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**Short Communication**

# Effect of fertigation with water soluble fertilizers on yield, nutrients uptake and quality characters of tomato (*Solanum lycopersicum* L.)

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Tomato is one of the widely grown vegetable and most important food crop in India. It is rich in minerals, essential amino acids, sugars and dietary fibres. It also contains much vitamin B and C, iron, lycopene and phosphorus (Bagal *et al*. 1989). It is well responsive to fertilizer application and reported to be heavy feeders of NPK. Adequate supply of nutrient can increase the yield, fruit quality, fruit size, keeping quality, colour and taste of tomato (Shukla and Naik 1993, Singh *et al*. 2010). Intensively cultivated vegetable soils of farmers' fields in Varanasi district of eastern Uttar Pradesh showed widespread nutrient deficiencies (N, P, K and S) due to imbalanced fertilization and excess use of nitrogen over the phosphatic and potassic application of fertilizers (Singh and Kumar 2012). Water–soluble fertilizers are the fertilizer mixture that is dissolved in water and applied to plants at the base or foliage throughout the growing season. They are ideal for tomato plants because, they are fast acting, supplies nutrients to plant almost immediately. Water soluble fertilizers can also be applied more frequently than granular fertilizers. Fertilizers applied under traditional methods are generally not utilized efficiently by the crop. In fertigation, nutrients are applied through emitters directly into the zone of maximum root activity and consequently nutrient use efficiency can be improved over conventional methods of fertilizer application. Generally, the crop response to fertilizer application through irrigation has been excellent and frequent nutrient application has improved the nutrient use efficiency (Malik *et al*. 1994). In order to improve the yield and quality of tomato, there should have the technologies which will eventually fulfil the farmer needs. Available information on the fertigation under farmers' field condition is inadequate. The present investigation was, therefore carried out with a view to study the fertigation of new grades of 100% water soluble fertilizers on yield, nutrient uptake and quality of tomato grown in vegetables growing alluvial soil in a farmer's field of Varanasi district.

The experiment was carried on farmer's field in village Shahanshahapur of Varanasi district, Uttar Pradesh during *Rabi* season of 2012- 2013. There were 7 treatments, four for fertigation systems (113, 60 and 75 kg /ha N, P and K, respectively) through 13:13:13+1 Mg O and 11:6:18+3 Mg O water soluble grades, 2 for recommended N, P and K fertilizers dose (150, 80, and 100 Kg/ha, respectively) including one control. The treatments were symbolized as : $T_{1-}$ Use of 13:13:13+1 MgO grade, rest of nutrients were applied through urea, phosphoric acid & SOP $T_{2-}$ Use of 11:6:18+3 MgO grade, rest of nutrients were applied through urea, phosphoric acid & SOP $T_{3-}$ Use of only two grades i.e. 13:13:13:+1 MgO & 11:6:18+3 MgO $T_{4-}$ Use of only two grades i.e. 13:13:13:+1 MgO & 11:6:18+3 MgO, rest of nutrients were applied through Urea, phosphoric acid & SOP $T_{5-}$ RDF through Urea, phosphoric acid & SOP $T_{6-}$ RDF through basal & top–dress (150:80:100 Kg N:$P_2O_5$:$K_2O$ / ha) $T_{7-}$ Control (No fertilizer). The other sources of nitrogen, phosphorus and potassium were urea, phosphoric acid and SOP & MOP respectively.

The experiment was laid out in RBD with three replications. Treatments wise N, P, and K were applied through fertigation and traditional methods at different intervals days (0-10, 11-40, 41-70 and 71-150) after transplanting in each plot. Healthy and uniformed size 30 days old seedlings of tomato (var. Namdhari 585) were transplanted on 1st October 2012 at spacing of 120 cm x 30 cm. Three plants were selected randomly in each treatment, their primary branches and mean were calculated. Three plants were selected randomly from each treatment at every picking the total number of fruits

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picked were counted and then average total number of fruits/plant was counted. Total nitrogen (N) in tomato was estimated after digestion in $H_2SO_4$ in the automatic digestion system. Total P, K and S were estimated after digestion in di-acid mixture ($HNO_3$:$HClO_4$ 9:1 ratio) using the standard methods. Uptake of N, P, K and S was computed by multiplying total nutrient concentration in fruits with yields of tomato. Composite surface (0-15 cm) soil samples from each plot were collected at the harvest of tomato. Soil samples were air-dried and pulverized to pass through a 2 mm sieve. Soils were analysed by using standard procedures as described for pH (Jackson, 1973), organic carbon, available nitrogen (Subbiah and Ashija, 1956), available phosphorus (Olsen *et. al.* 1954) and available potash (Jackson, 1973). Total soluble solid (TSS), ascorbic acid and lycopene content were analysed by using standard methods. Recorded data were analysed statistically. The initial soils in the farmer's field were sandy loam in texture with pH 7.3, organic carbon (0.39%), available N (187.6 kg/ha), available $P_2O_5$ (25.1 kg/ha) and available $K_2O$ (117.4 kg/ha).

