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Effect of Potassium Fertigation Levels on the Yield of Jalapeno pepper Grown in Red Bole Soil under Polyhouse Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment conducted at Instructional Farm Polyhouse, Department of Soil Science, Dr. Sharadchandra Pawar College of Agriculture, Baramati. The experiment was laid out in Randomized Block Design (RBD) with four replications. The treatments were five, viz., T_1- Control,

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T_2- Recommended dose of fertilizer, T_3- Recommended dose of nitrogen and phosphorus (RDNP) + 125% Recommended dose of potassium (RDK), T_4- Recommended dose of nitrogen and phosphorus (RDNP) + 150% Recommended dose of potassium (RDK) and T_5- Recommended dose of nitrogen and phosphorus (RDNP) + 175% Recommended dose of potassium (RDK). Data were taken on yield contributing characters and yield and the collected data were statistically analyzed for evaluation of the treatment effects. The yield contributing characters like fruit length (7.10 cm), fruit diameter (2.51 cm), no. of fruits per plant (28.19) and weight of fruit (20.56 gm) was obtained highest in treatment T_5 i.e. RDNP + 175% RDK. The greatest fruit yield per hectare was obtained in T_5 treatment (25.22 t/ha). The study revealed that, application of RDNP+ 175% RDK by fertigation from 10 DAT to 60 DAT was found to be optimum for growing of Jalapeno pepper in red bole soil under polyhouse condition.

Keywords: Jalapeno pepper; potassium; fertigation; length; diameter; weight; no. of fruits; yield.

1. INTRODUCTION

In many nations across the world chilli pepper (*Capsicum annuum* L.) is now a valuable spice and cash crop making it the third most important crop in the Solanaceae family and was Portuguese introduced in 16th century in India. Chilli originated in south and central America. Due to its pungent taste, lustrous green fruits and availability of hot chilli (*Capsicum annuum* L. Solanaceae, 2n = 24) is one of the most preferred spice or taste enhances in the world [1]. Chilli peppers (*Capsicum annuum*) are not just hot flavored fruits of capsicum pepper plants but also good source of vitamins, minerals and antioxidants and most commonly used as a fresh or dried spice. Green chilli fruits provide the following nutritional values per 100 grams: 111 mg vitamin C, 454 I.U. of vitamin A, 0.91% mineral matter and 6.7% fiber. Indian chillies are widely recognized as one of the spiciest vegetables across the globe having high SHU units and are popular among the good enthusiasts. Chilli cultivation is taken majority in tropical and subtropical climatic condition. Around 25 species in the genus capsicum have been identified but only five are domesticated and grown *C. annuum* L*, C. chinense, C. frutescens* L*, C. baccatum* L and *C. pubescens* [2]. Chilli cultivation is widespread globally, covering an area of about 1.776 million hectares. This extensive cultivation results in a total production of approximately 7.182 million tons of chilli peppers. India is currently the world's largest producer and exporter of chilli peppers. In India, Andhra Pradesh is the leading state in chilli cultivation. It has the maximum area dedicated to growing chillies, covering about 131.3 thousand hectares, which accounts for approximately 16.94% of the total chilli cultivation area in the country.

Jalapeno chilli (*Capsicum annum*) literally meaning from Jalapa got its unique name from the Spanish city which is the capital of Veracruz, a Mexican state where this pepper was first cultivated. Scientific name Jalapeno is *Capsicum annum* which is a species of the plant genus capsicum. Jalapeno grow in soil that has a pH of 4.5 to 7. The hotness of Jalapeno peppers will clear sinuses and help to relieve symptoms of colds such as fever and sore throats. The seeds are found in the center of a Jalapeno pepper and are surrounded by a membrane that contains most of the capsaicin in Jalapeno which makes it the most pungent part of the pepper. Potassium has the role in increasing the pigment of the chilli and also affects the pungency. Jalapeno peppers are rich source of potassium. Jalapeno contains Iron, magnesium, manganese, phosphorus and copper in trace amounts. Potassium plays a pivotal role and facilitates the production of photosynthates and their transport to storage organs of the plant such as fruits in Jalapeno chilli enhancing their conversion into starch, protein, vitamins and oil. While in Jalapeno chilli deficiency of potassium may lead to being arrested rate of photosynthesis and the rate of translocation and enzyme systems. Potassium being the key nutrient in fertilizers for chilli cultivation as it ensures healthy plant, lustrous growth and faster development. It has an impact on several fruit characteristics such as shape, flavor, color and size.

