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Influence of Auxins on Rooting of Stem Cuttings of the Small-Leaved White Crossby (Gudaim), *Grewia tenax* (Forsk)

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ABSTRACT

The small-leaved white crossberry (Gudaim), *Grewia tenax* (Forsk) Fiori , is a deciduous, tropical shrub or tree valued for its fruit. Being high in iron content, the fruit is considered as a simple safeguard against iron-deficiency anemia. In spite of this, the fruit is exploited from the wild and there have been little or no efforts to domesticate and cultivate this species. Information on the vegetative propagation of this species is not available at the present time. A series of nursery experiments were conducted during March-June 2003 to assess the effects of auxin source [indole acetic acid (IAA), indole-3-butyric acid (IBA) and α-phthalene acetic acid (NAA)], concentration (0, 1000, 1500 and 2000 ppm) duration of exposure (quick dip, one-minute dip and five-minutes dip (and form (liquid versus powder) on adventitious root formation in stem cuttings. Significant stimulation of rooting was observed with IBA at all concentrations and with IAA at 1000 and 1500 ppm. NAA, at all concentrations, was ineffective in promoting root formation. Maximum rooting success with IBA was achieved at 1500 ppm (43%) and with IAA at 1000 ppm (37%). Short-term exposure (quick dip or one-minute dip) of the cut surface to 1500 ppm IBA solution resulted in greater rooting success (57%-61%) than a five-minutes dip (32%). IBA talcum powder worked slightly better than in liquid form (56% versus 52%). It was concluded that application of 1500 ppm IBA as a quick dip in liquid or powder form is the most suitable treatment for rooting of stem cuttings of this species.

INTRODUCTION

The small-leaved white crossberry (Gudaim), *Grewia tenax* (Forsk) Fiori, is a tropical, deciduous fruit-producing shrub or tree. It is widespread in semi-arid and sub-humid tropical climates. The fruit، known locally in the Sudan as "Gudaim" is a rich source of carbohydrates, proteins, vitamins and minerals (Abdelmutti, 1991). Of the wide range of nutrients in the Grewia fruit, the high iron content (7.4 mg per 100 g pulp) has attracted most attention. The fruit is considered as a simple safeguard against iron-deficiency anemia (Abdelmutti, 1991). It is relished out of hand by children and adults, or made into juice as a refreshing drink (El-Siddig *et al*, 2003). The fruit pulp is also used with millet flour for making "*Nesha*", a thin porridge given to pregnant and lactating women to improve their health and milk production (Abdelmutti, 1991). Elsewhere in Africa and Asia, various pans of the plants are used in preparing infusions and decoctions for home remedies against colds and chest complaints (Vogts, 1995).

In spite of its potential, commercial plantations in the Sudan are practically not existing and wild plants are continuously being overexploited to meet the growing commercial demand for the fruit (El-Siddig *et al*, 2003). Recently, however, alternative and potentially high-value cash crops are being sought to supplement the incomes of small farmers who are currently dependent upon growing and selling millets، sorghum, sesame and groundnut. *G. tenax* has often been cited as prime candidate for domestication as a useful horticultural plant (El-Siddig *et al*, 2003).

G. tenax is traditionally grown from seeds. The primary disadvantage of seedlings is the genetic variability, which may result in variations in plant height, yield and fruit characteristics. On the other hand, vegetative propagation plays a key role in tree domestication and improvement programs as a means of a large-scale multiplication of superior genotypes. The retention of desirable characteristics, the creation of a uniform rootstock, and the ability to mass-produce homogeneous plants quickly and efficiently are all advantages of asexual propagation (Adriance and Brison, 1955). Growth regulating chemicals have been extensively used to promote rooting of asexually propagated plants (Hafimann *et al*., 1990). The class of compounds identified as auxins are the most predominant chemicals used to enhance rooting: The three most common auxins used for rooting are: indole-3-acetic acid (IAA), indole-3- butyric acid (IBA), and napthalene acetic acid (NAA). Auxin source، concentration, method of treatment and duration of contact may have considerable effects on the rooting of many plants. Therefore, the objective of this study is to determine the effects of these factors on rooting of stem cuttings of *Grewia tenax*.

