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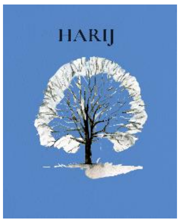

Effects of iron on the growth and yield of Radish in Helmand Province

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Abstract: Iron is an essential micronutrient that plays a critical role in plant physiological and biochemical processes. This study aimed to evaluate the effects of various iron concentrations on radish (Raphanus sativus L. cv. Mino Early Long White) growth and yield. The experiment was conducted in the Safian area of Lashkar Gah city using a Randomised Complete Block Design (RCBD) with four treatments and three replications, totalling 12 plots. Each plot measured 2.5 m × 3 m (6.25 m²), with an overall experimental area of 120 m². The treatments included four iron concentrations: T1 (0 mg/L), T2 (25 mg/L), T3 (50 mg/L), and T4 (75 mg/L). Plant spacing was 5 cm × 40 cm. The parameters measured were plant height, leaf width, number of leaves, tuber length, tuber diameter, weight per tuber, and yield per plot (kg). The application of iron significantly affected the growth and yield parameters. The highest yield was recorded in T4 (75 mg/L) with 48.8 kg/plot, followed closely by T3 (50 mg/L) with 48.4 kg/plot. The control treatment (T1 - 0 mg/L) resulted in the lowest yield of 36.6 kg/plot. The study concluded that applying 75 mg/L of iron significantly enhances radish growth and yield. Therefore, foliar application of iron at this rate can be recommended for improving radish production under similar agro-climatic conditions.

Keywords: Radish, Iron, Growth, Yield.

1. Introduction

White radish (Raphanus sativus L.) belongs to the Brassicaceae family and is a widely cultivated root vegetable known for its nutritional and medicinal value. Originating from Europe and Asia, Afghanistan is also considered a potential centre of origin due to its long-standing tradition of radish cultivation. Characterised by its elongated white root, this cool-season crop is now grown globally, with an estimated annual production of 7 million tons, representing approximately 2% of total vegetable production. The leading producers are China and Japan (Kopta & Pokluda, 2013). White radish thrives in full sunlight and cool temperatures, with an optimal growth range of 13°C to 25°C. The crop is propagated from seed and typically matures within 2 months during the winter season (Abdel, 2010). Morphologically, the radish root may reach lengths of 30–40 cm, diameters of around 6 cm, and weights of approximately 800 grams. Its leafy tops range from 5 to 35 cm in length. Under average growing conditions, white radish yields about 10–15 tons per hectare. This vegetable is consumed in various forms, including raw, cooked, pickled, or as an ingredient in salads and sandwiches (Baloch, 2014). Its health benefits are numerous; it is rich in dietary fiber that aids digestion, antioxidants that combat diseases, and essential vitamins such as A, C, and K that contribute to skin health and immune function. Furthermore, white radish contains minerals like potassium, iron, calcium, and sodium that support metabolic processes and blood sugar regulation. Additionally, the roots possess antimicrobial and antibacterial properties that can assist in disease management. Micronutrients play a vital role in achieving optimal crop performance, and among them, iron is especially important. Iron is a crucial component of several enzymes and pigments involved in key biological processes such as photosynthesis, respiration, carbohydrate metabolism, and enzyme activation (Hasegawa et al., 2011). Though not directly part of chlorophyll, iron is essential for its synthesis. Iron deficiency in plants causes interveinal chlorosis, reducing photosynthetic activity and resulting in poor crop quality. Despite the significance of iron in crop production, limited research exists on its optimal application for radish cultivation in Afghanistan. Therefore, the present study was conducted in Helmand Province under the title: "The Effect of Iron on the Growth and Yield of White Radish". This study aims to investigate how varying levels of iron influence the vegetative and yield characteristics of white radish in local agro-climatic conditions.

Problem Statement

Iron has a significant influence on the growth and yield of white radish. However, in Helmand province, the application of this essential nutrient receives inadequate attention. Most local farmers are not familiar with the proper dosage and importance of iron application in radish cultivation. To date, **no comprehensive research** has been conducted in Helmand to determine the effect of iron on white radish growth and productivity.

Significance of the Study

Iron is a crucial micronutrient for the proper growth and development of radish plants (Abdel, 2010). However, in Afghanistan, the use of iron fertilisers is not widely practised, and farmers often lack awareness regarding their correct usage. Inappropriate application or underuse of iron may be a key reason for low radish yields in the region. The significance of this study lies in identifying the optimum iron dosage required for white radish cultivation. The results will be shared with local farmers and agricultural stakeholders to encourage practical implementation in the field. This is expected to enhance crop productivity, improve the economic conditions of farmers, and ultimately contribute to the national economy.

