Standardization of integrated nutrient management for growth, yield and Post-harvest quality of tomato

Abstract

The cultivated tomato *Solanum lycopersicon* L., a commercial annual crop, belongs to the family of Solanaceae, with diploid chromosome number (2n= 2X= 24) and grown throughout the world for local utilization or as an export crop. Application of fertilizers, pesticides and herbicides those play key role in achieving very good production per unit area, but excess application than that of a recommended dose associated with problems like environment pollution (air, water and soil pollution). In an extensive study it was reported that if the farmers exposed to chemical insecticides spray for 18 months, results in visual symptoms seen were stinging/ burning of eyes (18.42 %), dry sore throat (21.05 %), blurred vision (23.68 %), burning of nose (28.9 %), shortness of breath/ excessive sweating (34.2%) and skin itching/ redness (50.0%). This tiny review article analyses the previous works and studies to investigate the role of various organic and inorganic nutrient sources in tomato crop. Integrated nutrient management (INM) is an approach that increases the agricultural production and safeguards the environment for future generations.

Keywords: Tomato, INM, Organic and Inorganic nutrient sources, Growth, Yield and Quality

Introduction

The cultivated tomato *Solanum lycopersicon* L., a commercial annual crop, belongs to the family of Solanaceae, with diploid chromosome number (2n= 2X= 24) and grown throughout the world for local utilization or as an export crop. This tiny review article analyses the previous works and studies to examine the role of various organic and inorganic source of nutrients in tomato crop. A fertilizer is any material which is of natural or synthetic origin and is applied to soils to supply one or more essential plant nutrients to overcome the plant nutrient deficiency to support better growth coupled with higher return in the form of yield as output. The dangerous effect of synthetic fertilizers starts right from their manufacturing as they produce hazard byproducts and poisonous gases such as CO_2, CH_4, and NH_4 *etc.*, that are drastically degrading the quality of air and thereby creating alarming situation for the environment. Also, application of fertilizers, pesticides and herbicides those play key role in achieving very good production per unit area, but excess application than that of a recommended dose associated with problems like environment pollution (air, water and soil pollution). Considering all the above problems, in order to meet up the food demands of

growing population in the first decades of the twenty first century, farmers must manage soil fertility and nutrients in an integrated manner. Integrated nutrient management (INM) is an approach that increases the agricultural production and safeguards the environment for future generations (Gruhn *et al.,* 2000). Hence, nutrient management is a strategy that includes both organic (farm yard manure, compost, green manure, gobar gas plant manure, bone meal, steamed bone meal, oil cake, fish manure, wood ash, sewage, sludge, coir pith, sugar cane press mud, biological sources, bio-fertilizers) and inorganic (major and micro nutrients) plant nutrients to gain maximum crop productivity, prevent on-site soil degradation (Tagaliavini and Marangoni, 2002) and supports to meet future food supply needs.

1.1 Importance of nutrient application in vegetable crops

Proper crop development requires sixteen essential plant nutrients. Every nutrient has equal importance, required in different quantities to the plant and these nutrient elements are grouped base on their essentialities in plants. There are three classes of nutrients like essential (macro) nutrients, secondary vitamins and micronutrients (Rajasekar *et al.,* 2017). Nutrients improves the root development and growth of the soil flora and fauna (Thy and Buntha, 2005). Nitrogen (N) plays a main function in the plant metabolism and hence is identified in growth and development (Fageria, 2013). Low phosphorus (P) availability is the main reason for the reduction of yields in world crop production system and less availability of phosphorus in all stages of crop development can minimize yields up to 5-15 percentage (Vance *et al.* 2003, Shenoy and Kalagudi, 2005). Magnesium (Mg) is a major constituent of cell walls and it plays a vital role in the process of photosynthesis in the plants. Sulphur (S) is now rated as fourth major nutrient after N, P and K and its importance is being recognized in view of its vital role in improving crop quality. Boron (B) is a micronutrient necessary for plant growth and it plays an important role in cell wall synthesis, sugar transport, cell division, cell development, auxin metabolism, good pollination and fruit set, seed development, synthesis of amino acids and proteins, nodule formation in legumes and regulation of carbohydrate metabolism (Dissoky and Kadar, 2013). Zinc (Zn) is viewed as indispensable for the growth of plants and has been noticed in a range of enzymes accountable for kinds of biochemical reactions.

