

## TRIALS OF SELECTIVE HERBICIDES FOR WEED CONTROL IN WHEAT

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### Abstract

Three selective herbicides Phordene, Phordester and Phenoxylenec used as pre-sowing treatment were generally effective in killing the broad leaved weeds, but weeds appeared again in the wheat growing season. Selective herbicides Phenoxylenec, 2,4-D amine, Fernoxone and Legumex sprayed on 6 and 8 weeks old wheat plants were more effective in keeping weeds under check than their early application 3 weeks after sowing. High weed population in January to April depressed wheat yield more than high weed population in seedling stage during December. Out of the selective herbicides under trial, Legumex was generally less effective than others for weed control and Phenoxylenec was the safest. Aerial application of 2,4 D in early February before jointing stage at 1/2 pint in 2 gallons water per acre reduced the number of weeds and increased the number of ear heads and yield of grain as compared to the unsprayed plots.

### Introduction

Weeds are known to compete with crop plants and cause losses in yield and quality. Losses in wheat production due to weeds have been estimated at 10 per cent in Asia and 9.8 per cent in the world (Cramor, 1967). Studies on the deleterious effects of weeds on the yield of wheat and the quantitative benefit derived from weed control have not received adequate attention in Pakistan.

Selective herbicides have been intensively investigated and are being extensively used in many countries of the world for weed control in wheat and other crops. Recently, increased interest in the use of selective herbicides in Pakistan, has resulted in the import of many formulations of herbicides. However, trials of selective herbicides for the control of weeds in wheat have been rather limited in Pakistan (Ahmed & Hamid, 1954; Kausar & Ali, 1971, 1975; Randhawa & Kausar, 1973). Consequently, adequate information is not available on the efficacy of herbicides available in various formulations for the control of common weeds in wheat and on the response of commonly grown varieties to different rates of these formulations applied, at different stages of growth of the crop.

The experiments reported in this paper were undertaken to evaluate the efficacy of certain selective herbicides for weed control in wheat, applied at different stages of growth of wheat and to determine their beneficial effect on the yield of wheat.

### Materials and Methods

The experiments were conducted at Issakhel Estate, Rahim Yar Khan, Bahawalpur Division during 1955-56 and 1956-57 wheat seasons. The formulations of the herbicides used as post-emergence treatment were: 2,4-D amine (du Pont)

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\*The work was done when the authors were serving the Department of Plant Protection, Ministry of Agriculture, Karachi.

Fernoxone (Plant Protection Ltd.) Phenoxyline plus and Lugumex, (Fissons Pest Control Ltd. Three selective herbicides Phordene, Phordester and Phenoxyline (Fissons Pest Control Ltd.) were tried as pre-sowing treatment.

Spraying of the herbicides was done on wheat plants at different stages of its growth as mentioned in the text. The spraying was done with a knapsack sprayer of 3 gallon capacity and enough water was employed to provide a rate of 48 gallons of spray fluid per acre. The formulations were tested in field and pot experiments, the details of which are given in the text. One herbicide, 2,4-D amine was used in large scale aerial spray trials.

The number and nature of weeds, their prevalence, their response to formulations, the response of wheat to the formulation and yield were studied. The population count of weeds was carried out before and after the spray of the herbicides. A wooden frame of one square yard dimension was placed at random in the standing crop and the density of weed species in the quadrat was recorded. This was repeated ten times in each plot or treatment.

