



Influence of drip irrigation system on growth and yield of onion (*Allium cepa* L.)

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ABSTRACT

Drip irrigation is an important and modern irrigation system. This system can save water and improve the growth and yield of onions. Accordingly, this experiment was carried out to examine onion growth, yield, and irrigation water efficiency under a drip irrigation system during the Kharif season 2019 using four onion varieties: Chiltan, Sariab Red, Sawat-1, and Gulnar in three replications in a randomized complete block design at the Directorate Vegetable Seed Farm, Quetta. The results revealed that drip irrigation yielded higher-quality growth, with the maximum plant height and neck thickness observed in the Gulnar variety of onions (64.72 cm) and (1.29 cm), respectively. Bulb formation was also superior in the Gulnar variety of onion under this system of irrigation in size and weight, which was (92.29 mm) and (307 g) respectively. The maximum yield obtained from this experiment was 27.6 kg/plot in the Gulnar variety. While the Chiltan variety was second-best-performer in this experiment, producing a mean bulb weight of 276.87 g and a total bulb yield of 25.83 kg/plot. Drip irrigation affected the morphological performance of onion, resulting in appropriate onion growth and yield parameters. The water-saving efficiency indicated that under drip irrigation, the soil moisture reached the root zone of the plant, and water runoff was not at all. Compared to classical irrigation, the drip irrigation system saved 32.8% more water, utilizing a total of 604 liters across all development stages. Therefore, it is suggested that a drip irrigation system should be installed for water-scarce areas and the Gulnar variety be cultivated for better onion production.

Keywords: Drip irrigation, onion, yield, growth parameters, water-use efficiency

INTRODUCTION

Due to their vital culinary traditions and nutritional value, onions (*Allium cepa* L.) hold a prominent position among vegetables and are consistently in demand in both domestic and international markets. In 2021, 107 million tonnes of onions (including shallots) were produced worldwide on 5.78 million hectares (FAO, 2022). In 2024, Pakistan produced 2.3 million tonnes on 0.14 million hectares (FAOSTAT, 2025). In Balochistan, onions are cultivated on 35.7 thousand hectares (21% of the country's cultivation area) with a production of 680.300 thousand tons (33% of the country's production) (Agricultural Statistics of Pakistan, Ministry of National Food Security & Research, Islamabad, 2023; FAO, 2023). Sustainable onion productivity increasingly depends on the efficient management of resources such as water and nutrients. Water is the most precious and essential resource for agriculture (Ray et al., 2023). For sustainable agriculture and the preservation of water resources, especially in

areas with limited water, effective water management is essential. In semi-arid areas, optimizing irrigation depth can greatly increase onion output and water use efficiency. Overwatering can also adversely affect the quality of the final crop. Due to relatively high deep percolation, particularly on sandy soils, large irrigation water applications can lead to low water productivity (WP). Water conservation and WP improvement will therefore greatly benefit from an effective irrigation technology that can avoid deep percolation and prevent plant water stress (Terán-Chaves et al., 2023).

Thanks to developments in irrigation technology, drip irrigation has become a widely used technique in arid agroecosystems worldwide (Yao et al., 2019). Drip irrigation offers several benefits over traditional irrigation techniques, such as flood or furrow irrigation, including considerable water savings and increased yield by delivering water directly to plant roots (Wu et al., 2023). These advantages are ascribed to drip irrigation's capacity to deliver water precisely and under control, minimizing water loss from evaporation, runoff, and deep percolation. Drip irrigation is frequently regarded as a successful technique for conserving water and enhancing the WP of onions since it can give tiny and frequent application depths (Wang et al., 2022). According to Wilson et al. (2024), compared to solid-set sprinkler irrigation, drip irrigation enhanced average bulb size by 9% while maintaining reduced soil water tension. The results of Asokhan et al. (2024) show that drip irrigation had a moderate influence on most onion-growing farmers (77.31%). Regarding the category-wise impact of drip irrigation on onion-growing farmers, the majority (84.90%) of the farmers were able to meet their needs, followed by 45.38 percent of the respondents had increased respect in their village, the majority (96.60%) of the farmers reported that water usage had decreased after adopting drip irrigation, 10% of the farmers reported that vigorous weed growth was suppressed after adopting drip irrigation; the majority (93.30%) of the farmers felt that the crop matured early.

