19. Ozaki, H.Y.; Iley, J.R. 1968 Phosphorus and magnesium fertilizer studies with pepper. *Proc. Amer. Soc. Hort. Sci* 93:462-469

20. Ozaki, H.Y , Ozaki, C T., Hamilton, M.G. 1955. The effects of applied nitrogen, phosphorus and potash on yield and growth of peppers. *Proc. Florida State Hort. Soc.* 68.230-233

21. Proctor, A 1966. Ornamental peppers. *Gard Chron.* 159 (25) 598.

22. Purseglove, J W. 1973 General agronomic aspects of spice crops. *In* Proceedings of the Conference on Spices held at the London School of Pharmacy, Brunswick Square, London WC IN IAX on 10th-14th August 1972. pp 85-90. Tropical Products Institute, London. 261 p

23. Sachs, R M., Kofranek, A.M , Hackett, W P 1976. Evaluating new pot plant species. *Florists' Rev.* 159:35-36, 80-84

24 Semeniuk, P. 1973 Response of *Browallia speciosa* Hook. to temperature in controlled environments *HortScience* 8:481.

25 Thomas, M.B. 1974 Research on the nutrition of container-grown Proteaceae plants and other nursery stock *Proc. Inter Plant Prop Soc.* 24 313-325

26 Thomas, M.B. 1979. Nutrition of container-grown plants with emphasis on the Proteaceae Thesis, Ph D Lincoln College, University of Canterbury, N Z. 207 p

27 Zimmer, K 1977 Plant size, nitrogen manuring, and flowering of *Brunfelsia Deutscher Gartenbau* 31 (25):1012, 1014-1015

28 Thomas, J R. and M D Heilman, 1967. Influence of moisture and fertilizer on growth and uptake by sweet peppers *Agron. Journ* 59.27-30.

SEED PROPAGATION OF *GENTIANA SCABRA*

ROSS A. BICKNELL

Levin Horticultural Research Centre
Ministry of Agriculture and Fisheries
Levin

INTRODUCTION

Although the genus *Gentiana* contains many hundred species, the cultivated cut flower cultivars have arisen principally from only three: *G. makinoi, G. triflora,* and *G. scabra*, all of which are native to Japan. *Gentiana* is a very popular flower in Japan where it blooms mainly between the months of July and October. In 1979 it was estimated that approximately 278 ha of *Gentiana* was cultivated in Japan. In 1982 this had increased to 449 ha.

Until recently most propagation has been by seed. Cutting propagation is used in some districts for white cultivars, which tend to have a poorer seed germination rate than the blue and purple ones. The tissue-cultured material which is now becoming available provides the advantages of clonal multiplication but is more expensive than seedlings. Seed, available

from several Japanese seed companies, is best purchased during November and December as this is when fresh stock is available from the previous season's crop. Although some seed lines have a germination rate of over 70% it is necessary to allow for large margins of loss as the seedlings are very delicate, especially during germination and the first month of growth.

In common with many other gentians, seed of *Gentiana scabra* will germinate poorly unless it has been subjected to a prolonged period of cold temperature. Traditional Japanese gentian growers sow large quantities of seed into outside beds in autumn, then await spring germination. It has been reported that gibberellic acid (GA_3) application can be used to replace the need for a cold period (1,2).

The objective of the current study was to determine the length of chilling required, the most effective concentration of GA_3 to use, and to evaluate the influence of light on seed germination in *G. scabra*. From the results a reliable method for propagating *G. scabra* from seed has been developed.

METHODS

G. scabra seeds number approximately 19,000 per gram. In all three experiments, replicate lots of approximately 0.01 g of dry seed were accurately weighed out. All results are expressed in seeds germinating per 0.01 g of dry seed. Replicate seed aliquots were then sown onto filter paper discs moistened with either distilled water or an aqueous solution of GA_3, neutralised to pH 7.0. The fungicides, Benlate (benomyl, du Pont) and Ridomil (metalaxyl, CIBA-GEIGY), were also applied to the paper discs to suppress fungus attack of the seeds or seedlings. These two chemicals were previously determined to have no effect on seed germination in this species. Each filter paper disc bearing seed was then sealed within a clear plastic petri plate.

