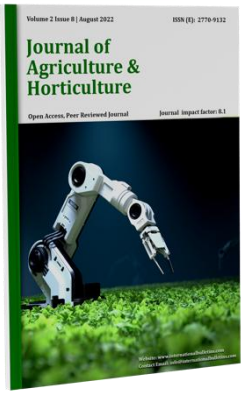

EFFECTS OF DIFFERENT IRRIGATION REGIMES AND MINERAL NUTRITION RATES ON WATERMELON YIELD

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Abstract: This study was conducted during 2022–2024 to investigate the effects of different irrigation regimes and mineral fertilizer application rates on the yield performance of watermelon varieties and hybrids. The experiment included the varieties ‘Shirin’ and ‘Sharq Ne’mati’ as well as the hybrids ‘Dolbi F1’ and ‘Krimstar F1’. A two-factor experimental design was implemented using a randomized complete block design with four replications, where factor A represented irrigation regimes and factor B represented mineral fertilization rates. Total and marketable yield indicators were evaluated annually and the mean values of treatments were calculated. The results demonstrated that the irrigation regime of 70–80–75% of field capacity and the fertilization rate of N140P120K60 kg/ha provided the highest efficiency across all watermelon genotypes. The highest total and marketable yields were recorded in ‘Dolbi F1’ and ‘Krimstar F1’ hybrids, reaching 74.6–73.2 t/ha and 52.0–49.0 t/ha, respectively. The findings indicate that optimizing irrigation and fertilizer inputs enables resource-efficient watermelon production and contributes to increased productivity in intensive agro-technological systems.

Keywords: Watermelon, irrigation regimes, mineral nutrition, NPK, yield, marketable yield, resource efficiency, ‘Dolbi F1’, ‘Krimstar F1’, ‘Shirin’, ‘Sharq Ne’mati’.

Introduction

The growing demand for agricultural products, particularly for cucurbit crops, necessitates the implementation of resource-efficient production technologies and the search for modern methods to enhance yield. Watermelon (*Citrullus lanatus*) is one of the most important vegetable crops due to its high nutritional value, short maturation period, and strong export potential. Its growth, development, and productivity are directly influenced by soil and climatic conditions, appropriate irrigation management, and adequate mineral nutrient supply.

In irrigated regions, especially under the conditions of Uzbekistan, the rational use of water resources is a critical priority. Drip irrigation systems reduce water consumption by applying water directly to the root zone, helping to maintain optimal soil moisture and improve mineral fertilizer uptake. Furthermore, the combined optimization of various irrigation regimes and mineral fertilization rates strongly affects the morpho-biological characteristics, fruit quality, and economic performance of watermelon production.

Previous research indicates that watermelon exhibits significant variation in growth dynamics and yield formation under different moisture conditions, while deficiencies in water and nutrients can reduce fruit weight and sugar accumulation. Therefore, regulating soil moisture according to plant phenological stages, along with selecting appropriate application rates of nitrogen, phosphorus, and potassium fertilizers, is considered a key approach to obtaining high yields and high-quality fruits.

In this context, the present study aims to evaluate the effects of different irrigation regimes and mineral fertilization rates on the yield performance of watermelon, identify the most efficient agrotechnical combinations, and develop practical recommendations for farmers and agricultural enterprises.

Methods and materials

The research was carried out during 2022–2024 under the agro-ecological conditions of Uzbekistan using a two-factor experimental design. The study involved two watermelon (*Citrullus lanatus*) varietys ('Shirin' and 'Sharq Ne'mati') and two hybrids ('Dolbi F1' and 'Krimstar F1'). The objective of the experiment was to determine intensive cultivation technologies adapted to local soil and climatic conditions.

Factor A: Irrigation regimes, % of field capacity (FC)

1. 60–70–65 % FC
2. 65–75–70 % FC
3. 70–80–75 % FC
4. 75–85–80 % FC

Factor B: Mineral fertilization rates, kg/ha

1. Without fertilizer (Control)
2. N100P80K40
3. N120P100K50
4. N140P120K60

The total number of treatment combinations was: 4 × 4 = 16 variants.

