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EVALUATION OF MORPHO-PHYSIOLOGICAL TRAITS OF WHEAT *(Triticum aestivum)* GENOTYPES UNDER IRRIGATED AND NON-IRRIGATED CONDITIONS

S.A.Yelore[1], S.B.Amarshettiwar[2], R.D.Deotale[3] A.Blesseena[4] and D.A. Raut[5]

ABSTRACT

Amongst several constraints which affect the wheat productivity, moisture availability ranks at the top, as it exposes the crop to moisture stress at anthesis or grain filling stage. Nevertheless all physiological and yield parameters are affected by moisture stress. Thus, it was necessary to evaluate wheat genotypes under two contrasting environments viz., irrigated and non-irrigated conditions. Amongst the eight different genotypes under study, genotypes AKAW 5104, AKW 1071 and AKW 381 recorded significantly higher grain yield as compared to any of the genotypes. These cultivars may ultimately proved to be outstanding under moisture stress conditions since these are able to produce highest chlorophyll content index, relative water content, relative growth rate, harvest index, numbers of grains spike^{-1}and grain yield (kg ha^{-1}).

(Key words: Wheat, full irrigation, moisture stress, grain yield)

INTRODUCTION

Wheat (*Triticum aestivum* L.) is originated in south west Asia region and belongs to family Gramineae. It is world'smost cultivated food crop hence, known as the king of all cereal crops as its cultivation is easier, economically suitable and contain high amount of nutrients. It is rich in carbohydrates, calcium, lysine, gluten, vitamin and minerals. Protein content in it is 7-12%. In India, it is second most important crop after rice. Moisture stress is the complex relationship between grain yield and water in wheat crop because yield is more sensitive to water deficits at certain growth stages. Therefore, grain yield is more dependent on irrigation well distributed over the growing season depending on demand at each stage than on total water available through the growing season, water deficit causes nearly all growth processes however, the stress response depend on the duration of exposure and stage of plant development of wheat crop, water stress occurring during pre-flowering, post flowering and grain filling stage decreasing grain filling percentage, seed size and number of grains spike^{-1} thus leading to strong yield reduction or even total crop loss. The objective of present investigation was to study the morpho-physiological parameters of wheat genotypes under irrigated and non-irrigated conditions.

MATERIALS AND METHODS

A field experiment was carried out during *rabi* season of 2018-19 at the research farm at Shankar nagar, of Botany section, College of Agriculture, Nagpur.The experiment was laid out in split plot design with full irrigation and moisture stressed environments as a main plot and eight wheat genotypes as sub plot factors. Each set of experiment was replicated three times. The size of the sub plot was 2.50 × 0.69 m^2. There were 5 rows of wheat plot^{-1} at 25 cm row spacing. The genotypes AKAW 4739, AKAW 4901, AKAW 5099, AKAW 5104, AKAW 4927, AKAW 4973-2, AKW 1071, AKW 381 were planted on 21st November, 2018.

The climate of the area is semi-arid and is characterized by three distinct season's *viz.,* summer, rainy and winter. The normal mean annual precipitation is received during the period of June to September, winter rains are few and uncertain. During *rabi* season of 2018-19 there was two rainy days 16.6 mm and 3.2 mm respectively, 60 DAS throughout experiment.Temperature during *rabi* season ranged between 27.8^{0}C to 34.1^{0}C (max.) and 21.6^{0}C to 16.5^{0}C (min.) and average humidity was 65.47% (at morning) and 39.19% (at evening) during *rabi* season of 2018-2019.

The morpho-physiological parameters *viz.,* chlorophyll content index (at anthesis and seven days after

1, 4 and 5. P.G. Students, BotanySection, College of agriculture, Nagpur
2. Associate Dean, College of Agriculture, Gadchiroli
3. Professor, Botany Section, College of agriculture, Nagpur

anthesis), canopy temperature (at anthesis), canopy temperature (seven days after anthesis), relative water content at 75 DAS, relative growth rate at 60-100 DAS, number of grains spike^{-1} at harvest, harvest index at harvest and grain yield kg ha^{-1} were recorded when wheat genotypes sown under irrigated and non-irrigated conditions.