The plates were held in a culture room at 23°C ± 1.0°C. Light was supplied by a bank of four 40W Thorn 'Cool White' fluorescent tubes on a 12 hours light/12 hours dark photoperiod. Seed plates subjected to continuous dark conditions were held in a light-proof container within the culture room.

Germination was defined as the emergence of the radicle through the seed coat. Germination counts were taken every 3 to 4 days from the time of entry into the culture room, until day 19 in Experiments 1 and 2, and day 40 in Experiment 3.

Experiment 1: The length of cold period required to break seed dormancy.

Method: Seeds were sown on filter paper discs moistened with distilled water and stored at 2°C for between 0 (control) and 4 weeks. Following the cold treatment seed plates were then transferred to the culture room and germination counts were taken every 3 to 4 days thereafter. The results are summarised in Figures 1 and 2.

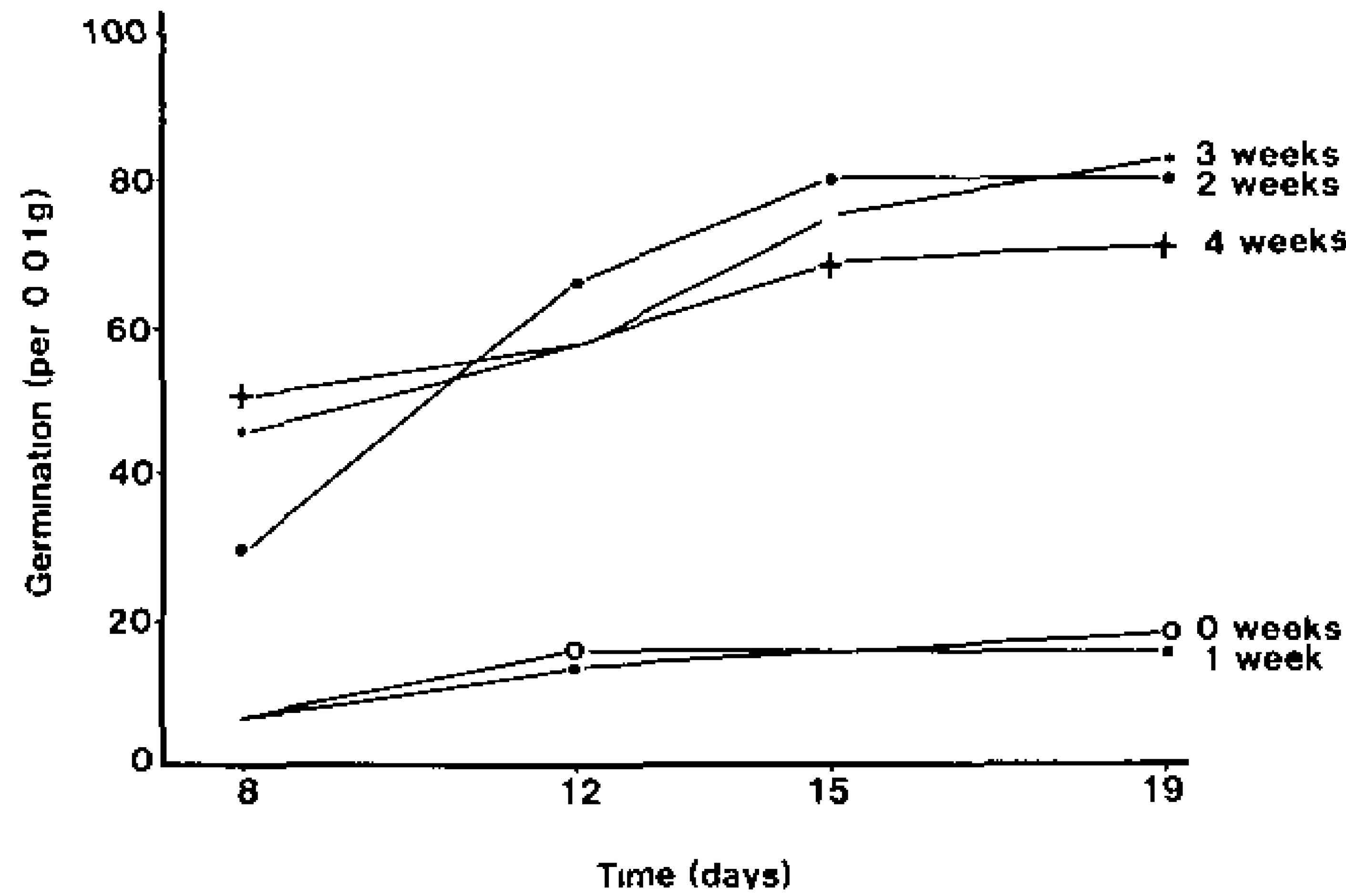

Figure 1. Progress of germination after various times of seed storage at 2°C

Results: Seed germination began between day 4 and day 8 in the culture room and was largely complete by day 19. No germination occurred during cool storage. Germination in the one week treatment was not significantly different to that in the control.

From these results it appears that 2 to 3 weeks at 2°C is sufficient to adequately break seed dormancy in *G. scabra* seed. It is important to note that the seed must remain damp throughout the chilling period.

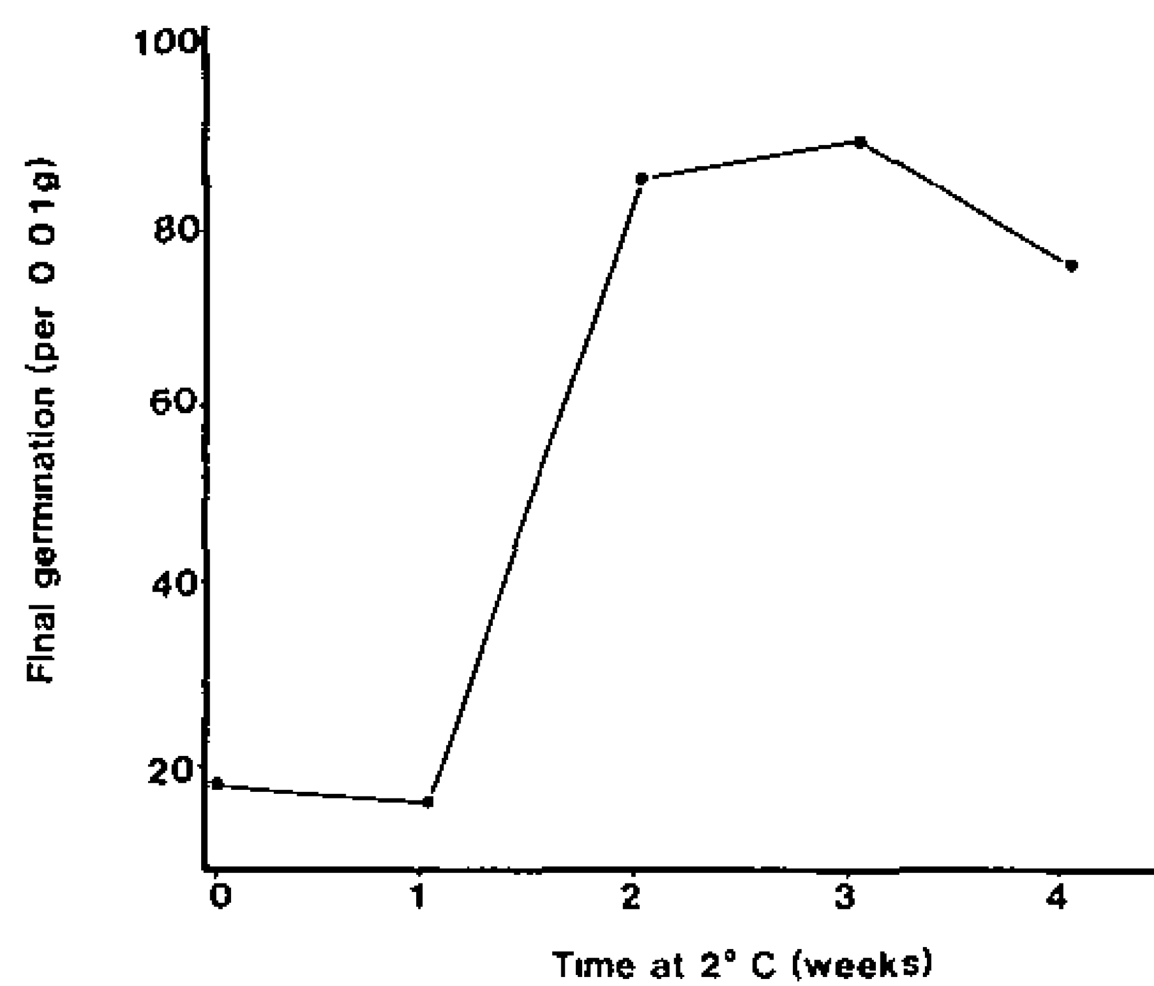

Figure 2. Final germination after various times of seed storage at 2°C

Experiment 2: The use of gibberellic acid to break seed dormancy.