Statistical Analysis

- Analysis of variance (ANOVA) was performed
- Significant differences among treatment means were evaluated at $P \leq 0.05$
- Yield parameters were assessed through linear comparison and correlation analysis
- Significant mean separation was determined using the LSD test

Results and discussion

Different irrigation regimes and mineral fertilizer application rates had a significant effect on the total yield of the watermelon variety 'Shirin'. Among the irrigation regimes, the lowest yield was observed under the 60–70–65% field capacity (FC) conditions. In this moisture interval, the unfertilized control treatment produced an average yield of 17.3 t/ha, whereas the application of N140P120K60 fertilizer increased the yield to 41.2 t/ha. This indicates that sufficient irrigation combined with balanced mineral nutrition can improve the yield potential by more than twofold.

Increasing the irrigation level to 65–75–70% FC further enhanced the total yield, with values ranging from 19.9 t/ha in the unfertilized treatment to 48.2 t/ha in the N140P120K60 variant. These results suggest that improved water availability enhances photosynthetic activity and promotes fruit formation, leading to increased yield.

Table 1. *Total yield of watermelon variety 'Shirin' grown under different irrigation regimes and mineral fertilization rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Total yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	16.4	17.3	18.1	17.3
2		$N_{100}P_{80}K_{40}$	29.7	30.5	31.3	30.5
3		$N_{120}P_{100}K_{50}$	34.8	35.5	36.5	35.6
4		$N_{140}P_{120}K_{60}$	40.4	41.2	42	41.2
5	65...75...70	no fertilizer	19.1	19.9	20.7	19.9
6		$N_{100}P_{80}K_{40}$	37	37.8	38.6	37.8
7		$N_{120}P_{100}K_{50}$	42.7	43.5	44.3	43.5
8		$N_{140}P_{120}K_{60}$	47.4	48.2	49	48.2
9	70...80...75	no fertilizer	22.3	22.5	23.6	22.8
10		$N_{100}P_{80}K_{40}$	56.6	57.4	58.2	57.4
11		$N_{120}P_{100}K_{50}$	63.4	64.2	65	64.2
12		$N_{140}P_{120}K_{60}$	69.2	70	70.8	70.0
13	75...85...80	no fertilizer	25.5	25.4	26.7	25.9
14		$N_{100}P_{80}K_{40}$	47.7	48.7	49.1	48.5
15		$N_{120}P_{100}K_{50}$	54.3	55.1	55.9	55.1
16		$N_{140}P_{120}K_{60}$	59.5	60.3	61.1	60.3

Under the 70–80–75% field capacity (FC) irrigation regime, the highest yield values were obtained. In this condition, the unfertilized treatment produced 25.9 t/ha, while the application of N140P120K60 resulted in a yield of 70.0 t/ha. This indicates that this regime ensures the optimal coordination of both resources, water and mineral nutrients. The yields in this interval were approximately 1.7–3.0 times higher compared to the 60–70–65% FC treatment.

A high yield level was also maintained under the 75–85–80% FC irrigation regime; however, a slight decrease in yield was observed compared to the 70–80–75% FC treatment. For instance, the most efficient variant (N120P100K50) achieved a yield of 55.1 t/ha. This suggests that excessive irrigation may disrupt the soil aeration–moisture balance and reduce root activity, leading to a slight decline in productivity.

Analysis of the fertilization factor revealed that across all irrigation regimes, the N140P120K60 and N120P100K50 fertilizer rates ensured the highest yield values. Compared to the unfertilized control, yield improvements reached 2–3.5 times. This confirms that NPK elements play a crucial role in promoting vigorous vegetative growth, flowering, and fruit development in watermelon.

