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Review article

A CRITICAL REVIEW ON ORGANIC FARMING OF VEGETABLES

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INTRODUCTION

India is the second most populous country in the world. With the increasing population, the cultivable land resource is shrinking day to day. To meet the food, fibre, fuel, fodder and other needs of the growing population, the productivity of agricultural land and soil health needs to be improved. 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 to be shifted from the "resource degrading" chemical agriculture to a "resource protective" biological or organic agriculture.

The vegetable crops have been well advocated in solving the problem of food security. They are rich source of minerals, vitamins, fibre and contain a fair amount of protein as well as carbohydrates. In addition to local market demand vegetables have the potential for both domestic and export market. The vegetable production of our country before independence was merely 15 million tonnes and now it is about 146.55 million tonnes during 2011-12,accounting 11.4% share of World vegetable production (Rai and Pandey, 2012). Although India is the second largest producer of vegetables next only to China in World, the productivity of different vegetables in our country is comparatively lower than the World's average productivity. Again the per capita availability of vegetable (210g/head/day) is still behind the recommended quantity (285g /head /day). Our demand by 2020 will be around 250 million tonnes. Thus due to the rapid growth of the population with reduction in land, in order to feed the population, the only solution is the vertical expansion or by increasing the productivity per unit area per unit time as the potential available land and water resources and of technology still remain unexploited. Our strategy should be produced more vegetables from less land, less water with less pesticides and with less detrimental to soil and environment as well. Organic vegetable cultivation offers one of the most sustainable farming systems with recurring benefits to only long-term soil health but provides a lasting stability in production by importing better resistance against various biotic and abiotic stresses. Organic vegetables fetch a premium price of 10%- 50% over conventional products. Market of organic products is growing at faster rate (20%) as compared to conventional ones (5%). This growth rate is highest in Japan, USA, Australia and EU. Export preference of organic vegetables offers a great scope to a country like India, which has inculcated the skill of growing organically since time immemorial.

Judicious plant nutrition and efficient plant protection enhances yield and quality in most of the crops. The present farming by and large depends on the use of chemical fertilizers, pesticides and growth regulators for enhancing crop productivity. It is a well documented fact that increased dependence on agro-chemicals including fertilizers has led to several ill effects on soil and the environment. Maintaining good soil health is a prerequisite for sustaining higher productivity under intensive agricultural production system. Soil health is the continued capacity of soil to function as a vital living system within ecosystem and land use boundaries to sustain the biological productivity. Increasing awareness of environmental impact of conventional high input intensive farming system has led to a move towards alternatives. The organic (biological/ecological) approach is one of the alternatives to conventional production system currently being advocated (Subbarao *et al.,* 2007). Considering the potential environmental benefits of organic production and its compatibility with integrated farming approaches, quality of food and sustainability, organic agriculture is considered as a viable alternative for sustainable agricultural development (Ramesh *et al.*,2005).

Organic agriculture is a system that relies on ecosystem management rather than external agricultural inputs. It is a system that begins to eliminate the use of synthetic inputs such as synthetic fertilizers, pesticides, veterinary drugs, genetically modified seeds and breeds, preservatives, additives and irradiation. These are replaced with site specific management practices that maintain and increase long term soil fertility and quality of the environment (Subbarao *et al.,* 2007). Organic agriculture is a holistic production management system in preference to the use of off- farm inputs taking into account that regional conditions require locally adapted systems which promotes and enhances agro-ecosystem health, including bio-diversity, biological activities which is accomplished by using wherever possible agronomic, biological and mechanical methods as opposed to using synthetic nutrients to fulfill any specific function within the system (FAO,1999). Organic system produced significant improvement in quality of soil mainly bulk density, maximum water holding capacity, infiltration rate, organic carbon, available nitrogen, phosphorus and potassium (Babalad *et al.*,2009). In Indian agriculture, the yield gap in various crops still remains large even after following the best management practices. Also the agricultural lands continue to shrink and there is a greater threat to global environment and soil resources in the form of erosion of biodiversity and climate change marching towards desertification and environmental pollution. Hence, there is now a great concern to maintain soil health and protect environment by popularizing eco friendly and cost effective organics. Using organic sources like farm yard manure, compost, vermicompost, sheep and goat manure in combination with liquid organic manures like cow urine, panchagavya, vermiwash, bio-digested liquid, jeevamrut etc deserves priority for sustained production and better on farm resource utilization. With this background a review has been made to study the effect of organic nutrients on growth, yield ,quality, nutrient uptake, soil properties, available soil nutrients of vegetables.