### Experimental Results

#### PRE SOWING TREATMENT OF SELECTIVE HERBICIDES

The effectiveness of herbicides for the control of weeds which cropped up after core watering was studied by spraying them on the weeds about seven days before seeding wheat. The herbicides used were Phordene (1/2 pint and 3 pints per acre), Phordester (1/2 pints and 3 pints per acre) and Phenoxyline (1½ pints and 5 pints per acre). At the time of application of herbicides, the predominating weeds

**TABLE 1. Effect of spraying selective herbicides on weed population and yield of wheat.**

Treatment	Herbicides sprayed on 3-week old seedlings		Herbicides sprayed on 8-week old plants		
	Weeds per sq. yard	Yield of grain (mds/acre)	Weeds per sq. yard		Yield of grain (mds/acre)
			Before spray	After spray	
Check	2.9a	25.3a	9.8	7.6a	23.0a*
Phenoxyline	1.0b	26.5a	5.5	1.3b	23.5a
Fernoxone	—	—	8.6	1.4b	23.9a
2,4-D	0.6b	27.8a	6.3	1.5b	22.5a

\*Figures having the same letter in a column do not differ significantly at 5 per cent level.

were *Convolvulus arvensis*, *Cressa cretica* and *Cyperus rotundus* with a population density of 7 to 22 per sq. yard. After the spray of herbicides the broad leaved weeds showed symptoms of yellowing and scorching while there was no effect on *Cyperus rotundus*. However, the weeds reappeared and the sprayed plots did not differ significantly from the unsprayed plots. One application of these herbicides before seeding wheat did not effectively control weeds during the growing period of wheat crop.

### POST SOWING TREATMENT

Phenoxylyene plus, 2,4-D and Fernoxone were sprayed at their recommended rates of 2 pints, 1 pint and 2 lbs per acre, respectively on 3-week old wheat plants which had not tillered and were in the 5 leaf stage, and on 8-week old wheat plants which had fully tillered but had not reached the jointing stage. The experiment was laid out in quadruplicated randomised blocks with a plot of 1/8th of an acre. The population count of weeds before and after the spray of herbicides and its effect on the yield of the grain are summarised in Table 1 and 2.

The predominant weeds were *Convolvulus arvensis*, *Chenopodium* sp., *Brassica* sp., *Trifolium alexandrianum* and *Cressa cretica*. After the spray on 3-week old wheat, the density of weeds was reduced to 1.03 in Phenoxylyene and 0.63 in 2,4-D treated plots as against 2.9 per sq. yard in untreated controls. Similarly, in 8-week old wheat sprayed with Phenoxylyene, Fernoxone and 2,4-D, the density of weeds was reduced to 1.3, 1.4 and 1.5 respectively as compared to 7.6 per sq. yard in unsprayed check plots. In general, the formulations were effective against these weeds except *Cressa cretica* and *Cyperus rotundus*. In these trials, *C. cretica* appeared after the spray of the formulations. On the other hand, in check plots the density of weeds either remained similar or increased.

**TABLE 2. Prevalence of weeds before and after the spray of selective herbicides on 8-week old wheat plants.**

Weeds	Number of weeds per sq. yard before and after the application of			
	<i>Fernoxone</i>	<i>Phenoxylyene</i>	2,4-D	Check
<i>Convolvulus arvensis</i>	5.0/0.8	3.4/1.0	4.5/0.7	6.9/6.1
<i>Chenopodium</i> sp.	2.5/0.1	1.7/0.5	1.4/0.1	2.2/p.4
<i>Cressa cretica</i>	0.0/0.2	0.0/0.3	0.0/0.6	0.05/0.1
<i>Trifolium alexandrianum</i>	0.5/0.1	0.3/0.05	0.3/0.1	0.4/0.3
<i>Brassica</i> sp.	0.2/0.0	0.2/0.0	0.1/0.0	0.08/0.0
Total:	8.6/1.4	5.5/1.3	6.3/1.5	9.8/7.6

There was an increase of 1.2 and 2.5 mds. per acre over the untreated plots by the application of Phenoxylyene and 2,4-D, respectively, on 3-week old wheat plants, whereas there was an increase of 0.5 to 0.9 mds. per acre by the application of Phenoxylyene and Fernoxone on 8-week old wheat plants over the untreated plots. When 2,4-D Amine was applied on 8-week old crop, there was a decrease of 18 seers per acre. However, the increase or decrease in yield was non-significant statistically. From these trials it was evident that the time of application of the herbicides was an important factor.

