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Dose-Response Relationship of NPK Fertigation on Melon Growth and Yield

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ABSTRACT

The goal of the study was to determine how different NPK fertigation levels affected the watermelon (Citrullus lanatus L.) growth and yield in Pakistan's Khyber Pakhtunkhwa (KP) ecological zone. Using three replications and a Randomized Complete Block Design (RCBD) with five NPK levels (0%, 25%, 50%, 75%, and 100% of the advised 150:120:90 kg/ha), the experiment was carried out at the Arid Zone Research Centre during the rainy season of 2021. Plant height, leaf count, number of male and female flowers, days to 50% flowering, fruit count, and fruit weight at harvest were among the parameters that were measured. Results showed that raising NPK levels, especially at 75% of the prescribed dose, significantly increased plant height, leaf count, and flower count. At 100% NPK, the plants reached their maximum height (119.68 cm at 6 weeks and 227.16 cm at 10 weeks) and leaf count (41 leaves at 6 weeks and 79 leaves at 10 weeks), with 75% NPK coming in close second. At 75% NPK (18 flowers) and 100% NPK (17 flowers), the largest number of blooms per plant was observed. Significant progress was also shown in the fruit weight, with the highest average fruit weight (6.43 kg) being produced by 75% NPK. According to the study's findings, NPK fertigation at 75% of the suggested dosage greatly increases watermelon growth and yield; as a result, farmers in the area are advised to use this technique to increase productivity and profitability.

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INTRODUCTION

Watermelon, scientifically known as *Citrullus lanatus* L., is a member of the Cucurbitaceae family. It falls under the kingdom Plantae and order Cucurbitales [1]. This plant is quite versatile, with a growth habit that resembles that of a vine. It is well-known for producing the highly sought-after watermelon fruit [2]. Watermelons have a rich history, tracing back to their origins in Africa, particularly the Kalahari and Sahara deserts, many centuries ago. Over time, they have expanded their reach from Africa to Asia, Europe, and North America, making their way to Asia and the Middle East between 900 and 1000 A.D., and to Europe between 1300 and 1400 A.D. [3]. The term "watermelon" was first recorded in an English dictionary in 1615.

China took the lead in watermelon production with a whopping 69,576,643 tonnes. Iran, Turkey, Brazil, and the United States also made significant contributions to the global production, resulting in a total of 104,472,354 tons [4].

Watermelons have a multitude of health benefits, as stated by Ijaz et al. [5]. These foods are packed with vitamin B, which helps with energy production, and beta-carotene, which enhances the immune system and fights against age-related vision problems. Watermelons have a high water content, which helps prevent dehydration. They are a popular choice for those watching their calorie intake because they are low in calories. Watermelons contain potassium, which can contribute to reducing blood pressure and protecting against kidney stones, strokes, and heart diseases. In addition, watermelons are rich in antioxidants that help combat free radicals, which can lower the risk of cancer and heart diseases. Additionally, their diuretic properties can be advantageous for maintaining kidney and bladder health, while their juice has been known to help reduce skin blemishes [6,7].

Watermelons thrive in warm climates and prefer well-drained soils that are rich in organic matter [8]. The seeds are high in fat and protein, commonly consumed as snacks, incorporated into various dishes, or utilized for their oil content. Watermelon is packed with beneficial nutrients like lycopene, phenolic antioxidants, cucurbitacin E, and citrulline, which contribute to its significant nutritional value [9].

Watermelon production is influenced by the climate and farming methods. Factors such as poor cultivation practices, inadequate spacing, and improper fertilizer application contribute to low yields. Fertilization is crucial for achieving optimal growth in regions with less fertile soils. This is particularly important in areas with savannah soils. Fertilizer application has a significant impact on the growth of watermelons, particularly when it comes to the role of nitrogen [10].

This study seeks to investigate the impact of NPK fertigation on watermelon growth and yield. The main focus is to find the best fertilizer rates to enhance sustainable yield improvement.

