JUST AGRICULTURE
multidisciplinary e-Newsletter

Lysimeter: Semi-High Throughput Plant Phenotyping Platform

Vishal Hivare[1*] and Kalyani Deshmukh[2]
[1]Vasanatrao Naik Marathawada Krishi Vidyapeeth, Parbhani (MH), 413402, India
[2]Vasanatrao Naik Marathawada Krishi Vidyapeeth, Parbhani (MH), 413402, India

ARTICLE ID: 24

Summary

Because fresh water resources are finite in nature and scarce in countries with big populations and increasing population growth rates, producing more food per unit of water has become a serious worry for humanity. Agriculture requires around 75% of total fresh water consumption, while this proportion drops to approximately 50% in industrialised nations where household and industrial water demand is significantly greater. As a result, as societies expand, there will be more rivalry for water resources between the agricultural and development sectors, putting pressure on agriculture to produce more food with less water. Lysemiter, an unique concept that measures gravimetric plant transpiration with analytical scales in plants cultivated at densities mimicking field circumstances, was developed in order to decode the possible reasons of critical features that regulate the plant water status associated with greater adaptation to water scarcity of many crops.

Importance

Phenotyping, or evaluating key crop features like drought tolerance, is important in breeding and genetics because it speeds up the production of new varieties. In pot studies, it is difficult to adequately measure transpiration in the field or quantify plant transpiration over time. A Lysimetric technique utilising long, huge PVC tubes installed outside has been developed (*Vadez et al., 2008*). The tube size and spacing are designed to provide the plants with a comparable amount of space and soil volume to that found in field conditions (Fig. 1). This approach permits monitoring of plant water use and biomass building (both vegetative and grain) from very early plant stages until maturity, as well as highly robust TE assessments with very low experimental error (Ratnakumar et al., 2009; Vadez et al., 2011a, 2011b). Lysimetric approach is being successfully used for phenotyping, particularly for

JUST AGRICULTURE
multidisciplinary e-Newsletter

plant responses to water-stress related to drought, and climate change adaptation. This technique measures transpiration over almost the whole crop cycle, minimising potential artefacts reported in short-term trials. Furthermore, this technology enables the monitoring of plant water use at key growth stages of the crop cycle.

Uses:

1. Exploit root systems to improve crop drought tolerance.
2. Determine water extraction during important crop stages.
3. Choose germplasm that is water-efficient (more-crop-per-drop)

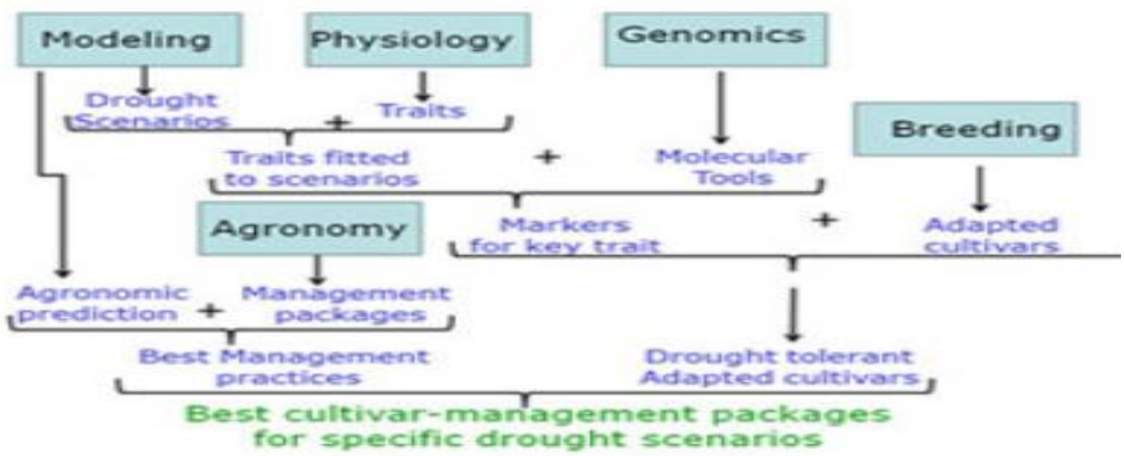
Structure

Lysimeters are made up of tubes ranging in length from 1.2 m and 20 cm in diameter to 2.0 m and 25 cm in diameter. These dimensions provide the plants with soil depth and aerial spacing equivalent to field conditions. Lysimeters supplement other phenotyping operations in the field as well as in controlled settings.

Working principle

The Lysimeter method bridges the gap between field and laboratory research. It allows for the collection of precise data on water consumption (quantities, time) that is linked to agronomic data (grain yield), as well as information on attributes that contribute to yield increase.

Importance in crop improvement



Lysemetric system has been successfully used to screen germplasm of sorghum, pearl millet, foxtail millet, peanut and other crops, and found very large variations for transpiration efficiency (TE, i.e. biomass produced per unit of water transpired). More exciting is the discovery in pearl millet and sorghum that high TE variants have the capacity to restrict transpiration under high evaporative demand (also called VPD, i.e. the vapor pressure deficit, an index of the dryness and temperature of the atmosphere). In other words, at high VPD, they save water.

References

Vadez, V., Kholova, J., Hummel, G., Zhokhavets, U., Gupta, S., and Hash, C. T. (2015). LeasyScan: a novel concept combining 3D imaging and lysimetry for high-throughput phenotyping of traits controlling plant water budget. *Journal of Experimental Botany*, *66*(18), 5581–5593. https://doi.org/10.1093/jxb/erv251

Vadez, V., Kholova, J., Medina, S., Kakkera, A., and Anderberg, H. (2014). Transpiration efficiency: new insights into an old story. (2014, March 5). *Journal of Experimental Botany*, *65*(21), 6141–6153.https://doi.org/10.1093/jxb/eru040

Gems – Science with human face (icrisat.org)