1.2 Importance of organic manure in enhancement of quantitative traits

To stimulate plant growth, yield and yield aspects of many vegetables crops the organic manures plays a most essential role (Fawzy *et al.,* 2016 and Sarhan *et al.,* 2011). Organic fertilizers supply balanced amount of principal nutrients and macronutrients for crop growth and development, which furnishes plants with additional resistance to cold. The

differential response of plants to differed doses of organic manures is due to the production of a lesser volume of growth-promoting components (Arancon *et al.,* 2004). Root initiation, improved root biomass, superior plant growth and development and sometimes, adjustments in plant morphology are among the most regularly claimed results of vermicompost treatment (Tomati *et al.,* 1988). Early maturity with the application of organic manures may be attributed to the quicker enhancement of vegetative growth and availability of strong ample reserve food material for differentiation of vegetative buds into flowers (Kuppuswamy *et al.,* 1992). Vermicompost contains most nutrients in plant handy forms such as phosphates, exchangeable calcium, soluble potassium and other macronutrients with a big quantity of helpful microorganisms, vitamins, and hormones which influence the growth, and yield of plants (Theunissen *et al.,* 2010). Seaweed extract is a natural organic liquid fertilizer which contains regulators, plant growth hormones, carbohydrates, auxins, gibberellins and vitamins those promotes faster seed germination, highly nutritious to plants and maintains fertility of soil (Sasikala *et al.,* 2016).

Application of NPK at recommended dose ensured quicker availability of major nutrients during early crop growth stage as compared to sole organic manure treatment, supported rapid new cell formation and elongation, resulted in optimum carbohydrate metabolism in crop and accumulated higher dry matter. Hence, combination of manure with synthetic fertilizers might had enhanced the process of mineralization of the labile fractions of organic matter and thereby promoted its optimum decomposition. Organic manures such as farmyard manure (rich in potassium), vermicompost (higher concentrations of nitrate-nitrogen and lower concentrations of ammonium-nitrogen) and poultry manure (least C:N ratio) increased the water-holding capacity of soil and maintained optimum moisture for prolonged period. It might had gradually added available carbon in the soil, which acted as an energy source to facilitated highly diverse microbial communities with various functional properties, ultimately supported dissolution and availability of nutrients (N, P, K and micronutrients) to the crop plants (Celikcan *et al.,* 2021). Also, incorporation of organic sources into soil could improve root morphological characteristics and root TTC (Tri phenyl Tetrazolium Chloride) reducing capacity, Nitrate Reductase (NR) and Glutamine Synthetase (GS) of crop plants by enhancing the root density, active adsorption area, and root surface phosphatase activity, and reflected the efficiency of N uptake and utilization by crops (Zhang *et al.,* 2020). Organic manures contain growth regulators like hormones in minor quantities (compounds with gibberellin, cytokinin and auxin-like activities have been detected) and a non-nutritional growth-promoting compound in the organic manures is humate. Humus or

humus-like substances are believed to encourage nutrient uptake and metabolism of plant, thereby influencing protein synthesis, and show hormone-like activity (Bachman and Metzger, 2008). The availability of various macro and micro nutrients in the soil during the crop growth period led to an increased cell elongation, increased photosynthesis, carbohydrate metabolism, photosynthates translocation to different plant parts, synthesis of protein, amino acids, nucleic acids and plant enzymes activation and there by resulted in the improvement of plant growth (biomass production) and yield (Adekiya *et al.,* 2020 and Kumar *et al.,* 2021). However, constant supplementation of organic nutrient sources as well as chemical fertilizers (NPK) might had encouraged the growth, activity and metabolism of soil microorganisms, leading to an enhancement in the dehydrogenase β-glucosidase and e-fluorescein diacetate (FDA) activity in the soil which in turn led to the degradation of biomass (Gogoi *et al.,* 2021)

