Root architecture in wheat 5U-5A CSSLs as an important subcomponent of performance under water deficit stress conditions

Ravneet Kaur[1], Himanshu Sharma[2], Maninder kaur[1], Achla Sharma[2], Satinder Kaur[1], Parveen Chhuneja[1]
[1]School of Agricultural Biotechnology, [2]Department of Plant Breeding & Genetics, PAU, Ludhiana
Corresponding author: ravneet.rai17@gmail.com

TIGR²ESS
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies

The Challenge

Why do we need to focus on drought resilient wheat?

Each 1 ℃ rise in temperature causes 18.1% yield reduction of wheat in Indo-Gangetic plain

Decreasing Yield

Drought Stress

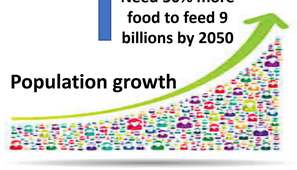
>70% of wheat harvesting region show yield variability due to change in precipitation and temperature

Increasing Food demand

Indo-Gangetic plains, the food basket of India, feeds about 40% population of our country

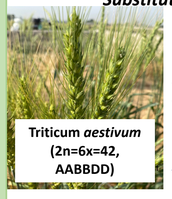
Need 50% more food to feed 9 billions by 2050

Population growth



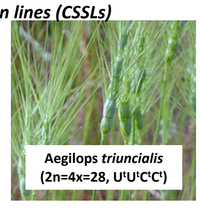
Methods

Development of Chromosomal Segmental Substitution lines (CSSLs)

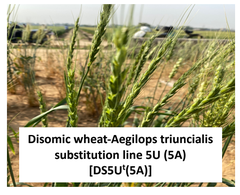


Triticum *aestivum* (2n=6x=42, AABBDD)

X

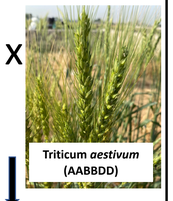


Aegilops *triuncialis* (2n=4x=28, $U^tU^tC^tC^t$)



Disomic wheat-Aegilops triuncialis substitution line 5U (5A) [DS5U^t(5A)]

X



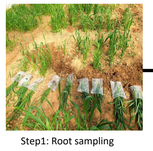
Triticum *aestivum* (AABBDD)

5U-5A wheat chromosomal segmental substitution lines (CSSLs) BC_2F_6

Evaluated for two consecutive years for root system architecture studies by sowing in rainout shelter with three replications in randomized block design under drought as well as irrigated conditions

Steps involved in root architecture studies

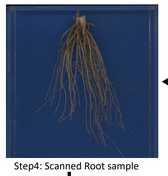
Drought trial of 5U-5A CSSLs under rainout shelter



Step1: Root sampling

Step2: Root washing

Step3 :Root scanning

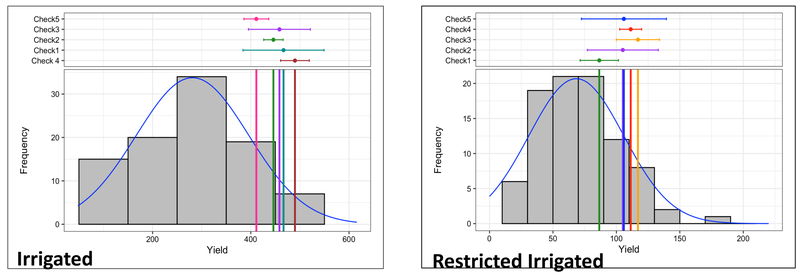


Step4: Scanned Root sample

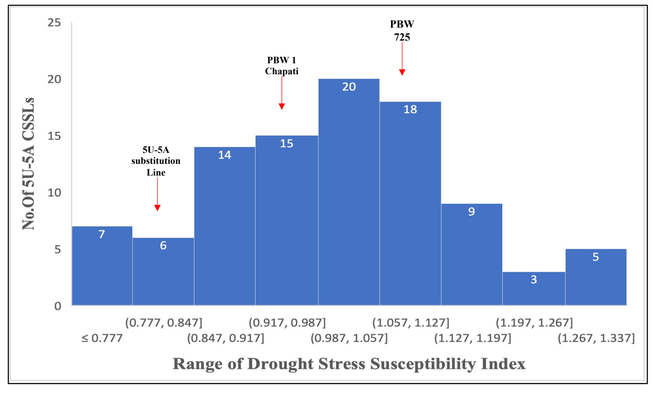
Analysis using WinRhizo software

Insights/Findings

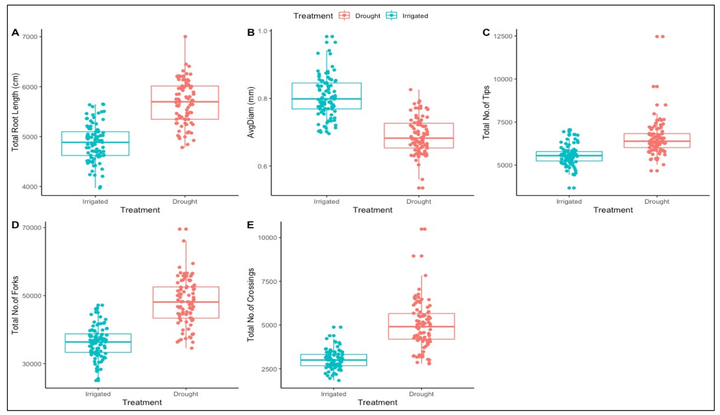
- Root is the important organ for improving crop adaptation to drought stress as it is the first organ to respond water deficit stress. But research on the impact of water deficit stress on root traits have been mostly neglected.
- Eight CSSLs named 5U-17, 5U-20, 5U-23, 5U-24, 5U-49, 5U-74, 5U-93, 5U-96 and 5U-98 have higher yield than popularly cultivated wheat varieties PBW 677 and PBW 1 Chapati under restricted irrigated conditions. Among these CSSLs, 5U-96 (1.047) has highest stress tolerance index followed by 5U-74 (0.776), 5U-24 (0.596), 5U-20 (0.592) and 5U-17 (0.557)
- Identified six CSSLs (5U-20, 49, 23, 93, 96, 98) having lowest drought stress susceptibility index.
- CSSLs named 5U-23, 49 and 96 identified as best lines having good root architecture (long, deep and thin roots and high root biomass), better drought tolerance index and were also amongst top ten lines for thousand kernel weight (g)



Yield per plot under Irrigated and Restricted irrigated conditions



Drought stress susceptibility Index in 5U-5A wheat CSSLs



Different root traits studied in 5U-5A wheat CSSLs sown under irrigated and drought conditions *(A) Total root length (B) Average Root diameter (C) No. of Tips (D) No. of Forks (E) No. of crossings*

Next Steps

- Best 5U-5A CSSLs can further be used in wheat breeding programs to tailor genetic make up of high yielding wheat cultivars that enables them to perform well under water deficit stress conditions.
- Valuable root traits can be incorporated into marker assisted selection using recent advances in sequencing data and RNA expression analysis.

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BGRI 2022 Virtual Technical Workshop, September 9, 2022