Dr. W. Jankowitz, Polytechnic of Namibia, Research on Fairy Circles

INTRODUCTION

In 1978, a group of researchers from the University of Pretoria, started investigating the origin of the mysterious 'fairy circles' in the Namib Desert (Van Rooyen *et al.* 2004). These circles (Figure 1) occur roughly between 60 and 120 km inland along the west coast from just north of the Kunene River in Angola, through Namibia, to just south of the Orange River. The existence of these so-called "fairy circles" has become a phenomenon of international interest as reflected by the worldwide reaction received after a publication in the New Scientist magazine of April 2004 (Cochlan 2004).

The earliest reference to these fairy circles in the scientific literature is found in Tinley (1971, 1974) who proposed that they were fossil termitaria formed when the annual rainfall was considerably higher. Theron (1979) suggested that an allelopathic compound released by *Euphorbia damarana* was responsible for the circles. However, a bio-assay done on the soils beneath live and dead *Euphorbia damarana* plants could not support an allelopathic origin for the fairy circles (Van Rooyen *et al.* 2004). In 1982, Eicker *et al.* reported on a microbiological study of the barren patches in the Giribes Plain, but offered no explanation for their origin. Moll (1994) suggested that these bare circles were caused by termites consuming all the grass seeds in the immediate vicinity of their nests and implicated *Hodotermes mossambicus* as the most probable termite species. Becker & Getzin (2000) elaborated on Moll's hypothesis without providing conclusive evidence. The latest hypothesis proposed by Albrecht *et al.* (2001) postulated that the barren patches were caused by a semi-volatile chemical substance associated with termite nests.

This project was initiated to follow up on the different hypotheses. Most hypotheses refer to termite activity in some way or another. Because it seemed unlikely that the circles were caused simply by the foraging activity of *Hodotermes mossambicus* as was suggested by Moll (1994) and Becker & Getzin (2000) it was decided to follow-up on Albrecht *et al*.'s (2001) hypothesis. The aim of this short communication is to report on the first *in situ* experiments to test the hypothesis whether a semi-volatile substance was inhibiting plant growth.

MATERIALS AND METHODS

Two distinct circles were selected in the Namib Rand Nature Reserve (Figure 2). Site A was located on a level sandy area (S 25º 01' 35.6" and E 15º 58' 36.6")and Site B was located on the southern aspect of the dune with a slope of approximately 4º (S 25º 01' 35.3" and E 15º 58' 34.1"). Both sites were fenced off with jackal proof fencing to prevent grazing by large herbivores.

In the present study the vitality of *Stipagrostis ciliata* grass plants were evaluated in different treatments. A factorial design was used with three factors being examined:

(a) The origin of the soil: The effect of the soil from inside the circle was compared with that of soil from the matrix between the circles. This also involved interchanging soils from the circle with that of the matrix and *vice versa.*

(b) The production of a semi-volatile substance in the soil: The presence of a gas was investigated by comparing the vitality of grass plants growing in containers that were sealed at the bottom versus containers that were open at the bottom.

(c) The position of the pots: This was investigated by placing the pots either in the circle or between the circles.

The seven different treatments used are set out in Figure 3. All treatments were replicated 10 times. A mature plant of *Stipagrostis ciliata* was planted into each container. The containers which were placed in the circle, were arranged in a cross-like pattern, with each spoke of the cross representing a different treatment. Treatments in the matrix were arranged in parallel rows at least 2 m from the circle, with each row representing a different treatment.

Before transplanting the grasses, the root systems were washed to ensure that the residues of the original soil were removed. To avoid leaching when watering the grass plants, the amount of water that could be applied to the specific volume of soil in the containers was established. It was determined that for watering purposes, 500 ml water penetrated almost to the bottom of the containers without actually reaching the bottom. To further avoid leaching, the plants were watered only once every two weeks.

To measure the vitality of the transplanted grasses an evaluation of each plant was done on a ten-point scale. This was done every two weeks from 5 May 2005 to 14 June 2005 while the grasses were watered.

