Review

Quality fruit production of tomato through integration of organic and inorganic nutrition: a review

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ABSTRACT

Vegetables can make a significant difference to the livelihood of marginal farmers. Vegetable production needs only a small area of land with minimal capital outlay and can provide access to a valuable food under subsistence conditions; but also has the potential to provide an initial step towards establishing an income base for poorer households. Tomato is universally treated as protective food and is a very good source of income to small and marginal farmers and contributes to the nutrition of the consumers. Integrated nutrient management (INM) integrates the use of all natural and man-made sources of plant nutrients so that productivity and nutrient status of food increases in an efficient and environmentally benefiting manner without sacrificing soil productivity of future generations. Quality fruit production of tomato can be done through integration of organic nutrition (farmyard manure, vermicompost, green manuring) and inorganic fertilizers. In this background, this review deals with the integration of organic and inorganic nutrition to produce quality fruit yield in tomato.

Keywords: Fruit yield; quality traits; tomato; organic; inorganic

INTRODUCTION

Tomato [*Solanum lycopersicon* (Mill) Wettsd], 2n= 2x= 24 is one of the most versatile vegetable crops grown throughout the world because of its wider adaptability, high yielding potential and suitability for uses in fresh as well as processed food industries. The red pigment (lycopene in tomato) is now being considered as the world's most powerful natural antioxidant. Therefore tomato is one of the most important protective foods because of its special nutritive value. One hundred g of edible part of tomato fruit contains 93.1 per cent moisture, 3.6 g carbohydrate, 1.9 g protein, 0.1 g fat, 0.6 g minerals, 0.7 g fibre, 320 IU vitamin A and 31.0 mg vitamin C (ascorbic acid) (Kumar et al 2018). Tomato fruits are eaten raw or cooked. Tomato in large quantities is used for the preparation of several processed items like soup, juice, ketchup, puree, paste, powder etc. Green tomatoes are also used for pickles and preserves. It has many other uses; seeds contain 24 per cent oil that is used as salad oil and in the manufacture of margarine.

All the species of tomato are native to western south America (Rick 1976). Tomatoes have been used as food by the inhabitants of central and south America since pre-historic time long before the discovery of America. The pre-Columbian and Aztecs developed larger fruited and new colours of tomato from the wild cherry tomato. Britishers believed to have introduced tomato in India in 1818 through Royal-Agri-Horticultural Society, Kolkatta, West Bengal and afterwards it spread to other parts of the country.

For several years tomato was known as classified under *Lycopersicon* although initially Linnaeus classified it in the genus *Solanum*. Recently molecular studies provided new data on the relationship between tomato-potato and based on these results tomato has been again assigned to the genus *Solanum. Solanum* section *Lycopersicon* includes the cultivated tomato *(Solanum lycopersicon*) and its wild relative, *Solanum lycopersicon* being the only domesticated species. The wild cherry tomato, *Lycopersicon esculentum* var *cerasiforme*, the ancestor of the modern cultivated tomato, has originated in Peru-Equator-Bolivia region of the Andes. The Veracruz-Puebla region of Mexico is the centre of domestication of the cultivated tomato. From Mexico, tomato was taken to Italy, Spain, Portugal and other European countries, Africa and Middle East by the explorers in the 16th century. It was taken to Philippines after its discovery by Magellan in 1521 and from there it was taken to other Asian countries. During the early years of its introduction tomato was considered to be poisonous in Britain, France, Spain and other European countries. Tomato moved to the USA from northern Europe around 1781 where it was first grown by Thomas Jefferson in Virginia.

The use of integrated nutrient management is concerned to the protection of soil productiveness and to provide these nutrients to the cultivated plants at a most favourable level for sustaining the desired yield through optimization of the benefits from all probable sources of organic, inorganic and biological ingredients in an integrated way (Reddy et al 2007, Sujatha et al 2008, Tetarwal et al 2011). Soil's potential to generate agricultural crops is principally determined by the environment that the soil provides for root growth. Roots absorb air, water, nutrients and plenty of space in which they develop (Shanwad et al 2010). Soil properties such as the capability to hold up water, acidity, depth and density determine how well roots develop. Alteration in these soil characteristics unswervingly affects the health of the plant. For example bulk density, a determination of the compactness of a soil, affects agricultural productivity (Praharaj and Rajendran 2007, Mondal et al 2015).

