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INTEGRATED NUTRIENT MANAGEMENT IN FRUIT CROP PRODUCTION: A REVIEW

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ABSTRACT

The extensive use of chemical pesticides, combined with inadequate nutrient management, presents substantial hazards to plant health, the environment, and human consumers. This indiscriminate reliance on synthetic agrochemicals has negative repercussions on the quality of diverse fruits, resulting in diminished consumer favour and decreased profits for farmers. Moreover, it fosters soil degradation and disturbs soil microorganisms, practices commonly observed among fruit growers. These detrimental methods heighten plants' vulnerability to both biotic and abiotic stresses. As a solution, adopting a holistic approach that harmonizes various sources of plant nutrients becomes imperative to uphold soil fertility and secure a consistent nutrient provision for sustaining optimal crop productivity.
***Keywords* :** Nutrient management, environment, organic manure, bio-fertilizers, quality, soil fertility & crop productivity.

Introduction

India benefits from a diverse array of climate and physio-geographical conditions, facilitating the adaptation of various horticultural crops to different agro-climatic regions across the country. Fruit crops cover a cultivation area of over 6506 thousand hectares in India, yielding a total production of 97358 thousand metric tonnes and achieving a productivity rate of 14.96 tonnes per hectare (Anonymous, 2018). Fruit production has indeed seen significant growth in the past decade; however, a noticeable gap persists between fruit demand and supply. Meeting the nutritional needs of the expanding population poses a formidable challenge to agrarian communities. Furthermore, fruits are integral to the human diet, serving as essential sources of vitamins, minerals, oils, fats, and proteins crucial for maintaining health and bolstering immunity.

In contemporary orchard management, inorganic fertilizers represent one of the costliest inputs. Nevertheless, the continuous application of large quantities of chemical fertilizers poses risks to soil health, productivity, environmental integrity, produce quality, and human health. Given these considerations, there is an imperative to enhance fruit production and productivity through Integrated Nutrient Management (INM).

What does Integrated Nutrient Management entail?

Integrated Nutrient Management encompasses the utilization of a combination of inorganic, organic, and biological sources of vital plant nutrients to enhance crop productivity while preserving or enhancing soil physico-chemical characteristics. This approach offers crop nutrition solutions that are technically robust, economically viable, operationally feasible, and environmentally sustainable. The primary objective of this integrated strategy is to optimize the utilization of all available plant nutrient sources in a prudent and effective manner

Objectives of INM

1. To reduce the dependence on chemical fertilizers
2. To reduce inputs cost by conserving locally available resources & utilize them in an efficient manner
3. To maintain productivity on sustainable basis without affecting soil health
4. To increase the fertilizer, use efficiency
5. To utilize the potential benefits of green manures, leguminous crops and biofertilizers
6. To prevent degradation of the environment
7. To meet the social and economic aspirations of the farmers without harming the natural resource base of the agricultural production

Why INM is required

It is required due to the following reasons

1. The decline in productivity can be attributed to the appearance of deficiency in secondary and micronutrients
2. Consistent increasing cost of chemical fertilizers
3. Unavailability of fertilizers as per requirement
4. Environmental pollution and its ill effects on soil, animals and human being due to continuous and excessive use of chemical fertilizers
5. Continuous depletion of soil nutrients
6. Without an integrated supply and use of plant nutrients from chemical fertilizer and organic sources, better production is not possible
7. The fertilizer production in our country is less than the required amount

Therefore, organic manures and biofertilizers have to be looked for as alternate sources to meet the nutrient requirement of crops and to bridge the more gaps. Such integrated approach will help to maintain soil health and productivity and improving farmer's profitability. It involves following components.

1. Use of organic manures
2. Use of biofertilizers
3. Use of chemical fertilizers
4. Management of problematic soils
5. Irrigation water management

Organic manures

Organic manures are materials of organic origin derived from plants and animals, utilized to enhance soil fertility and productivity. They primarily consist of organic matter in significant proportions and relatively low quantities of plant nutrients. Their application aims to amend soil physical, chemical, and biological properties, thereby improving soil productivity. Examples include Farm Yard Manure (FYM), vermicompost, compost, oil cakes, and green manure, among others. Green manure refers to freshly decomposed organic material used as a form of manure. It is acquired through two methods: cultivating green manure crops or collecting green leaves (along with twigs) from plants grown in various locations such as wastelands, fields, bunds, and forests. Green manuring typically involves cultivating plants, often belonging to the leguminous family, which are then incorporated into the soil after attaining sufficient growth. These plants grown specifically for green manuring purposes are termed green manure crops. Crop residues comprise materials remaining in agricultural fields or orchards post-harvest, usually after the leaf fall stage in fruit crops. These residues encompass stalks, stubble, leaves, seed pods, etc., which are also valuable as animal feed. In some cases, poultry manure or droppings are blended with other additives and utilized as feed for fish or cattle. Crop residue management typically involves practices such as removal, burning, or incorporation into the soil. While burning is a less common practice in India, crop residues serve as essential sources of organic matter that can be reintroduced into the soil for nutrient recycling and to enhance soil physical, chemical, and biological properties. (Kumar and Goh, 2000).

