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Effect of Irrigation Regimes and Nitrogenous Fertilization on Nitrogen Uptake in Tomato

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ABSTRACT

Background: Nitrogen plays a crucial role in growth cycling and development, thereby influencing the plant growth and productivity. Understanding the interactions between nitrogen uptake with different irrigation regimes and source of nitrogen fertilizers could provide a valuable insight for optimizing tomato production. Hence, this study aimed to investigate the effect of nitrogen uptake on tomato production under different nitrogen fertilizer and irrigation regimes.

Methods: The field experiment was carried out during 2022-2023 in split plot design with two irrigation main plots treatments and five different nitrogen fertilizer subplot treatments. Irrigation treatments consisted of 0.8 and 1.0 IW/CPE ratio and the nitrogen fertilizer treatments comprised of conventional urea, neem coated urea, ammonium sulfate, nano-urea and vermicompost.

Result: A higher nitrogen uptake was observed in the treatment combination of 0.8 and 1.0 IW/CPE ratio with vermicompost and nano-urea fertilizer applied treatments. Additionally, optimal irrigation conditions positively influenced nitrogen uptake and subsequent tomato fruit yield. This finding emphasizes the importance of considering nitrogen uptake when determining nitrogen fertilizer rates and irrigation management strategies for tomato production.

Key words: Fruit yield, IW/CPE ratio of irrigation, Nitrogen fertilizer, Nitrogen uptake, Tomato.

INTRODUCTION

Tomato cultivation plays a vital role in global agriculture, serving as significant source of essential nutrients and contributing to food security. In order to maximize the tomato production and quality, various factors must be considered including nutrient uptake and irrigation management (Del Amor *et al.,* 2001). Among the essential nutrients required by tomato plants, nitrogen (N), phosphorus (P) and potassium (K) play a crucial role in their growth and development. The efficient uptake of N, P and K by tomato plants is influenced by several factors, including the availability and concentration of these nutrients in the soil, the timing and method of application, as well as the irrigation regime employed. Proper management of these factors can significantly impact tomato yield, fruit quality, and overall plant health (Wang and Xing, 2017).

Nitrogen is an essential component of amino acids, proteins and chlorophyll which are the crucial for plant growth and photosynthesis (Ohyama, 2010). Adequate nitrogen availability promotes vigorous vegetative growth, while insufficient nitrogen levels can result in reduced yields and lower fruit quality. In addition to nitrogen availability, the irrigation regime could significantly influence the nitrogen uptake in tomato plants. The timing, rate and source of nitrogen fertilizers affects the plant growth, nutrient absorption and overall crop productivity. Understanding the effects of irrigation regimes on nitrogen utilization can lead to improved nutrient management strategies, reduced environmental impacts and enhanced tomato production.

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This study aims to explore the interactive relationship between plant nitrogen uptake with various irrigation regimes and nitrogen fertilizer source in tomato production. By investigating the interplay between these factors, we can gain valuable insights into optimizing irrigation and nutrient management practices, enhancing crop productivity and minimizing environmental concerns.

MATERIALS AND METHODS

To study the effects of different nitrogen fertilizers and irrigation regimes on nitrogen uptake of tomato, an experiment was conducted at eastern block farm, Department of Agronomy in Tamil Nadu Agricultural

University, Coimbatore. The farm is located in Western agro-climatic zone of Tamil Nadu located at 11° North latitude and 77° East longitude, at an elevation of 426.72 meters above mean sea level (MSL). The mean annual precipitation of 746.5 mm was recorded in 47 rainy days. The mean daily maximum temperature is 31.8°C and mean minimum temperature is 21.4°C. The experiment was carried out for two season between July 2022 and March 2023. The soil of the experiment was calcareous, with a clay loam texture. The characteristics of the soil before planting were: pH, 8.2; electrical conductivity (EC), 1.23 dS m^{-1}; organic matter, 21.7 g kg^{-1}; total N, 1.93 g kg^{-1}. There were two irrigation regimes (0.8 and 1.0 IW/CPE) and five nitrogen fertilizer (Urea, neem coated urea, Ammonium sulfate, Nano-urea and vermicompost).

The field experiment was carried out in a split plot design having two main plots and five subplots. The main plot treatments were comprised of irrigation regime such as 0.8 and 1.0 IW/CPE and subplot having different fertilizers sources as conventional urea, neem coated urea, ammonium sulfate, nano-urea and vermicompost. All the treatments were replicated thrice in experimental field.

