is the production of clusters of rounded bodies about ¼ inch in diameter on the lower parts of the stems. These are galls caused by a small insect somewhat related to the ants. The eggs are deposited in the young plant stems where the growth of the larvae irritates the tissues of the plant causing it to produce these abnormal growths. The insect remains in these over winter and emerges the next spring.

One rather showy but unimportant member of the group is **Hawksbeard** (*Crepis runcinata*) which is found in prairie sloughs where the soil is usually well supplied with water. Here it produces masses of yellow flower heads during the latter part of June. The leaves are mostly in a cluster near the ground but the branches reach a height of one to two feet. Another native species, *Agoseris*, grows much like a dandelion but the leaves are narrow and often without any teeth along the edges. It seems to grow quite often in patches and sometimes is conspicuous on lower prairies. It blooms mainly the latter part of June but may continue until late fall.

THE EFFECT OF THREE 2,4-D COMPOUNDS ON YIELD AND QUALITY OF NORTH DAKOTA WHEATS[1]

by

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Some plants give varying degrees of reaction to 2,4-D at different stages of growth[5]. Some reports from farmers have been highly favorable regarding the crop reaction to the application of these compounds, while others report unsatisfactory effects—principally reduced yields.

Part I. Effect of Dates of Application

An experiment to test the reaction of the wheat plant to the application of a standard amount of 2,4-D, at various stages of growth is described in this section.

This experiment was designed to establish the stages of growth at which wheat can be most safely treated with 2,4-D. Mida wheat, a variety widely grown in this area, was selected as the test crop.

Three different commercial 2,4-D formulations were used: (1) 40% butyl ester; (2) 40% alkanolamine salt; and (3) a 83.5% sodium salt. These were applied in a water solution, using a 3-gallon knapsack sprayer, at the uniform rate of 16 ounces of 2,4-D acid per acre, using 80 gallons of solution per acre. Applications were made at the full tiller, boot or shooting, blooming and soft dough stages.

Four replications of each treatment at each stage of growth were used, and blocks as well as treatments within the blocks were randomized. Three rows, 18 feet long and 1 foot apart, were used for each replication. These were planted with a "Columbia" nursery seeder at the rate of 15 grams of seed per 18-foot row. A 2-foot alley separated the blocks and four guard rows surrounded the entire planting.

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[1]Progress report on State project on "Chemical Control of Annual Weeds".
[2]Botanist; [3]Assistant in Botany; [4]Assistant Cereal Technologist.
[5]Weaver, Robt. J., Swenson, Carl P., Ennis, W. B., and Boyd, F. T. Bot. Gaz. 107:563-568. 1946.

Before actual application of the 2,4-D solutions, a strip of finely-woven muslin was set up, to the height of 5 feet, around the entire replicate to be sprayed, to serve as a protection against spray drift to adjacent plots. Application was then made with the sprayer equipped with a nozzle to deliver 80 gallons per acre.

A 16½ foot strip of the center row of each of the plots was harvested and threshed. The resultant grain was used to secure the yield per acre, test weight, and germination per cent. One outer rod row from each of the treatments and its four replicates was harvested and composited. These composites were used for the milling, baking and chemical determinations.

In addition to the samples previously mentioned, 200 heads were also harvested at random from each group of four replicates. These 200-head samples were hand-threshed and the grain used to determine the number of kernels per head and individual kernel weight.

One hundred plant height measurements were also taken, using 25 plants from each of the four replicates to determine the average plant height. To determine the average number of culms per plant, culm counts per rod row were taken and averaged for each treatment plot replica, as well as culm counts per 100 plants.

Results

The following tables present a summary of all data, including results of statistical analyses.

