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Performance of nutrient management on morpho-phenological parameters of muskmelon (*Cucumis melo*)

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Abstract
Muskmelon (*Cucumis melo*) is a popular and economically important fruit crop known for its sweet and aromatic flavor. It belongs to the Cucurbitaceae family and is cultivated worldwide in diverse climatic conditions. It is a warm-season crop that requires well-drained soil, adequate sunlight, and optimal temperature for successful growth and fruit development. The study aimed to investigate the effects of different nutrient management strategies on morphological and phenological parameters of muskmelon (*Cucumis melo* L.). A field experiment was conducted using a completely randomized design with eight treatments: T_1 (absolute control), T_2 (RDF-NPK), T_3 (NPK - 50% + 3 Spray of 0:0:50), T_4 (NPK - 50% + 3 Spray of 19:19:19), T_5 (NPK - 50% + 3 Spray of 0:52:34), T_6 (NPK - 50% + 1 Spray of 19:19:19 +1 Spray of 0:52:34, T_7 (NPK - 50% + 2 Spray of 19:19:19, + 1 Spray of 0:0:50) and T_8 (NPK - 50% + 2 Spray of 19:19:19, + 1 Spray of 0:52:34). The results showed that the nutrient management strategies significantly influenced the growth, yield, and quality of muskmelon. T_2 exhibited the highest vine length, chlorophyll content and number of branches, and leaf area index and T_1 exhibited lowest morphological parameters. In phenological parameters T_4 also had positive effects on number of staminate and pistillate flowers. Overall, the findings suggest that incorporating chemical fertilizers along with spray can enhance the growth of muskmelon. These nutrient management strategies can be adopted by farmers to optimize muskmelon production and improve marketable fruit quality. Further research is recommended to explore the long-term effects and economic feasibility of these strategies.

Keywords: *Cucumis melo*, morphology, phenology

Introduction

Muskmelon (*Cucumis melo* L.) is a well-known and significant vegetable crop that was once only grown as a "Desert Crop" in the warmer parts of the world. Uttar Pradesh, Punjab, Rajasthan, and Madhya Pradesh are among the North Indian states where it is well-liked. According to Schaefer *et al*. (2009) [13], the muskmelon (2n=24) is a member of the Cucurbitaceae family, which is also known as the cucurbits. It is now also grown in temperate locations. According to Whitaker and Davis (1962) [17], muskmelons are native to tropical Africa with secondary origins in Central Asia, which includes some regions of Southern Russia, Iran, Afghanistan, and north-western India. Vitamin and mineral content of muskmelons is high. Apart from this for every 100 g edible portion, melon provides 26-41 calory energy, 0.6-1.0 g protein, 5-10 mg calcium, 0.2-0.4 mg iron, 8.17 mg magnesium and 7.39 mg Phosphorous (Howard *et al*., 1962) [5].

The total land area and production of muskmelon in India in 2020–21 were 60.0 (000 hectares) and 1312.00 (000 MT), respectively (NHB 2020–21). The yearly production of muskmelon in Madhya Pradesh is 132 (000 tons). Due to its short lifespan, great production potential, high nutritional content, delicious flavour, and compatibility for cultivation under rain-fed, irrigated, and greenhouse conditions all year long, muskmelons are becoming increasingly popular. Even though muskmelon is the most nutrient-dense fruit in India, it produces less than other fruit vegetable. Beta-carotene is present in the yellow and orange-skinned melons, and muskmelon in particular has a high provitamin A content (4200 IU/100 g). 26 mg of vitamin C are present in every 100 grams of edible melon.

One of the many causes of low productivity is an inadequate source-sink relationship during the fruit development stage, which has an impact on later stages of fruit growth in terms of fruit size and quality due to poor photo assimilate translocation (Singh and Sahare, 2019) [15]. Combining the application of organic and inorganic nutrient sources is necessary for sustainable crop production and better plants due to rising costs, rising demand for chemical fertilizers, and declining soil fertility. The application of low C: N ratio plant residue, on the other hand, has been associated with significant nutrient loss due to leaching and volatilizations. Nitrogen, which affects plant availability, is the element that is most susceptible to changes. According to Petersen *et al*., (1998) [11], these processes in melons include leaching, ammonia volatilization, nitrification, denitrification, immobilization, and mineralization. According to Bhella and Wilcox (1986) [1], nitrogen fertilizers have an effect on the fruit's yield, size, and texture.