Biofertilizers

Biofertilizers are substances containing living cells of various microorganisms capable of converting nutritionally essential elements from non-usable to usable forms through biological processes. Examples include nitrogen-fixing bacteria such as Rhizobium, Azotobacter, and Azospirillum, phosphorus-solubilizing bacteria (PSB), potassium-solubilizing microorganisms (KSM), and Vesicular Arbuscular Mycorrhizae (VAM), among others. These microorganisms play a crucial role in enhancing soil fertility and promoting plant growth by making essential nutrients more accessible to plants.

Chemical fertilizers

Fertilizers are substances utilized to provide essential nutrients to crops, thereby enhancing their growth and productivity. Traditionally, the term "fertilizers" encompassed various materials fulfilling this purpose. However, in modern usage, "fertilizer" primarily refers to commercially manufactured, inorganic fertilizers. Chemical fertilizers, on the other hand, are defined as any material, whether solid, liquid, or gaseous, containing one or more nutrient elements in the form of chemical compounds, which may be organic or inorganic in nature.

Management of problematic soils

Problematic soils, including saline, alkali, acid, and waterlogged soils, have a detrimental impact on soil productivity. To address this, regular management and reclamation are necessary, often involving the application of soil amendments tailored to specific soil conditions. For instance, gypsum is utilized for alkali soils, lime for acid soils, and high-quality water for saline soils. Additionally, other organic and inorganic materials may be employed based on soil test results. This comprehensive approach aids in improving soil fertility, enhancing productivity, and sustaining crop yields.

Irrigation water management

Plants exclusively uptake nutrients from the soil when they are dissolved in water, emphasizing the necessity of sufficient moisture for nutrient utilization. Effective management of soil moisture through advanced irrigation methods such as drip, sprinkler, or basin systems, particularly in regions with low rainfall, is crucial. Additionally, draining waterlogged soils helps prevent stagnation, thereby enhancing water and nutrient accessibility to crops. This integrated approach optimizes water and nutrient availability, fostering healthier plant growth and improved crop yields.

Major Steps in Integrated Nutrient Management

1. Evaluate the field for potential of crop yield
2. Determine residual nutrient availability and major yield limiting factors for each field
3. Based on soil and leaf nutrient analysis, correction of nutrient deficiency will result in higher yield
4. Evaluate availability of on-farm nutrients from plant residues, green manures, cover crops, animal manures, symbiotic N-fixation by legumes and nutrients in irrigation water
5. Estimate and prioritize supplemental nutrient requirements for each field and crop
6. Establish the most efficient nutrient application programme with respect to crop, nutrient source, time of application, placement method and quantity
7. Regularly evaluate the results of nutrient application in terms of yield and quality responses of crop, residual nutrient levels and changes in soil quality

Mango

Kundu *et al.* (2011) conducted an experiment on mango at Horticultural Research Station, Bidhan Chandra Krishi Viswa vidyalaya, West Bengal and obtained higher fruit yield when the plants were treated with 100% NPK + Azotobacter + VAM (98.1 kg/plant) or 75% NPK + Azotobacter + VAM (93.5 kg/plant) as compared to much lesser yield (60 Kg/plant) with 100% NPK. It was concluded that the treatments 100% NPK + Azotobacter + VAM and 75% NPK + Azotobacter + VAM were effective and may be adopted to improve the vegetative growth and productivity with quality fruits.

Singh and Banik (2011) reported significantly maximum physical parameters viz., fruit weight (244.22 g), pulp weight (189.86 g), with minimum stone weight (26.18 g) through application of ½ RD of NPK + 50 kg FYM + 250 g Azospiriliium treatment. They also observed significantly maximum quality parameters viz., TSS (19.24 0Brix), reducing sugar (4.44%), total sugar (15.48%) with minimum acidity (0.14%) in same treatment.

Yadav *et al.* (2011) were recorded significantly maximum fruit length (10.08 cm), fruit width (6.62 cm), fruit weight (153 g), pulp weight (97.08 g), number of fruits/tree (184.67), fruit yield (26.72 q/ha), TSS (23.91 0Brix), ascorbic acid (45.63 mg/100 g) and total sugar (18.34%) with minimum acidity (0.121%) when mango trees treated with the application of recommended dose of NPK (500:250:250 g/tree) + 30 kg vermicompost + 250 g Azotobacter + 250 g PSB + Zn (0.40%) + paclobutrazol 5 ml/tree. Gautam *et al.* (2012) [12] observed that number of fruits/tree (409.6) and fruit yield (124.67 kg/tree) were found significantly maximum when mango plants treated with application of ½ RD of NPK + 50 kg FYM + 10 kg vermicompost/plant.

Kumar and Kumar (2013) were record of fruits/tree (840.0) and fruit yield (127.43 kg/tree) were found significantly maximum with application of 75 kg vermicompost/tree. Singh *et al.* (2017) studied the effect of integrated nutrient management on mango cv. Amrapali under high density planting at Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut and reported that maximum plant height, spread and number of panicles/plant were recorded in the plants treated with 75% RDF (750:375:750 g of N:P2O5:K2O) + 40 kg vermicompost + 250 g Azotobacter + 250 g PSB/plant closely followed by 75% RDF + 20 kg vermicompost + 250 g Azotobacter + 250 g PSB/plant. Whereas, they obtained the highest fruit length, fruit width, fruit weight, fruit yield, TSS, reducing sugar, non reducing, total sugar and lowest acidity in 75% RDF (750:375:750 g of N: P2O5:K2O) + 20 kg vermicompost + 250 g Azotobacter + 250 g PSB per plant treatment closely followed by 75% RDF + 40 kg vermicompost + 250 g Azotobacter + 250 g PSB per plant.

