GERMINATION RESPONSES OF NATIVE PLANT SEEDS TO RAINFALL IN SOUTH-WEST QUEENSLAND

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ABSTRACT

Regeneration of native species on mulga soils was observed in exclosures from October 1969 to April 1972. Some germination usually occurs after effective rainfall, and mass germination of native species was observed occasionally after unusually favourable rains.

Germination was more prolific in the spring and autumn months, with midsummer and midwinter being unfavourable. Microhabitats favoured seedling germination in certain areas, but these areas may change or migrate with time for various reasons, e.g. accumulation of windblown sand or surface wash of litter.

INTRODUCTION

In arid regions of the world the balance between optimum pasture utilisation and pasture degeneration is a very delicate one (Cook and Child, 1971). A rapid deterioration in the vegetation cover can easily occur, followed by scalding of the soil surface (Litchfield and Mabbutt, 1962) which makes re-establishment of the vegetation even more difficult. Once this stage is reached, it is usually many years on poor soils (Williams, 1968) before the most lenient management can encourage the pristine species to return (Osborne, Wood and Paltridge, 1931; Costello, 1944; Gardner, 1950). In parts of Australia, including the mulga lands of New South Wales, Western Australia and Queensland, this degeneration is thought to have occurred already (Wilcox, 1963; Moore, 1969; Newman and Condon, 1969).

There is also a need to inject greater quantities of energy (McMeniman 1972) into the diet of animals grazing thick mulga scrub. Beale (1971) found that thinning mulga scrub led to an increase in available forage. Native grasses will usually colonise newly cleared scrub areas within two years in south-west Queensland, particularly in more mesic areas, provided stock are excluded and some effective rain falls. But in the mulga regions of Queensland many of the colonising species are undesirable plants, e.g. *Aristida* spp., or low yielding species adapted to growing as a vegetation understorey, e.g. *Neurachne mitchelliana* and *Digitaria ammophila.* Graziers would prefer to replace these if possible. However, at present we do not know how to do so.

Attempts to replace the natural mulga scrub with productive grassland have largely failed (Burrows, 1970) except in the Nebine area south-east of Charleville, where native grasses have successfully carried increasing stock numbers in this more mesic environment. A programme to study the natural pattern of germination and establishment of these native species was undertaken in the Charleville area.

METHODS

Two representative sites were selected near Charleville as being typical of much of the eastern mulga soil (Isbell, Thompson *et al*, 1967). One (Site 1) was a densely timbered area in which a small clearing had been made in November 1968. The mulga density was initially about 900 trees/ha averaging 8-10 metres high, with a sparse

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ground cover of grasses e.g. *Neurachne mitchelliana, Danthonia bipartita, Digitaria ammophila*, and *Tripogon loliiformis*, and herbs e.g. *Hibiscus sturtii, Sida brachypoda, Sida filiformis* and *Cheilanthes sieberi.*

The other (Site 2) had been cleared many years before and subjected to intermittent stocking by cattle as well as periodic removal of mulga regrowth. It had developed into an *Aristida* grassland dotted with small mulgas, *Eremophila gilesii*, and *Cassia pleurocarpa*. The ground story was predominantly *Aristida jerichoensis* and *A. armata* with smaller amounts of *E. eriopoda, D. ammophila, E. lacunaria, N. mitchelliana, Hibiscus sturtii* and *Euphorbia drummondii.*

In October 1969 an area of 15 metres square was fenced at each site, the exclosure being in the clearing at Site 1. Within this area 36 plots each one metre square were pegged out and blocked into 4 groups with nine plots in each. All plants within the fence were carefully removed using scalpels. Recordings were subsequently made of the seedlings which germinated after every fall of rain and an identification effected if possible. Regular readings were taken of the numbers of seedlings surviving until such time as they died or seeded, at which time they were removed. Thus the soil was always relatively bare and the plants being recorded had not reached the flowering stage.