1.3 Importance of organic manure in enhancement of qualitative traits

Organic manures naturally enhance the soil physical, chemical, and biological properties along with conserving the moisture retaining ability of soil and for that reason, ensuring in more desirable crop productivity along with maintaining the quality of crop production. Organic fertilizers expand the availability of nutrients and furnish advisable effects to the soil also it helps to preserve the quality of plants (Maheswarappa *et al.,* 1999, Thy and Buntha, 2005). To improve fruit quality and help to prevent plant diseases, follow an organic potassium product like kelp meal or greensand.

1.4 Effect of Integrated nutrient Management on growth parameters

Meena and Verma (2019) conducted experimental studies on growth and yield of tomato (*Solanum lycopersicum* L.) as influenced by different source of organic manures and bio fertilizers. On the basis of experimental findings, application of Recommended Dose Fertilizer (100:50:60 NPK kg/ha) gave maximum plant height (117.13 cm) and number of primary branches (12.07). Chauhan *et al*. (2017) conducted experimental studies on effect of varieties and integrated nutrient management on growth and yield of chilli (*Capsicum annuum*). Significant increase in plant height (71.6 cm) and number of branches per plant (24.7) at 90 days after transplanting were recorded with application of Recommended dose of fertilizer and vermicompost 2.5 tons/ha. Mengistu *et al*. (2017) conducted experimental studies at Dire Dawa on the integrated use of excreta-based vermicompost and inorganic Nitrogen, Phosphorus fertilizer on tomato (*Solanum lycopersicum* L.) fruit yield, quality and soil fertility. Results showed that maximum plant height (75.20cm) and number of primary branches (8.90) were obtained with 75percent RDF and 11.25 ton/ha vermicompost

application. Rani *et al.* (2015) did work on evaluation of integrated nutrient management practices on growth, yield and economics of green chilli cv. Pusa Jwala (*Capsicum annuum* L.). Data revealed that combined application of 150 kg nitrogen/ha along with 10 t FYM and 0.5 t neem cake/ha was gave highest plant height (59, 58 cm) and number of branches per plant (23, 23) respectively. Singh *et al.* (2010) conducted experimental studies at research farm of ICAR research complex for NEH Region, Mizoram on vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits (*Solanum lycopersicum* L.). According to the research findings, highest plant height (96.4cm and 106.5cm) and stem thickness (14.7mm and 16.2mm) was obtained with T_4 (NPK 30:15:15 kg/ha and vermicompost 11.25 t/ha) and T_3 (NPK 60:30:30 kg/ha and vermicompost 7.50 t/ha) respectively in both years of experiment. Narayan *et al.* (2008) conducted studies on effect of organic manures and inorganic fertilizers on fruit yield of tomato. Application of FYM (20 t/ha) along with recommended dose of NPK (150:60:60 kg NPK / ha) shown maximum plant height (47.06cm).

1.5 Effect of Integrated nutrient Management on yield parameters

Mohit *et al.* (2019) carried out an experiment at HRC of Sardar vallabhbhai Patel University of agriculture and technology, Meerut on the effect of integrated use of organic and inorganic sources of nutrients on growth, yield quality and profitability of tomato (*Lycopersicon esculentum* Mill.) Var. Pusa Rohini and the experimental findings revealed that treatment T_4 (NPK 75 percent and FYM 25 percent (6.25 t/ha) was exhibited minimum days taken to first flowering (49.00), found superior in terms of number of fruits/plant (11.00), length of fruit (4.88cm), fruit diameter (4.76cm) and fruit weight per plant (1080 g) and fruit yield per ha (399.99 q/ha). Kumari and Tripathi (2018) conducted experimental studies at department of soil science and water management (farm), Dr. Y.S. Parmar University, Solan and reported that integrated nutrient management with 80 percent Nitrogen, Phosphorus and Potassium, 20 percent N through farmyard manure, vermicompost (50:50) and PGPR had the highest fruit yield (606.51 q/ha) of tomato. Chauhan *et al.* (2017) conducted experimental studies on effect of varieties and integrated nutrient management on growth and yield of chilli (*Capsicum annuum*). Results revealed that minimum days taken to first flowering (25.7 Days After Transplanting), maximum number of fruits per plant (112.8), fruit length (10.8 cm), fruit girth (2.38 cm), fruit yield per plant (271.5 g) and fresh fruit yield of (6816 kg/ha) at 90 days after transplanting was recorded with application of Recommended dose of fertilizer and vermicompost 2.5 tonnes/ha. Chopra *et al.* (2017) conducted an experiment to find effects of INM on agronomical attributes of tomato