Water use for crop production is important, especially for crops like onions, which are considered a main cash crop. Appropriate irrigation is important to produce onions. Management of irrigation improves growth, quality, bulb size, and yield (Maughan et al., 2015). Several studies have reported and proved the benefits of drip irrigation application, but onion crop growth and yield still need immediate attention, especially in water-scarce areas. Therefore, the current study was conducted with the objectives of studying the influence of drip irrigation on onion growth and development, and yield potential in the Quetta region, where water scarcity is a major problem.

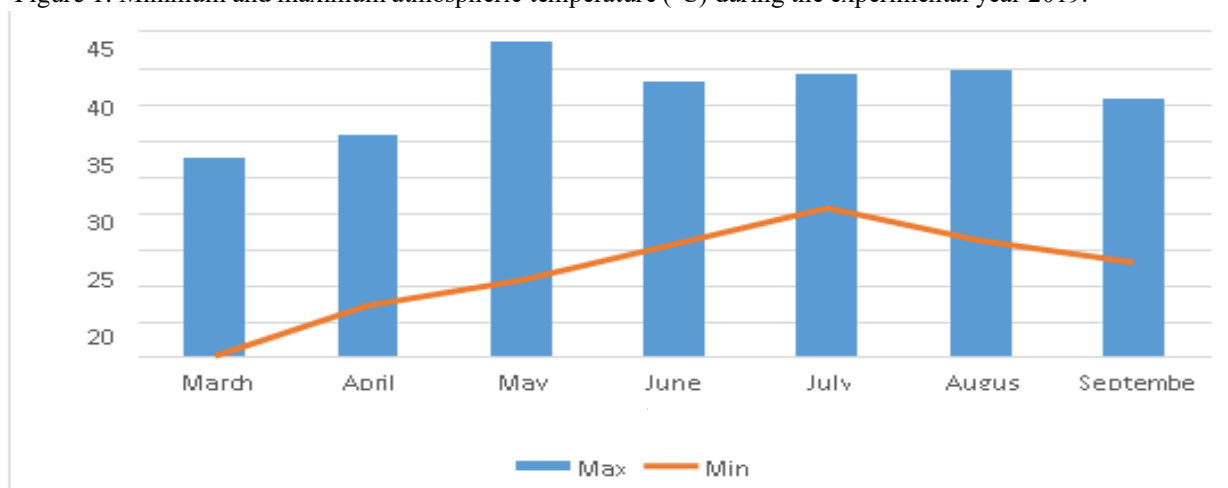
MATERIAL AND METHODS

Experimental site and material: The present experiment was conducted during the Kharif season of 2019 at the Directorate of Vegetable Seed Farm, Quetta, Balochistan, to study the influence of drip irrigation on onion growth and yield. The experimental field soil was loamy, and the pH was 8.3, indicating it was alkaline. The experimental field was irrigated before and after transplanting at two-day intervals. When the plant neck fell, the irrigation stopped 15 days before harvesting. Seeds were sown on 1st January in the nursery. The seedlings were transplanted on 15th March. The transplantation was done in the morning in the month of mid-March. For transplanting, healthy and uniform-sized seedlings were selected. The crop was ready to harvest about 182 days after transplanting. The harvesting was done on the morning of 12th September.

Field temperature: Experimental field temperature was recorded from the month of transplanting in March till the month of harvesting in mid-September. The maximum temperature was recorded in May at 43.5 °C, and the minimum temperature was recorded in March at 30.0 °C.

Experimental design: A Randomized Complete Block Design with four treatments and three replications was used in the present experiment. Treatments were T1 (Chiltan), T2 (Sariab Red), T3 (Sawat-1), and T4 (Gulnar). The seedlings were transplanted on both sides of the ridges. Plant-to-plant distance was 15 cm, and row-to-row distance was 13 cm. The size of the plot was 360 square feet. There were two ridges in a subplot with 80 seedlings transplanted in each.

Figure 1: Minimum and maximum atmospheric temperature (°C) during the experimental year 2019.



TRAITS OBSERVED

Seed germination (%): The germination of seeds was counted daily for each variety for three replications, and their average was recorded in percentage for the three replications accordingly.

