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A review: Influence of NPK levels on the nutrient contents in soil and plant of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*)

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Abstract
Macronutrients (NPK) levels basically perform a counter role on nutrient uptake in soil and plants of Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) and therefore required in large quantities for their survival. The solanaceous group of vegetables (tomato, eggplant, chili and bell peppers) generally take up large amounts of nutrients. The amount of nutrients they take up depends on the quantity of fruit and dry matter they produce, which in turn is influenced by a number of genetic and environmental variables. In the recent years, however, plant physiologists, biotechnologists, etc. have been working to investigate various other blind features of these minerals and their future prospective, because nutrients are involved in every step of plant life. Every macronutrient (NPK) has its own character, and is therefore involved in different metabolic processes of plant life. Herein, this review deals with the influence of macronutrients on nutrient uptake in soil and plants as well as future prospective of elemental research in plants.

Keywords: Macronutrients (NPK), cherry tomato, nutrient uptake, soil

Introduction

Judicious fertilizer application is a pre-requisite for the expression of genetic potential of any crop. The efficient and economic use of the nutrients helps to reduce the input costs of raising a bumper crop. Studies in different parts of India have revealed the importance of fertilizers in increasing growth and yield of tomato (Singh *et al.*, 1995) [22]. However, very limited scientific information is available on the NPK nutrition of cherry tomato for yield maximization. The relevant literature pertaining to the proposed study has been reviewed to study the effect of NPK levels on nutrient uptake in tomato and available nutrient contents.

Effect of NPK levels on nutrient uptake in tomato and available nutrient contents

The research conducted by Rao and Seth (1959) [18] at Indian Agricultural Research Institute, New Delhi, on the effect of fertilizer treatments on the yield and composition of tomato, observed that the addition of N @ 196 kg ha^{-1} increased the N content in fruit to 1.65 per cent as compared to 1.43 per cent under control treatment. Yawalkar *et al.* (1962) [25] reported that the tomato crop yielding 160 q ha^{-1} of ripened fruits was found to remove 41.7, 8.9 and 56.5 kg ha^{-1} of N, P2O5 and K_2O, respectively.

Dimitrov and Rankov (1970) [6] reported that under field conditions, yield levels of 1 tonne of tomatoes removed 2 to 4.5 kg N, 0.5 to 1.1 kg P_2O_5 and 2.2-4.6 kg K_2O ha_{-1} from the soil. Accordingly, they have recommended an average dressing of 3.2 kg N, 0.8 kg P_2O_5 and 3.3 kg K_2O ha^{-1} for obtaining the above said yields. Sharma and Shukla (1972) [21] observed that the tomato variety Pusa Ruby planted on sandy clay loam soil applied with N, P_2O_5 and K_2O (0-150, 0-150, 0-100 kg ha^{-1}), 5 respectively removed 117.30, 107.75 and 62.25 kg ha^{-1} of N, P and K, respectively. While, Anand and Muthukrishnan (1974) [2] suggested that Co-1 variety of tomato planted on medium black soil of Coimbtore, removed 150 and 100 kg ha-1 of N and P, respectively. Anand and Muthukrishnan (1974) [2] studied the effect of N fertilization on tomato and observed that the leaf N progressively increased from 2.52 to 3.05 per cent with the increase in N dose from 75 to 150 kg ha-1. Velchev and Velchev (1977) [24], in their green house studies, observed that the nutrient removal by whole plant ranged from 11.5-13.3 g N, 5.79-7.47 g P_2O_5 and 23.1-32.15 g K_2O per plant, which when converted comes out to be 4.03-4.75 kg N, 2.06-2.62 kg P_2O_5 and 8.10-11.44 kg K_2O, for a yield of 1 tonne.

Toriano and Leone (1977) conducted an experiment to study the changes in growth rate and nitrogen content of tomato plants after exposure to NO_2. Maximum N content was found in leaves harvested after 48 hours (2.67 mg per 100mg dry weight) exposed to NO_2 @ 0.47 mg m^{-3} for 80 hours from plants grown under NO_3-N @ 140 mg L^{-1}, whereas minimum N content was found in leaves harvested after 48 hours (1.15 mg per 100mg dry weight) from plants grown under NO3-N @ 28 mg L^{-1} and not exposed to NO_2.

