ABSTRACT

Plant growth regulatory (PGR) activities of two organoboranes, sodium tetr phenyl boron (TPB) and phenylboronic acid (PBOA) were investigated in laboratory and field experiments involving about 60 species of plants. TPB was introduced in 1951 as a sensitive reagent for the precipitation of K⁺. It reacts with cations such as Rb, Cs, Ag, NH₄ and more than twenty organic compounds including amines, amides, alkaloids and polyethylene glycol. TPB is also used in photosensitive materials, synthetic membranes, polymer synthesis, chromatography and drug testing. PBOA is a degradation product of TPB and has been used as early as 1959 to alter plant growth and development. PBOA was initially used in this investigation to determine if the effects of TPB were mediated through this degradation product. However, during the course of this investigation both TPB and PBOA proved to be independently acting PGRs.

TPB promotes growth of coleoptile, mesocotyl, hypocotyl, epicotyl and roots in several plants. It also increases whole plant length of seedlings and growing plants. TPB promotes plant height, fresh weight and leaf area in Amaranthus. It increases cotyledonary leaf expansion, enhances chlorophyll content and promotes rooting in some hardwood cuttings. In field-grown IR-50 rice, TPB increases plant height as well as 1000-grain weight. Depending upon the concentration it has a promotory or inhibitory effect on the gravitropic curvature response in sheath pulvini of paragrass.
TPB promotes curvature of lamina joint of the second leaf of IR-50 rice. With brassin (BR) this curvature effect is synergistic. The pith lining parenchyma cells (PLPC) in the internodes of paragrass are promoted to grow by TPB. This extension growth is inhibited by inhibitors of auxin transport, ethylene biosynthesis, and ethylene action.

TPB is most active in the concentration range of $10^{-10}$ to $10^{-7}$M. At higher concentration it has an inhibitory effect, and at $10^{-3}$M it completely inhibits germination in several seeds. At $10^{-4}$M hypocotyls are swollen and the shoot tip is malformed. Dose-response curve in wheat coleoptile straight growth test shows that TPB is more sensitive than even the strong auxin 2,4-dichlorophenoxyacetic acid (2,4-D).

TPB is a potent initiator of callus within 20 d in cotyledonary explants of tea, cashew, groundnut and broad bean. It also induces callus in leaf explants of *Aerva*, *Coleus*, *Nicotiana* and *Borassus*. TPB also promotes rhizogenesis and somatic embryo formation in several plants. TPB promotes cell division in isolated protoplasts of groundnut and leads to the establishment of cell colonies. Packed cell volume (PCV) is increased in groundnut suspension cultures and chlorella algal cell cultures in bioreactors in response to TPB. Immobilised cells of groundnut and chlorella treated with TPB secrete large amounts of amino acids. TPB also promotes nitrate reductase (NR) activity in leaf discs of *Coleus*. TPB is thus, a definite substitute for auxins, required in tissue culture studies.
The action of TPB is therefore generally that of an auxin, as shown by its ability to substitute for auxins in tissue culture, and also inhibition of its activity in other systems by the application of auxin transport inhibitors.

PBOA promotes growth in most systems where TPB is active but generally at higher concentration up to $10^{-5}$M. A characteristic effect of PBOA is the induction of epinasty in coleoptile, primary leaf sheath, and second leaf blade of rice seedlings. This effect of PBOA seems to be mediated via ethylene production since ethylene biosynthetic inhibitor AVG and action inhibitor AgNO$_3$ suppress the epinasty response.

PBOA also is very active as an auxin substitute in the promotion of callus, embryoids and rhizogenesis. Somatic embryos in *Arachis* and *Coleus* are induced with greatest frequency by PBOA. Callus induction in *Borassus* leaf explants occur only when treated with PBOA or TPB but with no other auxin. PBOA, like TPB, promotes proplast cell division, increases PCV in groundnut single cells and *Chlorella*, and increases amino acid secretion in immobilised cells of groundnut and chlorella. PBOA also enhances NR activity in $10^{-6}$M in the leaf discs of *Coleus*.

It is proposed that both TPB and PBOA could be considered as potent PGRs with potential for use in agri/horticulture, tissue culture, and physiological studies. Among the reactive properties of TPB are the ability to precipitate cations, react with organic bases, particularly polyamines, and influence Ca fluxes across membranes in animal systems. All these three properties are of interest in terms of the possible modes of action of TPB.
since Ca is implicated in a number of signal transducing systems and since polyamines are known to affect a variety of physiological process. TPB could be investigated in the future for its ability to influence Ca and polyamine content in plants. The high lipophilicity of the hydrophobic TPB ion might prove to be of significance in altering membrane properties in plant cells.

PBOA might act because of its ability to bind with enzymes. PBOA might also have a direct auxin like property since it is structurally related to some auxins. In view of the PGR properties, particularly the ability to induce biomass and morphogenetic changes in tissue culture, TPB and PBOA as well as a number of related organoboranes now available offer a rich field in PGR studies.