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SUMMARY OF DOCTORAL THESIS

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Title: Studies on the autotoxicity of strawberry and beans in hydroponics with their means to overcome

（水耕イチゴおよびマメ類の自家中毒とその回避法に関する研究）

In growth chamber bioassay, strawberry plants grown in non-renewed nutrient solution and electro-degraded (ED) weekly intervals showed growth inhibition whereas biweekly ED improved its growth. This growth inhibition in weekly ED nutrient solution was found to be attributed by the degradation Fe-EDTA (~ 10%) and low concentration of Ca^{2+} in culture solution. In without plant experiments, low pH (3.13) and increased temperature were two major constraints for longer ED duration (24 hours). Therefore, considering electric voltage, EC and pH, shorter ED duration (two hours) was selected for further experiments. In green house study, growth and yield of strawberry plants was decreased in non-renewed nutrient solution and its biweekly ED treatment but it was improved in non-renewed nutrient solution when ED applied at four weeks intervals. It was found that fruit yield of strawberry plant was completely recovered (≈ 99%) in non-renewed nutrient solution with ED at every four weeks, whereas, in our previous study the recovery was 71% compared to renewed nutrient solution. Therefore, we recommend application of ED to non-renewed nutrient solution for two hours at every four weeks intervals to avoid autotoxicity in strawberry in a closed hydroponic system.

The autotoxicity of *Pisum sativum*, *Phaseolus vulgaris*, and *Vicia faba* were investigated in hydroponics either with or without activated charcoal (AC) addition. In *Pisum sativum* plants grown in non-renewed culture solution without AC, the number of pods, pod fresh mass, number of seeds, and seed fresh mass were reduced by about half compared with those with AC. The number of pods $plant^{-1}$ and fresh mass of $pods^{-1}$ plant in *Phaseolus vulgaris*, as well as pod number in *Vicia faba*, were decreased significantly to 49~67% without AC addition. The identified allelochemicals were benzoic, salicylic, and malonic acids in the root exudates of *Phaseolus vulgaris* and lactic, benzoic, *p*-hydroxybenzoic, vanillic, adipic, succinic, malic, glycolic, and *p*-hydroxyphenylacetic acids in *Vicia faba*. Bioassay of the identified allelochemicals proved that benzoic, salicylic, and malonic acids significantly reduced the growth of *Phaseolus vulgaris* even at low concentrations. In *Vicia faba*, benzoic acid at 50 µM significantly reduced root length, and shoots fresh and dry mass by over 81% of those of the control, whereas adipic and *p*-hydroxyphenylacetic acids decreased root length to 87 and 88% of that of the control, respectively.

Sixty seven cultivars of 42 vegetable crop species from 14 families were tested in seedling growth bioassay using the used nutrient solution of *Asparagus officinalis* L. and replanting soil of *Asparagus officinalis* L., *Colocasia esculenta* Schott., *Vicia faba* L., *Pisum sativum* L. and *Phaseolus vulgaris* L. to select possible succeeding crops. Growth performances of succeeding crops were assayed using once used nutrient solution and/or replanting soil of these crops. Bioassay using asparagus used nutrient solution with or without AC suggest the tested cultivar of cucumber, garden pea, komatsuna, melon, pak-choi cv. 'Tyoukou', parsley, soybean (except cv. 'Tankurou'), cabbage cv. 'Early Ball' and lettuce cv. 'Shato' as succeeding crops. Bioassay using replanting soil with or without AC suggested that most of the cultivars tested can be planted after asparagus, taro, and three beans (*Vicia faba* L., *Pisum sativum* L. and *Phaseolus vulgaris* L.) with little adverse effects. Among the three methods of bioassay (i) used nutrient solution, (ii) direct seed sowing and (iii) seedling transplanting in replant soil; the nutrient solution bioassay proved more sensitive than replanting soil bioassay. However, results of nutrient solution bioassay may not be reproducible in the field condition. Therefore, seedling transplanting method can be used as an easy and practical bioassay method to select succeeding crops for fields with replanting problems.