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ORGANIC FARMING: A HOLISTIC APPROACH TOWARDS SUSTAINABLE FRUIT PRODUCTION

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ABSTRACT
India is the second largest producer of fruits in the world. With the increasing population, the cultivable land resource is shrinking day to day. Green Revolution in the post independence era has shown path to developing countries for self-sufficiency in food but sustaining agricultural production against the finite natural resource base demands has shifted from the "resource degrading" chemical agriculture to a "resource protective" biological or organic farming. The major component of organic farming is: manures, green manures, intercropping, mulching, vermiculture biotechnology, biofertilizers, homa farming/agnihotra, biodynamic farming, biocontrol etc. Application of bio-fertilizer was more effective than organic manures in enhancing fruit growth parameters. When bio-fertilizer was grouped together in 'Red Fleshed' guava, P-solubilizers were found to have more beneficial influence on fruit physico-chemical characteristics than that of N-fixers. It has also been observed in 'Bombai' litchi, combinations with farm yard manure + *Azotobacter* + phosphorous solubilizers + potash mobilizers showed higher total soluble solids and total sugar content, whereas vitamin C content was higher where a combination of neem cake + *Azospirillum* + phosphorous solubilizers + potash mobilizers was applied. The galloping explosion of population has been made during last 5-6 decades only and food and nutritional security in respect to fruits is therefore a serious global concern. Neither conventional farming with inorganic alone nor organic farming only with the use organic input can face this challenge; therefore, the combination of organic and inorganic is undoubtedly the best option.

KEYWORDS: organic farming, fruits, quality, yield, biocontrol.

INTRODUCTION
The concept of organic farming is not new to the Indian farming community as it is successfully practiced in diverse climates, particularly in rain fed, tribal, mountain and hill areas of the country. Much of the forest produce of economic importance, like herbs and medicinal plants, by default come under this category (Singh, 2007). India is the second most populous country in the world and with the increasing population; the cultivable land resource is shrinking day to day and therefore, to meet the food, fiber, fuel, fodder and other needs of the growing population, the productivity of agricultural land and soil health needs to be improved. Green revolution technologies such as greater use of synthetic agrochemicals like fertilizers and pesticides, adoption of nutrient-responsive, high-yielding varieties of crops, greater exploitation of irrigation potentials etc. has boosted the production output in most cases. Therefore, for sustaining the productivity of the crop, maintaining the soil health and healthy ecosystem, there is need for adoption of an alternative farming system, may be the Organic Farming.

India has converted 6.0 million ha of cultivated land into organic and another 1.17 million ha are under conversion (Yadav, 2012). Organic cultivation is particularly suitable for a country like India with a huge population of small farmers who still use traditional methods of farming with few agricultural inputs. At present, Global figures on growth of this sector are impressive and has taken only 1 to 2 per cent of agricultural sector but its growth is exponential (15 -25%). In a Country like India it is important to note is that the first initiatives in organic cultivation were taken by farmers NGOs and the private sector agri-business players. A government institutional intervention largely followed to respond to the farmer's and trade needs. Government interventions are mostly related to institutionalizing quality assurance mechanisms, however, the focus is also on supporting of farmland conversion to organic production and mandating/incorporating a comparative element in all related aspects the rough scientific to research (Anonymous, 2007).

Organic farming, as an outcome of different assessments of economic, ecological and social goals, consequently, technique strategies such as integrated pest management of balanced nutrient supply might improve conventional agriculture to such as an extent that it may appear unnecessary to strictly ban pesticides and mineral fertilizers as required by organic standard. Organic farming is a method of farming system, which primarily aims at cultivating the land and raising crops in such a way, so as to keep the soil alive and in good health. In the Indian context organic farming is also termed as 'Javik Krishi'. The term organic is best thought of referring not to the type of inputs used, but to the concept of the farm as an organism, in which all the components likes, soil minerals, organic matters, microorganisms, insects, plants, animals and humans interact to create coherent, self regulating and stable whole. Reliance on external inputs, whether chemical or organic, is reduced as far as possible. Organic farming is holistic production system.

