LABORATORY IN 1956

Surveys of the Abundance of Insect Pests of Clover and Alfalfa in Southwestern Ontario

H. B. Wressell

Entomology Laboratory
Chatham, Ontario

Weekly collections will be made from April to October in four separate fields in Kent county. The numbers of economic species present in 100 net sweeps will be recorded, but special reference will be given the potato leafhopper, *Empoasca fabae* (Harr.), and the meadow spittlebug, *Philaenus leucophthalmus* (L.).

A. Potato leafhopper--This insect is regarded as a migratory species, and is the subject of a co-operative project by the North Central Branch of the Entomological Society of America. One of the main problems is to discover more concerning its migratory habits and the influence of weather factors on peaks of abundance. Studies by the Chatham laboratory will be mainly of an ecological nature. Life-history and habitat preferences will be stressed. Population studies will be supplemented by light trap records from four sources.

B. Meadow spittlebug--Although this insect is of economic importance in southwestern Ontario, it is not known how great the losses are. Records will be made of the relative abundance of this insect in alfalfa during the season. The data will be correlated with temperature and humidity in alfalfa plots during the growing season. The effect on the insect population of clipping the crop at different stages will be investigated.

ANNUAL REPORT

of the

FIELD HUSBANDRY DEPARTMENT

to the

LEGUME RESEARCH COMMITTEE IN ONTARIO

for the year

1955

R. S. Fulkerson

ALSIKE SEED PRODUCTION PROJECT

In 1955 a three-acre block of alsike was harvested at Brampton for seed. The crop was uniformly good in both stand and height. It was seeded at 10 pounds per acre, fertilized with 300 pounds of 4-24-12 at the time of seeding and top-dressed with an equal amount of 4-12-10 in the spring of 1955. The Department of Entomology sprayed the crop for weevil control on June 7. The same evening bees were placed in the field at the rate of approximately three colonies per acre.

Parts of the seed crop were direct combined and yielded 294 pounds of clean seed per acre, parts were swathed and combined and yielded 180 pounds of clean seed. These yields, though not as high as in 1954, again pointed to the advantage of direct combining alsike and to the ability of farmers to produce good alsike seed crops if proper cultural recommendations are practised.

B. E. Twamley

Alfalfa

1. Strain trials sown in 1953 at Guelph indicate that the newer varieties such as Vernal, Narragansett and DuPuits consistently outyield the older types represented by Grimm, Ladak and Ontario Variegated as shown by the table below.

Total Yield of Dry Matter (4% Moisture) in Tons/Acre

	New varieties	Old varieties	Increase
1954	4.35	3.50	0.85
1955	6.50	5.65	0.85

2. A second series of strain trials containing 16 varieties many of which have not previously been tested at Guelph was seeded in 1955. Establishment was excellent due in no small measure to the irrigation facilities provided by the department of Agricultural Engineering.

3. An alfalfa management study was harvested for the first time in 1955 but treatment effects will not be evident until 1956 or 1957. Average yields in tons per acre and average plant counts expressed as number of plants per square foot are shown below.

	DuPuits	Ranger	Vernal	Grimm	Mean
Yield					
Total 1955	2.57	2.31	2.50	2.16	2.39
Plant Counts					
October 1954	22.8	23.8	23.6	21.8	23.0
April 1955	17.1	14.8	19.9	17.0	17.2
July 1955	14.6	12.7	14.5	14.0	14.0

Birdsfoot Trefoil

1. At Kemptville the average total yields in the first and second harvest years were 2.6 and 3.7 respectively. The corresponding yields for alfalfa were 4.4 and 5.3. At the O.A.C. the first harvest year yields averaged about 3.3 tons per acre.
2. A strain trial consisting of 10 varieties was successfully established at the O.A.C. in 1955.
3. Breeding work in birdsfoot trefoil was initiated in 1955. The emphasis in the early stages will be on selection for seedling vigor and improved competitive ability in the seedling year.

White Clover and Ladino

1. Based on one season's growth the yields of white or Dutch clover and Ladino averaged about 1.8 and 2.7 tons per acre respectively. In general the Ladino types were less winter hardy that the white clover types but some notable exceptions occurred.

Red Clover

1. Strain trials were established in 1953 at Guelph and Kemptville and in 1954 at Guelph and Hespeler. Although the results showed a certain lack of consistency caused possibly by regional adaptation, climatic variability and variability in seed lots the following conclusions were indicated.
   - i. Commercial Ontario-grown red clover is strongly biennial in nature. As a result second year yields are very low.
   - ii. Canadian varieties such as Lasalle excel American varieties almost invariably in disease resistance and commonly in

longevity.

iii. The three English red clovers included in the trials were inferior to Canadian varieties in yield, aftermath and longevity.

iv. Those American varieties that were developed in nearby states were superior at Guelph to those developed in Kentucky, Iowa, etc., but even the best were not superior to improved local varieties.

v. Improved strains such as Lasalle or Dollard usually but not invariably outyield commercial red clover.