MATERIALS AND METHODS

Procedures for preparing and planting of cuttings

The study was carried out during March-June 2003 at the Arid Land Research Center, Tottori University, Japan. The seed source of stock plants was a wild stand near Kutum (14^{0}11' N, 24^{0}40' E), North Darfur، Sudan. The stock plants were potted in 20-litre plastic pots, filled with river sand and placed in a naturally lit greenhouse. Two-node cuttings، *ca*. 10-15 cm were prepared using the first six apical nodes on shoots arising from each stock plant. Leaf laminae were trimmed to about one third of their size to prevent excessive water loss through transpiration. The cuttings were then placed into a bucket containing tap water to prevent drying out. Immediately after treatment, the cuttings were stuck about one-third of their length into the rooting medium. The rooting medium was a sand/peat mixture (2:1 v/v) contained in 5-litre pots، which were kept in a naturally lit greenhouse with mean day/night temperatures of 25/18˚C and a mean relative humidity of 40-60%. During propagation, cuttings were sprayed with tap water twice a day using a hand-held sprayer. The cuttings were carefully uprooted after 4-6 weeks and rated for survival and rooting percentages, mean number of roots per cutting and mean root length. The survival and rooting percentages. were transf01ned using arcsin transformations, and root numbers and lengths were transformed using square root [$\sqrt{(x + 0.5)}$] transformations. However, the values shown in the text and tables are original untransformed data. Three experiments were conducted as follows:

Experiment 1: Effects of auxin source and concentration

Three auxins [indole acetic acid (IAA), indole-3-butyric acid (IBA) and a-naphthalene acetic acid (NAA)] at three concentrations (1000، 1500 and 2000 ppm) were tested for their effects on rooting of *Grewia tenax* stem cuttings. Auxin solutions were prepared by dissolving 100، 150 or 200 mg of pure compound (Sigma Chemical Company Ltd., UK) in 50 ml of 95% ethanol and the solution was brought to 100 ml with distilled water. The 50% ethanol control (*v/v*) was made by adding equal amounts of ethanol and distilled water. A total of 10 treatments including the control were used. Three batches of 10 cuttings were prepared for each of the ten treatments. Basal ends of the cuttings were dipped quickly into the appropriate auxin solutions and planted in the propagation medium. The experiment was laid out in a completely randomized design with 10 treatments and 3 replications, giving a total of 30 pots with 10 cuttings each. The cuttings were carefully uprooted after 4 weeks and rated for survival and rooting percentages, mean number of roots per cutting and mean root length.

Experiment 2: Effect of duration of application

The results of experiment 1 indicated that adventitious roots were induced optimally by 1500 IBA; therefore the rooting solution utilized in this experiment was IBA at 1500 ppm. To compare the duration of exposure of the cut surface to auxin solution, two-node leafy cuttings were treated with 1500 ppm IBA as a quick dip, one-minute dip and a five-minutes dip. A quick dip in 50% ethanol solution was used as a control. The experiment was laid out in a completely randomized design with 4 treatments and 3 replications, giving a total of 12 pots with 10 cuttings each. The cuttings were carefully uprooted after 6 weeks and rated for survival and rooting percentages, mean number of roots per cutting and mean root length.

Experiment 3: Effect of formulation

To compare liquid versus powder formulation, two-node leafy cuttings were either dipped in 1500 ppm IBA solution or in 1500 ppm talc formulation. Talc formulation was prepared by mixing 1.5 g IBA with 97.5g talcum powder and allowing it to dry at room temperature. The basal end of the cutting was dipped approximately 2 cm into the powder before planting into the rooting medium. The experiment was laid out in a completely randomized design with 2 treatments and 3 replications‘ giving a total of 6 pots with 10 cuttiqgs each. The cuttings were carefully uprooted after 6 weeks and rated for survival and rooting percentages‘ mean number of roots per cutting and mean root length.

RESULTS AND DISCUSSION

The effects of auxins (IAA, IBA and NAA) applied at three concentrations: 1000, 1500 and 2000 ppm each as a quick dip on the rooting of *Grcwia tenax* cuttings are presented in Table l. The highest rooting percentage was attained with IBA treatments (18-43%), followed by IAA treatments (16-37%). NAA treatments (13-14%) were similar to the control (12%). Application of IBA promoted rooting up to an optimum concentration of 1500 ppm. In IAA treatments, survival and rooting percentages were highest at 1000 ppm and decreased with increasing auxin concentration. The mean root number at all IAA, IBA and NAA treatments was significantly greater than the control, but did not differ among auxin concentration. The mean root length at all IAA and IBA treatments was significantly greater than the control, but did not differ among each auxin concentrations. No significant difference was observed in the mean root length between NAA-treated and untreated cuttings, but slightly higher values were found with NAA at 1000 and 2000 ppm.

Table l. Effects of auxins applied at three concentrations on survival and rooting percentage, root number and root length of 2-node leafy stem cuttings of *Grewia tenax*.