(*Lycopersicon esculentum* L. cv. F_1 Hybrid Arka Rakshak) under field conditions. Among various treatments investigated, the yield attributes like highest number of fruits per plant (45.12) and fruit yield per plant (5680.88 g) was recorded with 50 percent RDF and agro-residue vermicompost (ARV) at the rate 5 t/ha. Islam *et al.* (2017) conducted experimental study at Bangladesh Agricultural University, Mymensingh on the effect of organic and inorganic fertilizers on soil properties and the growth, yield and quality of tomato in Mymensingh, Bangladesh. The application of integrated plant nutrient system treatment with 8 tonnes of vermicompost and N (40 kg), P (14 kg), K (24 kg), S (5 kg), Zn (0.7 kg), B (700 g) gave maximum number of flower clusters per plant (31.28), fruit length (5.45 cm), fruit diameter (4.84 cm) and fruit yield (15.39 t/ha). Kumar *et al.* (2017) studied the impact of integrated nutrient management on yield and soil health in tomato and results shown that an average yield of tomato in demonstration fields ranged from 194.50 to 215.55 q/ha whereas in local practice it was 161.85 and 172.65 q/ha. Kumar *et al.* (2017) carried out research at department of vegetable Science, vegetable research farm, Haryana Agricultural University to find the response of tomato (*Lycopersicon esculentum* Mill.) to INM. Results found that application of 43.5 tonnes of farm yard manure and 50 percent of recommended dose of fertilizers gave maximum fruit yield (284.81q/ha) over control (198.6q/ha). Mengistu *et al.* (2017) conducted experimental studies at Dire Dawa on the integrated use of excreta-based vermicompost and inorganic Nitrogen, Phosphorus fertilizer on tomato (*Solanum lycopersicum* L.) fruit yield, quality and soil fertility. Findings showed that minimum days to 90 percent first fruit picking (96.67) with 0% RDF and 15 ton/ha vermicompost, maximum number of fruit cluster per plant (17.07), number of fruits per cluster (3.24), number of fruits per plant (52.67), fruit diameter (42.87mm), fruit weight (62.81g) and marketable fruit yield (52.51t/ha) with 75% RDF and 11.25 ton/ha vermicompost. Rajeev *et al.* (2017) investigated on the effect of INM on growth, yield and quality of Tomato (*Lycopersicon esculentum* L.) cv. Pusa Ruby. Combination of Recommended Dose of Fertilizers 25 percent, FYM 25 percent, *Azotobactor* 25 percent and *Azospirillum* 25 percent given minimum number of days to first flowering (37.72), maximum number of clusters per plant (9.78), number of fruit per plant (15.95), fruit diameter (60.69 cm), fruit weight (68.28 g), fruits yield per plant (1.09 kg), fruit yield per plot (17.44 kg) and fruit yield (363.60 q/ha). Tekale *et al.* (2017) conducted experiment at regional horticultural research station (RHRS), agricultural University, Navsari, Gujarat on integrated nutrient management (INM) on nutrient availability, uptake and yield of tomato (*Lycopersicon esculentum* Mill.) cv. "Gujrat Tomato-2". Integrated nutrient management treatment application with FYM 20 t/ha and100 percent

