Research Article

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Response of different potato genotypes to deficit irrigation in North-Western plains of India

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ABSTRACT

Field-based experimental trials were undertaken to assess the influence of water deficit stress on the tuber yield performance of nine distinct potato (*Solanum tuberosum* L.) genotypes. The genotypic set comprised officially released indigenous cultivars, advanced-stage breeding clones, and two standard control varieties. The experimental design incorporated two irrigation regimes: a fully irrigated control treatment (FI) representing optimal water supply, and two deficit irrigation treatments - alternate skip irrigation (DI) and complete cessation of irrigation during the tuber bulking phase (CS) - to simulate varying intensities of water stress. Among the genotypes evaluated under water-limited conditions, the cultivar 'Kufri Gaurav' exhibited the highest total tuber yield, followed sequentially by 'Kufri Ganga', 'Kufri Thar-2', and 'Kufri Kiran', indicating superior adaptive responses to water deficit stress.

Introduction

Potato (*Solanum tuberosum* L.) is one of the most water-sensitive crops due to its shallow root system, which typically penetrates only 50–60 cm into the soil (Levy, 1983). As a result, water deficiency is a major constraint, significantly affecting both tuber yield and quality. With the looming threat of climate change, which is expected to bring higher temperatures, extended dry periods, and unpredictable rainfall patterns, potato production is increasingly vulnerable. These climatic changes threaten the productivity of potato crops in many regions worldwide (Evers *et al.*, 2010).

Despite these challenges, potatoes remain a staple in the global food supply chain. Extensively grown and consumed, they provide a substantial source of calories, essential vitamins, and vital minerals for populations around the world. Potatoes are highly adaptable, able to thrive in a variety of climatic conditions and diverse soil compositions. This adaptability allows them to be cultivated in areas with limited agricultural resources, where other crops may struggle.

Due to their high yield potential and resilience under harsh conditions, potatoes play a critical role in food security. As one of the most widely grown and versatile crops, they help nourish billions of people and ensure a reliable global food supply. However, the ongoing issue of water scarcity has significantly impacted potato farming, leading to decreased yields and quality in many regions. This underscores the urgent need for sustainable water management practices and climate-resilient agricultural techniques to secure the future of potato cultivation, which remains a cornerstone of global

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food systems.

As climate change continues to exacerbate water scarcity and alter growing conditions, addressing the water needs of potato crops will be crucial for maintaining their role in global food security. Innovations in irrigation, soil management, and drought-resistant potato varieties will play a key role in adapting to these challenges and ensuring that potatoes remain a vital food source in the years to come.

Tuber yield remains the principal trait of interest in potato cultivation, and as such, is the most extensively studied parameter in potato production research. Achieving optimal yield under water-limited conditions is a critical goal in developing resilient cultivars. Keeping these issues in mind a study was conducted to evaluate the response of advanced clones and released varieties of ICAR-Central Potato Research Institute (CPRI), Shimla to deficit irrigation.

Material and Methods

Field experiments were conducted at ICAR-Central Potato Research Institute (Regional Station), Jalandhar, Punjab during *rabi* season of 2021-22 located at 31.27°N latitude and 75.54°E longitude, 237 meters above mean sea level. The experiment was laid out in Factorial Randomized Block Design with two factors and replicated thrice. First factor included nine advanced hybrids/parents/varieties viz., Kufri Thar-1, Kufri Kiran, HT 7/-620, MP/9-11, Kufri Ganga, Kufri Thar-2, HT/7-1105 along with two controls (Kufri Surya and Kufri Gaurav). The second factor was water stress treatment with three levels viz., recommended irrigation (FI), complete stop of irrigation after 55 DAP (CS) and deficit or alternate irrigation (DI) where we skipped alternate irrigation as compared to recommended irrigation.

The crop was irrigated through flood irrigation and in treatment with skip irrigation every alternate irrigation was skipped. Planting was done on 20 October and haulm cutting was done 80 days after planting. Yield observations were recorded in different treatments in terms of tuber number of tubers (‘000/ha) and yield (t/ha) in different grades according to weight. After harvesting the tubers were graded in under sized (<25 g), seed sized (25-125 g) and over-sized (>125 g) grades based on the tuber weight.