COMPONENTS AND ROLE OF ORGANIC FARMING

Organic manure

Composting, generally defined as the biological aerobic transformation of an organic by-product into a different organic product that can be added to the soil without detrimental effects on crop growth [Eghball *et al*., 1997]. It is one of the oldest techniques used for stabilizing natural wastes and biological fertilization of the soil. The main objective of this practice is to obtain a stable, chemically and biologically rich product with micro and macro nutrients [Coker, 2006]. The composting process can result in obtaining stable humus and humic and fulvic acids, characterized by a high nutritional value and potential for fertilization of soils with nutriment deficiencies [Tognetti *et al.*, 2005]. The benefits provided by composts are broad and can be of a physical, chemical, biological, or environmental nature. Application of compost depends on the condition of the organic matter, moisture content, temperature, the pH and presence of microorganisms in the compost pile. For example, composts improve drainage and absorption of moisture in soils with structural deficiencies or lack of nutrients. They also make it possible to 1) increase crop productivity, 2) promote plant growth by incorporating essential nutrients, 3) facilitate implementation in different types of soil, 4) reduce runoff, and 5) obtain economic benefits for farmers [Mills, 2006]. Adding organic composts to apple orchard soils has been shown to improve the blooming and growth of newly planted trees [Autio *et al*., 1991] and fruit yields [Niggli, *et al.*, 1990].

Compost is prepared by degeneration of agricultural and other organic waste materials. It is an age old practice to dig a shallow pit of 75-90 cm depth and 1.0 m width and then spread the wastes in the pit as and when generated. The material gets decomposed over 4-6 months. This practice also helps to keep the environment clean. However, as the process is slow and the output in normal course is very small, farmers have not been taking keen interest in this activity.

Decomposing organic matter in soil gradually releases nitrogen. Earthworms, 'the intestine of earth', are considered as agents to restore the soil fertility from the times of Aristotle. Earthworms are physically an aerator, crusher, mixer, a degrader and stimulator for decomposition of various organic wastes. This degradation of organic wastes by earthworm is known as vermin-composting. The potential of earthworms and vermiculture in India was realized in early 1980s. The vermi-compost is rich in micro and macronutrients, vital plant promoting substances, humus farming substances, nitrogen fixers and humus forming microorganisms (Bano *et al.*, 1987).

Singh *et al.* (2007) reported in guava cv. Lucknow-49 that the combination of IBA with rooting media helped in producing maximum number of primary roots (18.57), secondary roots (23.91), leaves on 60 days (14.36) and length of shoots on 60 days (5.31 cm). IBA 5000 ppm and poultry manure combination was found to be second best for survival of air layering (73.25%). Athani *et al.* (2007) has found that application of 75 per cent RDF + 10 kg vermin-compost plant-1 was found significant by superior in leaf area, fruit polar diameter, fruit weight, its fruit volume, pulp thickness and pulp weight. Maximum contents of nitrogen, phosphorus and potassium were noticed in the plants applied with 75 per cent RDF + 10 kg vermin-compost plant-1 which was followed by in situ application of vermiculture (at 50 worms plant-1) and 100 per cent RDF in Guava cv. Sardar. The increase in yield in vermiculture treatments may be attributed to increase in level of readily available nitrogen in the presence of either dead or live worms and offered growth mechanism in plants (Barve, 1992).

Mitra *et al.* (2012) standardized the organic nutrient management protocol of 'Sardar' guava under high density (625 plants per ha) planting. Different organic sources of nutrients (neem cake, vermicompost, farm yard manure and poultry manure) and biofertilizers (*Azotobacter* and *Azospirillium*) were tried and results revealed that application of neem cake along with *Azotobacter* significantly increased yield, fruit size and improve quality of fruit. Hasan *et al.* (2013) reported that vermicompost caused highest phosphorus uptake (62.13 mg/100 g fruit) by mango 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 (33.32 t/ha) and vermicompost, sheep manure and bhumilabha in combination with FYM treatments each equivalent to 50 per cent RDN.

