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EMERGENCE OF BUFFEL GRASS (CENCHRUS CILIARIS) FROM SEED AFTER FLOODING

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SUMMARY

The emergence of seven buffel grass (*Cenchrus ciliaris*) cultivars after simulated flooding for 0, 10, 20, 30 and 40 days in pots was investigated. Seed of known germination was planted in an alluvial clay soil of medium to heavy texture and flooding imposed immediately. Seedling emergence did not occur until flooding ceased, and emergence took longer in flooded treatments than in the control. Flooding caused a marked reduction in seedling emergence. The ability of the buffel grass cultivars to emerge was in the following order: American and Boorara > Biloela, Nunbank and Tarewinnabar > Gayndah and Molopo. The last two cultivars failed or had negligible emergence in all flooding treatments.

I. INTRODUCTION

In Area III of the Brigalow Development Scheme of Central Queensland large areas of land receive irregular flooding. This area, and the flooding hazard, have been described by Anderson (1970*a*). When a pasture is damaged by flooding it is able to regenerate by regrowth from established plants and/or re-establish from seed. Buffel grass (*Cenchrus ciliaris*) is the most widely used species in the region. Anderson (1970*b*) has reported some data on the flooding tolerance of buffel grass plants but no data have been reported for the regeneration from seed after flooding.

Regeneration of temperate pastures has received some attention in Canada from Heinrichs and McKenzie (1947), McKenzie, Anderson and Heinrichs (1949) and McKenzie (1951), who were concerned with the aspect of the germination and emergence of pasture seeds following early spring flooding. They found that seedings would be successful when made in late fall just before freeze up, on land likely to be flooded for several weeks in spring. Grasses endured more flooding than legumes. The seeding rate could be increased to compensate for the loss of seed viability from flooding.

The study of regeneration of tropical grass pastures from seed after flooding has generally been neglected.

This paper reports the emergence of buffel grass seedlings following simulated summer flooding.

II. MATERIALS AND METHODS

The experiment was conducted in 6 in. polyester pots in an open-sided glasshouse at the Mackay Experimental Centre of the Queensland Department of Primary Industries. An alluvial grey-brown clay soil of medium to heavy texture, classified as Ug 5·2 (Northcote 1965), was used. It was collected from a brigalow (*Acacia harpophylla*)-coolibah (*Eucalyptus microtheca*) association which received periodic flooding. Chemical analysis showed a pH of 7·1 (soil:water::1:5), available P of 69 p.p.m. (B.S.E.S. method of Kerr and von Stieglitz 1938), and replaceable K of 1·25 m-equiv. % (determined with an EEL flame photometer after leaching with N/20 HCl). Soil was crushed and sieved of root debris prior to potting. An equal mass and volume was placed in each pot.

Treatments, arranged in a randomized block design with four replicates, were 7 buffel grass cultivars (American, Biloela, Boorara, Gayndah, Molopo, Nunbank and Tarewinnabar) by 5 flood durations (0, 10, 20, 30 and 40 days).

The number of viable seeds to be planted in each plot was intended to be 30 and the planting rate necessary was calculated from known germination percentages (laboratory tested Nov.-Dec. 1968). The numbers of seeds planted and their laboratory germination percentage are given in Table 1. At planting the seed was evenly spread over the soil surface, covered with half an inch of soil, then firmed by lightly tamping.

TABLE 1

GERMINATION PERCENTAGE OF SEED SAMPLES USED AND NUMBER OF SEEDS SOWN PER POT

Cultivar	Germination Percentage (Nov.–Dec. 1968)	No. of Seeds/Pot (Planted Feb. 1969)
American	45	67
Biloela	45	67
Boorara	4	750
Gayndah	14	214
Molopo	18	167
Nunbank	7	429
Tarewinnabar	29	103

Flooding was simulated by submerging the pots in plastic bags containing water. The bags were held upright by attachment to an overhead trellis. The water was maintained 12 in. above the soil level. All flooding treatments commenced on February 6, 1969. After the removal of the flood water each pot was maintained at approximately field capacity.

