COLD TOLERANCE OF *STYLOSANTHES* SPECIES

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ABSTRACT

Collections of the genus Stylosanthes *were rated for tolerance to the freeze of January 1977 when temperatures reached a low of –6° at Fort Pierce in Florida. Cold tolerance here refers to the recovery of plants after all shoots were killed by frost.* Stylosanthes *hybrids and early flowering, low seed producing accessions of* S. guianensis *were highly frost tolerant. An accession of* S. erecta *from Ivory Coast regenerated from roots and a* S. macrocarpa *accession from Mexico regenerated from crown and roots after this freeze.* S. montevidensis *was also tolerant to frost.*

INTRODUCTION

Tropical legumes can be successfully grown for forage or pasture use in South Florida (Kretschmer *et al.* 1976). Growth of *Stylosanthes* spp. is usually slow during the winter and frost damage sometimes occurs. *Stylosanthes* spp. show a differential response to freezing temperatures. Earlier studies revealed that a *S. scabra* accession grown in the field at ARC Fort Pierce was more tolerant to light radiation frosts (0 to –2° C) than other accessions tested (J. B. Brolmann, unpublished data). However, when air temperatures dropped well below –2° C as a result of more severe radiation frost or moving cold fronts, shoots of all *Stylosanthes* were killed. In Australia survival of several *Stylosanthes* species has been reported after severe frost (Edye *et al.* 1976a). *S. scabra* survived significantly better than any other accession tested there. In other experiments in Australia, almost all *Stylosanthes* accessions were damaged by frost, but not killed, after 14 frosts with a minimum ground temperature of –3° C (Edye *et al.* 1976b). *S. guianensis* cv. Oxley and a *S. guianensis* introduction from Argentina showed some frost resistance.

When all top growth is killed by frost, the survival of *Stylosanthes* spp. depends on their ability to regenerate from subterranean parts and/or from seeds. The purpose of this study was to determine the effect of frost on the survival of *Stylosanthes* spp. plants and to select for frost tolerance.

MATERIALS AND METHODS

Experiment 1

In 1972, fifty *Stylosanthes* accessions which included several species (*S. erecta, S. scabra, S. guianensis, S. hamata* and *S. fruticosa*) were planted in combination with Pangola (*Digitaria decumbens*) in a 2.5 ha field of sandy soil at the Agricultural Research Centre (ARC), Fort Pierce, Florida. The plants were 1.5 m apart within rows and 1.8 m between rows. There were 24 replications of two plants of the same accession. The plants were harvested twice the first year, mowed in the fall of the following year, and allowed to regenerate freely. Natural crosses in the field produced a diverse population of persistent *Stylosanthes* types. In the spring of 1975 and 1976, 59 vigorous plants of *S. guianensis, S. scabra* and *Stylosanthes* hybrids with unknown parentage were isolated from this population and cuttings propagated in the greenhouse. These clones were planted in the spring of 1975 and 1976 in an experiment with 3 replications of 5 plants each for the 1975 clonal selections and 4 replications of 3 plants each for the 1976 clonal selections. The plants were spaced 1 m within rows and 1.8 m between rows. They were clipped at 7 cm once a year in the summer. Data

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were obtained on tolerance to cold after the severe freeze of January 1977 when several cold fronts moved in and air temperatures recorded at 150 cm reached −6° C. Six nights of frost were recorded.

Experiment 2

Some recent *Stylosanthes* introductions (*S. macrocarpa, S. viscosa, S. montevidensis* and *S. erecta*) were planted for seed-increase and further observation only in 1976. Seeds were germinated in petri dishes, plants transplanted to peat pots and later planted in the field in the spring of 1976. The number of plants of each accession varied with the number of seeds available from 4–120. There were no replications. Only the tops were cut for seed harvest and no clipping at low level occurred. Percentage of plants which survived cold were recorded and regrowth characteristics noted.

RESULTS

Experiment 1

Among the 1975 *Stylosanthes* accessions, the most cold tolerant ones were the *Stylosanthes* hybrids with 67–100% survival (Table 1). Survival of *S. scabra* and *S. guianensis* accessions varied greatly from 0–100%.