Banana

Hazarika and Ansari (2010) observed that bunch weight (16.50 kg), number of hands per branch (9.32) and fingers per hand (23.04) and yield (73.96 ton/ha) were significantly recorded maximum when banana plants treated with 100% RD of NPK (P as rock phosphate) + 12 kg FYM + 50 g Azospirillium + 50 g PSB /plant. Butani *et al.* (2012) found that application of full dose of NPK (300:90:200 g/tree) + 8 kg vermicompost gave maximum yield (55.64 ton/hectare). Patil and Shinde (2013) [30] reported that the maximum plant height (190.84 cm), plant girth (81.34 cm), number of leaves per plant (32.30) and leaf area (17.93 m2) with the minimum number of days (211.03) for shooting after planting and number of days for harvesting after shooting (117.46) were recorded under 50 per cent RDF + FYM + Azotobacter (50 g/plant) + PSB (50 g/plant) + VAM *Glomus fasciculatum* (250 g/plant). Similarly, this treatment was found beneficial in increasing bunch weight (19.31 kg) and yield per hectare of banana (85.80 t/ha). Vanilarasu and Balakrishnamurthy (2014) studied that combined application of organic manures, amendments and green manures (FYM @ 10 kg + neem cake @ 1.25 kg + vermicompost @ 5 kg and wood ash @ 1.75 kg per plant + triple green manuring with sun hemp + double intercropping of cow pea + biofertilizers viz., Vesicular Arbuscular Mycorrhizae @ 25 g, Azospirillum @ 50 g, phosphate solubilizing bacteria @ 50 g and *Trichoderma harzianum* @ 50 g per plant) registered the maximum growth and resulted in increasing yield and yield attributes, leaf nutrient status of N, P and K at 5th and 7th month after planting of banana and soil physiochemical properties at harvesting stage. Sangeeta *et al.* (2017) was reported maximum TSS (24.01 ºBrix), reducing sugar (18.92%), non-reducing sugar (3.51%) and total sugar (22.43%) by application of FYM @ 10 kg per tree + neem cake @ 1.25 kg per tree + vermicompost @ 5 kg per tree + wood ash @ 3.75 kg per tree in banana crop. Suhasini *et al.* (2018) were conducted research and studied the effect of integrated nutrient management on growth parameters of banana cv. Rajapuri and observed the highest plant height (197.44 cm) and pseudostem girth (73.05 cm) at shooting with application of RDF 100% (200,100,300 g NPK) + 20 kg FYM + PSB (20 g) + Azospirillum (20 g) per plant.

Citrus fruit crop

Musmade *et al.* (2009) was recording significantly higher yield (147.65 kg/plant) with better quality fruits were obtained from the 10-year-old trees receiving 600:300:600 g NPK + 15 kg each of FYM and neem cake per plant per year. Lal and Dayal (2014) were recorded the maximum vegetative growth and yield (7.58 kg per tree) of acid lime having highest fruit length (4.43 cm), fruit diameter (3.99 cm) and fruit weight (35.71 g) along with minimum seed (1.15%) and acidity content (6.06%) when plants treated with 50 per cent RDF + 50 per cent through goat manure. Similarly, maximum juice (43.37%), TSS (10.42%) and ascorbic acid content (86.33 mg/100 g juice) in the same treatment. Nurbhanej *et al.* (2016) was studied the effect of integrated nutrient management on yield and quality of acid lime at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand and reported that the acid lime trees treated with 75% RDF (675:562:375 g NPK) + 9 kg vermicompost + AAU PGPR Consortium (3.5 ml/tree) gave maximum fruit yield, fruit volume, fruit diameter, fruit weight, TSS, ascorbic acid and acidity. Prabhu *et al.* (2018) revealed that the application of 100 per cent recommended dose of fertilizers (600:200:300 g NPK per plant/year) + Azospirillum (100 g per plant) + phosphobacteria (100 g per plant) + Arbuscular Mycorrizhal Fungi (500 g per plant) + *Trichoderma harzianum* (100 g per plant) has showed a superior performance with respect to yield, yield attributing components and quality attributes of acid lime.