As an adjunct to this, a nearby uncleared area was fenced at each site and 48 plots one metre square were established in six blocks (see Figure 2). After major falls of rain, the numbers of seedlings emerging were recorded and an identification made if possible. All falls of rain at the site were recorded. Other observations regarding ambient temperature and cloud cover were taken from the Bureau of Meteorology at the Charleville aerodrome 2 km distant.

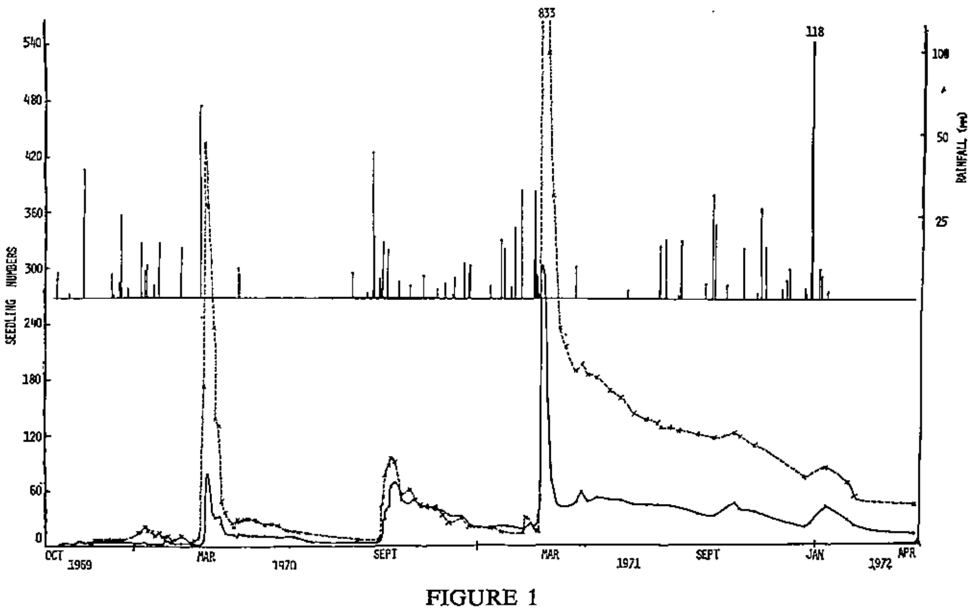

FIGURE 1

Seedling numbers in response to rainfall on a denuded mulga soil
At Charleville (A) Site 1 (·——·)
(B) Site 2 (x---x)
Significant falls of rain are also shown.

RESULTS

The total number of seedling plants in the disturbed exclosures at any one time is shown for the period October 1969 to April 1972, along with daily rainfalls (Figure 1). Rainfalls of less than 2 mm are omitted. Over the whole 30 months observation period, a total of 84 mature plants was removed from Site 1 and only 39 from Site 2. On only three occasions did a large number of seedlings emerge, i.e. March 1970, September 1970 and March 1971. Good falls of rain in December 1969, February 1971, September 1971 and December 1971 did not result in significant germination. There was always a greater number of seedlings at Site 2 than Site 1, though fewer plants reached maturity at Site 2.

Falls of rain totalling less than 25 mm rarely produced any germination, and a combined total of 33 mm in early August 1971 induced no seeds to germinate. In the extreme case, a total of 170 mm in 2 days in December 1971 resulted in only a few seedlings emerging. Generally a single fall of rain did not cause seeds to germinate. The exception to this was March 1970, when 58 mm in a single day resulted in a good germination of seed.

Table 1 shows the effect of soil surface conditions on the numbers of seeds germinating after effective rains in September 1970 and September 1971.

TABLE 1

Seedlings per metre² as affected by site and soil surface condition

	Site 1 Mulga Forest		Site 2 Grassland	
	Cleared	Undisturbed	Cleared	Undisturbed
September 1970	1.75	18	2.6	24
September 1971	0.3	0.46	0.15	31 (0.46)*

* Figure in parenthesis indicates the seedling density if *Aristida* spp. were to be excluded from the counts.

The inconsistent result in September 1971 at the Site 1 exclosure, where there was no vegetation disturbance, was due entirely to the absence of *Aristida* spp. from this area. At Site 2 there was a large mass of *Aristida* seed on the ground after the previous summer.