Results revealed that treatment $T_4$ had maximum number of branches per plant, which was found significantly higher over the other treatments (Table 1).The maximum number of fruits was observed in plots receiving ($T_4$) two new water soluble fertilizers as fertigation (13:13:13:+1 MgO & 11:6:18+3 MgO) and rest of the nutrients were applied through urea, phosphoric acid & SOP. Plant height at flowering stage was obtained maximum with $T_4$ and minimum height (36 cm) was observed in $T_1$. Fertigation of two grades i.e.13:13:13+1 MgO and 11:6:18+3 MgO grades had marked influence on fresh yield of tomato. The treatment effect was significant with combined application of two grades. It was observed that fresh yield of tomato was found almost similar at individual fertigation of these two grades. The highest yield of 436 q/ha was recorded with combined fertigation of 13:13:13+1 MgO and 11:6:18+3 MgO and nutrients adjusted through application of urea, phosphoric acid and SOP ($T_4$). The effectiveness of this treatment for higher yield may probably be due to water soluble nutrients (N, P, K and Mg) present in fertigation of both new grades, which is directly available to the roots of tomato plants at vegetative as well as reproductive phase at different days of intervals. The roots start to take up nutrients immediately from these water soluble grades after fertigation. Magnesium is important for the production of chlorophyll and absorption of both phosphorus and nitrogen. Sulphur also assists in chlorophyll production and makes nitrogen, phosphorus and potassium found in the soil more effectively. Also, supplement of sulphur added through SOP (18 % S) in this treatment favoured for healthy plant growth and development. Fresh tomato yield was also affected in a lesser magnitude by methods of recommended dose of NPK fertilizers over the control plot.

Total soluble solid (TSS) content of fruits varied considerably due to fertigation of two grades (13:13:13+1 MgO and 11:6:18+3 MgO) and soil application of recommended dose of N, P and K fertilizers. The highest TSS content (4.58%) was recorded from the fruits which were produced with combined fertigation of two grades ($T_4$) along with adjustment of nutrients through application of urea, phosphoric acid and SOP. It was found lowest with either basal or top dressed soil application of

**Table 1:** Effect of fertigation on plant growth, yield and quality of tomato

| Treatment | Growth attributes of tomato | | | | Quality parameters | | |
|---|---|---|---|---|---|---|---|
| | Number of branch / plant | Number of fruits / plant | Plant height (cm) | Yield (Q/ha) | TSS (%) | Ascorbic acid (mg/100 g) | Lycopene content (ug/100 g) |
| $T_1$ - Use of 13:13:13+1 MgO grade, rest of nutients were applied through urea, phosphoric acid & SOP | 4.00 | 35.0 | 51.0 | 401.0 | 4.45 | 10.19 | 86.31 |
| $T_2$- Use of 11:6:18+3 MgO grade, rest of nutients were applied through urea, phosphoric acid &SOP | 4.00 | 36.0 | 52.0 | 404.0 | 4.47 | 10.23 | 86.59 |
| $T_3$- Use of only two grades i.e. 13:13:13:+1 MgO & 11:6:18+3 MgO | 4.33 | 38.0 | 54.0 | 421.0 | 4.51 | 10.55 | 88.16 |
| $T_4$- Use of only two grades i.e. 13:13:13:+1 MgO &11:6:18+3 MgO, rest of nutrients were applied through Urea, phosphoric acid & SOP | 4.66 | 40.0 | 58.0 | 436.0 | 4.58 | 10.69 | 89.23 |
| $T_5$- RDF through Urea, phosphoric acid & SOP | 3.66 | 34.0 | 46.0 | 309.0 | 4.18 | 9.79 | 81.56 |
| $T_6$- RDF through Basal &Top –dress (150:80:100 Kg N:$P_2O_5$:$K_2O$ per ha) | 3.66 | 32.0 | 44.0 | 321.0 | 4.15 | 9.81 | 81.64 |
| $T_7$- Control (No fertilizer) | 2.67 | 26.0 | 36.0 | 268.0 | 3.90 | 9.11 | 75.90 |
| **SEM** | **0.08** | **0.37** | **0.67** | **8.72** | **0.10** | **0.23** | **1.91** |
| **CD (P=0.05)** | **0.24** | **1.11** | **2.03** | **26.86** | **0.30** | **0.70** | **5.89** |