Treatment	Survival (%)	Rooting (%)	Root no.	Root length
Control	20f	12f	3.5c	8.4b
IAA 1000 ppm	41c	37b	6.7ab	13.1a
IAA 1500 ppm	35d	27c	7.2a	13.1a
IAA 2000 ppm	23ef	16e	6.9ab	15.5a
IBA 1000 ppm	47b	37b	7.4a	14.9a
IBA 1500 ppm	62a	43a	6,7ab	15.6a
IBA 2000 ppm	27e	18d	6.4ab	15.8a
NAA 1000 ppm	23ef	14ef	5.3a	9.2b
NAA 1500 ppm	17f	13ef	6.1ab	7.8b
NAA 2000 ppm	17f	14ef	5.9ab	9.1b

Means with the same letters in a column are statistically similar according to Tuckey's Test (P=O.05)

The differential root-regenerating capacities of the different auxins might depend on their respective capacities to synthesize proteins essential for the regeneration and elongation of roots (Ghosh and Basu، 1974). Several hypotheses have been adopted to explain the rooting efficacy of IBA. IBA is more stable than IAA under various light and temperature conditions, both in solution and *in vivo* (Nissen and Sutter1990 ; Nordstrom *et. al*., 1991). Differences in transport, uptake, or metabolism might also contribute to the superior activity (Epestein and Ludwig-Muller 1993). Alternatively, a specific IBA to IAA ratio may be important for root development, and the application of exogenous IBA might shift the balance to promote rooting (Epestein and Ludwig-Muller، (1993) IBA is probably the most widely and commercially used auxin، because it is nontoxic over a wide range of plants and is effective in promoting rooting of a large number of plant species (Hamilton and Midcap, 1981).

Table 2 shows the survival and rooting percentages, mean root number and mean root length per cutting as influenced by the duration of exposure of the cut surface to 1500 ppm IBA solution. Treated cuttings showed significantly higher rooting percentage than untreated cuttings‹ irrespective of the duration of immersion of the cut surface. Short-term exposure as a quick dip or one-minute dip resulted in greater rooting. success than a five-minutes dip. Similar trend was observed for the mean root number. Many growers prefer the IBA quick dip immersion of basal ends for rooting of cuttings (Hartmann *et al*., 1990). Quick dip method using concentrated stock solution may have greater rooting success since the cuttings are immersed for a brief time at high auxin concentration. The basal ends of cuttings are immersed approximately 3 cm deep in solution for a few seconds and there may be adequate absorption of the IBA. On the other hand, immersion of the cut surface for a longer time (e.g. five minutes) may have increased IBA concentration beyond the threshold of auxin tolerance and inhibited root growth (Blazich, 1988) Immersion of the basal end of cuttings in 1500 ppm IBA for more than five minutes inhibited root regeneration and shoot development in scarlet oak (Struve and Moser, 1984).

Table 2. Effects of duration of exposure to IBA solution at 1500 ppm on survival and rooting percentages, root number and root length of 2-node leafy stem cuttings of *Grewia tenax.*

Treatment	Survival(%)	Rooting(%)	Root no.	Root length (cm)
Control	32a	17a	4.3a	9.4a
Quick dip	80b	57b	8.7bc	13.6b
I min dip	72bc	61b	9.4b	11.6ab
5 min dip	56d	32c	9.9a	10.9ab

Means with the same letters in a column are statistically similar according to Tuckey's Test (P=0.05)

Table 3 compares the effects of liquid and powder formulation on the survival and rooting percentages, mean root number and mean root length per cutting. Powder worked slightly better than liquid formulation in all rooting parameters, except the mean root length per cutting. It is difficult to relate concentration to promote rooting when comparing IBA blended in powders and liquids due to variations in the method of application, retention, and use of the IBA by the plant tissue (Blazich، (1988) There is, however, good evidence that quick dips in concentrated auxin solutions are superior to talc for rooting most cuttings. This may be related to the fact that the talc has to dissolve on the surface of the cutting before it can be absorbed and water will not penetrate as quickly as the alcohol solvent (Hartmann *et al*،. 1990) Moreover, powder application may show inconsistent results due to washing off the talc. However, the powders are the most practical for the amateur because they are diluted with talc to concentrations that will not harm the cuttings and they are easy to use (Larsen, 1997).

