Ann. Agric. Res. New Series Vol. 47 (1) : 45-51 (2026)

Effect of irrigation scheduling and nitrogen fertilization on physiological growth indices of Chandrasur (*Lepidium sativum* L.)

Nupur Sharma[1], Ankita[2], Versha Gupta[3], Vinod K. Yadav[4] and Anju Bijarnia[5]

Department of Agronomy[1], [2]Department of Agricultural Statistics and Computer Application[2], Soil Science & Agricultural Chemiastry[5] , Department of Agronomy[3,4,5] Agriculture University, Kota, Rajasthan, India[1,2,4,5], Birsa Agricultural University, India[3]

Received: December 2025; Revised Accepted: March 2026

Abstract

A two-year field experiment was conducted during 2018–19 and 2019–20 at Krishi Vigyan Kendra, Sawai Madhopur to evaluate the effect of irrigation scheduling and nitrogen fertilization on growth parameters of Chandrasur (*Lepidium sativum* L.). The results revealed that three irrigations (25, 50 and 75 DAS) recorded the highest plant height at 60, 90 DAS and at harvest (60.28 cm, 91.08 cm and 102.01 cm, respectively), which was significantly superior to two irrigations (I_2) and one irrigation (I_1). Among nitrogen levels, the maximum plant height was observed with application of 80 kg N ha^{-1}, which was significantly higher than that recorded with 60 kg N ha^{-1}. In terms of dry matter accumulation (g plant^{-1}) at 30, 60, 90 DAS and at harvest, crop growth rate (g m^{-2} day^{-1}), and relative growth rate (g g^{-1} day^{-1}), the interaction effect of three irrigations (25, 50 and 75 DAS) in combination with 80 kg N ha^{-1} was found to be superior over two irrigations (25 and 50 DAS) with 60 kg N ha^{-1}. The findings indicate that appropriate irrigation scheduling combined with optimum nitrogen fertilization significantly enhances growth performance and physiological efficiency of Chandrasur.

Key words: Chandrasur, growth indices, irrigation schedule, nitrogen

Introduction

The increasing global interest in plant-based therapeutics has enhanced the relevance of medicinal crops, among which *Lepidium sativum* (garden cress) is particularly noteworthy. This species is distinguished by its high nutritional value, containing significant amounts of proteins, essential fatty acids, minerals, and vitamins. In addition, garden cress seeds and tissues are rich in diverse phytochemicals, such as kaempferol glucuronide, gallic acid, protocatechuic acid, p-coumaric acid, caffeic acid, various terpenoids, and glucosinolates. These bioactive constituents exhibit a broad spectrum of biological activities, including antioxidant, thermogenic, depurative, ophthalmic, antiscorbutic, antianemic, diuretic, tonic, laxative, galactagogue, aphrodisiac, rubefacient, and emmenagogue properties. Collectively, the nutrient profile and pharmacologically active compounds underscore the medicinal significance and functional food potential of *L. sativum*. (Tufail *et al*., 2023). Garden cress (*Lepidium sativum* L.), commonly referred to as sialoo or asalia in Hindi and Chandrasoor in Sanskrit, is an important medicinal species belonging to the family Cruciferae (Brassicaceae).

Garden cress has gained substantial attention in the domains of food and nutrition due to the diverse uses of its various plant parts, including the leaves, seeds, roots, and whole plant

(Ramadan and Oraby, 2020). The increasing utilization of these components is largely attributed to their rich nutritional and therapeutic attributes. The root has been reported to possess benefits in conditions such as tenesmus and secondary syphilis, while the aerial parts of the plant are traditionally employed in managing cough, bleeding piles, and asthma, and are also used as fodder for camels and horses (Ramadan and Oraby, 2020).

It has traditionally been used as a general tonic for promoting growth in children, enhancing lactation in women, and alleviating chronic bronchial asthma (Paranjape and Mehta, 2004). In addition, garden cress has been identified as a potential emerging oilseed crop with considerable industrial relevance (Angelini *et al.,* 1997). Traditionally, this crop has been cultivated across various regions of India for many years owing to its medicinal significance. It is commonly grown under rainfed conditions and requires relatively low water input; however, there is still a need to standardize and refine its package of practices. Irrigation is a critical factor influencing growth and yield parameters, while nitrogen nutrition also plays a vital role in enhancing yield and overall crop performance. Therefore, keeping these points in view, the present study was undertaken to optimize irrigation scheduling and nitrogen levels for *Chandrasur* cultivation.

