ORGANIC FRUIT PRODUCTION: STRATEGIES, EXPORT POTENTIAL AND FUTURE THRUST

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Abstract

Organic farming is defined as a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity (FAO/WHO, 2013). Components of organic farming are green manures, crop rotation, vermicompost, bio-fertilizers, bio-dynamic farming, biological pest control, EM – technology, bio-stimulants, bio-films and use of liquid organic manures like Jeevamrut, Beejamrut, Vermiwash, Sanjivak and Panchgavya. Rapid increase of human population together with global climate variability resulted in increased demand of plant based food (Varshney et al., 2011). Fruits, thus, have an essential role to enhance quality of humankind life as they are rich source of fibers, vitamins, micronutrients and phytonutrients essential for human health. India is the second largest producer of fruits in the world after China with a production of 91.7 million MT during 2016-17. Fruits produced in India have greater export potential as they have larger demand around the world. Organic fruit production is a system to lower the cost of production and enhance the fruit quality to reduce health hazards produced by conventional farming systems. So a paradigm shift to organic fruit production is the need of the hour to enhance quality of life.

Keywords: *Organic, Bio- dynamic, Bio- stimulants, Jeevamrut, Beejamrut, Vermiwash, Sanjivak, Panchgavya, Phytonutrients, Paradigm*

Introduction

The word 'Organic' is derived from the Greek word "organon", which means "implement, instrument, tool", that is, something one works with. Organic (living) – consisting of or relating to living plants and animals. The term

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organic farming was coined by Lord Northbourne in his book 'Look to the Land' (written in 1939, published 1940). From his conception of "The farm as organism," he described a holistic, ecologically balanced approach to farming. The British botanist Sir Albert Howard is often referred to as the father of modern organic agriculture, because he was the first to apply modern scientific knowledge and methods to traditional agriculture.

Organic farming is systems which largely excludes the use of synthetic inputs and rely upon crop rotations, crop residues, animal manures, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection (FAO). Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (IFOAM). Rapid increase of human population together with global climate variably resulted in increased demand of plant based food and energy sources (Varshney et al., 2011). Fruits have essential role to enhance quality of humankind life since a diet based on cereal grains, roots and tuber crops lacked a wide range of products such as fibre, vitamin, pro-vitamins or other micronutrients and compounds exist in fruit crops (Heslop-Harrison, 2005). Owing to their commercial value and source of many processed products, fruits play a key role in the economy of many developing countries.

Current status and Export Potential

Rapid growth in fruit production has been accompanied by heavy use of chemical pesticides and fertilizers on fruit crops has raised a number of economic, ecological and lots of health problems. For enhanced profitability, quality fruit production is very important. As per available statistics, India's rank in terms of world's organic agricultural land is 9 as per 2018 data (Willer and Lernourd, 2018). India has about 3.56 million hectares of organic certified area and has about 835,000 organic producers in 2017-18. India produced around 1.70 million MT (2017-18). Among all the states, Madhya Pradesh has covered largest area under organic certification

followed by Rajasthan, Maharashtra and Uttar Pradesh. India has exported organic produce of around 4.58 lakh MT with an export value of INR 3453.48 crore to potential markets like US, Canada, Australia, Switzerland, New Zealand, South east asian countries and middle east. Among fruits, Apple, Walnut, Mango, Banana, Grapes, Pineapple, Passion fruit, Cashew nut, Custard apple and Mandarin are mostly exported to Asian as well as other countries. These fruit are only exported when they meet the export parameters set by the respective countries. In India, these organic commodities are certified by APEDA and other accreditation agencies like Tea Board, Coffee Board etc.