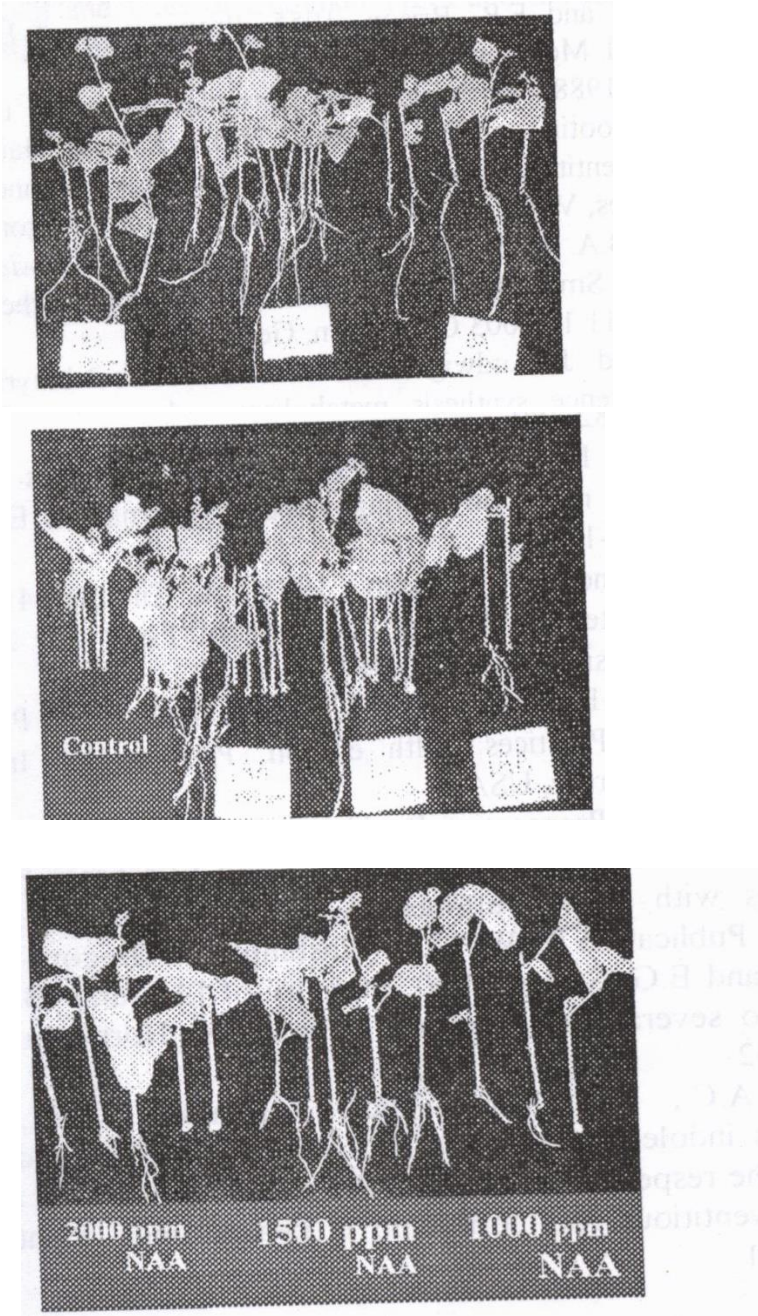
Table 3. Effects of liquid and powder formulation of 1500 ppm IBA on survival and rooting percentages, root number and root length of 2-node leafy stem cuttings of *Grewia tenax*.

Treatment	Survival(%)	Rooting(%)	Root no.	Root length (cm)
Liquid	78a	52a	7.9a	14.4a
Powder	87a	56a	8.4a	12.8a

Means the same letters in a column are statistically similar according to Tuckey's Test (P=0.05).

The difference in rooting success obtained from these trials could be attributed to duration of the trial. As can be seen in the photographs (Plate l), many of the cuttings in experiment l, which did not root until the end of the experiment, are well-callused and apparently healthy. They may still have rooted, had we left them in the rooting medium longer than 4 weeks. This explains the high rooting success in experiment 2 and ،3both of which lasted for 6 weeks, in comparison with experiment I From the present study, *G. tenax* seems to be a relatively easy-to-root species with the aid of exogenous auxin application. However, there appear to be differences in the success of rooting between auxin sources، concentrations, duration of exposure, and to a less extent, the form. The best results were achieved by application of 1500 ppm IBA as a quick dip in liquid or powder formulation. In conclusion, this treatment is the most suitable one for rooting of stem cuttings of this species.

Plate 1. The effect of auxins (IAA, IBA and NAA) at three concentrations (1000, 1500 and 2000 ppm) on rooting of stem cuttings of *Grewia tenax*.



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