Readers Insight
Publisher of open access books and journals

PJMLS OPEN ACCESS

Print ISSN: 2707-4471. Online ISSN: 2707-448X

Research Article	Pak-Euro Journal of Medical and Life Sciences
DOI: 10.31580/pjmls.v6i3.3228	Copyright © 2025 All rights are reserved by Corresponding Author
Vol. 6 No. 3, 2023: pp. 370i-370ix	
www.readersinsight.net/pjmls	**Revised:** August 25, 2023 **Accepted: August** 27, 2023
Submission: July 09, 2023	**Published Online: Sep**tember 01, 2023

IMPACT OF APPLICATION METHODS OF NITROGEN, SEED PRIMING AND IRRIGATION UNDER SALINE CONDITIONS ON WHEAT

Zahid Hussain[1]*, Roohul Amin[1], Rani Gul[1], Shah Nawaz Khan[1], Muhammad Farooq[2]*

[1]**Department of Agriculture,** Bacha Khan University, Charsadda, KPK, Pakistan

[2]**College of Food Science and Engineering,** Northwest A and F University, Yangling, Shaanxi 712100, PR China

***Corresponding Authors:** Muhammad Farooq and Zahid Hussain.

E. mails: farooq.fst28@gmail.com and drzahid97@gmail.com

Abstract

In Pakistan, traditional practices such as flood irrigation and broadcast application of nitrogen fertilizers have been identified as major factors contributing to inefficient resource utilization, increased weed infestation, and reduced wheat productivity. To address these challenges, a field study was conducted in the districts of Charsadda, Swabi, and Kohat in Khyber Pakhtunkhwa, using the wheat variety Pir-Sabak 2015. The experiment aimed to assess the effects of improved agronomic practices, including controlled irrigation based on Management Allowed Depletion (MAD) levels of 60%, 70%, and 80%; nitrogen application methods (broadcast vs. placement) at three fertilizer rates (60, 90, and 120 kg urea/ha); and seed priming techniques (control, hydropriming, and osmopriming using 100 g of Polyethylene Glycol per liter). The results showed a strong positive correlation between wheat yield parameters and controlled irrigation, targeted nitrogen application, and seed priming. Specifically, the highest values for emergence, grains per spike, grain weight, spikes per square meter, grain yield, leaf area, specific leaf area, leaf area ratio, and crop growth rate were achieved with 70% MAD irrigation and the placement application of 90 kg urea per hectare., and both hydro- and osmopriming. Conversely, yield parameters declined with 60% and 80% MAD irrigation, broadcast urea application, and the absence of seed priming. These findings underscore the importance of optimized irrigation, fertilization, and seed priming techniques for improving wheat production efficiency in Pakistan.

Keywords: *Cereals, Fertilizer methods, Irrigation, Seed treatment, Soil types*

INTRODUCTION

Flood irrigation, while providing ample water, often leads to excessive moisture, fostering vigorous vegetative growth at the expense of grain filling and maturation. This surplus water creates an environment conducive to weed proliferation, crop diseases, and pest infestations. Furthermore, it can result in nitrogen leaching from the root zone, diminishing nutrient availability. Notably, flood irrigation in wheat cultivation has been linked to water logging and increased salinity (1). In contrast, bed planting has demonstrated significant water savings and yield improvements compared to traditional flood irrigation methods (2). Subsurface drip irrigation has shown even greater promise, achieving a 24.95% an increase in crop productivity and a 19.5% improvement in irrigation water efficiency. Productivity compared to flooding (3). These findings underscore the necessity for strategic water management in wheat cultivation to optimize yield and profitability. A promising approach is Managed Allowed Depletion (MAD), a technique that requires skill rather than expensive hardware, allowing for controlled water application.

Optimizing nitrogen application timing and method is equally crucial for wheat production. In Pakistan, the prevalent broadcast method often leads to inefficient nutrient utilization, promoting weed growth and attracting pests and diseases. Conversely, placement methods offer targeted nutrient delivery, minimizing losses and maximizing uptake. Complementing this, seed priming has proven effective in enhancing wheat emergence and stand establishment. This technique triggers various physiological processes, including deoxyribonucleic acid mitosis (4), increased protein synthesis (5, 6), enhanced adenosine triphosphate availability (7), facilitated seed coat rupture (8), minimized seed Building upon the documented challenges of traditional flood irrigation and inefficient nitrogen application, this research aims to optimize wheat production through a strategic combination of irrigation and fertilization techniques, complemented by seed priming. Traditional flood irrigation often results in water logging, salinity, and nutrient leaching (1), while broadcast nitrogen application promotes weed infestation and inefficient nutrient uptake. In contrast, studies have demonstrated the benefits of alternative approaches, such as bed planting and subsurface drip irrigation, in enhancing water productivity and yield (2, 3). Seed priming has been found to enhance emergence and stand establishment by activating essential physiological processes (4-11).

