Possible Use of Plant Peptide Hormone in Horticulture©

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Plant hormones, phytohormones, are chemicals acting as signal molecules. They are produced in plants and occur in extremely low concentrations. They shape the plants and are environmentally responsive signal molecules. We accept that there are five major classes of plant hormones: abscisic acid, auxins, cytokinins, ethylene, and gibberellins. Recently, brassinosteroids, jasmonates, florigen (FT protein), plant peptide hormones, salicylic acid, and strigolactone have been identified as plant hormones by plant physiologists. However, I am sure that most people involved in horticulture do not know about plant peptide hormones and strigolactone.

Plant growth regulators(PGRs) are extensively used in horticulture. They are plant hormones, derivatives of plant hormones, and chemicals controlling and enhancing natural plant growth processes. One PGR, prohydrojasmon, is a skin color accelerator for apples and table grapes and a rind puffing inhibitor for satsuma mandarins. Prohydrojasmon is a derivative of jasmonates which promotes the production of defense proteins, signal molecules, which are used to fend off invading organisms. If prohydrojasmon is used more in agriculture and horticulture, we will recognize jasmonates as plant hormones. Brassinosteroids have been intensively investigated for three decades and used on farms with poor environment to improve crop production, but they are not used in advanced countries because their agricultural land is fertile. Hence, most farmers do not know brassinosteroids. It will take a long time for most agriculturists and horticulturists to utilize brassinosteroids as plant hormones. New signal molecules found by plant physiologists may be recognized as plant hormones after an extensive use of them or their derivatives in agriculture and horticulture.

Peptides are short amino acid chains and peptide hormones such as growth hormone, insulin, and vasopressin are well known as important hormones in animals. Peptides also exist in plants and, in recent years, many studies have demonstrated that peptide signaling plays a great role in various aspects of plant growth and development. Plant physiologists have found over 15 plant peptide hormones. Systemin is an 18 amino acid peptide and its main function is to coordinate defensive responses against insect herbivores through the production of jasmonic acid. Phytosulfokine is 5 amino acid peptide and promotes proliferation of plant cells. Stomagen is 102 amino acid peptide and controls differentiation of stomata. LUREs are 83 and 93 amino acid peptides that were identified as pollen-tube attractants.

A substantial proportion of these peptides are secretory and act as local signals mediating cell-to-cell communication. Specific receptors for several peptides were identified as being membrane-localized receptor kinases (Matsubayashi and Sakagami, 2006). These results were found in a model plant, *Arabidopsis thaliana*, and most of the basic research on plant peptide hormones were conducted with *Arabidopsis thaliana* by plant physiologists. However, we can find no report about their use in applied research, although basic research has indicated that they could be explored as PGRs in agriculture and horticulture.

Arabidopsis thaliana has 32 CLE peptides, named for the CLAVATA3 (CLV3)/ESR-related peptide family, including CLV3 (Betsuyaku et al., 2011). The CLE peptides are thought to regulate cellular differentiation activity in the shoot and root apical meristem, and synthetic CLV3 peptide reduced the size of shoot and root meristems (Kondo et al., 2006). We identified five *CLV3*-like genes from grape vine (Tominaga-Wada et al., 2013). These *CLV3*-like genes encode peptides containing 43 - 128 amino acids. Expression analyses showed that the five grape *CLV3*-like genes are expressed in leaves, stems, roots, and axillary buds with significant differences in their levels of expression.

Callus cultures of persimmon, citrus, and lychee were cultured on differentiation media supplemented with 1 µM synthetic CLV3 peptide, which killed buds on mango shoots, but they grew as well as those on the control media. One of CLE peptide family, CLE25, is thought to be more biologically active than CLV3. For rooting of persimmon shoots, 100 nM CLE25 was added to the root inducing medium, and inhibited their rooting and decreased the number of roots compared to the control. Moreover, 100 nM CLE25 in the root development medium, which was used 10 days after the root induction in the root inducing medium, did not prevent the shoots from rooting. These results suggested that the differentiation of root primordia was suppressed by CLE25. Similarly, CLE25 may control root meristems, because the root meristems in the root development medium with 100 nM CLE25 seemed to stop growing 40 days after the rooting culture. The CLE peptide family is known to control differentiation of epidermal cells and further experiments are needed.

Synthetic CLE peptides are very expensive to produce. In addition, the biological activities of peptides are drastically changed by glycosylation and phosphorylation. It will take a very long time to use plant peptide hormones in horticulture. I hope for rapid progress of studies in this field.

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