Objectives

- To evaluate the response of white radish to different levels of iron application.
- To determine the optimum iron dosage for white radish cultivation.
- To prevent the wastage of iron fertiliser through evidence-based application.
- To reduce economic losses for farmers caused by improper nutrient use.
- To increase the yield of white radish through balanced fertilisation.

2. Materials and Method

1.1 Study Area and Duration

This research was conducted in the Safiyan area of Lashkargah City, the centre of Helmand Province, Afghanistan. The region is characterised by a hot and dry climate. It receives an average annual rainfall of 121 mm, with relative humidity ranging from 7% to 27%, and wind speed ranging from 5 to 15 km/h.
The geographical coordinates of the site are:
Latitude: 31°57'10" N
Longitude: 64°37'32" E
Altitude: 798 meters above sea level.
The soil type of the study area is loam, with a pH of 7.5.

1.2 Experimental Design

This study was carried out under the title "Effect of Iron on the Growth and Yield of White Radish (Raphanus sativus L.)", using the variety 'Radish Mino Early Long White' on a total land area of 90 m².
The experiment was laid out in a Randomised Complete Block Design (RCBD) in an open field setting. The RCBD was selected due to the difficulty in maintaining uniform environmental conditions in the field. The blocking in RCBD helps to minimise the effects of uncontrolled variables such as soil fertility variations, wind direction, pest or disease incidence, and other environmental factors.
The study consisted of four treatments, each replicated three times, making a total of 12 plots.
Plot size: 2.5 m × 3 m = 7.5 m² per plot.

1.3 Land Preparation and Sowing

The land was prepared on 1402/7/29 (Solar Hijri calendar). Five days after land preparation, the seeds were sown in a row planting method with a spacing of 40 cm between rows and 5 cm between plants.

1.4 Fertilizer Application

Four different concentrations of iron (Fe) were used as treatments:

- T1 = 0 mg/L
- T2 = 25 mg/L
- T3 = 50 mg/L
- T4 = 75 mg/L

Each treatment dosage was split into two equal applications:

- The first half was applied on 1402/10/1.
- The second half was applied on 1402/10/20.

1.5 Irrigation

A total of 11 irrigations were applied during the crop growth period. The specific irrigation schedule and dates are presented in the following table:

Table 1. Irrigation Schedule

Irrigation No.	Date	Irrigation No.	Date
1	2023/10/27	7	2023/12/11
2	2023/11/03	8	2023/12/20
3	2023/11/11	9	2024/01/01
4	2023/11/18	10	2024/01/09
5	2023/11/26	11	2024/01/18
6	2023/12/03	12	—

1.6 Thinning and Weed Control

Thinning and weed control were carried out on 9th December 2023 (1402/9/20 SH). This operation was performed to ensure proper spacing between plants and reduce weed competition, thereby enhancing nutrient availability and overall plant development.

1.7 Harvesting

The crop was harvested on 25th January 2024 (1402/11/5 SH). After harvesting, five plants were randomly selected from each plot for detailed measurements. The following parameters were measured:

- Root length (cm)
- Root diameter (cm)
- Leaf length (cm)
- Leaf width (cm)

Additionally, the total yield per plot was weighed to calculate the yield in kilograms per plot.

1.8 Measured Parameters

- The following agronomic parameters were measured during the study:
- Number of leaves per plant
- Leaf length (cm)
- Leaf width (cm)
- Root length (cm)
- Root diameter (cm)
- Individual root weight (g)
- Yield per plot (kg)

1.9 Data Sources

The primary data for this research were collected directly from the experimental field. For secondary data, various books, scientific journals, academic articles, and reliable internet sources were used. For data analysis, Microsoft Excel was used to process and interpret the data.

1.10 Statistical Analysis

The recorded observations were analysed statistically using Microsoft Excel. The data were tested for statistical significance at the 1% level. Treatments with no significant difference were indicated using "NS" (Not Significant). Wherever the treatment effects were found to be significant, comparisons and discussions were based on 1% level of significance.

Fig.1. Land Preparation

Fig. 2. Fertilization

Fig .3. Thinning and Weed Control

Fig. 4. Harvesting

3. Results

3.1 Number of Leaves per Plant

The number of leaves per plant was significantly affected by the different levels of iron application. The data presented in Table 2 shows a noticeable variation in leaf count among treatments. Plants that received 50 mg/L of iron (T3) produced the highest number of leaves per plant, followed by those in the 75 mg/L (T4) treatment. The lowest number of leaves was observed in the control treatment (T1), which received no iron. These results suggest that iron plays a vital role in vegetative growth, particularly in chlorophyll synthesis and photosynthetic efficiency, which are directly related to leaf production.

