THE EFFECT OF IBA AND/OR NAA AND CUTTING WOOD SELECTION ON THE ROOTING OF *RHAPHIOLEPIS INDICA* 'JACK EVANS'

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Abstract. Solutions of IBA (0, 1000, 5000 and 9000 ppm), NAA (0, 1000 and 2000 ppm) and all possible IBA + NAA combinations were tested for effectiveness in rooting cuttings taken from the upper and lower portions of semi-hardened shoots of *Rhaphiolepis indica* 'Jack Evans.' Combinations produced rooting which was greater than that produced using IBA or NAA alone. With minimal compound use, 5000 + 2000 and 9000 + 1000 (IBA ppm + NAA ppm) yielded the greatest percentages of transplantable cuttings (67 to 68%). Cuttings prepared from the upper and lower portions of shoots responded similarly to the range of solutions tested, with cuttings from lower portions rooting only slightly better than those from upper portions.

INTRODUCTION

Rhaphiolepis indica 'Jack Evans' is considered to be a moderately difficult plant to propagate. In nursery production, rooting percentages range from 40 to 70%. Traditionally, 3-indolebutyric acid (IBA) has been used to promote rooting. But more recently, improved rooting has resulted from using IBA in combination with 1-naphthaleneacetic acid (NAA) (1).

Preliminary rooting studies on *R. i.* 'Jack Evans' were carried out to understand the effectiveness of IBA or NAA used individually. Results from these studies indicated that the effective concentration range for IBA was 6000 to 12,000 ppm while that for NAA was 1000 to 3000 ppm. It was also noted that cuttings which had been taken from the lower portions of semi-hardened shoots seemed to root better than cuttings which had been taken from the upper portions. These findings led to the present study in which solutions of IBA and NAA, alone and in combination, were tested on cuttings taken from the upper and lower portions of semi-hardened shoots of *R. i.* 'Jack Evans' to determine the following:

1. If IBA + NAA combinations more effectively root cuttings than do IBA or NAA alone.
2. If cuttings prepared from the lower portions of semi-hardened shoots root better than cuttings selected from upper portions.
3. If the same solutions can be used to root cuttings selected from both the upper and lower portions of a semi-hardened shoot.

METHODS AND MATERIALS

Twelve rooting solutions were tested on each of 2 cutting types for a total of 24 treatments. Each treatment involved 15 cuttings and was replicated 7 times.

The 12 rooting solutions (Table 1) resulted from a factorial combination of 4 IBA concentrations (0, 1000, 5000 and 9000 ppm) with 3 NAA concentrations (0, 1000 and 2000 ppm). All solutions were 50% ethanol by volume.

Table 1. Rooting solutions tested (IBA ppm + NAA ppm)

IBA	NAA	Combinations	Control
1000 + 0	0 + 1000	1000 + 1000	0 + 0
5000 + 0	0 + 2000	5000 + 1000	
9000 + 0		9000 + 1000	
		1000 + 2000	
		5000 + 2000	
		9000 + 2000	

Cuttings were made October 11, 1984 from 11 to 14 in. shoots gathered from plants grown in #4 containers. After the soft tip was discarded, the remaining semi-hardened stem provided two cuttings: one from the upper, softer, brown-maroon, finely-haired, younger portion, and another from the lower, harder, brown, finely-grained, older portion. Throughout this report these cutting types will be referred to respectively as upper and lower cuttings.

The top stem cut of an upper cutting was made approximately 1 in. below the point where the wood had begun to harden. The top stem cut of a lower cutting was made at the color transition from brown to brown-maroon. Diagonal bottom cuts for both cuttings were made 3¼ in. below top cuts. The 3 to 4 fully expanded leaves remaining after lower ones were removed by tearing made the total cutting length approximately 5 in.

Cuttings were stuck in 14 flats: 7 for lower cuttings and 7 for upper cuttings. Each flat held one replication of each of the rooting solution treatments. Within a flat, rooting treatments were organized into 12 randomized rows of 15 cuttings each with one treatment per row. This block of treatment rows was buffered on two sides by double rows of cuttings to protect against edge effects, bringing the total rows per flat to 16.