Materials and Methods

The experiment was conducted at the research farm of Krishi Vigyan Kendra, Sawai Madhopur, Rajasthan, India, during two consecutive rabi seasons of 2018–19 and 2019–20 (coordinates: 26.0689288° N latitude and 76.3673391° E longitude). The soil of the experimental site was classified as sandy loam, with a pH of 9.0 and an electrical conductivity of 0.30 dS m^{-1}. The organic carbon content was 0.30%, while the available nitrogen, phosphorus (P_2O_5), and potassium (K_2O) were 243, 20.2, and 247 kg ha^{-1}, respectively. The field was nearly level with a slight slope and exhibited a fine soil structure. The location falls under a semi-arid climate, receiving an average annual rainfall of about 873 mm, predominantly concentrated between July and September. The experiment was conducted using a split-plot design with four replications. Seeds of Chandrasur were manually sown in rows spaced 30 cm apart. Each plot measured 5.0 m × 3.0 m, covering an area of 15 m^2. The experimental layout consisted of main and sub-irrigation channels with width of 1.5 m and 1.0 m, respectively. Irrigation water was applied uniformly to a depth of 5 cm. Within-row plant spacing was maintained at 10 cm. A full dose of phosphorus and half the recommended nitrogen, according to the treatment specifications, were applied as basal during land preparation, while the remaining nitrogen was top-dressed after the first irrigation at 25 days after sowing (DAS). Yield-attributing traits were recorded from ten randomly selected plants in each plot. The crop was harvested manually. To maintain the crop free from weed infestation, two manual weedings along with hoeing were carried out at 30 and 45 days after sowing (DAS). Plant samples (grain and stover) collected at harvest were initially sun-dried and subsequently oven-dried for further analysis.

Crop growth rate (CGR) and relative growth rate (RGR): The gwowth parameters, CGR and RGR, for the intervals 30–60, 60–90 and 90– at harvest DAS were calculated based on dry matter accumulation. The CGR was computed using the formula proposed by Redford (1967):

$$\text{CGR (g m}^{-2}\text{ day}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{P}$$

RGR was calculated using the formula given by Dhopte and Manuel (1989):

$$\text{RGR (g g}^{-1}\text{ day}^{-1}) = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

Where:

- W_1= Total dry matter at time t_1
- W_1= Total dry matter at time t_2
- t_1= Time of first observation
- t_1= Time of second observation
- p = Ground area occupied by the plant

The standard procedures described by Gomez and Gomez (1984) were followed for the statistical analysis. Analysis of variance (ANOVA) appropriate for a split plot design was applied to test the significance of treatment effects. A pooled analysis across both years was also performed to determine the overall response and treatment trends.

Results and Discussion

Effect on plant height

Table 1 describes the effect of irrigation and nitrogen levels on plant height of Chandrasur. Plant height was significantly affected by irrigation schedules and nitrogen levels at all stages of crop growth (30, 60, 90 DAS and at harvest) during both years and in the pooled analysis. Among irrigation treatments, three irrigations at 25, 50 and 75 DAS (I_1) produced the tallest plants throughout the crop period (60.28 cm at 60 DAS, 91.08 cm at 90 DAS and 102.01 cm at harvest), followed by two irrigations (I_2) and one irrigation (I_3), indicating that frequent irrigation enhanced vegetative growth and crop vigor. Similarly, nitrogen application significantly increased plant height with increasing dose, and 80 kg N ha^{-1} (N_1) recorded the highest plant height at all growth stages (18.90 cm at 30 DAS, 60.31 cm at 60 DAS, 94.09 cm at 90 DAS and 105.38 cm at harvest), whereas the lowest values were observed under 20 kg N ha^{-1} (N_2). Analysis of variance showed that the main effects of irrigation and nitrogen were significant ($P \leq 0.05$) in both seasons and in the pooled analysis, whereas the irrigation × nitrogen interaction was non-significant in the individual years. However, in pooled data the irrigation × nitrogen interaction became significant, indicating a combined influence of irrigation and nitrogen when data were analyzed across years. The effect of year and its interactions with irrigation and nitrogen were non-significant, confirming consistency of treatment effects across seasons, and thereby indicating that both irrigation scheduling and nitrogen management independently and reliably improved plant height.

