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Phytotoxicity of dalapon on *hariyali (Cynodon dactylon* Pers.) as influenced by gibberellic acid, surfactants and nitrogen fertilisation *

by

S. KANNAN [1]

Synopsis: An experiment was conducted to determine the effects of gibberellic acid, surfactants and nitrogen fertilisation on the phytotoxicity of dalapon on *Cynodon dactylon*. Complete necrosis was recorded on all the nitrogen-treated plants. Observations also showed that nitrogen in combination with gibberellic acid caused more injury to the plants.

Introduction: Among the several chemicals recently developed and utilised as possessing herbicidal properties for controlling perennial grasses, dalapon is a promising recent addition to the family of chloro-sbstituted alkane carboxilic acids. Dalapon, 2, 2-dichloro-propionic acid, exhibits a systemic type of action and is actively absorbed and translocated through the living grass foliage. The object of the present study was to determine the effectiveness of dalapon on *Cynodon dactylon* Pers. *(hariyali)* as influenced by gibberellic acid, surfactants and nitrogen fertilisation.

Review of Literature: Following the discovery of its herbicidal properties in 1951, dalapon has become the outstanding herbicide for controlling perennial grassess such as *hariyali*, Johnsongrass *(Sorghum halepense)* and quackgrass *(Agropyron repens)*. Wormley (1954) classified dalapon as a partner to 2, 4-D (2, 4-Dichlorophenoxyacetic acid). Using five different chemicals in different combinations in sugarcane fields, Stamper (1957) indicated that 3, 4 and 6 pounds acid equivalent of dalapon per acre was effective in controlling Johnsongrass. Watson (1955) demonstrated that a total of three applications of dalapon resulted in 95% to 98% control of established Johnsongrass in cotton. Hauser and Thompson (1956) found that two repeated applications of dalapon, at the rate of 5 pounds per acre each, appeared more effective in controlling Johnsongrass than a single application of 10, 15 or 20 pounds per acre. Likewise several studies have shown that multiple applications are more effective than a single application of the same total amount of the chemical (Foy and Miller, 1955a; Hauser and Thompson, 1958; Santelmann and Meade, 1958).

Westmoreland (1959) reviewed the literature regarding the use of dalapon on *hariyali* and Johnsongrass. Searcy (1957) reported that a rate of 10 to 15 pounds per acre in 50 gallons of water gave good control of *hariyali*. Hanson (1956) obtained complete kill of *hariyali* in sugarcane fields in Hawaii through four applications of dalapon at 2½ pounds per acre each or two applications of 5 pounds.

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[1] Assistant Lecturer in Agronomy, Agricultural College and Research Institute, Coimbatore-3.

Studying the effects of the chemical on annual grasses, research personnel in Arizona, California, Missouri and Missisipi reported in 1953 that directed basal sprays were effective in killing or severely stunting annual grass species (Dow Chemical Co. Bulletin 2). The control of annual grasses in cotton was obtained in California by Swezey and Fisher (1955). Danielson *et al.* (1955) observed that a minimum of 4 pounds was necessary as a pre-emergence treatment to control annual grasses in a sandy clay loam soil. The effect of dalapon on nutgrass *(Cyperus rotundus)* was studied by Stamper and Melville (1955). They concluded that dalapon at 12 and 24 pounds per acre gave much faster kill of nutgrass than amitrole or a combination of the two herbicides.

Factors influencing dalapon activity were studied by some workers. Swezy (1954) and Foy and Miller (1956) reported that poor soil moisture conditions, insufficient vegetative growth and disking tend to reduce the effectiveness of dalapon on Johnsongrass. Deep ploughing and mowing, under some conditions, have increased the effectiveness (Watson, 1954; Foy and Miller, 1955a; Borrows, 1957; Buchholtz and Peterson, 1957; Santelmann and Meade, 1958). Some workers (Buchholtz and Peterson, 1957) advocated nitrogen fertilisation to promote rapid development of shoots prior to treatment with dalapon and found that control of grasses on fertilised areas was frequently better than on unfertilised areas. The influence of weather conditions such as temperature, relative humidity, wind and rainfall on the effectiveness of herbicides was a matter of common observation in the field; however, the individual factors have received very little critical study (Standifer and Ennis, 1956; Hanson, 1956).

Hauser (1959), using 10, 100 and 1,000 ppm. of gibberellic acid, found that high concentrations stimulated elongation of nutgrass. The same author also studied the interaction of dalapon and gibberellic acid. Similarly Rao (1962) studied the effect of gibberellic acid and dalapon on *hariyali*. His results indicated that applications at concentrations of 50 and 100 ppm. caused lengthening of the internodes and the herbicidal action of dalapon was most rapid on grass which had received 50 ppm. gibberellic acid.