Plant Height (cm): The height of the plant from five plants from each treatment was measured in centimeters using a measuring tape. It was measured before harvesting. Four treatments were used for statistical analysis and interpretation of results.

Neck thickness (cm): Four treatments were taken to measure the neck thickness in centimeters using a measuring tape. This data was taken before the harvest. The data was recorded for five plants per replication.

Bulb Size (mm): Five bulbs were selected from each treatment, and then the diameter of each bulb was measured in millimeters. The average of these was used for statistical analysis and interpretation of results. A Vernier caliper was used for measuring the bulb size.

Bulb Weight (g): Five bulbs from each treatment were selected, and then each bulb was measured in grams. The average of these was used for statistical analysis and interpretation of results.

Total bulb yield (kg): The yield of each replication was measured separately, and their average was recorded in kilograms by a digital weighing machine in kg/plot. The yield of each treatment was analyzed for statistical analysis.

Drip irrigation system: The field was irrigated by a drip irrigation system with two-day intervals. There were 40 emitters per ridge irrigating 80 seedlings per ridge. The discharge of water from drip irrigation was 2 liters per hour with a pressure of 2.0 bars.

Statistical analysis: The data collected were statistically analyzed by using Statistix 8.1 software, and the differences among treatment means were compared using the least significant difference (LSD) test at 5% probability level, as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The present experiment results showed that the growth and yield parameters of onions were significantly influenced by the application of a drip irrigation system with two-day intervals. Data was collected on plant height, neck thickness, bulb size, bulb weight, yield, and efficiency of irrigation water.

Seed germination: The germination took place in Gulnar on the second day, 10%, in Chiltan on the second day, about 6%, in Sawat-1, 2%, and Sariab Red germinated on the third day, 6%. Gulnar reached to 100% as earlier on 10th day, Chiltan on the 11th day, while Sariab Red and Sawat-1 on the 13th day each.

Table 1: Average seed germination percentage of onion varieties from three replications

Sr. No.	Varieties	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13
1	Chiltan	0	6	12	18	24	33	45	55	65	82	100		
2	Sariab Red	0	0	6	12	15	20	25	39	48	60	71	81	100
3	Sawat-1	0	2	8	10	14	25	30	42	54	68	74	86	100
4	Gulnar	0	10	15	25	36	48	63	75	86	100			

Plant height: Plant height is an essential characteristic in onions. Any practice that modifies the plant height would affect the yield of the onion. In the present experiment, the highest plant height was recorded (64.72 cm) in Gulnar, (58.49 cm) in Chiltan, (57.01 cm) in Sawat-1, and (53.79 cm) in Sariab Red, which showed that in the drip irrigation system, plants obtained soil moisture availability under drip irrigation, thus increasing plant growth vigor. The result, according to Bhasker et al. (2018) and Sanker et al. (2008), also observed the highest plant height (66.37 cm) and (73.6cm), respectively.

Table2: Influence of drip irrigation on plant height (cm)

Treatment	Mean
Gulnar	64.72 A
Chiltan	58.49 B
Sawat-1	57.01 BC
Sariab Red	53.79 C
LSD	4.15

Different letters show significant differences at 5% probability level.

Neck thickness: The highest neck thickness recorded (1.29 cm) was in Gulnar, Chiltan recorded neck thickness (0.96 cm), and then Sawat- 1 (0.72 cm) and Sariab Red (0.58 cm) due to the availability of moisture during the

complete onion growing period favor the development of neck thickness. High neck thickness leads to a large bulb diameter and weight. Similar results were also obtained by Rao et al. (2019) and Bhasker et al. (2018); they also found that, in their study, the highest neck thickness was 1.36 cm and 1.62 cm, respectively.

Table3: Influence of drip irrigation on plant neck thickness (cm)

Treatment	Mean
Gulnar	1.29 A
Chiltan	0.96 B
Sawat-1	0.72 C
Sariab Red	0.58 C
LSD	0.20

Different letters show significant differences at 5% probability level.