The spatial distribution of germinating seedlings after the September rains in 1970 and 1971 is shown in Figure 2. Data for the disturbed exclosures are not shown as the populations were so low.

An area in which germination was more prolific in September 1970 was not necessarily a more favourable site in September 1971, e.g. southern corner of each exclosure [Figure 2(a) and 2(b)]. However, some sites were always comparatively unfavourable to seed germination, e.g. the plot in Figure 2(b) on the SW side where only 2 seedlings emerged each time.

DISCUSSION

It is clear that mass germination of seedlings on mulga soils occurs infrequently (Figure 1). In a period of 30 months, on only three occasions was there a major germination of seeds. In comparing the cleared exclosures, a greater number of seedlings always emerged at Site 2. This was probably due to the larger seed reserve at Site 2 where *Aristida* species dominated the vegetation. At Site 1 the stands of herbage before clearing were very sparse (<100 kg/ha), and thus it is unlikely that there was a large seed reserve. Added to this, during the twelve months between the clearing of the mulga at Site 1 and the beginning of the experiment, a great deal of the seed existing in the soil may have germinated after the disturbance of the soil and vegetation (Sauer and Struick, 1964).

(a)

2 (1)	7 (0)	23 (0)	7 (0)	19 (0)	20 (0)
5 (1)	5 (0)	4 (0)	23 (1)	17 (0)	69 (0)
30 (1)	7 (3)	1 (0)	61 (0)	69 (0)	68 (1)
22 (0)	9 (1)	4 (0)	32 (0)	18 (0)	21 (1)
19 (0)	7 (0)	11 (1)	7 (1)	9 (0)	16 (2)
18 (0)	28 (0)	12 (0)	16 (1)	5 (0)	6 (0)
22 (0)	15 (0)	19 (0)	7 (1)	14 (0)	3 (2)
259 (2)	65 (0)	23 (2)	2 (0)	9 (0)	9 (0)

N

(b)

17 (28)	39 (16)	28 (8)	30 (6)	34 (35)	2 (17)
13 (73)	31 (6)	17 (7)	30 (12)	7 (103)	8 (15)
1 (23)	12 (31)	19 (19)	21 (5)	19 (113)	9 (11)
4 (30)	13 (41)	41 (37)	19 (6)	35 (49)	22 (184)
2 (2)	1 (23)	40 (33)	64 (4)	9 (66)	4 (64)
32 (1)	5 (10)	64 (36)	81 (8)	3 (29)	25 (108)
66 (2)	4 (13)	28 (29)	31 (10)	8 (14)	28 (68)
66 (9)	11 (4)	24 (11)	53 (14)	0 (12)	20 (30)

FIGURE 2

Spatial distribution of germinating seedlings from rain in September 1970 and September 1971 (in brackets) at (a) the undisturbed mulga forest, site 1 and (b) the undisturbed grassland, site 2.

However, a few seeds germinated after each significant fall of rain in the warmer months. Generally these falls needed to be greater than 25 mm to produce any number of new seedlings. The anomalies occurred in April 1970 and April 1971 where falls below 25 mm produced a noticeable increase in seedling numbers. This month seemed to be very favourable for seedling germination, possibly because night temperatures were still fairly high (Evans and Young, 1972), though daytime conditions were mild. In general, a single day of rain rarely produced any significant seed germination, although 58 mm in March 1970 did when a thick cloud cover lasted for several days after the rain. In inland Queensland it is not common for a complete cloud cover to persist after heavy falls of rain.

Another interesting observation from Figure 1 is the lack of response to good falls of rain in August 1971 and December 1971. This can probably be ascribed in August to temperatures being too low for germination even though the soil was wet for days, e.g. Burrows (1971) found that at 10°C germination of *Eremophila gilesii* was very slow. Other studies by the author (unpublished data) show that 10°C inhibits the germination of most of the grass species found on mulga soils. In December the rain fell quickly and then fine, hot weather prevailed for more than a week.

