EFFECT OF KIND OF 2,4-D AND DATE OF APPLICATION ON YIELD, QUALITY, TILLERING AND TEST WEIGHT OF WINTER VARIETIES OF HARD AND SOFT RED WHEAT, BARLEY, AND OATS

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INTRODUCTION

The use of 2,4-D chemicals and a study of the response of small grain varieties to different rates and dates of application are relatively new ventures. Up to the present time no experiment station data have been published in Oklahoma. Farmers realize that 2,4-D chemicals must be used with precaution and that information in regard to variety responses to different dates and rates of application will be of benefit. Farmers know that the control of weeds is essential to conserve moisture and permit harvesting of small grains. Therefore, they are constantly requesting information pertaining to the response of different varieties of the small grain crops to 2,4-D treatments from the experiment station and other agricultural workers.

The proper use of 2,4-D chemicals on small grains is an important part of the farming operation, particularly, since it contributes to increased yields and better quality grains.

Until the present time most of the research work with 2,4-D chemicals has been to determine the toxicity of the chemicals to weeds. Little attention has been given to the effects of 2,4-D on the crop plant in which the weeds were growing.

The primary objective of this investigation was to determine the effect of the kind of 2,4-D and date of application on yield, quality, tillering and test weight of winter varieties of hard and soft red wheat, barley, and oats.

REVIEW OF LITERATURE

Experimental data showing the effects of using 2,4-D on the growth and yield of small grains are somewhat limited; however, there are some data that have a bearing on this problem.

Effect of 2,4-D on Barley

Shaw and Willard (4)[1] conducted an experiment at Columbus, Ohio, with Ohio number one winter barley. The variety was treated with triethanol amine salt and butyl ester of 2,4-D at 0.25, 0.50, 0.75 and 1.00 pound per acre[2] on 4 dates: 1. March 30 when it was 6 inches tall, 2. April 17 at 10 inches, 3. May 5 at two-joint stage, and 4. May 20 at full bloom. The butyl ester at 1 pound on May 5, delayed heading about a week. No other treatment produced any visible effect on growth. There were no significant differences in yield between 2,4-D materials, dates of treatment, or rates of treatment.

Effect of 2,4-D on Oats

An investigation on differential responses of Brunker, Kanota, Osage, and Otoe oats to 3 types of 2,4-D butyl ester, triethanol, amine salt, and sodium salt at 4 rates, 0.25, 0.50, 1.00, and 1.50 pounds per acre was made in Nebraska by Viehmeyer and Wolfe (5). The crops were grown on weed free soil and 2,4-D was applied when most of the heads were emerging from the sheath. They found the lowest yield was produced from 1.00- and 1.50-pound

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[1] Figures in parenthesis refer to "Literature Cited", p. 22.

[2] Pounds per acre of 2,4-D is always given on basis of pounds per acre of acid equivalent.

rates of butyl ester, while the highest yield was produced from the sodium salt. However, there were no significant differences in yield.

Effect of 2,4-D on Winter Wheats

Pawnee wheat was sprayed in Oklahoma by Elder (1) at two stages, jointing and soft dough, with an ester and a salt of 2,4-D at rates of 1.5 gallons per square rod of 0.50, 1.00, 1.50, and 2.00 pounds per acre. He found slightly higher yields on plots sprayed at the jointing stage as compared with those sprayed during the soft dough stage. The 0.50-pound per acre application gave a slight decrease in yield as compared with the check, while the 2.0-pound application gave a 15% decrease. Fall applications caused poor stools to be produced and delayed maturity.

In Nebraska, Klingman (2) sprayed weed-free Pawnee wheat with a 2,4-D ester at 10 rates ranging from 0.0 to 2.0 pounds each at 4 stages of growth: jointing, early boot, late boot, and headed. He found that the wheat grew vigorously throughout the period in which treatments were made. He concluded that most of the injury to the wheat occurred when sprayed in the early boot stage. The most notable injury was a reduction in the number of kernels and the number of spikelets per head.

A spray and a dust formulation of (sodium salt, methyl ester, and acid) 2,4-D and 1 spray concentration of methoxone were applied to fall-sown Federation wheat on April 15, 1947, when the plants were about 6 inches high by McNeal (3) in Oregon. These plots contained about 42 mustard plants and 23 tarweed plants per square rod. Hand weeding increased the yield 3 bushels per acre. All chemical treatments reduced the yield of wheat as compared with the weeded check plots, indicating some injury to wheat. All differences except for the sodium salt spray were statistically significant at the 5%

level. Also, all treatments reduced the yield of wheat below the average of the unweeded checks, but only the methyl ester and acid sprays produced significant differences. The spray treatments reduced the plant height somewhat and tended to be more injurious than were the corresponding dusts. The test weight per bushel of wheat was not materially affected by any treatment.