Ghosh *et al.* (2014) investigated that among different organic manures, vermicompost at 20 kg/tree resulted maximum plant growth (spread and height) with quality fruits in respect of total soluble solids and vitamin C content but FYM at 40 kg/tree treated plants produced fruits with maximum total sugar content. However, highest yield and maximum sizeable fruits were obtained when the plants were treated with neem cake at 7.5 kg/tree in sweet orange.

Biofertilizer

Biofertilizer plays very significant role in improving soil fertility by fixing atmospheric nitrogen both in association with plant roots and without it. It also solubilizes insoluble soil phosphate and produces plant growth substances in the soil and are environmental friendly playing a significant role in crop production. The soil loses its biological dynamism owing to repeated and indiscriminate use of inorganic source of fertilizer. Biofertilizers are able to fix atmospheric nitrogen in the range of 20-200kg/ha/year, solubilize P in the range of 30-50 kg P_2O_5/ha/year and helps to mobilize P, Zn, Fe and Mo to varying extent. They also help host plants to resist diseases and withstand stress conditions by different mechanism which vary depending upon the type of biofertilizer agent involved. Nitrogen fixing bacteria and phosphate solubilizer are the main biofertilizers for horticultural crops. These micro-organisms are either free living in soil or symbiotic with plants and contribute directly or indirectly towards nitrogen and phosphorus nutrition of the plants. Biofertlizer is a cost effective renewable energy source and plays a crucial role in reducing the inorganic fertilizer application and at the same time increasing the crop yield besides maintaining soil fertility. In other words, biofertilizers are based on renewable energy sources and are ecofriendly compared to commercial fertilizers (Verma and Bhattacharyya, 1994).

Dey *et al.* (2005) studied the effect of two free living N fixers like *Azotobacter* and *Azospirillum* and three phosphate-solubilizers viz., VAM, Microphos and Phosphobactrin on fruit physico-chemical characteristics of L-49 guava applied each @ 200 g/tree/year charged with 20 kg FYM. They reported that application of P solubilizers significantly influenced fruit weight of guava and highest fruit weight (154.50 g) was obtained with the application of Phosphobactrin**.** Ram *et al.* (2007) conducted an investigation on integrated nutrient management on seven years Sardar guava under Lucknow conditions and reported that integrated application of different fertilizers viz., N, P_2O_5, K_2O) along with organic manures (FYM, neem cake, *Sesbania*) and biofertilizer (*Azotobacter*) improved vegetative growth parameters. They further reported that maximum increase in tree height (0.45 m), tree spread (0.34 m east -west and 0.57 m north-south) was observed with application of 250 g nitrogen + 100 g phosphorus + 250 g potash + 10 kg FYM + 250 g *Azotobacter*.

Ram *et al.* (2007) reported maximum TSS (13.5 ^{0}Brix) and reducing sugar (3.50%) in guava fruits obtained from the trees treated with 250 g nitrogen + 100 g phosphorus + 200 g potash + 10 kg FYM + 250 g *Azotobacter* whereas, highest ascorbic acid content (340mg/100 g pulp) was observed with 250 g nitrogen + 100 g phosphorus + 250 g potash along with 250 g Azotobacter and acidity (0.54%) with 250 g nitrogen + 100 g phosphorus + 100 g potash + 10 kg FYM + 250 g *Azospirillum* application. Dutta *et al.* (2009) conducted an experiment to study the response of biofertilizer on growth and productivity of guava cv. L-49 under Nadia conditions (WB). They employed two levels of urea i.e. 565 g urea/plant (100% N) and 283 g urea/plant (50% N), two levels of SSP i.e. 200 g SSP/plant (100%) and 100 g SSP/plant (50%) and 30 g each of *Azospirillum* or VAM inoculation constituting the treatment combination of nine. They further reported that *Azospirillum* plus VAM (30g each) inoculation along with 100% N + 100% P_2O_5 showed maximum increase in plant height (24.07 cm). Whereas, maximum increase in plant spread (40.00 cm east -west and 35.83 cm north-south) was recorded with 100% N + 50% P2O5+ 30 g VAM inoculation.