Bulb size: In drip irrigation system, application of water at a low rate for a longer period at frequent intervals near the root zone increases the moisture with a reduction of water loss. In this study, the maximum bulb size obtained from Gulnar was (92.29 mm), the recorded data of Chiltan was (85.41 mm), and then Sawat-1 (81.54 mm) and Sariab Red (76.19 mm). This result was confirmed by the findings of Tripathi et al. (2010) and Sanker et al. (2008), who revealed that bulb size was significantly larger (5.78 cm) and (5.77 cm) under a drip irrigation system, respectively.

Table4: Influence of drip irrigation on bulb size (mm)

Treatment	Mean
Gulnar	92.29 A
Chiltan	85.41 B
Sawat-1	81.54 BC
Sariab Red	76.19 C
LSD	6.12

Different letters show significant differences at 5% probability level.

Bulb weight: The recorded data indicated the highest bulb weight (307.33 g) in Gulnar, the second highest bulb weight observed in Chiltan (276.87 g), then Sawat-1 (264.67 g), and (215.60 g) Sariab Red. This high bulb weight is also due to the reduction of surface water runoff with consistent water application. Growth uniformity is directly related to bulb size, bulb weight, and yield. This result is related to the results of Tripathi et al. (2017) and Sanjay et al. (2013), who revealed bulb weight (60.99 g) and (56.8 g), respectively.

Table 5: Influence of drip irrigation on bulb weight (g)

Treatment	Mean
Gulnar	307.33 A
Chiltan	276.87 B
Sawat-1	264.67 B
Sariab Red	215.60 C
LSD	21.35

Different letters show significant differences at 5% probability level.

Total bulb yield per plot: The maximum yield observed (27.16 kg/plot) was obtained from Gulnar, the second maximum yield was recorded in Chiltan (25.83 kg/plot), and then Sawat-1 (25.33 kg/plot) and Sariab Red (22.66 kg/plot), which is the highest yield. In this experiment, the increased yield of all four varieties of onion is due to a constant moisture regime. Moisture, aeration, and variation in soil moisture are reduced by drip irrigation. This result agrees with Bhasker et al. (2018) and further reveals that Tripathi et al. (2017) obtained yields of (33.93 t/ha) and (47.47 t/ha) from the drip irrigation system.

Table 6: Influence of drip irrigation on total bulb yield

Treatment	Mean
Gulnar	27.16 A
Chiltan	25.83 AB
Sawat-1	25.33 B
Sariab Red	22.66 C
LSD	1.58

Different letters show significant differences at 5% probability level.

Influence of drip irrigation: In the present experiment, scheduling of drip irrigation with two-day intervals was effective for the onion, which increased the growth as well as the yield parameters. The shorter intervals in drip irrigation supplied moisture to the root zone. A drip irrigation system kept soil physical circumstances in a congenial form for plant growth by keeping an ideal soil water balance around the plant base. Due to this, growth performance is better with the application of drip irrigation and shorter intervals. Plant growth and high vigor occurred when the crop root system enlarged; thus, this root system enlargement is favored by the drip irrigation method. This result lines up with the conclusions of Bagali et al. (2012) and Shock et al. (2005) that drip irrigation applied at one- or two-day intervals improves the performance of entire growth and yield parameters because of the requirement for more frequent water applied per irrigation cycle.

Figure 2 describes the three stages of growth and water saving by the application of a drip irrigation system. The total irrigated water applied in the entire experiment was 604 liters, indicating 32.8% of water was saved as compared to the classical irrigation method for the onion crop, approximately 900 liters of irrigation water. The results are supported by Sanker et al. (2008) and Halvorson et al. (2008), who revealed that (37.8%) water was saved, and 72% less water was applied. Hence, the results prove that the drip irrigation system is an appropriate system of irrigation for onion growth and yield under the agro-climatic conditions of Quetta; however, results may vary depending on environmental factors, including rainfall, temperature, soil type, and irrigation water quality.