### FIELD TRIALS

More elaborate field trials were made during 1956-57 wheat season. The experiment was laid out in a split plot design with three replications. Four herbicides viz., Phenoxylyene, 2,4-D Amine, Fernoxone, and Legumex were applied on 3, 6 and 8 weeks old wheat seedlings. The three times of application formed the main plots. Four herbicides and an untreated check comprising the five treatments formed the next split within the main plots of time of application. Each sub-plot measured 1/8 th of an acre.

The prevalence of weeds recorded before and after the application of the herbicides and finally at the time of harvest is summarised in Table 3 and 4. The initial weed population increased as the time of application of the herbicides was

**TABLE 3. Effect of spraying selective herbicides at different times on the population of weeds in wheat.**

Time of weed count	Weed counts (per sq. yd) before and after spraying				
	Phenoxylyene	2,4-D Amine	Fernoxone	Legumex M	Check
Spray 3 weeks after sowing					
Before spray	1.8	2.0	3.1	2.0	3.1
After spray	0.7	0.5	0.9	0.6	6.0
At harvest	3.4	3.3	3.4	3.3	9.4
Spray six weeks after sowing					
Before spray	2.7	4.3	4.0	4.9	3.9
After spray	0.3	0.6	0.7	0.5	5.6
At harvest	1.2	1.7	1.5	2.6	10.5
Spray eight weeks after sowing					
Before spray	6.0	7.8	6.9	6.5	7.5
After spray	0.8	0.7	0.8	0.8	9.6
At harvest	1.1	0.7	1.0	2.0	5.2

TABLE 4. Prevalence of Weeds before and after the application of selective herbicides in 3, 6 and 8 weeks old wheat crop.

Herbicides	Number of weeds per sq. yard before and after the application of herbicides							Total
	Brassica sp.	Chenopodium sp.	C. arvensis	C. cretica	M. parviflora	Miscellaneous		
	3—week old wheat crop.							
Fernoxone	0.0/0.0	0.0/0.2	0.03/0.0	0.0/0.0	0.0/0.03	3.1/0.7	3.1/0.0	
Legumex	0.0/0.03	0.0/0.1	0.0/0.1	0.0/0.0	0.0/0.2	2.0/0.2	2.0/0.6	
Phenoxylene	0.0/0.0	0.0/0.03	0.0/0.1	0.0/0.0	0.0/0.1	1.8/0.5	1.8/0.7	
2,4-D	0.0/0.0	0.0/0.1	0.0/0.03	0.0/0.0	0.0/0.03	2.0/0.4	2.0/0.5	
Check	0.0/0.6	0.0/1.8	0.0/0.9	0.0/0.1	0.0/0.3	3.1/2.8	3.1/6.5	
	6—week old wheat crop.							
Fernoxone	0.0/0.0	1.7/0.2	0.03/0.0	1.2/0.0	0.4/0.1	1.8/0.5	4.0/0.7	
Legumex	0.1/0.0	1.8/0.2	0.5/0.1	0.0/0.8	0.9/0.1	1.1/0.2	5.3/0.5	
Phenoxylene	0.03/0.0	0.9/0.03	0.2/0.0	0.0/0.0	0.1/0.03	1.4/0.2	2.7/0.3	
2,4-D	0.1/0.0	0.4/0.1	1.7/0.2	0.0/0.0	0.3/0.1	1.8/0.3	4.3/0.6	
Check	0.2/0.1	0.6/1.8	0.3/0.4	0.03/0.1	0.5/1.4	2.2/1.7	3.8/5.5	
	8—week old wheat crop.							
Fernoxone	0.5/0.03	1.4/0.1	0.0/0.0	0.0/0.0	4.2/0.5	1.0/0.2	7.0/0.8	
Legumex	0.3/0.2	1.1/0.1	0.2/0.0	0.0/0.0	3.2/0.4	0.7/0.4	5.5/0.9	
Phenoxylene	1.0/0.03	1.2/0.1	0.0/0.03	0.0/0.0	2.4/0.2	1.5/0.5	6.0/0.9	
2,4-D	0.4/0.0	3.1/0.1	0.0/0.0	0.0/0.0	4.7/0.4	0.6/0.3	7.8/0.7	
Check	0.4/0.6	1.4/1.9	0.3/0.5	0.0/0.0	4.8/5.9	0.5/0.9	7.5/9.7	

