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Report Name: Agricultural Research Related to Climate Change in Israel

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Report Highlights:

The Israeli government has come to understand of the threats of climate change and the need to reduce its contribution to global warming. The Israeli Ministry of Agriculture and Rural Development (MOAG) has the mandate to track the impact of agriculture on global warming and develop new measures to cope with the changing climate. The Volcani Center is the research arm of MOAG and performs vast studies and research on different agricultural aspects including global warming.

Overview
As part of climate change assessments, the Israeli government made a decision that recognizes the occurrence of climate change around the world. It also recognized the need to increase the country's preparedness for the effects of climate change and reduce the health, environmental and economic risks. More details on the subject can be found at:

https://www.gov.il/en/departments/policies/climate_related_govt_decisions
https://www.gov.il/en/departments/policies/natl_climate_change_adaptation_program_july_2018

The Israeli Ministry of Agriculture and Rural Development (MOAG) has the mandate for the agricultural aspect of the government's recommendations. MOAG organized accordingly and its agroecology department started gathering information and field data from farmers to be translated into recommendations and used for further research.

The Agricultural Research Organization, Volcani Center (ARO) serves as MOAG's research arm and provides research opportunities for local and international scientists at post-graduate levels, as well as educational opportunities for Israeli students, farmers, and scientists. The organization supports Israeli agriculture research, focusing on plant sciences, animal sciences, plant protection, soil and environmental sciences, food sciences, and agricultural engineering. The organization was founded in 1921, and since then has been involved in most of Israel's agricultural innovations.

The Volcani ARO collaborates with other government-sponsored researchers, related industry bodies, educational institutions, farmers, and international organizations and scientists. The ARO's funding comes from the Israeli government, farmers' organizations, and the private sector. The Volcani Center in general conducts activities that relate to the adaptation of agriculture to climate change, and to a lesser extent in easing the changes themselves (mitigation).

Below ARO's list of research conducted or planned to take place in the near future related to climate change effects on agriculture, and to some extent the effects of agricultural activities on climate change. Some of the topics are broad and include researchers from different fields.

Topic: Soil, Water, and Environment
Effects of Climate Change

- Evaporation from soil and water reservoirs.
- Soil thermal regime.
- Changes in atmospheric concentration of carbon dioxide and its effect on nitrogen consumption in plants.
- Direct and indirect effects of climate change, especially change in rain and wind regimes. The spread of rainstorms during the year and of rain intensities on overhead runoff and soil erosion.
- Frequency and intensity of wildfires and the effect on the soil, wild habitats, and agriculture.
- Effects on land conservation, soil health, salting and erosion, causing soil depletion.
- Impact of climate conditions on salinity and water availability for plants.

Effects on Climate Change

- Greenhouse gas emissions in the context of nitrogen cycle (nitrogen fertilizers).
- Greenhouse gas emissions from the soil.
- Food production systems, including agricultural systems that have a considerable environmental footprint.
- Agricultural waste, especially from animal farms, as a source of greenhouse gas emissions.

Tackling Climate Change

- Plant reaction to abiotic stress.
- Adjusting nitrogen feed to address plant needs in the face of increased concentration of atmospheric carbon dioxide.
- Change in the hydraulic properties of plants to adapt to developing environmental conditions; climatizing plants for dry soil and air conditions.
- The effect of global warming and increase in atmospheric carbon dioxide concentration on organic material in the soil.
- Forming new irrigation and feed protocols for cultivars in arid zones.
- Building mathematical and statistical models for irrigation of cultivars.
- Researching the biological ground membranes.
- Treatments for food and agricultural wastes in order to reduce greenhouse gas emissions.
- Integrative treatments in wastes for maximum utilization of resources (energy- water-food).
- Developing methods for agricultural waste treatments to maximize energy and feed resources.
- Developing improved methods for maximizing the use of organic matter and minerals in waste for the reuse in agriculture.
- Use of bio-coal and other pyrolysis products in agriculture.
- Developing of methods for extracting active materials from waste for plant protection applications and reduce the use of other pesticides.
- The impact of forest fires, deforestation, and planting of new forests, change in soil cultivation, plant cover and land uses as a result of climate change on soil properties, runoff and soil erosion rates.
- Rehabilitation of soils that were affected as a result of climate change.
- The impact of climate change on wind soil erosion and study of the interaction between soil erosion caused by wind and rain.
- Breathing soil and breathing roots (carbon flow between the soil and the atmosphere with a dependence on temperature, soil moisture, and other factors).
- Electromagnetic methods for assessing soil moisture and salinity, the direct effect of temperature on the electrical properties of the soil (as the Earth's temperature continues to rise, these measurements will become more vital).
- Auxiliary irrigation in areas with shallow groundwater (areas that were previously irrigated depended on root absorption from shallow groundwater. In the future, groundwater levels will drop and salinity will increase and the need for auxiliary irrigation from other sources will be critical).
- Irrigation and fertilizer use under stress conditions in arid zones. Efficiency of water and nutrient uptake.