Guava

Dey *et al.* (2005) was reported significantly maximum fruit weight (154.50 g), fruit length (4.27 cm) and fruit diameter (4.68 cm) with the application of 200 g Phosphobacterin/ tree whereas TSS (10.10 0Brix) and vitamin C (151.8 mg/100 g) were found significantly maximum with application of 200 g VAM/tree. Ram *et al.* (2007) were reported that the application of different fertilizers, organic manures and biofertilizers improve the vegetative growth, number of fruits and yield of guava cv. Sardar. Dutta *et al.* (2009) was observed that fruit length (9.5 cm), fruit diameter (8.9 cm), weight of fruit (255.0 g), weight of pulp (205.0 g) and fruit yield (51.26 kg/plant) were found significantly maximum in 100% N + 100% P2O5 + 30 g Azospirillium + 30 g VAM/plant treatment. Godage *et al.* (2013) [13] reported significantly minimum days of flowering (32.33) and the highest fruit characters like number of flowers/branch (25.33), fruit set/branch (90.20%), fruit diameter (10.07 cm) and fruit weight (215.06 g) when guava plants treated with 75% N + 75% P2O5 + 100% K2O + Azotobacter 5ml /tree + PSB 5ml /tree. Shukla *et al.* (2014) gave stated that application of 10 kg vermicompost + Azotobacter + phosphate solubilizing microorganism + *Trichoderma harzianum* + organic mulching recorded the highest fruit weight, fruit diameter, fruit length, TSS, titratable acidity, total sugars and ascorbic acid content. Dwivedi and Agnihotri (2018) were revealed the application of 50 per cent RDF (250:100:250 g NPK) + 25 kg FYM + 5 kg vermicompost per tree gave maximum plant height (3.93 m) and canopy height (3.06 m), spread E-W and N-S (3.85 & 3.66 m), plant girth (0.33 m), leaf length (6.99 cm) and width (3.51 cm) and tree volume (369 m3) as well as significantly increased yield attributes viz., number of fruits per tree (200), fruit weight (258 g) and yield per tree (34.3 kg). Kumrawat *et al.* (2018) were revealed the application of 100% NPK + 5 kg vermicompost + 150 gm Azotobacter recorded maximum TSS (12.67 ºBrix), TSS/acid ratio (56.39), ascorbic acid (206.07 mg/100 g pulp), pectin (0.75%), total sugars (8.21%), reducing sugars (4.15%) and non-reducing sugars (4.06%) with minimum acidity (0.23%). Whereas, the maximum number of fruits per tree (286.91), fruit weight (209.88 g) and yield per tree (60.20 kg) were recorded with the application of 100% NPK + 5 kg vermicompost + 150 g VAM. Tiwari *et al.* (2018) was recorded the maximum plant height (4.07 m), circumference of root stock (38.51 m) and scion (36.57), plant spread E-W and N-S (3.79 & 3.80 m), leaf length (17.98 cm), leaf width (8.94 cm), tree volume (184 m3) and fruit yield (65.58 kg/tree and 181.64 q/ha) in case of when fruit trees treated with 100% NPK (500:250:500 g) + Zn (05%), B (0.2%), Mn (1%) as foliar spray twice + organic mulch (10 cm thick).

Sapota

Patel and Naik (2010) were revealed the application of 5 kg vermicompost + 400 + 60 + 300 g NPK/tree was found to be superior in extending post-harvest shelf-life and physico-chemical parameters viz., volume, peel weight, pulp weight, colour acceptance, TSS, reducing sugar, non reducing sugar, acidity and vitamin C content, while maximum firmness of fruits was found under 25 kg FYM + 400 + 60 + 300 g NPK/tree. Organoleptic test in respect of colour and texture was more acceptable under 5 kg vermicompost + 400 + 60 + 300 kg NPK/tree while flavour and taste were superior under 25 kg FYM alone/tree. Baviskar *et al.* (2011) concluded that fruit weight (125.87 g), fruit length (4.36 cm), fruit breadth (5.26 cm), fruit volume (117.20 cc), pulp weight (101.66 g), peel weight (22.50 g), number of fruits/plant (1569.33) and fruit yield (197.53 kg/plant) were found significantly maximum in 1125:750:375 g NPK + 15 kg vermicompost + 250 g Azotobacter + 250 g PSB/plant treatment. Similarly, quality traits like TSS (23.16 0Brix) and total sugar (18.03%) were found significantly maximum with minimum acidity (0.050%) in same treatment. Patel *et al.* (2017) recorded maximum total soluble solids (24.50 ºBrix), acidity (0.21%), ascorbic acid (20.37 mg/100 g pulp), reducing sugar (10.52%), non-reducing sugar (12.01%), total sugars (22.53%), shelf life of fruits (8.05), fruit firmness (7.78 kg/cm2) and physiological loss in weight (5.24%) 4th day after harvest when trees were treated with 75% NPK + vermicompost 15 kg + AAU Bio NPK 10 ml/tree.

Pomegranate

Hiwale (2009) mentioned about an experiment carried out at Central Horticultural Experiment Station, Vejalpur on pomegranate crop and reported that fruit characteristics of pomegranate like fruit weight (188.75 g), fruit length (69.72 mm), fruit retention per plant (57) and fruit yield (10.75 kg/plant) were significantly observed maximum when plants treated with 50 per cent N through FYM + 25 per cent N through castor cake + 25 percent N through urea. Dighe *et al.* (2014) was reported that total number of fruits per tree (86.27), marketable fruit yield (27.95 kg/tree or 20.68 ton/ ha) and total fruit yield (31.06 kg/tree or 22.98 ton/ha) were found significantly maximum when pomegranate plants treated with GRDF while average weight of fruit (370 g) were found significantly maximum in 50% RDN and 50% N through FYM treatment. Dutta Ray *et al.* (2014) was investigated that the fruits of pomegranate treated with 300 g nitrogen + 1 kg neem cake plant per hectare showed significantly maximum fruit weight (239.83 g), fruit length (7.75 cm), fruit yield (6.94 kg/plant), juice content (75.63%), total soluble solid (12.29 0Brix), TSS/acid ratio (31.36), reducing sugar (9.78%) and total sugar (10.74%) with minimum acidity (0.39%). Greeshma *et al.* (2017) was carried out an experiment on pomegranate crop at Kaladagi village of Bagalkot district, Karnataka and recorded the highest number of hermaphrodite flowers (139.0), number of fruit (98.01) and marketable fruit yield (26.43 kg/plant & 19.56 t/ha) with application of 50% RDN & P_2O_5 (200: 100: 200 N: P_2O_5:K_2O gram per plant) + 20 kg oil cakes + bioinoculants treatment. Whereas, fruit weight (294.20 g) and size (77.19 & 102.55-mm fruit diameter and length) was noticed maximum in 75% RDN & P2O5 (300: 150: 200 N: P_2O_5: K_2O gram per plant) + 10 kg oil cakes + bioinoculants treatment. Kirankumar *et al.* (2018) were conducted an experiment on pomegranate at the farmer's field of Somerhalli village, Hiriyurtaluk of Chitradurga district, Karnataka and revealed that application of 100% recommended dose of fertilizers (RDF) along with vermicompost + poultry manure + Azospirillum + PSB + KSB has recorded the maximum aril weight (212.47 g), aril per cent (72.53%) and lowest seed: aril ratio (0.016). Whereas, maximum TSS (15.30 ºBrix), TSS/TA ratio (46.48%), reducing sugars (12.79%), non-reducing sugars (1.65%) total sugars (14.39%), and lowest titratable acidity (0.33%) was recorded in 100% recommended dose of fertilizers (RDF) along with vermicompost + poultry manure + Azospirillum + PSB + KSB.