This study will investigate the synergistic effects of Managed Allowed Depletion (MAD) for irrigation, precise placement methods for nitrogen fertilizer, and seed priming on wheat yield and resource efficiency. MAD allows for controlled water application, minimizing excess moisture and associated issues. Precise placement of nitrogen ensures targeted nutrient delivery, reducing losses and maximizing uptake. Seed priming enhances seed vigor and early growth, contributing to improved stand establishment. The primary objective is to develop a comprehensive approach that enhances wheat production efficiency and sustainability under local conditions. By optimizing water and nitrogen use, this research seeks to minimize the environmental impact of wheat farming, specifically addressing issues like water logging, salinity, and nutrient leaching. The evaluation of these integrated techniques will be conducted in a specific region, ensuring that the results are directly applicable to the local agricultural practices and environmental conditions, thereby contributing to more sustainable and productive wheat cultivation (11).

MATERIALS AND METHODS

The trials were carried out across three distinct regions of KPK, Pakistan. The study sites were characterized based on their geographic coordinates, mean annual rainfall, seasonal temperature variations (high/low during summer and winter), and soil type. The detailed information for each location is provided below:

The trials were carried out across three distinct regions of KPK, Pakistan: Charsadda, Swabi, and Kohat. Each location varied in geographical coordinates, climate conditions, and soil composition. Charsadda is situated between 34°03' and 34°38' N latitude and 71°28' and 71°53' E longitude. The area receives an average annual rainfall of 132 mm. During summer, temperatures range from 41°C (high) to 26°C (low), while in winter, they range from 19°C (high) to 5°C (low). The soil composition consists of 52.4% sand, 43% silt, and 4.6% clay, classifying it as sandy loam.

Swabi is located at 34°7′0″ N latitude and 72°28′0″ E longitude, with an annual rainfall of 639 mm. Summer temperatures range from 39.5°C (high) to 27.5°C (low), while winter temperatures vary between 18°C (high) and 5°C (low). The soil consists of 30.31% sand, 43.93% silt, and 26.22% clay, making it a loam soil type.

Kohat lies between 32°47' and 33°53' N latitude and 70°34' and 72°17' E longitude. The region experiences an annual rainfall of 303 mm. Summer temperatures range from 38.1°C (high) to 28.7°C (low), while winter temperatures range from 15.6°C (high) to 7.4°C (low). The soil composition includes 29.58% sand, 37.42% silt, and 33% clay, classifying it as clay loam these variations in climate and soil type across the three zones provided valuable insights into the experimental outcomes.

Land Preparation: The field was thoroughly prepared using a moldboard plow and soil cutter, ensuring proper leveling and debris removal.

TREATMENT APPLICATION

The study, conducted in 2022-23, evaluated the wheat variety Pirsabak 2015 using a (RCBD) with three replications. Treatments included seed priming (Control, Hydropriming, and 100 g/L PEG), nitrogen management Urea was applied at rates of 60, 90, and 120 kg per hectare using either the broadcast (BC) or placement method (PM), along with irrigation levels set at 60%, 70%, and 80% Management Allowed Depletion (MAD).

Seeds were primed for 24 hours at room temperature using either tap water or 100 g/L PEG, and then dried in the shade before sowing. Urea (46% nitrogen) was applied in two split doses at sowing and first irrigation, either as broadcast (BC) across the field or by placement method in rows during sowing and first irrigation. Water was applied at tillering, heading, and milky stages using the MAD technique, with field depths of 30, 70, and 100 cm. A flume and stopwatch** were used to measure water discharge and irrigation timing.

Time (sec) = Area of the field (A) x Depth of root zone (d) Discharge of water (Q)

Management Allowed Depletion (MAD) was applied based on soil type, water discharge, and crop stage. Soil moisture content was measured before irrigation to make necessary adjustments. The field was carefully leveled to ensure uniform water distribution.

Wheat attributes contributing to yield were recorded as follow methods.

$$\text{Emergence/Spikes } m^{-2} = \frac{\text{Number of Plant counted}}{\text{R-R distance (m) x row length (m) x No. of rows}}$$

Grains Spike-1 (GS): The number of grains from ten mature spikes was counted and averaged.

Grain Weight (GW): A thousand grains were weighed using an electronic balance (in grams).

Leaf Area (LA): Leaf area from five tillers was measured using a leaf area meter and averaged.

Leaf Area Ratio (LAR) = Total leaf area (cm^2) / Average tiller dry weight (g)

$$\text{Specific Leaf Area (SLA)} = \frac{\text{Average leaf area } (cm^2)}{\text{Average leaf dry weight (g)}}$$

$$\text{Crop Growth Rate (CGR)} = \frac{W2-W1}{T2-T1} \times \frac{1}{G.A}$$

W1	=	Plants dry weight (g) at tillering/heading
W2	=	Plants dry weight (g) at heading/maturity
T1	=	Days to tillering/heading
T2	=	Days to heading/maturity

$$\text{Grain yield (GY)} = \frac{\text{Grain yield (kg) x 10,000 } m^2}{\text{Row length (m) x R-R distance (m) x No. of rows}}$$

STATISTICAL ANALYSIS

The data were statistically analyzed using Pearson computer software and the MStatc test, while mean comparisons were conducted using the LSD test at a 5% probability level.

