

Sensitivity of dwarf and desi wheats at different growth stages to the application of 2, 4-D

N. K. BEHL AND M. K. MOOLANI*

Competition between crop plants and weeds for moisture, nutrients and light is probably the single factor limiting the crop yields. In wheat, the yield losses due to weeds are higher because of recent introduction of high yielding varieties which require more moisture and nutrients. Various workers have reported the wheat yield losses upto 60-70% due to competitive effects of associated weeds (Pande, 1956; Verma, 1962).

The wheat crop is mostly infested with broadleaved weeds. For the control of these weeds, selective post emergence spraying of 2, 4-D is now widely adopted. Different workers have found the effective dose of 1 kg a.e./ha of sodium salt of 2, 4-D which may vary under different soil and agro-climate conditions (Verma and Bhardwaj, 1957, Singh and Moolani, 1968). With the use of higher concentrations of 2, 4-D abnormalities of wheat shoots and ears were also reported (Shivapuri and Sinha, 1954). It has been recognised for sometimes that wheat though resistant to 2, 4-D suffers some damage at some growth stages. The general recommendations that the chemical be applied during the period between a well advanced seedling stage (5-6 leaf stage) and the boot stage (upper sheath begins to swell with enlarging head) appears to be sound and seems to provide a good margin of safety. The physiological stages of crop at which wheat may be susceptible to 2, 4-D injury has not been studied in our country and the work on this aspect has been done to some extent in other countries. With the above objectives in view, the present studies were undertaken in the *rabi* season of 1967-68 and 1968-69.

REVIEW OF LITERATURE

Foster (1949) reported that the damage to wheat due to 2, 4-D was most severe during the period from 13 to 20 days after emergence. Olson *et al* (1951) noticed more damage specially when ester formulation of 2, 4-D was applied in early growth stages of wheat, oats and barley. Klingman (1953) claimed that

*Research Assistant (Agronomy) and Professor and Head, Department of Agronomy, Punjab Agricultural University, Hissar, respectively.

as the rates of 2, 4-D ester were increased from 1/8 to 3/4 kg a.e./ha, the early boot and flowering stage resulted in more plant injury than the joining or late-boot stage.

In field trials conducted by Johanson and Muzik (1961), spike abnormalities including curvature and doubling of the rachis occurred in wheat sprayed at either the seedling or boot stages. In glass house, he further concluded that foliar application of 2000 ppm solution of 2, 4-D as solubilized acid to wheat seedlings stimulated elongation of the primary roots but inhibition of lateral root development and swelling of both lateral roots and culm bases. Growth of plumul and radicle in wheat was stimulated by lower concentration i.e. 0.001 to 1.0 ppm and depressed by higher doses of 100 to 1000 ppm (Rojas-Gardiciduenas, 1962).

Brasesco (1964) reported from the trials laid out for 4 successive years that best time to apply 2, 4-D butyl ester (0.75-1.51 of commercial product containing 35% a. e.) in wheat was at the commencement of tillering Hanf (1962) also suggested that 2, 4-D and MCPA in wheat should be sprayed between 4 and 7 leaf stages respectively. Spraying approximately 6 weeks after sowing i.e. at 4-5 leaf stage gave 15% increase in yield as compared to control. If it is sprayed at more than 8 weeks after sowing when plants are fully formed with main shoot, gave only 4% increase in yield. Franco (1963) found that application of picloram applied at 0.07 and 0.21 kg a. i./ha were better at tillering (early and end of tillering) than boot, flowering or milk ripe stages.

MATERIAL AND METHODS

The field trials were laid out for two successive years in the *rabi* season of 1967-68 and 1968-69 at the Agronomy Research Farm of Punjab Agricultural University, Hissar. The main objectives were to find out *firstly* the effects of 2, 4-D on growth and yield of wheat and associated weed, *secondly* the best time of 2, 4-D application in mexican and desi wheats and *thirdly* to find out the stages of crop growth when wheat is more susceptible to 2, 4-D. Response of six different times of 2, 4-D spray with weed free and weedy check to Dwarf and Desi wheat were tested in a Randomized Block Design replicated four times. The treatments are detailed out below :

- Time of 2, 4-D spray**
1. As pre-emergence
 2. 15 days after sowing
 3. 30 days after sowing
 4. 45 days after sowing

- Wheat varieties**
1. Dwarf wheat-K 227 Desi
 2. Wheat-C-306

5. 60 days after sowing

6. 75 days after sowing

7. Weed free

8. Weedy check

The soil of the experimental area is of sandy loam type containing on an average 61.38% sand, 23.41% silt and 15.21% clay. Soil pH is about 8.5 and is low in nitrogen and medium in phosphorus status.

