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INTERACTION EFFECT OF LIGHT INTENSITIES AND PRIMING ON PLANT DRY WEIGHT AND RELATIVE GROWTH RATE OF TWO GENOTYPES OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

A comparative interactive study on the effect of hydro- and halo-priming and light intensity [100, 70 and 50%] on plant dry weight and relative growth rate (RGR) of two wheat genotypes [WR-544 and DBW-187] was undertaken at Ranchi (India). Distilled water was used for hydro-priming; whereas K and Mg-salts *viz*., KCl, KH_2PO_4, $Mg(NO_3)_2$ and $MgSO_4$ @ 0.5, 1.0, and 1.5%, respectively, were used for halo-priming. The mosquito net covered over iron frame was used for creating 70% light (21000 lux) while muslin cloth was used for creating 50% light (15000 lux) intensities. The light intensity in open field condition was considered as 100% light (30000 lux). The 100% light intensity showed better plant growth in later plant growth period in both the varieties which was more prominent from 1st to 4th harvests. The higher light intensity interacted with hydro- and halo-primed plants at all test concentrations revealed better plant dry weight in both the varieties even in un-primed seed plants. The genotype 'WR-544' at 5th harvest in 100% light intensity + 1.5% $Mg(NO_3)_2$ treatment showed maximum plant growth. The RGR showed a fluctuating trend between the harvests in both the varieties. Maximum RGR was observed in early harvest of plant growth which later showed a diminishing trend with least value in last harvests in all treatment under variable light intensities in both genotypes.

Keywords: Halo-priming, hydro-priming, light intensity, plant dry weight, relative growth rate, salts, wheat

INTRODUCTION

In India wheat crop is generally grown in the months of November-December as an important *rabi* crop. It is a major cereal crop grown as a staple food throughout Asia and Africa. The wheat production in Jharkhand (India) is much below the level of its consumption due to several reasons like rocky areas, water scarcity, laterite and acidic soil in tarn areas, low soil fertility, etc. Hence, low cost priming techniques might improve the growth and production of this crop.

The effect of hydro- and halo-priming have been studied in several crops (Raai *et al.*, 2020; Das *et al.*, 2022; Khatoon and Singh, 2024). The seed/grains are partially hydrated during priming so that pre-germinations metabolic activities proceed, while radicle emergence is prevented (safe limit), and then dried back to its original moisture level. Several priming techniques are used to improve plant growth and yield. Seed priming with suitable technique reportedly improves seedling establishment, plant growth and productivity, salt and other stress tolerance (Das *et al.*, 2022, Sarath *et al.*, 2022). Several workers have studied the impact of light intensities on various growth and productivity parameters in different plants (Raai *et al.*, 2020). However, insufficient information is available on the interactive effect of seed priming and light intensities. Several workers like have achieved better plant growth and yield due to halo-priming in several crops like maize, wheat, rice, and canola (Basra *et al*., 2005; Chen *et al*., 2010, Mamun *et al*., 2018; Mirmazloum *et al*., 2020). The improvement in plant growth and yield is attributed to a variety of reasons like initiation of germination related processes, early DNA replication, increase RNA and protein synthesis, repair of deteriorated seed parts, enhanced embryo growth, increase in various free radical scavenging enzymes, etc.

The individual effect of light intensities and various priming techniques on growth and yield of different plant species have previously been studied (Jadhav, 1987; Khatoon and Singh, 2024) and the present was aimed to study the interaction of varying light intensities and priming techniques on plant dry weight and relative growth rate in two genotypes of wheat grown in Jharkhand (India).

MATERIALS AND METHODS

The seeds of two wheat genotypes namely 'WR-544' and 'DBW-187' were procured from Birsa Agriculture University, Ranchi (India). Distilled water was used for hydro-priming, whereas 0.5% KCl, 1.0% KH_2PO_4, 1.5% solutions each of $MgSO_4$ and $Mg(NO_3)_2$ was used for halo-priming. These salt concentrations were chosen on the basis of better performance of these wheat genotypes as regards their study on germination and early seedling growth under these concentrations of salts. Pot culture experiments were undertaken in the earthen pots filled with powdered field soil, sandy soil and farmyard manure (5:2:3) to study the relative growth rate and dry weight. The seeds of wheat genotypes were sown in these earthen pots. The seedlings were thinned out after a week of sowing to have only one plant in each pot. The experiment was conducted in a completely randomized plan with each treatment replicated three times. The pots were irrigated regularly with tap water at 4 days interval to their field capacity from the date of sowing till the time of last harvest on the maturity of crop. The plants were provided different light intensity of 100, 70 and 50%, as per treatment, by keeping the pots in open (100% having 30000 lux), 70% by using mosquito net (21000 lux) and muslin cloth for 50% light intensity (15000 lux) covered over iron frame. The monoliths of the pots were taken out and washed with fine jet of water to remove the soil particles. The root, shoot and leaves were separated and kept separately in butter paper bags for measuring their dry weights after drying them at 80°C in an oven for 48 h, and stored in a desiccator before measuring the weight. The leaf area was measured with the help of a graph paper, whereas dry weight of root, shoot, leaves and whole plant was measured with the help of digital balance. The relative growth rates (RGR) were measured as per Evans (1972) using the following formula:

$$\text{RGR (mg/mg/week)} = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

Wherein W_1 and W_2 were total plant dry weights at time t_1 and t_2, respectively, and $t_2 - t_1$ was 14 days (2 weeks) in all treatments.

RESULTS AND DISCUSSION

The whole plant dry weight and relative growth rate (RGR) of two wheat genotypes under the interaction of hydro- or halo-priming with 100, 70 and 50% light intensities are presented in Table 1 and 2. Genotype 'WR-544' showed healthier performance than genotype 'DBW-187' under all the treatment conditions and depicted better growth. The highest plant dry weight of 25787 mg was observed in wheat genotype 'WR-544' at 5th harvest under 100% light intensity + 1.5% $Mg(NO_3)_2$ treatment; while lowest dry weight was 111 mg in genotype 'WR-544' at 1st harvest in 70% light intensity under hydro-priming condition. The genotype 'DBW-187' exhibited its maximum total plant dry weight (18266 mg) at 5th harvest in 100% light intensity with 0.5% KCl treatment. Conversely, the minimum total plant dry weight (107 mg) was observed at 1st harvest under 50% light intensity with hydro-priming. The maximum plant dry weight was observed in 'WR-544' genotype at 5th harvest under 100% light intensity + 1.5% $Mg(NO_3)_2$ treatment. The genotype 'WR-544' showed more plant dry weight than genotype 'DBW-187', especially in later harvests. The difference between the two genotypes became more pronounced with increasing harvest number. Higher light intensity (100%) lead to the increased plant dry weight in both the genotypes. The 1.0% KH_2PO_4 treatment and hydro-priming also improved plant growth. However, 1.5% $MgSO_4$ treatment negatively affected the plant growth in certain cases. Plant dry weight showed growth increment with each successive harvests. Among all the treatments, 1.5% $Mg(NO_3)_2$ under 100% light intensity appeared best performer than other salts (Table 1). The 100% light supported better plant growth in later harvest periods and a similar response was also evident under the influence of hydro- and halo-priming in both the genotypes. These results are in line with those of Sarkar and Paal (2006). Enhanced rate of photosynthesis under the influence of halo-priming appeared to boost plant growth in genotype 'WR-544' more effectively. This is because of enhanced photosynthesis under the effect of halo-priming treatment which has caused greater plant growth in genotype 'WR-544' more effectively. Both wheat genotypes depicted reduced growth under low light intensities treatment. This in agreement with the findings of Evans and Hughes (1961), Abdel Mawgoud *et al*. (1993) and Juraimi *et al.* (2004). The study revealed that shading negatively impacts dry matter production and overall plant development.

RGR is useful in estimating the rate at which a plant increases its biomass. The RGR value of unprimed, hydro- and halo-primed plants under different concentration of KCl, KH_2PO_4, $MgSO_4$ and $Mg(NO_3)_2$ in two genotypes is given in Table 2. The minimum RGR in wheat genotype 'WR-544' was 0.07 mg mg^{-1} $week^{-1}$ in 1.5% $Mg(NO_3)_2$ + 100% light intensity between 3rd-4th harvest, while maximum

Table 1: Effect of hydro-and halo-priming with K and Mg-salts under variable light intensities on plant dry weight of two wheat genotypes