Components of Organic farming

a) **Organic manures**

It includes Bulky organic manures and concentrated organic manures.

b) **Liquid organic manures**

It includes Panchgavya, Jeevamrut, Beejamrut and Amritpani.

c) **Vermiwash**

Vermiwash is prepared from populations of earthworms reared in earthen pots or plastic drums. The extract contains important micronutrients, vitamins (such as B12) and hormones (gibberellins) secreted by earthworms. Earthworms produce bacteriostatic substances and thus its use can prevent bacterial infection.

d) **Vermicompost**

Vermicompost refers to organic manure produced by earthworms, which is a mixture of worm forming (fecal excretions) organic materials including humus, live earthworms, their cocoons and other micro-organisms. Vermicompost is complex bio-fertilizer and is not desirable to compare its status as a mere supplier of NPK fertilizers. It has found that addition of bio-agents like Pseudomonas and Trichoderma improved the quality of vermicompost. It is richer than other type of composts.

e) Biofertilizers

The preparations containing living or latent cells of microbes capable of transforming the unavailable form of naturally occurring nutrients in to a form which can be easily assimilated by the plants. For example:
For Nitrogen – Rhizobium, Azotobacter
For Phosphorus - Pseudomonas, Bacillus
For potassium - Fraturia aurentia

f) Bio-film

Biofilm production is an association of microbial cells (algal, fungal, bacterial and/or other microbial) plus an extracellular bio-polymer known as extracellular polymeric substance (EPS) with biotic or abiotic surfaces. Microorganisms may be present as monocultures or in consortium as group performing specialized metabolic functions. EPS provides an ambient environment for exchange of genetic material between cells of different communities.

g) Bio-dynamic farming

Biodynamics is a spiritual-ethical-ecological approach to horticulture, fruit production and nutrition-Anthroposophy. It is based on systematic and synergistic harnessing of energies from cosmos, earth, plant and cow e.g. BD-500-508, Cow Pat Pit etc

h) EM- Technology (Effective micro-organisms Technology)

EM (Effective Micro-organisms) technology was developed by Dr. Teruo Higa in Japan. It acts as an anti-oxidant and develops a favorable environment for the crops to grow. EM mainly consists of Lactic Acid bacteria (Lactobacillus sp.), Photosynthetic bacteria (Rhodopseudomonas sp.) and Yeast (Saccharomyces sp.).

i) Homa-farming

It is a healing fire from the ancient science of 'Atharvaveda'. The basic process used in Homa farming is Agnihotra. It is a process of purifying the atmosphere through a specially prepared fire performed at sunrise

and sunset daily. It involves burning of specific organic substances like cows ghee, rice grains, twigs of plant like peepal, bael etc.

j) Biostimulants

Any substance or microorganism applied to plants with the aim to enhance nutrition efficiency, abiotic stress tolerance and/or crop quality traits, regardless of its nutrients content. It Include natural substances such as humic and fulvic acids, protein hydrolysates, seaweed extracts (beneficial fungí (eg, arbuscular mycorrhizal fungi and Trichoderma spp.) and plant growth promoting rhizobacteria. Example: Agri Gro organic biostimulant.

k) Indigenous Technical Knowledge (ITK)

Indigenous Knowledge (IK) can be broadly defined as the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment. This definition encompasses all forms of knowledge – technologies, know-how skills, practices and beliefs – that enable the community to achieve stable livelihoods in their environment.

Case studies on organic fruit production

Athani et al. (2007) studied the effect of organic and inorganic fertilizers on growth, leaf, major nutrient and chlorophyll content and yield of guava cv. Sardar and reported that application of 75% RDF + 10 kg vermicompost resulted in maximum yield, nutrient and chlorophyll content.

Effect of organic manure on growth and yield of litchi (Litchi chinensis Sonn.) cv. Rose Scented was performed by Kaur et al. (2007), who reported that FYM @ 100 kg/tree led to maximum tree spread , fruit yield, stem girth and reduction in fruit cracking.

Rai et al. (2009) studied the effect of different sources of organic manures on yield and quality of low chill pear (Pyrus pyrifolia) cv. Gola and concluded that application of 40 kg vermicompost/tree increases the yield and quality of the fruit.

The influence of different sea weed doses on table quality of grapes characterizing of cv. Trakya and Ilken was studied by Kok et al. (2010) and reported that sea weed @ 1000 and 3000 ppm gave the best results for the table grape quality.

Influence of bio-inoculants and inorganic fertilizers on quality of strawberry (Fragaria × ananassa) was studied by Singh et al. (2010). They reported that application of Azotobacter + Azospirrilum + Pseudomonas led to maximum TSS, TSS: acid ratio, total sugars and ascorbic acid.

Effect of organic nutrition practices on papaya (cv. Surya) soil health was studied by Reddy et al. (2010) and found that application of 7 kg urban compost/ plant or 10 kg FYM/ plant was ideal for improving soil health.