Emerged seedlings were counted and removed every fourth day. Counting continued for 40 days after the cessation of each flooding treatment except for the 40 day duration treatment, in which it ceased after 30 days when emergence had ceased.

The average temperatures for February and March were maximum 86·3°F and 82·9°F and minimum 74·9°F and 73·2°F, respectively.

III. RESULTS

Seedlings in the control pots began to emerge approximately 7 days after watering, while in all flooded treatments emergence of seedlings was not observed until 10 days after the removal of the water. Final emergences recorded have been expressed as the number of seedlings emerging as (a) the percentage of the number of seeds planted (Table 2) and (b) the percentage of the control (Table 3). An inverse sine transformation was used for statistical analysis.

TABLE 2

EFFECT OF FLOOD DURATION ON THE EMERGENCE OF BUFFEL GRASS CULTIVARS EXPRESSED AS A PERCENTAGE OF THE NUMBER OF SEEDS SOWN

Cultivar	Flood Duration (days)				
	0	10	20	30	40
American ..	73·45 (1·030)*	25·34 (0·527)	30·39 (0·584)	15·97 (0·411)	4·48 (0·213)
Tarewinnabar	68·70 (0·977)	5·56 (0·238)	4·00 (0·201)	3·73 (0·194)	0·36 (0·060)
Nunbank ..	30·21 (0·582)	3·61 (0·191)	1·88 (0·138)	1·62 (0·127)	0·56 (0·075)
Biloela ..	22·58 (0·495)	3·63 (0·192)	0 (0)	0·28 (0·053)	1·69 (0·130)
Boorara ..	6·06 (0·249)	2·13 (0·146)	1·09 (0·105)	1·04 (0·102)	0·26 (0·051)
Molopo ..	17·47 (0·431)	0·04 (0·019)	0·04 (0·019)	0 (0)	0 (0)
Gayndah ..	13·34 (0·374)	0·09 (0·030)	0 (0)	0 (0)	0 (0)

S.E. = (0·043) *P* < 0·01 = (0·159) *P* < 0·05 = (0·120)

* Transformed data in parentheses.

TABLE 3

EFFECT OF FLOOD DURATION ON THE EMERGENCE OF BUFFEL GRASS CULTIVARS EXPRESSED AS A PERCENTAGE OF THEIR CONTROL POTS (= 100%)

Cultivar	Flood Duration (days)			
	10	20	30	40
American	35·27 (0·636)*	41·97 (0·705)	22·11 (0·490)	6·17 (0·251)
Boorara	34·57 (0·629)	17·55 (0·432)	16·53 (0·419)	4·03 (0·202)
Nunbank	11·88 (0·352)	6·14 (0·250)	5·29 (0·232)	1·82 (0·135)
Tarewinnabar	8·14 (0·289)	5·86 (0·245)	5·47 (0·236)	0·52 (0·072)
Biloela	15·53 (0·405)	0 (0)	1·23 (0·111)	7·24 (0·272)
Molopo	0·21 (0·046)	0·21 (0·046)	0 (0)	0 (0)
Gayndah	0·61 (0·078)	0 (0)	0 (0)	0 (0)

S.E. = (0·065) *P* < 0·01 = (·242) *P* < 0·05 = (0·183)

* Transformed data in parentheses.

Emergence percentages calculated from the number of seed sown (Table 2) showed in the control American and Tarewinnabar > Nunbank > Biloela, Molopo and Gayndah > Boorara. Only, Boorara, Gayndah and Molopo had percentage emergence agreeing with the expected germination percentage (see Table 1). American, Nunbank and Tarewinnabar were greater than expected, and Biloela was lower.