MATERIALS AND METHODS

Four hard red winter wheat varieties (#1 Triumph C. I. 12132, #2 Comanche C. I. 11673, #3 Pawnee C. I. 11669, and #4 Wichita C. I. 11952), 1 soft winter wheat (Clarkan C. I. 8858), 2 fall oats (#1 Wintok C. I. 3424 and #2 Traveler C. I. 4206), and 1 winter barley (Tenkow C. I. 646) were used in this study.

All varieties were treated with Ceresan M for control of smut and were planted on September 26, 1948, with a 1-row planter at rates of 1.0 bushel for wheat, 1.5 bushels for barley, and 2.0 bushels for oats.

All plantings were made in 64-foot rows spaced 1 foot apart. A factorial design with three replications was used. Each replication was divided into four 16-foot sub-plots with one date treatment assigned at random to each plot. The date treatments included fall tiller (October 25, 1948), spring or full tiller (March 27 to 31, 1949), boot (April 23 to 28, 1949), and soft dough stage (May 10 to 14, 1949). The four 2,4-D treatments were randomly assigned to each date treatment for all varieties (Fig. 1).

The outside row on each side of each plot and 3 feet at the end of each row were left for borders. A 4-foot border of Pawnee wheat was planted around the entire field. A 2-foot border was cut between each replication before harvest time. Fourteen feet of the 2 inside rows of each 4-row plot in each chemical treatment were sprayed and harvested.

Stage of Application

	Fall Tiller	Boot	Spring or Full Tiller	Soft Dough	Fall Tiller
Triumph Var. 1	Check	Amine	Salt	Ester	Salt
	Ester	Check	Check	Amine	Amine
	Amine	Salt	Amine	Check	Ester
	Salt	Ester	Ester	Salt	Check
Var. 2					
Var. 3 etc.					

Figure 1.--Method of plot arrangement, stage of application, and chemical treatment for Triumph wheat in replication No. 1 Agronomy Farm Perkins, Oklahoma, in 1949.

The percentage of "onion leaf"[13], forage loss, and poor exertion, caused by the fall tiller stage of treatment was estimated. The length and width of the leaves as affected by the fall tiller stage were determined by measurement of 3 leaves on 3 randomly chosen plants in each plot.

At maturity all varieties were harvested with a hand sickle. Immediately after harvest, all samples were bagged and stored on racks until they were threshed. The number of tillers in two 1-foot samples from each plot was counted. A small nursery thresher was used to thresh the grain. The yield was determined for each plot, while the test weight was determined after the 3 plots of each treatment were combined.

RESULTS AND DISCUSSIONS

Climatic Conditions

The climatic conditions at Perkins, Oklahoma, are characterized by moderate rainfall (35 inches annually) which is somewhat erratic in distribution. The winters are usually moderate with occasional severe freezes. The rainfall was below normal during September, October, December, and February. July, August, November, March, and April were characterized by moderate rainfall, while January, May, and June were fairly wet months. Rainfall amounting to 1.28 inches on September 21, made it possible to obtain a good stand on all the small grains. The heavy rainfall and hail the latter part of May caused some of the plants to lodge. The temperature was below normal during January, and there were 3 severe snow storms during the latter part of the month. All of the varieties recovered from the severe cold. The fall season was very dry but the spring was favorable for small grains.

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[13] Onion Leaf - Abnormal curling of the leaves.

Yield of Grain

The yields for each variety for each stage of growth for 3 different types of 2,4-D in all replications are presented in Table 7 (Appendix). A summary of these data is given in Table 1. The average yields in bushels per acre of the check plots for the 3 crops and for each stage of growth treatment were as follows:

Fall tiller - oats, 54.6; wheat, 24.8; barley, 41.6
Spring tiller-oats, 55.9; wheat, 25.2; barley, 39.6
Boot stage - oats, 56.3; wheat, 25.6; barley, 43.7
Soft dough - oats, 57.1; wheat, 24.3; barley, 41.0

The yields for the different stages of growth were quite different with the fall tiller being 8.7 bushels below the check yield for that stage of treatment. The yield for the spring and boot stages were about the same as their corresponding checks, while the yield for the soft dough stage was slightly below its check.

For each crop and type of 2,4-D in the fall tiller stage of growth the ester reduced the average oat-yield the most (40%) below the check, followed by the amine and salt (19%). The average wheat yields were reduced the most by the ester, 40% below the check, followed by the amine (20%) and salt (17%). The ester reduced the average barley yield the most below the check (30%), followed by amine (23%) and salt (18%). All small grain crop yields were reduced by all types of 2,4-D, but there were no apparent differences in the percentages of decrease for each crop. The average yield for all crops and all types of 2,4-D for the fall tiller stage of growth was reduced 25% below the check yield.

