

# Update On Root-Promoting Chemicals and Formulations

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## INTRODUCTION

In my 20 years as a member of this society, I have read more papers and heard more questions about root-promoting chemicals than any other subject. Members have eagerly tested chemicals and formulations, but none has been as effective as indolebutyric acid (IBA) and naphthaleneacetic acid (NAA) (Dirr, 1981; Dirr and Heuser, 1987).

A major hurdle to the development of new root-promoting chemicals, particularly in the United States, is the EPA registration process. The chemical must undergo screening for toxicity to a wide range of organisms. Since the root-promoting chemicals are categorized as minor-use compounds, companies are not enthusiastic about spending the necessary money to bring them to market. A recent estimate placed the cost between 4 and 10 million dollars for the introduction of a new non-food chemical like IBA.

IBA and NAA are legally registered for use in plant propagation. Theoretically, plant propagators cannot buy and use the actual chemicals. They must purchase products from end-use formulators that have been approved by EPA. Read the labels on products like Dip 'N Grow, Hormodin #1, and Hormo-Root. An EPA Registration Number appears on each formulation. For example, Hormodin 1, 2, and 3, represent 0.1%, 0.3%, and 0.8% IBA in talc. Each concentration has a separate EPA number.

## AVAILABILITY AND COSTS

IBA, NAA, and the potassium salts of each can be purchased from companies listed in Table 1. Always purchase the gamma form of IBA and the alpha form of NAA. Consistently, the potassium (K) salts are higher priced than the acid formulation. Table 2 provides a guide to costs based on fall 1992 catalog prices. NAA is always less expensive than IBA, but is not as broad-spectrum effective. I seldom use NAA; the salt of IBA has become the common denominator in our propagation program.

## STORAGE AND PURITY

The chemical companies recommend that IBA be stored at 32 to 41°F and NAA at room temperature. However, Research Organics, Inc. recommends storing the K-salts of IBA and NAA at room temperature. I have found that refrigerator storage of both works well.

The stability of IBA solutions is perennially debated. Robbins (1987) reported that a 5,000 ppm solution of IBA was stable and maintained biological activity for six months. Storage temperatures of 72 to 77°F, 32°F, or 43°F made no difference. However, significant loss of activity occurred after 19 months.

Often propagators are overly concerned about the absolute concentration of the rooting powder or solution. Be as accurate as possible, but the actual IBA is 97 to 99% pure, NAA 95%. This means that for every gram (1,000 mg) of 97% IBA, 30 mg are something else. In short, the propagator starts with a 3% error for IBA or

**Table 1.** Suppliers and costs of alpha-naphthalene acetamide, alpha-naphthaleneacetic acid, potassium salt of NAA, indolebutyric acid, and potassium salt of IBA.

Alpha-NAA	NAA	KNAA	IBA	KIBA
ICN <sup>*1</sup>				
10 g - \$6.35	25 g - \$8.75	N/A**	1 g - \$5.70	5 g - \$18.85
25 g - \$11.45	100 g - \$23.45		5 g - \$17.80	25 g - \$81.10
100 g - \$31.80			25 g - \$50.15	
			50 g - \$94.05	
Sigma <sup>2</sup>				
10 g - \$4.70	25 g - \$8.90	N/A	1 g - \$5.70	1 g - \$7.55
25 g - \$9.35	100 g - \$23.60		5 g - \$17.25	5 g - \$17.35
100 g - \$26.00			25 g - \$46.10	25 g - \$46.20
Research Organics <sup>3</sup>				
N/A	25 g - \$7.95	25 g - \$10.50	5 g - \$6.75	5 g - \$11.85
	100 g - \$21.60	100 g - \$32.00	10 g - \$11.70	50 g - \$76.50
	1 kg - \$198.50	1 kg - \$276.00	100 g - \$91.00	500 g - \$595.00
			500 g - \$420.50	
			1 kg - \$786.00	
U.S. Biochemical <sup>4</sup>				
N/A	N/A	N/A	1 g - \$3.65	1 g - \$4.05
			5 g - \$8.85	5 g - \$12.30
			25 g - \$34.25	25 g - \$49.15
			100 g - \$129.50	
			1 kg - \$1,276.80	
Aldrich Chemical Co. <sup>5</sup>				
25 g - \$9.35	5 g - \$8.00	N/A	5 g - \$17.28	N/A
	100 g - \$23.60		25 g - \$46.10	
	1 kg - \$121.40			

\*Chemical Supply Company, 1992 catalog prices

\*\*N/A = not available

<sup>1</sup>ICN, 3300 Hyland Ave., Costa Mesa, CA 92626<sup>2</sup>Sigma, P.O. Box 14508, St. Louis, MO 63178, Phone:(800) 325-3010, FAX:(800) 883-1576<sup>3</sup>Research Organics, 4353 East 49th Street, Cleveland, OH 44125, Phone:(800) 321-0570, FAX:(216) 883-1576<sup>4</sup>U.S. Biochemical, P.O. Box 22400, Cleveland, OH 44122, Phone:(800) 321-9322<sup>5</sup>Aldrich Chemical Co., 1001 W. Saint Paul, Milwaukee, WI 53233, Phone:(800) 558-9160

**Table 2.** Comparative costs of indolebutyric acid, naphthaleneacetic acid, and their potassium salts.

Chemical	Cost (\$) Acid	Cost (\$) Salt
IBA	6.75/5 g	420/500 g
KIBA	11.85/5 g	595/500 g
NAA	7.95/5 g	198/1000 g
KNAA	10.50/25 g	276/1000 g

a 5% error for NAA unless these numbers are factored into the process. To calculate the quantity of 97% IBA to be added to 1 liter of solvent to obtain 10,000 ppm IBA, divide 100 by 97 and then multiply this by 10 g (10.31 g).