Papaya

Singh *et al.* (2010) revealed that maximum number of leaves (18.73), trunk girth (0.26 m), number of fruits per plant (46), average fruit weight (0.85 kg), pulp thickness (3.5 cm), shelf life of fruit (12 days), vitamin A (2280 IU/100 g pulp) and TSS (15.8 °Brix) were recorded with 75% RDF + 25% vermicompost + rhizosphere bacteria culture treatment, while maximum plant height (185.35 cm) and petiole length (8.42 cm) were observed with 100% RDF alone. Yadav *et al.* (2011) [46, 47] revealed that combination of 10 kg vermicompost + 100% NPK+ 25 g Azotobacter enhanced the growth characters like plant height, girth and fruiting depth and improved physico-chemical characters like fruit length, width, ascorbic acid, total soluble solids and total sugar content compared to other treatments. Shivakumar *et al.* (2012) were revealed that application of FYM equivalent to 100 per cent recommended dose of nitrogen (RDN) (154.3 t/ha) in papaya gave significantly higher fruit yield of 173.9 t/ha as compared to control with RDF and other organic manure treatments except agrogold equivalent to 100 per cent RDN (33.32 t/ha) and vermicompost, sheep manure and bhumilabha in combination with FYM treatments each equivalent to 50 per cent RDN. Tandel *et al*. (2017) indicated that the application of 25% RDN through bio compost + 25% RDN through castor cake + 50% RDN through inorganic fertilizer gave higher values of yield characters viz., number of fruit (28.57), average weight of fruit (1.062 kg), yield per plant (30.24 kg), yield per hectare (83.99 t), fruit diameter (24.87 cm) and fruit volume (900.23 ml) with minimum fruit cavity index (24.13%) and initiation of flowering (105.17 day). Similarly, fruit firmness (7.38 Kg/cm2), shelf life (7.54 days), total soluble solid (8.12%), total sugar (9.80%), reducing sugar (8.45%) and vitamin C (23.90 mg/100g pulp) was found in same treatment along with minimum physiological loss in weight (11.20%) and titratable acidity (0.016%).

Bael

Vishwakarma *et al.* (2017) showed that maximum fruit length, fruit width, fruit weight, pulp weight, TSS and ascorbic acid were recorded with application of 50 kg FYM + 100% NPK + 200 g each (Azotobacter + PSB).

Ber

Bohane and Tiwari (2014) conducted an experiment at College of Horticulture, Mandsaur on five years old trees of ber cv. Gola and revealed that the application of 50 per cent recommended dose of NPK as vermicompost + 50 per cent RDF NPK + 50 g Azotobacter + 50 g PSB significantly increased the fruit length and diameter, fruit volume, pulp weight, stone weight, TSS, ascorbic acid, reducing sugar, non-reducing sugar, total sugars, TSS/acid ratio and chlorophyll content in leaves spad value over other treatments.

Litchi

Dutta *et al.* (2010) was conducted an study and shown that the application of 50 kg/tree FYM + 150 g Azotobacter + 100 g VAM + 500 g N: 250 g P_2O_5: 500 g K_2O/tree/year through fertilizer showed maximum yield (98.72 kg/plant) and also have a significant improvement in terms of TSS, total sugars, ascorbic acid, TSS: acid ratio, fruit weight and fruit size. Rani *et al*. (2013) was conducted an experiment on litchi cv. Rose Scented for two years at Horticulture Research Centre, Patharchatta, Pantnagar and obtained maximum tree height, tree spread, tree volume, panicle length, fruit set, fruit retention and higher yield through application of FYM at 150 kg per tree.

Aonla

Korwar *et al*. (2006) was stated that the growth, yield and quality of aonla were influenced by different sources of nutrients. Combination of organic and inorganic nutrients increased the fruit yield and quality. Application of vermicompost improved the fruit quality. Mandal *et al*. (2013) concluded that the application of 100: 25:150 g NPK/plant + 10 kg FYM + 50 g PSB /plant is beneficial for increasing. Vegetative growth as well as improving yield and yield attributing characters of aonla cv. NA-7 under red and lateritic region of West Bengal.

