

# Vegetative propagation of *Grindelia chiloensis* (Asteraceae)

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## Abstract

*Grindelia chiloensis* (Asteraceae) is a shrub native to Patagonia, Argentina, in the process of domestication as a source of resin to complement rosin production by pines. Vegetative propagation to multiply selected genotypes has produced breakthroughs in the cultivation of new crops like jojoba (*Simmondsia chinensis*). The only available way to propagate *Grindelia* is by transplanting seedlings or direct seeding. Both alternatives rely on selected varieties, a process that takes several years in an open-pollinated, self-incompatible species. The objective of this study was to generate a protocol for the vegetative propagation of *G. chiloensis*. Two experiments were carried out to evaluate the effect of the mother plant, the source of the cutting (apical or basal), and the concentration of indole butyric acid (IBA) on rooting success and root and above-ground biomass accumulation. A third study was conducted to evaluate the field survival of the propagated plants. Stems (15 cm) were cut from several mother plants growing in the field and stored in plastic containers with ice for about 4 h. Two types of cuttings were prepared from each stem: apical (upper 6–8 nodes) and basal (lower 6–8 nodes). A commercially available IBA source (Hormex, rooting powder, Brooker Chemical, Hollywood, CA) was used at six concentrations (0.1, 0.3, 0.8, 1.6, 3.0, and 4.5%). The cuttings were dipped in water and in the plant regulator and planted into speedlings filled with peat moss, vermiculite and sand (1:1:1, v/v/v). The speedlings were placed under a mist system in a greenhouse at 25°C. Rooting success and root weight were evaluated 30 days after the experiments were started. The position of the cutting, the IBA concentration, and the mother plant affected rooting success. None of the basal cuttings rooted even with IBA treatment. For the apical cuttings, IBA concentrations between 0.1 and 1.6% resulted in more than 64% rooting and the largest root mass ( $P < 0.01$ ). The control cuttings (0% IBA) did not produce adventitious roots. Accessions differed on rooting success. Transplanting survival varied between 25 and 100% depending on the clone. Vegetative propagation will allow the multiplication of *Grindelia* clones selected for their productive superiority. Traits such as resin content and composition, and regrowth after harvest are important characteristics to select for. © 2000 Elsevier Science B.V. All rights reserved.

**Keywords:** Crop establishment; New crops; Arid lands; Resin; Shrubs

## 1. Introduction

*Grindelia chiloensis* (Corn.) Cabr. (Asteraceae) is a shrub native to Patagonia, Argentina, and is

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in the process of domestication as a source of resin to complement rosin production by pines (Ravetta et al., 1996a,b). Trichomes on the surface of the leaves, capitula, and stems of this species produce diterpene resin acids that are similar to those found in the North American *G. camporum*. They could potentially be used in various applications in the naval stores industry complementing those produced by pines with current prices of around 0.45 US\$/kg (Hoffmann and McLaughlin, 1986; Ravetta et al., 1996a). *G. chilensis* appears as a good candidate species because accessions with resin contents up to 30% of the biomass dry weight have been found (Ravetta et al., 1996a) and compares favorably with *G. camporum* with approximately 10% resin (McLaughlin and Linker, 1987; Ravetta et al., 1996b). Tetraploid *G. chilensis* accessions produced 14% more total resin per plant than *G. camporum* showing the importance of resin content on total resin production (Ravetta et al., 1996b). Although resin production appears to be modified by environmental variables such as water (Zavala and Ravetta, 1997; Zavala et al., 1997), nitrogen (Wassner et al., 1997), and radiation availability (Zavala and Ravetta, unpublished data), there is also a large variability in resin content and resin production, which is related to genetic make-up (McLaughlin, 1986).

The only way available to propagate *Grindelia* has been to transplant greenhouse-grown seedlings or by direct seeding (McLaughlin and Linker, 1987). Direct seeding has weed competition problems because of the slow growth from cotyledon to the 6-leaf stage. Both alternatives need to rely on selected varieties, a process which would take several years in an open-pollinated, self-incompatible species like *G. chilensis*.

For species that can be propagated vegetatively, this method has several advantages, the most important one being the true propagation of superior genotypes. Once variability has been described and analyzed, productive traits can be fixed immediately. The use of vegetative propagation when possible, has produced breakthroughs in the cultivation of new crops like jojoba (National Academy of Sciences, 1985; Prat et al., 1998). The objective of this study was to generate

a protocol for vegetative propagation of *G. chilensis* and to evaluate transplant survival under field conditions.

## 2. Materials and methods

A factorial experiment was carried out to evaluate the effect of the source of the cutting (position in the stem, apical or basal) and concentration of a plant regulator on rooting success and root formation. Fifteen-cm-long stems were cut on 2 April 1998 from several mother plants of accession 569 growing in the field at Buenos Aires and stored in plastic containers with ice for about 4 h. Two types of cuttings were prepared from each stem: apical (upper 6–8 nodes) and basal (lower 6–8 nodes). A commercially available powder indole-3 butyric acid (IBA) source (Hormex, rooting powder, Brooker Chemical, Hollywood CA) was used in six concentrations of 0.1, 0.3, 0.8, 1.6, 3.0, and 4.5%. The cuttings were first dipped in water and then in the IBA powder and placed in speedlings (the cell size was  $2 \times 2 \times 7$  cm) filled with peat moss, vermiculite and sand (1:1:1, v/v/v). Five replicates of 10 cuttings for the two positions and growth regulator levels were used. The speedlings were placed under a mist system set at 9 min intervals for 3 s in a greenhouse at 25°C. Rooting success, root weight and above-ground biomass were evaluated 30 days after the experiment was started.

