CONTINUITY OF ROOTS EMERGENCE AND GROWTH IN *Tigridia pavonia* Ker. Gawl.

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SUMMARY

Root growth and emergence were studied from October 1996 to April 1997, during the late seasonal plant growth and bulb dormancy period. The objective was to test if the emission of roots was a continuous process and to define types of roots produced by bulbs. Bulbs, with their leaves and roots, were extracted from the soil and placed between sheets of wet newspaper in plastic bags. These were held at room temperature varying from 20-24/18°C (day/night). The sheets of paper were changed monthly. Small bulbs, below 10 g were used. The measurements included the size and the number of roots and leaves. Periodically the dying roots were removed. The foliated bulbs or which lost their leaves, ubicated in beds, produced new contractile roots since the second half of the flowering and continued to grow. Both, roots emergence and the longitudinal growth were maintained for a few weeks after the bulbs lost their leaves. The bulbs started to cease the emission of new roots approximately at the end of January. The root forming meristems were in dormancy for 4 to 6 weeks**.** The bulbs reinitiated emitting new roots at the end of February or at the beginning of March. This, was followed by the emission of new shoots. The bulbs produced contractile roots, from the second half of the flowering period; at the start of a new season of growth produced only the feeder roots. Both root types may be present during the flowering period.

KEY WORDS: Emission of roots, extension growth, dormancy, contractile roots, feeder roots.

EMERGENCIA Y CRECIMIENTO CONTÍNUO DE RAÍCES DE *Tigridia pavonia* Ker. Gawl.

RESUMEN

El crecimiento radical y la emergencia de raíces en bulbos fueron estudiados desde octubre 1996 hasta abril 1997. El objetivo de este estudio fue comprobar si la emisión de raíces continua durante el periodo de reposo y definir los tipos radicales producidos por los bulbos. Los bulbos con hojas y raíces fueron extraídos del suelo y colocados sin suelo entre las hojas de papel periódico, húmedo y en bolsas de plástico. El conjunto fue ubicado en un cuarto a temperatura ambiental que varió de 20-24/18°C (día/noche). Se utilizaron bulbos pequeños, de un peso menor de 10 g, en su mayoría. Las variables evaluadas fueron: el número de raíces y su largo. Las raíces muertas fueron eliminadas. Los bulbos ubicados en el campo produjeron raíces contráctiles desde la segunda mitad de la floración. Su crecimiento durante el desarrollo fue continuo. La emergencia y el crecimiento longitudinal de raíces se presentaron durante algunas semanas después de desaparición de las hojas. Los bulbos entraron en el período de reposo en enero y reiniciaron la producción de nuevas raíces finas, absorbentes, al final de febrero y en marzo. Luego emitieron los vástagos. Los bulbos produjeron raíces contráctiles desde la segunda mitad de la floración y raíces absorbentes finas al iniciar un nuevo período de crecimiento. Ambos tipos radicales pueden presentarse en el período de la floración.

PALABRAS CLAVE: Emisión de raíces, crecimiento a lo largo, reposo, raíces contráctiles y absorbentes.

INTRODUCTION

Information upon roots in bulbous plants is scarse, especially in wild or rarely cultivated species. Molseed (1970) mentioned, that the main contractil root reached the size of the bulbs diameter, which in some species can be as much as 3 cm. Accidental observations on the root system of *Tigridia pavonia* indicated that it dies at the end of the rainy season, which normally marks the end of growth. New roots appeared when the rainy season started or irrigation was applied. It was also noted, that in both periods of observations, the number of roots and its morphology varied much.

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Bulbs of plants finishing their growth were characterized by thick, ramified roots, whereas those initiating growth in the rainy season gave thin feeder roots. The importance of two types of roots is evident. The contractile roots are forcing the bulb into deeper soil layers. The feeder roots have absorbing function. This initial observations forced us to study the number of roots in bulbs of *Tigridia pavonia* during the period from the end of flowering to the start of new growth of shoots, results of which are presented.