RESULTS

WHEAT YIELD PARAMETERS

Highest emergence (80 seedlings m^{-2}), GS (56), GW of 35.91 g, spikes m^{-2} (286) and GY (3203 kg ha^{-1}) obtained for 90 kg urea ha^{-1} as PM. Lowest emergence of 70 seedlings m^{-2}, number of 46 GS, GW (30.03 g), number of 258 Spikes m^{-2} and GY (2649 kg ha^{-1}) was recorded for 60 kg urea ha^{-1} as BC. For irrigation maximum GS (55), 1000 GW (34.51 g), spikes m^{-2} (278) and GY (7179 kg ha^{-1}) recorded for 70% MAD. However minimum number of 49 GS[1] and GW (31.9 g) obtained for 60% MAD and for 80% MAD lowest number of 267 spikes m^{-2} and GY of 2757 kg ha^{-1}. For seed priming maximum emergence (79 seedlings m^{-2}), GS (52), GW of 33.43 g and GY (3021 kg ha^{-1}) obtained for PEG seed priming. However, maximum 276 spikes m^{-2} recorded for hydro priming (Figure 1-3). For irrigation x seed priming, highest GS (57 and 56), GW (35.55 g and 35.19 g), spikes m^{-2} (284 and 283) noted respectively for PEG and hydro priming and maximum GY (3347 kg ha^{-1}) recorded for PEG seed priming under 70% MAD. Lowest GS (46), GW (31.53 g) obtained for the control under 60% MAD. While minimum spikes m^{-2} (263) GY (2688 kg ha^{-1}) noted for control under 80% MAD. For interaction irrigation x nitrogen management, highest GS (61), spikes m^{-2} (295) and GY (3574 kg ha⁻¹) recorded for 90 kg urea ha⁻¹ with placement under 70% MAD. Lowest GS (45), spikes m^{-2} (255) and GY (2531 kg ha^{-1}) obtained for 60 kg urea ha^{-1} with broadcast under 80% MAD.

LEAF PARAMETERS

Maximum LA (79.57 cm^2) and SLA (308.48 cm^2 g^{-1}) attained for placement application of 90 kg urea ha^{-1} as compared to minimum LA (65.87 cm^2) and SLA (287.04 cm^2 g^{-1}) recorded for broadcast application of 60 kg urea ha^{-1}. Mean data concerning to irrigation proposed that highest LA of 76.27 cm^2, LAR (22.87 cm^2 g^{-1}) and SLA (310.58 cm^2 g^{-1}) acquired with 70% MAD and lowest LA (71.06 cm^2), LAR (21.25 cm^2 g^{-1}), and SLA (286.94 cm^2 g^{-1}) noted for 80% MAD. With reference to seed priming maximal LA (74.9 cm^2), LAR (22.29 cm^2 g^{-1}) and SLA (301.68 cm^2 g^{-1}) attained with PEG seed priming as compared to minimal LA (69.4 cm^2), LAR (21.39 cm^2 g^{-1}) and SLA (293.37 cm^2 g^{-1}) attained for the control. Interaction of irrigation x seed priming proposed that highest LA (77.8 cm^2) for hydro priming while highest LAR (23.4 cm^2 g^{-1}) and SLA (314.7 cm^2 g^{-1}) obtained for PEG seed priming with 70% MAD. However lowest LA (65.5 cm^2) noted for 60% MAD, and LAR (20.8 cm^2 g^{-1}), SLA (283.9 cm^2 g^{-1}) for control plots under 80% MAD (Figs. 1-4 and Table I).