According to Mamonova (1978) [11] the removal of nutrients from the soils by plants increased with the increase in the rates of application of N, P, K fertilizers. He found that when N, P_2O_5 and K_2O were applied at the rate of 85, 230 and 250g m-2, respectively, the nutrient removal per 10 kg fruit was 23.4 g N, 12.2 g P and 55.2 g K, which means that for production of 1 tonne of tomato, the plants remove 0.2 kg N, 0.28 kg P and 0.66 kg K. Orphanos and Papadopolus (1980) [15], while studying the NPK requirement of tomato under greenhouse condition in Cyprus, reported that for producing 7 kg fruit per plant, the fertilizer required will be 17g N, 4.0g P (9.16g P_2O_5) and 10 g K (12g K_2O) per plant. Using the average of N,P and K contents in fruit and plant, they worked out the whole plant uptake to be equivalent to 365 N, 112.2 kg P_2O_5 and 700 kg K_2O ha^{-1}.

Cornillon and Auge (1980) [5] reported a removal of 28.6 g N, 6.15 g P_2O_5 and 48.1 g K_2O m^{-2}, when N, P, K were applied as liquid fertilizer (11-11-11 N P K) equivalent to a total of 513 kg ha^{-1} of each of N, P_2O_5 and K_2O to tomato crop cv. Montanet H 63-5, producing about 11 kg tomato fruit per m^2. This comes out to be 280 kg N, 141 kg P_2O_5 and 577 kg K_2O ha^{-1} for a yield target of 110 tonnes ha^{-1}.

Dimri and Lal (1988) studied the effect of N levels on leaf N status of tomato at Pantnagar, Uttarakhand and observed that N fertilization significantly increased the leaf N from 2.92 to 3.21 per cent as the level of N was increased from 60 to 120 kg ha^{-1}. Mortley *et al.*, (1991) [13] observed an increase in leaf and fruit N, P and K contents of tomato with the increase in levels of N, P_2O_5 and K_2O from 56 to 224 kg ha^{-1} of each. The leaf NPK contents were observed to increase from 4.22 to 4.41 per cent, 0.28 to 0.32 per cent and 3.47 to 3.55 per cent, respectively. Similarly, the contents of respective nutrient in fruits increased from 2.93 to 3.15 per cent, 0.39 to 0.42 per cent and 4.03 to 4.23 per cent. Aasi (1992) [1] on the basis of three years study under mid-hill conditions of Himachal Pradesh reported that K removal by whole tomato plant increased with increasing levels of K. The tomato plant removed 96.22, 108.85 and 115.69 kg K_2O ha^{-1} when K was applied @ 30, 60 and 90 kg ha^{-1}, respectively.

Tyagi and Bhardwaj (1994) [23] studied the effect of continuous cropping and fertilization on the nutrient status of Mollisols in India and found that the graded application of NPK fertilizers, significantly increased nitrogen and phosphorus availability relative to control, whereas, Bhardwaj and Omanwar (1994) [23] reported depletion of available nitrogen under continuous cropping without fertilization.

Harikrishna *et al.* (2002) [8] conducted an experiment to study the effect of integrated nutrient management (INM) on availability and uptake of nutrients and yield of tomato, reported that the application of recommended dose of fertilizers (115:100:60 kg N: P_2O_5: K_2O ha^{-1}) recorded higher uptake of N (74.73 kg ha^{-1}), P (15.58 kg ha^{-1}) and K (160.69 kg ha^{-1}) over 50.33, 11.06 and 123.94 kg ha^{-1} N, P and K with FYM @ 25 t ha^{-1}. However, per cent N (1.25) and P (0.26) in tomato were maximum with recommended dose of fertilizers whereas, per cent K (2.81) was maximum with 50.33, 11.06 and 123.94 kg ha^{-1} N, P and K, with FYM @ 25 t ha^{-1}. Baskar (2003) [3] reported that the application of 100 per cent recommended dose of fertilizers + FYM @ 12.5 t ha^{-1} resulted in significant increase in the uptake of N, P and K by rice grain and straw (58.50; 89.40, 26.50; 8.80 and 19.00; 99.90 kg ha^{-1}, respectively) compared to 100 per cent recommended dose of nitrogen through inorganics alone.