- Use of new water sources for irrigation (i.e., saline and brackish, desalinated, recycled water).
- Precision irrigation.
- Use of sensors and data in agricultural decision making – fertilizing, irrigation use of agro-chemicals and other agricultural practices
- Agricultural meteorology; plant landscape canopy structure; distribution of radiation in landscape and agricultural structures; global changes in solar radiation; environmental physiology of plants and animals.
- Flow of water in trees.
- Plant energy balances.
- Evaporation models of fields, plants, water bodies, and forests.
- Water requirements for agricultural crops.

Topic: Plant Science

Effects of Climate Change

- The impact of climate change on the development process of deciduous fruit trees; accumulation of chill hours, flowering, fruit formation, blossoms and development of landscape and fruit.
- Effects of stress, salinity, heat, radiation, flooding on non-deciduous fruit trees, vegetable crops and flowers in the process of growing and yielding.
- Effects on open field crops and greenhouse cultivars. Formation of pollen, fertilization, fruit formation, fruit and seed quality under changing climatic conditions and changing carbon dioxide levels.

Tackling Climate Change

- Chill needs and dormancy in deciduous fruit trees. The effect of the warm winters on dormancy. Breeding of new resistant cultivars with less chill demands.
- Genetics of measuring chill hours in trees, adapting species to different climate zones, improving species suitable for climate change.
- Characterizing the effect of spring temperature changes on landscape growth, flowering, fruit formation and alternation of fruit trees yield.
- Breeding for new varieties according to expected changes and according to the needs in hot climates.
- Locating genes related to the plant's response to changes in temperature.
- Breeding and selection of fruit tree varieties.
- Changes in the control of the dormancy cycle in buds of deciduous fruit trees in general, and in the vines in particular.
- Fruit ripening control.
- Seasonal changes in the activity of the cambium tissue of vines.
- Temperature effects on primordial differentiation and on fruit formation.
- Breeding of new apple varieties, adapted to grow in hot areas.
- Reaction/adaptation of plants to light levels.
- Developing practical measures to increase the sustainability of fruit trees to heat stress.
- Breeding for plants with improved resistance to cold and high radiation conditions.
- Plant stress from high solar radiation.
- Building a model for subtropical fruit trees for coping with frost.

- The impact of climate change on various aspects of olive cultivation; the effect of high temperatures in summer on the development of the fruit and the accumulation of oil and its quality in the olive fruit.
- Characterizing resistance to drought in olive trees.
- The effect of high spring temperatures on development of inflorescence and the ability to fertilize olives.
- Improving the use of water and the use of marginal water (brackish and recycled sewage water) in various crops.
- Breeding fruit trees for salinity tolerance.
- The impact of climate change on the pollination of agricultural crops.
- The effect of climate change and high carbon dioxide levels on pollinators.
- New methods for cooling canopies in to reduce the loss of flower buds in fruit trees.
- Use of overhead nets in plantations.
- Soil mulching.
- Development of technologies for computerized molecular measurement of gene expression in real time for the plant's response to water stress, using optical equipment.
- Development of optical sensors for identification of pests and diseases.
- Studies on tackling climate change aspects in open field and covered crops.
- Molecular markers for stress tolerance.
- Introduction and breeding of new edible cultivars sustainable to hot zones.
- Adaptation of herbaceous crops to environmental changes.
- Coping of fruit plants with abiotic stress with the aim of preventing crop loss at high temperatures.
- Identification of genes and/or mechanisms that control heat resistance in tomato plants and other crops.
- Growing geophyte plants in a changing climate, environmental impacts on development and production.
- Physiology and plant biochemistry under stress conditions, plant hormones and control.
- Plant mechanisms for stress (temperature changes, drought, salinity, increased carbon dioxide levels) and combinations of biotic and abiotic stresses.
- Adaptation of plants to temperature change, especially in the aspect of biological cycles.
- Production capacity and quality of produce as influenced by environmental conditions and volatile climate conditions. In field crops in general, and wheat in particular.
- The study of the genetic basis for drought and heat tolerance in wheat. For example, genetic mapping of durum wheat.
- Concentration of soluble sugars in the wheat plant as a mean for improving the tolerance of wheat to drought and heat.
- The effect of high temperatures at the beginning of the season on the production of wheat kernels, locating a genetic basis for tolerance.
- Eco-physiological properties of wheat plants that may improve the adaptation of the plant to heat and drought.
- Comparative examination of grain crops for fodder under dry conditions.
- The relationship between high night temperature and losses of dry matter accumulation in the respiratory processes at night, in wheat.
- Grain crops for fodder in a Mediterranean and semi-arid environment; characterizing traditional wheat varieties for their response to drought under semi-arid conditions.