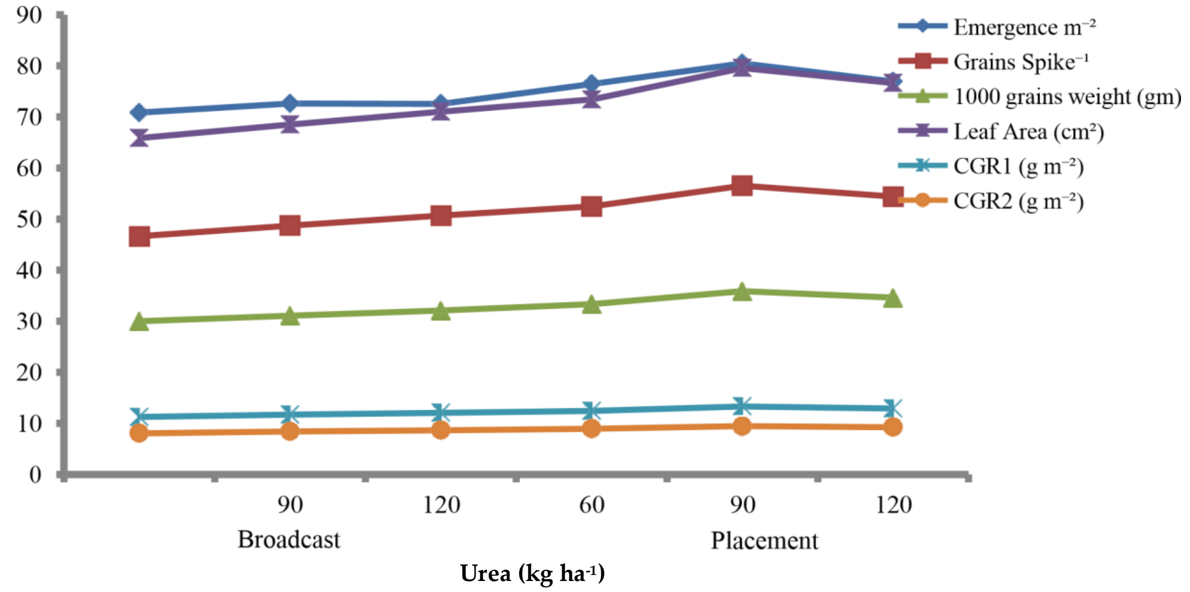

Fig. 1. Effect of nitrogen managements on emergence m^{-2}, Grains $Spike^{-1}$, 1000 grains weight (gm), Leaf Area (cm^2), CGR1 (g m^{-2}) and CGR2 (g m^{-2}) of wheat

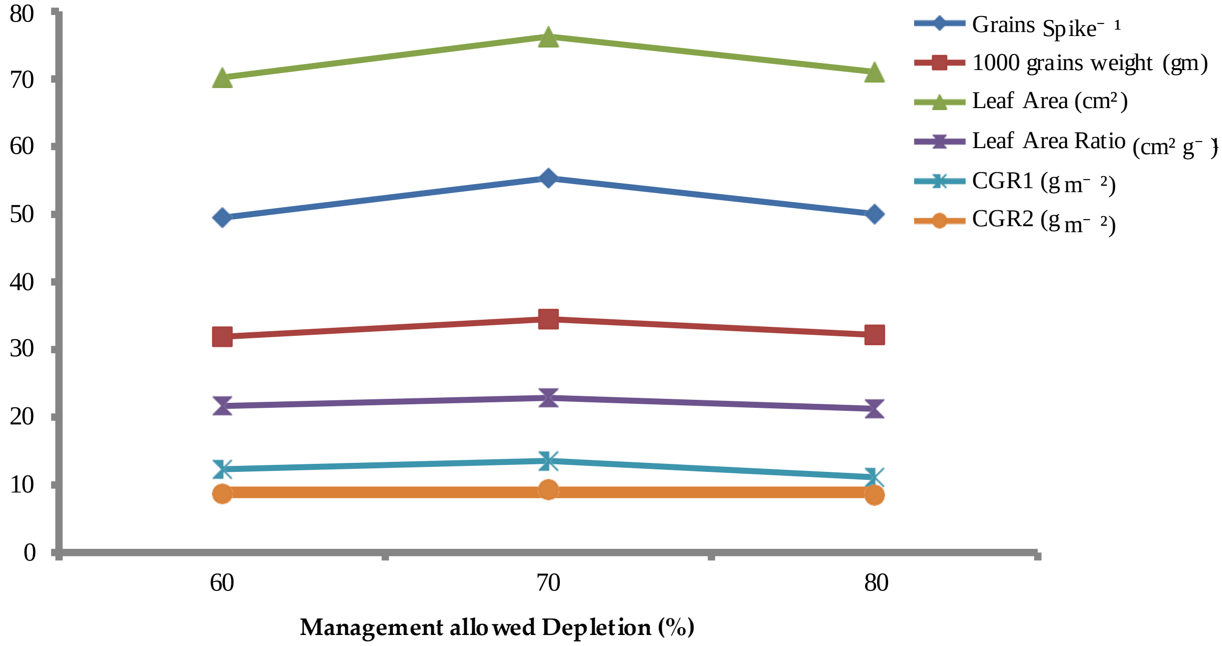

Fig. 2. Effect of irrigation managements on Grains $Spike^{-1}$, 1000 grains weight (gm), Leaf Area (cm^2), Leaf Area Ratio (cm^2 g^{-1}), CGR1 (g m^{-2}) and CGR2 (g m^{-2}) of wheat

