EDITORIAL COLUMN

Technology Development for Conservation, Propagation and Adaptation of Native Crops to Biotic and Abiotic Stress Factors: Concept, Hypothesis and Confirmation

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1. Introduction

The ever increasing human population under the changing Climate, Global Warming, Pollution, Biotic and Abiotic Stress, Drought and Salinity is facing an acute threat for Global Food Security.

The focus of the breeders has always been on increased food production. It started with identifying high yielding varieties and production of hybrids.

Green Revolution was sought to increase food production through novel cultivation practices and use of synthetic pest and insect control measures. All the high yielding cultivars cultivated by the application of chemical fertilizers and pesticides had great impact on the environment degrading the virgin soils to barren; polluting the fresh water bodies making them unsafe for consumption; and drastically affecting the atmosphere resulting in Global Warming, Green House Gases, thinning of the Ozone Layer, Floods inundating the coastal regions and small islands, and increasing Soil Salinity. All these pose a great threat to the very existence of our Natural Resources and the human survival.

The next remarkable step in the technology of food production was GM (Genetically Modified) crop plants. The most popular amongst this is the incorporation of the Bt (*Bacillus thuringiensis*) genes into the susceptible cotton variety making it resistant to the Borer insect. However, the wisdom of use of GM crops is being questioned considering the time and expenditure for this procedure.

An urgent need for a concerted research to address the Global Food Security thus is to find acceptable and sustainable agricultural practices by inter/multi-disciplinary group of Crop Scientists. One of the best options is to search for wild genes for biotic and abiotic resistance. The emphasis thus is in retrieving, conserving and propagating the long forgotten wild species and recovery of ethnic knowledge systems. Implementation of simple, sustainable and cost effective techniques would be helpful to the small farmers too.

In this context, I present a few of my notable research works that could be of reasonable help to the plant breeders.

2. Concepts/ Hypothesis

2.1. Fiber bundle structure/orientation

It determines the yield and quality of bast fiber crops such as jute, mesta, ramie etc. In bast fibre crops, relationship between fiber structure, fiber yield and quality was established (Maiti, 2002).

2.2. Anatomical and morphological traits related to drought resistance

Plants have thick leaves with compactly arranged palisade tissue, high density of trichomes, thick cuticle on leaf surface, thick and stout petiole with thick collenchyma, and deep root system with inclined lateral roots). It is confirmed that drought resistant cotton and sunflower possess these traits. Bt-cotton hybrids selected on these traits are found to be drought resistant in field conditions. Therefore, mass-scale screening may be undertaken for initial selection of potential drought resistant cotton and sunflower (not yet published).

2.3. Plant architecture determines the productivity potential of a crop (cotton, chilli, tomato)

Open canopy helps in efficient translocation of photosynthates directly to the fruit in these crops. Plants with crowded leaves are in general poor yielders due to wastage of resource. Therefore, this concept may help in efficient selection process. (Maiti and Gozalez-Rodriguez, 2011). This is supported by Ideotype Concepts in Cotton (Maiti, 2008).

2.4. Root responses are indicators of tolerance/resistance to salinity and drought

Drought resistant cotton, sunflower and maize produce deep robust root system with inclined lateral roots (work in progress).

In general, salinity tolerant lines produce long tap root with profuse lateral roots and plants having superficial root system for osmotic adjustment. Root ideotypes have been constructed for salinity and/or drought resistance in cotton and maize (Maiti et al., 2009).

3. Technology Developed and Confirmed

3.1. Propagation of native species

3.1.1. Simulating natural condition- breaking seed dormancy in cactus, wild chili (chile piquin) and wild mustard in Mexico

Dormancy is a mechanism of survival in wild species. Different wild plant species disperse seeds in different seasons. They are left exposed to natural vagaries of temperature, light, moisture, etc. before they break dormancy. Therefore, simulating natural conditions may help break seed dormancy. For instance, in Mexico, wild chili sheds seeds in cold season, and wild mustard during hard winters. Simulating these natural conditions exposing to low temperature (4^{o}C) in presence of light in wild chilli and mustard we were successful in breaking seed dormancy. Exposure to sunlight induces phytochrome on seed coat and turns green and start germinating (Maiti et al., 2005).