TABLE 1

Survival percent after frost in the 1975 Stylosanthes *accessions.*

Accession number‡	Species*	% Survival April 1977
7522	Hy	92 (80)†
7524	Hy	92 (80)
7525	Hy	100 (90)
7527	Hy	67 (60)
7528	Hy	83 (75)
7532	Hy	100 (90)
7535	Hy	100 (90)
7537	Hy	100 (90)
7541	Hy	100 (90)
7526	G	58 (55)
7543	G	0 (0)
7546	G	100 (90)
7553	G	0 (0)
7554	G	25 (25)
7544	G	0 (0)
7550	G	0 (0)
7555	G	100 (90)
7521	Sc	100 (90)
7523	Sc	0 (0)
7529	Sc	0 (0)
7531	Sc	17 (15)
7534	Sc	75 (70)
7536	Sc	17 (15)
7538	Sc	100 (90)
7539	Sc	100 (90)
7540	Sc	0 (0)
7545	Sc	83 (75)
7547	Sc	50 (40)
7548	Sc	17 (15)
7549	Sc	0 (0)
7551	Sc	67 (60)
7552	Sc	25 (20)
L.S.D. (P=0.05)		(34)
L.S.D. (P=0.01)		(45)

*Hy — *S.* hybrid
G — *S. guianensis*
Sc — *S. scabra*

†( ) Arcsin transformation
‡ Indian River Field Laboratory (IRFL) number

Of the *Stylosanthes* selected in 1976, the *Stylosanthes* hybrids again had the greatest number of plants that survived (58–100%) (Table 2). Five of nine *S. scabra* accessions were killed by frost. The early flowering, low seed producing accessions of *S. guianensis* (7623, 7624, 7637) regenerated after frost, whereas the late flowering, high seed producing accessions (7627, 7629, 7630) had little or no cold tolerance (0–8% survival).

TABLE 2

Survival percent after frost in the 1976 Stylosanthes *accessions.*

Accession Number‡	Species*	% Survival April 1977	Accession number	Species*	% Survival April 1977
7601	Hy	75 (63)†	7612	G	83 (76)
7602	Hy	83 (72)	7622	G	100 (90)
7604	Hy	83 (72)	7623	G	100 (90)
7605	Hy	92 (81)	7625	G	92 (81)
7606	Hy	83 (72)	7627	G	0 (0)
7607	Hy	67 (59)	7629	G	8 (9)
7608	Hy	96 (81)	7630	G	8 (9)
7609	Hy	100 (90)	7635	G	67 (63)
7610	Hy	83 (72)	7637	G	100 (90)
7611	Hy	100 (90)	7639	G	75 (67)
7614	Hy	75 (68)	7640	G	75 (67)
7617	Hy	58 (54)	7645	G	100 (90)
7618	Hy	58 (50)	7653	G	0 (0)
7619	Hy	75 (63)	7654	G	0 (0)
7620	Hy	83 (72)	7658	G	100 (90)
7624	Hy	83 (72)	7659	G	96 (81)
7626	Hy	100 (90)	7603	Sc	0 (0)
7631	Hy	92 (81)	7613	Sc	0 (0)
7634	Hy	67 (59)	7615	Sc	0 (0)
7636	Hy	75 (68)	7621	Sc	25 (23)
7641	Hy	58 (50)	7632	Sc	33 (31)
7642	Hy	92 (81)	7633	Sc	0 (0)
7643	Hy	75 (63)	7648	Sc	100 (90)
7644	Hy	100 (90)	7650	Sc	8 (9)
7646	Hy	75 (63)	7655	Sc	0 (0)
7649	Hy	58 (50)	7656	Sc	0 (0)
7657	Hy	66 (54)			
			L.S.D. (P=0.05)		(30)
			L.S.D. (P=0.01)		(41)

*Hy — *S.* hybrid
G — *S. guianensis*
Sc — *S. scabra*

†( ) Arcsin transformation
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Experiment 2

S. macrocarpa, an introduction from Mexico, was very tolerant to frost (Table 3). Even when shoots were completely killed, the plant regenerated from the root system 7 cm below the soil level.