MATERIAL AND METHODS

One or two years old bulbs (<10 g) of *Tigridia pavonia* were used. Plants with their bulbs, leaves, and roots, growing in beds of Bulb´s Collection UPAEP, were extracted from the soil and placed free of soil between two to three sheets of newspaper and identity numbers assigned. The paper was thoroughly saturated with drinking water. Sheets were rolled and placed vertically in a plastic bag (Figure 1). Previous tests indicated that such procedure secured a healthy and continued generation of roots and longitudinal growth of emitted roots, contractile or feeder, providing periodic change of paper. The room temperature varied in the range of 20-24/18°C (day/night) throughout the observation period.

The experimental design included five replications, each containing 10 bulbs of similar range of weight and type of bulbs, one bulb forming the experimental unit. The variables measured were: number and length of contractile and feeder root of each bulb; the contractile roots were measured during the period from October 1996 to January 1997 and feeder roots from January 1997 to April 1997. No other roots appeared at this time. Observations and measurements were conducted at 10-14 days interval from October 96 to April 97, whenever possible. Analysis of variance was done. Visual observations were conducted on field grown plants taking samples at 3-4 weeks interval, at random, during shoots intensive growth (May-September). These observations were used to complement the cycle of measurements of roots emergence, length of growth and type of roots formed by bulbs in "paper sheets". The results of field observations enabled us to represent the diagram of appearance of plant parts (Fig. 6). No measurements were taken on the roots size components of field extracted plants. Samples were taken from field grown plants during shoots intensive growth until flowering. This, to define the end of feeder roots formation and the initiation of release of contractile roots or the coexistence of both type of roots. The term "root" refers to the main axis, without the laterals.

RESULTS AND DISCUSSION

Visual observations

The collected bulbs, which entered the final stage of flowering, subjected to the test, produced thick, contractile roots, regardless of size and bulb type (Figure 2). These roots, thick and short at the beginning, later, elongated and ramified in the apical section. Finally, such roots died. Long before its elongation a second one, and third thick root appeared at the same time. These roots stopped to appear gradually after shoots and basal leaves died. The bulbs, finally entered a rest period. The growth was not noted visually for a few weeks, although the bulbs were kept in optimum moist conditions and at room temperature.

After a rest period new roots showed up. These were thin, numerous, with laterals of first orden (Figure 3a, b). These roots, appearing in the border area of the basal plate, due to the form of outgrowth, were named crown roots, for being similar to the gladiolus roots (Leszczyñska-Borys and Borys, 1994). Both types of roots varied in morphology, number of roots and functional life span. The last attribute being of longer life in crown roots. The observations upon the roots of field grown plants during May-September indicate that the feeder type of roots are replaced gradually by thick, contractile roots. The last one were evidently present at time of flowering. The older contractile roots were ramified.

Number of roots

The number of roots per type of root presents Figure 4. Analisis of variance ($P \leq 0.01$) indicated highly significant effect of the date of measurement upon the number of roots.The roots that appeared from October 5th to December 12th were contractile, of a low number per bulb. The feeder type of roots, increased continuosly in number (Figure 4). A short, few weeks long roots-free period was present. Not all the bulbs entered the rest at the same time (Table 1).

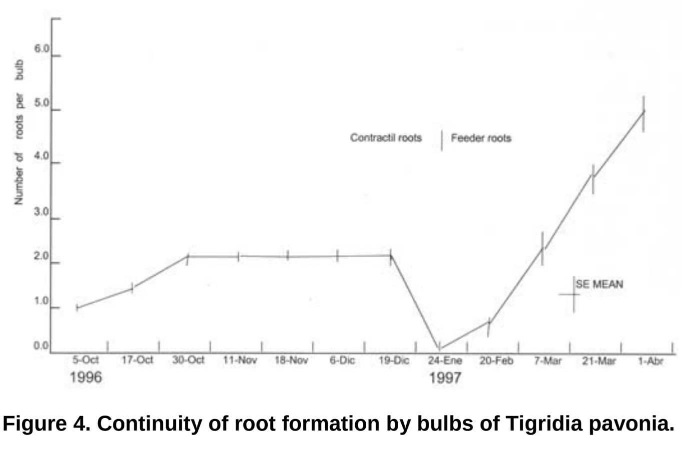

Figure 4. Continuity of root formation by bulbs of Tigridia pavonia.

Root length

The contractile roots showed a steady increase in the average length up to December, when they suddenly stopped to elongate. The feeder roots elongated continously (Figure 5).