Wheat crop was sown on 10th and 16th November respectively in 1967-68 and 1968-69 using seed rate of 100 kg/ha and spacing of 20 cm between the rows. Nitrogen was applied to the crop in the form of urea at 60 and 120 kg N/ha in desi and dwarf wheats respectively applied in two split doses, half at the time of sowing and rest with the first irrigation. A basal dose of 50 kg. P_2O_5 /ha was also drilled before sowing the crop in both the varieties.

2, 4-D was applied to the wheat crop at 720 gm a. e./ha of amine salt (Bladex G) mixed with about 600 litres of water and sprayed uniformly using Knap-Sack sprayer. Same concentration of 2, 4-D was used at different times of 2, 4-D spray tried in the experiment. Weeding was done with hand labour in the weed free plots.

Meteorological data during the crop growing season for the year 1967-68 and 1968-69 is presented in table 1.

Table 1
Meteorological data of the experimental period

Month	1967-68				1968-69			
	Minimum Temperature °C	Maximum Temperature °C	Relative humidity %	Rain-fall (mm)	Minimum Temperature °C	Maximum Temperature °C	Relative humidity %	Rain-fall (mm)
November	11.5	27.0	56	24.6	10.5	25.8	56	—
December	8.6	20.0	73	68.8	7.1	22.9	54	—
January	5.8	18.4	72	—	6.0	20.9	60	2.4
February	6.9	20.6	69	13.1	9.3	23.8	68	21.8
March	13.5	28.7	55	12.0	16.3	32.0	58	5.9
April	18.7	35.7	43	—	20.7	36.6	31	3.8

RESULTS AND DISCUSSION

1. Weed spectrum : The percentage weed infestation of different species was calculated on the basis of weedy check plots as under :

Botanical name of the weed	Percentage infestation	
	1967-68	1968-69
1. <i>Chenopodium album</i>	63.8	79.3
2. <i>Convolvulus arvensis</i>	15.6	8.5
3. <i>Protulaca eleraceae</i>	8.9	3.2
4. <i>Cyperus rotundus</i>	3.5	6.9
5. Other weeds	8.2	2.1

Wheat crop in the experimental area had competition mainly with *Chenopodium album* (60-80%) followed by *Convolvulus arvensis* (8 to 16%), these weeds are broadleaf in nature.

2. Weed population and dry weight of weeds : Weed population was taken 105 days after sowing when all the spraying of 2, 4-D were completed at different crop stages. The data obtained are presented in table 2.

Data clearly indicates that 2,4-D sprayed 30 and 45 days after sowing in K-227 and 45 days in C-306 reduced the population of weed significantly as compared to all other treatments. 2, 4-D sprayed at pre-emergence and seedling stage (15 days after sowing) could not control the weeds completely because by that time the weed population was much less. It is general observation that weeds in wheat appear only after the application of first irrigation. Thus the majority of the weeds appear after first irrigation when competitive influence of the associated weeds is inflicted on the crop. 2, 4-D spray after 45 days after sowing does not prove effective. This may possibly be due to the fact that surface area of the land might be covered with the closely sown crop by that time or it may be that the weeds might have shown resistance because of more maturity.

The injurious effect of 2, 4-D on weeds was very much marked after 2 days after spraying and 2, 4-D killed mostly the broadleaf weeds, but *Convolvulus arvensis* was again regenerated because of its deep root system. Symptoms noticed on the weeds were twisting of leaves, bending of shoots, burning in the form of browning, blackening and finally death of the weed plants.

Growth of weeds measured in terms of dry matter was also appreciably low in 2, 4-D sprayed as compared to weedy check. However, the dry weight of weeds was comparatively much less in 2, 4-D sprayed 30 and 45 days after sowing.