In the spring or full tiller, boot and soft dough stages of growth, the average yield for all the small grain crops was not materially affected by any of the 2,4-D types, when compared with the check yields. It is

Table 1.--Average yield of grain in bushels per acre for 8 varieties of small grains treated at 4 stages of growth with different types of 2,4-D at 0.75 pound per acre at Perkins, Oklahoma in 1948-49.

Stage of Growth	Crop	Variety	Treatment				
			Ester	Amine	Salt	Av.	Check
Fall tiller							
	Oats	Traveler	36.0	47.3	45.2	42.8	54.9
		Wintok	29.4	40.6	43.0	37.8	54.3
	Av.		32.7	44.1	44.1	40.3	54.6
	Wheat	Triumph	20.1	19.9	26.1	22.0	27.3
		Comanche	15.2	20.2	19.2	18.2	25.6
		Pawnee	11.2	14.7	16.5	14.1	23.4
		Wichita	15.0	25.8	22.2	21.0	26.1
		Clarkan	13.3	19.2	19.4	17.3	21.4
	Av.		14.9	19.9	20.7	18.5	24.8
	Barley	Tenkow	29.5	31.9	34.0	31.8	41.6
		Av.	21.2	27.5	28.2	25.6	34.3
Spring or full tiller							
	Oats	Traveler	61.8	59.7	57.2	59.6	61.5
		Wintok	43.4	48.2	49.1	46.9	50.3
	Av.		52.6	53.9	53.1	53.2	55.9
	Wheat	Triumph	27.7	27.9	27.6	27.7	26.7
		Comanche	26.6	27.1	26.1	26.6	26.3
		Pawnee	24.2	25.3	22.8	24.1	25.0
		Wichita	26.4	28.0	25.5	26.6	26.5
		Clarkan	21.7	21.6	23.0	22.1	21.4
	Av.		25.3	26.0	25.0	25.4	25.2
	Barley	Tenkow	47.6	43.5	42.0	44.4	39.6
		Av.	34.9	35.2	34.2	34.8	34.7

Table 1.--(Continued).

Stage of Growth	Crop	Variety	Treatment				
			Ester	Amine	Salt	Av.	Check
Boot							
	Oats	Traveler	53.8	58.9	59.3	57.3	58.1
		Wintok	54.4	49.8	52.3	52.2	54.5
	Av.		54.1	54.3	55.8	54.7	56.3
	Wheat	Triumph	27.3	27.8	23.4	26.2	28.9
		Comanche	25.1	27.3	26.4	26.3	26.3
		Pawnee	24.0	21.9	23.3	23.1	20.3
		Wichita	27.1	26.2	27.7	27.0	31.0
		Clarkan	18.1	20.8	23.4	20.8	21.4
	Av.		24.3	24.8	24.8	24.7	25.6
	Barley	Tenkow	42.8	39.9	46.1	42.9	43.7
		Av.	34.1	34.1	35.2	34.5	35.5
Soft dough							
	Oats	Traveler	57.7	56.7	58.8	57.7	58.4
		Wintok	54.5	56.7	53.6	54.9	55.8
	Av.		56.1	56.7	56.2	56.3	57.1
	Wheat	Triumph	23.6	25.8	24.0	24.5	23.9
		Comanche	27.1	28.0	26.3	27.1	26.1
		Pawnee	22.3	21.4	21.3	21.7	22.3
		Wichita	28.7	25.9	27.4	27.3	28.0
		Clarkan	24.5	18.8	21.9	21.7	21.2
	Av.		25.2	24.0	24.2	24.5	24.3
	Barley	Tenkow	44.7	41.2	44.9	43.6	41.0
		Av.	35.4	34.3	34.8	34.8	34.6
		Grand Av.	31.4	32.7	33.1	32.4	34.8

obvious that there is a real difference in the effects produced by the different chemical treatments. It appears that the early or fall application of 2,4-D is more severe on small grain yields than the spring application.

For each type of 2,4-D for all small grain crops in all stages of growth, the ester reduced the average yield the most (10%) when compared to the checks, followed by amine (6%) and salt (5%).

For each small grain crop, for all types of 2,4-D, and stages of growth, the oats showed the greatest reduction in average yield (9%) below the check, followed by wheat (7%), and barley (2%).

Test Weight

The test weight per bushel for all varieties of small grains is tabulated in Table 2. There was little difference in the average test weight of all treated plots when compared with the checks. The average check test weight per bushel for all small grain crops was about equal in all stages of growth. The fall tiller stage of treatment was the only stage of growth that showed any decrease in average test weight below the check. The average test weights for spring or full tiller, boot and soft dough stages, for all types of 2,4-D, were all equal to or above the check test weights.

