E D I T O R I A L

C O L U M N

Application of Botany in Abiotic and Biotic Stress Resistances in Crops: a Synthesis

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It is a matter of great concern that Master in Botany is disappearing in many of the universities in India, thereby the importance is decreasing gradually. Most of the botanists are concentrating on basic research, but there is a great necessity of initiation of applied botany. The basic botany is dominated now by molecular biology.Botanists can contribute directly to crop improvement. The basic concepts of botany can be used in crop improvement. Herein is cited the salient outline of my research findings on the application of botanical concepts in biotic and abiotic stress resistances in crops. It is necessary to mention here that the variability in morpho-anatomical and physiological traits in the seedling and adult stage can be related to their efficiency of adaptation to biotic and abiotic stresses. Conclusions are made on the basis of my research findings and ideas (published and unpublished).

I. Crop Establishment

Several factors affect crop establishment of various crops such as poor germination, poor seedling vigour, soil crust, soil temperature etc.

a. Seedling vigour

It has been observed that there exists variability in seedling vigour (determined by seedling height, leaf area visually) in sorghum, pearl millet, maize. High seedling vigour lines are found to show good establishment, high emergence from deeper depth of planting, emergence through soil crus, thereby giving opportunity in the selection of high seedling vigour lines for better crop establishment. Similar studies need to be undertaken in other crops.

b. Depth of sowing

We have observed variability in emergence in sorghum genotypes from different depth of planting. Sorghum genotypes showing greater emergence from deeper soil layer exhibits greater mesocotyle elongation. Generally the bigger seeds having high endosperm content has capacity to emerge from deeper soil layeras has been observed in the case of maize. For this reason, it is recommended to sow small seeded genotypes at shallower depths for having less endosperm content. On the other hand, legume seeds having bigger cotyledons are recommended to sow at shallower depth owing to the fact that it is difficult for bigger cotyledon to push through soil covers. Similar studies need to be undertaken in other crops.

c. Nature of soil crust

Erratic rainfall followed by sunny days form hard crust in alfisol, thereby affecting seedling emergence of various crops. Research undertaken on sorghum under crust showed variability in seedling emergence, thereby giving opportunity to select genotypes with good emergence capability under hard soil crust.

d. Adaptation to dry sowing

With the expectation of precipitation, farmers in semi-arid regions adopt dry sowing. With the onset of rains, seeds start emerging which may dry up in following sunny days, thereby affecting seedling emergence in several crops. It has been observed that seed soaking from few hours up to 20 hours followed by drying in room temperature for 4-5 days showed variability in emergence among sorghum genotypes. Some genotypes even after drying regained capacity to recover and emerge. It has been suggested that the genotypes selected for could be adapted under dry sowing. Similar study needs to be undertaken and confirmed in other crops.Sorghum genotypes selected for adaptation to dry sowing are found to accumulate aminoacids that help in better germinability under these conditions.

II. Abiotic Stress Tolerance

Gradual increase of global warming, heat stress, drought, salinity and other abiotic stresses affect the crop productivity drastically. Significant research inputs have been directed to understand the gravity of these stress factors, its effects, and study the physiological, biochemical and molecular basis of mechanisms of resistance such as in the case of drought and salinity, little attempts have been undertaken to increase the crop productivity under these stress prone areas. On the otherhand, there is a dire need of efficient technologies to evaluate and select crop cultivars for tolerance to these stress factors. The physiologists could not develop simple technology which can be utilized for mass scale screening of breeding lines. Most of them concentrate on basic physiology with little attempt to find its application in crop improvement programme. Sophisticated instruments for water potential, stomatal conductivity, transpiration, have not been used much in large scale for screening crop genotypes in mass scale. Some studies have been directed to evaluate germplasm of different for the selection genotypes resistant to these stress factors such as drought and salinity, and we have been successful to select resistant genotypes but with poor yield. I adopted a different strategy to use pipe line hybrids/parents with good agronomic background and developed simple low-cost technologies for tolerance to different stress factors mentioned below. The applications of basic physiological concepts are well documented in our studies.

a. Salinity tolerance

A semi-hydroponic simple and cheap technique using cocoa-peat in plastic glasses and NaCl concentration has been developed to screen and select pipe line hybrids/varieties of various field crops such as cotton, sunflower, castor, maize, pearl millet, rice, wheat and vegetable crops such as tomato, chilli.Significant genotypic variability was found among various crop cultivars for salinity tolerance and several genotypes of each species were selected which was confirmed in saline prone areas for example in the case of cotton, sunflower, rice, pearl millet. The salt tolerant crop cultivars with high yielding potential were adapted under saline prone areas.This clearly exemplifies the transfer of technology from the labto the land. It has been observed that salt tolerant cultivarsof dicot crops show increase in root elongation with profuse lateral roots, while in monocots there is an increase in the number of adventitious roots in tolerant plants under higher salt concentration. The increase in root length and number of lateral roots function as osmotic adjustment under saline conditions. Salt tolerant genotypes produce lateral roots located in the upper soil horizon. It has been confirmed that emergence percentage, root elongation, and increase in lateral roots can be considered as selection criteria. Some of these results are published and few not published. Many studies on salinity tolerance of various field and vegetable crops are mentioned in the references.