Studies on integrated nutrient management in flowering and fruit quality of mango cv. Amrapali under high density orcharding was conducted by Yadav et al. (2011) and reported that maximum fruit length, fruit weight was found with recommended NPK + vermicompost + Azotobacter + PSB + Zn + Fe + Paclobutrazol.

Goswami et al. (2012) conducted an experiment to know the effect of biofertilizers enriched in FYM along with half dose of recommended fertilizers on five years old guava plants cv. Pant Prabhat. They reported that trees grown with half dose of RDF (250 g N: 195 g P: 150 g K) + 50 kg FYM enriched with 250 g Azospirrilum/tree/year produced maximum increase in plant height (0.24 and 0.25), plant spread (0.58 and 0.66 m), trunk diameter (2.68 and 2.71 cm) and tree volume (0.055 and 0.041 m3) during 2007-08 and 2008-09, respectively.

Mitra et al. (2012) standardized the organic nutrient management protocol of Sardar guava under high density (625 plants/ha) planting. Different organic sources of nutrients (neem cake, vermicompost, farm yard manure and poultry manure) and biofertilizers (Azotobacter and Azospirrilum) were tried and results revealed that application of neem cake along with Azotobacter significantly increases yield, fruit size and improve quality of fruit.

Shivakumar et al. (2012) reported in papaya that application of FYM equivalent to 100 per cent recommended dose of nitrogen (154.3 t/ha) gave significantly higher fruit yield of 173.9 t/ha as compared to control with RDF and other organic manure treatments except agrigold equivalent to 100 per cent RDN (33.2 t/ha) and vermicompost, sheep manure and bhumilabha in combination with FYM treatments each equivalent to 50 per cent RDN.

Effect of plant bio-stimulants on fruit cracking and quality attributes of pomegranate cv. Kandhari kabuli was studied by Abubakar et al. (2013). They concluded that highest fruit length, diameter, weight, volume and minimum fruit cracking were recorded in trees treated with spic cytozyme @ 4ml/l whereas highest intensity as ground over colour were observed with the application of vipul @ 15 ml/l.

Godage et al. (2013) revealed that influences of chemical and biofertilizers on fruit yield of guava cv. Sardar. The treatment of 75 per cent N + 75 per cent P2O5 + 100 per cent K2O + Azotobacter 5 ml/tree + PSB 5 ml/tree resulted significantly maximum fruit diameter (10.07 cm), fruit weight (2015.06 g), pulp weight (193.44 g), tree height (3.80 m), east –west spread.

Devi et al. (2014) showed that in Bombai litchi, combinations with farm yard manure + Azotobacter + phosphorus solubilizers + potash mobilizers recorded higher total soluble solids (17.57%), whereas vitamin C content (53.48 mg/100g pulp) was higher where a combination of neem cake + Azospirrilum + phosphorus solubilizers + potash mobilizers was applied.

Garhwal et al. (2014) evaluated the effect of organic manure and nitrogen on growth, yield of kinnow mandarin and revealed that application of 80 kg FYM/plant increased trunk diameter, fruit yield, number of fruits, average fruit weight, fruit diameter, fruit length, volume of fruit, peel weight, juice percentage, TSS, ascorbic acid, total sugars etc. Although application of 60kg/plant gave maximum benefit: cost ratio and net returns.

Effect of organic manuring on growth, yield and quality of sweet orange (Citrus sinensis L. Osbeck.) was studied by Ghosh et al. (2014) and reported that application of neem cake @ 7.5 kg/tree lead to highest yield and maximum sizeable fruits whereas application of vermicompost and mustard

cake lead to maximum available nitrogen. They concluded that application of vermicompost + neem cake should be used for higher vegetative growth and higher production of quality fruits in case of sweet orange.

While studying the effect of EM and K2SO4 on productivity and fruit quality of Hayany date palm grown under salinity stress, Salama et al. (2014) applied EM @ 60 and 90 ml/palm/year and K2SO4 @ 1 and 1.5 kg/palm/year as well as their combinations. They reported that EM @ 90 ml/palm/year + K2SO4 @ 1.5 kg/palm/year as a soil application promoted enhancement of leaf chlorophyll content, fruit set, retained fruit, yield, fruit quality and leaf nutrient status.