Number of Tillers

The data obtained of the tiller counts are presented in Table 3. The average number of tillers for the check plots of oats and wheat were fairly uniform for all stages of growth, while the barley checks were somewhat irregular.

For each type of 2,4-D in the fall tiller stage of growth, the ester reduced the average oat tiller count the most (27%) below the check, followed

Table 2.--Test weight for 8 varieties of small grain treated at 4 stages of growth with different types of 2,4-D at 0.75 pound per acre at Perkins, Oklahoma, in 1948-49.

Stage of Growth	Variety	Treatment				
		Ester	Amine	Salt	Av.	Check
Fall tiller						
	Traveler	25.1	27.3	28.6	27.0	28.0
	Wintok	30.3	27.3	31.7	29.8	32.1
Av.		27.7	27.3	30.1	28.4	30.0
	Triumph	60.0	61.0	61.0	60.7	61.0
	Comanche	56.5	57.5	56.5	56.8	58.0
	Pawnee	56.0	58.0	58.0	57.3	58.5
	Wichita	60.0	60.5	61.0	60.5	61.0
	Clarkan	59.5	60.0	60.0	59.8	60.0
Av.		58.4	59.4	59.3	59.0	59.7
	Tenkow	40.2	40.3	35.3	38.6	40.4
	Av.	48.4	49.0	49.0	48.8	49.9
Spring or full tiller						
	Traveler	29.2	29.8	29.2	29.4	28.5
	Wintok	30.4	30.8	30.8	30.7	31.2
Av.		29.8	30.3	30.0	30.0	29.8
	Triumph	61.5	61.0	60.0	60.8	61.0
	Comanche	58.0	58.0	59.0	58.3	58.0
	Pawnee	58.0	58.0	58.0	58.0	58.0
	Wichita	61.0	61.0	60.0	60.7	61.5
	Clarkan	60.0	60.5	60.0	60.2	60.0
Av.		59.7	59.7	59.4	59.6	59.7
	Tenkow	39.8	40.4	39.6	39.9	37.8
	Av.	49.7	49.9	49.6	49.7	49.5
Boot						
	Traveler	28.0	28.8	28.5	28.4	28.3
	Wintok	32.6	31.3	32.1	32.0	31.8
Av.		30.3	30.0	30.3	30.2	31.8

Table 2.--(Continued).

Stage of Growth	Variety	Treatment Ester	Amine	Salt	Av.	Check
Boot						
	Triumph	61.5	60.5	61.0	61.0	61.0
	Comanche	57.5	59.0	58.5	58.3	60.0
	Pawnee	58.0	58.0	58.5	58.2	59.0
	Wichita	60.5	61.0	61.0	60.8	61.0
	Clarkan	60.5	60.5	60.5	60.5	60.0
Av.		59.6	59.6	59.9	59.7	60.2
	Tenkow	40.8	36.5	40.0	39.1	38.6
	Av.	49.9	49.4	50.0	49.8	49.9
Soft dough						
	Traveler	29.6	30.2	27.7	29.2	27.3
	Wintok	30.9	32.0	31.9	31.6	31.8
Av.		30.2	31.1	29.8	30.4	29.5
	Triumph	61.0	61.0	61.0	61.0	61.0
	Comanche	58.5	58.0	58.0	58.2	58.0
	Pawnee	59.0	59.0	58.5	58.8	58.5
	Wichita	61.0	61.5	60.5	61.0	61.0
	Clarkan	60.5	59.0	60.0	59.8	60.0
Av.		59.8	59.7	59.4	59.6	59.7
	Tenkow	38.2	37.8	38.6	38.2	38.8
	Av.	49.8	49.7	49.5	49.7	49.5
	Grand Av.	49.5	49.5	49.5	49.5	49.7

Table 3.--Average number of tillers for 8 varieties of small grain treated at 4 stages of growth with different types of 2,4-D at 0.75 pound per acre in 1948-49.

Stage of Growth	Variety	Average Number of Tillers				
		Ester	Amine	Salt	Av.	Check
Fall tiller						
	Traveler	47.7	56.0	45.0	49.6	56.0
	Wintok	72.3	94.3	80.0	82.2	108.3
Av.		60.0	75.1	62.5	65.9	82.1
	Triumph	67.3	74.3	71.3	71.0	83.3
	Comanche	64.0	78.0	68.7	70.2	88.0
	Pawnee	77.7	87.0	65.0	76.6	94.3
	Wichita	65.7	57.5	57.0	60.1	78.3
	Clarkan	56.0	76.0	42.7	58.2	75.3
Av.		66.1	74.6	60.9	67.2	83.8
	Tenkow	62.3	66.7	50.3	59.8	58.3
	Av.	64.1	73.8	60.0	66.0	80.2
Spring or full tiller						
	Traveler	66.6	52.0	61.7	60.1	64.3
	Wintok	95.7	88.3	87.7	90.6	93.7
Av.		81.1	70.1	74.7	75.3	79.0
	Triumph	85.0	85.3	81.0	83.8	90.0
	Comanche	93.3	91.3	104.3	96.3	89.0
	Pawnee	85.7	92.7	103.7	94.0	118.0
	Wichita	75.7	103.3	75.3	84.8	74.7
	Clarkan	64.0	67.3	67.7	66.3	69.7
Av.		80.7	88.0	86.4	85.0	88.3
	Tenkow	63.3	63.0	69.0	65.1	74.3
	Av.	78.7	80.4	81.3	80.1	84.2
Boot						
	Traveler	53.7	67.7	66.3	62.6	60.3
	Wintok	89.0	109.3	87.7	95.3	96.3
Av.		71.3	88.5	77.0	78.9	78.3