Surfactants usually enhance foliar penetration of herbicides. A comprehensive review by Currier and Dybing (1959) discussed literature regarding the usefulness of spray additives in increasing the effectiveness of a number of herbicides. Foy (1958), using both C^{14} and Cl^{36} labelled dalapon, demonstrated the advantages of using wetting agents along with dalapon. Recently Leasure (1961) has conducted a study to determine the effect of surfactants on the translocation of sodium dalapon into the rhizomes of quackgrass. Sixty-three surfactants of different classes were evaluated by Jensen *et al.* (1961) for effects on the herbicidal activity of water-soluable forms of dalapon, 2, 4–D, ametrole, *etc.* on soyabeans and maize. Their findings indicated that progressive enhancement of herbicidal activity was obtained with an increase in surfactant concentrations. Polymerised salts of alkylaryl sulfonic acids, however, brought about progressive suppression of the herbicidal activity and still others were ineffective in changing the level of activity attributable to the herbicide alone.

Materials and Methods: This experiment was carried out in the greenhouse at the Tennessee Agricultural Experiment Station, Knoxville, Tennessee, U. S. A., during the spring and summer of 1961. At the time of initiation of experiment, outdoor temperatures were too low for the growth of *hariyali*. The effects of gibberellic acid, nitrogen and surfactants on the phytotoxicity of dalapon on *hariyali* were studied. The treatments were outlined in table 1. Each of the 28 treatments was replicated three times.

Two-inch plugs of common *hariyali* were planted into one-gallon cans each containing about 4 kg. of a Morrell Fine Sandy Loam in a polyethylene bag. Pots were watered whenever necessary to maintain optimum soil moisture. After the plants were 12 inches tall, 84 pots with uniform plants were selected for the experiment and half of these received an application of ammonium nitrate at the rate of 400 pounds of nitrogen per acre or 2.7 grams of fertiliser per pot.

Application of an emulsion of the potassium salt of gibberellic acid was begun one week after the fertiliser application. Two different concentrations of gibberellic acid, 50 ppm. and 100 ppm., were applied to the plants at three different times, 3 weeks before, 2 weeks before and 1 week before the plants were treated with dalapon. In addition, an untreated check without gibberellic acid was also used. Finally the influence of surfactants on the behaviour of the herbicide was also studied by treating the plants with dalapon, with and without an adjuvant. A surfactant containing alkylarylpolyoxyethylene glycols-free fatty acids-isopropanol was mixed with dalpon at one part per 100 parts of solution by volume. Application of the herbicide was made at the rate of one part of acid equivalent of dalapon dissolved in 125 parts of demineralised water by weight. Those pots which were to receive dalapon without surfactant were treated first, then the adjuvant was mixed thoroughly with the herbicide solution before treating the remaining pots.

Since this was an exploratory study, the heavy rate of nitrogen was applied to induce profuse vegetative growth and determine whether or not this would influence the susceptibility of the grass to dalapon.

Both the gibberelllic acid and dalapon were applied as foliar application. This was done by dipping the aerial portion of the grass in the respective chemical solutions for 30 seconds. All the leaves were completely immersed to give a uniform application. Because of the small size of the pots it would have been difficult to give an equal treatment to all plants by spraying. Observations were made periodically on the general symptoms after the application of dalapon. Weights of the air-dry, dead foliage were recorded 8 weeks after herbicide treatment.

Results and Discussion: The response of *hariyali* to gibberellic acid was visible within two days after application. Gibberellic acid at both concentrations stimulated elongation of stem internodes of the grass. Although gibberellic acid at 50 ppm. appeared to stimulate more growth than at 100 ppm. the difference was not marked. All the plants treated with gibberellic acid were charecterised by faster growth. During the three week period after application the growth of the foliage was accelerated. The new growth promoted by gibberellic acic was pale green, particularly in plants not receiving nitrogen.

The effect of nitrogen fertilisation was seen one week after treatment. All the fertilised plants produced profuse vegetative growth. The combined effect of nitrogen and gibberellic acid on foliage growth was much greater than that of gibberellic acid alone and slightly greater than that of nitrogen alone. The amount of foliage produced by these plants was triple that of the untreated plants. The weights of the *hariyali* grass, taken 8 weeks after treatment with dalapon, are shown in table 1. The mean weight of the air-dry foliage which did not receive nitrogen was only 1·9 grams whereas the weight of the nitrogen-treated foliage was 7·18 grams.

TABLE 1

Nitrogen fertilisation, rate and time of gibberellic acid application and use of surfactant prior to application of dalapon to *hariyali*; also shown is the weight of air-dry foliage in each treatment 8 weeks after herbicide application (average of 3 pots).