Method: Aqueous solutions of GA_3 ranging in concentration from 0 ppm (distilled water) to 500 ppm, were used to moisten filter paper discs on which seeds were sown. All

solutions were neutralised to pH 7.0 using NaOH. Sealed plates were then placed in the culture room and germination counts began on day 4. Results are summarised in Figures 3 and 4.

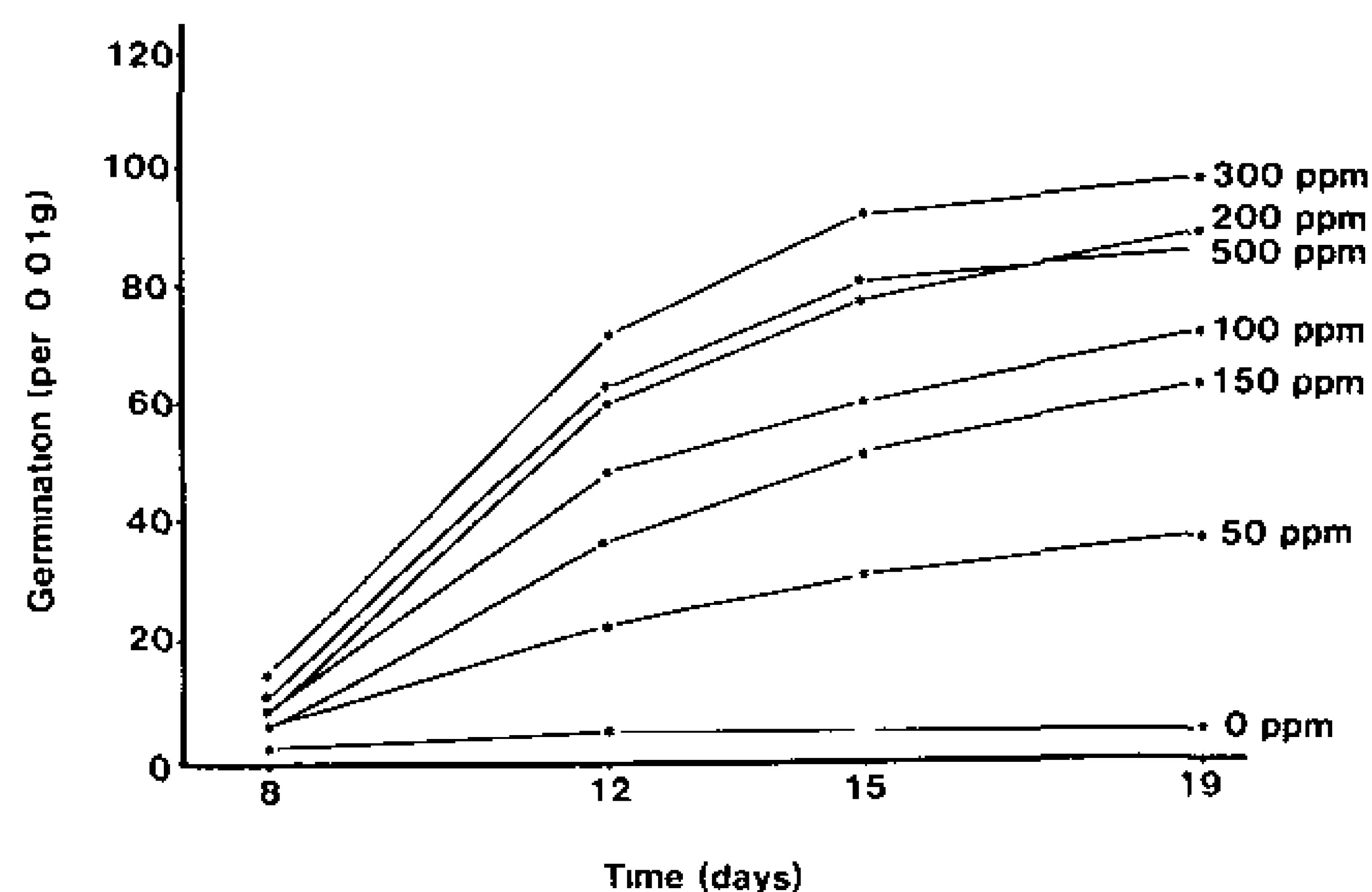

Figure 3. Progress of seed germination at various concentrations of GA_3

Results: As in Experiment 1, germination began between day 4 and day 8 and progressed up to the end of the experiment. At day 19 the highest total germination count occurred in the 300 ppm treatment (Figure 4). As the 300 ppm treatment yielded higher counts throughout the experiment than those of the 500 ppm treatment, it appears that an excessive concentration of GA_3 can suppress seed germination in *G. scabra*.