Organic fertilizers hold comparatively low concentrations of nutrients in contrast to chemical one but they perform significant functions which the chemical fertilizers do not do (Jeyajothi and Durairaj 2015). The addition of organic fertilizers and their appropriate administration can decrease the need for chemical fertilizers thus allowing the small farmers to save in the part the price of manufacture. Additionally the discharge of inorganic fertilizers compared to organic one is higher. As a result, available nutrients are utilized and lost rapidly by different means. Alternatively organic fertilizers are decomposed gradually and nutrients are accessible for longer period of time which helps to preserve soil nutrient status (Praharaj and Rajendran 2007, Tetarwal et al 2011).

The growth of crop plants is the result of a complex of carbon dioxide, water and nutrients from the soil. In all, between 21 and 24 elements are necessary for plant growth (Kalhapure et al 2013). The primary nutrients for plant growth are nitrogen, phosphorus and potassium (NPK). Whilst inadequate, these primary nutrients are mainly accountable for limiting crop development (Antil and Singh 2007, Pandey and Chandra 2013). Nitrogen, the most intensively used element, is accessible in almost infinite quantities in the atmosphere and is repeatedly recycled among plants, soil, water and air. However it is often unavailable in the right form for proper absorption and synthesis by the plant (Togay et al 2008). Presently there has been great increase of fertilizer use; yet the proportion of different nutrients used in the country is not at all balanced. N alone constitutes about 78 per cent of the total nutrients used in the country which may not help improve crop productivity unless other limiting nutrients are supplemented along with nitrogen. In order to improve crop productivity, the limiting micronutrient(s) must be identified and the soils should be enriched with addition of these nutrients in properly balanced fertilizer programme. Integrated nutrient management (INM) integrates the use of all natural and man-made sources of plant nutrients so that productivity and nutrient status of food increases in an efficient and environmentally benefiting manner without sacrificing soil productivity.

Growth attributes

Application of FYM 15 tonnes/ha along with 75 per cent RDF (NPK) + B + Zn proved to be the best treatment combination in terms of number of primary branches per plant and average number of fruits per plant (Manohar et al 2013). The plants treated with 50 per cent RDF +10 tonnes/ha FYM + 5 tonnes/ha poultry manure + biofertilizer showed maximum number of leaves per plant (Singh et al 2015). Increased plant height, leaf number, branch number and stem girth revealed that tomato performed better ($P < 0.05$) with the application of 125 kg/ha NPK + 3 tonnes/ha poultry manure application (Ogundare et al 2015). Siddaling et al (2017) observed that the growth parameters of tomato plants such as plant height (108.60, 113.50 and 122.36 cm) number of branches (12.00, 15.20 and 18.30) and leaf area (68.53 cm^2) were recorded maximum in the treatment that received 75 per cent RDF + *Azotobacter* + phosphorus solubilizing bacteria (PSB) + VAM at 45, 90 and 135 days after transplanting respectively. Integration of 50 per cent RDF with ARV (agro-residue vermicompost) @ 5 tonnes/ha produced maximum plant height, root length, dry weight, chlorophyll content and leaf area index of tomato cv Arka Rakshak (Chopra et al 2017). Application (RDF 25% + FYM 25% + *Azotobactor* 25% + *Azospirillum* 25%) at optimum level is quite effective to promote height, leaves and branches (Kumar et al 2017a). Kumar et al (2017b) reported that the growth characteristics like plant height and branches per plant were significantly influenced by various INM treatments. Application of 43.5 tonnes of FYM and 50 per cent RDF gave taller plants (60.0 cm). Integration of organic manures in combination with inorganic fertilizers was found significant in improving the overall plant growth (Jat et al 2018).