**Table 2:** Effect of fertigation on nutrient uptake by the plant and its availability in soil

| Treatments | Nutrients uptake (kg/ha) | | | Soil available nutrients (kg/ha) | | |
|---|---|---|---|---|---|---|
| | N | P | K | N | $P_2O_5$ | $K_2O$ |
| T1 - Use of 13:13:13+1 MgO grade, rest of nutients were applied through urea, phosphoric acid &SOP | 176.7 | 61.6 | 201.4 | 280.0 | 25.4 | 121.0 |
| T2- Use of 11:6:18+3 MgO grade, rest of nutients were applied through urea, phosphoric acid &SOP | 162.6 | 70.9 | 204.7 | 284.0 | 27.2 | 127.8 |
| T3- Use of only two grades i.e. 13:13:13:+1 MgO &11:6:18 + 3 MgO | 189.5 | 84.2 | 214.2 | 296.0 | 28.5 | 134.2 |
| T4- Use of only two grades i.e. 13:13:13:+1 MgO & 11:6:18+ 3 MgO, rest of nutrients were applied through urea, phosphoric acid & SOP | 199.0 | 88.9 | 225.9 | 319.0 | 38.2 | 156.4 |
| T5- RDF through Urea, phosphoric acid & SOP | 108.0 | 43.3 | 169.9 | 221.0 | 33.9 | 124.9 |
| T6- RDF through Basal &Top –dress (150:80:100 Kg N:P2O5:K2O per ha) | 105.9 | 38.9 | 173.3 | 234.0 | 30.0 | 122.5 |
| T7- Control (No fertilizer) | 87.7 | 29.8 | 135.8 | 190.0 | 26.7 | 119.5 |
| SEM | 3.79 | 1.64 | 4.47 | 6.06 | 0.65 | 2.87 |
| CD (P=0.05) | 11.69 | 5.06 | 13.77 | 18.69 | 2.01 | 8.84 |

recommended dose of NPK compared to fertigation treatments over control (3.90%). The highest ascorbic acid (10.69mg/100g) was found in the fruits which were produced with fertigation of both grades along with adjustment of application of urea, phosphoric acid and SOP ($T_4$) followed by $T_3$. The highest lycopene (89.23ug/100g) was measured within fruits which were produced with combined fertigation of both grades ($T_4$) and adjustment of N, P and K through urea, phosphoric acid and SOP ($T_4$). On the other hand, lycopene was recorded lowest with soil application of recommended dose of fertilizers and unfertilized control plot (75.9ug/100g). Salam *et al.,* (2010) obtained higher level of total soluble solid, ascorbic acid and lycopene content in tomato fruit with application of N, P and K fertilizers.

Total N, P and K uptake by tomato was varied considerably with fertigation and soil application of recommended dose of N, P and K fertilizers (Table 2). The highest total N, P and K uptake (199.0, 88.9 and 225.9 kg/ha, respectively) was reported with $T_4$ treatment. Uptake of N, P and K was also significantly differed with soil application of recommended dose of NPK fertilizers over the unfertilized control plot. The formula 13-13-13+1MgO and 11-6-18+3MgO beside creating an acidic environment in the water solution in the pipes, also create an acidic environment in the root zone thus enable a better uptake of the nutrients by the plant. This increase in uptake per plant was due to the better availability of nutrients in the root zone as a result of frequent application of nutrients coupled with better root activity. Further, it was also due to the reduced loss of nutrients, primarily because of leaching in fertigation compared to soil application of N, P and K fertilizers. The better performance under fertigation was in the root zone, which in turn helped the plants to utilize moisture as well as nutrient more efficiently by tomato. Similar observations of increased uptake as a result of application of N, P, and K fertilizers have been reported earlier by Vasane *et al.* (1996).

Available N, P and K content of the post-harvest experimental soils was considerably influenced by application of fertigation (Table 2). Soil available N, P and K varied from 261 to 319, 25.4 to 38.2 and 121 to 156.4 Kg/ha. The highest soil available N, P and K content was recorded with $T_4$ treatment. On the other hand, soil application of recommended dose of N, P and K has resulted in lower improvement in the content available status of N, P and K as compared to fertigation over the unfertilized plot. The availability of N, P and K in surface soil was significantly higher in fertigation of new water soluble fertilizers because of the complete solubility of N, P and K and frequent and small application rates compared to the recommended dose of N, P and K soil application. From the present investigation, it may be concluded that combined fertigation of two new grades of 100% water soluble fertilizers (13:13:13+1 MgO and 11:6:18+3 MgO) along with adjustment of N, P and K nutrients through urea, phosphoric acid and SOP may be recommended as better option over soil application of recommended dose of N, P and K fertilizers in terms of obtaining the higher fruit yield, N, P and K uptake and quality of tomato in alluvial soil at farmer's field of Varanasi district in eastern Uttar Pradesh.

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