Khachi et al. (2015) performed an experiment to compare efficacy of bio-organic nutrient on plant growth, leaf nutrient content and fruit quality attributes of Kiwi fruit. They reported that FYM @ 15kg vine + green manure + vermicompost @ 15 kg vine + biofertilizer (mixed culture @ 50 g/vine) + vermiwash at 15 days interval @ 2% v/v produced better fruit quality.

Effect of foliar application of biozyme on yield and physico-chemical properties of rainy season guava (Psidium guajava L.) cv. Allahabad Safeda was studied by Sau et al. (2015) and reported that application of biozyme @ 10 ppm led to maximum number of shoots, highest fruit set, fruit yield, chlorophyll content, number of seeds and fruit quality parameters.

Effect of panchagavya and GA3 on germination, seedling growth in cashew (Anacardium occidentale L.) was studied by Singh et al. (2015) and found that best root growth was recorded with Panchgavya at 20%.

Al-Janabi et al. (2016) studied the effect of biofertilizers (EM-1) and organic fertilizer (Acadian) on vegetative growth of many cultivars of apricot seedling (Prunus armeniaca L.) and reported that EM-1 @ 1 ml/100 ml caused significant increase in vegetative growth of most of the cultivars.
Influence of organics, inorganics, biofertilizers on growth, soil characters and fruit quality was studied by Dutta et al. (2016). They revealed that application of biofertilizers (Azotobacter + PSB) along with 50% inorganic fertilizer increased growth, improved fruit quality, increased the shelf life with low respiration rate.

Response of strawberry to organic versus inorganic fertilizers was studied by Yadav et al. (2016) and they found that when Azotobacter inoculation is done along with half dose of N supplied through vermicompost and the remaining through inorganic chemical fertilizers in two equal splits each at establishment and before flowering leads to maximum growth and yield of fruits.

Bhat et al. (2017) studied the response of organic formulations on fruiting and yield of litchi (Litchi chinensis Sonn.) cv. Rose Scented and reported that trees applied with FYM (100 kg/tree) + vermicompost (50 kg/tree) + 10% cow urine/tree + 10% Vermiwash/tree + Nutrisol 25 ml/l resulted in maximum fruit set, fruit retention, fruit yield, minimum fruit drop and fruit cracking.

Efficacy of organics on plant nutrient uptake, growth behavior, fruit yield and quality attributes, disease incidence and soil health was evaluated by Marathe et al. (2017). They reported that application of poultry manure gave maximum fruit yield as well as Aspergillus niger and PSM activity was higher in green manure with Karanj and sun hemp where highest availability of nutrients was with application of FYM.

Influence of organic–inorganic nutrient management practices on growth and yield of sweet orange var. Nucellar (Citrus sinensis L. Osbeck) was studied by Patil et al. (2017). They recorded that application of 75% RDF + 25% FYM + green manuring resulted in highest plant height, girth of stem, plant spread and canopy volume whereas fruit yield was higher with 75% RDF + 25% vermicompost + green manuring.

Studies on the effect of cow dung slurry, chemical fertilizers and biofertilizers on fruit quality and shelf life of guava (Psidium guajava L.) was conducted by Sahu et al. (2017) They found that application of 75% RDF + cow dung slurry @ 10 l/tree led to higher yield, ascorbic acid, fruit length, TSS, total sugars and also resulted in minimum physiological loss in weight.
Sau et al. (2017) studied the influence of biofertilizers and liquid organic manures on growth, fruit quality and leaf nutrient content of mango cv. Himsagar and reported that application of Azotobacter chorococcum @ 250 g + Azospirrilum brasilense @ 250 g + AM fungi (Glomus mussae) +

Panchgavya @ 3% showed maximum fruit weight, yield and bio-chemical qualities with prolonged shelf life of 10 days.

Sharma et al. (2017) conducted an experiment to study about the response of nectarines to organic fertilization under the rainfed system of North west Himalayas and found that application of vermicompost @ 25 kg/tree + biofertilizers @ 40 g/tree + FYM @ 30 kg/tree + compost @ 15 kg/tree + Vermiwash @ 1:10 + Cow urine @ 1:10 led to improved plant growth and fruit quality characteristics of the tree.