Treatment No.	Nitrogen fertilisation per acre	Surfactant applied or not	Gibberellic acid concentration	Time prior to dalapon	Weight of air-dry foliage
	pounds		ppm.	weeks	gms.
1	0	no	0	—	2·14
2	0	no	50	1	1·47
3	0	no	100	1	1·33
4	0	no	50	2	1·87
5	0	no	100	2	1·47
6	0	no	50	3	1·53
7	0	no	100	3	1·73
8	0	yes	0	—	1·93
9	0	yes	50	1	1·80
10	0	yes	100	1	1·87
11	0	yes	50	2	2·60
12	0	yes	100	2	2·27
13	0	yes	50	3	2·40
14	0	yes	100	3	2·20
15	400	no	0	—	10·40
16	400	no	50	1	4·60
17	400	no	100	1	5·33
18	400	no	50	2	5·47
19	400	no	100	2	4·47
20	400	no	50	3	6·73
21	400	no	100	3	6·83
22	400	yes	0	—	9·47
23	400	yes	50	1	7·20
24	400	yes	100	1	3·73
25	400	yes	50	2	8·13
26	400	yes	100	2	8·40
27	400	yes	50	3	10·73
28	400	yes	100	3	9·07

Hariyali was growing rapidly when application of dalapon was made. Dalapon caused some visible injury to the plants at varying degrees by the third week after application. All the dalapon-treated plants started showing signs of injury in the terminal leaves. For the first four weeks the action of dalapon was slow and no appreciable differences in injury was indicated between treatments. During the fifth week the toxic action of dalapon was rapid on all the nitrogen-treated plants resulting in death of the entire plant at the end of 6 weeks. On the other hand only a few leaves of the unfertilised plants were affected. This clearly shows the influence of nitrogen in increasing the effectiveness of dalapon on *hariyali*. Nitrogen produces more vegetative growth. The cells elongate resulting in thinner leaves and longer stem. This aids the penetration of dalapon into the grass foliage leading to more rapid absorption and translocation of the herbicide. In addition there was more surface area for absorption. Nitrogen had more pronounced effect on the action of dalapon then gibberellic acid though the latter also possesses stem-lengthening properties. No difference was observed in the response of the plants to dalapon between the two concentrations of gibberellic acid, 50 ppm. and 100 ppm., either among the unfertilised plants or among the nitrogen-treated plants. Also, the surfactants used in the study did not appear to influence the effectiveness of dalapon during the period of observation.

Observations also indicated that although all the nitrogen-treated plants were necrotic by the sixth week, plants treated with nitrogen as well as gibberellic acid, applied 2 weeks and 3 weeks before dalapon, died first. Plants receiving nitrogen alone and those with both nitrogen and gibberellic acid, applied one week prior to dalapon, were less responsive. Death did not occur during the fifth week under these two treatments nitrogen with gibberellic acid applied one week before dalapon and nitrogen alone. The remaining nitrogen-treated plants were necrotic at that time.

Observations made during the seventh week on the unfertilised plants did not indicate any apparent difference in injury due to gibberellic acid. Dalapon was equally toxic to all the plants and death was slow. Even at the end of seven weeks only 60% of the foliage was dead. This indicates that, under the conditions of the experiment, gibberellic acid did not promote the phytotoxicity of dalapon on *hariyali* if the plants were not treated with nitrogen. In most of the plants not receiving nitrogen regrowth appeared at the base, whereas none of the nitrogen-treated plants showed any sign of new growth.

These findings suggest that, for hastening the phytotoxicity of dalapon on *hariyali* (1) liberal fertilisation with nitrogen is necessary to stimulate vegetative growth and to increase the susceptibility of the plants, (2) nitrogen in combination with gibberellic acid is better than nitrogen alone and (3) the best time to apply gibberellic acid to nitrogen-treated plants is 2 or 3 weeks prior to dalapon application.

Summary and Conclusion: An investigation was carried out to determine the effects of nitrogen fertilisation, gibberellic acid and surfactants on the toxic action of dalapon on *Cynodon dactylon (hariyali)*. Gibberellic acid at

concentrations of 50 ppm. and 100 ppm. stimulated growth and the heavy fertilisation with 400 pounds of nitrogen per acre resulted in profuse vegetative growth of the grass.

The results of the experiment indicated that at the end of 6 weeks after treatment with dalapon, complete necrosis was recorded on all nitrogen-treated plants. Neither the two concentrations of gibberellic acid nor the time of application had any influence on dalapon activity in plants not receiving nitrogen. Observations also showed that nitrogen fertilisation in combination with gibberellic acid (50 ppm. or 100 ppm.), applied either 2 weeks or 3 weeks before treatment with dalapon, caused greater susceptibility of the plants than nitrogen alone. The effectiveness of dalapon was not increased by the surfactant added.

