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EFFECT OF 2,4-D ON SURVIVAL AND DRY MATTER YIELD OF SEEDLINGS OF STYLOSANTHES SPECIES

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SUMMARY

The seedling response of 11 lines of six *Stylosanthes* species to four rates of 2,4-D (nil, 0·37, 0·75, 1·50 kg a.e. ha^{-1}) was examined in a factorial pot trial. Nine lines showed significant dry matter yield reductions at 0·75 kg a.e. ha^{-1} but there were no further significant reductions in yield at 1·50 kg a.e. ha^{-1}. Yield reductions for *S. guianensis* cv. Schofield were higher than previously reported for a similar line in pot and field trials. Survival was greater than 75% in all lines except *S. scabra* C.P.I. 34925 at the 1·50 kg a.e. ha^{-1} rate, even though dry weight per plant was reduced by 70%.

I. INTRODUCTION

Since seedlings of a line of *Stylosanthes guianensis* similar to cv. Schofield were found to be resistant to 2,4-D (2,4-dichlorophenoxy acetic acid) (Bailey 1964a,b) this herbicide has been widely used in *Stylosanthes* spp. seed crops to minimize weed problems. Seedlings with two trifoliate leaves were resistant to 0·27 kg a.e. ha^{-1}, while those at the 17 to 23 leaf stage were resistant to 1·1 kg a.e. ha^{-1}. However, at 1·7 kg a.e. ha^{-1}, a yield reduction of 30% could be expected (Bailey 1969a). Current commercial application rates are up to 1 kg a.e. ha^{-1} on seedlings, and much higher on established stands.

The use of this herbicide required re-examination for two reasons. Firstly, the trend towards using old cultivation for seed production necessitates weed control earlier than the 17 to 23 leaf stage as some fast growing weeds rapidly lose their susceptibility to 2,4-D with age (Bailey 1969b). Secondly, unreleased lines of *Stylosanthes* have shown variable tolerance to 2,4-D, between species and within *S. guianensis* lines (C. P. Miller personal communication).

The aim of this study was to determine the response of seedlings of 11 *Stylosanthes* lines to 2,4-D in terms of dry matter yield and survival.

II. MATERIALS AND METHODS

The study was carried out in 22-cm pots containing 10 kg of infertile loamy sand to which 600 kg ha^{-1} of superphosphate, 100 kg ha^{-1} of urea and 50 kg ha^{-1} of 'Aquasol' (a complete fertilizer containing nitrogen, phosphorus, potassium and all trace elements) were added 14 days before planting. Eleven lines of *Stylosanthes* (table 1) and four rates of 2,4-D (nil, 0·37, 0·75 and 1·50 kg a.e. ha^{-1}) were combined in a complete factorial design with three replications laid out in randomized blocks. The 2,4-D used was a commercial preparation containing 500 g l^{-1} 2,4-D as the dimethylamine salt in aqueous solution, with 0·5% 'Agral 60' wetting agent added to improve the leaf wetting on those lines with viscid leaves.

For each line, 40 mechanically scarified seeds were planted in each pre-watered pot on 17 August 1974. The pots were covered with plastic sheets and warmed to approximately 35°C, to simulate the hot, humid conditions of summer. After 2 days the plastic sheets were removed, and the pots moved to an open shadehouse at Walkamin Research Station, north Queensland. Despite satisfactory germination rates in the laboratory, establishment in the pots was poor and variable. Twenty days after planting, seedlings were thinned to a constant number for each line (varying from 2 to 8, table 1).

TABLE 1

Species and Accessions Used, Plants per Pot, Mean Leaf Number per Plant at Spraying and Mean Survival at Harvest Expressed as a Percentage of Plants at Spraying

	Plants pot^{-1}	Leaf No.	Survival at Harvest (%)			
			0 kg ha^{-1}	0·37 kg ha^{-1}	0·75 kg ha^{-1}	1·50 kg ha^{-1}
S. guianensis cv. Cook ..	3	10·8 (0·8)*	100	89	100	78
S. guianensis cv. Endeavour	5	7·4 (0·6)	100	100	87	100
S. guianensis cv. Schofield	3	9·2 (0·5)	100	100	100	100
S. guianensis C.P.I. 34000	5	7·4 (0·5)	100	93	87	87
S. scabra C.P.I. 34925 ..	2	4·6 (0·4)	83	67	100	50
S. scabra C.P.I. 40205 ..	8	6·1 (0·2)	100	100	92	79
S. scabra cv. Seca ..	3	5·2 (0·4)	100	100	100	78
S. fruticosa C.P.I. 34119A	3	4·3 (0·2)	100	88	100	83
S. viscosa C.P.I. 34904	7	7·9 (0·4)	100	95	90	86
S. humilis Townsville stylo	8	14·8 (1·4)	100	100	92	83
S. hamata cv. Verano ..	8	9·5 (0·8)	96	100	96	92

* Figures in parentheses are the standard errors of leaf numbers.