delayed. The weed population was significantly reduced by the application of herbicides. However, the weed population increased later in the treated plots, but remained at a lower level than the untreated check by the harvest time.

The initial weed population density by the first week of December before the application of herbicides varied between 1.8 and 3.1 per sq. yard in plots of different treatments, with an average of 2.4. After the application of the herbicides on 7th December (3 weeks after sowing), the weed population was reduced and varied between 0.5 and 0.9 in different treatments (with an average of 0.7) by the first of January, as against 6.0 in the untreated check. However, the weed population increased later and by the first week of April varied between 3.3 and 3.4 in different treatments, with an average of 3.35, as against 9.4 per sq. yard in the untreated check.

Similarly, the herbicides applied in the first week of January (6 weeks after sowing) reduced the initial weed population varying between 2.7 and 4.9 (with an average of 4.0) to 0.3-0.7 (with an average of 0.5), as against 5.6 per sq. yard in the untreated check. The weed population increased later and by the first week of April varied between 1.2 and 2.6 (with an average of 1.8), as against 10.5 per sq. yard in the untreated check.

The herbicides applied 8 weeks after sowing were effective in reducing the initial weed population varying between 5.5 and 7.8 (with an average of 6.5) to 0.7-0.8 (with an average of 0.78), as against 9.6 per sq. yard in the untreated check. The weed population by first week of April varied between 0.7 and 2.0 (with an average of 1.2), as against 5.2 per sq. yard in the untreated check.

Thus, the average weed counts by the first week of April before harvest were respectively 3.35, 1.8 and 1.2 in plots treated with herbicides 3, 6 and 8 weeks after planting. This indicated that the application of herbicides 6 and 8 weeks after sowing

**TABLE 5. Effect of spraying selective herbicides at different times on the yield of wheat grain.**

Herbicide	Yield of grain (mds/acre) by spraying after.			
	3 weeks	6 weeks	8 weeks	Average
Phenoxyleno	12.1	22.0	22.1	18.7a*
Fernoxone	14.9	17.3	19.3	17.2ab
2,4-D Amine	13.3	16.2	17.3	15.6ab
Legumex	13.8	15.3	17.2	15.4ab
Check	12.4	12.3	16.7	13.8b
Average	13.3	16.6	18.5	

\*Figures having the same letter in a column do not differ significantly at 5 per cent level.

were more effective in keeping the weeds under check than the early application 3 weeks after sowing. In general, Phenoxylyene, 2,4-D Amine and Fernoxone were more effective than Legumox M in reducing the weed population and keeping it under check.

The time of application of the herbicides influenced the yield of grain of wheat (Table 5). The average yield of wheat grain for all herbicidal treatments was 13.3, 16.6 and 18.5 maunds per acre for application made at 3, 6 and 8 weeks respectively after planting. The difference between the yield from 3 and 8 week applications only was significant statistically. This indicated that high weed population in January to April after early application of herbicides depressed yield more than high weed population during early wheat seedling stages during December.

As average of the three times of application, the yield of wheat treated with Phenoxylyene, Fernoxone, 2,4-D Amine and Legumox were 18.7, 17.2, 15.6, 15.4 mds. per acre as against 13.8 from untreated check. The increase in yield was significant only for Phenoxylyene. Non-significant interaction between time of application and herbicides indicated that the behaviour of the herbicides was similar for different times of application.