All plants of *S. montevidensis* survived. This introduction from Paraguay regenerated from subterranean axillary buds. However, this accession is too stemy to be of any value as a forage plant.

The three *S. viscosa* accessions recovered moderately well after frost, whereas accessions of *S. subsericea* did not. The death of the *S. subsericea* cannot be attributed entirely to the effect of frost since accessions of this species often act as an annual in south Florida. All plants of the *S. erecta* accessions survived. Although its shoots were very susceptible to frost, the *S. erecta* plants regrew from roots about 8 cm below the soil surface. About two months elapsed before any of the plants recovered completely.

TABLE 3

Percentage survival in Stylosanthes *species after the* 1976-77 *winter in south Florida*

Accession number*	Plant introduction or identification number	Species	Country of origin	Latitude (degrees)	Altitude (metres)	No. of plants	Survival (%) 20/5/77
7061	CPI 33832	S. macrocarpa	Mexico	22 N	20	29	100
7046	401517	S. montevidensis	Paraguay	26 S	121	23	100
7052	401524	S. viscosa	Mexico	22 N	20	81	71
7058	CPI 40296	S. viscosa	Brazil	24 S	850	9	66
7059	CPI 50223	S. viscosa	Texas (USA)	27 N	50	4	100
7005	401522	S. subsericea	Mexico	—	—	63	0
7051	401523	S. subsericea	Honduras	14 N	1064	120	3
6940	358375	S. erecta	Ivory Coast	6 N	—	12	100
7062	Q 8361	S. fruticosa	Kenya	1 N	2134	7	0
7055	CPI 46584C	S. guianensis	Guatemala	15 N	1524	10	30

* Indian River Field Laboratory (IRFL) number.

DISCUSSION

The successful use of *Stylosanthes* spp. in Florida greatly depends on their tolerance to cold and frost. Although regeneration from roots as occurs in *S. erecta* and *S. macrocarpa* is of value for survival of the plants, this offers no direct solution towards filling the need for forage during the winter months in south Florida. None of the accessions or hybrids studied had green shoots after frosting. The recovery of *S. erecta* after frost is slow, while *Stylosanthes* hybrids show a fast recovery. The use of near-sterile hybrids however is currently impractical since they have to be propagated by cuttings. Since *S. erecta* and the *Stylosanthes* hybrids are tolerant of wet soils (Brolmann 1977b) breeding efforts will be made to increase fertility in the hybrids and to search for faster recovery in *S. erecta*.

The cold tolerance found in some of the early flowering and low seed-producing *S. guianensis* accessions is encouraging. Recent studies indicate that seed production can be increased, and this and other studies indicate that cold tolerance is maintained in the progeny of these accessions (J. B. Brolmann, unpublished data). *S. macrocarpa* and *S. montevidensis* also survived the 1976-77 winter at Gainesville (central Florida) where a total of 26 nights with frost were recorded (Brolmann 1977a). *S. scabra, S. hamata* and *S. guianensis* did not survive but early flowering and heavy seed producing lines of *Stylosanthes guianensis* and *S. hamata* have regenerated from seed in that part of the state.

Our findings suggest that the climate of origin determines in most cases the frost tolerance of the *Stylosanthes* species (Table 3). *S. montevidensis* from Paraguay (lat. 26° S) had excellent winter survival whereas *S. guianensis* from Guatemala (lat. 15° N) showed less winter survival. Edye *et al.* (1976b) showed that two accessions of *S. guianensis* from latitude 25° S and 31° S respectively had some frost tolerance, whereas all other accessions tested were frosted. The winter survival of *S. erecta*, a tropical species from Africa, is somewhat unexpected.

In future selecting for cold tolerance it may be desirable to introduce plant material from the higher altitudes and latitudes in the tropics or subtropics. The cold tolerance found in several *Stylosanthes* species and accessions suggest that *Stylosanthes* can be grown at higher latitudes (lat. 30° N) in Florida than generally realized.

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