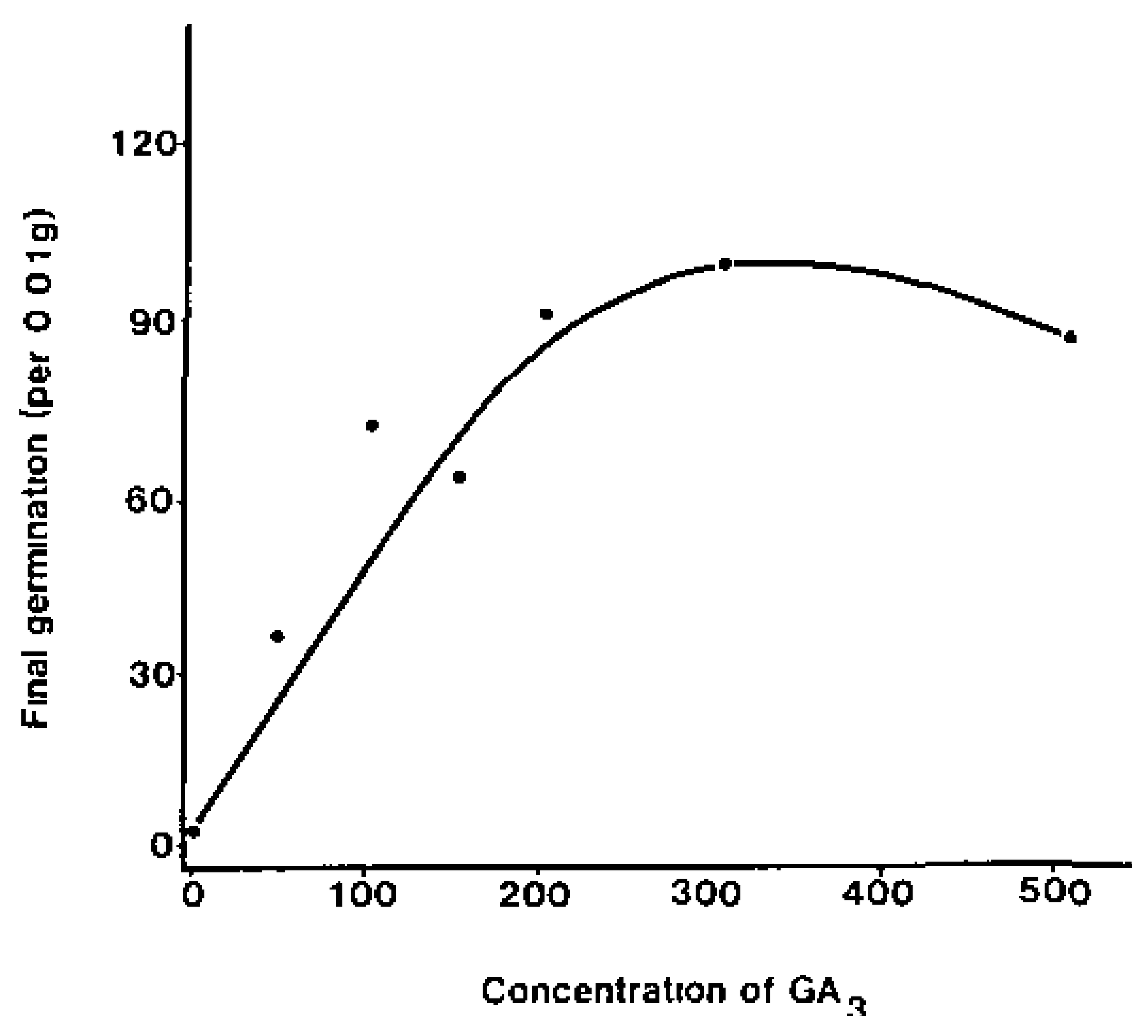

Figure 4. Final seed germination at various concentrations of GA_3

Experiment 3: The influence of light on seed germination.

Method: During the early stages of this study it became apparent that light was influencing the speed of seed germination. As a result of this observation Experiments 1 and 2 were conducted in a room in which the photoperiod and the light intensity were controlled.

To evaluate the importance of light, a third experiment was conducted. Seed was sown on paper discs drenched with a 300 ppm solution of GA_3 and enclosed within plastic petri plates as before. One set of plates was placed in the culture room under lights (in a 12 hours light/12 hours dark photoper-

iod), while a second set was held within a light-proof container in the same room. As the seeds had to be exposed to light for counts to be taken, for the "dark" treatment a separate set of replicates was used on each sampling date.

Results: Seeds kept in the dark began germinating later than those in the light (Frame 5). Throughout the period of the trial (40 days) total germination of the dark-treated seeds was less than that of the seed exposed to the light.

It is apparent that germination occurs more rapidly and more uniformly in *G. scabra* seeds exposed to light than in seeds placed in the dark.