#### SMALL SCALE EXPERIMENT

The effect of four selective herbicides at different rates of application on two, three and six weeks old wheat seedlings grown in rod rows was also studied during 1956-57 wheat season.

Application of 2,4-D at 2 pints per acre on 2-week old wheat seedlings reduced the number of culms and yield of grain as compared to the application at the recommended rate of 1/2 pint per acre (Table 6). Similarly, Fernoxone at 1 and 2 lbs per

**TABLE 6. Effect of spraying herbicides on two-week old wheat plants per yard row length.**

Treatments	Rate of application per acre	Number of culms	Number of culms without ears	Number of deformed ears	Yield (grms)
Check		53.0	1.5	0	75.0b*
2,4-D	2 pints	37.5a	1.5	15	24.5a
	1 pint	59.5a	5.0	24.5	53.0b
	1/2 pint	76.0a	3.0	23.5	62.5b
Phenoxylyene	4 pints	57.0a	7.5	2.0	54.5b
	2 pints	59.5a	3.0	1.5	57.0b
	1 pint	59.5a	2.0	0.5	60.5b
Fernoxone	2 lbs.	37.0a	8.5	22.0	15.5a
	1 lb.	41.5a	12.0	26.0	14.0a
	1/2 lb.	63.0b	5.0	33.5	34.5a

\*Figures having the same letter in a column do not differ significantly at 5 per cent level.

**TABLE 7. Effect of spraying herbicides on three week old wheat plants per yard row length.**

	Number of Culms	Culms without ears	Deformed ears	Yield of grain (gms)
Check	51.5a	2.5	0.0	51.5a*
Phenoxylylene	61.5a	7.5	1.0	42.5a
Fernoxone	63.5a	11.5	1.0	47.5a
2, 4-D	48.5a	2.5	2.0	45.0a
Legumex	54.0a	11.0	34.2	23.5b

\*Figures having the same letter in a column do not differ significantly at 5 per cent level.

acre reduced the number of culms significantly as compared to application at 1/2 lbs. per acre. However, the number of culms and yield of grain from plants sprayed with Phenoxylylene at 1, 2 and 4 pints per acre did not differ significantly among themselves and from the untreated check. Phenoxylylene sprayed plants had negligible number of deformed ears, and on the whole, was the safest herbicide at the rates used. Application of Fernoxone at 1/2, 1 and 2 lbs per acre produced significantly high number of deformed ears and as a consequence reduced the yield of grain significantly.

Application of Phenoxylylene (2 pints per acre), Fernoxone (1 lb per acre), and 2,4-D (1/2 pint per acre) on three-week old seedlings reduced the yield of grain significantly, but Legumex (3 pints per acre) produced significantly high number of deformed ears and reduced the yield. However, these herbicides had no deleterious effect on the number of culms (Table 7). The application of these herbicides on six-week old seedlings did not influence the number of culms, culms without ears, deformed ears and yield of grain (Table 8).

#### LARGE SCALE AERIAL APPLICATION OF HERBICIDE

Large scale trial of aerial spraying of 2,4-D Amine was carried out with a Beaver plane and a Piper cub in 1956 and 1957 respectively. The herbicide was applied at the rate of 1/2 pint in 2 gallon of water per acre. Wheat had been planted in continuous strips suitable for aerial spraying. The spraying operation was carried out in early February when the crop was 2-2½ months old, plants had fully tillered but had not reached the jointing stage. The spraying was done over an area of 900 acres in 1956 and 1957 with the help of a Beaver plane or a Piper cub flying at a height of 7 to 9 feet over the crop, making 2 sorties in an acre and consuming 2 gallons of spray liquid per acre.