RESULTS AND DISCUSSION

Amongst several constraints which affect the wheat productivity, moisture availability ranks at the top as it exposes the crop to moisture stress at anthesis or grain filling stage. Nevertheless all morpho-physiological and yield parameters are affected by moisture stress. Thus, it was necessary to evaluate wheat genotypes under two contrasting environments *viz.,* irrigated and non-irrigated conditions.

Effect of moisture conditions

Wheat crop sown under different moisture availability i.e. irrigated and non-irrigated conditions.

In non-irrigated condition, chlorophyll content index (at anthesis and 7 days after anthesis), relative water content, relative growth rate, harvest index, number of grains spike^{-1}and grain yield were lowest as compared to irrigated condition, but canopy temperature (at anthesis and 7 days after anthesis) increased in non-irrigated condition as compared to irrigated condition.

Effect of Genotypes

Different genotypes of wheat gave significant variations on morpho-physiological and yield parameters. Genotypes AKAW 5104, AKW 1071, and AKAW 4739 showed high yield potential in irrigated as well as in moisture stress condition as compared to remaining genotypes.

Interaction Effect

Interaction effect between moisture availability and genotypes were found to be non-significant for Canopy temperature (^{0}C) at anthesis.

Interaction between moisture conditions and genotypes was significantly differed. Under irrigated condition, significantly highest CCI was recorded in genotypes AKAW 5104 followed by AKW 1071, AKAW 4927 and AKAW 4901. However, significantly lowest CCI was noticed in genotypes AKAW 4973-2 and AKAW 4739. Under non-irrigated conditions genotype AKAW 5104 recorded significantly highest CCI followed by AKW 1071 and AKAW 5099. Significantly lowest CCI recorded in genotype AKAW 4973-2 over all other genotypes under study. The highest chlorophyll content Index was obtained under well-watered conditions. While in water stress condition, significant reduction in chlorophyll content index was noted.Similar findings were also reported by Chandrashekar *et al.* (2000) i.e. Chlorophyll content was highest in irrigated condition. There was significant decrease in chlorophyll content under water stress in all the cultivars.

Interaction effect between moisture conditions and genotypes was significant. Under irrigated conditions, genotype AKAW 5104 recorded significantly lowest canopy temperature among all the genotypes.Genotype AKAW 4973-2 noted highest followed by AKAW 4927 and AKAW 4739 however found at par among each other in canopy temperature. In non-irrigated conditions, among all the genotypes, minimum canopy temperature was noted by AKW 381. Whereas, significantly higher canopy temperature have been observed in AKAW 4913-2 followed by AKAW 5099 and AKAW 4901. Canopy temperature was higher in non-irrigated condition as compared to irrigated condition.Similar results were observed by Siddique *et al.* (2000). They reported that canopy temperature (^{0}C) for wheat under un-irrigated conditions was higher than under irrigated conditions. Similar findings were also recorded by Srivastava *et al.* (2017). They recorded more canopy temperature in non-irrigated as compared to irrigated condition.

Interaction between moisture conditions and genotypes was significantly differed. Under irrigated condition, significantly highest RWC was maintained by genotypes AKAW 5104, AKW1071 and AKW 381. However, significantly lowest RWC was noticed in genotypesAKAW 4973-2 and AKAW 4901. Under non-irrigate condition,AKW 1071 recorded significantly highest RWC followed by AKAW 5104 and AKW 381. Lowest RWC recorded in AKAW 4901 and AKAW 5099 and found significantly lowest among all genotypes. Siddique *et al.* (2000) observed decrease in RWC from 88% to 45% during water stress. Whereas, Almeselmani *et al.* (2011) also observed reduction in relative water content under moisture stress environment.

Interaction effect between moisture conditions and genotypes was significantly different. Under irrigated condition, among all the wheat genotypes, significantly highest RGR was found in AKW 1071 followed by AKW 381 and AKAW 5104. However, Lowest RGR was noted in AKAW 4927 and AKAW 5099 under irrigated conditions. Undernon-irrigated condition, AKW 381, AKW 1071 and AKAW 5104 showed significantly highest RGR. However, lowest RGR was noted byAKAW 4927 and AKAW 4739.Irrigated condition showed high rate of RGR as compared to moisture stress. Hossain *et al.* (2010) found similar results. They observed that, irrigated conditions showed high rate of RGR as compared to moisture stress.