Abayomi et al. [3] state that soil been a living entity that provides all essential nutrients needed for growth and development of any crop has reached its declining stage due to various factors like soil pollution, nutrient exploitation or nutrient leaching in soil which makes at necessary to incorporate vital amendment that can enhance its health. The nutrient has been established between the crop and the soil as the soil is no more able to completely provide the nutrient demand of the crop. Plant nutrients include K is most important nutrients contributing 6% of plant dry weight [4]. While potassium is not a structural component of organic molecules like carbon, hydrogen and oxygen it is certainly a critical element for the proper functioning of living organisms including plants.

2. MATERIALS AND METHODS

2.1 Geographical Location and Experimental Site

Baramati city comes under the Pune district of Maharashtra state. It is situated in south east zone at the latitude 18.14 ^{0} N and longitude 74.52 ^{0} E. The elevation is 563 m above mean sea level. The Instructional farm situated 4 km away from Malegaon village and about 6.8 km away from Baramati tehsil place. The field experiment was conducted at the Instructional farm, Polyhouse, Dr. Sharadchandra Pawar College of Agriculture, Baramati.

2.2 Design of Experiment

The field experiment was conducted in Randomized Block Design (RBD) with 4 replications and 5 treatments in each replication.

2.3 Treatment Details

The experimental details of treatment, which were comprised 5 treatments are presented in Table 1.

Table 1. Treatment details

Tr. No.	Treatments
T_1	Control
T_2	RDF – (100:50:50) (N, P_2O_5, K_2O kg ha^{-1})
T_3	RDNP + 125% RDK
T_4	RDNP + 150% RDK
T_5	RDNP + 175% RDK

2.4 Transplanting

All the beds were saturated by providing sufficient quantity of water through drip system before transplanting. The four week old healthy and uniform chilli seedlings were transplanted at the spacing of 90 cm x 45 cm on the raised beds. The roots of seedling along with coco peat were placed in soil and slightly pressed for easy establishment of seedling. Placement of plant was zigzag. Each treatment was having twenty-one plants with four replications.

2.5 Fertigation

Drip irrigation system was installed for application of water and fertilizer. Fertigation was done through water soluble fertilizers through soil in control throughout the cropping period. water soluble fertilizers were applied at an interval of 10, 30, 45 and 60 days after transplanting.

2.6 Cultural Practices

2.6.1 Weeding and irrigation

Manual weeding was done whenever weeds were noticed to keep the plots clean. Drip irrigation was resorted for irrigating the plot frequently to maintain the optimum moisture levels in the soil. All the plant protection measures were taken to control pests and diseases as and when necessary, as per package of practice.

2.6.2 Staking

The plants were staked with the help of jute thread and tied to a barbed wire 30 days after transplanting to prevent lodging of plants.

2.7 Details of Observation

Five plants were selected in each replication as observational plants to record the data on defined characters in research trial.

2.7.1 Yield contributing characters

2.7.1.1 Fruit length (cm)

Five fruits were selected to determine the fruit length. Length from base to the tip of the fruit measured using metric scale then averaged and expressed in centimeters as length of the fruit.

2.7.1.2 Fruit diameter (cm)

Horizontal diameter of harvested fruit (cm) was recorded at the middle portion of 5 randomly selected fruits from each plot with the digital Vernier Calliper in centimeter and then their average was taken as the diameter of the fruits.

2.7.1.3 Number of fruits plant^{-1}

Total fruit number was counted from 5 selected plants from 1st to last harvest and average number was calculated as number of fruits per plant.