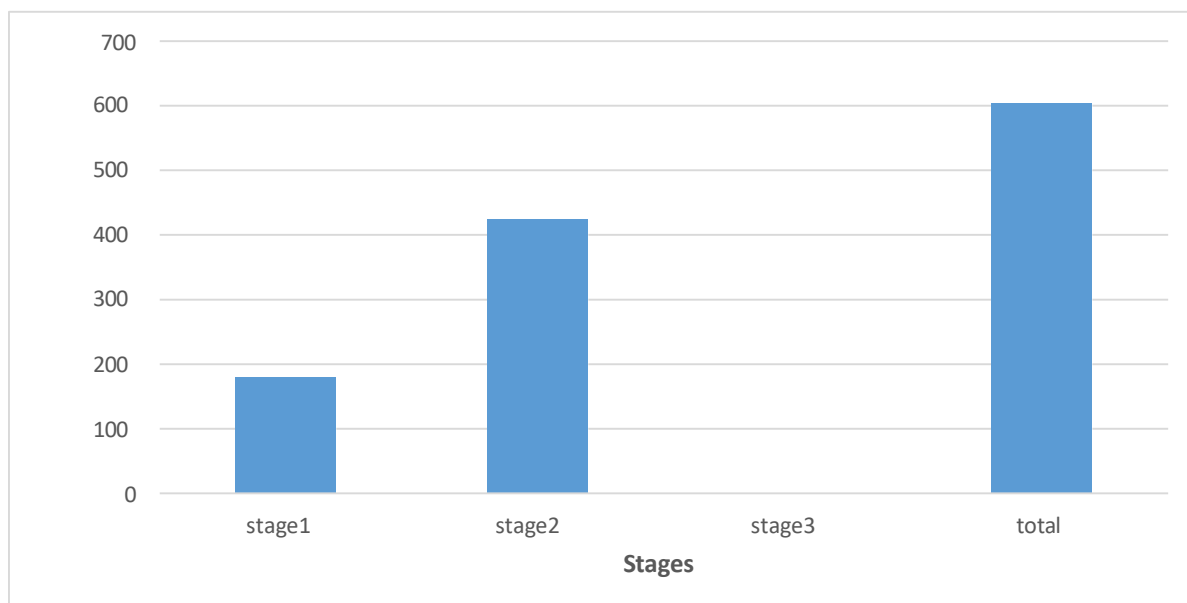


Figure 2: Influence of drip irrigation on water saving

CONCLUSIONS

The drip irrigation markedly improved the growth and achieved the uniform yield of onion cultivars. Moreover, the outcomes of the current study demonstrated that drip irrigation is highly efficient in saving water, consuming only 604 liters of water throughout the growth stages of the crop. Gulnar and Chiltan showed considerably demonstrated better performance across all traits in comparison with their counterpart varieties. Drip irrigation was equally efficient and appropriate for all varieties under the agro-climatic conditions of Quetta. Therefore, both small and large-scale onion growers can adopt this drip irrigation system to enhance production while conserving water.

RECOMMENDATIONS

It is recommended that a drip irrigation system be installed for water-scarce areas and the Gulnar variety be

cultivated for better onion production.

CONFLICT OF INTEREST

The authors declare no conflict of interest in publishing this manuscript.

AUTHORS' CONTRIBUTION

Nighat Aslam conducted research, collected data, and wrote the manuscript. Saifullah and Babar Ali helped with data analysis. Nagina Bano and Faisal Ahmed helped in data