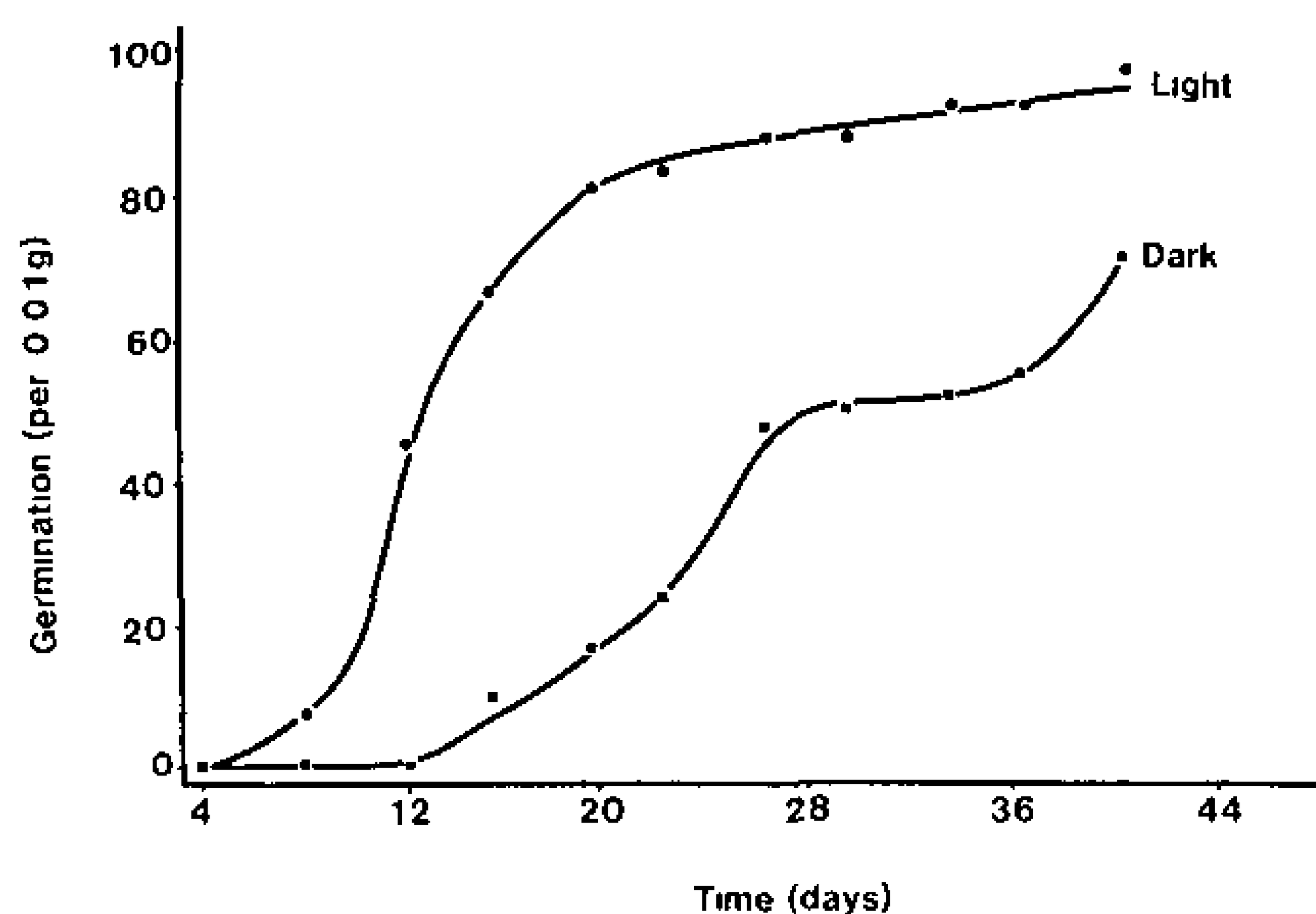

Figure 5. The influence of light on the progress of seed germination

DEVELOPMENT OF A TECHNIQUE

Gibberellic acid application is both faster and more convenient to perform than cold treatment of seeds. Furthermore, the overall seed germination from the optimal GA_3 rate (300 ppm) was slightly higher than that from the best cold treatment used (3 weeks at 2°C).

Following from these and previous findings, a method for germinating *G. scabra* seed has been developed.

Seed samples are placed into a 300 ppm GA_3 solution, neutralised to pH 7.0 using dilute NaOH. The fungicides, Benlate and Ridomil are added to the solution, both at the rate of 0.075 g/l. Air is continuously bubbled through the solution to prevent anoxic conditions developing. The seeds, which initially float, imbibe the solution rapidly and sink within three to five hours. After five days the GA_3 solution is decanted off and the seed rinsed twice in water. Seed is then stirred into suspension in water and sluiced over a prepared tray of a moist medium. As the water drains away the seeds are left on the surface. A glass sheet is then laid over the tray to maintain a high humidity about the germinating seeds. Shade cloth can be placed over the glass to prevent overheating.

The medium should be free draining and contain fertiliser at a rate similar to that used for bedding plants. The medium I have used is made up of 30% composted Fibremix (N.Z. Forest Products Ltd), 30% granulated bark, and 40% medium grade pumice. To this the following fertilisers are added per m^3 of mix:

5 kg dolomite limestone