2.7.1.4 Weight of fruit (g)

Tagged plants from each treatment were selected and harvest the mature green fruits. The average of harvested tagged plant fruit weight was measured with a digital weighing machine and expressed in gram.

2.7.1.5 Fruit yield per plant (g)

The weight of fruits per plant harvested from randomly tagged five plants from each treatment and each replication was noted down at each picking. The total weight of fruits harvested in each picking was computed, averaged and expressed in weight per plant in grams.

2.7.1.6 Fruit yield per plot (kg)

The weight of fruits harvested from each picking was recorded from each plot (including the tagged plants) and total yield per plot was estimated by adding the yield of all the harvest and expressed in kilograms per plot.

2.7.1.7 Fruit yield per hectare (t ha^{-1})

Total yield per plot was calculated from total yield obtained per plant and then plot yield was converted into yield per hectare.

$$\text{Yield per hectare (t)} = \frac{\text{Yield per plot (kg)}}{\text{Plot area}} \times \frac{10000}{1000}$$

3. RESULTS

3.1 Fruit Length

The length of fruits is a critical parameter influencing marketability and consumer preference. The data presented in Table 2 and Fig. 1 shows the variation in fruit length under different levels of potassium fertigation. The maximum fruit length (7.10 cm) was observed in T_5 treatment (RDNP + 175 % RDK) and found to be at par with treatment T_4 i.e. RDNP + 150% RDK noted (7.04 cm) fruit length. The control treatment (T_1) showed the lowest fruit length at (5.45 cm). Potassium is crucial for transporting nutrients and sugars from leaves to fruit, which is essential for fruit development and growth, including fruit length. Islam et al. [5] discovered that optimal potassium levels influenced plant nutrient absorption capability, encouraging cell division, hormonal and enzymatic activities and resulting in longer fruit length. Similar finding also reported by Malik et al. [6] Kar et al. [7], Samsangheile et al. [8] and Ahmed et al. [9].

3.2 Fruit Diameter

The findings on the impact of potassium fertigation on fruit diameter has been presented in Table 3 and graphically depicted in Fig. 2 Comparing the effects of levels of K fertigation, the maximum diameter (2.51cm) was observed in the fruits produced by the crop fertilized with RDNP + 175% RDK through fertigation (T_5) which was significantly superior to other treatment and at par with treatment T_4 (2.48 cm) by RDNP + 150% RDK). Significantly lowest fruit diameter was recorded (2.02 cm) in T_1 treatment. Babanjeet et al. [10] found that N and K plays important role to increase fruit size. Fruit development depends on potassium, as seen by the steady rise in fruit diameter with increasing potassium levels. Potassium has been shown to improve a variety of physiological processes, including photosynthesis, enzyme activation and water and nutrient transport, all of which contribute to greater fruit sizes. According to Islam et al. [5] fruit diameter was significantly impacted by various potassium doses. Similar result revealed that Sarker et al. [11] and Samsangheile et al. [8].

Table 2. Effect of potassium fertigation levels on the fruit length of Jalapeno pepper

Tr. no.	Treatment	Fruit Length (cm)
T_1	Control	5.45
T_2	RDF – (100:50:50) (N: P_2O_5: K_2O kg ha^{-1})	6.14
T_3	RDNP + 125% RDK	6.52
T_4	RDNP + 150% RDK	7.04
T_5	RDNP + 175% RDK	7.10
	S. Em ±	0.10
	CD (P= 0.05)	0.32

Table 3. Effect of potassium fertigation levels on the fruit diameter of Jalapeno pepper

Tr. no.	Treatment	Fruit diameter (cm)
T_1	Control	2.02
T_2	RDF – (100:50:50) (N: P_2O_5: K_2O kg ha^{-1})	2.23
T_3	RDNP + 125% RDK	2.32
T_4	RDNP + 150% RDK	2.48
T_5	RDNP + 175% RDK	2.51
	S. Em ±	0.03
	CD (P= 0.05)	0.10