Kundu (2011) studied the effect of three levels of inorganic fertilizers (100% NPK, 75% NPK and 50% NPK) were applied alone and also in combinations with different biofertilizers (*Azotobacter*, *Azospirillum* and VAM). He reported that all the inorganic and biofertilizer combinations exhibited profound effect on growth, yield and fruit quality and leaf mineral composition than inorganic fertilizer alone in mango cv. Amrapali. Dwevedi *et al.* (2012) concluded that the application of bio-fertilizer was more effective than organic manures in enhancing fruit growth parameters. When biofertilizers were grouped together, P-solubilizers were found to have more beneficial influence on fruit physico-chemical characteristics of 'Red Fleshed' guava than that of N-fixers.

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 year old guava plants cv. Pant Parbhat. 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 Azospirillum/tree/year produced maximum annual 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. Godage *et al*. (2013) revealed the influences of chemical and biofertilizers on fruit yield of guava cv. Sardar. The treatment of 75 per cent N + 75 per cent P_2O_5+ 100 per cent K_2O + *Azotobacter* 5 ml/tree + PSB 5ml/tree resulted significantly maximum fruit diameter (10.07cm), fruit weight (215.06g), pulp weight (193.44g), tree height (3.80m), East-West tree spread

(5.20 m) and North-South tree spread (5.13m) at harvesting stage.

Kumar *et al.* (2014) studied that the combination of AMF + *Azospirillum* enhances higher morphological growth performance. The AMF + *Azospirillum* applicated seedlings produce more leaves and shoot length which could have increase the rate of photosynthesis. They also reported that the nutritional status might be attributing to enhance inorganic and organic nutrient absorption by biofertilizers which in turn make the essential nutrient available to the promoting growth and increase nutrient content in leaves.

Devi *et al*. (2014) showed that in 'Bombai' litchi, combinations with farm yard manure + *Azotobacter* + phosphorous solubilizers + potash mobilizers recorded higher total soluble solids (17.79°Brix) and total sugar content (17.57%), whereas vitamin C content (53.48 mg/100 g pulp) was higher where a combination of neem cake + *Azospirillum* + phosphorous solubilizers + potash mobilizers was applied. Organic manures and biofertilizers have a direct role in nitrogen fixation, production of phytohormone-like substances and increased uptake of nutrients and hence quality improvement of fruit characteristics. It is apparent that the soil health improved gradually and after two years the microbial population in soil was markedly improved. The higher microbial population in soil releases many of the nutrients, particularly micronutrients which are normally not available to the tree. This caused increased yield and improved fruit quality.

Vermiculture Biotechnology

Vermiculture biotechnology is vermicompost preparation from waste materials like leaves, dung, kitchen waste etc., by earthworms. The worms eat the waste material and their droppings are called as vermicompost, which is used as quality compost in the agriculture fields. Vermicompost use in the fields is considered as way towards organic cultivation. *Eisenia foetida* earthworm species is used for vermicompost preparation due to its adaptability to wider range of climatic conditions. Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration, drainage, and water-holding capacity and microbial activity, which are stabilized by interactions between earthworms and microorganismsin a non-thermophilic process [Edwards *et al*., 1988]. Vermicomposts contain most nutrients in plant-available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium [Edwards, 1998]. Vermicomposts have large particulate surface areas that provide many microsites for microbial activity and for strong retention of nutrients [Zhao and Huang, 1991]. Also, they are rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes [Edwards, 1998].