A third feature of the graph is the larger numbers of seedlings surviving after each major germination event. This is probably a reflection of the better sub-soil moisture conditions prevailing in 1971 after a reasonable season in 1970. Soil moisture levels were very low in early 1970 after several "dry" years. Certainly the study area did not develop a more favourable surface for plant establishment. In fact, it appeared to become more scalded as it lay denuded for a longer period of time at both sites. Termite activity was a constant feature of both sites and the hard indurated nest surfaces (Watson and Gay, 1970) were often exposed.

A far greater number of seedlings germinated under the more mesic environment of an undisturbed mulga scrub at Site 1, and the undisturbed grassland at Site 2 (Table 1). The same rainfall on both sites produced vastly different germination conditions. At Site 1 the dense mulga canopy provided favourable conditions when denuded areas were unfavourable. Surface soil temperature could have played a big role in this difference. Other factors contributing to this improved germination could include the presence of litter (Rickert, 1970), and the more friable soil under the trees. An important agent in keeping this soil friable appears to be a native cockroach (*Macropanesthia rhinoceros* Sauss. family Blaberidae) which makes a nest of mulga leaves underground (Pressland, pers. comm) and burrows out after good falls of rain, leaving a large mound (30 cm diam and 5 cm high) of loose earth behind. Density of these mounds has been recorded up to 0.5/m^2 and this magnitude of activity can be expected several times each year.

It is difficult to explain the different responses to good falls of rain in September 1970 and September 1971. Adequate soil moisture and soil temperature data are needed and these were not available. There were four falls in 7 days, producing 36 mm of rain in 1970 compared with two falls in 4 days producing 54 mm of rain in 1971. In general there is a delay of about 3 days between a fall of rain and seedling emergence, and most successfully germinating seeds lay within 1.5 cm of the soil surface. Thus adequate surface soil moisture must be maintained for at least this long to ensure germination.

Aristida species, however, germinated *en masse* in September 1971 in contrast to 1970 (Table 1). These seeds will germinate at almost any time of the year and their apparent tolerance of hot, dry conditions in the seedling stage could have accounted for their successful emergence at Site 2 in that year in contrast to other species. A large mass of seed on the ground from the previous summer also ensured that there would be adequate amounts for mass germination should conditions prove suitable, which they did. Perennial *Aristida* species are rarely found growing under thick mulga scrub in the Charleville area, which accounts for their absence in the undisturbed exclosure at Site 1.

Figure 2 shows that certain areas are more favourable for seed germination than others at both sites. However, what may be a favourable area at one particular point in time, may not remain favourable at all times. Some areas during the course of these observations remained unfavourable to germination at all times. At Site 2, it was the tops of termite nests, while under the undisturbed mulga scrub at Site 1 it was often due to the presence of an extremely thick mat of undecomposed litter on the soil surface (Rickert, 1970). This mat of litter can change its position as a result of rainwater wash during heavy storms, and produce the differences between 1970 and 1971 as illustrated towards the north-east corner of Figure 2(a). In open windswept places like Site 2, seedlings tended to emerge near the butts of established plants in the loose sand which was caught at the base. This is especially so with awned seeds, e.g. *Aristida*. Stoloniferous species like *Goodenia glabra* trap loose sand very effectively also.

The unusually large number of seedlings present in the south west corner of Figure 2(a) was due to surface disturbance by an intruding horse, which caused a mass germination of *Kochia* species (250 in all) in a small area. This also helps to emphasise the point made earlier, that following disturbance of a community, particularly soil disturbance, there is often an increased germination of seedlings (Sauer and Struick, 1964) following the first rains, which can seriously deplete the total seed reserves in the soil. Thus early overstocking of newly cleared mulga scrub could seriously jeopardise the chances of a good grass cover for many years.

CONCLUSION

It is obvious from this study that the more mesic the conditions, the better the germination. Thus shaded sites with surface littler and a friable soil would be favourable sites for seed germination provided the soil temperatures are appropriate, and that sufficient moisture exists in the soil. Soil moisture can probably be regarded as the chief direct factor limiting establishment with temperature, mulch and soil surface conditions exerting effects via soil moisture availability.

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