Nitrogen (N), phosphorus (P) and potassium (K) are the three major nutrients routinely supplied by both organic and inorganic fertilizers. Adequate nitrogen supply promotes vegetative growth, fruit production, fruit size and yield. Since muskmelon has an unstable growth habit that requires nitrogen input up to and during harvest, total requirements and intakes varies according to plant phenology which are helpful for fertilization. Nitrogen is an essential macronutrient for plant growth and one of the most abundant elements in the Earth's atmosphere and surface. However, its deficiency is one of the most common agricultural nutrition problems worldwide. The reason for the widespread shortage is that most of the nitrogen in the atmosphere and crust is not readily absorbed by plants. Nitrogen affects total soluble solids and potassium absorption in melon.

Phosphorus is a macronutrient that plays an important role in plant reproduction. It can have a significant effect on the yield of grain or fruit. P deficiency is a common issue in the field that results in crop stunting or crop discoloration. One of the most significant sources of phosphorus for crops is soil organic matter. Potassium is second in abundance after nitrogen in plant tissues excluding seeds. Optimum plant tissue K concentrations tend to be between 2% and 5% of the plant’s dry weight. Although potassium does not play a critical role in any major plant structure, it does play a critical regulator role in many of the physiological processes essential for plant development (Pollard and Jones, 1979) [12]

Materials and Methods

The survey was carried out during the Zaid season of 2022 in a polyhouse that is naturally ventilated. The location of the site is at 23012'09.2 north latitude at 79057'31.2 east longitude at 300 m above sea level. The research centre is at Maharajpur, under Department of horticulture, College of Agriculture, Jawaharlal Krishi Vishwa Vidyalaya, Jabalpur (M.P).This experiment was laid on CRD. It was done with 24 plots and the number of plant per plot is 5. There were 8 treatments and 3 replications in this study.

Apply the FYM to the pits before a week of transplanting according to the 20 tonne per hectare guideline. The recommended ratio of fertilizer is 100:60:60 per hectare. At the time of transplant, half nitrogen and half phosphorus and potassium are added as a basal dose. For each treatment, three muskmelon plants were randomly selected for sampling by tagging at different intervals from the onset of the crop growth period to harvest. The parameters was recorded according to the methods given under the following parameters:

1. Morphological Parameters

a. Vine Length (cm)

The measurement of vine length is conducted using a meter scale, commencing from the base to the apical bud (leaf apex) at 30, 45, and 60 days post-transplanting. The vine length at harvest is then quantified in centimeters.

b. Chlorophyll content

The chlorophyll content in the sample was determined using a spadmeter, which provides a direct calculation of the amount of chlorophyll present.

c. Number of branches at final harvest

The aggregate count of branches per plant was tallied and subsequently averaged.

2. Phenological Parameters

a. Days to 1st female flower appearance

The duration between sowing and the emergence of the initial female flower was recorded for five plants chosen at random from each plot, and the mean value was computed.

b. Days to 1st male flower appearance

The duration between sowing and the emergence of the initial male flower on five plants chosen at random from each plot was recorded, and the mean value was computed.

c. Number of female flowers per plant

The number of pistillate flowers per plant was recorded for each of the five selected plants per treatment.

d. Number of male flowers per plant

The total count of staminate flowers/plants was documented from the five designated plants per treatments.

e. Sex ratio

The sex ratio was determined through the division of the total count of staminate flowers by the total count of pistillate flowers.

Results and Discussion

Diverse nutrition management approaches exerted a significant influence on the distinct morphological traits of muskmelon, encompassing vine length (in centimeters), chlorophyll content, and the quantity of branches per vine during the harvest period.