Table 3.--(Continued).

Stage of Growth	Variety	Average Number of Tillers				Check
		Ester	Amine	Salt	Av.	
Boot						
	Triumph	96.3	96.0	79.0	90.4	84.0
	Comanche	104.0	96.3	94.3	98.2	96.0
	Pawnee	122.0	84.3	95.7	100.7	115.0
	Wichita	76.3	105.0	73.0	84.8	81.7
	Clarkan	82.3	72.0	65.3	73.2	72.3
Av.		96.2	90.7	81.5	89.5	89.8
	Tenkow	57.7	60.0	65.0	60.9	60.0
	Av.	85.2	86.3	78.3	83.3	83.2
Soft dough						
	Traveler	58.3	58.7	56.3	57.8	56.0
	Wintok	99.7	112.3	100.0	104.0	115.0
Av.		79.0	85.5	78.1	80.9	85.5
	Triumph	94.0	81.7	89.0	88.2	75.3
	Comanche	79.0	91.3	98.3	89.5	88.0
	Pawnee	86.3	89.0	11.1	62.1	97.7
	Wichita	80.7	77.7	71.0	76.5	80.7
	Clarkan	76.3	79.0	90.3	81.9	71.3
Av.		83.3	83.7	71.9	79.6	82.6
	Tenkow	63.0	66.6	63.0	64.2	65.7
	Av.	79.7	82.0	72.4	78.0	81.2

by the salt (24%) and the amine (9%). The salt reduced the average wheat tiller count the most (27%), followed by ester (21%) and amine (11%). The salt reduced the average barley tiller count 14%. The ester increased the average barley tiller count 6% and the amine increased it 13% above the checks. An average of the chemical treatments shows a reduction in the number of tillers for oats and wheat but not for barley when compared with the check.

For the spring stage an average for the chemical treatments showed a reduction in the number of tillers for all crops when compared to the check. No apparent differences are evident for the 2,4-D treatments used in the checks for the boot and soft dough stages. Apparently the 2,4-D treatments produced different effects when applied at different stages of growth.

There were rather large differences in the average number of tillers found for the different dates of treatment for oats and wheat, while for barley the difference was small. The 2,4-D salt appeared to produce the greatest over-all reduction in number of tillers.

Development of Forage

Measurements that were made to determine the average length and width of the blades of the small grains treated in fall tiller stage of growth are tabulated in Table 4. The average length and width of leaves for the checks were all fairly consistent.

Considering the effect of the types of 2,4-D on the small grain crops, the ester reduced the average length of the oat and the barley leaves the most below the check, followed by the amine and salt. The ester and amine reduced the average length of the wheat leaves the most followed by the salt.

The ester reduced the average width of the oat and barley leaves the most below the checks, followed by the salt and amine. The ester reduced the

Table 4.--Average length and width of leaves for 8 varieties of small grain treated with different types of 2,4-D at 0.75 pound per acre in fall 1948.

Variety	Treatment					Treatment				
	Ester	Amine	Salt	Av.	Check	Ester	Amine	Salt	Av.	Check
	Length (inches)					Width (inches)				
Traveler	6.3	6.8	6.9	6.7	7.4	.23	.28	.25	.25	.35
Wintok	4.9	5.1	5.4	5.1	6.4	.17	.20	.18	.18	.23
Av.	5.6	5.9	6.1	5.9	6.9	.20	.24	.21	.22	.29
Triumph	7.3	7.5	7.7	7.5	7.5	.28	.31	.30	.30	.30
Comanche	6.9	7.5	7.3	7.2	8.0	.27	.30	.32	.30	.31
Pawnee	6.9	6.0	6.6	6.5	7.0	.25	.27	.27	.26	.28
Wichita	7.3	7.4	7.6	7.4	7.4	.27	.28	.28	.28	.27
Clarkan	7.5	7.6	7.3	7.5	7.7	.27	.33	.30	.30	.30
Av.	7.2	7.2	7.3	7.2	7.5	.27	.30	.29	.29	.29
Tenkow	7.1	7.5	7.5	7.4	7.8	.30	.33	.35	.33	.35
Av.	6.8	6.9	7.0	6.9	7.4	.25	.29	.28	.27	.30

average width of the wheat leaves 8% below checks, while the amine showed an increase of 3%. The average for all the replications showed that the leaf area was reduced below the checks by all types of 2,4-D with the ester being the most severe.