Hebbar *et al.* (2004) [9] conducted an experiment to study the effect of NPK drip fertigation on tomato. He observed that NPK uptake was maximum in case of WSF (Water soluble fertilizer) fertigation (165.7, 16.5, 113.5 kg ha-1) while lowest was recorded in case of furrow irrigation control (109.3, 9.5, 69.1 kg ha^{-1}). Santoshkumar and Shishidhara (2006) [20] observed an increase in uptake of N, P, K, S, Cu and Fe with combined application of FYM @ 10 t ha^{-1} along with 100 per cent recommended dose of fertilizer compared to recommended dose of fertilizer alone. The increase in nitrogen, phosphorus and potassium uptake was to the tune of 49.4, 9.0, 40.2 kg ha^{-1}, respectively.

Poudel and Lee (2009) [16] observed the ranges for concentrations of major elements in tomato *viz.*, nitrogen (2.17-2.46 per cent), phosphorous (0.28-0.37 per cent) and potassium (4.08-4.57 per cent); and trace elements *viz.*, iron (149.44-184.55 ppm), manganese (70.18 - 110.26 ppm), zinc (16.59-33.13 ppm) and copper (6.55-21.10 ppm). Reddy and Reddy (2011) [19] studied integrated use of organic manures and inorganic fertilizers for crop response in tomato-onion cropping system. Application of organic manures with inorganic fertilizers significantly increased the availability of N, P and K, with the increase in level of organic manures application and with no fertilizer registered maximum but on par with 50 and 75 per cent manure levels while the 25 per cent level of organic manure recorded minimum. The study concluded that the combined use of organic manures and inorganic fertilizers is suitable for sustaining yield and maintaining soil health.

Kinoshita and Masuda (2011) [10] studied the nutrient concentrations in shoot and fruit of tomato plants on different fertilizer regimes. No significant difference was observed in N content among controlled-release fertilizer (CRF) (2.85%) and liquid fertilizer (LF) (2.98%). Likewise, no significant difference was observed for N content in fruits among CRF (1.60%) and LF (1.68%). However, P content varied significantly in shoot among CRF (0.58%) and LF (0.74%). In case of fruit, P content varied non-significantly from 1.60 (CRF) to 1.60 (LF). The K content in shoot had significant difference between CRF (3.67%) and LF (4.15%). Similarly, significant difference was found for K content in fruit among CRF (2.75%) and LF (3.20%). Prativa and Bhattarai (2011) [17] conducted a study to scrutinize the effect of integrated nutrient management on the growth, yield and soil nutrient status of tomato (*Lycopersicon lycopersicum* (L.) Karsten). The pH was found near to neutral in treatment 10 mt ha^{-1} vermicompost. Similarly, the maximum organic matter percentage was also recorded in treatment 10 mt ha^{-1} vermicompost.

Nurzyński and Jarosz (2012) [14] conducted an experiment to study the nutrient content in leaves of greenhouse tomato grown in various substrates. N content in straw varied from 3.91 to 3.92 percent, P content varied from 0.36 to 0.46 percent and K content from 4.56 to 4.89 percent in straw. Chaitanya *et al.* (2013) [4] reported that the N (103.76 kg ha^{-1}), P (17.40 kg ha^{-1}) and K (61.82 kg ha^{-1}) uptakes by tomato crop at harvesting stage respectively, were highest in 75% RDN (Recommended dose of nutrient) through fertilizers +

25% RDN through vermicompost. The fruit yield (84.97 q ha^{-1}) of tomato was highest in 75% RDN through fertilizers + 25% RDN through vermicompost. The highest available P_2O_5 (42.4 kg ha^{-1}) and K_2O (332.9 kg ha^{-1}) were recorded in 50% RDN through vermicompost + 50% RDN through poultry manure at harvesting stage of the crop.

Min *et al.* (2015) observed that tomato N uptake (305±8.8 kg N ha^{-1}) in the winter spring season in 2009 was significantly higher than that (153±8.8 kg N ha^{-1}) in 2008. There was no significant difference in mean tomato N uptake between the treatments of conventional fertilization (135±6.4 kg N ha^{-1}), reduced fertilization (133±6.5 kg N ha^{-1}), and reduced fertilization with catch crop (137±6.8 kg N ha^{-1}) in 2008. However, in 2009, mean tomato N uptake in the reduced fertilization with catch crop treatment (221±10.2 kg N ha^{-1}) was significantly higher than that of the reduced fertilization treatment (170±8.5 kg N ha^{-1}). The mean P and K uptake by tomato fruits and plants at harvest was 37–39 kg P ha^{-1} and 193–211 kg K ha^{-1}, respectively, in the conventional fertilization, reduced fertilization, and reduced fertilization with catch crop treatments.

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