Vermicomposts contain plant growth regulators and other plant growth-influencing materials produced by microorganisms [Tomati *et al*., 1990] including humates [Atiyeh, *et al.* 2002] and also contain large amounts of humic substances [Masciandaro *et al*., 1997] and some of the effects of these substances on plant growth have been shown to be very similar to the effects of soil-applied plant growth regulators or hormones [Muscolo *et al*., 1999]. Some studies have revealed that the positive effect of two kinds of vermicomposts on growth of strawberry plants is not influenced only by macronutrients availability, but also by the impact of plant growth regulators produced by microorganisms during the composting process [Arancon *et al.*, 2004].

Vermicast nutrient content varies with earthworm feed type, but feeding waste to earthworms does cause nitrogen mineralization, followed by phosphorous and sulphur mineralization after egestion. A typical nutrient analysis of casts is C: N ratio 12 to 15:1; 1.5 to 2.5 per cent N, 1.25 to 2.25 per cent P_2O_5 and 1 to 2 per cent K_2O at 75 to 80 per cent moisture content. The slow-release granules structure of earthworm casts allows nutrients to be released relatively slowly in sync with plant needs.

Biodynamic

Among organic farming systems, Biodynamic is also prevalent in India. Biodynamic agriculture appears to be one of the sound alternatives. It is based on systematic and synergistic harnessing of energies from cosmos, earth, plant and cow (Steiner, 1920). Some examples of biodynamic formulations are BD-500-508, Cow Pat Pit etc., which show remarkable effect on growth, nutritive value of compost metabolism (Carpenter *et al*., 2000), crop yield and quality (Pfeiffer, 1984). It has been observed that these practices do not require sophisticated facilities and most of them can be created on farm itself by simple effort. These are components of biological agriculture and capable of affording long-term sustainability to agriculture and particularly to the ecosystem. Main emphasis is made to adopt an agriculture calendar for crop cultivation along with some specific preparations.

Many efforts are made to restore soil fertility in the form of humus, increase in living system of soil by skilful application of appropriate crop rotation by Edwards, 1965 and Edwards and Thompson, 1973. Rupela *et al.* (2003) reported that BD preparations had 3.2410 to 6.9010 g^{-1} of bacteria antagonistic to disease causing fungi. In any nutrient management programme, the appropriate use of the biodynamic preparations is of prime importance. After closely working for more than 5 years with the system an integrated system of Biodynamic Agriculture has been developed, which is capable of meeting the issues and could afford sustainable agriculture.

The important components of biodynamic farming are as follows

i. Turning in plant materials such as green crops and straw
ii. Not using chemical fertilizers and pesticides
iii. Avoiding soil compaction by machinery or animals, particularly in wet weather
iv. Keeping soil covered by pasture, crops or mulch not destroying the soil structure by poor farming practices such as excessive use of rotary hoe or cultivation in unsuitable weather (too wet or too dry)
v. Fallowing the land by planting deep-rooting permanent pasture species or using green crops
vi. Use of preparations BD-500 and BD-501
vii. Compost made with preparations BD-502 – BD-507
viii. Liquid manure made with preparations BD-502 – BD-507
ix. Cowpat pit manure made with preparations BD-502 – BD-507

These biodynamic preparations named BD-500 to BD-507 are not food for the plants, but they facilitate the effective functioning of etheric forces. They are also not the usual compost starters, but can stimulate compost organisms in various ways. In short they are biologically active dynamic preparations which help in harvesting the potential of astral and etheral powers for the benefit of the soil and various biological cycles in the soil. So far 9 biodynamic preparations have been developed, named as formulation 500 to 508. Out of these, formulation-500 (cow horn compost) and formulation- 501 (horn-silica) are very popular and are being used by large number of organic farmers. Formulations-502 to 507 are compost enrichers and promoters, while formulation 508 is of prophylactic in nature and helps in control of fungal diseases.