In conclusion, this study indicated that nitrogen is the most important factor studied influencing the action of dalapon on *hariyali*. Since nitrogen is less expensive then gibberellic acid, the merit of this finding has a practical approach in achieving more effective control of the weed with dalapon.

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REFERENCES

Barrows, K. C. 1957 Fall application of dowpon for quaekgrass control. *Down to Earth.* **13**: (2): 12-3.

Buchholtz, K. P. and D. R. Peterson 1957 Control of quackgrass with dalapon. *Ibid.*, **12**: 4-5.

Currier, H. B. and C. D. Dybing 1959 Foliar penetration of herbicides review and present status. *Weeds.* **7**: 195-213.

Danielson, L.L., H. Maxine and H. Schumacher 1955 Experimental use of dalapon and nitrin on certain transplanted vegetable crops. *Proc. Northeastern Weed Control Conf.* **9**: 97-103.

Dow Chemical Company Bulletin 1953 Dalapon 2.

Foy, C. L. 1958 Studies on the absorption, distribution and metabolism of 2, 2-dichloropropionic acid in relation to phytotoxicity. *Doctoral dissertation: Univ. of Calif.*

—— and J. H. Miller 1955 The response of cotton to directed sprays of dalapon. *Proc. Southern Weed Conf.* **8**: 87-91.

—— 1956 Chemical control of Johnsongrass. *Ibid.*, **9**: 197-203.

Hanson, N. S. 1956 Dalapon for control of grasses in Hawaiian sugar, cane lands. *Down to Earth* **12**: (2): 2-3.

Hauser, E. W. 1959 Some responses to nutgrass to potasium salt of gibberellic acid. *Proc. Southern Weed Conf.* **12**: 196.

——— and J. T. Thompson	1956	Progress report on the control of established Johnsongrass with chemicals and crops. *Ibid.*, **9**: 199–96.
Hauser, E. W. and J. T. Thompson	1958	A study of the absorption and translocation of several chemicals in Johnsongrass and an evaluation of their effectiveness for its control under field conditions. *Weed. Soc. Amer.* (Abstracts) p. 36.
Jansen, L. L., W. A. Gentner and W. C. Shaw	1961	Effects of surfactants on herbicidal activity of several herbicides in aqueous spray solution. *Weeds.* **9**: 381–405.
Leasure, J. K.	1961	Some techniques and results on quackgrass with labelled dalapon with and without wetting agent. *Down to Earth.* **16**: (4): 20–24.
Marth, P. C., W. W. Audia and J. W. Mitchell	1956a	Effect of gibberellic acid on growth and development of various species of plants. *Plant. Physio. Suppl.* **31**: XLIII.
Rao, J. S.	1962	A study of the effect of gibberellic acid on the phytoxicity of dalapon on Bermudagrass. *Madras agric. J.*, **49**: 209–21.
Santelmann, P. H. and J. A. Meade	1958	Johnsongrass control with Dowpon in Maryland. *Down to Earth*, **13**: (4): 10–11.
Searcy, V. S.	1957	Chemical control of Johnsongrass and Bermudagrass now a fact. *Highlights of Agrl. Res.*, **4**: 1–4.
Stamper, E. R.	1957	The effect of chemical combinations as herbicides on Johnsongrass control in Louisinna sugarcane. *Proc. Southern Weed Conf.* **'10**: 40–46.
——— and A. Melville	1955	Studies on the contral of nutgrass. *Ibid.*, **9**: 220-9.
Standifer, L. C. and W. B. Ennis, Jr.	1956	Development studies on sodium 2, 2-dichloropropionate as herbicide for Johnsongrass. *Ibid.*, **9**: 183-9.
Swezy, A. W.	1954	Dalapon—a new grass killer. *Proc. Calif. Weed Conf.* **'6**: 15–20.
——— and J. R. Fisher	1955	The control of annual grasses in California cotton with dalapon. *Down to Earth.* **11** (1): 2-5.
Watson, A. J.	1954	Johnsongrass control with dalapon in the Mississippi Delta. *Ibid.*, **10** (3): 12-3.
———	1955	Controlling established Johnson-grass in cotton with spot treatment with dalapon. *Ibid.* **'11** (3): 2-3.
Westermoreland, N. G.	1959	The North Carolina demonstrations program with dalapon. *Proc. Southern Weed Conf.* **'12**: 164-66.
Wormley, G. W.	1954	Dalapon: Partner for 2, 4-D? *Farm Journal.* **78**: 34.