- Examination of planting of grain varieties under preservative growth interfaces to reduce soil erosion.
- Studying the conditions in which natural systems deal with abiotic stresses to secure productive and sustainable agriculture; study of agriculture and forestry in terms of soil-plant-air context, plant physiology, soil ecology, climate change and environmental models.
- Heat effects on the quality of pollen and their productivity. Mechanisms for heat resistance; the hydraulic effects in critical stages of the development and functioning of pollen grains.
- Control of the opening/closing of plant stomata (pores) under high carbon dioxide levels and heat.
- The effects of increased concentrations atmospheric carbon dioxide levels in the atmosphere, heat, frost, drought, and extreme climate events such as cold chills on agricultural crops; understanding molecular mechanisms that control plant transpiration.
- Understanding basic mechanisms involved in transpiration control.
- The impact of climate change on the efficiency of absorbing nutrients from the soil and their effect on the crop.
- Interaction between plants and pests.
- Effects of microorganisms that promote growth.
- Adaptation of plants and pathogens under climate change conditions.

Topic: Plant Protection

Effects of Climate Change

- Pests, diseases and weeds: presence for longer seasons, introduction of new varieties not indigenous to the zone.
- Changes in the activity of semiochemicals and pheromones which can affect insect populations and activity, including pest behavior.
- Climate change accelerating existing stress conditions that will weaken plants but also encourage biotic damage.
- The increasing demand to import agricultural products due to decreased local production will boost introduction of quarantine pests.
- Due to climate change, natural plant resistance may decrease.
- Regulation related to climate change might limit the use of different pesticides and affect production.

Existing and Future Research in Plant Protection of Fruit, Vegetable, Flower, and Field Crops

- Building models for predicting the development of plant epidemics, diseases, pest activity, weeds, and assessing plant disorders under future climate change conditions.
- Study on the future distribution of Mel-Seko's disease (citrus) in the Mediterranean basin in light of various models of climate change.
- Treatments for new diseases, pests, and weeds.
- The impact of climate change on the ability of plants to cope with diseases, bacteria, fungi, viruses, and other factors.
- Pathogenesis in the vine under changing climate conditions of drought and heat.
- Temperature effects on the quality of vine propagation material and the effect of this change on the ability to produce virus and fungi-free plants and mother plants.

- Effect of heat stress, drought, salinity, on plant health and expression of the stress on biotic disorders.
- The prevalence and severity of potato diseases affected by climate change in Israel and the effect of climate change on the health of potato propagation material imported to Israel.
- Study on the bacterial complex that causes dropping and black leg diseases in potatoes
- Study of a new bacteria species *dickeya solani* and *pectobacterium carotovora subsp brasiliense*, both adapted to high temperatures, that arrive to Israel with imported propagation material and cause crop decay and productivity reduction in locally produced potato seeds.
- Study of changes in cotton plant response to diseases in respect of temperature changes and increased stress conditions, especially drought and salinity.
- Changes in the composition of pathogen population and interaction between pathogens as a result of higher temperatures.
- Changes in the interaction between the pathogen and the host plant.
- Effects of warming on chemical communication in insects (pheromones).
- Effects on the dynamics of harmful insect populations (mainly leaf aphid species, moth aphids, thrips) that serve as vectors, on the development and behavior of these insects in the transmission of plant viruses, bacteria (phitoplasma), viruses (viroids).
- Dynamics of populations as tobacco whitefly, which is now defined as the most significant and dangerous vector for plant diseases, transmits more than 100 plant viruses in a variety of crops from different botanical families (the dynamics of populations in light of the climate change).
- The biological natural diversity on plants and animals/insects under changing climate conditions.
- Biological variance and diversity on soil microorganisms in agricultural soil.
- Study of biological pest control under changing climate conditions.
  The effect of climate change on the spread of insects in the warehouse - for the design of an interface for the maintenance of grains in the warehouse.
- Biostimulant development suitable for new microcephaly conditions and the development of systems for transporting biostimolants and protections that help the plant cope with climate change
- Development of post-harvest degasses especially in grain storage facilities.
- Research on biological clocks of insects as an effect of changing climate conditions.
- Producing slow-release pesticides.
- Production of nano capsules for pest control.