Table 2. Effect of Iron Levels on the Number of Leaves per Plant

Treatment	R1	R2	R3	Total	Average
T1	17	17	14	48	16
T2	15	20	23	58	19.33333
T3	18	19	17	54	18
T4	23	26	19	68	22.66667

The highest number of leaves was recorded in treatment T4, with 75 mg/L iron, resulting in 22 leaves per plant. This difference was statistically significant at the 5% probability level, as shown in the following ANOVA table.

Table 3: Analysis of Variance (ANOVA) for the Variation in Number of Leaves

Source	df	Ss	MS	Fc	ft1%	ft5%
Block	2	2711.333	0.000738	4.68 ns	10.92	5.14
treatment	3	3521.333	1173.778	7.43 *	10.92	5.14
Error	6	946.6667	157.7778			
Total	11	7179.333				

Table 4: Comparison of Means Using the Least Significant Difference (LSD) Test

Treatments	Mean	Difference
Treatment1	16	
treatment2	19.33 *	3.33
treatment3	18 ns	2
treatment4	22.66*	6.66

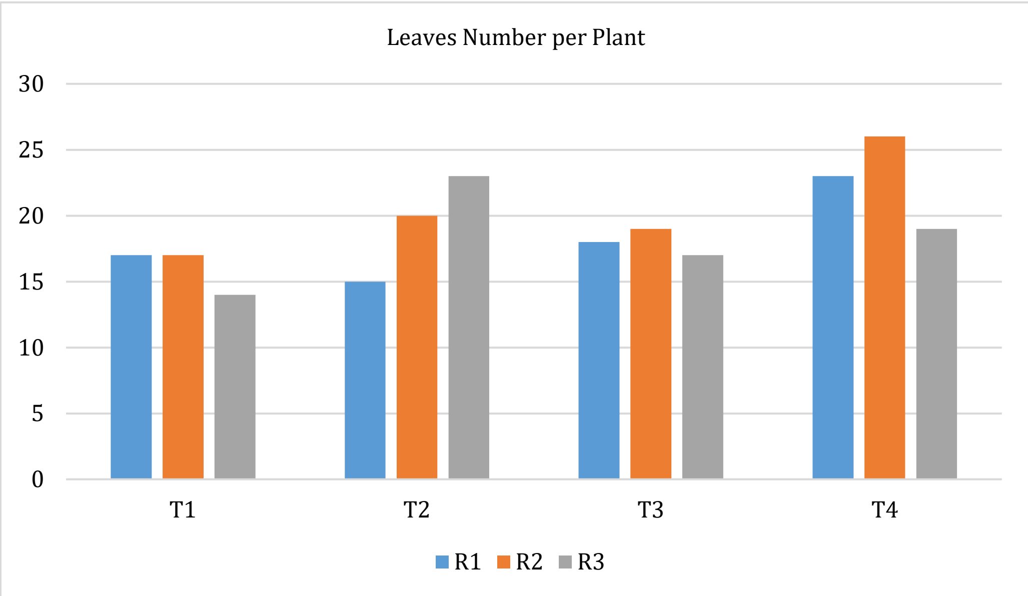

Fig. 5. Effects of Different Iron Levels on the Number of Leaves

Iron is an essential element for chlorophyll synthesis, helping plants convert solar energy into chemical energy. Iron is also vital for nitrogen-fixing bacteria, which influences the number of leaves. Consequently, the highest number of leaves (22.6) was observed in treatment T4 with 75 mg/L iron application.

3.2 Leaf Length (cm)

Table 5: Leaf Length (cm)

Treatment	R1	R2	R3	Total	Average
T1	18.6	20.5	20.4	59.5	19.83
T2	17.5	21	22	60.5	20.16
T3	15.1	19	25	59.1	19.7
T4	23	23.6	18.7	65.3	21.76

The longest leaf length was recorded in treatment T4 with 75 ppm iron, measuring 21.7 cm. This difference was statistically significant at the 1% probability level, as shown in the following ANOVA table.