The small grain crop most effected was oats, the leaf area being reduced (17%) below checks, followed by barley (3%) and wheat (2%).

Onion-Leaf and Reduction of Forage

The average percentage of onion-leaf and forage loss as determined by observation is tabulated in Table 5. There was no onion-leaf or loss of forage in the check plots.

The data show the highest percentage of onion-leaf was produced in oats by the amine type of 2,4-D followed by the ester and salt. For wheat and barley the ester developed the most onion-leaf, followed by amine and salt. An average for all small grain crops shows that the ester developed the highest percentage of onion-leaf (16.2) followed by the amine (13.0) and salt (7.6).

For each small grain crop the oats developed the highest average percentage of onion-leaf (29.0) followed by barley (13.3) and wheat (5.4).

Considering the percentage of decrease in forage for each type of 2,4-D and each crop, the amine caused the biggest reduction in the oats, followed by ester and salt. The ester reduced the wheat the most followed by amine and salt. The barley was decreased the most by amine, followed by ester and salt. An average for all small grain crops shows that the ester caused the largest percentage decrease in forage (8.2) followed by the amine (7.9) and salt (6.2).

For each small grain crop the oats showed the highest percentage loss of

Table 5.--Average % onion leaf and decrease in forage for 8 varieties of small grain treated with different types of 2,4-D at 0.75 pound per acre in the fall of 1948.

	Percentage							
	Onion Leaf				Decrease in Forage			
Variety	Ester	Amine	Salt	Av.	Ester	Amine	Salt	Av.
Traveler	42.0	32.0	15.0	29.7	15.0	5.0	5.0	8.0
Wintok	22.0	35.0	28.0	28.3	18.0	18.0	15.0	17.0
Av.	32.0	33.5	21.5	29.0	16.5	11.0	14.7	12.0
Triumph	5.0	0.0	0.0	1.7	5.0	5.0	5.0	5.0
Comanche	12.0	5.0	3.0	6.7	5.0	5.0	5.0	5.0
Pawnee	10.0	5.0	2.0	5.7	8.0	5.0	5.0	6.0
Wichita	12.0	8.0	3.0	7.7	5.0	5.0	5.0	5.0
Clarkan	8.0	2.0	5.0	5.0	5.0	5.0	5.0	5.0
Av.	9.5	4.0	2.6	5.4	5.6	5.0	5.0	5.2
Tenkow	18.0	17.0	5.0	13.3	5.0	15.0	5.0	8.3
Av.	16.2	13.0	7.6	12.3	8.2	7.9	6.2	7.4

forage (12.7) followed by the barley (8.3) and wheat (5.2).

Exertion

The percentage of small grain plants showing poor exertion as observed after the fall tiller stage of growth is presented in Table 6. Exertion was not affected on the plants grown on the check plots.

For each small grain crop the barley developed the highest percentage of poor exertion (22.7) followed by oats (7.0) and wheat (6.1).

SUMMARY AND CONCLUSIONS

This experiment was conducted in 1948-49, on the Oklahoma Agricultural Experiment Station Farm at Perkins, Oklahoma, in order to determine the effect of kind of 2,4-D and date of application on yield, quality, tillering, and test weight of winter varieties of hard and soft red wheats, barley and oats.

The data presented in this paper include the results of the 1948-49 test and indicate the following:

1. The fall tiller stage of growth reduced the grain yields of all small grain crops 25% below the check yields, while the other stages of growth produced very little effect on the yield.

2. The ester type of 2,4-D reduced the grain yields for all small grain crops and stages of growth 10%, while the amine only reduced the yield 6% and the salt 5% below the check.

3. For all types of 2,4-D and all stages of growth, the average grain yield for oats was reduced 9% below the check, for wheat 7% and for barley 2%.

4. The test weight per bushel for the wheat, oats, and barley was not

Table 6.--Average % of plants showing poor exertion for 8 varieties of small grain treated with different types of 2,4-D at 0.75 pound per acre in the fall 1948.

Variety	Ester	Amine	Salt	Av.
Traveler	19	8	8	11.7
Wintok	5	2	0	2.3
Av.	12	5	4	7.0
Triumph	11	2	2	5.0
Comanche	10	6	3	6.3
Pawnee	8	3	0	3.7
Wichita	30	13	4	15.7
Clarkan	0	0	0	0.0
Av.	11.8	4.8	1.8	6.1
Tenkow	37	18	13	22.7
Av.	15.0	6.5	3.7	8.4

materially affected by the types of 2,4-D or times of application when compared with the checks.