MATERIALS AND METHODS

The experiment was carried out in the Arid Zone Research Centre through the course of the rainy season in the year 2022. The location is located in the Khyber Pakhtunkhwa (KP) ecological zone of Pakistan, at an elevation of 173 meters above sea level, at a latitude of 31 degrees 49 minutes north and a longitude of 70 degrees 55 minutes east. In this particular region, the climate is distinguished by the presence of distinct dry and rainy seasons. According to Rahmani et al. [11]

the soil at the experimental location is predominantly composed of clay-loam and has a diminished cation exchange capacity (CEC).

"Sugar Baby" watermelon variety was utilized for the experiment. This particular variety matures early and is ready for harvesting within seventy to seventy-five days. There were five different amounts of NPK fertilizer that were used in the experimental design. These levels were 0%, 25%, 50%, 75%, and 100% of the prescribed 150:120:90 kg/ha NPK. There were a total of fifteen experimental units, which was achieved by performing three separate replications of each treatment level.

The experimental design was a Randomized Complete Block Design (RCBD), and there were three replications of the experiment to guarantee that the results were reliable and representative of the whole. Two to three weeks following planting, application of fertilizer treatments was carried out in order to guarantee adequate nutrient uptake during crucial periods of plant development. Plant height, the number of leaves, the number of male and female flowers, the number of days until fifty percent of the flowers have bloomed, the number of fruits, and the weight of the fruits during harvest were the parameters that were measured.

In order to obtain comprehensive information regarding growth and yield, data gathering was carried out with great care at a number of different stages of progression. In order to establish the statistical significance of the treatment effects, the data that were collected were analyzed using the technique known as Analysis of Variance (ANOVA). The Least Significant Difference (LSD) test, which was described by Gomez and Gomez [12], was utilized in order to assess the mean differences that existed between the various treatments. The dependability and precision of the experimental data were ensured by this meticulous analytical technique, which also provided useful insights into the ideal quantities of NPK fertilizer for watermelon production under the conditions that were present.

RESULTS AND DISCUSSION

Plant Height

The impact of different NPK fertilizer levels on plant height at various stages of watermelon growth was analyzed, and the results are summarized in Table 1. At 2 weeks after sowing (WAS), there was no significant difference in plant height across the different treatments. However, by 6 WAS and 10 WAS, significant differences were observed. At 6 WAS, the application of 100% recommended NPK (150:120:90 kg/ha) resulted in the highest plant height (119.68 cm), followed by 75% NPK (103.45 cm), 50% NPK (83.64 cm), 25% NPK (72.41 cm), and the control (52.73 cm). At 10 WAS, the highest plant heights were recorded for 100% NPK (227.16 cm) and 75% NPK (224.34 cm), with 50% NPK (213.18 cm) and 25% NPK (197.42 cm) also showing significant increases compared to the control (154.67 cm).

The Least Significant Difference (LSD) test confirmed the significance of these differences at 6 and 10 WAS, indicating that higher doses of NPK fertilizer positively influence the plant height of watermelon, with the 100% and 75% NPK levels being particularly effective.

Number of Leaves

The number of leaves also showed significant variation among the treatments at different stages of growth (Table 1). At 2 WAS, there was no significant difference in the number of leaves

across the treatments. By 6 WAS, the 75% NPK treatment resulted in the highest number of leaves (41), followed closely by 100% NPK (39). The 50% NPK (35) and 25% NPK (31) treatments also showed significant increases compared to the control (16). At 10 WAS, the highest number of leaves was recorded for 75% NPK (79), with 100% NPK (75), 50% NPK (74), and 25% NPK (63) showing significant increases compared to the control (45).

The Least Significant Difference (LSD) test verified the significance of these differences at 6 and 10 WAS. This indicates that larger dosages of NPK fertilizer have a favorable influence on the number of leaves that watermelon produces, with the levels of 100% and 75% NPK being particularly effective.