Table 6: Analysis of Variance (ANOVA) for Variation in Leaf Length

Source	df	ss	ms	Fc	ft1%	ft5%
Block	2	3821.16	0.000523	7.35*	10.92	5.14
treatment	3	4635.973	1545.324	21.69**	10.92	5.14
Error	6	427.3067	71.21778			
Total	11	8884.44				

Table 7: Comparison of Means Using Least Significant Difference (LSD) Test

Treatments	Mean	Difference
Treatment1	19.83	
treatment2	20.16 ns	0.33
treatment3	19.7 ns	0.13
treatment4	21.76 *	1.93

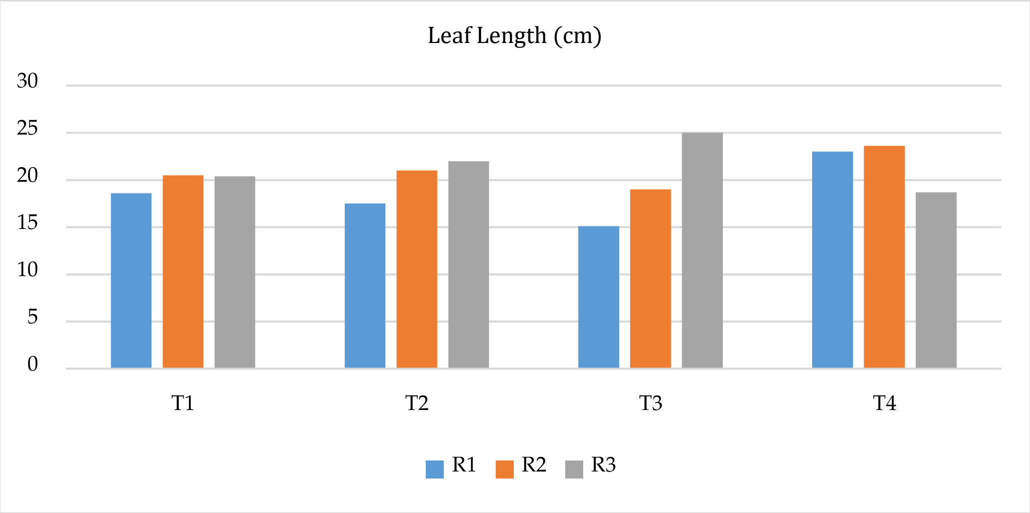

Figure 7: Effects of Different Iron Levels on Leaf Length

Iron plays a vital role in protein synthesis, and proteins aid in cell division. Consequently, leaf length increased with higher iron application.

3. 3. Leaf Width (cm)

Table 8: Leaf Width (cm)

	R1	R2	R3	Total	Average
T1	5.9	6.4	7.2	19.5	6.5
T2	5.8	6.56	8.2	20.56	6.85
T3	6.1	6.9	8.5	21.5	7.166
T4	8	8.4	9	25.4	8.46

The greatest leaf width was observed in the fourth treatment (T4) with 75 ppm iron, measuring 8.46 cm. This difference was statistically significant at the 5% probability level, as shown in the following ANOVA table.

Table 9: Analysis of Variance (ANOVA) for Variation in Leaf Width

source	df	ss	ms	fc	Ft 1%	Ft 5%
block	2	418.7859	0.004776	0.241ns	10.92	5.14
treatment	3	525.0801	175.0267	8.81 *	10.92	5.14
error	6	119.0735	19.84558			
Total	11	1062.939				

Table 10: Comparison of Means Using Least Significant Difference (LSD) Test

Treatments	Mean	Difference
Treatment1	6.5	
treatment2	6.85 ns	0.35
treatment3	7.16 ns	0.66
treatment4	8.46 *	1.96

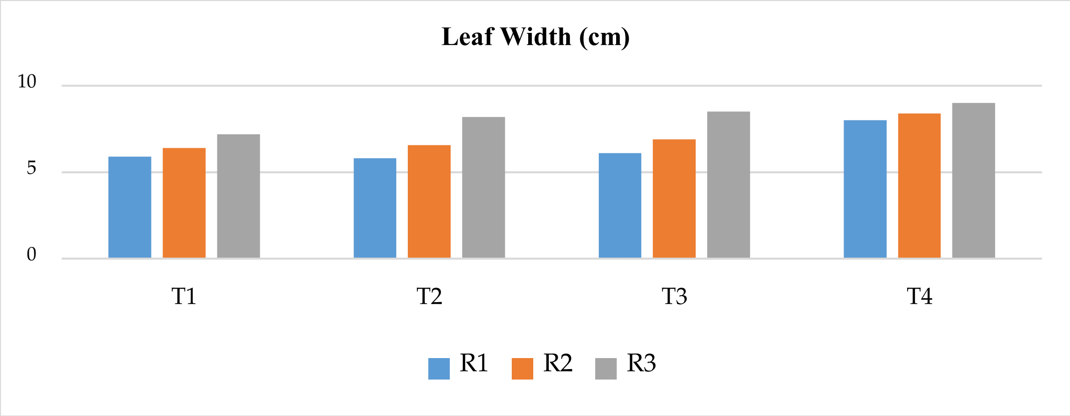

Figure 8: Leaf Width (cm)

Iron affects biosynthesis, leading to increased nutrient production. With adequate nutrient availability, the leaf width of radish increases.