In the experimental site, uniform seedlings were transplanted to each plot. Pre-germinated 25 days old seedlings were transplanted in the field in the spacing of 60×45 cm. Gap filling for all the plots was done on 7th DAT to maintain a uniform plant population in the field. All plots were irrigated 40 mm of water when it reached 0.8 IW/CPE ratio in I_1 and 1.0 IW/CPE ratio in I_2 plot. Recommended fertilizer dose (200:250:250 kg NPK ha^{-1}) was applied to all the treatment plots. Nitrogen fertilizer given as urea, neem coated urea, ammonium sulfate, nano-urea and vermicompost. Nano-urea was given as liquid fertilizer as 500 ml was equated with 45 kg of urea. Nitrogen fertilizer was applied at basal, 15 DAT, 30 DAT and 45 DAT. Hand weeding was done to manage the weeds and pesticides were not applied in the experimental plots. As per HCPG (2019) all other cultivation practices were carried out. The total plot size of the experimental field was 4×5 m. Five plant samples from each plot were collected and dried then stored at 2°C for plant nitrogen uptake analysis. From the digested plant solution, nitrogen content was estimated using Microkjeldahl method described by Humphries (1956) in Kjeldahl Automatic Nitrogen Distillation System (Model: Classic DX VA) and ex pressed in gram/plant.

RESULTS AND DISCUSSION

Nitrogen uptake

Nitrogen uptake was significantly differed with different irrigation regimes and different fertilizer sources. Based on the irrigation regimes, I_1 (Irrigation at 0.8 IW/CPE ratio) was performed better than I_2 (Irrigation at 1.0 IW/CPE ratio). This is mainly due to availability and uptake of nitrate in tomato under the optimum level of irrigation regime. Similar findings were reported as availability of nitrate was varied with different irrigation level in peanut by Saudy *et al*. (2020) and El-Metwally *et al*. (2022) in onion. Excessive application of irrigation leads to leaching of nutrients in rooting zone (Maynard and Hochmuth, 2007) and also decreased the efficiency of nutrient uptake (El-Metwally *et al*., 2021).

Effect of nitrogen uptake (g/plant) on different irrigation regimes and nitrogen fertilizer in tomato production were presented in Table 1 during both the seasons. Among the different sources of nitrogen fertilizer, vermicompost and nano-urea applied treatments were performed well in terms of nitrogen uptake while a lower nitrogen uptake was observed in neem coated urea fertilizer applied treatments. During *Kharif* 2022 season, at vegetative stage, in regarding with main plot I_1, vermicompost application was documented

Table 1: Effect of nitrogen uptake (g/plant) on different irrigation regimes and nitrogen fertilizer in tomato production.

Treatments		*Kharif* season						Late *rabi* season					
		Vegetative stage		Flowering stage		Ripening stage		Vegetative stage		Flowering stage		Ripening stage	
I_1	N_1	0.153		0.399		1.406		0.185		0.365		1.003	
	N_2	0.162		0.568		1.568		0.282		0.428		1.468	
	N_3	0.159		0.421		1.425		0.206		0.386		1.124	
	N_4	0.178		0.659		1.899		0.312		0.460		1.835	
	N_5	0.196		0.712		1.956		0.345		0.482		1.991	
I_2	N_1	0.154		0.401		1.412		0.172		0.348		1.108	
	N_2	0.166		0.545		1.612		0.264		0.431		1.442	
	N_3	0.158		0.465		1.487		0.218		0.366		1.248	
	N_4	0.172		0.683		1.867		0.326		0.462		1.908	
	N_5	0.194		0.745		1.938		0.361		0.491		1.957	
		SEd	CD (0.01)	SEd	CD (0.01)	SEd	CD (0.01)	SEd	CD (0.01)	SEd	CD (0.01)	SEd	CD (0.01)
I		0.001	0.014	0.007	0.076	0.012	0.125	0.003	0.033	0.004	0.043	0.019	0.192
N		0.002	0.006	0.008	0.023	0.021	0.059	0.005	0.013	0.008	0.023	0.020	0.059
I × N		0.003	0.014	0.013	0.069	0.029	0.123	0.007	0.032	0.011	0.044	0.032	0.175

I_1- Irrigation at 0.8 IW/CPE ratio; I_2- Irrigation at 1.0 IW/CPE ratio; N_1- Conventional urea; N_2- Neem coated urea; N_3- Ammonium sulfate, N_4- Nano-urea; N_5- Vermicompost.

a higher nitrogen uptake (0.196 g/plant) value followed by nano urea application (0.659 g/plant). The treatment with application of ammonium sulfate was recorded a lower nitrogen uptake (0.153 g/plant) than all other treatments. Likewise, in irrigation at I_2 regimes, application of vermicompost was recorded a higher nitrogen uptake (0.194 g/plant) value than all other treatments but it was on par with nano-urea applied treatment (0.172 g/plant). Application of ammonium sulfate was observed a lower nitrogen uptake than others and it was on par with conventional urea received plot. Similar results were obtained at both flowering (0.712 and 0.745 g/plant) and ripening stage (1.956 and 1.938 g/plant) from the vermicompost treatment in the I_1 and I_2 irrigation regimes, respectively. Among the treatment combinations, Irrigation at 0.8 IW/CPE ratio with vermicompost treatment recorded a higher nitrogen uptake followed by Irrigation at 1.0 IW/CPE ratio with vermicompost irrespective with growth stages and seasons. While, I_1N_3 and I_2N_3 were recorded a lower nitrogen uptake in the both flowering and ripening stage. The same trend of results was observed during the late *Rabi* 2022-23 season. The results in the present study were agreed with observed with plant amended of tomato crop (Masood 2020).