RDF had significantly the highest fruit yield per plant was 1.49, 1.58 and 1.54 kg and fruit yield per plot was 29.86, 31.56 and 30.71 kg in both seasons and pooled data. Avhad *et al.* (2016) conducted experiment at department of horticulture, tomato improvement scheme, M.P.K.V., Rahuri (alkaline soils) and studied that the effect of INM on growth, yield, quality and nutrient uptake in tomato. Results revealed that application of Recommended dose of fertilizer 300: 150:150 kg NPK and FYM 20 t/ha gave maximum value of number of fruits per plant (42.62), average weight of fruit (86.33 g) and fruit yield per plant (2.54 kg). Kumar, (2016) conducted experimental work on the use of integrated nutrient management to enhance soil fertility and crop yield of hybrid cultivar of brinjal (*Solanum melongena* L.) under field conditions. Research findings significantly influenced by among various treatments, the highest number of fruits per plant (55.64) and crop yield per plant (6084.25g) was recorded with 50 percent of recommended dose of fertilizer and vermicompost at 5t/ha. Ilupeju *et al.* (2015) studied the impact of organic and inorganic fertilizers on growth, fruit yield, nutritional and lycopene contents of three varieties of tomato (*Lycopersicon esculentum* (L.) Mill) in Ogbomoso, Nigeria. They found highest fruit yield obtained with Ogbomoso local was 45 and 56 percent increase in Roma VF as compared with other varieties with application of 50 percent NPK and 50 percent tithonia compost. Laxmi *et al.* (2015) conducted experiment at department of horticulture, SHIATS, Allahabad (horticultural experimental field) on effect of organic manures and chemical fertilizers on plant growth, yield, fruit quality and shelf life of tomato (*Solanum lycopersicon* L.) cv. PKM-1. Results showed that 50 percent RDF and 50 percent FYM combination recorded minimum days to first flowering (29.47) and maximum number of fruits per cluster (5.67), number of fruits per plant (36.72), average fruit weight (41.67g), fruit yield per plant (849 g), fruit yield per plot (13.50 kg) and fruit yield per hectare (33.77 t/ha). Rani *et al.* (2015) did an evaluation on integrated nutrient management practices on growth, yield and economics of green chilli cv. Pusa Jwala (*Capsicum annuum* L.). Recorded data showed that combined application of 150 kg nitrogen/ha along with 10 t FYM and 0.5 t neem cake/ha was gave highest number of fruits per plant (194 and 164), fruit yield per plant (410 and 315 g) and total green chilli yield per hectare (13306 and 10550 kg/ha) respectively. Singh, (2014) was did research at Krishi Vigyan Kendra Research farm, Pampoli, Arunachal Pradesh and has reported that maximum number of fruit clusters (7.21), fruit weight (55.90 g) and fruit yield per hectare (26.74 mt/ha) were recorded in treatment combination of 14.33 mt/ha farmyard manure, 7.20 mt/ha vermicompost and NPK. Chaitanya *et al.* (2013) conducted experiment at College of Agriculture, Rajendranagar, Hyderabad (sandy loam soil) on the effect of integrated nutrient