2. The following strain trials were established at Guelph in 1955:

i. Single cut types - 7 strains

ii. Double cut types - 14 strains

iii. Redon - 7 seed lots of different origin.

Sweet Clover

Because of poor establishment in 1954 yield data were not recorded and notes were taken only on earliness, coarseness, etc.

Miscellaneous Projects

A number of small experiments designed to provide information on time of seeding, mulching for establishment, companion crops, band seeding, etc., were conducted in 1954-55. These experiments are recorded in the 1954 and 1955 copies of the Annual Report, Forage Crops Investigations, Department of Field Husbandry.

PROPOSED PLANS FOR 1956

1. Four legume strains trials will be established at the O.A.C.

   Sweet clover - annual types

   Sweet clover - biennial types

   Red clover - British early types

   Red clover - British late types

2. Data will be obtained from several alfalfa, birdsfoot trefoil, red clover and white clover strain trials established in the period 1953-55.

3. A nursery of about 2500 birdsfoot trefoil plants will be established at the O.A.C. These represent plants, in the main, that were selected from a larger population on the basis of seedling vigor. Further selection will be done on the basis of adult plant phenotype and of breeding behaviour.

A Preliminary Study of Forage Legume Viruses that may Affect Canning Peas in Southwestern Ontario

W. G. Benedict

Observations in recent years of the commercially grown pea crops in Essex County, made at about the time that forage legumes were being cut for hay, disclosed that it was not uncommon to find many fields of peas reduced in vigor and yield to the point that crop failures resulted. It became the practice that as soon as aphids were noted in pea fields, an insecticide was applied but this did not prevent damage to the crop which differed according to the pea variety and was attributed to root rot.

The observations and events led to experimentation with some local clover viruses. During April and May, 1955, 14 virus isolates were obtained from forage legumes in the pea growing districts and were tested in the greenhouse as to their pathogenicity in three commercially important pea varieties.

Results of the tests indicated that the highest yielding and best quality pea variety of the three was highly susceptible to and severely affected by most of the virus isolates. The other two varieties which were somewhat earlier maturing were apparently markedly less susceptible. The greatest effect of the viruses, however, which presumably under field conditions are transmitted from forage legumes to the peas by aphids, is the predisposition of the peas to attack by soil borne fungus diseases. The resulting root rots have been the more obvious "cause" of pea crop failures to growers and field men alike in recent years.

An Exploratory Study of Some Factors Contributing to Forage Crop Failures on Sandy Loam Soils in Southwestern Ontario

An observed increase in clover seedling failure on sandy loam soils in southwestern Ontario during recent years indicated that a study of biological factors related to such failures was necessary.

The experimental approach included the utilization of chemicals to control biological groups of organisms such as insects, fungi, and nematodes in "failure"-infested sandy loam soil. All of the legume and grass forage crops generally grown in the area were tested under both greenhouse and field conditions. Pertinent weather data were recorded in the field plots.

Six treatments of the soil were used, namely, (a) check, (b) insecticide, (Dieldrin), (c) fungicide (Brassicol), (d) nematocide (DD-mixture), (e) a mixture of (b), (c), and (d), and (f) the "eridicant" fumigant (Vapam). Forage crops consisted of six legumes sweet clover, alfalfa, red clover, alsike clover, Ladino clover and birdsfoot trefoil and seven grasses, orchard grass, timothy, perennial ryegrass, meadow fescue, red top, smooth brome and Kentucky bluegrass. In the greenhouse experiment a duplicate of all treatments was made in steam sterilized sandy loam soil in order to have a check on the effect of the chemicals on the growth of the plants in the absence of soil borne pathogens.

The results based upon one year's work are the following. Quantitative measurements of plant growth and numbers of insects, fungi, and nematodes by standard procedures were used as the criterion to evaluate the efficacy of the chemicals to control the soil borne organisms.

In the greenhouse, a comparison of plant growth in steam sterilized soil and infested soil showed that alfalfa, birdsfoot trefoil, and Ladino clover grew better in the infested soil. Kentucky bluegrass grew equally well in infested and sterilized soil. Other clover and grasses grew from 16 to 90% better in the sterilized soil, the extremes of this range being, respectively, red clover and timothy. An analysis of the results of the treatments showed that only birdsfoot trefoil and Ladino clover grew significantly better in soil treated with any of the chemicals. Among the grasses and clovers tested here only Ladino clover benefited by treatment of the infested soil with the insecticide, the fungicide, the nematocide, and the mixture of all three of them. The "eradicant" fumigant Vapam was not better than the check in the infested soil. With the exception just mentioned the chemical treatments and soil sterilization neither stimulated nor retarded growth of the forage plants significantly under greenhouse conditions.