Effect on dry matter accumulation

As presented in Table 2, dry matter accumulation was significantly influenced by irrigation schedules and nitrogen levels at all growth stages (30, 60, 90 DAS and at harvest) during both years as well as in the pooled analysis. Among the irrigation treatments, three irrigations at 25, 50 and 75 DAS (I_1) recorded the highest mean dry matter accumulation, registering values of 36.01, 61.22, 72.38 and 74.55 g $plant^{-1}$ at 30, 60, 90 DAS and at harvest, respectively. These values were signifi-

Table 1. Effect of irrigation and nitrogen levels on plant height (cm) at 30, 60, 90 and harvest

Treatments	at 30 DAS			60 DAS			90 DAS			at Harvest		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Irrigation levels												
One (25 DAS) (I_1)	10.34	12.40	11.37	56.33	58.02	57.17	81.33	88.64	84.98	91.08	99.28	95.18
Two (25 & 50 DAS) (I_2)	10.95	13.14	12.04	55.46	57.12	56.29	86.20	93.95	90.07	96.54	105.23	100.88
Three(25, 50 & 75 DAS) (I_3)	10.94	13.13	12.03	59.39	61.18	60.28	87.16	95.00	91.08	97.61	106.40	102.01
SEm±	0.71	0.85	0.55	0.75	0.78	0.54	1.94	2.11	1.43	2.17	2.37	1.61
CD (P=0.05)	NS	NS	NS	2.61	2.68	1.67	6.71	7.31	4.42	7.52	8.19	4.95
Nitrogen levels												
20kg N ha^{-1} (N_1)	8.53	10.24	9.39	54.11	55.73	54.92	81.04	88.33	84.68	90.76	98.93	94.85
40 kg N ha^{-1} (N_2)	10.06	12.07	11.06	56.37	58.06	57.21	81.51	88.84	85.18	91.29	99.51	95.40
60 kg N ha^{-1} (N_3)	12.14	14.57	13.35	58.35	60.10	59.23	86.99	94.82	90.90	97.43	106.19	101.81
80 kg N ha^{-1} (N_4)	12.24	14.68	13.46	59.41	61.20	60.31	90.04	98.14	94.09	100.84	109.92	105.38
SEm±	0.42	0.50	0.33	1.28	1.31	0.92	1.53	1.67	1.13	1.72	1.87	1.27
CD (P=0.05)	NS	NS	NS	3.70	3.81	2.60	4.45	4.85	3.22	4.98	5.43	3.60

Table 2. Effect of irrigation and nitrogen levels on dry matter accumulation (g plant^{-1}) at 30, 60, 90 and harvest

Treatments	at 30 DAS			60 DAS			90 DAS			At Harvest		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Irrigation levels												
One (25 DAS) (I_1)	27.90	28.80	28.35	47.43	48.96	48.19	56.07	57.89	56.98	57.76	59.63	58.69
Two (25 & 50 DAS) (I_2)	30.66	31.66	31.16	52.12	53.82	52.97	61.63	63.63	62.63	63.48	65.54	64.51
Three(25, 50 & 75 DAS) (I_3)	35.43	36.58	36.01	60.24	62.19	61.22	71.22	73.53	72.38	73.36	75.74	74.55
SEm±	0.86	0.89	0.62	1.47	1.51	1.05	1.73	1.79	1.24	1.78	1.84	1.28
CD (P=0.05)	2.98	3.08	1.91	5.07	5.23	3.24	5.99	6.18	3.83	6.17	6.37	3.95
Nitrogen levels												
20kg N ha^{-1} (N_1)	28.45	29.38	28.91	48.37	49.94	49.15	57.19	59.05	58.12	58.91	60.82	59.86
40 kg N ha^{-1} (N_2)	30.19	31.17	30.68	51.33	53.00	52.16	60.69	62.66	61.67	62.51	64.54	63.52
60 kg N ha^{-1} (N_3)	32.58	33.64	33.11	55.38	57.18	56.28	65.48	67.61	66.54	67.45	69.63	68.54
80 kg N ha^{-1} (N_4)	34.10	35.21	34.65	57.97	59.85	58.91	68.54	70.76	69.65	70.60	72.89	71.74
SEm±	0.58	0.59	0.41	0.98	1.01	0.70	1.16	1.20	0.83	1.19	1.23	0.86
CD (P=0.05)	1.67	1.73	1.18	2.85	2.93	2.00	3.37	3.47	2.36	3.47	3.57	2.43