management on uptake and yield of tomato (*Lycopersican esculentum* L.) and availability of nutrients in soil. The highest fruit yield per hectare (84.97 q/ha) of tomato was found with treatment application of 75 percent RDN through fertilizers and 25 percent RDN through vermicompost. Islam *et al.* (2013) studied on the integrated nutrient management on soil fertility, growth and yield of tomato. Results revealed that combination of poultry manure 2t/ha and 75 percent of RDF shown maximum values in number of fruits/plant (15.67), fruit diameter, fruit yield/plant and yield/hectare of tomato. Babajide and Salami (2012) reported the response of tomato plants by integrated application of 30 kg N/ha of urea and 2.5 t/ha of Tithonia-compost as a combination treatment gave maximum number of fruits per plant (51.40), fruit diameter (4.90 cm) and total fruit yield (30.02 t/ha). Chaitanya *et al.* (2011) reported that the effect of integrated nutrient management on soil dehydrogenase activity, nutrient uptake and fruit yield of tomato (*Lycopersican esculentum* L.). The highest fruit yield (84.97 q/ha) of tomato was recorded in treatment receiving recommended Dose of Nutrient Fertilizers through 75 percent inorganic fertilizer and 25 percent vermicompost. Prativa and Bhattarai (2011) carried research work at integrated research farm of HICAST at Bandegaon, Lalitpur and on the effect of integrated nutrient management on the growth, yield and soil nutrient status in tomato. Results showed that maximum fruit weight (52.80 g) and fruit yield (25.74 mt/ha) were recorded with application of 16.66 mt/ha farmyard manure, 8.33 mt/ha vermicompost and NPK combination. Singh *et al.* (2010) conducted experimental studies research farm of ICAR research complex for NEH Region, Mizoram on vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits (*Solanum lycopersicum* L.). According to research findings, highest fruit weight (88.9g and 93.6g) with T_3 (NPK 60:30:30 kg/ha and vermicompost 7.50 t/ha) in both years of experiment. Singh *et al.* (2010) conducted experiment at research farm of ICAR research complex for NEH Region, Mizoram and observed that vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits: (*Solanum lycopersicum* L.). Results showed that application of vermicompost in the amount of 7.5 t/ha in combination with 50 percent dose of NPK fertilizer (60:30:30 kg/ha) gave maximum fruit weight (88.9 and 93.6 g) and fruit yield per plant (2.939 and 3.049 kg) in both years as compared to control. Narayan *et al.* (2008) conducted studies on effect of organic manures and inorganic fertilizers on fruit yield of tomato. Application of farmyard manure (20 t/ha) along with recommended dose of NPK (150:60:60 kg NPK / ha) shown maximum fruit yield per ha (479.43 q/ ha). Rodge and Yadlod (2009) conducted experimental studies on effect of organic and inorganic fertilizers on growth, yield and quality of tomato

(*Lycopersicon esculentum* Mill.) and the results revealed that highest number of fruits per plant, fruit weight, fruit yield per plant and per plot were recorded with the application 50 percent RDF and 50 percent FYM (T-8). Singh and Singh, (2004) conducted experiment at Narendra Deva University of Agriculture and Technology, Uttar Pradesh reported that the application of NPK at the rate 120:60:60 kg/ha, farmyard manure at the rate 10 t/ha, sulphur at the rate 25 kg/ha, *Azotobacter*, mixture of all micronutrients significantly influenced the length of fruit (5.72 cm), width of fruit (6.56 cm), number of fruits/plant (6.56), average fruit weight (51.98 g) and fruit yield per plant (1.158 kg) and fruit yield (368.35 q/ha).