On 4 October 1974 (48 days after planting), the mean trifoliate leaf number of 20 plants of each line was determined (table 1). Three randomly selected pots of each line were placed together with all other pots receiving the same application rate, and the herbicide was applied in one passage of an Oxford Precision Sprayer at 225 *l* ha^{-1}.

Pots were returned to the shadehouse after spraying, and arranged in three randomized blocks. Pots were re-randomized weekly for position within each block.

Four weeks after spraying, surviving plants were counted, and all above ground material was harvested (dead plants were not harvested). This material was dried at 80° for 24 h, and weighed.

III. RESULTS

Initially, 2,4-D caused wilting, with the degree of wilting varying between lines and increasing with heavier application rates. The most severe wilting was in *S. humilis, S. viscosa* and the *S. guianensis* lines, with Endeavour being least affected in the latter group. All *S. scabra* lines wilted at 0·75 and 1·50 kg a.e. ha^{-1} rates, while Verano was slightly wilted. Although recovery was slowest in the most severely wilted plants, all surviving plants were turgid after 1 week. Plants which did not recover from initial wilting died within 14 days.

S. humilis, Verano and *S. scabra* C.P.I. 40205 were the only lines to flower before harvesting. In all cases, emergence of the first flower was delayed by 2 to 3 days at the 0·37 kg a.e. ha^{-1} rate and by up to 7 days at the 1·50 kg a.e. ha^{-1} rate.

Dry weight per pot was analysed as a full factorial and gave a significant application rate by line interaction. Thus each line has to be considered separately (table 2).

TABLE 2

MEAN DRY MATTER YIELDS (G POT^{-1}), FOUR WEEKS AFTER SPRAYING

	0 kg ha^{-1}	0·37 kg ha^{-1}	0·75 kg ha^{-1}	1·50 kg ha^{-1}
S. guianensis cv. Cook	5·11 a*	2·17 b	1·57 bc	1·08 c
S. guianensis cv. Endeavour ..	3·27 a	1·80 b	1·14 b	1·14 b
S. guianensis cv. Schofield ..	4·07 a	2·47 b	0·93 c	0·94 c
S. guianensis C.P.I. 34000 ..	4·19 a	1·64 b	1·03 b	1·15 b
S. scabra C.P.I. 34925	0·56 a	0·20 a	0·46 a	0·10 a
S. scabra C.P.I. 40205	3·42 a	2·49 ab	1·61 bc	0·86 c
S. scabra cv. Seca	1·63 a	0·88 ab	0·39 b	0·35 b
S. fruticosa C.P.I. 34119 A ..	0·46 a	0·42 a	0·55 a	0·21 a
S. viscosa C.P.I. 34904	2·42 a	1·57 ab	0·93 b	0·66 b
S. humilis Townsville stylo ..	5·29 a	2·82 b	1·96 bc	1·55 c
S. hamata cv. Verano	3·31 a	2·22 b	1·43 b	1·32 b

* Values in the same line with different postscripts are significantly different, $P < 0·05$

All lines, except *S. fruticosa* and *S. scabra* C.P.I. 34925 showed significant reductions in dry matter per pot at 0·75 kg a.e. ha^{-1}; however, there were no further significant reductions at the 1·50 kg a.e. ha^{-1} rate. The yields of *S. fruticosa* and *S. scabra* C.P.I. 34925 were not affected at any rate of 2,4-D. Plant numbers were very low in these lines and individual plant variability was high, rendering the results for these two lines doubtful.

In Endeavour, *S. guianensis* C.P.I. 34000, Seca, *S. viscosa* and Verano there were no significant differences between the 0·37, 0·75 and 1·50 kg a.e. ha^{-1} rates. Lines with the greatest reduction in dry matter yield were those that had the highest degree of wilting.