In the field, a comparison of plant growth according to soil treatment showed that the following plants grew significantly better in treated than in naturally infested soil: timothy and Kentucky bluegrass in the insecticide treated soil, sweet clover in the nematocide treated soil, and sweet clover, alsike clover, timothy, and Kentucky bluegrass in the "mixture" treated soil. A comparison of growth between treatments showed that alsike clover and meadow fascue grew significantly better in the nematocide treated soil, and orchard grass in the insecticide treated soil than each of these grew in the fungicide treated soil. Otherwise, plant growth was not better in soil treated with the chemicals than in naturally infested soil.

In the laboratory, samples of roots and soil beneath the plants in the field plots at harvest time were analyzed for populations of insects, fungi, and nematodes. Only from the soil obtained under sweet clover, orchard grass, timothy, and perennial ryegrass a few larval forms of wireworms emerged when the funnel method of drying the soil samples with heat applied at the surface was used to drive insects out of the soil. By direct microscopic examinations of the plant roots that were washed and stained with acid fuchsin in lactophenol it was found that the hosts which carried the largest fungus populations were Kentucky bluegrass, red clover, and alfalfa while those carrying the least were timothy, red top, and orchard grass. When the total fungi according to treatment were compared, the roots in Vapam treated soil contained the fewest fungi. Principal fungi were <u>Rhizoctonia solani</u> and <u>Fusarium</u> sp. Then, by the Baermann funnel technique and direct microscopic examination, the nematodes in the roots of the clovers and grasses were determined. Root lesion nematodes of the genus Pratylenchus were the only endoparasites present. Occasionally ectoparasitic forms of <u>Rotylenchus</u>, the spiral nematode, and <u>Xiphinema</u>, the needle nematode, were found. The most favourable hosts for <u>Pratylenchus</u> appeared to be red clover, orchard grass, timothy, and Kentucky bluegrass. The least favourable hosts were sweet clover, alfalfa, and smooth brome. Saprophytic nematodes were numerous in necrotic tissues of sweet clover, red clover, and alsike clover roots but were absent from roots of alfalfa and the grasses. There were wide fluctuations in the populations of the nematodes among the treatments for any particular host.

In available soil moisture which was recorded in the field throughout the growing season by means of a conductivity bridge apparatus a relationship of special influence on the biological factors in this study was obtained. During a period of 52 days from June 16 until August 7, 1955, at Harrow, Ontario, when the soil temperature remained above 80°F. and at one time reached 96.5°F. at a depth of four inches below the surface, the available soil moisture dropped sharply from 88% to 28% and remained below 35% under red clover for a period of 15 days. During this period a low soil moisture reading of 14.3% was reached even though frequent light rains occurred.

It may be concluded from the results of the present study that such important disease inducing biological groups of organisms as the insects, the fungi, and the nematodes could not clearly account for the clover seedling failures on sandy loam soils nor did they seriously affect any of the forage crops tested so much as did a seasonal critical period of drought. Although it is realized that conclusions have a greater degree of acceptance when they are based upon several or many years work, due to force of circumstances the present study must be ended. The present work, however, was carefully planned and executed and would support the recommendation for late summer seeding of the small seeded legumes and other forage crops in order to escape the effects of a local annual occurrence of a mid-season drought on the sandy loam soils.

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REPORT TO LEGUME RESEARCH COMMITTEE

DEPARTMENT OF SOILS - MARCH, 1956

The effect of trace element fertilizers on growth and seed production of red clover on Burford loam at S.A.E. Farm, Guelph. (Project SC 40.1 - Dr. Willis)

Trace element treatments were applied to red clover on small field plots in April 1955. Treatments included two rates of boron, copper, manganese, zinc, molybdenum applied singly and in various combinations. In addition to soil treatments, foliar spray applications of borax and manganese were made. The early growth was allowed to bloom and produce seed. Bees were provided by the Apiculture Department.

Plots were harvested for yield of seed in September. Yield estimates ranged from 105.5 to 73.2 lbs. per acre, with the untreated plots averaging 90.8 lbs. These variations were not considered significant and it is concluded that trace elements are not responsible for failures in the production of red clover seed.

WORK PROPOSED FOR LEGUME RESEARCH COMMITTEE 1956

DEPARTMENT OF SOILS

The Department of Soils has not set up any projects specifically for seed production studies in the field in 1956.

Sub Project SF. 25.9 - "The effect of fertility level on yield, character of growth and nutrient uptake by red clover plants in light chambers" is being set up conjointly with the Department of Botany. A preliminary report is being presented at the 1956 Legume Meetings and additional work is planned.

The Department wishes to continue its policy of offering materials or results from any of its projects to the Legume Committee. If at any time an opportunity is presented for seed production studies, it will be drawn to the Committee's attention.