Table 2. *Marketable yield of watermelon variety 'Shirin' grown under different irrigation regimes and mineral fertilization rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Marketable yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	9.1	9.2	9.3	9.2
2		$N_{100}P_{80}K_{40}$	20.1	21.7	22.5	21.4
3		$N_{120}P_{100}K_{50}$	23.2	24.8	25.6	24.5
4		$N_{140}P_{120}K_{60}$	25.4	27	27.8	26.7
5	65...75...70	no fertilizer	9.5	11.1	11.9	10.8
6		$N_{100}P_{80}K_{40}$	23.4	25	25.8	24.7
7		$N_{120}P_{100}K_{50}$	25.9	27.5	28.3	27.2
8		$N_{140}P_{120}K_{60}$	31.2	32.8	33.6	32.5
9	70...80...75	no fertilizer	10.3	11.9	12.7	11.6
10		$N_{100}P_{80}K_{40}$	38.6	40.2	41	39.9
11		$N_{120}P_{100}K_{50}$	41.2	42.8	43.6	42.5
12		$N_{140}P_{120}K_{60}$	44.5	46.1	46.9	45.8
13	75...85...80	no fertilizer	10.5	12.1	12.9	11.8
14		$N_{100}P_{80}K_{40}$	34.3	35.9	36.7	35.6
15		$N_{120}P_{100}K_{50}$	37	38.6	39.4	38.3
16		$N_{140}P_{120}K_{60}$	40.1	41.7	42.5	41.4

The marketable yield of the watermelon variety ‘Shirin’ was found to be strongly dependent on irrigation regimes and mineral fertilizer application rates. The lowest values were recorded under the 60–70–65% field capacity (FC) irrigation regime without fertilization, with only 9.2 t/ha being obtained on average. Under the same irrigation level, the application of N140P120K60 increased marketable yield to 26.7 t/ha, which corresponds to nearly a threefold yield improvement compared to the control.

Increasing the irrigation regime to 65–75–70% FC further enhanced the effectiveness of mineral fertilization. As a result, marketable yield increased from 24.7 to 32.5 t/ha depending on the treatment. This demonstrates that under optimal soil moisture conditions, mineral nutrients more effectively stimulate fruit setting and accumulation of fruit mass.

The highest marketable yield was achieved under the 70–80–75% FC irrigation regime. In this case, the unfertilized plots produced 11.6 t/ha, while the N140P120K60 treatment resulted in 45.8 t/ha, which represents more than a fourfold increase compared to the control. This confirms that the balance between soil moisture and nutrient supply reaches its optimal level under this irrigation interval.

Under the 75–85–80% FC irrigation regime, the highest mineral fertilization rate (N140P120K60) ensured a yield of 41.4 t/ha. However, this value was slightly lower than under the 70–80–75% FC regime, likely due to excessive moisture negatively affecting soil aeration and plant physiological processes.

The results obtained for the variety ‘Sharq Ne’mati’ similarly confirmed a strong influence of irrigation regimes and mineral fertilization on total yield. The lowest total yield was observed under the 60–70–65% FC unfertilized treatment (17.6 t/ha). Under the same

regime, the application of N140P120K60 increased yield to 42.8 t/ha, representing an approximately 2.5-fold increase over the control.

Table 3. *Total yield of watermelon variety 'Sharq Ne'mati' under different irrigation regimes and mineral fertilization rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Total yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	17	17.4	18.4	17.6
2		$N_{100}P_{80}K_{40}$	33.6	34.4	35.2	34.4
3		$N_{120}P_{100}K_{50}$	40.4	41.2	42	41.2
4		$N_{140}P_{120}K_{60}$	42	42.8	43.6	42.8
5	65...75...70	no fertilizer	19.6	20.4	21.2	20.4
6		$N_{100}P_{80}K_{40}$	44.6	45.4	46.2	45.4
7		$N_{120}P_{100}K_{50}$	49.3	50.2	51.1	50.2
8		$N_{140}P_{120}K_{60}$	56	56.8	57.6	56.8
9	70...80...75	no fertilizer	22.6	23.4	24.2	23.4
10		$N_{100}P_{80}K_{40}$	57.3	58.1	58.9	58.1
11		$N_{120}P_{100}K_{50}$	66.2	67	67.8	67.0
12		$N_{140}P_{120}K_{60}$	71.8	72.6	73.4	72.6
13	75...85...80	no fertilizer	25.7	26.5	27.3	26.5
14		$N_{100}P_{80}K_{40}$	53	53.8	54.6	53.8
15		$N_{120}P_{100}K_{50}$	58.3	59.1	59.9	59.1
16		$N_{140}P_{120}K_{60}$	65.7	66.5	67.3	66.5