3.4. Root Length (cm)

Table 11: Root Length (cm)

Treatment	R1	R2	R3	Total	Average
T1	25	31	29	85	28.33333
T2	29	32	33	94	31.33333
T3	25	34	38	97	32.33333
T4	31	37	35	103	34.33333

The longest root length was observed in the fourth treatment (T4), measuring 34.3 cm. This difference was statistically significant at the 1% probability level, as shown in the following ANOVA table.

Table 12: Analysis of Variance (ANOVA) for Variation

source	df	ss	Ms	Fc	Ft 1%	ft5 %
Block	2	9021	0.000222	1.11 ns	10.92	5.14
treatment	3	10966.83	3655.611	18.36 **	10.92	5.14
error	6	1194.167	199.0278			
Total	11	21182				

Table 13: Comparison of Means Using Least Significant Difference (LSD) Test

Treatments	Mean	Difference
Treatment1	28.33333	
treatment2	31.33 ns	3
treatment3	32.33*	4
treatment4	34.33*	6

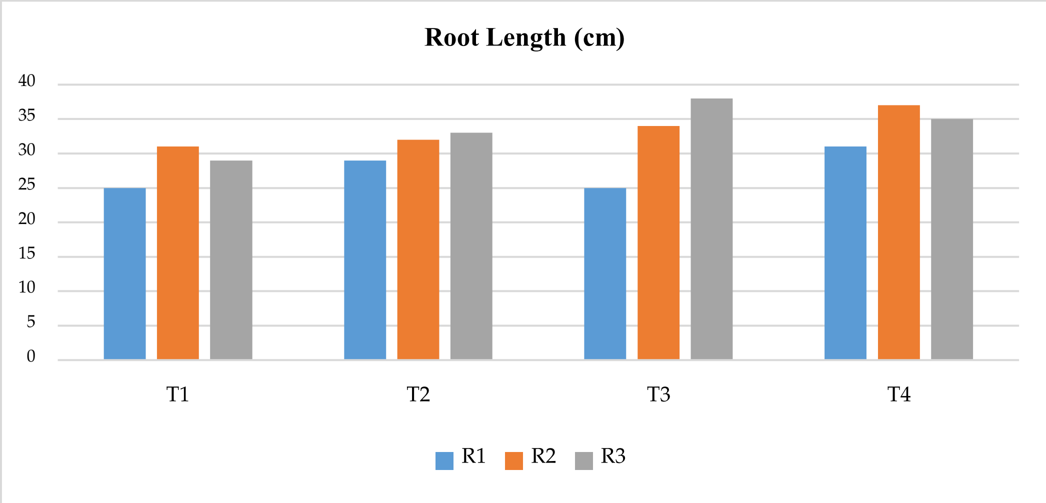

Figure 9: Effects of Different Iron Levels on Root Length

Iron participates in biosynthesis, nutrient transport, and several other metabolic processes, all of which positively affect radish growth. As a result, the length of the root and other plant parts increases

3.5. Root Diameter (cm)

Table 14: Root Diameter (cm)

Treatment	R1	R2	R3	Total	Average
T1	11	13	12	36	12
T2	9	13	13	35	11.66667
T3	11	12	14	37	12.33333
T4	14	13	14	41	13.66667

The largest root diameter was observed in the third treatment (T3), measuring 30.6 cm. This difference was statistically significant at the 1% probability level, as shown in the following ANOVA table.

Table 15: Analysis of Variance (ANOVA) for Variation in Root Diameter

source	df	ss	ms	fc	ft1%	ft5%
block	2	1357.667	0.001473	4.21 ns	10.92	5.14
treatment	3	1664.833	554.9444	15.84 **	10.92	5.14
error	6	210.1667	35.02778			
Total	11	3232.667				

Table 16: Comparison of Means Using Least Significant Difference (LSD) Test

Treatments	Mean	Difference
Treatment1	12	
treatment2	11.66 ns	0.33333
treatment3	12.33 ns	0.333333
treatment4	13.66*	1.666667

