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Theme 4. Biodiversity, conservation and genetic improvement of range and forage species
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Drought tolerance screening of *Avena* species by inducing water stress conditions at vegetative and flowering stage

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Introduction

Oats is the most important cereal fodder crop grown in the winter season in the north western, central India and now extending to the eastern region. In India it is grown in Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and Bengal. Oat is a high yielding crop and the average yield varies from 45-55 ton of green fodder per hectare. Oat is ranked sixth in world cereal production statistics following wheat, maize, rice, barley and sorghum. Mostly oats are grown as green fodder and grain to be used as a feed for cattle. Since water availability is usually main factor affecting the productivity in dry regions, strategies aiming at improving sustainable use of water and plant drought tolerance are urgent (Erice *et al*., 2010). The physiological and morphological responses of cereals to water stress have been studied extensively by Boyer and Westgate (2004) and Blum (2005). Genetic modification of plants by breeding and identification of germplasm for their growth and yield under unfavorable conditions may be a solution to the problem of environmental stresses. The present work aims to study the morphological, physiological and biochemical changes in seven *Avena* species grown under water limited environment. The study also aims to identify some drought tolerant species for its utilization as the donor in oat breeding programme.

Materials and Methods

Seeds of seven *Avena* species v*iz*., *A. strigosa*, *A. brevis*, *A. vaviloviana*, *A. abyssinica*, *A. sativa*, *A. maroccana* and *A. sterilis* were sown in porcelain pots size (30x20cm) filled with 20 kg garden soil and farmyard manure in 2:1 ratio. After uniform germination 3 plants in each pot was maintained. The crop was grown as per recommended agronomical practices. The water stress was created by with-holding the irrigation at vegetative and flowering stage. One set of each species was maintained with irrigation at 100% field capacity and another set was at moisture stress by withholding water. Relative water content (RWC) was measured as per Barrs and Weatherley (1962). Leaf water potential was measured at mid-day (10-12 noon) in fully expanded leaves with thermocouple psychrometer (Wescor Inc. USA). Osmolality was also measured in leaves. Proline content in leaves was estimated following Bates *et al.* (1973).

Results and Discussion

In this study seven species tested for moisture stress and compared among themselves. At vegetative stage all the seven species of *Avena* grouped under three categories in response to the extent of moisture stress. In first group, *A. sterilis* considered to be the most tolerant species with respect to maximum accumulation of proline, osmolality and RWC. In the second group, *A. strigosa* showed maximum tolerance at 12th day of drought. The tolerance was due to its ability to maintain optimum level of RWC, osmotic potential and proline. However, *Avena sativa*, the most abundantly cultivated species showed tolerance up to 9th day only. Hence, it can be concluded that *A. sterilis* reflects maximum tolerance to drought followed by *A. strigosa* and *Avena sativa* at vegetative stage.

At flowering stage, drought appeared only at 5th day of water withholding that too in six species of *i.e. A. strigosa*, *A. brevis*, *A. vaviloviana*, *A. abyssinica*, *A. maroccana* and *A. sativa*). *A. sterilis* showed, drought on the 4th day. The lesser extent of drought period at flowering stage may be due to the increase in air temperature and higher biomass. Among these six species, *A. maroccana* showed better moisture retention capacity in terms of less decrease in RWC, water potential and reasonable increase in osmolality and proline followed by *A. Abyssinica.*

Present investigation reveals that proline content was increased with corresponding decrease in RWC, water potential and osmotic potential. However, the extent of increase in proline varied among the species. Thus it may be concluded that species with higher accumulation of proline with a low RWC, water potential, osmotic potential and higher osmolality may have better tolerance to drought. The relationship between leaf water potential and osmotic potential showed an active osmotic adjustment in the *Avena* species. Yang *et al*., (2011) reported that osmotic adjustment (OA), defined as the lowering of osmotic potential in plant tissue due to net accumulation of organic or mineral solutes, which is a key points of plant osmo-tolerance. Bimpong *et al*. (2011) reported that measurement of relative water content (RWC) and water potential (WP) are indices of plant water status, which is useful in monitoring the development of stress in plants which are growing under drought conditions.

These results are in accordance with those of Benlaribi *et al*. (1990) and Sayer *et al*. (2008) where a positive correlation between leaf water potential and drought tolerance has been depicted. Slama *et al*. (2011) and Bibi *et al*. (2010) have also reported that osmotic potential could be used as selection traits for drought tolerance as it contributes maximum towards water stress among all drought parameters. Relative water content has also been used profoundly to know the water status of the leaf. In cereals it has been demonstrated that tolerance to drought stress is a quantitative trait and RWC is an authentic tool to screen drought tolerant lines.

Conclusion

Climate change is a concern in present times, and researchers are engaged in under- standing its impact on growth and yield of crops, and also identify suitable management options to sustain the crop productivity under the climate change scenarios. Our studies have revealed that water stress is detrimental for crop growth and losses are different at different phenophases (vegetative and flowering stage). There is a growing need to quantify the effects of water stress on yield of crops in different agro-ecologies and agri-production environments.

References

Barrs, H. D. and P. E. Weatherley. 1962. A re-examination of the relative turgidity technique for estimating water deficit in leaves. *Australian Journal of Biological Science.* 15: 413-428.

Bates, L.S., R. P. Walbren and T. D. Teare. 1973. Rapid determination of free proline water stress studies. *Plant Soil*. 39: 205-207.

Benlaribi, M., P. Monneveux and P. Grignac. 1990. Etude des caracteres d’enracinement et de leur role dans I’adaptation au deficit hydrique chez le ble dur. *Agron.* 10:305-322.

Bibi, A., H. A. Sadaqat, H. M. Akram and T. M. Khan. 2010. Physiological and agronomic responses of sudangrass to water stress. *J. Agric. Res*. 48(3):369-380.

Bimpong, I. K., R. Serraj, J. H. Chin, E. M. T. Mendoza, J. Hermandez and M. S. Mendioro. 2011. Determination of genetic variability for physiological traits related to drought tolerence in African rice (*Oryza glaberrima*). *J. Plant Breeding and Crop Science.* 3(4):60-67.

Blum, A. 2005. Drought resistance, water-use efficiency and yield potential are they compatible, dissonant or mutual exclusive. *Australian Journal of Agricultural Research*. 56:1159-1168.

Boyer, J.S. and M.E. Westgate. 2004. Grain yield with limited water. *J. Exp. Bot.* 10:1093/jxb/erh/219.

Erice, G., S. Louahlia, J. J. Irigoyen, M. Sanchez-Diaz and J. C. Avice. 2010. Biomass partitioning, morphology and water status of four alfalfa genotypes submitted to progressive drought and subsequent recovery. *J. Plant Physiol*. 167:114-120.

Sayar, R., H. Khemira, A. Kameli and M. Mosbahi. 2008. Physiological tests as predictive appreciation for drought tolerance in durum wheat (*Triticum durum* Desf.). *Agronomy Research* 6(1):79-90.

Slama, I., S. Tayachi, A. Jdey, A. Rouached and C. Abdelly. 2011. Differential response to water deficit stress in alfalfa (*Medicago sativa*) cultivars: Growth, water relations, osmolyte accumulation and lipid peroxidation. *African Journal of Biotechnology*. 10(72): 16250-16259.

Yang, P., P. Zang, B. Li and T. Hu. 2011. Effect of nodules on dehydration response in alfalfa (*Medicago sativa* L.). *Environ. Exp. Bot*. Dol:10.1016/j.nvexpbot. pp. 05-012.

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