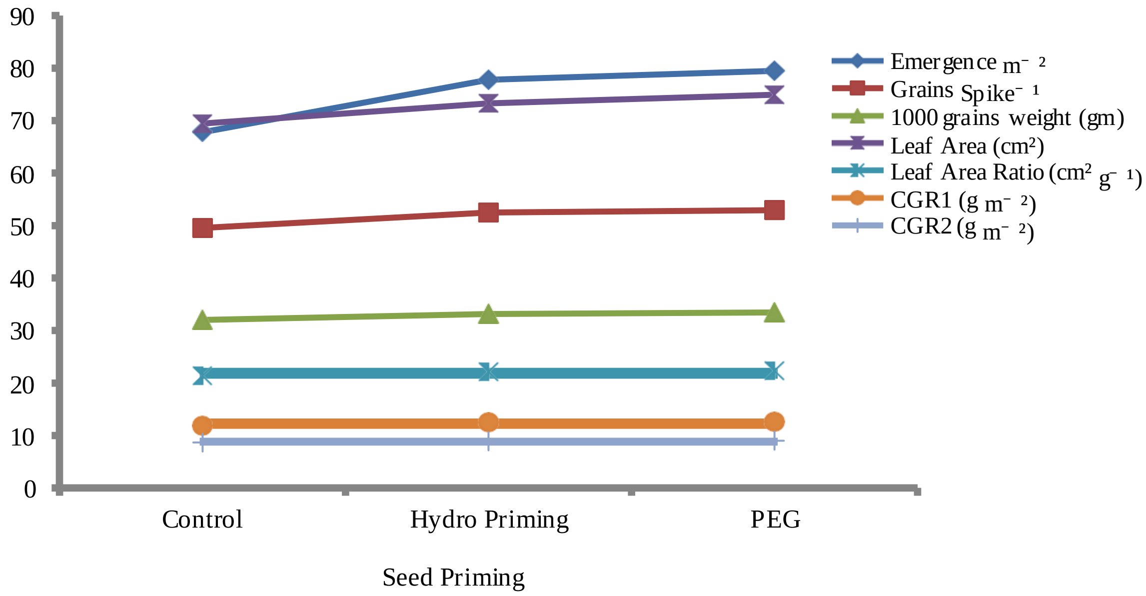

Fig. 3. Effect of seed priming on Emergence m^{-2}, Grains Spike^{-1}, 1000 grains weight (gm), Leaf Area (cm^2), Leaf Area Ratio (cm^2 g^{-1}), CGR1 (g m^{-2}) and CGR2 (g m^{-2}) of wheat

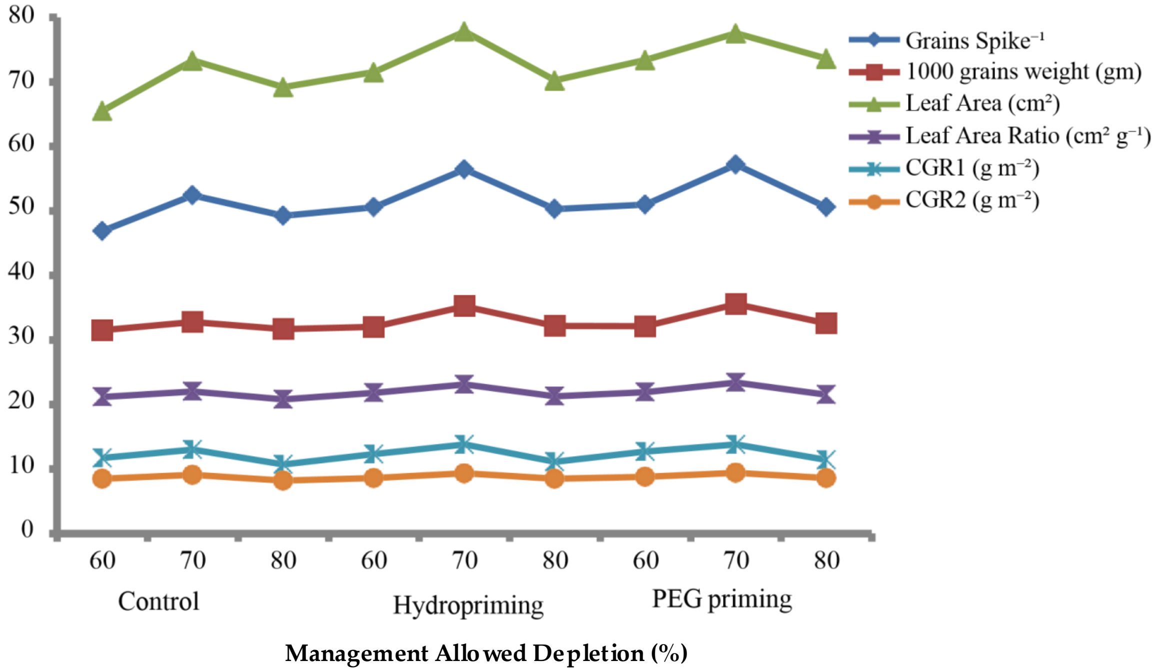

Fig. 4. Interaction effects of seed priming and irrigation managements on Grains Spike^{-1}, 1000 grains weight (gm), Leaf Area (cm^2), Leaf Area Ratio (cm^2 g^{-1}), CGR1 (g m^{-2}) and CGR2 (g m^{-2}) of wheat

CROP GROWTH RATE (G M^{-2} D^{-1})

Maximum crop growth rate from tillering-heading (CGR1) (13.34 g m^{-2} d^{-1}) and crop growth rate from heading-maturity (CGR2) (9.50 g m^{-2} d^{-1}) recorded for 90 kg urea ha^{-1} as placement. However, minimum CGR1 (11.30 g m^{-2} d^{-1}) and CGR2 (8.08 g m^{-2} d^{-1}) noted for 60 kg urea ha^{-1} as broadcast. Irrigation managements revealed highest CGR1 (13.55 g m^{-2} d^{-1}) and CGR2 (9.32 g m^{-2} d^{-1}) obtained for 70% MAD while least CGR1 (11.13 g m^{-2} d^{-1}) and CGR2 (8.49 g m^{-2} d^{-1}) attained for 80% MAD. Seed priming maximal CGR1 (12.66 g m^{-2} d^{-1}) and CGR2 (9.00 g m^{-2} d^{-1}) obtained for PEG seed priming and minimal CGR1 (11.86 g m^{-2} d^{-1}) and CGR2 (8.65 g m^{-2} d^{-1}) attained for control. Interaction of irrigation managements x seed priming revealed that highest CGR1 of 13.8 g m^{-2} d^{-1} and CGR2 of 9.4 g m^{-2} d^{-1} recorded both for PEG priming under 70% MAD. In contrast lowest CGR1 of 10.70 g m^{-2} d^{-1} and CGR2 of 8.2 g m^{-2} d^{-1} noted for control under 80% MAD. Interaction of irrigation management x nitrogen managements revealed highest CGR1 (14.9 g m^{-2} d^{-1}) and CGR2 (10.1 g m^{-2} d^{-1}) produced by the application of 90 kg urea ha^{-1} with placement under 70% MAD.