4 kg 4-month resin-coated slow-release fertiliser (14/6.1/11.6)
1 kg superphosphate
0.2 kg calcium ammonium nitrate
0.2 kg fritted trace elements

This has proven adequate to date but may be improved upon in the future as more experience is gained with the crop.

Just prior to sowing, the mix is drenched with Terrazole (etridiazole, Olin) to suppress damping off. A second application is applied three days after sowing. Thereafter, alternating applications of Ridomil and Benlate are applied once every 3 to 4 days until the first set of true leaves have formed. Weekly applications are then adequate up to the time of planting out. The glass is slowly lifted after the plants have developed their first set of true leaves. If the seedlings are in a glasshouse under strong light, a shade tent may be required to prevent scorching. Pricking out is performed once the second set of true leaves have formed.

LITERATURE CITED

1. Hayashi, T. 1983 New Techniques for the Cultivation of Cut Flowers; Perennial Plants, Vol 11 Seibundo Shinkosha, Japan
2 Ohteki, T 1982 Cut flower production — Japanese techniques *Tech. Bull* No 1. Ministry of Agriculture and Fisheries, N Z

PROPAGATING FEIJOA BY BENCH GRAFTING

IAN FANKHAUSER

Duncan & Davies Ltd.
New Plymouth

Feijoa, a native of South America, was introduced to New Zealand in the early 1900's. Since this time selections of plants with fruit suitable for export is an ongoing process with "improved" cultivars coming onto the market periodically.

In the late 1950's, Duncan & Davies were producing named cultivars feijoa by layering. Trials have been done since then with field grafting, bench grafting, budding, and