Before sticking, the basal ends of cuttings (½ to ¾ in.) were treated with the test solutions using the quick dip method (<1 second in solution). Cuttings were stuck in flats containing coarse perlite and expanded fine peat (9:1 by volume). Flats were then placed on a heated bed under intermittant mist in full sun. Root zone temperature was maintained between 68° and 73°F. Mist was applied during the day as needed, usually every 8 or 16 min. for 4 to 6 sec.

After a 40-day rooting period, cuttings were removed from the mist and 8 days later, harvested. Treatment rooting percentages were then determined for 2 categories: *transplantable cuttings* which consisted of cuttings with a minimum of 5 to 6 roots, each at least 1 in. in length, and *rooted cuttings* which consisted of all cuttings with roots (including transplantable ones).

RESULTS AND DISCUSSION

Most Effective Solutions. Three solutions, 5000 + 2000, 9000 + 1000, and 9000 + 2000, produced the highest rooting percentages for *R. i.* 'Jack Evans' (Table 2). For transplantable cuttings, these percentages ranged from 67 to 68% and for all rooted cuttings, from 85 to 91%. It should be noted that these more highly concentrated solutions gave results not statistically different from others tested. However, they were determined to be most effective since the general trend among treatments was for percentages to increase as concentrations increased (Figure 1).

Table 2. The effect of IBA and/or NAA on the rooting of *Rhaphiolepis indica* 'Jack Evans'[1].

Transplantable Cuttings		All Rooted Cuttings	
IBA + NAA(ppm)	Rooting %[2]	IBA + NAA(ppm)	Rooting %
9000 + 1000	68 a	9000 + 1000	91 a
9000 + 2000	67 a	5000 + 2000	89 ab
5000 + 2000	67 a	9000 + 2000	85 abc
0 + 2000	58 ab	0 + 2000	84 abcd
1000 + 2000	58 ab	1000 + 2000	83 abcd
5000 + 1000	53 ab	5000 + 1000	79 abcd
9000 + 0	47 ab	9000 + 0	76 abcd
0 + 1000	41 b	1000 + 1000	73 bcd
1000 + 1000	38 b	0 + 1000	70 cd
5000 + 0	36 b	5000 + 0	62 d
1000 + 0	7 c	1000 + 0	33 e
0 + 0 (control)	6 c	0 + 0 (control)	23 e

[1] 30 cuttings per treatment replicated 7 times.
[2] *Mean separation within columns by Duncan's Multiple Range Test at the 10% level* of significance.

Of the three most effective solutions, 5000 + 2000 and 9000 + 1000 produced high rooting with minimal compound use. No additional rooting resulted from using the more concentrated 9000 + 2000 solution.

Extrapolation from the data indicates that rooting percentages higher than those which occurred may be obtained with other solutions. For example, in Figure 1 with solutions containing 1000 ppm NAA, rooting may continue to increase as IBA is increased to levels higher than 9000 ppm. Likewise with solutions containing 5000 ppm IBA, rooting may continue to increase as NAA is increased to levels higher than 2000 ppm.

Effectiveness of IBA + NAA Combinations. For each IBA concentration, the combination with NAA resulted in higher rooting percentages than when IBA was used alone (Figure 1).