## FORMULATIONS

**Liquid and Talc Formulations.** The liquid and talc formulations currently available from United States and European companies are listed in Table 3. The newest, easy-to-use product is the Rhizopon-AA soluble tablet. (Available from Hortus USA Corp., 245 West 24th St., New York, NY 10011-1717, 212-929-0927). It looks like a giant brownish aspirin, weighs 250 mg and is 20% IBA. The actual IBA is 50 mg per tablet. Theoretically dissolve 20 tablets in a liter of solvent to produce a resultant 1,000 ppm IBA solution. Note, the tablets are made from the acid form of IBA and to produce more concentrated solutions, a solvent like alcohol must be used.

**Table 3.** Root-promoting talc and liquid formulations.

Talcs/tablet	Liquid
Rhizopon AA soluble tablets	Woods Rooting Compound
Hormex 1, 2, 3, 8, 16, 30, 45	Dip 'N Grow
Hormo-Root A, B, C, 1, 2, 3, 4	C-Mone
Hormodin 1, 2, 3	Stim-Root (Canadian)
Plantabbs rooting powder	Synergol (European)
Ferti-lome rooting powder	
Grow more rapid root	
Security clip and dip rooting compound	
Rootone F	
Seradix (European)	

In the United States, I found only three commercially available liquid formulations (Table 3). Dip 'N Grow and Woods Rooting Compound are well known to most propagators. They consist of approximately 1.0% IBA and 0.5% NAA in various solvents. C-Mone is available from Coor Farm Supply Service, Inc., Smithfield, North Carolina 27577 (800-999-4573). There are a number of formulations,

including K-salts, available from Coor. To date, Coor Farm Supply is the only company in the United States offering KIBA formulations.

**Table 4.** The relative weight in grams of IBA, KIBA, NAA, and KNAA (average of 5 weights).

	1/2 teaspoon	1 teaspoon	1 tablespoon
IBA	0.71	1.61	4.36
KIBA	0.80	1.55	4.85
NAA	0.53	1.00	2.93
KNAA	0.45	0.96	3.04

**Preparation of IBA and NAA Formulations.** I weighed level 1/2 teaspoon, teaspoon, and a tablespoon of "pure" forms of IBA, NAA, and the K-salts (Table 4). The differences were enormous, particularly between IBA and NAA. Weigh as accurately as possible when mixing the chemicals to produce a liquid or talc formulation. Do not accept volumetric measurements as representative of a given weight. For absolute precision, weigh with a gram scale and use metric volumetric vessels.

For realistic purposes and sanity maintenance, weigh 5 g of the chemical and add to one pint of solvent to obtain 10,000 ppm or 1.0% stock solutions. Ten grams to a quart of solvent produces the same results.

The solvents most commonly used are water for the K-salts and alcohol for acids. Carriers or penetrants including DMSO (dimethyl sulfoxide) have been used but are no longer included in commercial formulations. Woods Rooting Compound will no longer include dimethyl formamide (DMF).

**Table 5.** Dilution rates for producing 1,000, 3,000, and 5,000 ppm IBA solutions from 10,000 ppm IBA stock solution.

Desired concentration	Stock (10,000 ppm IBA)	Solvent (dilutant)
1,000 ppm IBA	1 part (10 ml)*	9 parts (90 ml)
3,000 ppm IBA	3 parts (30 ml)	7 parts (70 ml)
5,000 ppm IBA	1 part (50 ml)	1 part (50 ml)

\*Represents the volume in milliliters (ml) assuming a 100-ml graduated cylinder is used. For a 500-ml graduated cylinder use 5 times the amount listed; 1,000-ml graduated cylinder use 10 times the amount listed.

Much has been written about the use of propylene glycol and polyethylene glycol; however, their overall efficacy is still unclear (Barnes, 1988; Barnes, 1989; Dirr, 1989). If the data are intensely scrutinized, their use appears beneficial for extremely difficult-to-root species and species that are sensitive to alcohol.

Once the concentrated stock solutions are made, it is easy to produce lower concentration solutions by simple dilution with the appropriate solvent. Use 100-, 500-, and 1000-ml graduated cylinders to facilitate the process (Table 5). For most softwood cuttings, 1,000 to 3,000 ppm is the concentration range of choice. Use 5,000 ppm for firmer-wooded, late season cuttings and 10,000 ppm for extremely difficult species.

IBA and NAA can be dissolved or mixed together. Most commercial liquid formulations use a ratio of 2 : 1, IBA : NAA. I estimate that 3 : 1 or 4 : 1 are probably as effective. Experimentation is worthwhile, and the solutions permit quick and accurate mixing and dilution.

For mixing talc formulations the reader should refer to Machen (1977).

Always, when using liquid or talc preparations, decant a small volume or weigh and never return it to the stock solution. Common sense also dictates the use of rubber or plastic gloves. No matter what chemical, protect yourself and workers from undue exposure. The superiority and easy-to-handle nature of liquid formulations make them the product of choice for the commercial propagator.

Always learn all you can about new products and their claimed effectiveness, but remember that IBA and NAA have been the mainstays of our industry for over 57 years.

## LITERATURE CITED

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