However least CGR1 (10.01 g m^{-2} d^{-1}) and CGR2 of 7.8 g m^{-2} d^{-1} observed for 60 kg urea ha^{-1} with broadcast under 80% MAD (Figs. 1-5).

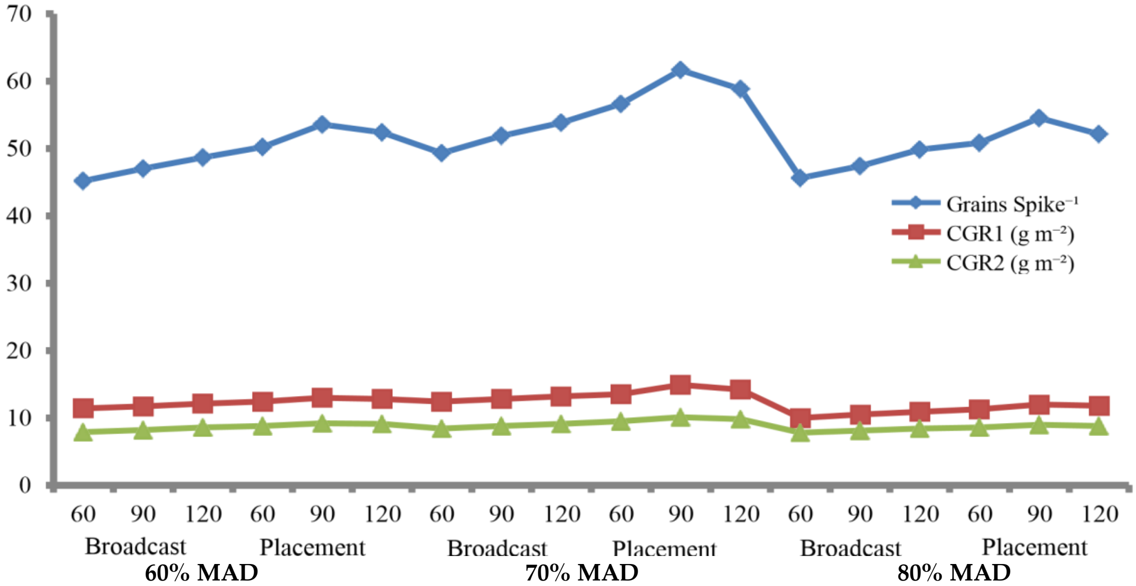

Fig. 5. Interaction effects of nitrogen and irrigation managements on Grains Spike^{-1}, CGR1 (g m^{-2}) and CGR2 (g m^{-2}) of wheat

Table I. Effect of nitrogen managements, irrigation and seed priming on wheat parameters under saline conditions

Parameters	**Nitrogen Managements (urea kg ha^{-1})**								LSD Value at p<0.05
	Broadcast			**Placement**					
	60	**90**	**120**	**60**	**90**	**120**			
Spikes m^{-2}	258.36	263.81	269.25	275.20	286.17	280.28			2.035
Specific Leaf Area (cm^2 g^{-1})	287.04f	291.47e	295.41d	300.07c	308.48a	304.49b			2.00
Grain Yield (kg ha^{-1})	2649f	2756 e	2848d	2963 c	3203a	3087b			32.65
	MAD%								
	60		**70**		**80**				
Spike sm^{-2}	270.56		278.08		267.89				1.439
Specific Leaf Area (cm^2g^{-1})	295.96		310.58		286.94				1.418
Grain Yield (kg ha^{-1})	2816.00		3179.00		2757.00				23.09
	Seed Priming								
	Control		**Hydro Priming**		**PEG**				
Spikes m^{-2}	264.78		276.54		275.22				1.439
Specific Leaf Area (cm^2 g^{-1})	293.37		298.44		301.68				1.418
Grain Yield (kg ha^{-1})	2761.00		2971.00		3021.00				23.09
	Control			**Hydro priming**			**PEG**		
	MAD%			**MAD%**			**MAD%**		
	60	**70**	**80**	**60**	**70**	**80**	**60**	**80**	
Spikes m^{-2}	264.25	266.66	263.43	273.99	283.11	272.52	273.44	267.73	
Specific Leaf Area (cm^2 g^{-1})	290.90	305.20	283.90	296.00		284.48		289.30	
Grain Yield (kg ha^{-1})	2704	2890	2688	2838	311.70	287.50	300.90	2808	
						314.70			
					3302	2774	2907		
LSD value at p<0.05									
Spikes m^{-2}	2.492								
Specific Leaf Area (cm^2 g^{-1})	2.456								
Grain Yield (kg ha^{-1})	39.99								

$$\text{Leaf Area Ratio (LAR)} = \frac{\text{Average leaf area (cm}^2\text{)}}{\text{Average tiller dry weight (g)}}$$

$$\text{Specific Leaf Area (SLA)} = \frac{\text{Average leaf area (cm}^2\text{)}}{\text{Average leaf dry weight (g)}}$$