Foliar application of different plant bio-stimulants promote growth and fruit quality of strawberry plants grown under nutritional limitations was conducted by Soppelsa et al. (2017) and reported that application of alfalfa hydrolysates and chitosan promoted the plant growth and improved the fruit quality.

Reddy et al. (2017) studied the effect of bio-inoculants and organic supplementation on growth and yield of pomegranate and reported that application of 50% RDF + organics + bio-inoculants led to highest number of hermaphrodite flowers (139) as well as highest fruit yield (26.43 kg/plant).

Roussos et al. (2017) studied the impact of organic fertilization on soil properties, plant physiology and yield in two newly planted olive (Olea europaea L.) cultivars under Mediterranean conditions and reported that organic fertilizer application resulted in lower soil pH values (8.0-8.15 as compared to 8.46) and also led to increased carbon assimilation rate (17.4-18.7 µmol m-2 s-1) as compared to control (14.9 µmol m-2 s-1).

Frioni et al. (2018) applied Ascophyllus nodosum (brown sea weed extract) @ 1.5 kg/ha to grapevines cv. Sangiovere, Pinot Noir and Cabernet Franc and studied its effect on ripening dynamics and fruit quality, they reported that it improved anthocyanin accumulation in all the cultivars and increased the phenolic content particularly in Sangiovere. They concluded that medium late application of the seaweed extract can be a simple way to favour chromatic and chemical properties of wine grapes.

Influence of organic manures and bio-dynamic preparations on growth, yield and quality of Khasi mandarin (Citrus reticulata Blanco) was studied by

Malsawmkimi and Hazarika (2018) . They reported that application of Vermicompost + Cow pat pit + BD 500 + BD 501 gave the maximum yield whereas application of FYM + Cow pat pit + BD 500 + BSD 501 recorded highest TSS, ascorbic acid, TSS: acid ratio and lowest titratable acidity.

Ram et al. (2018) performed microbial characterization of on-farm produced enhancers used in organic farming and concluded that Panchgavya contained the highest number of total bacteria (6.25 × 10 9 cfu/ml) followed by jeevamrita (3.24 v× 10 9 cfu/ml) and Amritpani (5.49 × 10 8 cfu/ml).

Sood et al. (2018) studied the effect of biofertilizers and plant growth regulators on fruit quality and yield of strawberry and reported that application of PSB (6 kg/ha) + Triacontanol (5 ppm) led to highest fruit yield (13.48 t/ha), TSS (11.4°B), ascorbic acid (63.67 mg/100g), total sugars (7.7 %) with a anthocyanin content of 1.9.

Soppelsa et al. (2018) performed a study on the use of bio-stimulants for organic apple production and reported that application of siliforce @ 300 ml/ha gave highest yield with greater number of fruits but quality storage was improved by reducing the risk of Jonathan spot using zinc @ 3 kg/ha.

Future strategies

- Development of research methods appropriate for organic farming systems and practices.
- A renewed partnership between farmers, farm advisors, scientists and consumers.
- Integration of technological, social and ecological dimensions of innovation.
- Development of organic farming systems with diversified crops and enterprises.
- Direct and indirect benefits of organic farming on a long term basis needs to be quantified.
- Information on economic viability of organic farming system should be elucidated.
- Dependable marketing infrastructure for organically grown produce.
- Demonstrations for spreading the concept and technologies of organic farming.

Conclusion

Today organic farming is not the same as was in 1950s. It is intensive and has grown with science and thus is equally productive. Consumers are now demanding safe and healthy food with growing self awareness. Complexities and adverse impact of agrochemicals has led to its promotion. Thus, in order to grow further, it needs institutional support for research inputs, regular flow of technologies, varieties and seeds. Organic as on today may be as 15-20% low yielder in intensive cultivation but 20-25% higher under rain fed. Diversified systems are better adapted and promise 15-20% higher yields. Organic farming system as an alternative and appropriate management system would help to improve soil health environment thus increase the productive levels and improve quality of fruit crops. India has tremendous potential to grow crops & fruit organically and emerge as a major supplier of organic products in the world's organic market. We have spent a lot in research and extension for conventional farming. If organic farming is supported with just 10% of the same it can compete with conventional farming with majority of aspects.

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