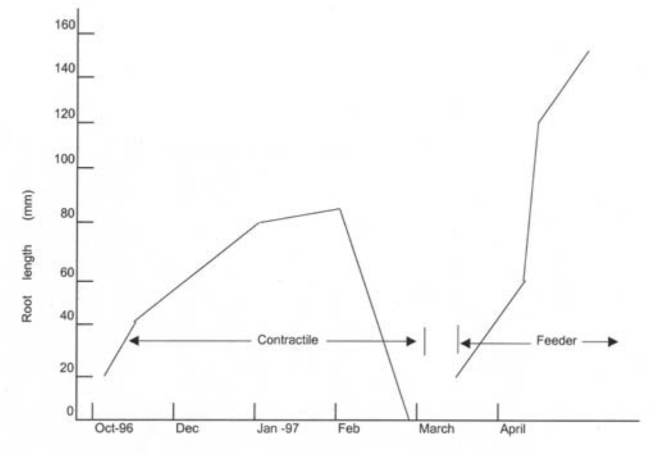

Figure 5. Average length of contractile and feeder root per bulb.

Relationships among roots and above ground parts.

The events of growth phenomenons in *T. pavonia* plants are summarized in the diagram (Figure 6). The leaves and roots formation in the period from September 1996 to January 1997 reflects the bulbs readiness to support the growth of both parts under experimental conditions, with water and temperature unlimited. Under an open field conditions the lack of water is a limiting factor and obstructs growth.

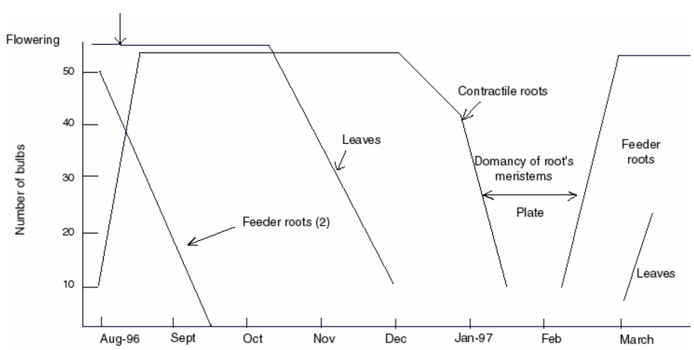

Figure 6. Diagram of appearance of plant parts in tigridia since flowering till new growing season starts; (2) hipothetical curve.

The growth in length of contractile roots was supplied by the bulbs for longer time than the formation of new roots. Comparison of the time curve of number of roots (Figure 4) with the time curve of leaves presence per bulb, under "paper tests" suggests, that the formation of a new contractile roots may be conditioned by the presence of leaves, while the longitudinal growth of those roots seems to depend more upon the bulbs (longitudinal growth of contractil roots was present for a longer time than the leaves presence - Figure 6). The presence of a rest period found under experimental conditions (unlimited factor of water availability and temperature) during which no new roots and leaves appered is of importance.

In general, the results confirmed the previous observations on the presence of two types of root system during *T. pavonia* growing season (Leszczyñska-Borys et Borys, 1995). The formation of two root types, events separated by a rest period, suggests the existence of two specialized meristems, one involved in the formation of feeder roots, the second one in contractile roots. This aspects of root growth require an anatomic confirmation.

The bulbs of *T. pavonia* stopped to emit new roots although in this experiment the water and temperature were in optimum. Thus, the rest period seems to be internally determined. However, the apparent rest may be imposed by a layer of dead tissue formed at the bulb basis. This, may constitute a physical barrier to the emission of new type of roots - the crown (feeder) roots. Such a barrier requires time to be weakened by microbial activity.

The apparent steady state in the number of contractile roots (Figure 4), is a contrasting feature of *T. pavonia* bulbs compared to the steady rise in number of feeder roots. This feature requires its confirmation in experiments conducted under controlled environmental conditions.

The contractile roots of seedlings of *T. pavonia* are growing continuously in width (Molseed, 1970). Our data refer to the emision and longitudinal growth of roots formed by bulbs which are one or two years old. Such contractile roots grew initially in width and at initial phases their extension growth was very slow. Later, these roots diminished in width, elongated and ramified. Seedling roots showed similar pattern (unpublished data). The contractile roots, with age, changed their function.

