Influence of Light Emitting Diodes (LED) Light on the Productivity and Quality of Selected Crops in a Closed Plant Factory System

PROJECT DESCRIPTION: (FA-142K) – April, 2016 – March, 2018

Under the harsh climatic conditions of Kuwait, the MAPS system is a good option for the stable production of crops with consistent quality and a steady year-round harvest resulting in the improvement of food supplies. Conducting such studies on MAPS is essential as Kuwait's agricultural sector requires further research, development, extension, training, and new norms of application to meet local requirements. Considering the short- and long-term needs of protected agriculture in Kuwait, the results of such a study utilizing the MAPS facility will be a transformation from the existing greenhouse agriculture to a productive water- and cost-efficient high-tech Enterprise. Research and experiments will focus on light from LEDs, which will provide technique parameters for potential efficiency (high yield and good quality) during plant growth and development. Such studies will prove the possibility of regulating the productivity and nutritional quality of horticultural crops in protected facilities. Research will be done on the conditions and stages of plant growth by specifically working on the plant responses to LED lighting. Plants will be grown under different light qualities and intensities in the presently available modular plant growth chamber to determine the benefits of increased photosynthetic lighting. Since leafy vegetables, strawberries, cherry tomatoes, etc., can be grown hydroponically in MAPS and they need no chemical pesticide for pest control, this can be seen as a model of hygienic vegetable and fruit production in Kuwait. The project would focus on standardizing LED light quality for obtaining fruits and vegetables with increased productivity and nutritional quality in a protected plant production system.

OBJECTIVES:

- Development of specific LED light recipes for enhanced productivity and quality of selected crop classes in the MAPS.
- Physiological and molecular characterization of selected crop plants grown in MAPS under different LED light quality treatments.

EXPERIMENTAL PLAN SUMMARY:

S.No.	Description	Activity
1	Crops to be tested	Lettuce (*Lactuca sativa* L). And Strawberry (*Fragaria* x *ananassa*)
2	Light quality treatments and photoperiod to be tested in the research study	Four light treatments (three LED light qualities in MAPS compared with natural sunlight in the greenhouse). White LED (WL); combination light from red, blue, and white LEDs (RBW); a mixture of red and blue LEDs (RB). Photoperiod of 18/6 (light/dark)
3	Physiological growth and quality analysis of plants	Growth parameters, photosynthesis, transpiration rate and stomatal conductance measurements for individual light quality treatments. Nutritional quality, secondary metabolite, and toxicity content analysis.
4	Transcriptomic analysis	Isolation of DNA, sequencing of RNA, and determination of global gene expression profile at various light quality treatments using bioinformatics tools.
5	Research study outcomes	Statistical analysis, interpretation of results, conclusions from the research study, and generation of progress reports.

RESEARCH TEAM

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METHODOLOGY & RESULTS ACHIEVED SO FAR:

A single lettuce (*Lactuca sativa* cv. New red fire) crop was planted and grown for a period of approximately 6 weeks. Lettuce was seeded in a growth room in rockwool cubes for 12 days under white fluorescent light at 21±1℃ temperature and relative humidity 60±10%, and transplanted into the MAPS prototype growing system. A total of 54 seedlings were planted on each level, for a total crop production of 162 heads of lettuce. Lettuce grown on each level was growth with either blue (top), white (middle) or red (bottom) light and all were fed from the same nutrient tank. The growing conditions were uniformly maintained at 200±10 $\mu mol \cdot m^{-2} \cdot s^{-1}$ photosynthetic photon flux, 16/8 photoperiod (Light/Dark), 21±1℃ temperature and 60±10% relative humidity in all three levels. Plants were harvested at 42 days and were randomly selected for fresh and dry mass measurements. Also differences in other plant physiological and biochemical parameters were calculated. Growth and yield of the test crop was recorded at harvestable maturity and the data generated was subjected to statistical analysis using 'R' open source software. The study revealed that plant height, leaf length, canopy length and canopy spread were significantly greater under blue LED light treatment as compared to those of the plants under white and red LED light treatments. Similar trend was observed in leaf moisture content at the time of harvesting. However, plants grown under red LED light significantly excelled in fresh weight and dry matter accumulation; whereas blue and white LED treated plants trailed and remained comparable. Width of the largest leaf and chlorophyll index (SPAD value) were not influenced by the treatments.