Fruit yield

Application of FYM 15 tonnes/ha along with 75 per cent RDF (NPK) + B + Zn proved to be the best treatment combination in terms of average number of fruits per plant and fruit yield per plant, per plot and per hectare (Manohar et al 2013). Yield attributes like fruit number per plant and fruit weight revealed that tomato performed better with the application of 125 kg/ha NPK + 3 tonnes/ha poultry manure application. For good yield and better productivity of tomato, a combination of 125 kg/ha NPK fertilizer + 3 tonnes/ha poultry waste is recommended for production (Ogundare et al 2015). The plants treated with 50 per cent RDF +10 tonnes/ha FYM + 5 tonnes/ha poultry manure + biofertilizer showed maximum number of leaves per plant (36.88), fruits per plant (74.69), fruit length (6.85 cm), mean fruit weight (134.33 g), yield per plant (10.77 kg), yield per plot (38.90 kg) (Singh et al 2015).

Integration of 50 per cent RDF with ARV (agro-residue vermicompost) @ 5 tonnes/ha produced maximum number of flowers/plant, fruits/plant and crop yield/plant of tomato cv Arka Rakshak (Chopra et al 2017). Application (RDF 25% + FYM 25% + *Azotobactor* 25% + *Azospirillum* 25%) at optimum level is quite effective to promote fruit diameter and yield per hectare (Kumar et al 2017a). Plant supplied with 75 per cent RDF + *Azotobacter* + PSB + VAM recorded maximum fruit weight (69.70 g), number of fruits per plant (80.00), fruit length (7.15 cm), fruit diameter (5.88 cm), fruit yield /plot (7.50 kg/plot) and total yield (112.50 tonnes/ha) (Siddaling et al 2017). Tekale et al (2017) reported that the application of organic nutrients along with inorganic nutrients FYM 20 tonnes/ha + 100 per cent RDF produced higher fruit yield/plant (1.49, 1.58 and 1.54 kg) and fruit yield/plot (29.86, 31.56 and 30.71 kg) during 2011-12, 2012-13 and pooled analysis respectively. Kumar et al (2017a) found that the organic sources of nutrition along with inorganic sources showed incremental effect for almost all parameters including yield over inorganic sources alone. Integration of organic manures in combination with inorganic fertilizers was found significant in improving the overall fruit yield in tomato (Jat et al 2018).

Quality traits

The plants treated with 50 per cent RDF +10 tonnes/ha FYM + 5 tonnes/ha poultry manure + biofertilizer showed maximum ascorbic acid content (40.02 mg/100 g) over treatment having 100 RDF alone (Singh et al 2015). Recommended dose of fertilizers @ 50 per cent integrated with ARV (agro-residue vermicompost) @ 5 tonnes/ha produced maximum biochemical ingredients like crude protein, dietary fiber, total carbohydrates and total sugar of *L esculentum* tomato cv Arka Rakshak (Chopra et al 2017). Application (RDF 25% + FYM 25% + *Azotobactor* 25% + *Azospirillum* 25%) at optimum level is quite effective to increase quality of fruits like TSS, acidity and ascorbic acid (Kumar et al 2017a).

It is observed that the application of 43.75 tonnes/ha FYM and 50 per cent RDF gave maximum ascorbic acid content (25.38 mg/g) and titratable acidity (0.61%) over control (19.57 mg/g and 0.40% respectively). Fruit quality enhancement was also observed in organic sources alone or in combination with inorganic components. The increase in titratable acidity might be due to the increased activity of the enzyme acetone (Kumar et al 2017b).

CONCLUSION

Sustainable agricultural production incorporates the idea that natural resources should be used to generate increased output and incomes especially for low income groups without depleting the natural resource base. On the basis of review of past studies conducted by many scientists, it may be concluded that the application of organic fertilizers (FYM and vermicompost), biofertilizers (*Azotobactor*, phosphorus solubilizing bacteria and VAM) in combination with the synthetic fertilizers can increase the growth and produce good quality fruits of tomato.

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