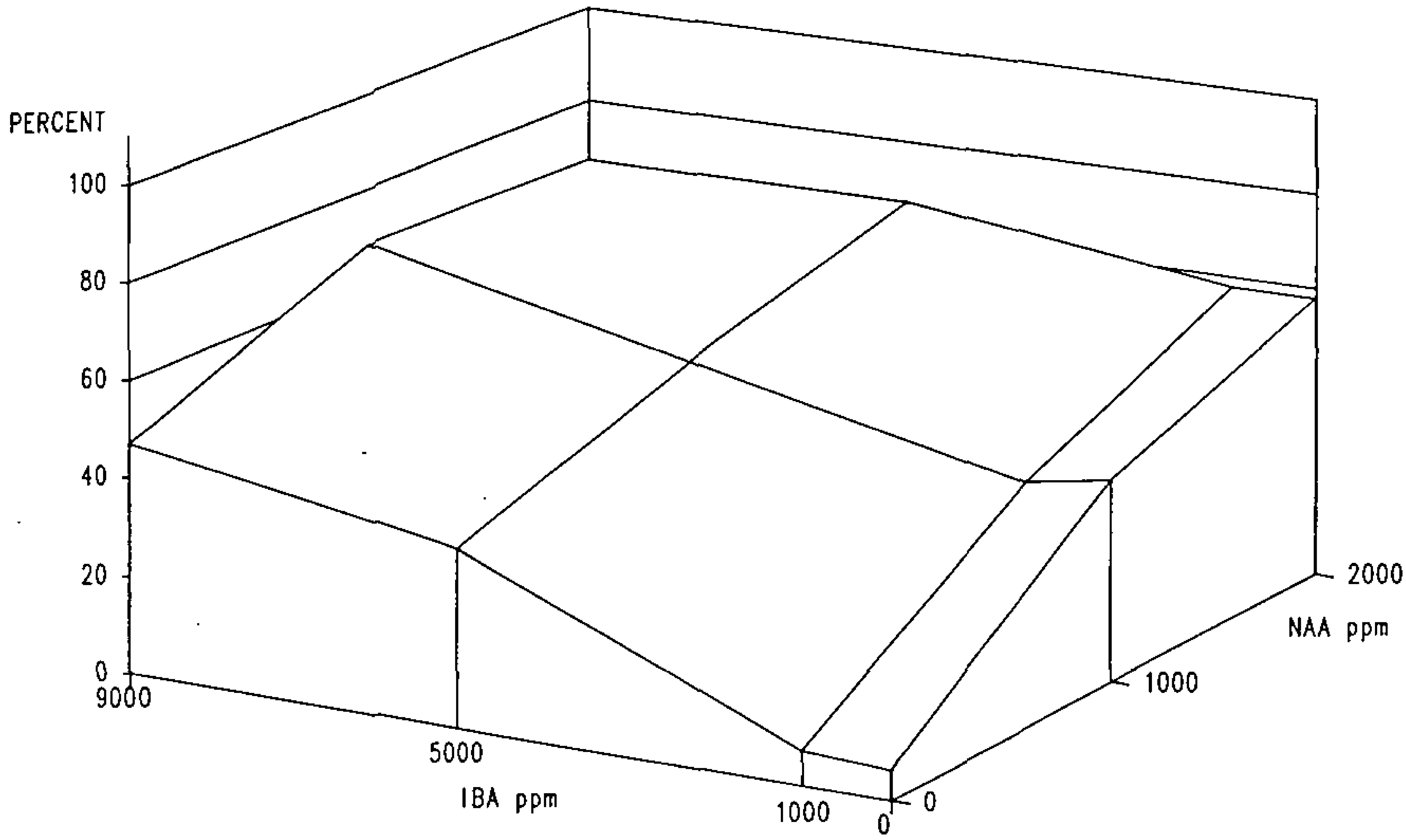

Figure 1. The effect of IBA and/or NAA on the rooting of *Rhaphiolepis indica* 'Jack Evans' (transplantable cuttings).

Likewise, for each NAA concentration, the combination with IBA (except for 1000 ppm) resulted in higher percentages than when NAA was used alone. These differences indicate that IBA + NAA combinations are generally more effective than is IBA or NAA alone.

When IBA + NAA combinations are compared at a particular rooting percentage, it is observed that the effectiveness of a particular combination lies not in any ideal IBA or NAA concentration, but in their relative concentrations. An inverse relationship between the compound concentrations of a solution may be seen when comparing the equally effective 9000 + 1000 and 5000 + 2000 combinations. For 9000 + 1000, a high concentration of IBA is effective with a low-medium concentration of NAA, but for 5000 + 2000, a lower concentration of IBA is effective with a high concentration of NAA.

Effect of Cutting Wood Selection. Lower cuttings had higher rooting percentages than did upper cuttings for the majority of rooting solutions (Table 3). When averaged for all rooting solutions, the data for transplantable cuttings indicate that 6% more lower cuttings rooted than did upper cuttings (Table 4). Likewise, for rooted cuttings, 9% more lower cuttings rooted than did upper cuttings. When analyzed, the 6% difference was not found to be significant while the 9% was. Though these results indicate that cuttings taken from the upper and lower portions of semi-hardened shoots may root differently, the difference is minor.