Generally treatment with the three compounds causes a chlorotic appearance for a period of 3 to 5 days followed by complete recovery. There was some evidence that the sodium salt had less effect than the other two compounds. Plant growth was affected in the case of the amine

Table 1—Stage Trials—Summary of Test Data

Stage of growth	2,4-D formulation	Yield bu. per acre	Test wt. lbs. per bushel	Ave. culms per plant	Ave. head length, inches	Ave. kernels per head	Ave. kernel wt., mg.	Ave. plant height, inches	Germination %
Tiller	Sodium salt	29.3	61	2.4	2.5	18	34	37	95
Tiller	Amine	26.4	61	2.6	2.6	17	34	35	95
Tiller	Ester	26.8	60	2.4	2.6	18	34	34	91
Boot	Sodium salt	29.5	63	2.5	2.3	16	39	36	97
Boot	Amine	25.4	62	2.6	2.3	15	38	33	91
Boot	Ester	11.8	61	2.6	2.3	16	38	32	85
Bloom	Sodium salt	30.9	62	2.4	2.4	20	35	37	96
Bloom	Amine	29.2	61	2.5	2.4	20	33	38	97
Bloom	Ester	32.7	62	2.4	2.5	20	35	37	90
Soft dough	Sodium salt	31.5	62	2.5	2.5	19	36	38	95
Soft dough	Amine	29.0	62	2.4	2.5	19	37	38	92
Soft dough	Ester	30.6	62	2.5	2.4	19	35	38	94
Check		32.7	62	2.4	2.6	19	36	38	93

and ester compounds after approximately one week when these substances were applied at the tiller and boot stages. These plants failed to attain the height of the plants in the control and the plots treated with the sodium salt.

Slight reductions in yield occurred from ester and amine treatments at all stages, but a marked reduction resulted from ester treatments in the boot stage (Table 1). Statistical analyses indicate that a difference of yield of 4 bushels is significant when growth stages are compared and 3.3 bushels when chemicals are compared (Table 3).

No abnormal heads were formed in any treatment nor was there any significant difference in culm counts between plots.

Germination percentages were reduced by 11% when the boot stage was treated with an ester, otherwise no consistent effects on germination were shown. Kernel weight, number of kernels per head, length of head, length of head and test weight were relatively constant for all plots. Lodging occurred when plants were treated in the bloom or soft dough stages.

Table 2—Milling and Baking Data (Micro-method) Secured From Mida Wheat Exposed to Various Treatments*

Growth Stage	2,4-D formulation	Protein content[1] (=x5.7)	Flour Yield			Loaf volume	Mixogram type	
			Long patent	Low grade	Total			
		%	%	%	%	cc.		
	Check	15.1	68.1	3.2	71.3	175	Med.	weak
Tiller	Sodium salt	15.4	67.9	3.9	71.8	170	"	"
"	Amine	15.7	67.1	3.5	70.6	180	"	"
"	Ester	15.9	67.5	3.3	70.8	215	"	"
Boot	Sodium salt	15.8	66.6	4.0	70.6	150		
"	Amine	15.8	65.6	3.7	69.3	135		
"	Ester	16.2	66.5	4.2	70.7	155		
Bloom	Sodium salt	15.8	68.8	3.9	72.7	165		
"	Amine	16.6	66.3	3.8	70.1	170		
"	Ester	16.1	65.9	3.8	69.7	170		
Soft dough	Sodium salt	15.2	67.1	3.8	70.9	155	Med.	weak
"	Amine	15.4	67.6	4.0	71.6	155	"	"
"	Ester	15.3	68.0	3.5	71.5	160	"	"

*These tests run by Department of Cereal Technology.
[1]Expressed on a 13.5% moisture basis.

There was a significant rise in protein content in grain from the amine and ester plots of the tiller stage as compared with the check, while a significant rise was also noted in all treatments in both boot and bloom stages. In the tiller and boot stages the ester treatment yielded the highest protein, while in the bloom stage the amine was high.

Loaf volume was quite variable, there being a general reduction in the boot and soft-dough stages, while the bloom stage compared favorably with the check. The tiller stage ester and amine treatments showed a significant increase (Table 2).