Topic: Postharvest and Other Topics

Effects of Climate Change

- Chill damage – increases the sensitivity of fresh produce to chill damage due to global warming during their storage at the optimal temperatures.
- Refrigerated storage for agricultural produce may undergo a crisis as a result of global warming as fruits and vegetables will grow at higher temperatures, increasing their sensitivity to cooling.
- The quality of deciduous fruits will change due to climate change and less chill hours.
- Hibernation and vertex control of potatoes and similar crops will be affected by the changing climate.

- The effect of climate change on the entrenchment and survival of humane pathogens, transmitted in food, and in the agricultural environment.
- Study on salmonella adaptation to dry conditions and the development of cross-tolerance to other environmental stresses.
- The effect of seawater warming on the distribution and activity of vibrio pathogens in aqua systems.
- Toxic blue bacterial rashes affected by rising temperatures.

Existing and Future Studies on Postharvest Produce

- Quarantine cold treatments. There is a possibility that with warming temperatures, the existing quarantine cold treatments against the quarantine pests will cause irreversible chill damage during treatment and therefore will not be effective.
- The effect of global warming on hibernation. Genomic editing to improve heat or cold resistance in growth and storage; Genetic research to detect heat resistance.
- Molecular aspects of hibernation and vertex control in tubers and bulbs. For example, genomic editing in potatoes and cassava.
- Survival of human pathogens transmitted in food, in the agricultural environment under varying dry conditions and temperature.
- Adaptation of salmonella to dry conditions and the development of cross-tolerance to other environmental stresses; Understanding adaptation mechanisms in order to develop new approaches to salmonella pest control in the agricultural environment.
- Growing microalgae in conditions of global warming as a future protein source for humans and animals.

Animal Science

Effects of Climate Change

- Development of stress in cows (and other animals) under higher heat conditions.
- Heat stress affects ruminant's fertility.
- Poultry adaptations for optimal growing under environment conditions, especially for heat stress.
- Response of sweet water fish to temperature stress (cold/heat).
- Physiological changes in the fish as a response to temperature stress mainly in the liver, gills, and intestine tissues.
- Coral diseases under increasing sea temperatures.

Existing or Future Studies in Animal Science

- Improving the ability for dairy cows to cope under environmental heat stress; development of nutritional and interface measures to reduce stress under these conditions.
- Characterizing and establishing biomarkers for heat stress in dairy cows and developing measures and interfaces to reduce stress under these conditions.
- Characterizing stress indicators in the blood, tissue, and milk through biochemical and other analytical measurements of cows under metabolic stress grown under heat stress.
- Effect of heat stress on hormone secretion that control milk production in dairy cows.
- Study of "Baladi beef" – local wild cattle that is resistant to climate change and to blood parasites. Compared to European beef breeds and utilizes better low quality food.

- Changes in incubation conditions in order to cause a change in the setpoint that affects the resting metabolic rate of poultry, the production of metabolic heat, and resistance to environmental stress while improving physiological characteristics.
- The behavioral response to temperature increase in sweet water fish; the endocrine response to temperature increase in fish.
- Initial characterization (at the transcendium level and metabolic indicators) of the hypothalamic response to chill in tilapia fish.
- Hypothalamic control of the homeostatic response to temperature stress in the fish brain.
- Characterizing the hypothalamic response to heat stress and examining common mechanisms and differing in their involvement in homeostatic control of the various channels in fish.
- Study of coral diseases also affected by rising seawater temperature.

Topic: Agricultural Engineering
Existing or Future Studies in Agricultural Engineering

- Energy production and handling of solid waste (agricultural and urban), liquid waste, and use of greenhouse gases.
- Energy control in agricultural structures.
- Monitoring climate changes by electro-optical means and algorithms.
- Pyrolysis of agricultural and other waste.
- Production of nitrate fertilizer from coop waste.
- Biogas production from dairy farm waste.
- Production of nitrate fertilizer from the treatment of poultry waste.
- Reduction and reuse of greenhouse gases produced in agriculture.

Post Tel Aviv will be happy to assist people with interest in any of the research listed above and to contact the Israeli researchers for further information or potential collaboration.

In many cases, the outcome of the research of the Volcani institute is translated into practical use and tested in local farms. Post is also happy to assist anyone with interest, to locate local farmers that use and adapt new farming practices for coping with climate change aspects.

Attachments:

No Attachments.