When the irrigation level was increased to 65–75–70% of field capacity (FC), plant growth and development processes were further stimulated, and total yield increased from 20.4 to 56.8 t/ha. This indicates that ensuring adequate soil moisture enhances the effectiveness of mineral fertilizers in yield formation.

The highest yield values were recorded under the 70–80–75% FC irrigation regime. In this regime, the unfertilized treatment produced 23.4 t/ha, whereas the N140P120K60 treatment resulted in a yield of 72.6 t/ha. This represents more than a threefold increase compared to the control and indicates the most favorable interaction between water and nutrient supply within this interval.

In the treatments irrigated at 75–85–80% FC, high yields were also maintained. The highest mineral fertilization rate (N140P120K60) produced 66.5 t/ha. However, this value was slightly lower compared to the 70–80–75% FC regime. This suggests that excessive moisture may restrict root respiration, thereby negatively affecting plant physiological activity.

Table 4. *Marketable yield of watermelon variety 'Sharq Ne'mati' under different irrigation regimes and mineral fertilization rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Marketable yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	9.6	10	10.8	10.1
2		$N_{100}P_{80}K_{40}$	22.3	23.1	23.9	23.1
3		$N_{120}P_{100}K_{50}$	25.7	26.5	27.3	26.5
4		$N_{140}P_{120}K_{60}$	26.3	27.1	27.9	27.1
5	65...75...70	no fertilizer	9.7	10.5	11.3	10.5
6		$N_{100}P_{80}K_{40}$	28.6	29.4	30.2	29.4
7		$N_{120}P_{100}K_{50}$	31.2	32	32.8	32.0
8		$N_{140}P_{120}K_{60}$	35.5	36.3	37.1	36.3
9	70...80...75	no fertilizer	10.3	11.1	11.9	11.1
10		$N_{100}P_{80}K_{40}$	37.7	38.5	39.3	38.5
11		$N_{120}P_{100}K_{50}$	42.2	43	43.8	43.0
12		$N_{140}P_{120}K_{60}$	46	46.8	47.6	46.8
13	75...85...80	no fertilizer	11.1	11.9	12.7	11.9
14		$N_{100}P_{80}K_{40}$	33.3	34.1	34.9	34.1
15		$N_{120}P_{100}K_{50}$	38	38.8	39.6	38.8
16		$N_{140}P_{120}K_{60}$	41.1	41.9	42.7	41.9

For the variety 'Sharq Ne'mati', marketable yield varied significantly depending on irrigation regimes and mineral fertilizer rates. The lowest marketable yield was observed under the 60–70–65% field capacity (FC) regime without fertilization, averaging 10.1 t/ha. In the same irrigation interval, the application of N140P120K60 increased yield to 27.1 t/ha, representing approximately a 2.7-fold improvement over the control.

Under the 65–75–70% FC irrigation regime, marketable yield increased further. While the unfertilized treatment produced 10.5 t/ha, application of N140P120K60 increased yield to 36.3 t/ha, confirming the high efficiency of mineral fertilizers under optimal moisture conditions.

The highest marketable yield for this variety was achieved under the 70–80–75% FC irrigation regime. In this case, the application of N140P120K60 resulted in 46.8 t/ha, nearly a fourfold increase compared to the unfertilized control, and this regime was identified as the most effective treatment in the experiment.

In the 75–85–80% FC irrigation regime, marketable yield remained high, although slightly lower compared to the 70–80–75% FC regime. For instance, the N120P100K50 treatment resulted in 43.0 t/ha and the N140P120K60 treatment in 41.9 t/ha. This suggests that excessive irrigation may disrupt soil aeration and limit physiological processes in the root system.