cantly superior to those obtained under two irrigations (I_2) and one irrigation (I_3), indicating that increased frequency of irrigation enhanced dry matter production due to improved moisture availability throughout the crop growth period. Under nitrogen levels the highest DMA (g plant^{-1}) at 30, 60, 90 & Harvest were found with 80 kg N ha^{-1} which was statistically at par with 60 kg N ha^{-1} during both the years and in mean also. With respect to nitrogen levels, application of 80 kg N ha^{-1} (N_1) resulted in the highest dry matter accumulation at all stages of crop growth, with mean values of 34.65, 58.91, 69.65 and 71.74 g plant^{-1} at 30, 60, 90 DAS and at harvest, respectively. However, this treatment was found to be statistically at par with 60 kg N ha^{-1} (N_2), while both were significantly superior to lower nitrogen levels. This clearly indicates that higher nitrogen availability promoted biomass accumulation by supporting vigorous vegetative growth and enhanced photosynthetic activity. These results are in close conformity with Nie *et al*., 2024 and Zhai *et al*., 2022).

The analysis of variance revealed that the interaction between irrigation regimes and nitrogen levels was statistically significant during both individual years as well as in the pooled mean analysis. This showed that with increased level of irrigations and N levels increase growth and productivity of Chandrasur. These results are in close conformity with Khan *et al*., 2023.

Effect on crop growth rate

Effect of Irrigation and nitrogen levels on CGR crop growth rate was significant with application of different level of irrigations and nitrogen levels. Highest crop growth rate was found with three level of irrigations (28.00 at 30-60 DAS, 12.40 at 60-90 DAS and 2.41 at 90- at harvest) which was significantly higher over two irrigations during both years and in mean analysis. In terms of nitrogen levels increasing trend of crop growth rate was also found with increasing N levels and the highest was found with 80 kg N ha^{-1} (26.95 at 30-60 DAS, 11.94 at 60-90 DAS and 2.32 at 90- at harvest) significantly higher over 60 kg N ha^{-1}.

The analysis of variance for crop growth rate (CGR) during 30–60, 60–90 DAS and 90 DAS to harvest revealed a significant influence of irrigation and nitrogen levels during both the experimental years as well as in pooled analysis. The significant irrigation effect across all growth stages indicates that improved soil moisture availability positively regulated crop growth by maintaining higher leaf area and assimilate production, which ultimately enhanced biomass accumulation. Adequate irrigation at critical crop stages promotes better root development and nutrient uptake, leading to sustained physiological activity and improved dry matter partitioning towards economic parts.

Nitrogen also exerted a highly significant effect on CGR at all stages of crop growth, reflecting its fundamental role in chlorophyll synthesis, protein formation and cell division. Higher nitrogen levels possibly enhanced photosynthetic efficiency and canopy expansion, resulting in accelerated dry matter production. These results agree with earlier findings that sufficient nitrogen availability increases vegetative growth rate and improves biomass development by improving enzymatic activity and assimilate translocation.