The percentage survival figures could not be statistically analysed (table 1), but they are useful in interpretation. Schofield was the only line with 100% survival in all treatments. Survival was greater than 75% in all lines except *S. scabra* C.P.I. 34925, even though pot dry weights were reduced to approximately 30% of control at the 1·50 kg a.e. ha^{-1} rate.

IV. DISCUSSION

During the 1960s, many legumes were screened for their susceptibility to 2,4-D (Bailey 1964a,b, 1965, 1967a,b, 1969a). A line of *S. guianensis* similar to the present cv. Schofield was one of these. Field studies led to the conclusion that *S. guianensis* was a very tolerant species if sprayed at 7 weeks of age (Bailey 1965).

The data from this pot experiment indicate that this is not the case for all *S. guianensis* lines, as growth retardation was marked even at 0·37 kg a.e. ha^{-1} (table 3). For Schofield, yield reductions were observed at rates that Bailey indicated did not retard growth of *S. guianensis*. The 77% reduction in plant dry matter (1 month after spraying) at the 1·50 kg a.e. ha^{-1} rate is much higher than the 30% reduction expected at 1·7 kg a.e. ha^{-1} (2 to 4 months after spraying) (Bailey 1969a).

TABLE 3

MEAN DRY MATTER YIELDS PER PLANT PER EXPRESSED AS A PERCENTAGE OF THE CONTROL

	0 kg ha^{-1}	0·37 kg ha^{-1}	0·75 kg ha^{-1}	1·50 kg ha^{-1}
S. guianensis cv. Cook	100	46	31	28
S. guianensis cv. Endeavour ..	100	55	38	35
S. guianensis cv. Schofield ..	100	61	23	23
S. guianensis C.P.I. 34000 ..	100	40	31	33
S. scabra C.P.I. 34925	100	53	72	19
S. scabra C.P.I. 40205	100	72	51	30
S. scabra cv. Seca	100	54	24	26
S. fruticosa C.P.I. 34119 A ..	100	117	117	50
S. viscosa C.P.I. 34904	100	69	40	31
S. humilis Townsville stylo ..	100	55	39	35
S. hamata cv. Verano	100	64	43	41

Another point of difference is that in the present study there was a significant yield difference between the 0·37 and 0·75 kg a.e. ha^{-1} rates whereas Bailey (1965) records no difference in a field trial between yields for plots sprayed with 0·28, 0·56 and 1·12 kg a.e. ha^{-1} of 2,4-D.

The different developmental stages at spraying, the different periods from spraying to harvest, the different seasons under which the experiments were conducted and the fact that most of Bailey's results were obtained from field trials compared with the present pot study could have contributed to the disparity between these results. This illustrates that care must be taken when extrapolating results to different lines of the same species, let alone different species.

Spraying a pasture of *S. guianensis-Panicum maximum* at 7 weeks of age gave no significant increase in *S. guianensis* yields over untreated control even though the number of weeds was reduced by more than 70% (Bailey 1965). However, in two of the three application rates, grass yield was significantly increased. The legume therefore made up a smaller proportion of total yield at these rates, even though yields were not affected. With the marked yield reductions reported here, spraying a mixed pasture early in the legume's development could lead to grass-dominant pasture. Generally, this is undesirable and illustrates the potential problems of spraying at an early growth stage.

Despite the plant yield reductions observed at high application rates (table 3), survival was high in all lines except *S. scabra* C.P.I. 34925. A previous pot trial (Gilbert, unpublished data) showed no mortality of Endeavour and Verano when sprayed 30 days after germination with up to 1·7 kg a.e. ha^{-1}. *S. viscosa* C.P.I. 34904 and *S. subsericea* C.P.I. 38605 showed 34% and 14% survival, respectively, at the 1·7 kg a.e. ha^{-1} rate. The results for Endeavour and Verano are similar to those found here, while the other species show that some lines are more susceptible than those tested in this experiment.

For the lines tested here, rates up to 1·5 kg a.e. ha^{-1} could be used without serious losses due to plant death.

Seed production studies are now required to determine the effect on seed yield of initial dry matter reduction, and the interference with emergence of first flowers (and possibly floral initiation) caused by 2,4-D. The delay in emergence of first flowers may be important in those areas where moisture stress can occur during seed formation as it may lengthen the period from planting to harvest, exposing the crop to a greater chance of poor seed set.

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