Mode of Action, Metabolism, and Uptake of BAS 125W, Prohexadione-calcium

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INTRODUCTION

BAS 125W (trade name Apogee™) is the experimental code for the plant growth regulator prohexadione-calcium (common name proposed to International Organization for Standardization), or prohexadione-Ca in short, or calcium 3-oxido-4-propionyl-5-oxo-3-cyclohexene-carboxylate as a systematic chemical name (Fig. 1). Other codes for this active ingredient include BX-112, KIM 112, and BAS 9054W. The active ingredient, prohexadione-calcium, is patented by Kumiai Chemical Industry Co., which has registered it for growth control in rice (*Oryza sativa* L.) in Japan. Prohexadione-calcium is being developed for registration in the United States for use on apples (*Malus × domestica* Borkh.) and peanuts (*Arachis hypogaea* L.) by the BASF Corp., and in several European countries by BASF AG for use on small grains and apples.

Foliar application of BAS 125W at rates of 125 to 250 mg·L⁻¹ a.i. has typically provided effective control of vegetative growth of apple trees. Generally, as the vegetative vigor of a tree increases, the rate of prohexadione-calcium needed for effective vegetative control has to be raised. Vegetative vigor is influenced by numerous factors, including fruit load, location, variety, rootstock, age, pruning, and training system. Applying prohexadione-calcium when new shoot growth is between 5 to 10 cm has provided more effective control of vegetative growth relative than has application after new shoot growth has

exceeded 10 cm. Because of its short-term effect and lack of persistence, prohexadione-calcium can be a flexible tool in developing user-specific growth management strategies.

MODE OF ACTION

Prohexadione-calcium inhibits the biosynthesis of growth active gibberellins (GAs), thereby reducing longitudinal shoot growth. The structure of prohexadione is similar to that of 2-oxoglutaric acid, which is the co-substrate for dioxygenases catalyzing hydroxylations involved in late stages of GA biosynthesis. The primary target of prohexadione-calcium seems to be 3β hydroxylation. As a consequence, its application reduces levels of GA₁ (highly active) and causes accumulation of its immediate precursor, GA₂₀ (inactive) (Fig. 2). For details see Brown et al. (1997), Griggs et al. (1991), Hedden and

Fig. 1. Structure of prohexadione-calcium.

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Fig. 2. Simplified scheme of GA biosynthesis and main point of inhibition by prohexadone-calcium (MVA = mevalonic acid, IPP = isopentenylphosphate, GGPP = geranylgeranylbisphosphate).

Fig. 3. Metabolism of prohexadone-calcium in higher plants.

Kamiya (1997), Nakayama et al. (1990a, 1990b), and Rademacher et al. (1992). Related dioxygenases involved in flavonoid metabolism may also be affected to some extent by prohexadone-calcium and related compounds (Rademacher et al., 1992).

METABOLISM

Prohexadone-calcium degrades in higher plants with a half life time of a few weeks. After deacylation and ring cleavage the naturally occurring propane-1,2,3-tricarboxylic acid (tricarballic acid) is formed, which is incorporated into the plant matrix (cf. Fig. 3). In soil, prohexadone-calcium decomposes, mostly to carbon dioxide, with a half life of <7 d. In water, prohexadone-calcium degrades by photolysis to carbon dioxide and other natural products. In mammals, prohexadone-calcium is rapidly absorbed and then excreted. Accumulation in tissues of mammals has not been observed.

TOXICOLOGICAL AND ECOTOXICOLOGICAL PROPERTIES

Prohexadone-calcium has an acute rat oral LD₅₀ >5000 mg·kg⁻¹ and an acute rat dermal LD₅₀ >2000 mg·kg⁻¹. The material is not mutagenic, carcinogenic, or teratogenic. Prohexadone-calcium has no negative effects on birds, fish, honey bees (*Apis mellifera* L.), or soil micro-organisms.

UPTAKE AND TRANSLOCATION

Prohexadone-calcium is absorbed by apple foliage, maximum uptake requiring a minimum of 8 h, and is translocated acropetally to the growing points of individual shoots. Basipetal movement is minimal. Typically, only the growth of treated shoots is affected. Prohexadone-calcium does not persist in the plant or directly affect vegetative growth the following season.

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