REFERENCES

- Agriculture Statistics of Pakistan, Ministry of National Food Security & Research Islamabad, (2023). Provincial wise area and production of onion.
- Asokhan, M., Abinaya, A., & Sujeetha, T. N. (2024). Impact caused by the drip irrigation system among onion growing farmers in Coimbatore district of Tamil Nadu, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, **42(11)**, 1-8.
- Bagali, A.N., Patil, H.B., Guled, M. B & Patil, R.V. (2012). Effect of scheduling of drip irrigation on growth, yield and water use efficiency of onion (*Allium cepa* L.). *Karnataka Journal of Agriculture Science*, **25**: 116-119.
- Bhasker, P., Singh, R.K. S., Gupta, R.C., Sharma, H., & Gupta P. K. (2018). Effect of drip irrigation on growth and yield of onion (*Allium cepa* L.). *Journal of spices and aromatic crops*, **27(1)**, 32-37.
- FAO (2023). Pakistan Investment Plans and Opportunities HiH Investment Forum 2023.
- FAO. (2022). Agricultural production statistics. 2000–2021. FAOSTAT Analytical Brief Series No. 60. Rome. <https://doi.org/10.4060/cc3751en>.
- FAOSTAT (2025). Food and Agriculture Organization of the United States of America. Agricultural production statistics. 2023–2024. FAOSTAT Analytical Brief Series No. 60. Rome.
- Halvorson, A. D., Del Grosso, S. J., & Reule, C. A. (2008). Nitrogen, tillage, and crop rotation effects on nitrous oxide emissions from irrigated cropping systems. *Journal of Environmental Quality*, **37(4)**, 1337-1344.
- Maughan, T., Drost, D., & Allen, L. (2015). Vegetable Irrigation Onion. Extension Utah University. Horticulture/Vegetable/ 2015-2. Extension-USU-Edu.
- Rao, K.V., Suchi G Pushplata, A., & Deepika., Y., (2019). Growth, yield, economic and water use efficiency of onion under different micro irrigation system. *Journal of Pharmacognosy and Phytochemistry*, **8(3)**, 3866-3869.
- Ray, L. I., Swetha, K., Singh, A. K., & Singh, N. J. (2023). Water productivity of major pulses—A review. *Agricultural Water Management*, **281**, 108249.
- Regional Meteorological Center, Quetta, Balochistan. (2019). Rainfall (mm) and temperature min and Max taken in (°C) at Quetta, 2019.
- Sanjay, T.S., Man, S., Manoj, K., Singh, A.K., & Ahmad, T. (2013). Response of drip irrigation onion crop to irrigation intervals and fertigation strategies. *Indian Journal of Horticulture*, **70 (2)**, 293-295.
- Sanker, V., Lawanda, K.E., & Tripathi, P.C. (2008). Effect of micro irrigation on growth, yield and Water use efficiency of onion (*Allium cepa*) Seed Production under Western Maharashtra Conditions. *National Academy Agriculture Science*, **78 (7)**, 584-8.
- Shock, C.C., Flock, R., Feibert, E., Shock, C.A., Jensen, L and Klauzer, J. (2005) Drip irrigation guide for onion growers in the Treasure village. *Oregon State University, Extension services EM 8901*.
- Steel, R. G. D., & Torrie, J. S. (1980). Principles and Procedures of Statistics. A biological approach. Second Edition. McGraw Hill Book Company Inc., New York, USA.
- Terán-Chaves, C. A., Montejo-Nuñez, L., Cordero-Cordero, C., & Polo-Murcia, S. M. (2023). Water productivity indices of onion (*Allium cepa*) under drip irrigation and mulching in a semi-arid tropical region of Colombia. *Horticulturae*, **9(6)**, 632.
- Tripathi, P. C., Sankar, V., & Lawande, K. E. (2010). Influence of micro irrigation methods on growth, yield and storage of Rabi onion. *Indian Journal of Horticulture*, **67**, 61-65.
- Tripathi, P. C., Sankar, V., & Lawande, K. E. (2017). Micro irrigation in onion and garlic a review. *Current Horticulture*, **5(1)**, 3-14.
- Wang, H., Wang, N., Quan, H., Zhang, F., Fan, J., Feng, H., Cheng, M., Liao, Z., Wang, X. & Xiang, Y., (2022). Yield and water productivity of crops, vegetables and fruits under subsurface drip irrigation: A global meta-analysis. *Agricultural Water Management*, **269**, p.107645.
- Wilson, R. G., Aegerter, B. J., & LaHue, G. (2024). The Influence of Sprinkler and Drip Irrigation on the Incidence and Severity of Bacterial Disease in Onions Grown in Northeast California. *Plant Health Progress*, **25(3)**, 293-298.
- Wu, Y., Si, W., Yan, S., Wu, L., Zhao, W., Zhang, J., Zhang, F. & Fan, J., (2023). Water consumption, soil nitrate-nitrogen residue and fruit yield of drip-irrigated greenhouse tomato under various irrigation levels and fertilization practices. *Agricultural Water Management*, **277**, p.108092.
- Yao, Z., Yan, G., Wang, R., Zheng, X., Liu, C., & Butterbach-Bahl, K. (2019). Drip irrigation or reduced N-fertilizer rate can mitigate the high annual N₂O+ NO fluxes from Chinese intensive greenhouse vegetable systems. *Atmospheric Environment*, **212**, 183-193.

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