The significant interaction between irrigation and nitrogen as shown in Fig. 1 (I × N) observed in pooled analysis further indicates that nitrogen efficiency increases under adequate moisture conditions. This confirms that nutrient response becomes more prominent when soil moisture is non-limiting, as optimal water availability improves nitrogen mobility in soil and its uptake by roots. Overall, the combined application of frequent irrigation along with higher nitrogen levels significantly improved crop growth rate by enhancing physiological efficiency and nutrient use. These results underline the importance of integrated water and nutrient management strategies to maximize growth potential and productivity under semi-arid conditions. These results are closely associated with Singh *et al*., 2015, Khan *et al*., 2023, Shirazi *et al*., 2014.

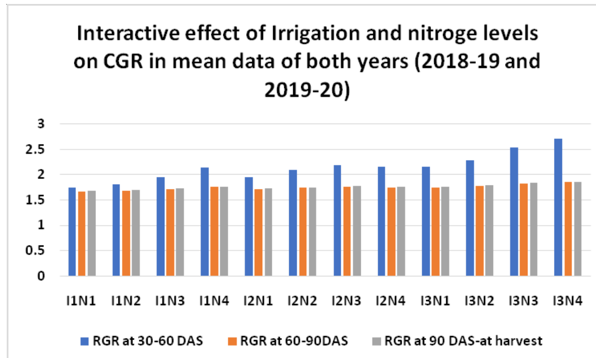

Fig. 1. Interactive effect of irrigation and nitrogen levels on CGR in mean data of both years (2018-19 and 2019-20)

Effect on relative growth rate

As shown in Table 4 relative growth rate was significantly influenced by irrigation regimes and nitrogen levels during all growth intervals (30-60 DAS, 60-90 DAS and 90 DAS-at harvest) across both the years and in pooled mean analysis. Among irrigation treatments the highest mean RGR at all growth stages recorded with three irrigations applied at 25, 50 & 75 DAS with values of 1.728, 1.793 and 1.803 g g^{-1} day^{-1}) during 30-60 DAS, 60-90 DAS and 90 DAS-at harvest which was significantly higher over two and one irrigations. With respect to N level increasing trend of RGR

Table 3. Effect of irrigation and nitrogen levels on crop growth rate (g m^{-2} day^{-1})

Treatments	30-60 DAS			60-90 DAS			90 DAS - at Harvest		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Irrigation levels									
One (25 DAS) (I_1)	21.69	22.40	22.05	9.61	9.92	9.76	1.87	1.93	1.90
Two (25 & 50 DAS) (I_2)	23.84	24.62	24.23	10.56	10.90	10.73	2.05	2.12	2.09
Three (25, 50 & 75 DAS) ($I_{3)}$	27.56	28.45	28.00	12.21	12.60	12.40	2.37	2.45	2.41
SEm±	0.67	0.69	0.48	0.30	0.31	0.21	0.06	0.06	0.04
CD (P=0.05)	2.32	2.39	1.48	1.03	1.06	0.66	0.20	0.21	0.13
Nitrogen levels									
20kg N ha^{-1} (N_1)	22.13	22.84	22.48	9.80	10.12	9.96	1.91	1.97	1.94
40 kg N ha^{-1} (N_2)	23.48	24.24	23.86	10.40	10.74	10.57	2.02	2.09	2.06
60 kg N ha^{-1} (N_3)	25.33	26.16	25.75	11.22	11.59	11.40	2.18	2.25	2.22
80 kg N ha^{-1} (N_4)	26.52	27.38	26.95	11.75	12.13	11.94	2.28	2.36	2.32
SEm±	0.44	0.46	0.32	0.20	0.20	0.14	0.04	0.04	0.03
CD (P=0.05)	1.30	1.34	0.91	0.58	0.59	0.40	0.11	0.12	0.08

were found with increasing N levels, application of 80 Kg N ha^{-1} found highest RGR values of 1.712, 1.777 and 1.788 g g^{-1} day^{-1} during 30–60 DAS, 60–90 DAS and 90 DAS to harvest, respectively, and was statistically superior to all lower nitrogen levels. Conversely, the minimum RGR was recorded under 20 kg N ha^{-1} (N) throughout the growth period.