b. Drought tolerance

About one third of arable lands in the world are affected by drought which is increasing constantly. A simple technique has been adopted to screen pipe lines crop cvs. exposed to different levels of drought cycle depending on the crop species such as cotton, sunflower, maize, pearl millet, wheat, castor, okra etc. for drought resistance showing genotypic variability both at the seedling and vegetative growth stage. Few cultivars have been selected of each species for drought tolerance and confirmed their efficiency under drought prone areas. Cultivars resistant to drought produce robust root systems and more number of inclined lateral roots at deeper levels.

Roots play an important role for adaptation to salinity and drought. In our studies it has been assesses that root responses of crop cultivars exposed to salinity and drought. Crop cvs. (dicots) tolerant to salinity produce profuse lateral roots located in the upper layers of soils functioning as osmotic adjustment. In the case of monocots the salt tolerant lines produce profuse adventitious roots.

Some morpho-anatomical traits are found to be related to drought tolerance. In general drought tolerant cultivars possess profuse trichomes, thick cuticle, compactly arranged palisade cells, strong in the leaves, and thick collenchymas in the petiole. In a study in the case of cotton mass scale screening of about 100 pipe line genotypes of cotton on the basis of these leaf traits and short listed about 16 genotypes having these traits. To my utter surprise, these genotypes were found to be well adapted in drought prone areas. This is a classical example of the application of botany in agriculture. Therefore, this can be used in mass scale screening of cotton cultivars for drought tolerance which may be confirmed in further studies in different dicots.

c. Heat and cold tolerance

The viability of pollen grains with 3% potassium iodide can be judged of the crops exposed to high temperature (>40^{o}C). Staining pollens with 3% potassium iodide of several crop species such as sunflower, maize, pearl millet cvs. grown in hot summer showed that viable pollens of crop cultivarstolerant to heat stress took deep stain which can be used in selecting cultivarstolerant to heat stress. The same technique using potassium iodide is used to select maize genotypes exposed to cold temperature (10-12 ^{o}C) for cold tolerance.

d. Tolerance to flooding

Technique has been standardized to screen maize cultivars for to tolerance to flooding by growing genotypes in pots with standing water by closing the holes with commercial sealantM-SEAL. Genotypic variability was found among cultivars for flooding tolerance. Genotypes tolerant to flooding were found to produce fleshy roots with aerenchyma as source of oxygen under inundated condition. Similar result was observed in the case of cotton cultivar tolerant to flooding.

III. Biotic Stresses

Sufficient literatures are available reporting the role of trichomes and pubescence for tolerance to several insects. Herein is cited few examples of my research findings revealing the role of anatomy in the applied field.

a. Shootfly tolerance in sorghum:

It has been well documented that at the seedling stage glossy sorghum genotypes with shining leaf surface and erect leaves are more tolerant to shootfly (*Atherigona soccata)* than non-glossy ones with broad drooping leaves. Anatomical observations reveals that glossy sorghums possess pointed stiff trichomes thereby affecting the movement of larva. Non-glossy lines possess glandular trichomes. Further studies are made on the role and mode of inheritance of trichomes mentioned in the references.

b. Sucking pest tolerance in cotton

It has been assessed that cotton cultivars possessing more trichomes on the lower leaf surface are tolerant to the aphid as well to virus (not published).

c. TOSPO virus resistance in tomato

Tomato genotypes showed variability in trichome density. The genotypes having dense trichomes are tolerant to TOSPO virus which has been confirmed by molecular studies.

d. Striga resistance

Sorgum is infested with the parasitic weed, *Striga* invading roots. Anatomical study revealed that Sorghum genotypes resistant to *Striga* produce strong sclerenchyma below endodermis, thereby blocking the invasion of haustoria inside the root. This is a classical example of the role of anatomy in the applied research.

Conclusion

Low cost screening techniques are very handy for large scale crop breeding programme, particularly for breeding programme with limited resources. Basic understanding in botany and physiology of plants can have far reaching applications in designing low cost rapid screening techniques, which have high applicability in selection programmes. Our works have documented many of these techniques for helping plant breeders and gives strong support to the idea that the basic concepts of botany and plant physiology could be effectively utilized fir adaptation of crops to abiotic and biotic stresses.