博 士 論 文 の 内 容 の 要 旨

氏名	R. M. Sangeeth M. B Rathnayaka
学位名	博士（農学）
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論文題目	Effect of environmental stresses on chemical components related to taste, growth and yield of chili pepper (*Capsicum* spp.) （環境ストレスがトウガラシ (Capsicum spp.) の呈味成分含量，成長および収量に及ぼす影響）

The chili pepper (*Capsicum annuum)* is the fruit of plants from the genus *Capsicum*, member of the nightshade family, Solanaceae, and the plants are widely grown for their fruits, which may be eaten fresh or cooked (salads, baked dishes, salsa, pizzas, etc.), used as a dried powder, or processed into oleoresins. Capsaicinoid and sugar contents in chili pepper are two important factors in the food industry. Taste components can be attributed to cultivar difference; additionally hereditary and environmental factors have influence on the concentration of taste components in chili pepper. Among various environmental stresses, drought stress and soil salinity are the most devastating environmental stresses that cause major reductions in cultivated land area, crop productivity and quality (Yamaguchi and Blumwald, 2005). It seems 25% of agricultural lands is reduced because of drought stress and 20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high salinity. Therefore, the experiments on how drought stress and salinity stress conditions influence crops is very important as population and demand is increasing. However though main spice in the world, there was limited experiments on the effects, especially regarding taste components, of stress in chili pepper. The present studies were conducted to determine the effect of environmental stresses on chemical components related to taste, growth and yield of chili pepper.

Chapter II, the first experiment, was conducted to evaluate the effect of water supply and harvesting date after flowering on sugar and capsaicinoid contents in fruit of the Japanese chili pepper cultivars ‘Botankosho’, ‘Fushimiamanaga’, ‘Manganji’, and ‘Sapporo Oonaga Nanban’. The experiment was conducted in a greenhouse from April to October in 2016 and 2017. Three water supply treatments were applied: 260 mL (excess), 130 mL (standard), and 50 mL (drought). Fruits were harvested at 20, 30, 40, and 50 days after flowering (DAF). The contents of glucose, glutamic acid, and total sugar were measured using a portable spectrophotometer, and capsaicinoid content was measured by HPLC. Total sugar content and Brix tended to increase with delay in harvesting, whereas glucose content did not change significantly with the increase of DAF. The glutamic acid content in the fruit increased up to 40 DAF, and thereafter remained unchanged or decreased. The capsaicinoid content of the fruit increased with fruit maturation and with the drought stress condition. Elevation in water supply induced an increase in the fruit glucose content and decrease in total sugar and glutamic acid contents.

Chapter III, the second experiment, was conducted to evaluate the effects of salinity stress and harvesting days after flowering (DAF) on the sugars, glutamic acid, and capsaicinoid contents of chili pepper cultivars 'Manganji', 'Fushimiamanaga', 'Sapporo Oonaga Namban' (*C. annuum*), and 'Habanero' (*C. chinense*). Experiments were conducted in a greenhouse from April to October in 2018 and 2019. Three levels of salinity stress were applied using sodium chloride (NaCl); control (0.9 dS/m), additional (5 dS/m), and excessive (10 dS/m). Fruit was harvested at 20, 30, 40, and 50 DAF. Fruit weight (g), contents of glucose, total sugar, and glutamic acid were measured using a portable spectrophotometer, and capsaicinoid content was measured by HPLC. Brix and the contents of total sugar, glutamic acid, and capsaicinoids increased, while glucose content decreased with delayed harvesting. Compared to the control, glucose content tended to be lower, but Brix and the contents of total sugar, glutamic acid, and capsaicinoids tended

to be higher in the excessive salinity treatment regardless of harvesting time in DAF in all varieties.

Chapter IV, the third experiment, was conducted to find out the effect of combined environmental stress (water and salinity) on Brix, capsaicinoid content, pod parameters, yield and plant growth in chili pepper. Experiment was conducted under the green house condition in the Research field of Shinshu University. 'Sapporo', 'Shishito', and 'Botankosho' (*C.annuum*) varieties were used and planted in plastic pots. To apply water stress condition, used three volumes of water stress in individual applications: drought (50 mL water), standard water supply (130 mL water), and excess water supply (260 mL water). And to apply salinity stress condition, used three salinity levels applied using sodium chloride (NaCl); excessive salinity (10 dS/m), additional salinity (5 dS/m), and the normal salinity as control (0.9 dS/m). During the cultivation period we collected Brix value, number of fruits, fruit weight, total yield, number of leaves, number of branches, and plant height on the individual plant basis. The fruit Brix-percentage of plants in all cultivars treated by water stress and salinity stress tended to increase with increasing stress condition. However, significantly lower number of fruits, number of leaves, plant height, number of branches, total yield, and fruit weight was observed in cultivars applied with drought stress treatment than those with excess water supply. Similar behavior was also shown in plants treated by salinity stress. In addition the quality of fruit getting improved as stress condition weakened. Thus, it is important to find out the equilibrium point where profitable harvest with the highest quality could be obtained by further experiments.

Chapter V, fourth experiment was conducted to evaluate drought stress induced increase of pungency and expression of capsaicinoid biosynthesis genes in chili pepper based on the results of experiment I and III. ‘Sapporo’ and ‘Shishito’ varieties were used to the experiment and collected fruits at 20 and 30 Days After Flowering (DAF) to analysis quantification of capsaicinoid content in placenta by using HPLC and gene expression analysis by using quantitative reverse transcription polymerase chain reaction (qRT-PCR) for 18 capsaicinoid biosynthesis genes. The results showed that eight capsaicinoid biosynthesis gens (*ACL*, *pAMT*, *Pun 1*, *WARKY9*, *CaKR1*, *CaMYB31*, *KAS I*, and *FAT*) was significantly highly expressed in drought stress condition and at 20 DAF in both cultivars. In addition *KAS III*, *BCKDH* and *BCAT* genes also expressed in significantly in the drought stress condition in ‘Shishito’ at 20 DAF. *ACS* and *4CL* genes also expressed in significantly in the drought stress condition in ‘Sapporo’ at 20 DAF; *4CL* in 30 DAF. However, remaining genes which most of belongs to phenylpropanoid pathway, also expressed in similarly with all stress conditions.

Present studies have clarified the relationships among major environmental stress conditions and taste components, fruit parameters and plant growth parameters in chili pepper fruit. Our findings was finalized that the quality of fruits significantly increased as stress condition by accelerating taste component synthesis pathways and quantity parameters significantly decreased when plants were under stress conditions. However, it’s need to carry out further experiments using several stress conditions considerable in present and conclude the behavior of the taste components and genes responsible to their synthesis when plant were in stress condition.