Panchgavya

Panchgavya is a special preparation made from five by-products of cow along with certain other ingredients, incubated for specific duration in an earthen or plastic container (Ramasamy *et al.*, 2004).. Ingredients required for preparation of Panchgavya are cow dung 5 kg, cow urine 10 lit, cow milk 3 lit, cow curd 2 lit, cow ghee 1 kg, sugarcane juice 3 lit, tender coconut water 3 lit, ripe banana 12 and toddy (if available) 2 lit.

1. Recommended Dosages. In general, spray of 3 per cent (3kg100^{-1} L of water) solution has been found most effective. It is advisable to filter the mixture with muslin cloth and spray with high volume sprayer.

2. Flow System. Panchgavya can be mixed with irrigation water at 50 L ha-1 either through drips or with irrigation flow.

Enriched Panchgavya (or Dashagavya)

The ingredients of enriched Panchgavya are cow dung 5 kg, cow urine 3 liter, cow milk 2 liter, curd 2 liter, cow deshi ghee 1 kg, sugarcane juice 3 liters, tender coconut water 3 liters, banana paste of 12 fruits and toddy or grape juice 2 liters. First, mix cow dung and ghee in a container and ferment for 3 days with intermittent stirring. Add rest of the ingredients on the fourth day and ferment for 15 days with stirring twice a day and formulation will be ready in 18 days. Sugarcane juice can be replaced with 500g jaggery in 3 liters of water. In case of non-availability of toddy or grape juice 100g yeast powder mixed with 100 g jaggery and two liters of warm water can also be used. For foliar spray three to four liters panchgavya is diluted with c liters of water. For soil application 50 lit panchagavya is sufficient for one ha. It can also be used for seed treatment.

Homa Farming (or Agnihotra Therapy)

Homa therapy is practiced in different European (Austria, Germany, Poland) and south American (Peru, Venezuela) countries, which has shown spectacular response with respect to crop production, animal, human health and creation of pollution free atmosphere. In organic production systems, it is presumed that 80 to 90 per cent nutrition can be derived from Cosmos, provided pollution free atmosphere is available for crop production (Bourguignon, 2005). Paranjpe (2004) has strongly propelled that this therapy can safely be integrated with other organic production systems. Brief account of Homa therapy is enumerated below: 'Homa' is a Sanskrit word used synonymously with Homa therapy.

It is a technical term from Vedic science of bio-energy, medicinal and climatic engineering denoting the process of removing the toxic conditions of the atmosphere through the agency of fire tuned to the specific bio-rhythm of sunrise and sunset. It is simply based on the principle that you heal the atmosphere and the healed atmosphere will heal you. It replenishes the nutrients that pollution robs from the environment. The simplest and widely acceptable is Agnihotra, which need to be integrated with other organic production systems to device package of Jaivik (organic) production. Resonance points with pyramids are established at four places surrounding the farm to spread the healing effects to wider areas of 40 to 50 hectare. By performing Agnihotra and other Homa on a farm, an atmosphere is created that is conducive to growing and therefore attracts nutrients, insects, microorganisms and animals that would thrive well with pollution free environment (Paranjpe, 2004).

The term Homa or Yagna can be described as describing the process of purification of the house and atmosphere through fire, which is tuned to rhythm of nature, radiation effects of astrological combinations and "Mantras" leads to better capture of cosmic energies from Sun and Moon and it helps to reset the energy cycle of the planet in natural harmony benefiting all concerns. The basic process used in Homa farming is Agnihotra. A copper pyramid shape container is used in the process. HOMA is the generic term for fire techniques which serve the purpose of purifying the atmosphere. The knowledge about this originates from the Vedas which hold the oldest treasure of knowledge of mankind.

Biocontrol

A 'pest' is an animal, plant or other organism that is injurious, noxious or troublesome, whether directly or indirectly, and also any injurious, noxious or troublesome condition or organic function of the animal, plant or other organism itself . A 'pesticide' is any substance intended to prevent, destroy, repel, or mitigate any of these pests. The term 'pesticide' includes insecticides, herbicides, fungicides, and various other substances used to control pests and plant regulators, defoliants, and desiccants. 'Biopesticides' are possible candidates for postharvest use on organic produce because they are derived from natural materials such as animals, plants, bacteria, and certain minerals. Using the Environmental Protection Agency (EPA) definition of biopesticide, there are three major biopesticide groups:

1) Microbial pesticides which consist of a micro-organism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient.