The overall effect of the flood duration was a marked reduction of emergence from 10 days' flooding. There was little further effect until 40 days' flooding had been imposed, although a slow reduction of emergence with increasing periods of flooding did occur (Table 3). With 40 days' flooding the emergence of all cultivars was severely affected. At less than maximum flooding American and Boorara showed least effect. Molopo and Gayndah were severely affected by all flood periods. Biloela showed some emergence after the 10 days' flooding but little from longer durations. Nunbank and Tarewinnabar reacted similarly to Biloela.

IV. DISCUSSION

It was not possible to obtain seed with similar germination percentages for this experiment. That available ranged from 45% (American and Biloela) to 4% (Boorara) (Table 1). Though the number of seeds planted was adjusted to give 30 viable seeds per pot, this was not achieved. Final results in control pots ranged from 130 seedlings (Nunbank=30·21%) to 15 seedlings (Biloela =22·58%) (Table 2). Consequently the results were assessed as a percentage of the controls. This may tend to reduce their significance but it is noteworthy that the ability to emerge shown by the different cultivars was not dependent on the original germination percentage *per se*. The reason for the disparity between the expected and the obtained germination percentages is not known. It could have arisen because of errors in the initial testing, because of changes in seed viability in the time between the germination test and the experiment, or because the laboratory germination gave no true indication of likely germination in pots.

The experiment shows clearly that flooding affected the emergence of seedlings. Excessive carbon dioxide in soils, especially in conjunction with deficient oxygen, is often cited as contributing to poor germination or vegetative growth of crops due to its toxic effect on the various plant processes. However, most of the experimental evidence for carbon dioxide toxicity to plants growing in soils is extremely inferential (Russell 1952, p. 253). This is supported by Grable and Danielson (1965), who also suggest that loss of viability is probably due to the breakdown of the seed from the excessive soil moisture and invasion by pathogenic organisms. The germination of seeds under water has been found not to be related to phylogeny or to the kinds of reserve material in the seeds (Morinaga 1926). Morinaga found that out of 78 genera of 24 families, 35 genera did not germinate under water.

The fact that seeds germinated once the water was removed suggests that gross oxygen deficiency was the major operative effect. The delay in emergence following flooding was probably due to the waterlogged conditions of the soil persisting after initial removal of the flooding waters rather than to any physiological factors in the seed. This view is supported by the observation that, by increasing the flooding period, no increase was noted in the length of time required for emergence after drainage. Similar delayed emergence was reported by Heinrichs and McKenzie (1947) and McKenzie, Anderson and Heinrichs (1949) with temperate pasture species.

Differences in the ability of buffel grass cultivars to emerge from seed after flooding were clearly shown. The regeneration of Molopo and Gayndah from seed after flooding would be most unlikely. Other work (unpublished) has shown that the established plants of these two cultivars (particularly Gayndah) are very susceptible to flooding and should be excluded from pasture mixtures to be sown on areas likely to be flooded. On the other hand, American, and to a lesser extent Boorara, showed superior emergence after flooding. However, this does not necessarily exclude the use of Nunbank, Tarewinnabar and Biloela, particularly in situations where they are heavy seeders and produce a high percentage of viable seed.

The correlation between emergence in pots and in the field is unknown. Important factors such as burial of seed by silt deposition and its removal by water movement would need to be considered. McKenzie (1951) reported that with temperate species practically all species examined were unable to endure flooding as long in the field as they did in the greenhouse. He nevertheless obtained the same relationship between species tested in the field and in the greenhouse. Some of the reasons he gave for lower field results included puddling of the soil by flooding, formation of a hard crust after drainage and weather conditions following drainage.

A field experiment designed to assess the flooding tolerance of a range of grass species was flooded in February 1971. Included in this experiment were Nunbank, Tarewinnabar and Biloela buffels. The original plant populations were approximately 7,000 plants per acre. The area received a total of 14 days' flood with depths up to 15 ft. All plants were killed by the flood but at a recording 16 weeks later an average of 200,000 seedlings per acre had re-established. This indicates that buffel grass is able to regenerate in the field after a flood and lends credence to the pot experiment described in this paper.

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