Table 5. *Total yield of watermelon hybrid 'Dolbi F1' under different irrigation regimes and mineral nutrition rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Total yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	19.3	20.1	20.9	20.1
2		$N_{100}P_{80}K_{40}$	39.4	39.4	40.6	39.8
3		$N_{120}P_{100}K_{50}$	43.4	44.2	45	44.2
4		$N_{140}P_{120}K_{60}$	48.4	48.8	49.2	48.8
5	65...75...70	no fertilizer	22.1	23.1	23.8	23.0
6		$N_{100}P_{80}K_{40}$	47.8	48.6	49.4	48.6
7		$N_{120}P_{100}K_{50}$	56.4	56.4	57.6	56.8
8		$N_{140}P_{120}K_{60}$	59.2	60.2	61.2	60.2
9	70...80...75	no fertilizer	25.4	26.2	27	26.2
10		$N_{100}P_{80}K_{40}$	62.5	63.3	64.1	63.3
11		$N_{120}P_{100}K_{50}$	66	66.8	67.6	66.8
12		$N_{140}P_{120}K_{60}$	73.8	74.6	75.4	74.6
13	75...85...80	no fertilizer	28.7	29.5	30.3	29.5
14		$N_{100}P_{80}K_{40}$	56.5	57.3	58.1	57.3
15		$N_{120}P_{100}K_{50}$	60.5	60.5	61.7	60.9
16		$N_{140}P_{120}K_{60}$	69.9	70.7	71.5	70.7

The hybrid 'Dolbi F1' demonstrated very high and stable total yield responses to irrigation regimes and mineral fertilizer rates. The lowest yield of 20.1 t/ha was recorded under the 60–70–65% FC unfertilized treatment. Under the same irrigation regime, application of N140P120K60 increased yield to 48.8 t/ha, representing approximately a 2.5-fold increase compared to the control.

Under the 65–75–70% FC irrigation regime, a substantial increase in total yield occurred. The unfertilized variant produced 23.0 t/ha, while N140P120K60 resulted in 60.2 t/ha, indicating that improved water supply enhanced nutrient uptake and stimulated fruit formation.

The highest total yields were recorded under the 70–80–75% FC regime. In this case, the unfertilized treatment produced 26.2 t/ha, while the application of N140P120K60 ensured 74.6 t/ha, confirming that the most optimal combination of irrigation and mineral nutrition was achieved under this moisture interval.

Even under the 75–85–80% FC irrigation regime, yield remained high, although slightly lower than in the 70–80–75% FC regime (70.7 t/ha under N140P120K60), suggesting that excessive moisture may restrict root respiration and suppress physiological activity.

Table 6. *Marketable yield of watermelon hybrid 'Dolbi F1' under different irrigation regimes and mineral nutrition rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Marketable yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	10.6	12.2	13	11.9
2		$N_{100}P_{80}K_{40}$	24.4	26.2	26.6	25.7
3		$N_{120}P_{100}K_{50}$	26.1	27.7	28.5	27.4
4		$N_{140}P_{120}K_{60}$	29.6	31.2	32	30.9
5	65...75...70	no fertilizer	11.2	12.8	13.4	12.5
6		$N_{100}P_{80}K_{40}$	31.2	32.8	33.6	32.5
7		$N_{120}P_{100}K_{50}$	36.7	38.3	39.1	38.0
8		$N_{140}P_{120}K_{60}$	39.1	40.7	41.5	40.4
9	70...80...75	no fertilizer	11.9	13.5	14.3	13.2
10		$N_{100}P_{80}K_{40}$	42.3	43.9	44.7	43.6
11		$N_{120}P_{100}K_{50}$	46.4	48.2	48.6	47.7
12		$N_{140}P_{120}K_{60}$	50.4	52.4	52.4	51.7
13	75...85...80	no fertilizer	12.2	13.8	14.6	13.5
14		$N_{100}P_{80}K_{40}$	36.8	38.4	39.2	38.1
15		$N_{120}P_{100}K_{50}$	41	42.6	43.4	42.3
16		$N_{140}P_{120}K_{60}$	47.3	48.9	49.7	48.6

For the hybrid 'Dolbi F1', marketable yield also increased significantly depending on irrigation regimes and mineral fertilizer rates. Under the 60–70–65% field capacity (FC) irrigation regime, the unfertilized treatment produced 11.9 t/ha. In the same irrigation interval, application of N140P120K60 increased the yield to 30.9 t/ha, indicating the high yield potential of this hybrid even under limited water and nutrient conditions.