The results of the study indicate that muskmelon vine length is significantly affected by different nutrient strategies at 30, 45, and 60 days after transplanting (Table 1). As muskmelon has an indeterminate growth habit, vine length increases progressively with plant age. Treatment T_2, which involved NPK-50% and three sprays of 19:19:19 at 30, 45, and 60 DAT, resulted in the highest vine length at 30 DAT, while treatment T_1 (Absolute Control) had the shortest vine length (40.80 cm). The maximum vine length was observed was 153.06 cm at 45 DAT and 207.97 cm at 60 DAT in treatments T_2 i.e. NPK - RDF (100%) (100:60:60 kg/ha) and T_4-(NPK-50%) + 3 Spray of 19:19:19 at 30, 45, and 60 DAT), respectively. Treatment T_1 had the minimum vine length of 123.53 cm at 45 DAT and 155.02 cm at 60 DAT. Nitrogen application significantly increased plant height, which could be attributed to improved nutritional conditions in the root zone and plant system. These findings are consistent with previous studies by Singh and Chhonkar (1986) [14] and Jilani *et al*, (2009) [6].

The application of various nutrients had a significant effect on the chlorophyll content at 30, 45, and 60 days after planting (Table 2). The data revealed that at 30 days after planting, treatment T_2 exhibited the highest chlorophyll content (34.42), while treatment T_1 had the lowest chlorophyll content (28.47%). At 45 days after planting, treatment T_2 demonstrated the maximum chlorophyll content (46.92), which was at par with treatment T_4 (45.35) and T_6 (45.15), whereas T_1 exhibited the minimum chlorophyll content (38.70). At 60 days after planting, treatment T_4 exhibited the highest chlorophyll content (58.59), which was at par with treatment T_7 (57.85) and T_8 (56.94), while T_1 exhibited the minimum (44.45) chlorophyll content. It is worth noting that nitrogen plays a crucial role in the synthesis of bio-molecules such as amino acids, nucleic acids, and pigments, and the amount of nitrogen was found to be correlated with chlorophyll content (Kaya *et al.*, 2019) [7].

Additionally, the number of branches is a key morphological feature that contributes to canopy spread. Treatment T_4 (NPK - 50% + 3 Sprays of 19:19:19 at 30, 45, and 60 DAT) exhibited the highest number of branches per vine of muskmelon at final harvest (5.33), while T_1 (Absolute control) exhibited the least (3.35), it is represented in Figure 1. The observed increase in the number of branches can be attributed to the higher levels of nutrients supplied through foliar application of water-soluble fertilizers during the early crop stage, as reported by Narayan *et al.*, (2012) [10]. This practice is known to stimulate the growth of auxiliary buds, resulting in a greater number of branches per vine. Optimal nutrient supply in the root zone is crucial for maximal nutrient and water absorption, leading to enhanced photosynthetic activity, increased cell division, and higher turgor in leaf tissue, all of which contribute to the development of a greater number of branches. These findings are consistent with the studies conducted by Farooq *et al.*, (2009) [3].

The application of NPK fertilizer has been observed to elicit a positive response in muskmelon, as evidenced by a significant increase in vegetative growth and branch count. Given that muskmelon flowers at each branch, a higher number of branches leads to a greater number of male and female flowers. Furthermore, the application of phosphorous has been found to significantly affect the phenological parameters of muskmelon. The initial emergence of the first female flower and male flower was significantly influenced by various nutrient strategies (Table 3). The minimum number of days to the first female flower appearance (38.54) and the first male flower appearance (33.19) were both observed in T_4 (NPK-50 percent + 3 Spray of 19:19:19 at 30,45, and 60 DAT), while the maximum number of days to the first male flower appearance (38.28) and the first female flower appearance (44.21) were both observed in T_1 (Absolute control).Foliar sprays of NPK fertilizers during the reproductive stage have been found to enhance early flowering. An increase in phosphorous levels resulted in a reduction in the number of days to flowering and a lower sex expression ratio. Nitrogen and phosphorus levels positively affected the onset of the first male and female flowers, which is consistent with the findings of Umamaheswarappa *et al.*, (2010) [16].