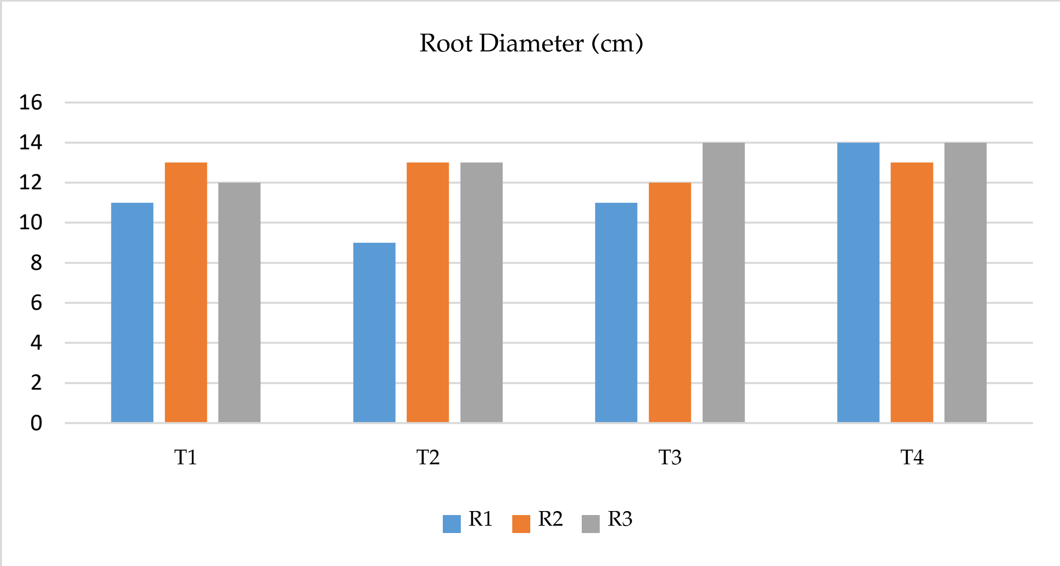

Figure 10: Effects of Nitrogen on Root Diameter

Iron influences the photosynthetic process, which produces nutrients. With adequate nutrient availability, root diameter increases. Additionally, radish is a root vegetable that stores its nutrients in its roots, leading to increased root diameter.

3.6. Individual Root Weight (g)

Table 17: Individual Root Weight (g)

Treatment	R1	R2	R3	Total	Average
T1	154	265	218.6	637.6	212.5333
T2	250	210	374	834	278
T3	390	340	368	1098	366
T4	514	391	259	1164	388

The highest individual root weight was recorded in the fourth treatment (T4), measuring 388 grams. This difference was statistically significant at the 5% probability level, as shown in the following ANOVA table.

Table 18: Analysis of Variance (ANOVA) for Variation in Individual Root Weight

source	df	ss	ms	fc	ft1%	ft5%
block	2	647644.1	3.09	5.33*	10.92	5.14
treatment	3	928030.9	309343.6	5.34*	10.92	5.14
error	6	347454.1	57909.01			
total	11	1923129				

Table 19: Comparison of Means Using Least Significant Difference (LSD) Test

Treatments	Mean	Difference
Treatment1	212.5333	
treatment2	278	65.46667
treatment3	366	153.4667
treatment4	388	175.4667

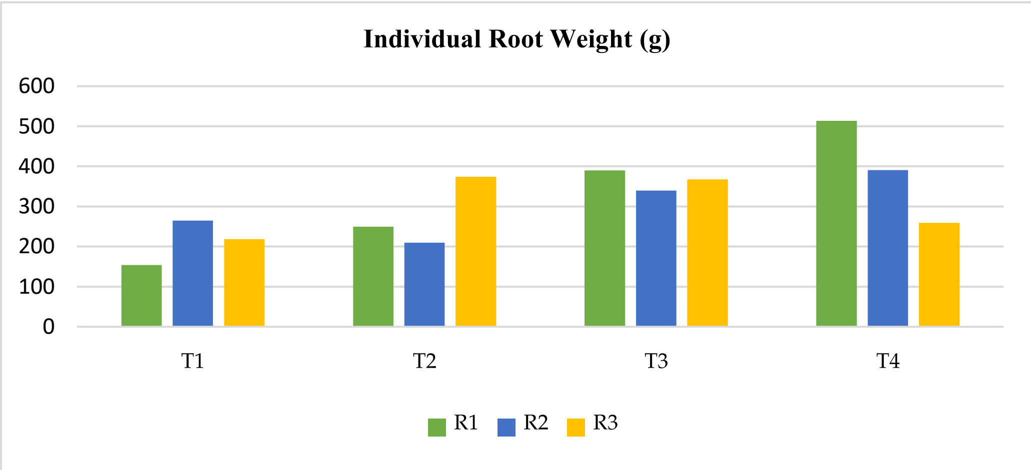

Figure 11: Effects of Iron on Individual Root Weight

Due to increased root length and diameter at higher iron doses, the individual root weight was also higher in the fourth treatment (T4).

3.7. Yield per Plot (kg)

Table 20: Yield per Hectare (kg/ha)

Treatment	R1	R2	R3	Total	Average
T1	31	40	39	110	36.66667
T2	39.5	40.22	47.55	127.27	42.42333
T3	47.4	49.21	48.88	145.49	48.49667
T4	49.88	50.21	46.5	146.59	48.86333

The highest yield was obtained from the fourth treatment (T4), measuring 48.8 kilograms per plot. This difference was statistically significant at the 1% probability level, as shown in the following ANOVA table.