DISCUSSIONS

The agricultural landscape in Pakistan is predominantly characterized by traditional practices such as flood irrigation and broadcast application of fertilizers. These primitive methods lead to leaching, erosion and weed infestations. Excess water and supplemental fertilizers application benefit weeds more as compared to main crop (12). Emergence, grains spike-1, 1000 grains weight, spikes m-2 and grains yield were highest for 70% MAD, 90 kg placement nitrogen and seed priming with either tape water or PEG. These yield parameters of wheat were lowest for broadcast nitrogen application, 60 and 80% MAD and trials of no seed priming (13-14-15). In fact dried seeds (no priming) pass through imbibitions to start germination and will take couple of days. Excess or deficient available water affects wheat crop simultaneously growth stages. Irrigation application at different management allowed depletion significantly affected wheat yield parameters (16). Nitrogen management improved grains weight with placement method compared with the broadcast. With wheat breeding and weed infestation it becomes mandatory to control irrigation and nutrition in the cropping systems (17). Healthy shoot and root establishment help the plant to get high nutrition and photosynthetic efficiencies (18). Cultural practices of wheat are depended on controlled irrigations and fertilizer application methods. Flood irrigation and broadcast fertilizers would only be effective if the wheat crop grown for vegetative purpose. As flood irrigation prolong vegetative stage and time for grain filling and squeezed seed size obtained due to light and temperature signals. In our trials broadcast was less effective compared with placement nitrogen method 19). Similarly seed priming had detrimental effect on grain yield of wheat in contrast to no seed priming (20). It was evident from the results that flood irrigation retarded potential growth of wheat. Placement nitrogen application and controlled irrigation through MAD enhanced LA, LAR and SLA. Seed priming minimized abiotic stresses on leaf area (21-22). As early reported that SLA increased by different water application in wheat (23). Seed priming increased leaf protein and improved growth of wheat (24). Placement nitrogen proved best for gaining higher CGR of wheat (25). Efficient CGR between different growth stages is detrimental for gaining higher yields. The growth rate is directly depended on soil fertility and controlled irrigation. High quantity of irrigation water lowered water use efficiency and economic benefit (26).

CONCLUSION

This study demonstrates that both hydropriming and osmopriming—particularly with PEG at a concentration of 100 g/liter—improved wheat yield attributes. However, due to the high cost of PEG, hydropriming emerges as a more cost-effective choice for farmers aiming to reduce input costs. For efficient nitrogen management, the recommended approach is to apply urea at 90 kg per hectare in two split doses using the placement method. In terms of irrigation, adopting a 70% Management Allowable Depletion (MAD) strategy during critical growth stages was found to be the most effective in maximizing yield. A 60% MAD resulted in water and time inefficiencies, while 80% MAD led to water stress. Controlled irrigation demonstrated superior water conservation. Furthermore, the placement method of urea fertilizer application significantly outperformed the broadcast method, which resulted in wasted resources and increased weed, insect, and pest pressures.

Acknowledgement:

The project was supported by Pakistan Agricultural Research Council, Islamabad, Pakistan under Agricultural Innovation Program (AIP) of CIMMYT funded by USAID. Field and experimental facilities were provided by the Bacha Khan University, Charsadda, Pakistan.

Conflict of interest:

There is no conflict of interest among authors regarding this article.

Authors` contribution:

ZH, RA, RG & SNK concept, prepared hypothesis and performed actual field research; MF & RA worked on data compilation, analysis, tables and graphs.

References:

1. Jamali MH, Laghari KQ. Comparison of Flooding and Raised Bed Irrigation Systems for Wheat Crop at Samoo (Village Bilawal Khan Jamali) District Jaffarabad Balochistan Pakistan. Irrigation Drainage Systems Engineering. 2019;8(1):1.
2. Hussain M, Ashfaq M, Ali A, Hassan S, Imran M. An econometric analysis of bed- furrow irrigation for cultivated wheat in irrigated areas of Punjab, Pakistan. Pakistan Journal of Agricultural Sciences. 2017;54:467-474.
3. Umair MT, Jiang H, Ahmad A, Yao J, Qi Y, Zhang Y, Min L, Shen Y. Water- Saving Potential of Subsurface Drip Irrigation For Winter Wheat. Sustainability. 2019;11:2978-2993.
4. Ibrahim A, Roberts EH, Murdoch AH. Viability of lettuce seed. II. Survival and oxygen uptake in osmotically controlled storage. Journal of Experimental Botany. 1983;34:631–640.
5. Bray CMPA, Davison M, Ashraf, Taylor RM. Biochemical events during osmopriming of leek seed. Annals of Applied Biology. 1989;102:185–193.
6. Fu JR, Lu SH, Chen RZ, Zhang BZ, Liu ZS, Li ZS, Cai DY. Osmoconditioning of peanut (*Arachis hypogaea* L.) seed with PEG to improve vigor and some biochemical activities. Seed Science and Technology. 1988;16:197–212.
7. Mazor L, Perl M, Negbi M. Changes in some ATP-dependent activities in seed during treatment with polyethylene glycol and during redrying process. Journal of Experimental Botany. 1984;35:1119–1127.
8. Dahal P, Bradford KJ, Jones RA. Effects of priming and endosperm integrity on seed germination rates of tomato genotypes. II. Germination at reduced water potential. Journal of Experimental Botany. 1990;41:1441–1453.
9. Saha R, Mandal AK, Basu RN. Physiology of seed invigoration treatments in soybean (Glycine max L.). Seed Science and Technology. 1990;18:269–276.
10. Styer RC, Cantliffe DJ. Evidence of repair processes in onion seed during storage at high seed moisture contents. Journal of Experimental Botany. 1983;34:277–282.
11. Harris D, Rahguwanshi B, Gangwar JS, Singh SC, Joshi KD, Rashid A, Hollington PA. Participatory evaluation by farmers of on-farm seed priming in Wheat in India, Nepal and Pakistan. Experimental Agriculture. 2001;37(3):403-415.
12. Muhammadi A, Rezvani M, Nezhad SZ, Karamzadeh H. Effect of nitrogen rate on yield and yield components of wheat in wild oat infested condition. International Journal of Agriculture Research and Review. 2012;2(4):496-503.
13. Hassan S, Oad WFC, Tunio SD, Gandahi AW, Siddiqui MH, Oad MS, Jagirani AW. Impact of nitrogen levels and application methods on agronomic, T and nutrient uptake traits of maize fodder. Pakistan Journal of Botany. 2010;42(6):4095-4101.
14. Ajirloo AR, Shaban M, Moghanloo GD, Ahmadi A. Effect of priming on seed germination characteristics of wheat (*Triticum aestivum* L.). International Journal of Agriculture and Crop Sciences. 2013;5:1670-1674.
15. Abbasdokht H. The effect of hydropriming and halopriming on germination and early growth stage of wheat (Triticum aestivum L.). Desert. 2010;16:61-68.
16. Keyvan S, Kobraee S. Bread wheat production under drought stress conditions. Annals of Biological Research. 2011;2(3):352-358.
17. Ali A, Syed AW, Khaliq A, Asif T, Aziz MM, Mubeen M. Effects of nitrogen on growth and yield components of wheat. International Journal of Biological Sciences. 2011;3(6):1004-1005.
18. Farooq M, Basra SMA, Rehman H, Saleem BA. Seed priming enhances the performance of late sown wheat (Triticum aestivum L.) by improving chilling tolerance. Journal of Agronomy and Crop Sciences. 2008;194(1):55-60.
19. Yousfi S, Gracia-Romero A, Kellas N, Kaddour M, Chadouli A, Karrou M, Serret MD. Combined Use of Low-Cost Remote Sensing Techniques and δ13C to Assess Bread Wheat Grain Yield under Different Water and Nitrogen Conditions. Agronomy. 2019; 9(6):285.
20. Jafar M, Farooq ZM, Cheema MA, Afzal I, Basra SMA, Wahid MA, Shahid M. Improving the performance of wheat by seed priming under saline conditions. Journal of Agronomy and Crop Sciences. 2012;198(1):38-45.
21. Mirza SR, Ilyas N, Batool N, Mazhar R, Bibi F, Kanwal S, Saeed M. Seed Priming: Technology to improve Wheat Growth under Abiotic Stress Conditions. International Journal of Biological Sciences. 2016;9(1):268-275.
22. Ahmad MA, Ahmed MKA, Shalaby AFM. Alleviation of water stress effects on wheat by mepiquat Chloride. International Journal of Agriculture and Biology. 2005;7(3):451–456.

23. Afzal I, Basra SMA, Hameed A, Farooq M. Physiological enhancements for alleviation of salt stress in wheat. Pakistan Journal of Botany. 2006;38(5):1649-1659.
24. Razzaq A, Ali Q, Qayyum A, Mahmood I, Ahmad M, Rasheed M. Physiological responses and drought resistance index of nine wheat (Triticum aestivum L.) cultivars under different moisture conditions. Pakistan Journal of Botany. 2013;45:151-155.
25. Bakhtiari M, Ghahraei RO, Ahmad D, Yazdanpanah AR, Jafari AM. Selection of fertilization method and fertilizer application rate on corn yield. International Commission of Agricultural Engineering. 2014;33(3):350-356.
26. Sun HY, Liu CM, Zhang XY, Shen YJ, Zhang YQ. Effects of irrigation on water balance, yield and WUE of winter wheat in the North China Plain. Agricultural Water Management. 2006;85:211–218.