Phalsa

Verma *et al.* (2014) revealed that the application of FYM + 75 per cent NPK + Azotobacter + PSB + $ZnSO_4$ (0.4%) recorded maximum plant growth and fruit yield (5.06 kg per plant and 5.23 kg per plant) in both the year, respectively. Similarly, maximum physical characters viz., fruit length (1.13 and 1.15 cm), fruit breadth (1.37 and 1.35 cm), weight of fifty fruits (38.63 and 39.10 g) and juice per cent (51.11 and 51.92%) and pulp/stone ratio (1.60 and 1.62) as well as maximum chemical characters viz., TSS (27.64 and 27.91%), ascorbic acid (38.51 and 38.21 mg/100 ml juice), reducing sugars (19.38 and 19.40%), non reducing sugars (2.37 and 2.38%) and total sugars (21.74 and 21.78%) along with minimum acidity (2.24 and 2.20%) were obtained in the same treatment during both the years respectively. Mani *et al*. (2013) were studied on the application of Azotobacter inoculated treatment with 75% N substitution by phosphate solubilizing bacteria and remaining 25% through inorganic fertilizer in two equal splits at establishment and before flowering stage increased length of shoot, number of shoots, number of leaves per shoot, internodal lengths, number of fruits per node, number of fruiting node per shoot, fruit yield, fruit length & width, juice per cent, pulp stone ratio and acidity. Basith *et al.* (2018) concluded that pruning of phalsa bushes around 20th December has resulted in a greater number of fruit clusters and yield under the Southern Telengana Agro-climatic conditions. Integrated application of 50% RDF along with organic manure and biofertilizers is best option to obtain higher yields and superior fruit quality in phalsa.

Conclusion

In conclusion, Integrated Nutrient Management (INM) stands as a pivotal strategy for sustainable agriculture, particularly in the cultivation of horticultural crops like fruits. India's diverse climatic and physio-geographical conditions provide an ideal backdrop for the adaptation of various fruit crops across different agro-climatic regions. However, despite the significant growth in fruit production over the past decade, a notable gap remains between demand and supply, posing a challenge to meet the nutritional needs of the growing population. INM offers a comprehensive approach to enhance fruit production and productivity while safeguarding soil health and environmental integrity. By combining inorganic, organic, and biological sources of vital plant nutrients, INM optimizes nutrient utilization in a manner that is technically sound, economically viable, operationally feasible, and environmentally sustainable. The key objectives of INM include reducing dependence on chemical fertilizers, minimizing input costs by utilizing locally available resources efficiently and sustaining productivity without compromising soil health, increasing fertilizer use efficiency, and mitigating environmental degradation. Several factors necessitate the adoption of INM, including the decline in productivity due to nutrient deficiencies, rising costs of chemical fertilizers, unavailability of fertilizers, environmental pollution from excessive fertilizer use, continuous depletion of soil nutrients, and insufficient fertilizer production. To address these challenges, organic manures and biofertilizers emerge as alternative nutrient sources, essential for bridging the nutrient gaps and maintaining soil health and productivity. INM encompasses various components, including the use of organic manures, biofertilizers, chemical fertilizers, management of problematic soils, and irrigation water management. Each component plays a crucial role in optimizing nutrient availability, enhancing soil fertility, and promoting healthy plant growth. Furthermore, INM's efficacy is evidenced by numerous studies conducted on various fruit crops like mango, banana, citrus fruits, guava, papaya, pomegranate, sapota, ber, litchi, aonla, and phalsa. These studies demonstrate that integrated nutrient management practices significantly improve fruit yield, quality, and other agronomic parameters, thereby contributing to sustainable fruit production. In essence, the adoption of Integrated Nutrient Management practices is imperative for ensuring food security, enhancing farmer livelihoods, and mitigating environmental risks in fruit cultivation. By harnessing the synergistic benefits of diverse nutrient sources, INM holds the key to sustainable and resilient horticulture systems in India.

References

Anonymous (2018). *Horticulture statistics*. Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Horticulture Statistics Division. Controller of Publications.

Basith, M. A., Khan, M. A., Ahire, L. M., & Mural, V. (2018). Response of phalsa (*Grewia subinaequalis* D.C.) to the dates of pruning and integrated nutrient management under sandy loam conditions of Southern Telangana state of India. *An International Refereed, Peer Reviewed & Indexed Quarterly Journal in Science, Agriculture & Engineering*, **8**(Special Issue E), 68–70.

Baviskar, M. N., Bharad, S. G., Dod, V. N., & Barne, V.G. (2011). Effect of integrated nutrient management on yield and quality of sapota. *Plant Archives*, **11**(2), 661–663.

Bohane, L., & Tiwari, R. (2014). Effect of integrated nutrient management on physico-chemical parameters of ber under Malwa plateau conditions. *Annals of Plant and Soil Research*, **16**(4), 346–348.

Butani, A. M., Chovatia, R. S., Patel, K. D., Vadaria, K. N., & Rankja, N. J. (2012). Effect of chemical fertilizer and vermicompost on yield, nutrient content and uptake by fruit of banana (*Musa paradisiaca* L.) cv. Grand Naine. *Asian Journal of Horticulture*, **7**(2), 594–598.

Dey, P., Rai, M., Kumar, S., Nath, V., Das, B., & Reddy, N. N. (2005). Effect of biofertilizer on physico-chemical characteristics of guava (*Psidium guajava* L.). *Indian Journal of Agricultural Sciences*, **75**(2), 95–96.