Table 2
Effect of 2, 4-D applied at different crop stages on weed population and dry weight of weeds

Times of 2, 4-D spray	Weed population (50 cm ²)						Dry weight of weeds (q/ha)						
	Kalyan-227			C-306			Kalyan-227			C-306			
	1967-68	1968-69	Mean	1967-68	1968-69	Mean	1967-68	1968-69	Mean	1967-68	1968-69	Mean	
Pre-emergence	22.16	27.92	25.4	32.15	35.16	33.66	24.56	26.78	25.67	25.12	26.92	26.02	
15 days after sowing	20.24	25.17	22.70	27.18	32.18	29.68	21.98	23.45	22.72	22.86	24.81	23.84	
30 days after sowing	1.41	1.87	1.64	14.01	16.98	15.49	0.19	0.23	0.21	12.25	10.26	11.26	
45 days after sowing	1.32	1.83	1.58	1.92	4.51	3.22	0.21	0.23	0.22	0.26	0.28	0.27	
60 days after sowing	10.81	14.23	12.52	17.12	20.13	18.63	11.89	12.34	12.12	13.26	13.52	13.39	
75 days after sowing	19.26	24.52	21.89	23.12	26.91	25.02	23.41	26.91	25.67	24.54	25.19	26.08	
Weed free	—	—	—	—	—	—	0.17	0.23	0.20	0.32	0.38	0.35	
Weedy check	40.13	60.01	50.07	50.01	69.38	59.69	42.67	51.39	47.03	48.91	54.36	51.64	
C. D. at 5% for Variety	<u>1967-68</u>			<u>1968-69</u>			<u>1967-68</u>			<u>1968-69</u>			<u>Mean</u>
	3.64			9.38			4.56 q/ha			5.71 q/ha			5.61 q/ha
C. D. at 5% for Weed control	7.13			10.22			3.91 q/ha			4.22 q/ha			4.09 q/ha

in K-227 and C-306 respectively as compared to other times of 2, 4-D spray.

3. **Wheat plant injury** : It was observed that severe plant injury was noticed only in plots where 2, 4-D was sprayed at seedling stage (15 days after sowing) where as in pre-emergence sprayed plots, only growth in the initial stages was stunted but later on it recouped. Various symptoms observed were onion-like leaves, clubbed heads associated with spikelets, supernumerous sterile spikelets, very erect spikes and bending of the ears.

Table 3

Sensitivity of dwarf and desi wheats to 2, 4-D applied at different growth stages

Time of 2, 4-D spray	Grain yield (q/ha)					
	Kalyan-227			C-306		
	1967-68	1968-69	Mean	1967-68	1968-69	Mean
Pre-emergence	43.31	39.78	41.55	22.67	21.60	22.14
15 days after sowing	30.24	31.52	31.03	14.87	18.90	16.89
30 days after sowing	51.98	56.16	54.07	27.95	25.74	26.35
45 days after sowing	51.48	57.97	54.73	30.31	30.60	30.46
60 days after sowing	46.89	45.63	46.16	27.28	26.10	26.69
75 days after sowing	40.91	33.37	39.64	22.73	22.68	22.70
Weed free	52.94	57.09	55.02	31.01	30.78	30.89
Weedy check	39.96	35.33	37.35	18.85	20.88	19.87
Mean	44.69	44.02	44.36	24.33	24.66	24.49
				<u>1967-68</u>	<u>1968-69</u>	<u>Mean</u>
C. D. at 5% for variety				4.86 q/ha	8.11 q/ha	6.69 q/ha
C. D. at 5% for weed control				1.71 q/ha	4.07 q/ha	3.12 q/ha

4. **Effect on Grain yield** : It is clear from the data in table 4 that the lowest yield was recorded in the plots where 2, 4-D was sprayed 15 days after sowing and was significantly inferior to all other treatments except weedy check and pre-emergence sprayed plots. Yields in weed-free plots and 2, 4-D spray plots 30 and 45 days after sowing in K-227 and C-306 respectively were statistically similar and gave an additional yield of 45% and 53% over weedy check in K-227 and C-306 varieties respectively. As the 2, 4-D spray was extended after 45 days, yield reduction occurred because of the poor weed-kill and more dry matter production of weeds. In pre-emergence sprayed plots also, weeds were regenerated after the application of first irrigation and thus produced more competition with the crop resulting in low crop yield. Brasco (1964) and Hanf (1952) also suggested that the best time to apply 2, 4-D in wheat is at the tillering stages which coincides with the period of 30-45 days after sowing.

Significant reduction in yield was obtained in the plots where 2, 4-D was sprayed 15 days after sowing i. e. seedling stage. This supports the findings of Foster (1949), Friesen (1949), Olesen *et al* (1951), Johnson and Muzik (1961). This reduction in yield at seedling stage occurred due to plant injury obtained in the form of onion like leaves and abnormalities of spikelets. Loomis (1949) suggests that flower and perhaps tiller meristems pass through short periods of sensitivity to 2, 4-D. Andersen and Hermansen (1950) reporting on sterility in barley and oats claimed that sprayings at seeding stage produce a number of sterile spikelets and also suggested that the occurrence of abnormalities depends on the stage of development of the plants which seems to indicate that the differentiation of cells forming the first rudiment of an organ may be appreciably by hormone derivatives applied at early stages.