The effect of nutrient management strategies had a significant effect on the total number of male and female flowers (Table 3). Treatment T_4 (NPK-50 percent + 3 Spray of 19:19:19 at 30, 45, and 60 DAT) exhibited the highest number of total staminate flowers (73.97) and pistillate flowers (15.80), while treatment T_1 had the lowest number of total staminate flowers (40.18) and pistillate flowers (9.30). Throughout the investigation, the sex ratio ranged from 4.31 to 4.98, with the lowest sex ratio observed in treatment T_1, followed by T_5, and the highest sex ratio found in treatment T_6 (Figure 2). The study also revealed a complementary relationship between nitrogen and phosphorus, as an increase in phosphorus levels resulted in an increase in soil available nitrogen. These findings are consistent with previous studies conducted by Bunker *et al.*, (2018) [2].

Table 1: Effect of nutrient management strategies on vine length (cm) of muskmelon at 30, 45, and 60 DAT

Treatment	Treatment Details	Vine length (cm)		
		30 DAT	**45 DAT**	**60 DAT**
T_1	Absolute Control	40.80	123.53	155.02
T_2	NPK - RDF (100%) (100:60:60 kg/ha)	59.36	153.06	189.91
T_3	NPK - 50% +3 Spray of 0:0:50 at 30,45,60 DAT	49.36	133.91	176.37
T_4	NPK - 50% + 3 Spray of 19:19:19 at 30,45,60 DAT	50.92	151.6	207.97
T_5	NPK - 50% + 3 Spray of 0:52:34 at 30,45,60 DAT	50.56	145.73	186.40
T_6	NPK - 50% + 1 Spray of 19:19:19 at 30+1 Spray of 0:52:34 at 45 DAT +1 Spray of 0:0:50 at 60 DAT	52.83	148.42	185.06
T_7	NPK - 50% + 2 Spray of 19:19:19 at 30,45 DAT + 1 Spray of 0:0:50 at 60 DAT	51.06	146.39	202.67
T_8	NPK - 50% + 2 Spray of 19:19:19 at30,45 DAT + 1 Spray of 0:52:34 at 60 DAT	50.06	142.48	198.60
	SE m ±	0.79	0.84	1.54
	C.D. at 5% level	2.35	2.51	4.63

Table 2: Effect of nutrient management strategies on Chlorophyll Content Index (SPAD Value) of muskmelon at 30, 45, and 60 DAT

Treatment	Treatment Details	Chlorophyll content		
		30 DAT	45 DAT	60 DAT
T_1	Absolute Control	28.47	38.70	44.45
T_2	NPK - RDF (100%) (100:60:60 kg/ha)	34.42	46.92	55.32
T_3	NPK - 50% +3 Spray of 0:0:50 at 30,45,60 DAT	30.88	42.38	49.38
T_4	NPK - 50% + 3 Spray of19:19:19 at 30,45,60 DAT	30.47	45.35	58.59
T_5	NPK - 50% + 3 Spray of 0:52:34 at 30,45,60 DAT	31.47	43.27	52.75
T_6	NPK - 50% + 1 Spray of 19:19:19 at 30+1 Spray of 0:52:34 at 45 DAT +1 Spray of 0:0:50 at 60 DAT	31.62	45.15	53.06
T_7	NPK - 50% + 2 Spray of 19:19:19 at 30,45 DAT + 1 Spray of 0:0:50 at 60 DAT	31.55	44.37	57.85
T_8	NPK - 50% + 2 Spray of 19:19:19 at30,45 DAT + 1 Spray of 0:52:34 at 60 DAT	30.38	44.14	56.94
	SE m ±	0.19	0.15	0.12
	C.D. at 5% level	0.57	0.45	0.37