Dighe, S. S., Masalkar, S. D., Kulkarni, S. S., Kadlag, K. D., Chavan, U. D., & Patil, R. S. (2014). Effect of integrated nutrient management on yield of pomegranate (*Punica granatum* L.) cv. Bhagwa. *Ecology, Environment & Conservation*, **20**, S479–S483.

Dutta Ray, S. K., Takawale, P. V., Chatterjee, R., & Hnamte, V. (2014). Yield and quality of pomegranate as influenced by organic and inorganic nutrients. *The Bioscan*, **9**(2), 617–620.

Dutta, P., Kundu, S., & Biswas, S. (2010). Integrated nutrient management in litchi cv. Bombai in new alluvial zone of West Bengal. *Indian Journal of Horticulture*, **67**(2), 181–184.

Dutta, P., Maji, S. B., & Das, B. C. (2009). Studies on the response of biofertilizer on growth and productivity of guava. *Indian Journal of Horticulture*, **66**(1), 39–42.

Dwivedi, V., & Agnihotri, S. (2018). Effect of integrated nutrient management on growth, yield and economics of guava (*Psidium guajava* L.) cv. Allahabad Safeda. *International Journal of Current Microbiology and Applied Sciences*, **7**(6), 3449–3453.

Gautam, U. S., Singh, R., Tiwari, N., Gurjar, P. S., & Kumar, A. (2012). Effect of integrated nutrient management in mango cv. Sunderja. *Indian Journal of Horticulture*, **69**(2), 151–155.

Godage, S. S., Parekh, N. S., & Nehete, D. S. (2013). Influence of chemical and biofertilizers on growth, flowering, fruit yield and quality of guava (*Psidium guajava* L.) cv. Allahabad Safeda. *International Journal of Agricultural Sciences*, **9**(1), 309–313.

Greeshma, R. B. C., Suma, R., Nagaraja, M. S., & Kulapati, H. (2017). Effect of bioinoculants and organic supplementation on growth and yield of pomegranate. *International Journal of Environmental Sciences & Natural Resources*, **4**(4), 1–5.

Hazarika, B. N., & Ansari, S. (2010). Effect of integrated nutrient management on growth and yield of banana cv. Jahaji. *Indian Journal of Agricultural Sciences*, **67**(2), 270–273.

Hiwale, S. S. (2009). *The pomegranate*. New India Publishing Agency.

Kirankumar, K. H., Shivakumara, B. S., Suresha, D. E., Madaiah, D., & Sarvjna, B. S. (2018). Effect of integrated nutrient management on quality and biochemical parameters of pomegranate cv. Bhagwa under central dry zone of Karnataka. *International Journal of Chemical Studies*, **6**(1), 5–6.

Korwar, G. R., Pratibha, G., Ravi, V., & Palanikumar, D. (2006). Influence of organics and inorganics on growth, yield of aonla (*Emblica officinalis*) and soil quality in semi-arid tropics. *Indian Journal of Agricultural Sciences*, **76**(8), 457–461.

Kumar, K., & Goh, K. M. (1999). Crop residues and management practices: Effects on soil quality, soil nitrogen dynamics, crop yield, and nitrogen recovery. *Advances in Agronomy*, **68**, 197–319.

Kumar, M., & Kumar, R. (2013). Response of organic manures on growth and yield of mango (*Mangifera indica* L.) cv. Dashehari. *HortFlora Research Spectrum*, **2**(1), 64–67.

Kumrawat, D., Kanpure, R. N., Singh, O. P., Bhandari, J., & Kachouli, B. (2018). Effect of integrated nutrient management on quality and yield parameters of guava (*Psidium guajava* L.) cv. L-49. *Journal of Pharmacognosy and Phytochemistry*, **7**(5), 1668–1670.

Kundu, S., Datta, P., Mishra, J., Rashmi, K., & Ghosh, B. (2011). Influence of biofertilizer and inorganic fertilizer in pruned mango orchard cv. Amrapali. *Journal of Crop and Weed*, **7**(2), 100–103.

Lal, G., & Dayal, H. (2014). Effect of integrated nutrient management on yield and quality of acid lime (*Citrus aurantifolia* Swingle). *African Journal of Agricultural Research*, **9**(40), 2985–2991.

Mandal, K. K., Rajak, A., Debnath, S., & Hasan, M. A. (2013). Integrated nutrient management in aonla cv. A-7 in the red lateritic region of West Bengal. *Journal of Crop and Weed*, **9**(1), 121–123.

Mani, S., Meena, M. L., Kumar, V., & Ram, R. B. (2013). Impact of integrated nutrient management on growth and yield of phalsa (*Grewia subinaequalis* D.C.). *Environment and Ecology*, **31**(2B), 898–903.

Musmade, A. M., Jagtap, D. D., Pujari, C. V., & Hiray, S. A. (2009). Integrated nutrient management in acid lime. *Asian Journal of Horticulture*, **4**(2), 305–308.

Nurbhanej, K. H., Patel, M. J., Barot, H. R., Thakkar, R. M., & Gadhavi, A. V. (2016). Effect of integrated nutrient management on growth, yield and quality of acid lime (*Citrus aurantifolia* Swingle) cv. Kagzi. *International Journal of Agriculture Sciences*, **8**(51), 2360–2363.