SUMMARY

Experimental trials were laid out at the Agronomy Research Farm of Punjab Agricultural University, Hissar for two years in the *rabi* season of 1967-68 and 1968-69 to study the response of 2, 4-Dichlorophenoxy acetic acid applied at different crop stages to wheat (Kalyan-227 and C-306). The soil of the experimental area is of sandy loam type and received about 118 and 36 mm of rainfall during the crop season for the year 1967-68 and 1968-69 respectively.

Results of the experiment clearly indicate that sensitive stage of the wheat crop to the application of 2,4-D is at seedling stage (Spray 15 days after sowing). At this stage, the leaves of the plants were onionlike in nature. Various abnormalities of the spikelets like numerous sterile spikes, curvature of the spikelets, erect spikes occurred due to which the yield of the wheat crop was reduced significantly as compared to all other treatments. The best time for spraying 2, 4-D application was found from 30-45 days in Kalyan 227 and 45 days after sowing in C-306 varieties of wheat. At earlier and later stages, the weed mortalities was found to be less as compared to optimum stages and thus had competition with wheat crop resulting in reduced crop yield.

REFERENCES

- Anderson, S. and Hermansen, J. Effect of hormone derivatives on cultivated plants. *Dept. for Agriculture Plant Culture of the Royal Veterinary and Agricultural high school. Paper No. 26* (1950).
- Brasenco, J. A. I. Time and rate of application of 2, 4-D in wheat. *Weed Abst.* 13 (5) : 229. (1964)
- Foster, J. Roe. Effect of 2, 4-D on spring sown barley and wheat. *Res. Rept. Sixth Ann. North Central Weed Control Conf. Sioux Falls, S. Dak :* 105-106. (1949)

- Franco, O and Cardenas, J. Critical periods of picloram applications in wheat (*Triticum vulgare*) and barley (*Hordeum vulgare*) at two levels of fertilization. *Weed Abst.* 18 (5) : 329. (1969).
- Friesen, H. N. Effect of 2, 4-D on cereals. *Proc. and Abstr. Third Western Canadian Weed Conf.* Edmonton Alberta : 40-45. (1949).
- Hanf, M. Only correct growth regulator application guarantees complete success. *Weed Abst.* 2 (1) : 5 (1962).
- Johanson, N. G. and Muzik, T. J. Some effects of 2, 4-D on wheat yield and root growth. *Bot. Gaz.* 122 (3) : 188-94 (1961).
- Klingmen, Dayton. L. Effects of varying rates of 2, 4-D and 2, 4, 5-T at different stages of growth on winter wheat. *Agron. J.* 45 : 606-610 (1953).
- Loomis, W. E. Investigations on physiological and chemical factors influencing practices in weed control. *Res. Rept. Sixth Ann. North Central Weed Control Conf.* Sioux Falls S. Dak : 210-215 (1949).
- Olson, P. J., Zalik, S., Breakey, W. J. and Brow, O. A. Sensitivity of wheat and barley at different stages of growth to treatment with 2, 4-D. *Agron. J.* 43 : 78-83 (1957).
- Pande, H. K. Effect of growth regulators on weeds in crop of wheat. *Proc. 43rd Indian Sci. Cong.* 3 : 311 (1956).
- Rojas-Gardiciduenas, M., Ruiz, M. A. and Carrilo, J. Effect on 2, 4-D and MCPA on germination and early growth of wheat *Weeds* 10 (1) : 69-71 (1962).
- Singh, Onkar and Moolani, M. K. Effect of different concentrations of 2, 4-D on weed control of wheat. *J. of Res.* 5 (4) : 481-486 (1961).
- Shivapuri, T. N. and Sinha, R. P. Effect of selective herbicides on the yield of wheat. *Proc. Indian Sci. Cong.* 41 : 254 (1954).
- Verma, R. D. 2, 4-D can end weed trouble in wheat. *Ext. Special Wheat Number* 3 (3) : 62-64 (1962).
- Verma, R. D. and Bhardwaj, R. B. L. Chemical weed control in wheat. *Indian J. Agron.* 2 : 243 (1957).