Results were analysed for statistically significant differences by using ANOVA in the Statistica 6 computer package (Statsoft Inc, Tulsa, USA).

RESULTS AND DISCUSSION

The results of the vitality scores done on 31 May 2005 are presented graphically (Figure 4). This date was considered to represent the peak condition of the grass plants before winter dormancy commenced.

- Plants growing in similar soils and containers performed significantly better when they were growing in the matrix than in the circle (Figure 4a). This indicates that the circle exerts a negative effect on grass growth. The difference was the most pronounced in the case of plants grown in open containers in soil from the circle.
- The vitality of the plants in the sealed containers was significantly higher than those in open containers when the plants were growing inside the circles (Figure 4b). However, when the plants were growing in the matrix, vitality was not improved by sealing the containers.
- The origin of the soil, i.e. whether the soil came from inside or outside the circles, did not significantly affect the performance of the plants when they were growing in the same position and type of container (Figure 4c). Grass plants growing in open containers in the circle performed poorly, irrespective of the origin of the soil. Plants growing in the sealed containers in the circle showed improved vitality, also without a significant effect of the origin of the soil. There was no significant difference in the vitality of plants when planted in the matrix, irrespective of soil origin and type of container.

The results of this *in situ* investigation indicate that the circle soil does not retain its growth inhibitory capacity when placed in containers in the matrix. Likewise the matrix soil does not continue to support good growth when placed in the circle.

The fact that plants in sealed containers fared better than plants in open containers when they were grown in the fairy circles seems to support the contention of Albrecht *et al.* (2001) that a semi-volatile gas produced in the circle soil is inhibiting the grass growth.

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REFERENCES

Albrecht, C.F., Joubert, J.J., de Rycke, P.H. 2001. Origin of the enigmatic, circular barren patches ('Fairy rings') of the pro-Namib. South African Journal of Science 97, 23-27.

Becker, T., Getzin, S. 2000. The fairy circles of Kaokoland (North-West Namib) – origin, distribution, and characteristics. Basic and Applied Ecology 1, 149-159.

Cochlan, A. 2004. Blame them on the fairies. NewScientist 182 , 12.

Eicker, A., Theron, G.K., Grobbelaar, N, 1982. 'n Mikrobiologiese studie van kaalkolle in die Giribesvlakte van Kaokoland, S.W.A. Namibië. South African Journal of Botany 1, 69-74.

Moll, E.J. 1994. The origin and distribution of fairy rings in Namibia. In: Seyani, J.H., Chikuni, A.C. (Eds.), Proceedings of the 13th Plenary Meeting AETFAT, Malawi, pp. 1203-1209.

Theron, G.K. 1979. Die verskynsel van kaalkolle in Kaokoland, Suidwes-Afrika. Journal of the South African Biological Society 20, 43-53.

Tinley, K.I. 1971. Etosha and the Kaokoveld. African Wild Life (Supplement) 25, 1-16.

Tinley, K.I. 1974. Synopsis of outstanding problems in Etosha-Damara-Kaokoveld region of SWA. Unpublished report, University of Pretoria, Pretoria.

Van Rooyen, M.W., Theron, G.K., Van Rooyne, N., Jankowitz, W.J., Matthews, W.S. 2004. Mysterious circles in the Namib Desert: Review of hypotheses on their origin. Journal of Arid Environments 57:467-485.

Captions to figures

Figure 1 A typical fairy circle in the Namib Rand Nature Reserve indicating the barren circle surrounded by an edge of taller growing grasses.

Figure 2 The fenced enclosures of site B in the foreground and site A in the background.

Figure 3 A diagrammatic representation of the experimental layout.

Figure 4 Grass vitality as scored (10-point scale) in different treatments on Namib Rand Nature Reserve on 31 May 2005. Comparisons are between grasses planted (a) inside versus outside the circle; (b) in open versus sealed containers; and (c) in soils obtained in the circle versus outside soils. The asterisk denotes a statistically significant difference ($p < 0.05$) between two adjacent bars.