Global warming and sexual plant reproduction

Afif Hedhly, Jose´ I. Hormaza and Marı´a Herrero. 2009. *Trends in Plant Science*

Nyadoi Priscilla
Uganda Wildlife Society

Global warming

The consequences in climate and species ecologies

- The sustained spatio temporal differential increase in average temperature of earth near surface air and oceans since 20^{th} century

- Sun radiations on reflection from earth/ocean surface are reflected back by stratosphere green house gasses (CO_2, CH_4, N_20, CFCs)

- Alteration of rainfall regimes, frequent extreme temperatures (lower- higher latitudes)

- Shifts in species geographic distribution, phenology, extinction risks

- Yields increase/decrease depending on species/geographic region
(Maize, Soybean in US, Rice in the Philipines)

- Phenotypic plasticity- ability of genotypes to adjust their developmental process in response to environment stress

- Genetic variation/evolution/emergency of new species

Known pathways of global warming effects on plants;
respiration
photosynthesis
reproductive stages
Phenotypic plasticity

Not yet well known;

- Actual effects of changes in and frequency of extreme temperatures on specific plant development stages

- Threshold temperatures for onset of responses in such stages

- Mechanisms underlying yield reductions

- Combined effect of increasing temperature and co_2 concentration on yields is being modelled.

Whole plant response to temperature stress modeled from simultaneous experiments in several development phases of few economic annual plants

The studies revealed that

Plants at the limit of their cultivation range or in reproductive stages may have narrow thresholds especially to changes in frequency and timing of extreme temperatures.

Knowledge of effects of spatio temporal temperature stress on reproductive phases (consecutive and interdependent gametic, progamic/pollination to fertilization and post zygotic/embryo stages of species will be needed to guide production modeling and management to avert extinctions.

The paper in focus reviewed here with the objectives to:

Discuss the effect of temperature change on plant reproductive phases from ecological, agricultural and physiological perspective.

Evaluate the potential implications of forecasted global warming effect on plant reproductive phases.

Temperature stress during gamete developments

- Reduce pollen production/number of seeds sired/female fitness.

- Uncouple pollinator insect and plant flowering phenology.

- Induces genotype and performance (viability-germinative ability, pollen tube growth rate) based selection of developing microgametophyte/pollen.

- The extent to which this may be general phenomena not known.

Temperature stress-post pollination/prezygotic development stage

- May cause out of phase female (stigma and ovule), male (pollen and pollen tube) gamete development and functions

- Successful mating require both be at same cell cycle-in synchrony

- Within adaptive range, temperature increase accelerates development (shortens receptivity of female to pollen/pollen tubes), decrease slows it (prolongs stigma receptivity and ovule longevity)

(example, ***Datura stramonium***)

Temperature stress during progamic phase

- Pollen competition/gametophytic selection sets in the pistil

- Only pollen/pollen tubes from parents best adapted to prevailing temperature conditions succeed to sire

- Thus differential parental contribution to next generation genetic variability

(examples, *Lycopersicon esculentum*, *Lycopersicon hirsutum*, *Prunus avium*)

Temperature stress in post zygotic phase

Epigenetic changes during embryo development and seed maturation responsible for progeny hardening;

- -increased offspring fitness
- -genotypic specific responses for seed germination
- -sporophyte flowering time
- -spikelet production
- -bud set and flushing etc

(examples, *Plantago lanceolata, Picea abis, Arabidopsis thaliana*)

Active interaction among sexual reproductive phases (Gametogenesis, pollen-pistil and embryo) and with heat- environment stress influence next generation reproductive output;

- -genetic variability
- -phenology of adaptive/fitness traits
- -production

Implications of global warming effects on sexual plant reproductive phases

Spatial climate variation may cause evolution of fitness/genetic variation via gametophytic selection (sexual reproduction) and phenotypic plasticity.

Susceptibility of sexual plant reproductive phases to climate variation provides opportunity for adaptation/population genetic structure dynamics.

Species-species geographic region dependent reproductive phenological change related migrations, genetic variation, and Irregular yields are immediate effects of global warming.

Perspectives on global warming and plant reproductive phase

Gametophytic selection and phenotypic plasticity may explain emergence of new landraces/genotypes in new latitudes.

Epigenetic machinery reported in phenotypic plasticity (*P. abies, A. thaliana*), molecular mechanisms underlying gametophytic selection still unknown.

Knowledge of epigenetic dynamics right from commitment of a sporophytic cell to be germ line, to embryo development stages in different species will help elucidate;

-*role of g*ametophyte selection and epigenetic machinery in modulation of plant constitution between generations

-new genotypes well adapted to changing environment.

THEN HOW DO WE PREPARE FOR THE CONSEQUENCES OF CLIMATE CHANGE IN AGRICULTURAL PRODUCTION
(which in Uganda is largely based on sexual plants –the crops):

-Should we aid farmers to watch and select for adapted genotypes and species
-Prepare them for adoption of new well adapted species/genotypes /emerging land races
-But we can also reduce/get away from practices that facilitate global warming- increase atmospheric concentration of $CO_{2.}$ $CH_{4,}$ N_20, CFCs by among others,

stopping deforestation and increasing the tree cover in our land use and in general promote appropriate land uses and management strategies in our day to day practices and therefore community/institutional work plans and as policies.

Use of CFC emitting appliances like refrigerators and co emitting automobiles.

Now, what is Nakasongola doing, can we identify loopholes and opportunities and plan to exploit and or fix them?

I am leaving the Floor to the District Environment Officer to come and take us through the exercise of identifying opportunities and need for the integration of long term strategies to address the changing climatic conditions (adaptations and mitigations) in the annual work plans of the Nakasongola District, to ensure security of the people and their livelihoods.

Thank you