3.1.2. Massive propagation of endangered cactus in Mexico

Many endemic species of *Cactaceae* in Mexico are endangered. Attempt has been made to propagate these species through tissue culture which proved to be expensive and time consuming. We simulated natural conditions by sowing the seeds right on soil surface in trays in presence of light (12-24 h). Using this technique massive production of cactus (more than 90% germination) has been undertaken by green house owners in Puebla, Mexico. This technique can be used effectively to propagate the endangered cactus in arid regions of different countries such as India and Africa (Maiti, 2007; Maiti, 2009).

3.1.3. Propagation of native Mexican wild chili (Chile piquin) in Mexico

Wild Mexican chili (*Chile piquin*) has a great demand in Mexico and USA which are harvested by the farmers from its wild habitat owing to the non-availability of the technique for propagation. This wild chili disperses seeds during severe winter that fall on the ground and exposed to the prevailing low temperature. The seed dormancy is broken with the advent of favorable weather and start germinating in presence of light and the seed coat turns green on exposure to light. By simulating natural conditions existing in its natural habitat hypothesized above, we developed novel technique for propagation of native species of wild chili (*Chile piquin*) for the first time, and encouraged massive propagation of endangered cactus in Mexico (Maiti et al., 2003).

3.1.4. Propagation of mesquites (Prosopis)

Seeds of *Prosopi*s fall on soil surface during hard summer thereby being exposed to the prevailing high temperature and start germinating with the advent of fresh showers. We used warm water (up to 80^{o}C) and sulfuric acid to induce germination by more than 90%. The same technique has been adopted in the case of wild *Phaseolus* species in Mexico.

3.2. Biotic stress factors

- *Striga* resistant sorghum produces extra sclerenchyma under the endodermis and production of some toxic metabolites which inhibits the growth of *Striga* (paper enclosed) (citation index>100).
- Identification of glossy traits and trichome density is related to tolerance to shoot fly and drought (paper enclosed).

3.3. Resistance to abiotic stresses (salinity, drought, heat stress, flooding, etc.)

- Developed simple technique for the evaluation of seedling vigor and traits in sorghum and pearl millet and its relation with crop establishment and abiotic stress resistance (Maiti et al., 1981, 1991).
- Evaluated and selected sorghum and pearl millet for tolerance to salinity and drought and its mechanism of tolerance in sorghum.

3.3.1. Salinity tolerance

Novel technique (semi-hydroponic) for screening salinity tolerance in several field crops, viz. cotton, sunflower, maize, pearl millet, rice (Maiti et al., 2009). Novel technique has been developed for evaluating field and vegetable crops for salinity tolerance. This indicated technology from lab to land.

3.3.2. Drought resistance

Novel technique for screening drought resistance in field crops (cotton, sunflower and maize). Novel technique has been developed for evaluating crops for drought resistance which have been selected and confirmed in field conditions. This is confirmed in cotton, sunflower and maize. The results are consistent and confirmed in field resistance (not yet published).

3.3.3. Direct impact on farmers

The area of total cultivated land can be increased by using drought resistant line in arid and semi-arid soils. We are working on the above mentioned parameters at Vibha Seeds, Hyderabad (India) and getting excellent results.

- Novel technique for propagation of cactus species.
- Development of technique for drought resistance in several field crops such as cotton, sunflower, maize, etc. which gave consistent results (results are kept confidential as company property).
- Construction of root ideotypes for tolerance to salinity and/or drought in the crops mentioned above.

3.4. Priming of vegetable Crops

Priming technique improves seedling vigor and yield in vegetable crops.

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