5. The number of tillers was affected by time of application of the 2,4-D chemicals. The types of 2,4-D appeared to produce different effects when applied at different stages of growth. The 2,4-D salt appeared to produce the greatest over-all reduction in the number of tillers.

6. In the fall tiller stage of growth, all types of 2,4-D developed 12.3% onion-leaf for all small grain crops and caused 7.4% decrease in forage. The oats developed the highest percentage of onion-leaf and forage loss, followed by the barley and wheat. The ester type of 2,4-D produced the highest percentage of onion-leaf and forage loss, followed by the amine and salt.

7. In the fall tiller stage of growth the leaf area for all small grain crops was reduced 8% below the checks by all types of 2,4-D. The ester being the most severe, it reduced the leaf area 10% below the check followed by the amine and salt, each with 6%. The small grain crop most affected was oats.

8. Barley developed the highest percentage of poor exertion, followed by oats and wheat. The ester type of 2,4-D caused the greatest amount of poor exertion, followed by amine and salt.

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A P P E N D I X

Table 7.--Yield of grain in bushels per acre for 8 varieties of small grains treated at 4 stages of growth with different types of 2,4-D at 0.75 pound per acre at Perkins, Oklahoma, in 1948-49.

Stage of Growth	Variety	Treatments				
		Ester	Amine	Salt	Av.	Check
		Replication 1				
Fall tiller						
	Traveler	28.4	44.3	38.3	37.0	52.6
	Wintok	28.4	38.8	40.9	36.0	54.9
	Triumph	14.3	13.8	24.2	17.4	26.0
	Comanche	16.0	28.4	20.0	21.5	27.7
	Pawnee	10.7	14.3	16.4	13.8	22.7
	Wichita	11.8	26.8	23.5	20.7	24.1
	Clarkan	16.8	20.6	21.4	19.6	23.0
	Tenkow	27.5	27.9	31.6	29.0	40.9
	Av.	19.2	26.9	27.0	24.4	34.0
Spring or full tiller						
	Traveler	65.4	57.0	68.1	63.5	67.2
	Wintok	39.7	50.6	49.7	46.7	51.4
	Triumph	29.1	25.9	27.7	27.6	27.4
	Comanche	26.2	28.2	27.0	27.1	32.0
	Pawnee	24.7	27.9	25.4	26.0	25.8
	Wichita	28.6	33.5	26.4	29.5	24.6
	Clarkan	24.3	23.2	25.6	24.4	25.1
	Tenkow	49.1	49.2	44.1	47.5	48.6
	Av.	35.9	36.9	36.7	36.5	37.8
Boot						
	Traveler	52.3	54.2	54.3	53.6	65.1
	Wintok	55.0	41.8	40.5	45.8	58.2
	Triumph	29.6	29.5	25.9	28.3	26.0
	Comanche	28.0	29.1	32.2	29.8	29.6
	Pawnee	21.4	22.2	22.7	22.1	18.7
	Wichita	31.4	28.2	33.4	31.0	32.0
	Clarkan	16.6	23.6	26.3	22.2	23.7
	Tenkow	45.6	42.2	49.3	45.7	46.3
	Av.	34.9	33.8	35.6	34.8	37.4
Soft dough						
	Traveler	59.3	58.3	57.4	58.3	58.3
	Wintok	56.3	58.5	41.2	52.0	53.6
	Triumph	27.4	26.1	26.3	26.6	21.1
	Comanche	30.0	32.4	28.0	30.1	28.0
	Pawnee	25.3	23.8	27.5	25.5	22.3
	Wichita	31.0	30.4	29.1	30.2	20.1
	Clarkan	27.7	20.0	21.3	23.0	21.3
	Tenkow	44.3	47.2	46.1	45.9	43.1
	Av.	37.7	37.1	34.6	36.5	34.6
	Av. of Rep. 1	31.9	33.6	33.5	33.0	35.9

Table 7.--(Continued).