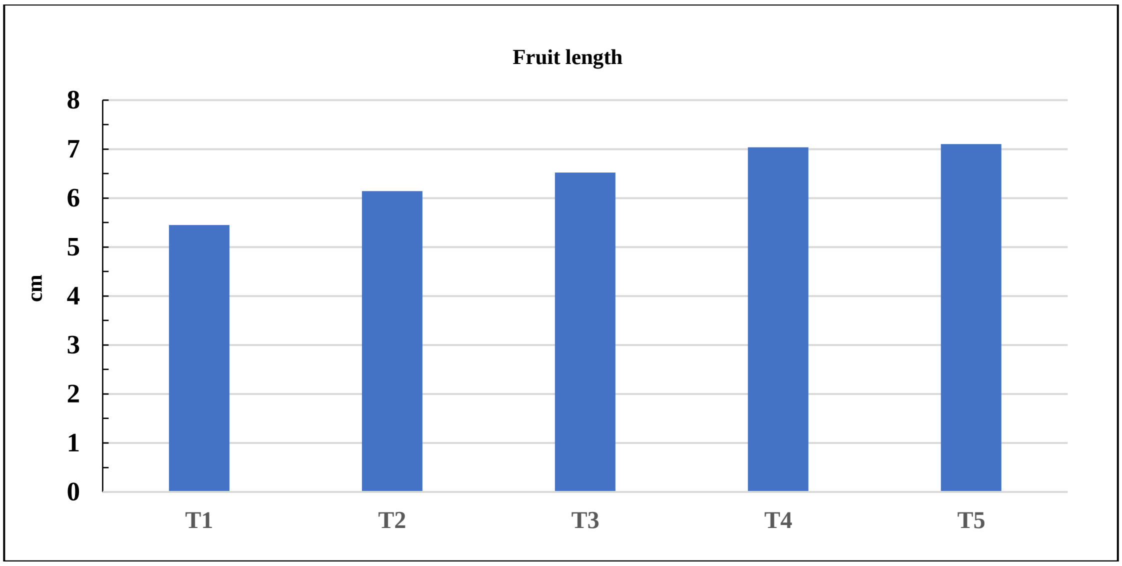

Fig. 1. Effect of potassium fertigation levels on the fruit length of Jalapeno pepper

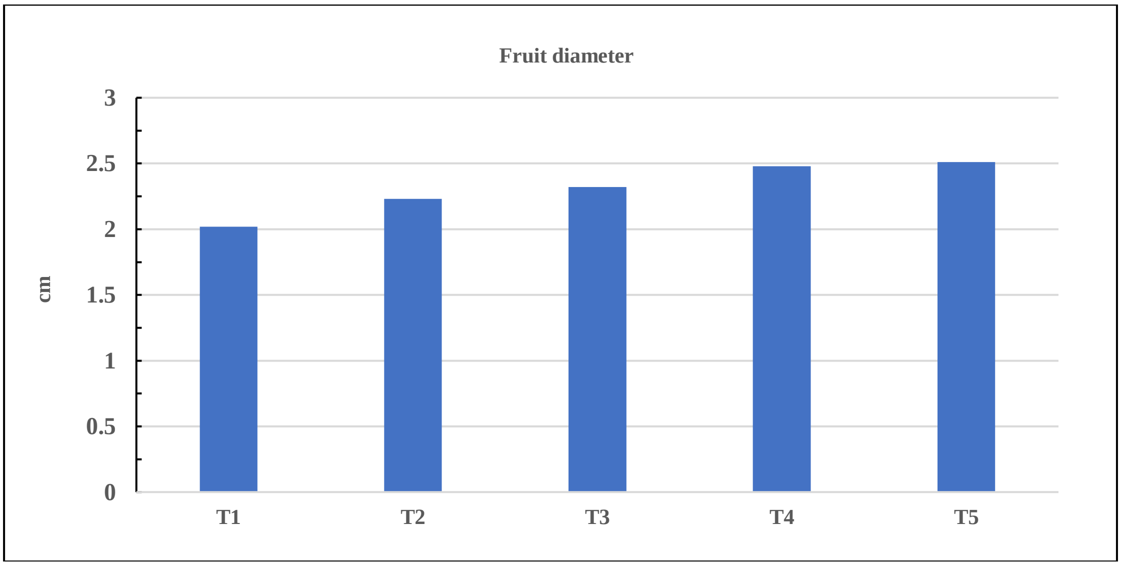

Fig. 2. Effect of potassium fertigation levels on the fruit diameter of Jalapeno pepper