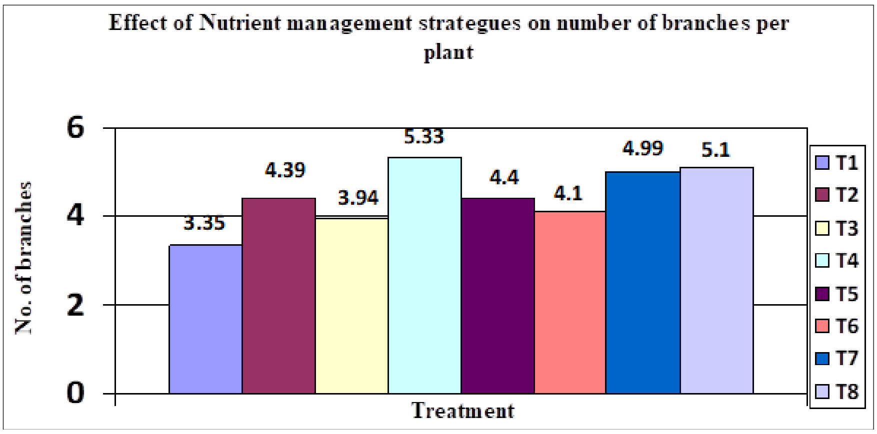

Fig 1: Effect of Nutrient management strategies on number of branches per plant

Table 3: Effect of nutrient management strategies on Days to 1st female flower and male flower appearance, number of female flowers of muskmelon and number of male flowers of muskmelon

Treatment	Treatment Details	Days to first female flower	Days to first male flower	Number of female flower	Number of male flowers
T_1	Absolute Control	44.21	38.28	9.30	40.18
T_2	NPK - RDF (100%) (100:60:60 kg/ha)	40.60	34.16	13.65	64.47
T_3	NPK - 50% +3 Spray of 0:0:50 at 30,45,60 DAT	41.14	34.83	10.47	47.87
T_4	NPK - 50% + 3 Spray of19:19:19 at 30,45,60 DAT	38.54	33.19	15.80	73.97
T_5	NPK - 50% + 3 Spray of 0:52:34 at 30,45,60 DAT	40.24	33.93	12.28	54.11
T_6	NPK - 50% + 1 Spray of 19:19:19 at 30+1 Spray of 0:52:34 at 45 DAT +1 Spray of 0:0:50 at 60 DAT	40.98	34.38	11.80	58.68
T_7	NPK - 50% + 2 Spray of 19:19:19 at 30,45 DAT + 1 Spray of 0:0:50 at 60 DAT	38.95	33.91	14.71	68.07
T_8	NPK - 50% + 2 Spray of 19:19:19 at30,45 DAT + 1 Spray of 0:52:34 at 60 DAT	39.24	33.66	14.42	67.33
	SE m ±	0.03	0.05	0.28	0.93
	C.D. at 5% level	0.10	0.15	0.85	2.77

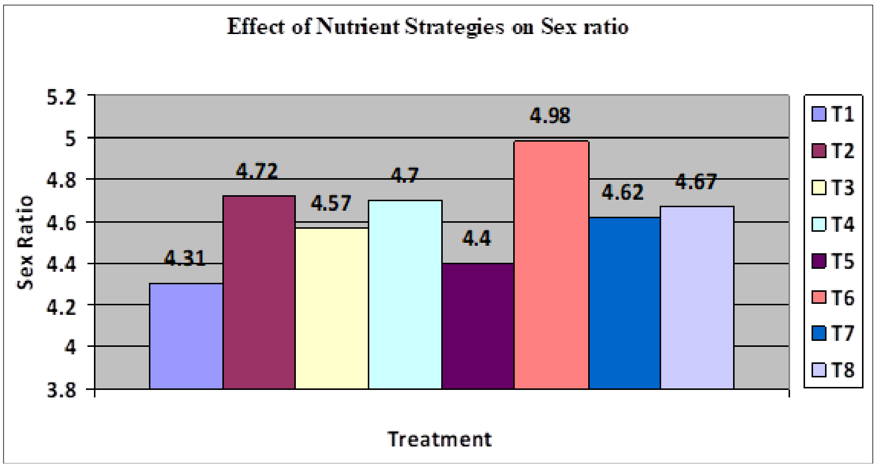

Fig 2: Effect of Nutrient strategies on sex ratio

Conclusion

It can be concluded that the morphological and phenological parameters are strongly affected by nutrient management strategies. In morphological parameter T_2 (NPK - RDF (100%) (100:60:60 kg/ha) had the longest vines, maximum chlorophyll content, more branches, and highest leaf area index. By phenological criteria T_4 (NPK - 50% + 3 Spray of 19:19:19 at 30, 45, 60 DAT) had an advantageous effect on the quantity of staminate and pistillate flowers. Overall, the outcomes suggest that using spray and chemical fertilizers together can promote muskmelon morphological and phenological characters. Farmers can implement these nutrient management techniques to increase the quality of marketable fruit and maximize muskmelon yield.

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