2) Plant-Incorporated-Protectants (PIPs) which are pesticidal substances that plants produce from genetic material that has been added to the plant, e.g., insertion of the gene for the Bt insecticidal protein into the plant's genetic material. It is important to note that this group is acceptable in conventional production but not acceptable in organic production.

3) Biochemical pesticides which are naturally-occurring substances that control pests by non-toxic mechanisms, e.g., minerals, fatty acids, insect sex pheromones, scented plant extracts that attract insect pests to traps and plant growth regulators. It is sometimes difficult to determine whether a substance is a biochemical biopesticide and this decision may vary amongst political jurisdictions. In the USA there is an EPA special committee to make such decisions. Based on the above comparison of biopesticides, biocontrol agents and permitted organic substances, it is clear that they are distinct and there are very few biocontrol agents that are included in all three spheres. At present there are only ca. 10-15 biocontrol agents that may fit in all three spheres.

Table 1: Some biocontrol agents for diseses in fruit crops are as follows

Fungus	**Disease(causal agent)**	**Fruit crops**
Trichoderma harzianum	Anthracnose (Colletotrichum musae)	Banana
	Gray mold (*Botrytis cinerea*)	Grape
	Gray mold (*Botrytis cinerea*)	Kiwifruit
	Gray mold (*Botrytis cinerea*)	Pear
	Anthracnose (*Colletotrichum gloeosporioides*)	Rambutan
	Brown spot (*Gliocephalotrichum microchlamydosporum* (Mey) Wiley & Simmons	Rambutan
	Stem end rot (*Botryodiplodia theobromae*	Rambutan
	Gray mold (*Botrytis cinerea*)	Strawberry
Trichoderma viride	Green mold (*Penicillium digitatum*)	Citrus
	Stem-end rot (*Botryodiplodia theobromae*)	Mango
	Gray mold (*Botrytis cinerea*)	Strawberry
Trichoderma spp.	Sour rot (*Geotrichum candidum*)	Citrus
	Fruit rots caused by *Lasiobasidium theobromae*, *Phomopsis psidi* and *Rhizopus* spp.	Guava
	Fruit rots (*Lasiobasidium theobromae* and *Rhizopus* spp.)	Mango
Acrimonies brevae(Sukapure& Thirumulachar) Gams	Gray mold (*Botrytis cinerea*)	Apple
Aureobasidium pullulans	Monilinia rot (*Monilinia laxa*)	Banana
	Penicillium rots (*Penicillium* spp.)	Citrus
	Soft rot (*Monilinia laxa*)	Grape

Bacillus subtilis	Brown rot (*Lasiodiplodia theobromae)*	Apricot
	Stem end rot (*Botryodiplodia theobromae* Pat.)	Avocado
	Green mold (*Penicillium digitatum*)	Citrus
	Stem end rot (*Botryodiplodia theobromae, Phomopsis citri* Fawc., *Alternaria citri* Ell.& Pierce)	Citrus
Pseudomonas fluorescens Migula	Gray mold (*Botrytis* Ruehle)	Apple

CONCLUSION

During the last four decades of the 20th Century, the global population doubled itself from 3 to 6 billion and it is estimated that by the year 2020, it will reach the 8 billion mark. It has also been noticed that the volume of population from 3000 BC to 1950 is almost same or less from 1950 to 2030. It means that the galloping explosion of population has been made during last 5-6 decades only. Food and nutritional security is therefore a serious global concern. Neither conventional farming with inorganic alone nor organic farming only with the use organic input can face this challenge. To meet out the food and nutritional security, organic farming helps to improve the quality of fruit crops.

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