3.3 Number of Fruits Plant^{-1}

Data on no. of fruits of Jalapeno pepper are mentioned in Table 4 and Fig. 3 The maximum no. of fruits per plant (28.19) was noticed at treatment T_5- RDNP+175% RDK which was superior than all the treatment and statistically at par with treatment T_4 – RDNP+150 % RDK

(26.43). The lowest no. of fruits plant^{-1} (15.12) was obtained in control (T_1) which was significantly lowest than other treatments. Potassium increases the osmoregulation, which promotes photosynthesis and makes it easier for carbon dioxide to enter the cell. Therefore, the production of more metabolites results in a greater number of fruit set and fruits. Ananthi et al. [12] concluded that hormonal balance induced in the plant system by the sulphur provided through SOP, which resulted in reduced less flower drop and increased fruit set. Different potassium levels significantly influenced the quantity of fruits produced by a plant, according to research by Islam et al. [5]. Similar finding also evaluated by Bhuvaneswari et al. [13], Ahmed et al. [9] and Slameto et al. [14].

3.4 Weight of Fruit

The data on fruit weight of Jalapeno pepper showed significant differences with the use of varying levels of potassium fertigation are depicted in Table 5 and Fig. 4 Among the fertigation levels, treatment T_5- RDNP + 175 % RDK (20.56 g) recorded significantly maximum fruit weight among all the treatment which was found to be at par with T_4 i.e. RDNP + 150 % RDK (19.54 g). Significantly the lowest fruit weight (13.60 g) was recorded in control treatment. Potassium activated various kinds of metabolic enzymes, including those that regulate fruit development and maturation. This enzymatic activity contributed to the fruit's overall development and weight. Navitha et al. [15] demonstrated that graded levels of potassium play a significant part in photosynthate transfer and fruit development, considerably improved fruit weight. Similar result was found that Hamdani et al. [16] and Ahmed et al. [9].

3.5 Fruit Yield Per Hectare

The data recorded on fruit yield are demonstrated in Table 6 and Fig. 5. The fruit yield was significantly influenced by the graded levels of potassium fertigation.

Table 4. Effect of potassium fertigation levels on the no. of fruits plant -1 of Jalapeno pepper

Tr. no.	Treatment	no. of fruits plant $^{-1}$
T_1	Control	15.12
T_2	RDF – (100:50:50) (N: P_2O_5: K_2O kg ha^{-1})	18.02
T_3	RDNP + 125% RDK	22.37
T_4	RDNP + 150% RDK	26.43
T_5	RDNP + 175% RDK	28.19
	S. Em ±	0.93
	CD (P= 0.05)	2.87