Harvest	Treatment → Genotype ↓	Control (Unprimed)			Hydro-priming			Halo-priming (salt conc.)											
								0.5% KCl			1.0% KH_2PO_4			1.5% $MgSO_4$			1.5% $Mg(NO_3)_2$		
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1st	WR-544	202 ±2.90	137 ±2.054	125 ±1.45	221 ±6.66	111 ±0.88	150 ±1.33	177 ±1.15	148 ±2.40	151 ±2.31	245 2.33	165 ±2.89	150 ±2.09	296 ±2.18	221 ±1.85	121 ±0.88	261 ±3.21	116 ±6.43	123 ±3.17
	DBW-187	180 ±2.65	125 ±1.877	162 ±1.33	205 ±1.73	108 ±2.31	107 ±.89	190 ±2.89	130 ±2.89	133 ±5.04	209 1.53	124 ±3.18	185 ±1.20	240 ±6.01	109 ±1.45	142 ±1.76	210 ±1.45	120 ±4.33	182 ±6.43
2nd	WR-544	1692 ±4.33	849 ±3.063	672 ±2.16	1302 ±2.96	1188 ±4.62	951 ±.20	1171 ±1.73	1124 ±1.85	971 ±2.18	1478 2.00	1004 ±1.76	622 ±2.90	1302 ±1.73	1191 ±4.63	828 ±4.98	2729 ±7.53	2291 ±2.33	842 ±8.35
	DBW-187	13205 ±5.29	710 ±3.741	761 ±2.64	1262 ±1.45	7445 ±0.58	702 ±0.88	1231 ±2.33	774 ±0.88	667 ±0.88	1186 2.18	863 ±3.18	879 ±3.18	1192 ±1.00	801 ±1.20	748 ±2.64	1128 ±2.90	572 ±4.05	898 ±13.29
3rd	WR-544	3822 ±4.37	2566 ±3.09	1531 ±2.18	3550 ±6.01	3017 ±1.53	3215 ±1.20	3930 ±2.08	3127 ±1.53	2781 ±4.48	2717 ±1.45	3513 ±2.33	2057 ±0.33	4233 ±4.72	3371 ±9.53	2589 ±0.35	7179 ±9.21	5351 ±3.21	2861 ±2.64
	DBW-187	3974 ±3.61	3384 ±2.551	1346 ±1.80	4269 ±4.10	2867 ±0.58	3077 ±2.33	3006 ±1.15	3534 ±0.88	3115 ±0.88	2707 ±1.47	3337 ±1.53	2834 ±1.15	2866 ±3.51	2317 ±7.23	1454 ±7.84	3476 ±3.51	3849 ±2.60	2601 ±1.45
4th	WR-544	9322 ±6.56	3808 ±4.636	3756 ±3.28	5324 ±10.14	7822 ±2.90	5401 ±1.53	7500 ±2.65	7981 ±2.96	7662 ±2.90	6075 ±2.96	8604 ±2.30	4786 ±0.88	7716 ±5.29	7876 ±10.69	3244 ±1.15	8315 ±9.87	7752 ±3.84	9341 ±1.69.
	DBW-187	5455 ±4.67	6793 ±3.299	6621 ±2.33	6528 ±2.40	8769 ±1.20	6933 ±1.45	6573 ±1.85	7799 ±2.33	7406 ±1.76	4708 ±2.91	6171 ±3.21	6259 ±3.66	5543 ±2.65	6382 ±3.46	4056 ±3.84	6580 ±4.67	5344 ±6.35	6941 ±4.10
5th	WR-544	9871 ±11.26	3062 ±7.961	8334 ±5.63	10847 ±2.33	16661 ±3.51	9121 ±1.00	1949 ±0.88	9484 ±1.45	12974 ±2.31	11006 ±3.05	14480 ±3.76	14224 ±1.15	18151 ±2.60	17058 ±2.67	11719 ±2.03	12486 ±0.67	25787 ±3.78	12040 ±3.79
	DBW-187	10345 ±30.06	14105 ±21.26	13375 ±15.03	14234 ±0.88	13066 ±0.88	10274 ±0.33	18266 ±1.15	12095 ±1.73	11538 ±2.08	12310 ±1.16	16256 ±1.62	10991 ±3.48	10612 ±1.15	17432 ±4.04	12673 ±5.20	11294 ±2.40	14031 ±3.84	13487 ±2.73

A, B and C are 100, 70 & 50% light intensities, respectively.

Table 2: Effect of hydro- and halo-priming with K and Mg-salts under variable light intensities on relative growth rate (RGR) [mg mg^{-1} week^{-1}] of two wheat genotypes