Stage of Growth	Variety	Treatments: Ester	Amine	Salt	Av.	Check
			Replication 2			
Fall tiller						
	Traveler	35.7	45.4	46.7	42.6	55.4
	Wintok	32.4	48.0	43.8	41.4	51.6
	Triumph	26.7	25.4	29.2	27.1	28.7
	Comanche	15.9	17.5	18.4	17.3	25.9
	Pawnee	13.8	13.3	19.5	15.5	28.0
	Wichita	15.9	26.4	23.7	22.0	25.8
	Clarkan	9.1	21.4	21.5	17.3	23.6
	Tenkow	38.0	38.1	36.6	37.6	40.4
	Av.	23.4	29.4	29.9	27.6	34.9
Spring or full tiller						
	Traveler	72.2	68.6	51.4	64.1	64.8
	Wintok	52.8	47.8	59.7	53.4	47.9
	Triumph	28.0	26.3	28.5	27.6	28.0
	Comanche	26.4	29.1	29.1	28.2	23.4
	Pawnee	25.5	24.2 /1	25.7	25.1 /1	26.3
	Wichita	24.1		22.3		28.2
	Clarkan	21.6	20.5	22.4	21.5	19.2
	Tenkow	43.9	42.5	43.9	43.4	33.2
	Av.	36.8		35.4		33.9
Boot						
	Traveler	56.5	67.7	67.1	63.8	63.9
	Wintok	51.3	53.3	59.8	54.8	53.7
	Triumph	26.1	26.7	26.1	26.3	28.5
	Comanche	24.3	25.0	23.6	24.3	24.5
	Pawnee	31.1	23.2	25.6	26.6	27.2
	Wichita	25.4	26.2	24.3	25.3	30.4
	Clarkan	19.4	21.5	21.7	20.9	20.1
	Tenkow	40.4	36.5	49.9	42.3	41.7
	Av.	34.3	35.0	37.3	35.5	36.2
Soft dough						
	Traveler	62.2	54.7	55.2	57.4	57.2
	Wintok	54.4	58.4	62.5	58.4	56.3
	Triumph	22.7	23.3	23.4	23.1	21.7
	Comanche	24.4	25.6	26.1 /1	25.4 /1	24.6
	Pawnee	27.1	21.6			24.2
	Wichita	23.9	23.6	26.0	24.5	26.6
	Clarkan	24.6	21.4	23.6	23.2	22.3
	Tenkow	49.7	36.4	41.6	42.6	37.8
	Av.	36.1	33.1	36.9		33.8
	Av. of Rep. 2	32.5				34.9

Table 7.--(Continued).

Stage of Growth	Variety	Treatments				
		Ester	Amine	Salt	Av.	Check
		Replication 3				
Fall tiller						
	Traveler	43.8	52.1	50.5	48.8	56.7
	Wintok	27.3	35.8	44.4	35.8	56.5
	Triumph	19.4	20.6	24.8	21.6	27.1
	Comanche	13.8	14.6	19.2	15.9	23.2
	Pawnee	9.2	16.4	13.5	13.0	19.4
	Wichita	17.2	24.1	19.4	20.2	28.3
	Clarkan	14.0	15.6	15.2	14.9	17.7
	Tenkow	23.1	29.6	33.7	28.8	43.6
	Av.	21.0	26.1	27.6	24.9	34.1
Spring or full tiller						
	Traveler	47.8	53.6	52.0	51.1	52.5
	Wintok	37.8	46.1	37.9	40.6	51.7
	Triumph	25.9	31.5	36.5	31.3	24.6
	Comanche	27.1	24.0	22.3	24.5	23.4
	Pawnee	22.3	23.8	17.2	21.1	22.9
	Wichita	26.6	22.6	27.9	25.7	26.6
	Clarkan	19.3	21.1	21.1	20.5	19.9
	Tenkow	49.7	38.9	37.9	42.2	37.1
	Av.	32.0	32.7	31.6	32.1	32.3
Boot						
	Traveler	42.5	54.8	65.2	54.2	55.4
	Wintok	57.0	54.3	56.6	56.0	51.7
	Triumph	26.2	27.3	18.1	23.9	32.2
	Comanche	23.1	27.8	23.3	24.7	24.9
	Pawnee	19.6	20.3	21.5	20.5	15.0
	Wichita	24.5	24.1	25.4	24.7	30.7
	Clarkan	18.4	17.3	22.2	19.3	20.5
	Tenkow	22.4	41.0	39.2	34.2	43.2
	Av.	29.2	33.4	33.9	32.2	34.2
Soft dough						
	Traveler	51.7	57.1	63.7	57.5	59.5
	Wintok	52.7	53.3	57.0	54.3	57.6
	Triumph	20.7	28.1	22.3	23.7	29.0
	Comanche	26.8	26.0	24.8	25.9	26.7
	Pawnee	14.7	18.8	15.2	16.2	20.5
	Wichita	31.1	23.8	27.2	27.4	28.2
	Clarkan	21.2	15.0	20.7	19.0	19.9
	Tenkow	40.2	40.0	47.1	42.4	42.2
	Av.	32.4	32.8	34.7	33.3	35.4
	Av. of Rep. 3	28.6	31.2	31.9	30.6	34.0
	Grand Av.	31.0				34.1

[1] These samples were lost during harvest.

Typist: Mary Wallace Spohn