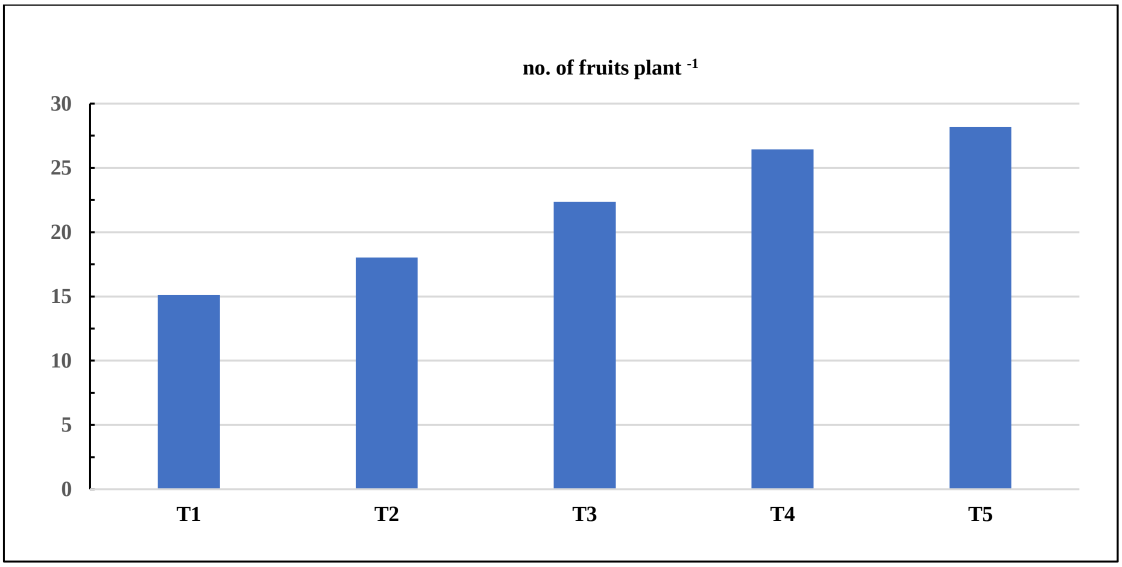

Fig. 3. Effect of potassium fertigation levels on the no. of fruits plant $^{-1}$ of Jalapeno pepper

Table 5. Effect of potassium fertigation levels on the weight of fruit of Jalapeno pepper

Tr. no.	Treatment	Weight of fruit (g)
T_1	Control	13.60
T_2	RDF – (100:50:50) (N: P_2O_5: K_2O kg ha^{-1})	16.70
T_3	RDNP + 125% RDK	17.01
T_4	RDNP + 150% RDK	19.54
T_5	RDNP + 175% RDK	20.56
	S. Em ±	0.76
	CD (P= 0.05)	2.35

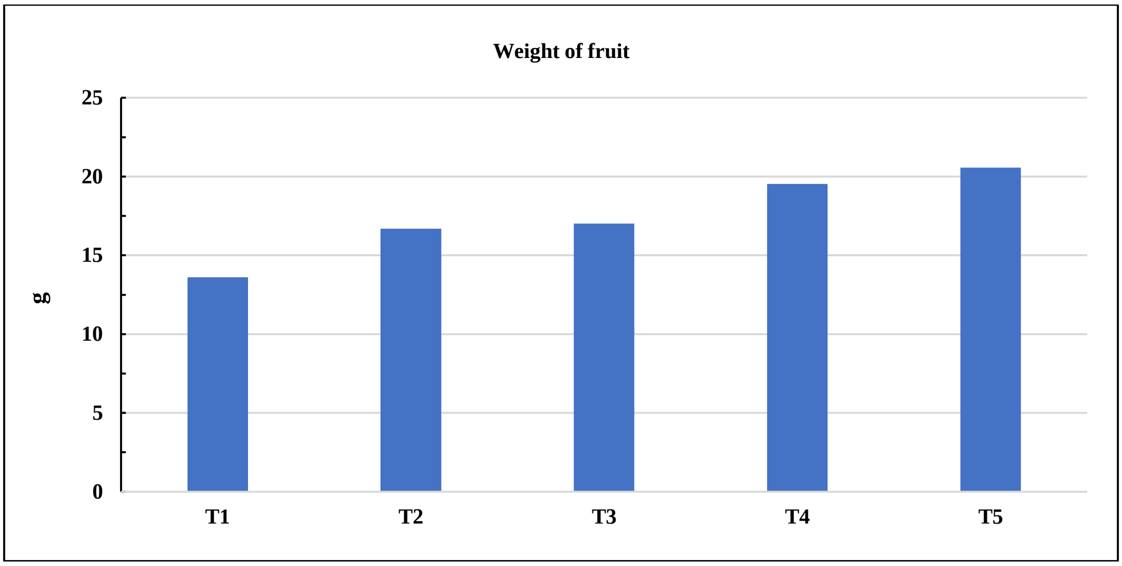

Fig. 4. Effect of potassium fertigation levels on the weight of fruit of Jalapeno pepper