Table 21: Analysis of Variance (ANOVA) for Yield Variation

Source	df	Ss	ms	fc	ft1%	ft5%
Block	2	16847.31	0.000119	2.74 ns	10.92	5.14
treatment	3	21151.06	7050.353	16.27 **	10.92	5.14
Error	6	2598.789	433.1316			
Total	11	40597.16				

Table 21: Comparison of Means

Treatments	Mean	Difference
Treatment1	36.66667	
treatment2	42.42333	5.756667
treatment3	48.49667	11.83
treatment4	48.86333	12.19667

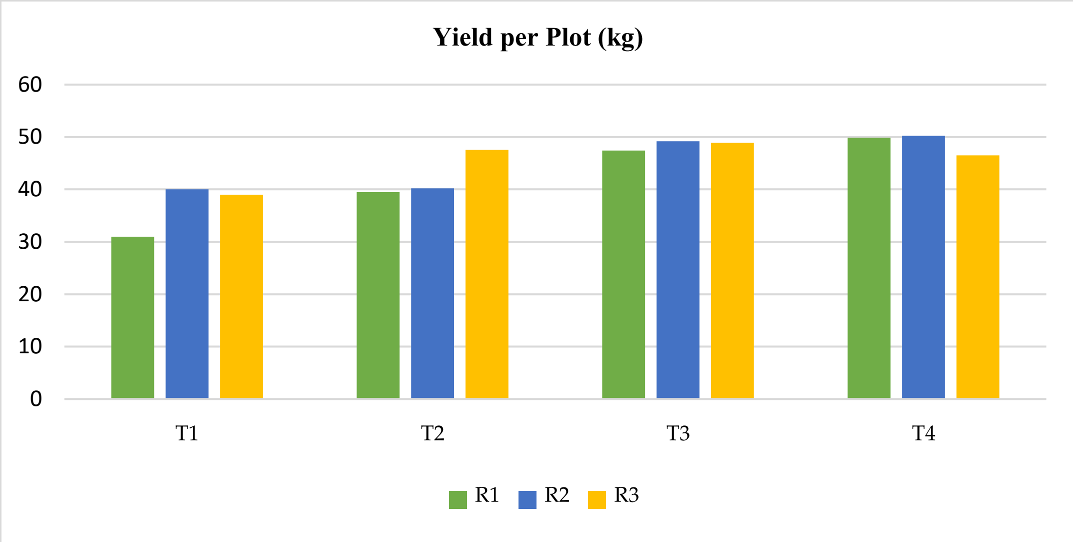

Figure 12: Effects of Different Iron Levels on Yield

Radish yield is closely related to root length and diameter. As both parameters increased in the fourth treatment (T4), the application of a higher iron dose also resulted in a higher yield — 48.8 kg per plot, equivalent to 6.1 kg/m².

4. Discussion

The present study evaluated the effect of different iron levels on the growth and yield of radish in Helmand Province, focusing on key agronomic parameters such as leaf number, leaf dimensions, root size, and overall yield.

Applying iron greatly improved the radish's leaf count. Treatments with 50–75 mg/L iron produced the highest leaf counts, while the control had the lowest. This emphasizes the function of iron in photosynthesis and the synthesis of chlorophyll. Abdel (2010) and Mahmoud et al. (2019) reported similar findings, demonstrating that ideal iron levels effectively promote leaf formation.

Radish leaves were considerably longer when iron was applied; treatment T4 (75 ppm) had the longest leaves, measuring 21.7 cm. Longer leaves result from iron's enhancement of protein synthesis, which promotes cell division and elongation. Gaohongbo et al. (2006) observed a maximum leaf length of 25 cm with 70 ppm iron, which is in line with these findings.

Iron application significantly increased leaf width in radish, with the widest leaves observed in treatment T4 (75 ppm) at 8.46 cm. Adequate iron enhances biosynthesis and nutrient availability, promoting leaf expansion. Similar findings were reported by Nagin et al. (2017), who observed a leaf width of 7.9 cm with 80 ppm iron.

Radish root length was greatly improved by iron administration; treatment T4 had the longest roots (34.3 cm). Iron promotes overall plant growth by supporting biosynthesis, nutrient transport, and other metabolic activities. Gaohongbo et al. (2006) reported similar findings, noting a root length of 32 cm with 70 ppm iron. Radish root diameter was greatly increased by iron administration; treatment T3 showed the highest diameter (30.6 cm). Since radish stores nutrients in its roots, sufficient iron encourages root thickness and improves photosynthesis and nutrient output. Madina et al. (2016) reported similar results, reporting a root diameter of 15 cm with 80 ppm iron.