**TABLE 8. Effect of spraying herbicides on 6-week old wheat plants per yard row length.**

	Number of culms	Culms without ears	Deformed ears	Yield of grain (gm)
Check	50.5a	1.5	0.0	50.5a*
Phenoxylene	61.5a	3.0	1.5	60.0a
Fernoxone	70.5a	4.5	4.0	51.5a
2, 4-D	58.5a	0.0	2.5	44.5a
Legumex	55.0a	1.5	2.5	41.5a

\*Figures having the same letter in a column do not differ significantly at 5 per cent level.

Aerial application of 2,4-D in 1957 reduced the number of weeds from 13.7 to 3.6 per sq. yard (Table 9). However, in the unsprayed plots, the weed density remained more or less similar. The herbicide was effective against *Brassica* sp., *Convolvulus arvensis*, *Chenopodium* sp., whereas *Cressa cretica* and *Melilotus parviflora* showed an increase in population after the application of the herbicide.

**TABLE 9. Effect of aerial application of 2,4-D on the control of weeds in wheat.**

Weed	Number of weeds per sq. yd.	
	Before spray	After spray
<i>Brassica</i> sp.	0.3	0.0
<i>Convolvulus arvensis</i>	3.5	0.7
<i>Cressa cretica</i>	0.1	0.4
<i>Chenopodium</i> sp.	2.2	0.0
<i>Melilotus parviflora</i>	0.6	2.2
Miscellaneous	7.0	0.3
All Weeds	13.7	3.6

**TABLE 10. Effect of aerial application 2,4-D on the number of culms, deformed ears and yield of grains.**

	Sprayed	Unsprayed
Number of culms per sq. yd.	204.9	161.6
Deformed ears per sq. yd.	0.9	0.0
Yield of grains in gram per sq. yd.	257.3	190.1

The wheat crop showed no adverse effects of the application of herbicide, except minor deformity in certain earheads. The application of the herbicide increased the number of earheads and yield of grains as compared to unsprayed plots (Table 10).

### Discussion

The formulations of the selective herbicides under trial proved generally effective in controlling almost all the common weeds in wheat. *Cressa cretica* and *Cyperus rotundus* were not effectively controlled by these herbicides at the rates of application.

From the results of various experiments it is apparent that the time of application is important both in the control of weeds and the yield of crop in general. Greater yield was obtained when herbicides were sprayed at 6 to 8 weeks after sowing in comparison to applications made at 3 weeks after sowing. At 3 weeks the plants were in the 5 leaf seedling stage whereas at 8 weeks after sowing they had completed tillering. These results corroborate the findings of Johanson & Muzik (1961) who obtained a higher yield with the application of 2,4-D in Brevol wheat plots at tillering stage in comparison to the control. The question whether the herbicides should be sprayed early or in the advanced stage of the crop, or two applications at these stages are needed for the complete eradication of the weeds, is important.

The extensive use of selective herbicides for the control of weeds in wheat in Pakistan revolves mostly on economic considerations. The increased yield obtained by the use of herbicides should be promising enough to make the use of herbicides economical. However, the application of herbicides in Pakistan presents certain difficulties on account of small holdings and other conditions of farming. Knapsack sprayer is useful for small areas, but is undoubtedly slow and requires labour. There is some trampling of the wheat crop which cannot be avoided. The use of power sprayers for larger holdings is economical, but more trampling of wheat crop takes place. Aerial spraying is helpful in areas where wheat has been sown in contiguous areas. However, the use of helicopters is limited by the presence of trees in the fields, unavailability of suitable landing grounds, and presence of fields of other crops susceptible to selective herbicides.

Selective herbicides for the control of weeds in mechanised farming assumes special importance particularly when reapers or combine harvesters are used for harvesting wheat. The presence of certain weeds including *Convolvulus arvensis*,

*Asphodelus fistulosus* and *Brassica* sp. make the working of such machines difficult. The use of herbicides on a farm under mechanised cultivation reported in the paper is, therefore, of special significance. Further trials on the effectiveness of herbicides for weed control, their effect on the yield of sprayed crops, economics of their application under different farming conditions should prove useful in Pakistan.

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