Table 3—Stage Trials—Results of Statistical Analyses Chemicals versus Stages

Growth stages	Least significant difference	YIELD IN BUSHELS PER ACRE			
		Check	Sodium	Amine	Ester
	bu.				
Tiller	4.0	31.2	29.3	26.4	26.9
Boot	4.0	32.6	29.5	25.4	11.8
Bloom	4.0	34.8	30.9	29.2	32.7
Soft dough	4.0	32.3	31.5	29.0	30.6
Least significant difference bu.		3.3	3.3	3.3	3.3

Part II. Effect of Variety

This section describes the results obtained when different varieties are treated with 2,4-D at the full tiller stage. Varieties used were for the hard reds, Mida, Thatcher, Regent, Rival and Pilot, and, for the durums, Mindum and Carleton. Methods of treatment, chemicals used and all other experimental details were similar to those described above under Part I.

Table 4—Variety Trials—Summary of Test Data

Variety and treatment	Yield bu. per acre	Test wt. lbs. per bushel	Culms per rod row	Average plant height	Ave. head length	Average kernels per head	Average wt. per kernel	Germination
				inches	inches		mg.	%
Thatcher—O*	28.6	58	776	35	2.4	24	21	82
Thatcher—Na*	28.8	58	826	34	2.5	23	22	93
Thatcher—Am*	25.3	58	820	32	2.4	22	21	96
Thatcher—Est*	24.4	58	752	31	2.4	23	21	92
Mida—O	35.8	62	669	37	2.4	19	36	79
Mida—Na	33.5	62	702	37	2.5	21	34	88
Mida—Am	30.1	61	735	35	2.5	18	33	86
Mida—Est	30.8	61	724	37	3.6	18	34	88
Regent—O	28.7	59	690	36	2.8	21	24	92
Regent—Na	28.1	59	716	35	2.6	19	24	93
Regent—Am	23.1	57	660	34	2.8	19	24	98
Regent—Est	24.6	58	784	33	2.7	18	24	90
Rival—O	33.6	60	804	38	2.6	24	29	94
Rival—Na	30.3	60	713	38	2.6	23	28	91
Rival—Am	28.8	59	732	36	2.5	22	27	91
Rival—Est	29.8	59	754	37	2.7	23	26	95
Pilot—O	28.4	56	650	37	2.7	29	22	93
Pilot—Na	26.5	57	682	37	2.7	29	23	95
Pilot—Am	24.3	56	656	37	2.7	28	22	95
Pilot—Est	25.5	56	733	37	2.6	26	22	95
Mindum—O	33.3	63	504	42	2.5	29	35	88
Mindum—Na	33.8	63	545	42	2.4	27	36	88
Mindum—Am	30.2	63	589	39	2.5	27	35	90
Mindum—Est	30.3	62	512	40	2.4	25	34	88
Carleton—O	34.3	62	611	41	2.2	27	36	91
Carleton—Na	33.4	63	549	43	2.2	26	37	90
Carleton—Am	32.9	62	604	37	2.1	25	35	85
Carleton—Est	31.9	62	668	37	2.0	23	34	86

*O—Control, Na—Sodium salt, Am—Amine, Est—Ester.

Results

Again, as in the stage trials, all varieties developed a chlorotic condition for about a week following treatment, with subsequent recovery. Plant height was reduced in all varieties when treated with an ester or amine compound. Stands, as measured by culm counts, were uniform within varieties, nor did there appear to be any difference in head length. Only one variety, Regent, showed any abnormal heads (Table 4).

Yields were reduced in the ester and amine plots (Tables 4 and 6) within varieties but there was no significant reduction in test weights nor in number of kernels or kernel size.

In germination tests on grain produced from these plots only two varieties of hard red wheats showed significant differences, namely, Mida and Thatcher. In these varieties there apparently was a stimulating effect due to 2,4-D application, the three treated plots of Mida showing an average increase of 8% over the check plot, while the treated plots of Thatcher showed an average increase of 12% over the checks. There were no significant differences within or between the durum varieties.