The interaction effect (as given in Fig. 2) of irrigation and nitrogen during both the years and in mean pooled analysis also found significant which showed that combine effect of increases irrigation with nitrogen application enhances overall biomass accumulation. The RGR recorded highest under three irrigation reflects the result of cell elongation, enhance leaf expansion and better translocation of assimilates under optimum soil moisture conditions. Adequate irrigation maintain plant water relationship which supports turgor driven cell expansion and photosynthetic activity which ultimately enhances growth rate and biomass accumulation (Khan *et al*., 2023) Nitrogen plays a crucial role in chlorophyll synthesis, enzyme activation and structural development of plant tissues. Increased nitrogen availability enhances photosynthetic capacity through greater leaf area development and higher chlorophyll concentration, resulting in increased dry matter production and relative growth rate (Singh *et al*., 2015). Similar enhancement in growth efficiency with increasing nitrogen levels has also been reported in wheat and maize, where optimum nitrogen application significantly increased biomass accumulation and physiological efficiency

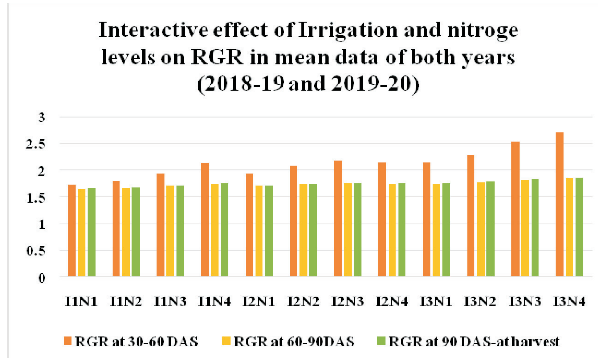

Fig. 2. Interactive effect of irrigation and nitroge levels on RGR in mean data of both years (2018-19 and 2019-20)

Fig. 3. Pictorial view of treatment combination Thrice irrigated at intervals of 25, 50, and 75 DAS with 20, 40, 60 and 80 kg N/ha

Table 4. Effect of irrigation and nitrogen levels on relative growth rate (g g^{-1}day^{-1})

Treatments	Relative growth rate (g g^{-1}day^{-1})								
	30-60 DAS			60-90 DAS			90 DAS - at Harvest		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
Irrigation levels									
One (25 DAS) (I_1)	1.622	1.636	1.629	1.687	1.701	1.694	1.698	1.711	1.704
Two (25 & 50 DAS) (I_2)	1.661	1.675	1.668	1.727	1.740	1.733	1.737	1.750	1.744
Three (25, 50 & 75 DAS) ($I_{3)}$	1.721	1.735	1.728	1.786	1.800	1.793	1.797	1.810	1.803
SEm±	0.007	0.007	0.005	0.007	0.007	0.005	0.007	0.007	0.005
CD (P=0.05)	0.026	0.026	0.016	0.026	0.026	0.016	0.026	0.026	0.016
Nitrogen levels									
20kg N ha^{-1} (N_1)	1.629	1.643	1.636	1.694	1.708	1.701	1.705	1.718	1.712
40 kg N ha^{-1} (N_2)	1.654	1.667	1.660	1.719	1.732	1.726	1.729	1.743	1.736
60 kg N ha^{-1} (N_3)	1.685	1.698	1.692	1.750	1.763	1.757	1.760	1.774	1.767
80 kg N ha^{-1} (N_4)	1.705	1.719	1.712	1.770	1.784	1.777	1.781	1.794	1.788
SEm±	0.008	0.008	0.006	0.008	0.008	0.006	0.008	0.008	0.006
CD (P=0.05)	0.024	0.024	0.017	0.024	0.024	0.017	0.024	0.024	0.017

(Fageria and Baligar, 2005; Kumar *et al.*, 2013).

Conclusion

Based on irrigation levels and nitrogen levels in agronomic parameters describes that with increasing irrigation and nitrogen levels significantly affect the crop growth, biomass accumulation, dry matter and CGR and RGR during all growth stages. Because optimum availability of water with nitrogen enhances the crop growth photosynthetic and enzymatic activity which is responsible for higher crop growth rate. The interactive effect of irrigation and nitrogen levels were also found significant in CGR, RGR which indicated that with optimum irrigation level combination with nitrogen level enhances crop growth and yield as shown in fig-3. In present study on the basis of plant height, dry matter accumulation, CGR, RGR, we can concluded that with application of three irrigation in combination with 80 kg N ha^{-1} significantly enhances the crop growth and yield.