Under the 65–75–70% FC irrigation regime, marketable yield improved further. The unfertilized plots produced 12.5 t/ha, whereas the N140P120K60 variant resulted in 40.4 t/ha. This confirms that improved water availability enhances nutrient uptake and stimulates more intensive fruit formation.

The highest yield performance was recorded under the 70–80–75% FC irrigation regime. In this case, the unfertilized treatment recorded 13.2 t/ha, while the application of N140P120K60 resulted in 51.7 t/ha. Compared with the control, this represents a more than 3.9-fold improvement in yield, confirming that this moisture interval ensures the most optimal balance between water and nutrient supply.

Even under the 75–85–80% FC irrigation regime, marketable yield remained high, although slightly lower compared to the 70–80–75% FC treatment (48.6 t/ha under N140P120K60). This suggests that excessive moisture may restrict root activity and reduce physiological efficiency.

The total yield indicators of the hybrid 'Krimstar F1' exhibited high sensitivity to irrigation regimes and mineral fertilization rates. The lowest yield of 18.3 t/ha was recorded under the 60–70–65% field capacity (FC) irrigation regime without fertilization. However,

under the same regime, the application of N140P120K60 increased yield to 44.2 t/ha, representing nearly a 2.5-fold improvement compared to the control.

Under the 65–75–70% FC irrigation regime, total yield improved significantly, increasing from 21.0 to 54.1 t/ha. This trend indicates that improved moisture availability promoted nutrient uptake and enhanced photosynthetic efficiency, resulting in increased yield formation.

The highest total yield was recorded under the 70–80–75% FC irrigation regime. In this treatment, the unfertilized plots produced 23.9 t/ha, while the application of N140P120K60 resulted in 73.2 t/ha. This represents one of the maximum values obtained in the experiment and demonstrates the high biological potential of this hybrid.

Although high yields were also observed under the 75–85–80% FC regime, there was a slight decrease compared to the 70–80–75% FC treatment. Specifically, the N120P100K50 rate produced 61.5 t/ha, whereas the N140P120K60 rate resulted in 63.3 t/ha. This suggests that excessive irrigation may negatively impact soil aeration and restrict root system activity, consequently reducing plant performance.

The marketable yield performance of the hybrid 'Krimstar F1' confirmed a strong dependence on irrigation regimes and mineral fertilization levels. The lowest marketable yield of 9.8 t/ha was recorded under the 60–70–65% field capacity (FC) regime without fertilization. Under the same moisture condition, the application of N140P120K60 increased yield to 28.0 t/ha, resulting in nearly a threefold improvement compared to the control.

Table 7. *Total yield of watermelon hybrid 'Krimstar F1' under different irrigation regimes and mineral fertilization rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Total yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	18.5	19.4	17.1	18.3
2		$N_{100}P_{80}K_{40}$	37.1	37.9	35.5	36.8
3		$N_{120}P_{100}K_{50}$	38.8	39.4	37.1	38.4
4		$N_{140}P_{120}K_{60}$	44.5	45.3	42.9	44.2
5	65...75...70	no fertilizer	21.3	22.1	19.7	21.0
6		$N_{100}P_{80}K_{40}$	43.3	44	41.5	42.9
7		$N_{120}P_{100}K_{50}$	45	45.8	43.4	44.7
8		$N_{140}P_{120}K_{60}$	54.3	55.2	52.9	54.1
9	70...80...75	no fertilizer	24.2	25	22.6	23.9
10		$N_{100}P_{80}K_{40}$	58.7	59.5	57.1	58.4
11		$N_{120}P_{100}K_{50}$	71.5	72.7	69.5	71.2
12		$N_{140}P_{120}K_{60}$	73.5	74.3	71.9	73.2
13	75...85...80	no fertilizer	27.4	28.2	25.8	27.1
14		$N_{100}P_{80}K_{40}$	53.1	53.7	51.5	52.8
15		$N_{120}P_{100}K_{50}$	61.6	62.4	60.4	61.5
16		$N_{140}P_{120}K_{60}$	63.2	64.4	62.4	63.3