Patel, D. R., & Naik, A. G. (2010). Effect of pre-harvest treatment of organic manures and inorganic fertilizers on post-harvest shelf life of sapota cv. Kalipatti. *Indian Journal of Horticulture*, **67**(3), 381–386.

Patel, M., Vihol, N. J., Patel, A. D., & Patel, H. C. (2017). Effect of integrated nutrient management on quality parameters of sapota [*Manilkara achras* (Mill.) Forsberg] cv. Kalipatti. *International Journal of Chemical Studies*, **5**(6), 889–891.

Patil, V. K., & Shinde, B. N. (2013). Studies of integrated nutrient management on growth and yield of banana cv. Ardhapur (*Musa* AAA). *Journal of Horticulture and Forestry*, **5**(9), 130–138.

Prabhu, M., Parthiban, S., Kumar, A. R., Rani, B. U., & Vijayasamundeeswari, A. (2018). Effect of integrated nutrient management on acid lime [*Citrus aurantifolia* Swingle (L.)]. *Indian Journal of Agricultural Research*, **52**(3), 290–294.

Ram, R. A., Bhriguvanshi, S. R., Garg, N., & Pathak, R. K. (2007). Studies on organic production of guava (*Psidium guajava* L.) cv. Allahabad Safeda. *Acta Horticulturae*, **735**, 373–379.

Rani, A., Lal, R. L., Uniyal, S., & Chand, S. (2013). Response of organic manures on growth, nutrient status and yield of litchi (*Litchi chinensis* Sonn.) cv. Rose Scented. *Progressive Horticulture*, **45**(1), 126–131.

Sangeeta, B. H., Shorol, A. M., Suresh, H., Lenkennavar, G. S., & Swamy, K. (2017). Effect of organic manures on yield and quality of banana cv. Grand Naine. *International Journal of Pure and Applied Bioscience*, **5**(6), 1094–1096.

Shivakumar, B. S., Dharmatim, P. R., & Channel, H. T. (2012). Effect of organic cultivation of papaya on yield, economics and soil nutrient status. *Karnataka Journal of Agricultural Sciences*, **25**(4), 488–492.

Shukla, S. K., Adak, T., Singha, A., Kumar, K., Singh, V. K., & Singh, A. (2014). Response of guava trees (*Psidium guajava* L.) to soil applications of mineral and organic fertilisers and biofertilizers under conditions of low fertile soil. *Journal of Horticultural Research*, **22**(2), 105–114.

Singh, K. K., Barche, S., & Singh, D. B. (2010). Integrated nutrient management in papaya (*Carica papaya* L.) cv. Surya. *Acta Horticulturae*, **851**, 377–380.

Singh, S. R., & Banik, B. C. (2011). Response of integrated nutrient management on flowering, fruit setting, yield and fruit quality in mango (*Mangifera indica* L.) cv. Himsagar. *The Asian Journal of Horticulture*, **6**(1), 151–154.

Singh, Y., Prakash, S., Prakash, O., & Kumar, D. (2017). Effect of integrated nutrient management on fruit yield and quality of Amrapali mango (*Mangifera indica* L.) under high density planting. *International Journal of Pure and Applied Bioscience*, **5**(3), 67–73.

Suhasini, S. P., Hipparagi, K., Biradar, I. B., Patil, S. N., Suma, R., & Awati, M. (2018). Effect of integrated nutrient management on growth parameters of banana cv. Rajapuri. *International Journal of Pure and Applied Bioscience*, **6**(1), 1328–1334.

Tandel, B. M., Ahir, M., Hiray, S., & Patel, K. A. (2017). Effect of integrated nutrient management on yield and quality of papaya (*Carica papaya* L.) cv. Taiwan Red Lady. *International Journal of Chemical Studies*, **5**(4), 1901–1903.

Tiwari, N., Singh, S. S., Singh, R., & Charmkar, N. K. (2018). Effect of organic cum inorganic sources of nutrients on growth, yield and economical gain from guava. *International Journal of Agricultural Sciences and Research*, **8**(1), 79–84.

Vanilarasu, K., & Balakrishnamurthy, G. (2014). Influences of organic manures and amendments in soils physico-chemical properties and their impact on growth, yield and nutrient uptake of banana. *The Bioscan*, **9**(2), 525–529.

Verma, R. S., Singh, H. K., & Verma, S. S. (2014). Effect of integrated nutrient management on plant growth, fruit yield and quality of phalsa (*Grewia subinaequalis* D.C.). *Asian Journal of Horticulture*, **9**(1), 48–52.

Vishwakarma, G., Yadav, A. L., Kumar, A., Singh, A., & Kumar, S. (2017). Effect of integrated nutrient management on physico-chemical characters of bael (*Aegle marmelos* Correa) cv. Narendra Bael-9. *International Journal of Current Microbiology and Applied Sciences*, **6**(6), 287–296.

Yadav, A. K., Singh, J. K., & Singh, H. K. (2011). Studies on integrated nutrient management in flowering, fruiting, yield and quality of mango cv. Amrapali under high density orcharding. *Indian Journal of Horticulture*, **68**(4), 453–460.

Yadav, P. K., Yadav, A. L., Yadav, A. S., & Yadav, H. C. (2011). Effect of integrated nutrient nourishment on vegetative growth and physico-chemical attributes of papaya (*Carica papaya* L.) fruit cv. Pusa Dwarf. *Plant Archives*, **11**(1), 327–329.