Results and Discussion

In the present study, significant reductions in both total and marketable tuber yields were observed under water stress across all evaluated varieties and clones (Table 1). However, substantial genotypic variability was evident. The highest total tuber yields were recorded in cultivars Kufri Ganga (55.093 t/ha) and Kufri Gaurav (54.129 t/ha), with the latter also exhibiting the maximum yield of seed-size tubers, followed closely by Kufri Ganga; these differences were not statistically significant. Kufri Kiran and Kufri Thar-2 also showed comparatively better performance under stress conditions in terms of both tuber yield and number. Conversely, HT/7-1105 and Kufri Thar-1 recorded the lowest yields under the same conditions.

Irrigation regime had a significant effect on yield performance. Full irrigation (FI) resulted in the highest tuber yield, while control stress (CS) treatment produced the lowest yield (41.56 t/ha), followed by deficit irrigation (DI) (44.85 t/ha) at 80 days after planting. The reduction in tuber yield under stress conditions is consistent with previous findings (Hassan *et al.*, 2002; Tourneux *et al.*, 2003; Schafleitner *et al.*, 2007), and is likely attributable to reduced vegetative growth, including diminished foliage development and canopy coverage. Significant interaction was recorded between genotype x irrigation treatment for number of oversize tubers and yield of oversized tubers. Where maximum yield and tuber number was recorded in Hybrid MP/9-11 with FI followed by K. Ganga with FI.

Tuber size distribution was also significantly influenced by genotype, with water stress exerting a pronounced effect on the yield of seed-size tubers. Analysis of tuber number (Table 2) revealed that Kufri Gaurav produced the highest total tuber count (807.47), followed closely by Kufri Ganga (803.25); these values were statistically comparable. In contrast, HT/7-1105 recorded the lowest tuber number and poorest yield performance under stress. Although the total tuber count was not significantly affected by water stress treatments, the number of seed-size tubers was markedly reduced. The highest number of seed-size tubers was observed under full irrigation, while the lowest was recorded under DI and CS treatments, with no significant difference between the latter two. These results are partially in agreement with Jefferies and MacKerron (1986), who reported no significant effect of drought on tuber number when water was withheld post-tuber initiation, but contrast with findings by Minhas and Bansal (1991), who documented reductions in tuber count under drought stress

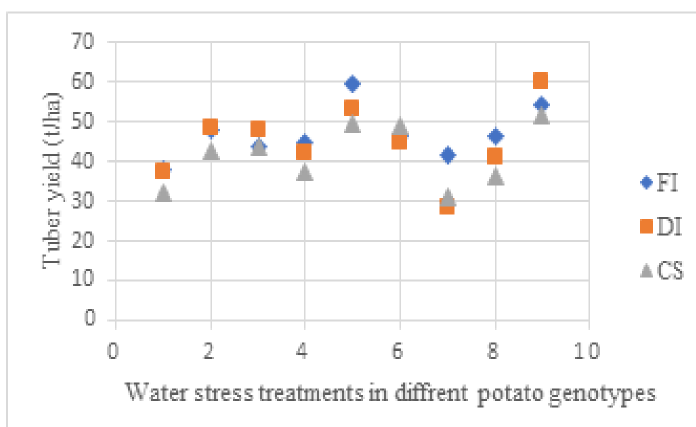

Fig. 1. Total tuber yield in different genotypes of potato with water stress treatments

Table 1. Tuber yield as influenced by water stress treatments in different varieties of potato

Treatments	Over-size tuber yield (t/ ha)	Seed-size tuber yield (t/ ha)	Under-size tuber yield (t/ ha)	Total tuber yield (t/ ha)
Varieties/ genotypes				
Kufri Thar-1	4.295	24.890	6.643	35.830
Kufri Kiran	7.142	37.312	1.885	46.342
HT 7/-620	5.107	35.468	4.687	45.262
MP/9-11	9.858	27.732	3.857	41.447
Kufri Ganga	9.493	40.623	4.977	55.093
Kufri Thar-2	9.895	35.092	1.645	46.635
HT/7-1105	7.618	23.595	2.372	33.588
Kufri Surya	6.893	33.278	1.013	41.187
Kufri Gaurav	6.742	43.257	4.130	54.129
SEm±	0.759	1.463	0.508	1.431
LSD	2.217	4.276	1.486	4.182
Water stress treatments				
Full Irrigation (FI)	7.373	35.601	3.293	46.869
Deficit irrigation/ Alternate irrigation (DI)	7.726	33.491	3.628	44.846
Complete stop of irrigation at bulking stage (CS)	7.248	31.323	3.582	41.557
SEm±	0.438	0.844	0.294	0.826
LSD	NS	2.468	NS	2.414