Under the 65–75–70% FC irrigation regime, yield improved further, ranging from 10.9 to 34.7 t/ha depending on fertilizer level. This indicates that improved moisture supply enhances nutrient uptake efficiency, which in turn stimulates more active fruit formation.

The highest marketable yield was obtained under the 70–80–75% FC regime. In this case, the unfertilized treatment yielded 11.8 t/ha, whereas the N140P120K60 treatment produced 49.0 t/ha. This represents nearly a fourfold increase compared to the unfertilized control, suggesting that the optimal balance between irrigation and nutrient supply is achieved within this moisture interval.

Although high yields were also observed under the 75–85–80% field capacity (FC) irrigation regime, a slight reduction was evident compared to the 70–80–75% FC treatment. Under the highest fertilization rate (N140P120K60), marketable yield reached 43.9 t/ha. This decline may be attributed to excessive soil moisture disrupting soil aeration and reducing physiological activity in the root system.

Table 8. *Marketable yield of watermelon hybrid 'Krimstar F1' under different irrigation regimes and mineral fertilization rates, 2022–2024*

№	Factor A: Irrigation regime, % FC	Factor B: Mineral fertilizer rate, kg/ha	Marketable yield, t/ha			
			Years			Average
			2022	2023	2024	
1	60...70...65	no fertilizer	9.8	9.9	9.7	9.8
2		$N_{100}P_{80}K_{40}$	22.8	23.6	21.2	22.5
3		$N_{120}P_{100}K_{50}$	26.4	27.2	24.8	26.1
4		$N_{140}P_{120}K_{60}$	28.3	29.1	26.7	28.0
5	65...75...70	no fertilizer	11.2	12	9.6	10.9
6		$N_{100}P_{80}K_{40}$	27.3	28.1	25.7	27.0
7		$N_{120}P_{100}K_{50}$	29.1	29.9	27.5	28.8
8		$N_{140}P_{120}K_{60}$	35	35.8	33.4	34.7
9	70...80...75	no fertilizer	12.1	12.9	10.5	11.8
10		$N_{100}P_{80}K_{40}$	43.5	44.3	41.9	43.2
11		$N_{120}P_{100}K_{50}$	47.9	48.7	46.3	47.6
12		$N_{140}P_{120}K_{60}$	49.3	50.1	47.7	49.0
13	75...85...80	no fertilizer	12.9	13.7	11.3	12.6
14		$N_{100}P_{80}K_{40}$	38.5	39.3	36.9	38.2
15		$N_{120}P_{100}K_{50}$	42.9	43.7	41.3	42.6
16		$N_{140}P_{120}K_{60}$	44.2	45	42.6	43.9

Conclusion

The study demonstrated that different irrigation regimes and mineral fertilization rates had a significant effect on the yield performance of watermelon varieties and hybrids. Increasing the irrigation level enhanced plant growth and fruit development, thereby improving productivity. Higher mineral fertilization rates, particularly the balanced application of nitrogen, phosphorus, and potassium, increased yield by two to four times depending on treatment combinations.

According to the experimental results, the irrigation regime of 70–80–75% field capacity (FC) was identified as the most optimal condition for all tested varieties and hybrids. Under this irrigation regime, the fertilization rate of N140P120K60 kg/ha provided the highest efficiency. This combination positively influenced the physiological and biochemical processes of watermelon plants, contributing to improved fruit set and enhanced product quality

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