1.6 Effect of Integrated nutrient Management on quality parameters

Chopra *et al.* (2017) studied effects of INM on agronomical attributes of tomato (*Lycopersicon esculentum* L. cv. F_1 Hybrid Arka Rakshak) under field conditions. Investigation revealed that among the different treatment combinations the characters like chlorophyll content (4.68 mg/gfwt) and total sugars are recorded highest with 50 % RDF and agro-residue vermicompost (ARV) @ 5 t/ha. Mengistu *et al*. (2017) conducted experimental studies at Dire Dawa on the integrated use of excreta-based vermicompost and inorganic Nitrogen, Phosphorus fertilizer on tomato (*Solanum lycopersicum* L.) fruit yield, quality and soil fertility. Results showed that maximum TSS (4.89 ºbrix) obtained with 75percent RDF and 11.25 ton/ha vermicompost. Rajeev *et al*. (2017) investigated effects of INM on growth, yield and quality of Tomato (*Lycopersicon esculentum* L.) cv. Pusa Ruby. Findings concluded that combination of RDF 25 percent, farmyard manure 25 percent, *Azotobactor* 25 percent and *Azospirillum* 25 percent given maximum acidity (0.59%), TSS (6.04) and vitamin-C (27.37 mg/100g). Kumar, (2016) conducted experimental studies on use of integrated nutrient management to enhance soil fertility and crop yield of hybrid cultivar of brinjal (*Solanum melongena* L.) under field conditions. Results revealed that among various treatments the highest chlorophyll content (4.82mg/100g) and total sugar of brinjal was recorded with 50percent of RDF and vermicompost at 5t/ha. Ilupeju *et al*. (2015) carried research work on impact of organic and inorganic fertilizers on growth, fruit yield, nutritional and lycopene contents of three varieties of tomato (*Lycopersicon esculentum* L.) in Ogbomoso, Nigeria. The highest vitamin C content 23 to 67 percent increase in Roma VF as compared with other varieties with application of 50 percent NPK and 50 percent tithonia compost. Laxmi *et al*. (2015) conducted experiment on effect of organic manures and chemical fertilizers on plant growth, yield, fruit quality and shelf life of tomato (*Solanum lycopersicon* L.) Cv. PKM-1. The plants treated with combination of 50 percent RDF and 50 percent FYM recorded highest TSS (5.0 ºbrix), ascorbic acid content (26.54 mg/100 g fruit

juice) and shelf life (11.67 days at room temperature). Chatterjee *et al.* (2013) conducted experimental studies on vermicompost substitution influences shelf life and fruit quality of tomato (*Lycopersicon esculentum* Mill.). Results showed that 75 percent RFD, 4 Mt/ha vermicompost and microbial amendment (22.67 days) followed by 75percent RFD and 4 Mt/ha vermicompost (20.67 days) and 75 percent RFD, 6 Mt/ha manure, 2 Mt/ha vermicompost and microbial amendment (19.33 days) gave maximum shelf life of tomato fruits at room temperature.75 percent RFD, 4 Mt/ha vermicompost and microbial amendment treatment shown maximum TSS (4.52 ºBrix) and total sugar (2.84%). Chaitanya *et al.* (2011) conducted research work on effect of integrated nutrient management on soil dehydrogenase activity, nutrient uptake and fruit yield of tomato (*Lycopersicon esculentum* L.). Plants received with 50 percent Vermicompost and 50 percent poultry manure recorded highest ascorbic acid (30.83 mg/100g) and lycopene (4.05 mg/100g).

1.7 Effect of Integrated nutrient Management on post-harvest soil parameters

Kumari and Tripathi (2018) conducted experimental studies at department of soil science and water management (farm), Dr. Y.S. Parmar University, Solan and concluded that more available phosphorus (91.07 kg/ha), available potassium (285.38 kg/ha) was recorded in T_3 80% NPKM + 20% N through FYM and VC (50:50) and PGPR treatment at harvest stage of the crop, respectively. Islam *et al.* (2013) reported highest soil pH (6.88), organic carbon (1.22%), total nitrogen content (0.41%), available P (20.79 µg g^{-1} soil) and exchangeable K (0.27 cmol 100 g^{-1} soil) was found from combined application of poultry manure @ 3 tonnes per hectare, rice straw @ 5 tonnes per hectare and recommended dose of plant hormone in post-harvested soil sample. Prativa and Bhattarai (2011) conducted research at integrated research farm of HICAST at Bandegaon, Lalitpur and clearly explained about available nutrient status of different integrated nutrient management treatments. Among the treatments maximum values for available nitrogen (382.80 kilogram per hectare), available phosphorus (100.40 kilogram per hectare) and available potash (230.80 kilogram per hectare) got with application of 1/2 NPK + 15 mt/ha Vermicompost (T_5). Babajide *et al.* (2012) reported that maximum pre cropping initial soil pH is 6.12 and maximum post cropping soil pH (6.34) were recorded in treatment C_2F_2 (composted tithonia-biomass@ 5 tonnes per hectare and 60 kg nitrogen in the form of urea per hectare). Mengistu *et al.* (2017) conducted experimental studies on integrated use of excreta-based vermicompost and inorganic Nitrogen, Phosphorus fertilizer on tomato (*Solanum lycopersicum* L.) fruit yield, quality and soil fertility and reported that maximum organic matter content (2.66%), recorded through application of zero percent RDF and 15 tonnes of vermicompost per hectare (T_8), application of 75% RDF and

