Drought tolerance of Nepalese wheat (*Triticum aestivum* L. em Thell) cultivars, breeding lines, and landraces and associated morpho-physiological, agronomic and root traits

Project Report

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Summary

Wheat (*Triticum aestivum* L. em Thell) is one of the major cereal crops vital for global food supply. In Nepal, wheat plays a crucial role in food security as the other two major cereals, rice and maize, are mainly grown during the Monsoon season and are at the risk of production instability. Due to expanding settlements and development of infrastructures on agricultural lands, especially in the wheat production areas of Terai, it is envisaged that the wheat area in Nepal will shrink in the future. Moreover, most of the wheat area in Nepal is rainfed and therefore is vulnerable to drought stress. Due to climate change impacts, it is anticipated that the frequency and severity of drought will intensify in the future and drought will become one of the major wheat production constraints in Nepal.

Enhanced drought tolerance of wheat cultivars can compensate for yield losses due to drought stress. In Nepal, wheat cultivars are mainly bred for high production environments and the drought tolerance of such mainstream cultivars is not known. The drought screening of Nepalese wheat cultivars and germplasm and the identification of drought adaptive traits will be useful for the improvement of drought tolerance of future wheat cultivars. The objectives of the present study were: (1) to evaluate Nepalese wheat cultivars, breeding lines, and landraces for drought tolerance in terms of grain yield stability, (2) to study the variability of morpho-physiological traits and to identify key determinants of grain yield under drought stress, and (3) to identify drought tolerant cultivars and germplasm.

Field experiments were carried out during the wheat season (November to April) of 2009 and 2010 at the research farm of Institute of Agriculture and Animal Science (IAAS) and on a farmer's field at Dobilla village, Nawalparasi. At IAAS, the test materials were evaluated under managed drought, rainfed, and irrigated environments in the 2009 wheat season and under rainfed and irrigated environments in the 2010 wheat season. At Dobilla, the materials were evaluated under rainfed conditions. A pot experiment was carried out during the 2010 wheat season at IAAS to evaluate grain yield and yield attributes under managed drought and optimum moisture conditions in pots. Moreover, the growth angle of seminal roots of the wheat cultivars and germplasm was also measured using gel observation chambers.

The studied wheat cultivars and germplasm showed varied response to drought stress, measured in terms of grain yield in managed and natural drought environments. Wheat cultivars, Vijaya and Gautam were among the top performers in moisture non-stressed environment, however, these cultivars had low grain yield in moisture stressed environment and thus suffered from drought stress. The old cultivar, Bhrikuti did not suffer from drought

stress, but had lower potential yield than Vijaya and Gautam. The findings suggested that the current Nepalese wheat cultivars are poorly adapted to drought. In the present study, two breeding lines: BABAX/LR42//BABAX*2/3/VIVITSI and KIRITATI//ATTILA*2/PASTOR (-43Y) were identified as drought tolerant lines with high potential yield. The landraces showed a wide range of drought tolerance, however, the potential yield of most of these landraces was low.

Plant height, biomass, 1000-grain weight, number of grains/spike and SPAD were consistently associated with the grain yield in all the field tests. Canopy Temperature Depression (CTD) was associated with the grain yield in most but not all the test environments, indicating this trait may only be utilized for drought screening under specific environments. In general, the traits associated with the grain yield in moisture non-stressed environments were also the important determinants of grain yield in moisture stressed environments. Grain weight/spike was associated with grain yield in natural drought environments of Nawalparasi. This trait was not associated with the grain in the relatively high yielding, moisture non-stressed environment of Rampur.

The characterization for drought tolerance of the wheat cultivars and germplasm in the pot experiment did not comply with the field experiment results indicating that drought screening in pots may not be a preferred method for breeding purposes. The Stress Tolerance Index based on grain yield in pots revealed drought check cultivar Dharwar Dry as one of the best drought tolerant cultivars. Cultivar Gautam showed better drought tolerance than Bhrikuti in the pot experiment, whereas in field experiments opposite response was observed. The growth angle of seminal roots was moderately and negatively correlated with the grain yield in the light soil-relatively moisture non-stressed environment of Rampur, contrasting with the loamy soil-relatively dry environment of Nawalparasi, in which the two traits were not correlated. This suggested for possible uses of root architectural traits for the improvement of drought tolerance in wheat for production environments like that of Rampur.