Individual radish root weight was greatly raised by iron administration, with treatment T4 showing the maximum weight (388 g). The larger root weight was a result of increased root diameter and length under higher iron dosages. Shohan et al. (2019) observed an individual root weight of 400 g with 90 ppm iron and reported similar findings. Radish production was greatly boosted by iron application; treatment T4 produced the maximum yield (48.8 kg per plot, or 6.1 kg/m2). Improvements in root diameter and length under increased iron dosages are closely linked to an increase in yield. Shohan et al. (2019) reported similar results, observing a yield of 7 kg/m² with 90 ppm iron.

5. Conclusion

Different levels of iron significantly affected radish growth and yield. Among the treatments, the application of 75 ppm iron (T4) resulted in the highest improvements, with the maximum number of leaves (22.6), leaf length (21.7 cm), leaf width (8.4 cm), root length (34.3 cm), root diameter (13.6 cm), individual root weight (388 g), and yield per plot (48.8

kg). In contrast, the control treatment (T1, 0 ppm iron) produced the lowest yield (36 kg per plot). These results demonstrate that 75 ppm iron is the most effective dose for enhancing both vegetative growth and radish yield.

Recommendations:

- The optimal iron concentration for radish growth and yield is 70 ppm, which significantly enhances vegetative growth and production.
- Application of iron above 100 ppm negatively affects radish growth and yield.
- Insufficient iron application causes chlorosis in radish leaves.

6. References

Abdel, C. G. (2011). Improving the production of radish (Raphanus sativus L.cv. local black) by Fe-EDDHA and carrots (Daucus carrota L. var. sativus cv. nates) by indole-3-butyric acid (IBA). African Journal of Agricultural Research, 6(4), 978–985.

Abdel, C. G. (2015). Leaf performance analysis of four radish (Raphanus sativus L. var. sativus) cultivars grown in controlled cabinets under varying temperatures and irrigation levels. International Journal of Agricultural Policy and Research, 3(1), 1–28.

Banihani, S. A. (2017). Radish (Raphanus sativus) and diabetes. Nutrients, 9(9),1014.

Baloch, P. A., Uddin, R., Nizamani, F. K., Solangi, A. H., & Siddiqui, A. A. (2014). Effect of Iron fertilisers on growth and yield characteristics of radish (Raphanus sativus L.). American-Eurasian Journal of Agricultural & Environmental Sciences, 14(6), 565–569.

Hasegawa, H., Rahman, M. A., Saitou, K., Kobayashi, M., & Okumura, C. (2011).Influence of chelating ligands on bioavailability and mobility of iron in plant growth media and their effect on radish growth. Environmental and Experimental Botany, 71(3), 345-351

Kopta, T., & Pokluda, R. (2013). Yields, quality and nutritional parameters of radish (Raphanus sativus) cultivars when grown organically in the Czech Republic.

Mahmoud, A. W. M., Abdelaziz, S. M., El-Mogy, M. M., & Abdeldaym, E. A.(2019). Effect of Foliar Zno and Feo Nanoparticles Application on Growth and Nutritional Quality of Red Radish and Assessment of Their Accumulation on Human Health. Agriculture/Pol'nohospodárstvo, 65(1).

Marya, M. H., Rahman, N. Y. A., & Zain, N. A. M. (2020). Effect of iron rates on growth and quality of radish. Annual Research & Review in Biology, 1–12.

Madina, A. A., Ona, A. F., Taufique, T., Mehraj, H., & Jamal Uddin, A. F.M.(2016). Influence of Iron on the growth and yield of radish. Journal of Experimental Biosciences, 4(2), 39–42.

Nagin,G.,Singh,M.,Kumar,R.,Yadav,R.K.,Datt,C.,Paul,K.,Soni, P.(2017).Yield and quality of Radish as affected by iron application and weed management during leanperiod,Indian J.Amin.Nutr,32(1).57-62.

Rashid,S. Vijaykumar,N. Gouraj,V. Vinay,G.& Murthy,S.(2018).Effect of varying levels of iron on growth and yield of radish. Journal of Emerging Technologies and Innovative Research (JETIR), 6(6), 305–310.

Solidoro,J.(2012).Introduction,scientific classific and etymology,and Botanical description,The science culture &politics of food spring.

shohan, J., Bei, Z., Zhang, Y., & Cao, L. (2019). Growth characteristics, water and Iron efficiencies of radish in different water and nitrogen levels. Sains Malaysiana, 43(11), 1665-1671.