A higher nitrogen uptake in the vermicompost applied treatments might be due to it enhances the growth of N fixing microorganisms in the soil rhizosphere region resulting in improving the nitrogen availability to the tomato plants. This is also in line with Singh and Varshney (2013) documented that application of vermicompost improves the availability of NH_4^+ N and NO_3^- N in the soil. Similar results were obtained in dragon by Heydarzadeh *et al*. (2023) reported that vermicompost was an alternative to chemical fertilizers in terms of quality of produce. As an organic fertilizer, vermicompost improves soil fertility by increasing soil water holding capacity and soil aggregates (Abul-Soud *et al*., 2014). It was rich in nutrients such as N, P, K, Ca and Mg, which are easily absorbed by plants (Hashem and Hassan, 2016). Ramesh (2018) also reported that a higher rice grain yield was obtained in vermicompost applied treatment. The next best treatment was nano urea which has slow release of nitrogen leads to increase nitrogen use efficiency under optimum irrigation level by the tomato crop. According to Baruah and Dutta (2009), nano-formulations of nitrogen fertilizer could decrease N losses due to leaching, emissions and soil microbial immobilization. This result was confirmed with Kottegoda *et al*. (2011) revealed that nitrogen at the nano form has slow-release characteristics. This is also in line with Sharaf-Eldin *et al*. (2022) documented that 75% fertigation with 25% foliar application of nano-nitrogen fertilizer enhanced the absorption of nitrogen, nitrogen use efficiency and apparent recovery efficiency in lettuce.

Fruit yield of tomato on different irrigation regimes and nitrogen fertilizer

Fruit yield of tomato were calculated from harvested field, weighed and presented in Fig 1. The highest fruit yield of was recorded in 0.8 IW/CPE ratio. The maximum yield of 82593 and 86520 kg ha^{-1} was observed in the treatment combination of 0.8 IW/CPE irrigation with neem coated urea fertilizer application (I_1N_2) followed by 1.0 IW/CPE irrigation with neem coated urea fertilizer application (I_2N_2) about 49549 and 51741 kg ha^{-1} during *Kharif* and *Rabi* season, respectively. The ammonium sulfate fertilizer applied treatment was recorded a lower fruit yield of 33284 and 38990 kg ha^{-1} during *Kharif* and *Rabi* season, respectively.

The ammonium sulfate fertilizer applied treatments was recorded a lower fruit yield of 24745 and 21181 kg ha^{-1} during *Kharif* and *Rabi* season, respectively. The correlation was calculated between fruit yield and nitrogen uptake to know their relationship. The correlation value shows that it was significantly positive (0.290* and 0.449* during *Kharif* and *Rabi* season, respectively) correlated between nitrogen uptakes in all the stages with fruit yield. Irrigation practices and various nitrogen levels significantly influenced the production and yield contributing parameters in wheat (Shirazi *et al*., 2014). According to Abd–Elrahman *et al*.

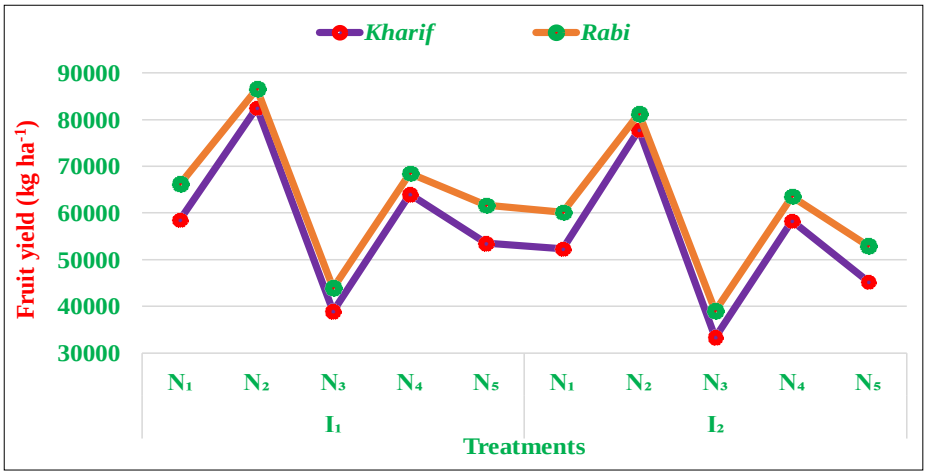

Fig 1: Fruit yield of tomato on different irrigation regimes and nitrogen fertilizer.

(2022) documented that application of irrigation at 80% rather than 100% of crop evapotranspiration was recorded a higher lettuce productivity in organically fertilized lettuce (especially with vermicompost) and also observed a lower NO_3^- content in leaf.

CONCLUSION

This study highlighted the significance of nitrogen uptake in tomato production and its interaction with nitrogen fertilizer and irrigation regimes. Optimization of these factors could contribute to enhanced nutrient availability, plant growth and ultimately results in higher tomato yields. The experimental results concluded that, the irrigation level of 0.8 IW/CPE ratio was observed a higher yield and among the nitrogen fertilizers, vermicompost and nano-urea were performed better than others.

Conflict of interest: None.

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