Seminar and workshops
Impacts and risk mitigation of climate change for the sustainability production of high-quality horticultural crops

According to the Intergovernmental Panel on Global Change (IPCC), global air-temperature has risen by more than 0.7°C over the last 100 years, with East Asia, particularly Japan, exhibiting an increase of nearly 1°C. A recent survey revealed that this temperature increase has already adversely affected crop growth in various respects, and are particularly noticeable in horticultural crops such as fruit trees, vegetables, and flowers. The phenological changes of horticultural crops caused by increased temperature can be frequently observed in fruit-size enlargement, softening of fruit flesh, increased acidity, skin/leaf burning, insufficient color development and fruit deformity, decreased fruit setting, lack of head formation in heading crucifers, increased physiological disorders such as tip-burn and blossom end-rot, delay of endodormancy, etc.

Meanwhile, optimum areas for horticultural crop cultivation are expected to shift northwards as the climatic change proceeds. This is also true with the onset and spread of insect pests. Diaphorina citri (psylla), the citrus greening disease (Huanglongbing or HLB) vector, was first identified in Iriomote island (next to Taiwan), and has successively moved northwards to Yakushima island (close to Kyushu mainland) in 2002 with the increasing temperature.

An air-temperature increase of less than 1°C brought about serious phenological disorder in horticultural crops, thus resulting in substantial yield loss and devaluation of their market prices. IPCC projected that average air-temperature will rise at a maximum of 4°C during the 21st century. Hence, it has become urgent to develop effective and promising technologies to mitigate the serious risks brought about by climate change to horticultural crop production.

Mulching and climate change
To mitigate the hazardous effects of increased temperature on horticultural crops, a variety of practical and promising technologies have been developed and practiced in experimental farms as well as in commercial production. For instance, mulching the cultivation beds with reflective silver-color film is popularly used to improve skin coloring of apples, with increasing sunlight reflection from the bottom. Plastic mulching in combination with drip irrigation (which also supplies relevant nutrients) has become a common practice to attain high-quality and high-yield production in citrus orchards. In greenhouse cultivation of vegetables, various devices such as efficient ventilation, shading, fog cooling, heat pump, photo-selective film, etc., are developed and tested for practical use in minimizing interior temperature rise.
A survey of promising tropical vegetables

There is another interesting approach to overcoming climate change for horticultural crops, particularly for vegetables. With economic globalization, a variety of exotic and foreign vegetables and fruits are available in various Asian countries all-year round. In the last decade, summer temperature in East Asia has gone up to an abnormally high level, at which summer vegetables cultivated in temperate zone could not grow normally until harvest. A province in southern Japan has launched a new project to cope with this situation, and dispatched expert teams to tropical Asian countries such as Taiwan, Thailand and Vietnam to conduct a survey of promising tropical vegetables for parameters such as people’s acceptability, appropriate cooking method, nutritional facts, successful cultural practices, etc. The expert teams brought back a sizable number of commercially available tropical vegetable seeds from the said three countries. After intensive research on the economic and technical viability of their domestication, people’s acceptance for alternative summer vegetables, stability of nutrition facts, appropriate cultural practices under local conditions, all the promising vegetable seeds were confirmed and distributed to various farmers’ groups with the appropriate cultural practices. Consequently, the tropical vegetables proved to be a good alternative to summer vegetables in the temperate zones under the global warming condition.

In tropical Asia, farmers have been traditionally cultivating temperate vegetables, fruits, tea, etc., in highland areas such as Baguio, Philippines; Cameron Highland, Malaysia; Bandung, Indonesia, and so forth. Temperate horticultural crops are generally more superior in taste, quality and nutrition, have higher acceptance among consumers, and hence, command higher prices than the tropical counterparts. Urban dwellers are willing to pay more money for high-quality vegetables and fruits produced in the highlands. Thanks to a significant improvement in the transportation between the highland and urban cities, fresh produce can now reach urban dwellers on the same day as harvest.