3.75 tonnes vermicompost per hectare (T_4) gave maximum pH (8.59) and available phosphorus (25.69 ppm) recorded in T_6 (75% RDF and 11.25 vermicompost tonnes per hectare). Tekale *et al.* (2017) carried out an experimental work at regional horticultural research station (RHRS), agricultural University, Navsari, Gujarat on integrated nutrient management (INM) on nutrient availability, uptake and yield of tomato (*Lycopersicon esculentum* Mill.) cv. "Gujrat Tomato-2". Results showed that highest available nitrogen (255 and 259 kg/ha), available phosphorus (61.9 and 31 kg/ha) and available potash (327 and 322 kg/ha) recorded with application of farmyard manure @ 20 tonnes per hectare and 100 % Recommended Dose of Fertiliser (T_1). Avhad *et al.* (2016) conducted experiment at department of horticulture, tomato improvement scheme, M.P.K.V., Rahuri (alkaline soils) to know the effect of INM on growth, yield, quality and nutrient uptake in tomato. Recommended Dose of Fertilizers (300:150:150 kg NPK) and 20 tonnes of FYM per hector (T_3) gave highest organic carbon (0.62%).

1.8 Effect of Integrated Nutrient Management on benefit cost ratio

Kumar *et al.* (2017) conducted experiment at department of vegetable Science, vegetable research farm, Haryana Agricultural University on the response of tomato (*Lycopersicon esculentum* Mill.) to INM. Results found that application of 43.5 tonnes of FYM and 50 percent of RDF gave highest B: C ratio (1.29). Laxmi *et al.* (2015) conducted experiment on effect of organic manures and chemical fertilizers on plant growth, yield, fruit quality and shelf life of tomato (*Solanum lycopersicon* L.) *cv.* PKM-1. Results showed that 50 percent Recommended Dose of Fertilizer and 50 percent Farm Yard Manure combination recorded maximum B:C ratio (2.75:1). Manohar *et al.* (2013) conducted experiment at farm of department of horticulture, S.K.N. College of agriculture, Jaipur and was on the integrated nutrient management in tomato (*Lycopersicon esculentum* Mill) cv. Rocky. Results shown that application of FYM 15 t/ha along with 75 per cent RDF (NPK), B and Zn has best treatment combination in terms of net returns and B: C ratio. Singh and Singh, (2004) conducted experiment at Narendra Deva University of Agriculture and Technology, Uttar Pradesh and reported that application of NPK at the rate 120:60:60 kg/ha, FYM at the rate 10 t/ha, sulphur at the rate 25 kg/ha, *Azotobacter*, mixture of all micronutrients significantly gave maximum benefit cost ratio 2.40 as compare to control.

Conclusion:

In conclusion, the review examination put emphasis on the management approaches of organic and inorganic nutrient sources, role, and the significances of Integrated Nutrient

Management in Tomato. In current times, India is the 2nd most populous country in the world with an rapid rate of increasing population and shrinkage of cultivable land resource regularly have made evident that the food needed for the growing population could be meet only by increased agricultural production and productivity. The Integrated Nutrient Management is the substitute method for sustainable, environment friendly and cost-effective management for improving soil fertility (health), soil productivity, quality, and reducing the impact of synthetic fertilizers on the environment. Combined application of inorganic and organic nutrient sources resulted in good growth, yield and quality attributes of Tomato, significantly higher yield, and controlling disease in Tomato. Hence, there is a vital need to examine the impact of straight or integrated application of organic manure, inorganic fertilizer along with biofertilizers with possible reduction of inorganic fertilizers on the yield and quality of Tomato. Finally, the findings suggested that Integrated Nutrient Management may be one of the viable nutrient management options in for Tomato.

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