The appearance of contractile roots in one-year or older bulbs of apparently simple structure, seems to constitute an external, macroscopic expression of appearance of a daughter bulb. Hence, the origin of contractile roots in bulbs of major size could be explained. The "basal leaf" seems to be directly related to such a bulb in formation.

CONCLUSIONS

Bulbs of *T. pavonia* presented a period of formation of contractile roots, separated by a rest period without root forming activity, followed by a resumption of bulbs rooting of the feeder type. The contractile roots are shorter, less numerous than the feeder type. The contractile roots, initially very thick and short, later presented extension growth and were covered with lateral ones. The feeder roots were thiner, appeared around the plate, more numerously and were steadily increasing in number and length of the main axis. The total length of feeder bulb roots was a little longer than the contractile roots.

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Figure 1. The method of forcing the bulbs of tigridia to emit roots and shoots consisted of wrapping bulbs in wet sheets of paper from newspaper, collacated in a plastic bag, kept in vertical position.

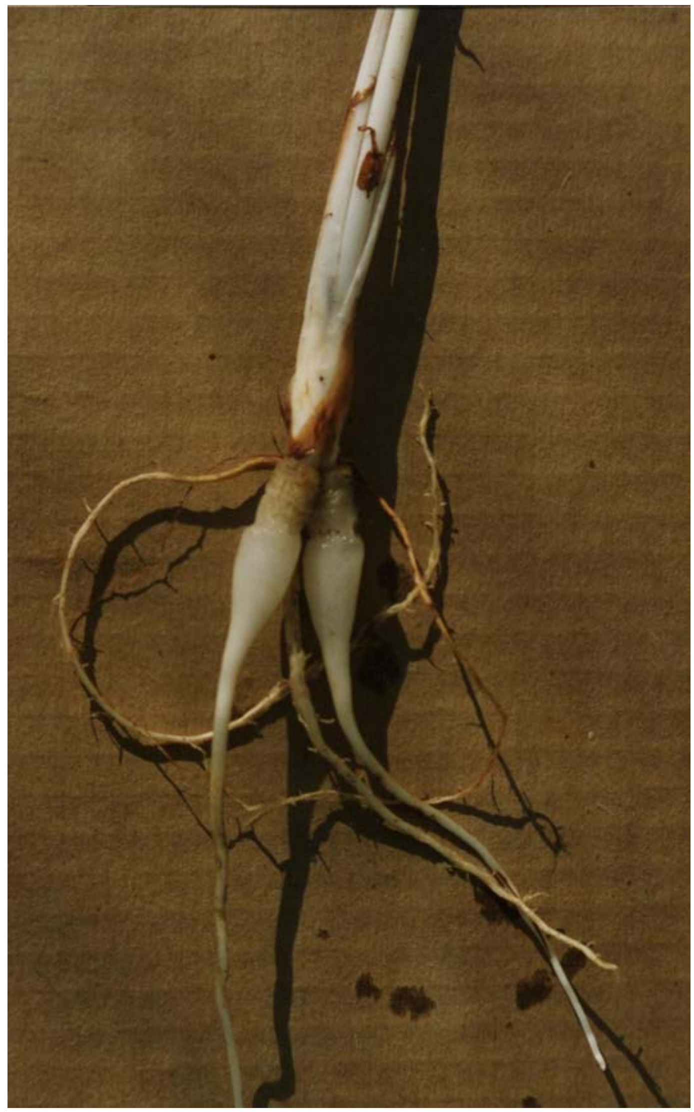

Figure 2. The tigridia bulbs of late season growth gave a few contractile roots, thick or very thick, later presenting typical rings at their base. These roots, presented an extension growth, formed first orden laterals. The contractile roots were formed even after the death of shoot and the basal leaf. Finally, the bulbs stopped to form them and these root died.

(a) **(b)**

Figure 3. Tigridia bulbs emitted feeder roots with a new growth season. These roots increased steadily in number and length. The size of the bulb root system was related to the size and type of bulbs single or clustered (a). Later in the season, the bulbs produced mixed roots seeder and contractile (b).