References

Angelini, L.G., Moscheni, E., Colonna, G., Belloni, P. and Bonari, E. 1997. Variation in agronomic characteristics and seed oil composition of new oil seed crops in central Italy. *Industrial Crops and Products,* **6**(34): 313–23.

Dhopte, A.M. and Manuel, L. 1989. *Principles and techniques for plant growth analysis*. Pune: Agrobios (India).

Fageria, N. K. and Baligar, V. C. 2005. Enhancing nitrogen use efficiency in crop plants. *Advances in Agronomy*, **88**: 97–185.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedure for agriculture research. 2nd Ed. John Willy & Sons Inc. New York, pp: 317-356.

Khan, A. G., Niaz, A., Mahpara, S., Ullah, R., Tahir, M., Qazi, M. A., Ahmed, A., Koçyiðit, N., Shah, S. A. H., Rauf, A., Muneer, M., Akram, M. Z., Gaafar, A.-R. Z., Elshikh, M. S. and Fouad, M. S. 2023. Impact of various irrigation levels and nitrogen rates on wheat (*Triticum aestivum* L.) yield and nitrate leaching. *Journal of King Saud University – Science,* **35**: 102940. https://doi.org/10.1016/j.jksus.2023.102940

Kumar, R., Singh, M. and Yadav, S. 2013. Effect of nitrogen on growth characteristics of wheat. *Journal of Applied and Natural Science*, **5**(2): 432–437.

Nie, T., Li, J., Jiang, L., Zhang, Z., Chen, P., Li, T., Dai, C., Sun, Z., Yin, S. and Wang, M. 2024. Optimizing irrigation and nitrogen application to enhance millet yield, improve water and nitrogen use efficiency and reduce inorganic nitrogen accumulation in Northeast China. *Plants*, **13**, 3067. https://doi.org/XXXXX

Paranjape, A.N. and Mehta, A.A. 2004. Lepidium sativum in chronic bronchial asthma. An experimental and clinical study. *Indian Journal of Pharmacology,* **36**(2): 117.

Ramadan, M.F. and Oraby, H.F. 2020. *Lepidium sativum* seeds: Therapeutic significance and health-promoting potential. In: *Nuts and Seeds in Health and Disease Prevention*, Academic Press, pp. 273–289. https://doi.org/10.1016/B978-0-12-818553-7.00020-6

Redford, P. J. 1967. Growth analysis formulae – Their use and abuse. *Crop Science,* **7**(3): 171–175.

Shirazi, S. M., Yusop, Z., Zardari, N. H. and Ismail, Z. 2014. Effect of irrigation regimes and nitrogen levels on the growth and yield of wheat. *Advances in Agriculture, 2014*, Article ID 250874, 1–6.https://doi.org/10.1155/2014/250874

Singh, P. K., Kumar, S., Kumar, S. and Kumar, A. 2015. Effect of planting/irrigation techniques and nitrogen levels on growth, total chlorophyll, development, yield, and quality of maize (*Zea mays* L.). *Indian Journal of Agricultural Research,* **49**(2): 148–153.DOI: 10.5958/0976-058X.2015.00021.9

Tufail, T., Khan, T., Bader Ul Ain, H., Morya, S. and Shah, M.A. 2024. Garden cress seeds: a review on nutritional composition, therapeutic potential, and industrial utilization. *Food Science & Nutrition,* **12**: e4096. https://pmc.ncbi.nlm.nih.gov/articles/PMC11167195/pdf/FSN3-12-3834.pdf

Zhai, J., Zhang, G., Zhang, Y., Xu, W., Xie, R., Ming, B., Hou, P., Wang, K., Xue, J. and Li, S. 2022. Effect of the rate of nitrogen application on dry matter accumulation and yield formation of densely planted maize. *Sustainability*, **14**(3): 1324.https://doi.org/10.3390/su14031324