Interaction between both moisture conditions and genotypes were significantly influenced for number of grains spike^{-1}. Under irrigated conditions, genotype AKAW 4927 recorded significantly highest grains spike^{-1} followed by AKAW 5104, AKW 1071 and AKAW 5099. Whereas, lowest grains spike^{-1} were observed in AKAW 4973-2 followed by AKW 381 which were at par with each other. Under moisture stress conditions AKAW 4927, AKAW 5104 and AKW 381 recorded significantly highest grains spike^{-1} whereas, lowest grains spike^{-1} recorded in AKAW 5099 and AKAW 4973-2.Reduction in number of grains spike^{-1} at

Table 1. Effect of moisture availability and genotypes on different morpho-physiological parameters of wheat

Genotypes	CCI (A)			CCI (AA)			CT (AA) ^0C			RWC (%)		
	Irrigated	Non-irrigated	Mean	Irrigated	Non-irrigated	Mean	Irrigated	Non-irrigated	Mean	Irrigated	Non-irridated	Mean
AKAW 4739	24.33	21.98	23.18	22.83	18.70	20.75	23.45	26.46	24.95	65.37	54.40	59.88
AKAW 4901	25.43	21.47	23.45	25.30	21.77	23.53	24.44	28.70	26.57	64.67	50.53	57.60
AKAW 5099	24.67	22.07	23.37	23.80	20.47	22.13	23.33	29.59	26.46	65.30	51.47	58.38
AKAW 5104	31.97	24.83	28.40	27.17	21.10	24.13	22.55	26.65	24.60	75.30	63.40	69.35
AKAW 4927	25.50	21.67	23.57	23.37	20.57	21.97	23.63	27.46	25.54	70.37	55.40	62.88
AKAW 4973-2	23.53	21.61	22.58	20.47	17.50	18.98	23.84	31.09	27.46	60.53	53.97	57.25
AKW 1071	27.47	24.27	25.87	23.90	21.17	22.53	23.67	27.62	25.64	73.67	63.53	68.60
AKW 381	24.60	21.97	23.29	21.57	19.57	20.57	22.85	26.42	24.63	70.47	60.43	65.45
Mean	26.06	22.48	24.27	23.55	20.10	21.82	23.47	28.00	25.73	68.21	56.64	62.42
Irrigation (I)												
SE(m) ±			0.23			0.27			0.48			0.18
CD at 5%			0.69			0.87			1.44			0.54
Genotype (G)												
SE(m) ±			0.44			0.48			0.45			0.45
CD at 5%			1.28			1.39			1.31			1.31
I x G SE(m) ±			0.62			0.68			0.64			0.63
CD at 5%			1.81			1.97			1.86			1.83

Where, CCI (A) – Chlorophyll content index at anthesis, CCI (AA) - Chlorophyll content index at 7 days after anthesis,

CT (AA) – Canopy temperature at 7 days after anthesis, RWC – Relative water content

Table 2. Effect of moisture availability and genotypes on different morpho-physiological parameters of wheat