Table 3. The effect of IBA and/or NAA on the rooting of upper and lower cuttings of *Rhaphiolepis indica* 'Jack Evans' (transplantable cuttings)[1].

Upper Cuttings		Lower Cuttings	
IBA + NAA(ppm)	Rootings %[2]	IBA + NAA(ppm)	Rooting %
9000 + 2000	69 a	9000 + 1000	69 a
9000 + 1000	67 ab	5000 + 2000	69 a
5000 + 2000	65 ab	0 + 2000	66 a
1000 + 2000	51 ab	9000 + 2000	66 a
0 + 2000	50 ab	1000 + 2000	64 a
9000 + 0	49 ab	5000 + 1000	57 a
5000 + 1000	49 ab	0 + 1000	49 a
1000 + 1000	41 ab	9000 + 0	46 a
0 + 1000	34 ab	5000 + 0	43 a
5000 + 0	31 b	1000 + 1000	34 ab
1000 + 0	6 c	1000 + 0	9 bc
0 + 0 (control)	3 c	0 + 0 (control)	8 c

[1] 15 cuttings per treatment replicated 7 times.
[2] Mean separation within columns by Duncan's Multiple Range Test at the 10% level of significance.

Table 4. The effect of cutting position on the rooting of *Rhaphiolepis indica* 'Jack Evans'[1].

	Rooting %[2]	
Cutting Position	Transplantable Cuttings	All Rooted Cuttings
Lower	46 a	77 a
Upper	40 a	68 b

[1] 180 cuttings per treatment replicated 7 times.
[2] Mean separation within columns by Duncan's Multiple Range Test at the 10% level of significance.

Effect of Rooting Solutions on Upper and Lower Cuttings. Rooting solutions which were most and least effective for rooting upper cuttings were generally the same as those which were most and least effective for lower cuttings (Table 3). This indicates that *the recommended rooting solutions for R. i. 'Jack Evans' will be* suitable for all cuttings selected from the semi-hardened portions of shoots.

CONCLUSIONS

Combinations of IBA and NAA are more effective for rooting *Rhaphiolepis indica* 'Jack Evans' than is IBA or NAA alone. The concentrations of IBA and NAA used in equally effective combinations *may* be inversely related; a high concentration of one compound is effective with a low concentration of the other compound.

Of the solutions tested, the combinations 5000 + 2000 and 9000 + 1000 (IBA ppm + NAA ppm) are recommended because they maximize rooting percentages while minimizing compound use. For the cost-conscious propagator, 5000 + 2000 is more highly recommended since the cost of NAA is one-fifth that of IBA.

Cuttings prepared from the lower portions of semi-hardened shoots root only slightly better than those selected from upper portions. While it is important to consider wood selection during cutting preparation, the choice of the proper rooting solution can have a greater impact on the rooting of *Rhaphiolepis indica* 'Jack Evans'.

Cuttings prepared from both the upper and lower portions of a shoot have the same relative responses to rooting solutions. Thus, the recommended solutions can be used for all cuttings which are derived from the semi-hardened portions of shoots.

LITERATURE CITED

1. Berry, James B. 1984. Rooting hormone formulations: a chance for advancement. *Proc. Inter. Plant Prop. Soc.* 34:486–491.

A 17-YEAR CASE HISTORY OF RESEARCH AND IMPLEMENTATION OF WATER RECYCLING ON CONTAINER NURSERY STOCK

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INTRODUCTION

This is a case history report on our progress in recycling irrigation runoff water over container ornamentals. In 1974, at the 15th Annual Meeting of IPPS, Western Region, I described a minor system of filtration of water for reuse. Later that year, we began more intensive research in the study of recycling water. This report describes the increase in knowledge gained since the original project was conceived, the culmination of this research, and the resulting construction of a 2.0 million gallon per day (MGD) (7571 m^3) water processing plant, and the results since we began recycling in 1979.

HISTORY

In 1971 we foresaw the need to control water pollution and to conserve water. In this respect we studied nitrogen (N) in the environment to determine ways to reduce its usage and we built a minor filtration plant with the thought of recycling both the water