Changes in precipitation patterns

The expected hazardous effect of climate change is not only limited to increased temperature, but also to changes in the period, intensity and pattern of precipitation, which in turn cause both increased frequency and extent of floods, droughts, and increased soil salinity in coastal areas. The direct hazardous damage of increased temperature in tropical Asia (Southeast Asia) may not be as severe as in temperate Asia (East Asia), but the change in precipitation pattern may inevitably bring about the shift in the optimum planting time of various crops, in particular, in rainfed agricultural areas. This leads to the urgent need to initiate the development of promising cultural practices and other countermeasures to cope with this change. In the medium to long term, the challenge is to come up with strategies to overcome much more serious effects of climate change such as drought, flood, salinity and so forth.

To mitigate the adverse effects of climate change on the production and quality of horticultural produce, strategic and technological countermeasures should be developed. As adaptation technologies against increased temperature and other climatic abnormalities. In addition, a more reliable and accurate impact assessment of climate change in its nature, degree of severity, duration and pattern on agriculture must be established.

Workshop discussion, prospects and recommendations

The papers presented by the speakers could be categorized into four groups such as: 1) Critical impacts of climate change (as related to high temperature, frost, GHG, etc.) on physiological process, geographic shift of production areas, cropping practices, disease and pest spread, crop production and yield, product quality, etc.; 2) Recent
achievements on the development of crop production technologies and systems to adapt to high temperature, frost, and diseases and pests; 3) Crop genetic improvement (including variety adaptation, biodiversity and underutilized crops) to adapt to high temperature, drought and flooding; and 4) Molecular aspects of high temperature adaptation and quality change. The crops which were discussed included both temperate and tropical fruits, flowers, common vegetables, and exotic and underutilized species.

It was concluded that the General Climate Model (GCM) and other scenarios are useful tools to address climate change in horticultural production. However, there is a need to consider which models can be applicable to specific locations. Each country should tailor its strategies according to respective conditions. On adaptation and mitigation of horticultural crops to climate change, there should be a development of common parameters or indices to monitor R & D progress in different agricultural systems.

It was proposed that cooperation for a database be established. The following were suggested as part of its contents: climate change variability; crop response; soil conditions; trans-boundary disease; adaptation technology; genetic resources, etc. Some other issues that need to be ironed out are the following: establishment of Asian Network for Climate Change on Horticultural crops as a common platform for information exchange and preparation of the database establishment; and nomination of network coordinator and country representative.

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Held in Tsukuba, Japan, 25-27 October 2011
No. of participating countries: 7 (Australia, Japan, Korea, Philippines, Thailand, Taiwan, Vietnam)
No. of papers presented: 13
Co-sponsors: National Institute of Fruit Trees Sciences (NIFTS), NARO, Japan

List of papers

Keynote papers

1. Climate change and climate variability — risks and opportunities for horticulture
   - Neil White
2. Impact of climate change on horticulture industry and possible countermeasures in Japan
   - Toshihiko Sogiura

Resource papers

1. Effect of high temperature on flowering and flower color in chrysanthemum
   - Seiichi Fukai
2. Effect of elevated CO2 and high temperature on apples and Asian pears
   - Jeom Hwa Han
3. Climate change and horticultural crop production in Vietnam
   - Tran Khac Thi
4. Towards a climate change resilient horticulture in the Philippines
   - Marita Carlos
5. Geographic shift in horticultural crop production in the context of climate change in Korea
   - Kwang Hwan Moon
6. Climate effects of transboundary diseases in citrus culture
   - Toru Iwanami
7. Climate change and frost damage to fruit trees
   - Toshikazu Asakura
8. Underutilized crops for adaptation to climate change
   - Yingyong Paisooksantivatana
9. Effects of climate change of vegetable production in Taiwan and its responsive strategies
   - Ming-Hsien Hsieh
10. Apple skin color under global warming conditions: means and mechanism for improving red coloration
    - Takaya Moriguchi
11. Expression analyses of bolting-related genes in lettuce exposed to high temperature
    - Machiko Fukuda

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