Genotypes	RGR (g $g^{-1}d^{-1}$)			NG/S			HI (%)			GY (kg ha^{-1})		
	Irrigated	Non-irrigated	Mean	Irrigated	Non-irrigated	Mean	Irrigated	Non-irrigated	Mean	Irrigated	Non-irridated	Mean
AKAW 4739	0.0051	0.0038	0.0045	43.53	33.40	38.46	31.25	25.49	28.37	3286.08	3000.75	3143.53
AKAW 4901	0.0061	0.0048	0.0054	41.29	34.12	37.71	34.90	27.43	31.16	3131.66	2761.65	2949.66
AKAW 5099	0.0051	0.0039	0.0045	46.38	27.40	36.89	32.87	25.69	30.29	3269.26	2469.05	2869.15
AKAW 5104	0.0067	0.0049	0.0058	54.53	39.19	46.86	36.51	28.36	32.44	3736.12	2929.26	3332.69
AKAW 4927	0.0042	0.0035	0.0039	50.33	42.55	46.44	29.44	24.75	27.10	3408.35	2551.10	2979.72
AKAW 4973-2	0.0053	0.0039	0.0046	37.91	30.76	34.34	28.52	24.29	26.40	2748.87	2442.11	2595.49
AKW 1071	0.0084	0.0051	0.0067	49.66	31.94	40.80	30.09	25.15	27.62	3609.42	2847.33	3233.38
AKW 381	0.0074	0.0057	0.0065	40.79	34.45	37.62	31.60	26.36	28.98	3365.92	2652.88	3009.40
Mean	0.0062	0.0042	0.0052	45.55	34.23	39.89	31.90	25.94	28.96	3315.33	2703.68	3009.50
Irrigation (I)												
SE(m) ±			0.0001			0.62			0.26			10.36
CD at 5%			0.0003			1.78			0.70			31.07
Genotype (G)												
SE(m) ±			0.0001			0.0001			0.57			56.74
CD at 5%			0.0002			2.05			1.64			164.33
I x G SE(m) ±			0.0001			1.00			0.80			80.24
CD at 5%			0.0003			2.90			2.32			232.40

Where, RGR – Relative growth rate, NG/S – Numbers of grains spike^{-1}, HI – Harvest index, GY – Grain yield harvest under non-irrigated condition as compared to irrigated condition was noted. Mohammadi *et al.* (2012) observed terminal drought occurring during the grain filling period is known to induced grain abortion and reduced grain filling capacity, i.e. sink strength adjust to reduce source capacity.

Interaction between both moisture conditions and genotypes found significantly differed for harvest index. Under irrigated conditions, significantly highest harvest index was observed by genotype AKAW 5104 followed by genotypes AKAW 4901, AKAW 5099 and AKW 381. However, lowest harvest index was observed in AKAW 4973-2 and AKAW 4927. Under non-irrigated conditions, significantly highest harvest index was observed in genotype AKAW 5104 followed by genotypes AKAW 4901 and AKW 381.Lowest harvest index observed in AKAW 4973-2 and AKAW 4927.

Similar findings were also recorded by Saeidi and Abdoli (2010), according to him significant reduction in grain yield due to post-anthesis water stress may result from a reduction of the production of photo-assimilates, the sink power to absorb photo-assimilates, and the grain filling duration. Farnia and Tork (2015) also exhibited similar results. They found significant reduction in harvest index under post anthesis water stress with more significant reduction in grain yield production than biomass production. It means that increasing of grain weight is accompanied with increasing harvest index.

Interaction between both moisture conditions and genotypes were significantly influenced for grain yield ha^{-1}. In irrigated conditions, genotype AKAW 5104 recorded significantly highest grain yield 3332.69 kg ha^{-1}followed by AKW 1071, AKAW 4927 and AKW 381 whereas, significantly lowest grain yield ha^{-1} than all other genotypes under study were observed in AKAW 4973-2 and AKAW 4901. In non-irrigatedcondition genotypes AKAW 4739, AKAW 5104 and AKW 1071 recorded significantly highest grain yield ha^{-1}however at par among themselves whereas, significantly lowest grain yield ha^{-1} recorded in AKAW 4973-2 and AKAW 5099. Saeidi and Abdoli (2010), also found significant reduction in grain yield due to post-anthesis water stress may result from a reduction of the production of photo-assimilates, the sink power to absorb photo-assimilates, and the grain filling duration.

Wheat genotypes sown under irrigated condition were significantly superior for all the morpho-physiological as well as yield and yield contributing characters viz., chlorophyll content index (at anthesis and 7 days after anthesis), canopy temperature (at anthesis and 7 days after anthesis), relative water content, relative growth rate, harvest index and numbers of grains $spike^{-1}$resulted in significant increase in grain yield of wheat as compared to wheat genotypes evaluated under non-irrigated condition. Amongst the eight different genotypes, genotype AKAW 5104, AKW 1071 and AKAW 4739 enhanced morpho-physiological parameters and ultimately increased grain yield as compared to any of the genotypes. The differential response of evaluated wheat genotypes for imposed non-irrigated condition indicates the drought tolerance ability.

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