Table 1. *Effect of different fertigation concentrations on plant height and leaves count of water melon*

Fertigation Treatments	**Plant Height (cm)**			**Number of Leaves**		
	Weeks After Sowing (WAS)					
	2	**6**	**10**	**2**	**6**	**10**
0	2.71	52.73 e	154.67 d	4	16 c	45 c
25%	3.11	72.41 d	197.42 c	3	31 b	63 b
50%	3.19	83.64 c	213.18 b	3	35 ab	74 a
75%	3.21	103.45 b	224.34 a	5	41 a	79 a
100%	3.14	119.68 a	227.16 a	4	39 a	75 a
LS	NS	*	*	NS	*	*
LSD		5.67	7.86		6.41	5.93

Flower Count per Plant

The study evaluated the impact of various NPK fertigation treatments on the flower count per plant and the results are presented in Table 2. The flower count per plant varied significantly across the different NPK fertigation treatments. The highest flower counts were observed in the 75% NPK treatment (18 flowers per plant) and the 100% NPK treatment (17 flowers per plant), both of which were statistically similar and significantly higher than the other treatments. The 50% NPK treatment also showed a notable increase in flower count (13 flowers per plant), while the 25% NPK treatment had a moderate increase (10 flowers per plant). The control treatment, with no NPK application, had the lowest flower count (4 flowers per plant).

The Least Significant Difference (LSD) test confirmed the statistical significance of these differences, with an LSD of 2.08 for flower count, indicating that the differences among treatments were significant at the 5% probability level.

Fruit Weight

Fruit weight also exhibited significant differences among the treatments described in Table 2. The 75% NPK treatment resulted in the highest fruit weight (6.43 kg), followed closely by the 100% NPK treatment (6.36 kg). Both treatments significantly outperformed the other fertigation levels. The 50% NPK treatment achieved a fruit weight of 4.01 kg, while the 25% NPK treatment resulted in a fruit weight of 3.23 kg. The control treatment produced the lowest fruit weight (2.78 kg).

The statistical significance of these differences was validated by the Least Significant Difference (LSD) test, which yielded a value of 1.21 for fruit weight. This value indicates that the differences between treatments were significant at the 5% probability level.

Table 2: *Impact of various NPK fertigation treatments on the flower count per plant and fruit weight of watermelon*

Fertigation Treatments	Flower Count per plant	Fruit Weight (Kg)
0	4 d	2.78 c
25%	10 c	3.23 bc
50%	13 b	4.01 b
75%	18 a	6.43 a
100%	17 a	6.36 a
LS	*	*
LSD	2.08	1.21

DISCUSSION

A considerable increase in watermelon growth and yield can be achieved with the application of NPK fertigation, according to the findings of the study. There was a significant rise in the height of the plant as the amount of NPK fertilizer increased, reaching up to 75% of the required dose. The findings of this study are consistent with the findings of Kacha et al. [13] and Aitbayeva et al. [14], who showed that greater fertilizer treatment resulted in improved growth and yield components of watermelon. In addition, Kacha et al. [13] observed that an enhanced nutrient supply to cucumbers results in improved carbon utilization, which in turn leads to the subsequent production of assimilates and other compounds.

At both six and ten weeks after sowing (WAS), the administration of fertilizer resulted in a considerable increase in the quantity of leaves. All of the treatments were much more effective than the control, despite the fact that the differences between the different doses of fertilizer were not statistically significant. According to Ndereyimana et al. [15] and Fernandez et al. [16], who showed increased vine length and leaf number in watermelon with higher nitrogen application, this data lends credence to the conclusions of those researchers.

In addition, the research showed that the use of fertilizer had a favorable impact on the quantity of blooms that were produced by each kind of plant. The increased flower count can be linked to the higher vegetative development that occurred as a result of the increased availability of different nutrients. The findings of Yakimova et al. [17], who indicated that the blossoming of watermelon responds to the application of fertilizer, are in agreement with these findings.

CONCLUSION

According to the findings of the study, the application of NPK fertigation at a dose that is 75% of the prescribed dosage had a substantial impact on the plant's height, the number of leaves, the number of flowers produced by each plant, and the ultimate weight of the watermelon fruit. Taking into consideration these findings, it is suggested that farmers in the area under investigation implement this degree of fertigation in order to increase the profitability of their

watermelon output. In addition to contributing to improved economic outcomes for farmers, this method has the potential to result in increased growth and yields over time.

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