Table 2. Tuber Number as influenced by water stress treatments in different varieties of potato

Treatments	Over-size tuber number ('000/ ha)	Seed-size tuber number ('000/ ha)	Under-size tuber number ('000/ ha)	Total tuber number ('000/ ha)
Varieties/ genotypes				
Kufri Thar-1	19.483	298.373	343.185	661.050
Kufri Kiran	31.730	458.693	112.447	602.867
HT 7/-620	25.328	401.913	176.742	603.983
MP/9-11	57.058	279.725	151.135	487.933
Kufri Ganga	58.450	486.527	258.293	803.250
Kufri Thar-2	42.585	384.935	121.353	548.883
HT/7-1105	32.843	282.508	141.672	457.067
Kufri Surya	34.792	374.915	105.488	515.217
Kufri Gaurav	31.452	499.330	276.663	807.467
SEm±	3.943	13.604	23.163	31.398
LSD	11.527	39.766	67.707	91.777
Water stress treatments				
Full Irrigation (FI)	38.132	409.428	173.494	621.067

Deficit irrigation/ Alternate irrigation (DI)	38.039	383.265	196.782	618.095
Complete stop of irrigation at bulking stage (CS)	35.070	362.947	192.050	590.078
SEm±	2.277	7.855	13.373	18.128
LSD	NS	22.959	NS	NS

Conclusion

It was observed that the highest yield and maximum tuber count were recorded in the Kufri Gaurav and Kufri Ganga varieties followed by Kufri Kiran and Kufri Thar-2. Therefore, these varieties are highly suitable for cultivation in regions experiencing water scarcity. They can be promoted in areas where irrigation water is limited, as they require fewer irrigations - potentially saving one to two irrigation cycles without significantly compromising yield. Given their resilience to water-deficit conditions, these varieties present a promising option for sustainable potato cultivation in the face of future climate change challenges.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

References

Evers, D., Lefevre, I., Legay, S., Lamoureux, D., Hausman, J., Rosales, R. O. G., *et al.* 2010. Identification of drought responsive compounds in potato through a combined transcriptomic and targeted metabolite approach. *Journal of Experimental Botany*, 61: 2327–2343.

Hassan, A. A., Sarkar, A. A., Ali, M. H. and Karim, N. N. 2002. Effect of deficit irrigation at different growth stages on the yield of potato. *Pakistan Journal of Biological Sciences*, 5: 128–134.

Jefferies, R. A. and MacKerron, D. K. L. 1986. The Influence of soil water restrictions on tuber numbers. *Potato Research,* 29: 262.

Levy, D. 1983. Varietal differences in the response of potatoes to repeated short periods of water stress in hot climates. 2. Tuber yield and dry matter accumulation and other tuber properties. *Potato Research,* 26: 315-21.

Minhas, J. S. and Bansal, K. C. 1991. Tuber yield in relation to water stress at different stages of growth in potato (*Solanum tuberosum* L.). *Journal of Indian Potato Association*, 18: 1–8.

Schafleitner, R., Gutierrez, R., Gaudin, A., Perez, J., Martinez, M., Dominguez, A., *et al.* 2007. Field screening for variation of drought tolerance in *Solanum tuberosum* L. by agronomical, physiological, and genetic analysis. *Potato Research*, 50: 71–85.

Tourneux, C., Devaux, A., Camacho, M. R., Maani, P., & Ledent, J. F. 2003. Effects of water shortage on six potato genotypes in the highlands of Bolivia (1): Morphological parameters, growth, and yield. *Agronomie*, 23:169–179.