Another experiment was conducted to evaluate the variability in rooting success related to accession of the source-plant from which the cuttings were obtained. For each of five accessions, 20 cuttings were obtained from each of five plants (100 cuttings/accession). The accessions were: 533 (Mendoza, 25 de Mayo), 547 (Neuquen, Chos Malal), 555 (Rio Negro, El Cuy), 569 (Chubut, Rio Chico), and 575 (Chubut, Playa Union). Only apical cuttings were used in this experiment. All plants were growing under field conditions in an irrigated experiment in Trelew, Patagonia.

In a third experiment, accession 555 was used to evaluate rooting success and transplant survival in the field. Twenty cuttings from each of 40 555-plants were cut from field-grown plants on 16

Table 1

Rooting of cuttings, and root and above-ground biomass accumulation of *Grindelia* cuttings treated with different concentrations of IBA<sup>a</sup>

Treatment	Rooting (%)		Root biomass (g D.W.)		Above-ground biomass (g D.W.)	
Control	0.0	c	0.0	c	0.0	c
T1 (0.1% IBA)	64.0	a	2.6	b	4.3	a
T2 (0.3% IBA)	78.0	a	6.3	a	4.4	a
T3 (0.8% IBA)	73.7	a	5.8	a	3.5	b
T4 (1.6% IBA)	64.4	a	6.5	a	4.5	a
T5 (3.0% IBA)	42.5	b	4.8	a	3.4	b
T6 (4.5% IBA)	37.2	b	6.6	a	2.9	b

<sup>a</sup> Five replicates of 10 cuttings each.

March 1998. The cuttings were transported to Buenos Aires in refrigerated coolers, and rooted using Hormex 0.8% on 17 March, 1998. The mother plants had been transplanted in the field in April 1997, and formed seeds during the summer 1997/1998 (December–February), and were ready for harvest in May 1998. The rooted cuttings of accession 555 were transplanted to the field in Trelew, Patagonia on 30 April 1998. The plants were irrigated immediately after transplanting and a second time 2 weeks after the transplant. Survival was evaluated after the winter season on 10 August 1998.

### 3. Results and discussion

Cutting position was the most important variable influencing rooting success. None of the basal cuttings rooted (data not shown). In many vegetatively propagated species, older, lignified wood cuttings are more difficult to root than newly formed stems (Hartmann et al., 1990). For apical cuttings, IBA concentrations between 0.1 and 1.6% resulted in more than 64% rooting (Table 1). IBA concentrations of 3.0% and higher were less effective in promoting root formation ( $P < 0.01$ ), whereas the control cuttings (0% IBA) did not produce adventitious roots. Root biomass was similar for the IBA treatments between 0.3 and 4.5% ( $P < 0.01$ ), and the largest above-ground biomass accumulation was found for the 0.1, 0.3 and 1.6% treatments ( $P < 0.01$ ; Table 1).

IBA concentrations above 3.0% reduced shoot biomass probably as a consequence of the inhibition of apical meristems (Hartmann et al., 1990). Based on these results, the recommended IBA concentration which combined the highest rooting and biomass production is between 0.3 and 1.6%.

Rooting success differed among the accessions (Table 2). Studies on jojoba have showed clonal differences in rooting responses (Cardam, 1980; Prat et al., 1998). Interactions between the clone and basal temperature were observed for jojoba, with the lower rooting clones showing increasing rooting success with higher temperatures (Prat et al., 1998). Empirical trials with each cultivar are necessary to determine fully the influence of plant and environmental factors on rooting (Hartmann et al., 1990).

Transplanting survival for the 40 555-clones also varied with values ranging between 25 and 100% (with only two clones with survival below 25%, data not shown). The average survival for

Table 2

Rooting of cuttings for five *Grindelia* accessions<sup>a</sup>

Accession	Rooting (%)	
555 ( $n = 45$ )	77.0	a
547 ( $n = 5$ )	67.3	ab
533 ( $n = 5$ )	61.7	bc
569 ( $n = 5$ )	56.2	c
575 ( $n = 5$ )	42.6	d

<sup>a</sup>  $n = 5$  Plants/accession, 20 cuttings/plant, except for accession 555 with  $n = 45$ , 20 cuttings/plant.

all clones was 62%. Survival of the transplanted seedlings of comparable size has been close to 90% in experiments in these same fields (Ravetta, unpublished data), similar to the clones when the two low surviving clones are not considered.

#### 4. Conclusions

Vegetative propagation is possible for *G. chiloensis* using IBA in concentrations between 0.3 and 1.6%. This method appears to be promising for establishing cultivated stands, because it permits the increase of improved lines. Traits such as resin content and composition, and regrowth after harvest are some of the most important characteristics to select for.

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