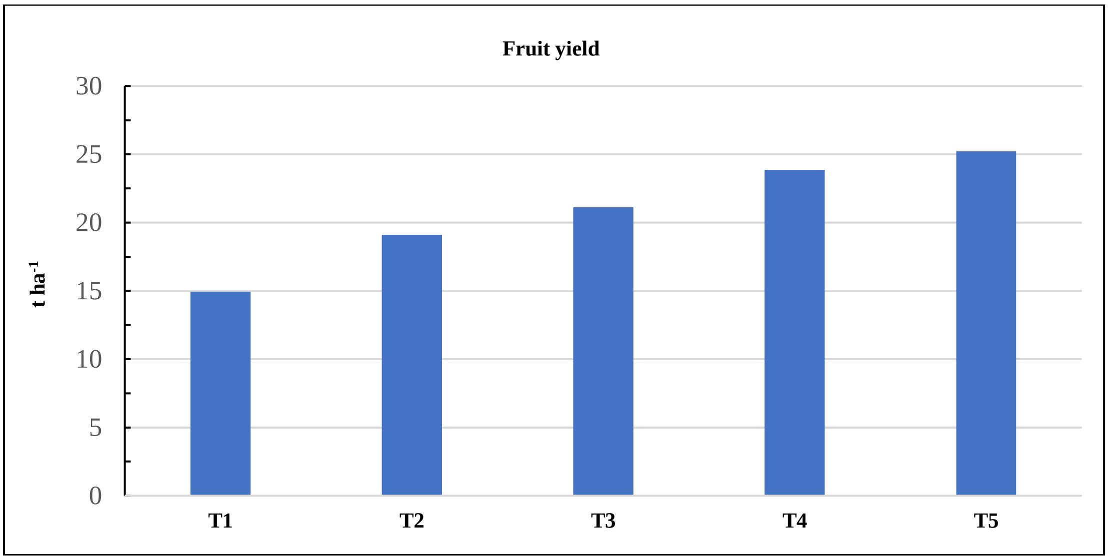

Fig. 5. Effect of potassium fertigation levels on the fruit yield ton per hectare of Jalapeno pepper

The data has indicated that fruit yield was significantly maximum in T_5 treatment (RDNP + 175% RDK) with (25.22 t ha^{-1}) found to be superior than other treatment which was at par with treatment T_4- RDNP + 150 % RDK recorded (23.87 t ha^{-1}). While, the lowest fruit yield (14.94 t ha^{-1}) was noticed in the treatment (T_1) control. Neelima et al. [17] revealed that continuous

Table 6. Effect of potassium fertigation levels on the fruit yield ton per hectare of Jalapeno pepper

Tr. no.	Treatment	Fruit yield (t/ha)
T_1	Control	14.94
T_2	RDF – (100:50:50) (N: P_2O_5: K_2O kg ha^{-1})	19.11
T_3	RDNP + 125% RDK	21.13
T_4	RDNP + 150% RDK	23.87
T_5	RDNP + 175% RDK	25.22
	S. Em ±	0.78
	CD (P= 0.05)	2.40

nutrient delivery to the crop root zone promotes growth and development by increasing the activity of metabolism in the plant system. Comparable outcome was also reported by Khan et al*.* [18] Mishra et al*.* [19] Woldemariam et al*.* [20] Ahmed et al. [9] and Khaskelia et al*.* [21].

4. CONCLUSION

Based on the outcomes of the present study, revealed that the application of RDNP + 175% RDK (T_5) treatment achieved the highest fruit length, fruit diameter, fruit weight, no. of fruits $plant^{-1}$ and fruit yield ha^{-1}. Therefore, it could be recommended for advantageous Jalapeno pepper production.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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