Table 5—Milling and Baking Data (Micro-method) Secured From Wheat Exposed to Various Treatments.*

Variety	2,4-D Formulation	Protein content† (=x5.7)	FLOUR YIELD			Loaf volume	Mixogram type
			Long patent	Low grade	Total		
		%	%	%	%	cc.	
Thatcher	Check	15.1	63.0	3.2	66.2	165	Strong
"	Sodium	15.0	64.0	4.4	68.4	185	"
"	Amine	16.2	61.9	5.0	66.9	190	"
"	Ester	15.7	63.4	3.4	66.8	190	"
Rival	Check	14.7	66.2	5.5	71.7	175	
"	Sodium	14.3	67.8	4.6	72.4	150	
"	Amine	14.5	64.8	3.8	68.6	170	
"	Ester	14.9	65.4	4.4	69.8	165	
Pilot	Check	15.0	59.8	4.3	64.1	175	
"	Sodium	14.9	60.4	3.5	63.9	155	
"	Amine	15.4	61.2	3.4	64.6	170	
"	Ester	15.6	61.8	3.5	65.3	200	
Mida	Check	14.7	69.9	2.0	71.9	170	Med. weak
"	Sodium	14.7	67.4	3.2	70.6	170	" "
"	Amine	15.3	67.8	2.8	70.6	160	" "
"	Ester	15.1	67.6	3.7	71.3	180	" "
Regent	Check	15.2	66.8	3.5	70.3	175	Med. strong
"	Sodium	15.3	66.5	3.5	70.0	205	" "
"	Amine	16.1	66.2	3.6	69.8	225	" "
"	Ester	16.1	64.8	3.7	68.5	220	" "

*These tests run by Department of Cereal Technology.
†Expressed on a 13.5% moisture basis.

A significant rise in protein content was noted in the grain from the ester treated plots of Thatcher, Pilot, Regent and Mindum varieties, while a similar rise in protein content was noted in the amine treated

plots of Mida, Regent and Thatcher. There was a significant reduction of protein content in the Carleton durum treated with the sodium salt and amine treatment, as compared with the check.

Loaf volume results were quite variable but generally there was no indication of reduction as the result of chemical treatments (Table 5).

Table 6—Variety Trials—Results of Statistical Analyses. Varieties versus Chemicals

Variety	Least significant difference	YIELD IN BUSHELS PER ACRE			
		Check	Sodium	Amine	Ester
	bu.				
Thatcher	5.0	28.6	28.8	25.3	24.4
Mida	5.0	35.8	33.5	30.1	30.8
Regent	5.0	28.7	28.1	23.1	24.6
Rival	5.0	33.6	30.3	28.8	29.8
Pilot	5.0	28.4	26.5	24.3	25.5
Mindum	5.0	33.3	33.8	30.2	30.3
Carleton	5.0	34.3	33.4	32.9	31.9
Least significant difference bu.		3.3	3.3	3.3	3.3

Summary and Conclusions

1. During the summer of 1947, experiments were conducted to test the effect of three 2,4-D compounds on growth, yield and quality of grain produced by several spring wheats when treated at the tiller, boot, bloom and soft-dough stages.
2. Yields were reduced by amine and ester treatments in the boot stage.
3. Height of plant was affected particularly by the amine and ester treatments when applied in the tiller and boot stages.
4. Germination of grain was reduced by ester treatment in the boot stage only.
5. In general varieties responded in a similar manner in germination, vegetative characteristics and yield.
6. Protein was increased slightly in ester treatments of Pilot, Regent, Thatcher and Mindum and in amine treatments of Mida, Regent and Thatcher. Sodium salt and amine treatments appeared to reduce the protein of Carleton durum grain.
7. Loaf volumes though variable, generally followed the protein content of the source grain.

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