Treatment→	Control (Unprimed)			Hydro-priming			Halo-priming (Salt conc.)											
Genotype ↓							KCl (0.5%)			KH_2PO_4 (1.0%)			$MgSO_4$ (1.5%)			$Mg(NO_3)_2$(1.5%)		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1st - 2nd harvest interval																		
WR-544	1.06	0.88	0.77	0.88	1.17	0.87	0.94	0.98	0.85	0.88	0.91	0.66	0.74	0.82	0.78	1.17	1.25	0.79
DBW-187	0.99	0.85	0.80	0.91	0.67	0.89	0.93	0.86	0.78	0.87	0.93	0.75	0.81	0.95	0.79	0.84	0.76	0.79
2nd - 3rd harvest interval																		
WR-544	0.41	0.55	0.82	0.51	0.49	0.61	0.61	0.51	0.52	0.31	0.62	0.59	0.58	0.52	0.58	0.48	0.42	0.61
DBW-187	0.55	0.74	0.41	0.89	0.93	0.61	0.44	0.75	0.52	0.41	0.67	0.51	0.43	0.53	0.35	0.56	0.95	0.53
3rd - 4th harvest interval																		
WR-544	0.44	0.19	0.44	0.21	0.47	0.25	0.32	0.46	0.51	0.41	0.44	0.42	0.31	0.42	0.23	0.07	0.18	0.59
DBW-187	0.15	0.28	0.79	0.21	0.55	0.4	0.39	0.39	0.43	0.27	0.23	0.39	0.32	0.51	0.48	0.31	0.16	0.49
4th - 5th harvest interval																		
WR-544	0.20	0.78	0.39	0.35	0.77	0.31	0.47	0.86	0.26	0.29	0.26	0.54	0.42	0.39	0.63	0.21	0.61	0.63
DBW-187	0.31	0.36	0.35	0.38	0.19	0.25	0.51	0.21	0.22	0.48	0.48	0.28	0.32	0.51	0.56	0.58	0.29	0.33

A, B and C are 100, 70 & 50% light intensities, respectively.

maximum RGR was 1.17 mg mg^{-1} week^{-1} in hydro-priming at 70% light intensity and 1.5% $Mg(NO_3)_2$ + 100% light during 1st-2nd harvest interval (Table 2). The minimum RGR value in genotype 'DBW-187' was 0.19 mg mg^{-1} week^{-1} in hydro-priming at 70% light; whereas maximum value was 0.95 mg mg^{-1} week $^{-1}$ in 1.5 % $Mg(NO_3)_2$ at 70% light between 2nd-3rd harvest. The data revealed that RGR value in initial harvest intervals 1st-2nd and 2nd-3rd were higher than the values in later harvest intervals (3rd-4th and 4th-5th). Greater RGR values in initial harvest appear owing to the greater dry matter accumulation attributed to higher rate of photosynthesis. Higher RGR in earlier growth stages is due to the ability of young leaves to harness greater amounts of chlorophyll, thus higher rate of photosynthesis. Since in the beginning, the leaves are young, so leaves possessed greater amount of chlorophyll and higher conversion efficiencies. The lesser RGR value in later harvest intervals toward senescence i.e. harvest interval of 3rd-4th and 4th-5th appears due to the decreasing rate of photosynthesis, as a result of diminishing chlorophyll content. Similar findings have been reported by Hunt *et al*. (2017) and Rezvan *et al*. (2020). Greater RGR was observed during early harvests in almost all the treatment in both the varieties. These findings are in line with Gardener *et al*. (1985). Halo-priming with different salts yielded mixed results. KCl at low concentration appeared supportive, while KH_2PO_4 showed fluctuating effects. $MgSO_4$ also appeared positive, but less pronounced than KCl. The $Mg(NO_3)_2$ showed fluctuating effects.

ANOVA analysis of data revealed significant effect of seed priming on RGR under different harvest in all intensities of light (Table 3). Statistical test was conducted at 99% confidence level and differences at $P \geq 0.01\%$ were considered as significant. In later phase of development, higher light

Table 3: Analysis of variance (ANOVA) for the data on RGR in two wheat genotypes

Source of variation	Degree of freedom	Light intensity					
		100%		70%		50%	
		MSS	F-valve	MSS	F-valve	MSS	F-valve
Varieties	1	0.01229	(1.52)	0.03000	(1.25)	0.01880	1.68
Treatments	5	0.01002	(1.86)	0.00979	(3.85)	0.01185	1.06
Harvest	3	0.95806	51.17**	0.71231	18.84**	0.37067	33.30**
Variety x Treatments	5	0.00707	(2.64)	0.01703	2.21	0.00533	2.08
Treatments x Harvest	18	0.01749	(1.07)	0.01358	(2.78)	0.01669	1.49
Varieties x Harvest	3	0.02181	1.16	0.15028	3.97	0.03626	3.25
Residual	15	0.01872	-	0.03780	-	0.01113	-
Total	50	-	-	-	-	-	

** = 1 % Significance level; A, B and C are 100, 70 & 50% light intensities, respectively.

intensity appeared supportive and played significant role in dry matter accumulation in the absence of sufficient chlorophyll. Hydro-priming and 1.5% $Mg(NO_3)_2$ appeared equally effective in enhancing the RGR. The wheat genotype ‘WR-544’ proved more efficient in RGR than genotype ‘DBW-187’.

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