Effect of Organic nutrient management practices on growth parameters of vegetables

Combined application of organics to chilli crop mainly FYM(50%) + poultry manure(50%), vermicompost (50%) + poultry manure(50%), FYM(50%) + neem cake(50%) and poultry manure@7.5 t ha $^{-1}$ recorded significantly higher plant height, number of branches per plant and leaf area (Thimma Naik, 2006). Application of glyricidia loppings @ 10 t ha $^{-1}$, crop residues @ 10 t ha $^{-1}$ along with FYM+organic solutions significantly increased the growth parameters of chilli compared to inorganic fertilizers (Yadahalli, 2008). Along with organic manures, combined inoculation of *Azospirillum*(AZUS10) and PSB isolate(PSB7) produced synergistic effect and resulted in increased root length, shoot length, stem girth, number of leaves and number of branches in solanaceous crop plants (Vasanthakumar, 2003). Among the different organic manure treatments, okra responded well to the application of FYM @20 t ha $^{-1}$ (Premsekhar and Rajashree, 2009). Plant height, number of branches per plant, leaf area and leaf area index in chilli were significantly higher at all growth stages due to application of vermicompost@2.0 t ha $^{-1}$ or biogas spent slurry/FYM/redgram stalk (Shashidhara, 2000). Application of recommended nitrogen through different organic sources significantly enhanced the growth and yield of tomato. Among the different organic sources, substitution of 100 percent N through FYM recorded higher plant height, number of branches plant $^{-1}$ and yield which was comparable with that of 100 percent RDN through urea (Kannan *et al.*, 2006). A study on tomato var Parbhani Yashashri at MAU, Parbhani showed that significantly higher growth parameters of tomato on a slightly alkaline soil with organic mode of plant nutrition through various combinations of neem cake and vermicompost and was found superior to chemical fertilizers alone. A higher number of branches and fruit yield with the combination of 50 percent N through neem cake and 50 percent N through vermicompost were recorded (Sable *et al.,* 2007). Application of green manure (sunnhemp) + neem cake @2 t ha $^{-1}$ +*Azospirillum* @ 2 kg ha $^{-1}$ + burnt ash(crop residue) + phosphobacteria recorded higher growth parameters like plant height, plant spread, number of branches per plant of chilli over RDF alone (Bharathi *et al.,* 2011). Significant improvement in vegetative characters such as plant height and number of leaves per plant in brinjal was recorded when compared to recommended rate of N fertilizer due to inoculation of *Azotobacter+Azospirillum* with 75 kg N ha $^{-1}$(Wange and Kale, 2004). In greengram, plant growth parameters *viz.*, shoot and root length and number of leaves plant^{-1} at 45 DAS were significantly increased due to inoculation of P-solubilizing fungal strains along with rock phosphate application (Chandrashekhar, 2003). In soybean, plant height, number of branches plant $^{-1}$, leaf area index and dry matter accumulation were found to be higher with the application of crop residues @ 5 t ha $^{-1}$ +FYM@ 5 t ha $^{-1}$ over FYM@ 5 t ha $^{-1}$ (Dash *et al.,* 2005). The growth parameters of chilli *viz.*, plant height, number of branches, leaf area, leaf area index and dry matter production in various plant parts were significantly higher with combined application of organic compost and FYM (Sunitha, 2000). The growth parameters of chilli were significantly higher with the inoculation of biological nitrogen fixers mainly *Azospirillum* and *Azotobacte*r (Khan *et al*., 2011).

Effect of Organic nutrient management practices on yield and yield parameters of vegetables

Application of vermicompost @ 2.5 t ha $^{-1}$ along with vermiwash :water 1:1 spray registered significantly maximum dry chilli yield (George,2006). (Singh *et al.,* 1997) registered higher fruit yield per plant in chilli with the application of vermicompost@ 10 t ha $^{-1}$. Application of organic based nutrients mainly biogas slurry+FYM, vermicompost+FYM and vermicompost alone recorded maximum fruit size and more number of fruits plant^{-1} in tomato (Renuka and Ravishankar,1998). Highest number of fruits per plant, fruit weight, fruit length and fruit diameter of chilli was obtained by applying vermicompost alone as compared to inorganic fertilizers (Yadav and Vijayakumari, 2003). Combined application of organics to chilli crop mainly FYM(50%) + poultry manure(50%), vermicompost (50%) + poultry manure(50%), FYM(50%) + neem cake(50%) and poultry manure@7.5 t ha $^{-1}$ recorded significantly higher dry fruit yield (Thimma Naik, 2006). Studies at bijapur (Bagali *et al.*.2012) showed that application of compost and poultry manure recorded significantly higher bulb yield of onion and were on par with each other and with application of recommended chemical fertilizer. In a integrated crop management studies at Dharwad, significantly higher chilli yield was observed with application of vermicompost@ 2.5t ha $^{-1}$+ neem cake @250 kg ha $^{-1}$ without application of recommended dose of fertilizers (Gundannavar *et al.,* 2007). . Field studies at Dharwad under rainfed conditions showed that combined application of enriched compost, poultry manure and green leaf manure(Gliricidia) each one third equivalent to recommended 100 kg N ha $^{-1}$ produced significantly higher dry chilli yield and yield parameters as compared to their individual application(Babalad *et al*.,2009). In okra, significantly higher number of fruits per plant and fruit yield was observed with application of 4 t ha $^{-1}$ compost, split applied twice at planting and 5 weeks after planting as compared to recommended N dose through inorganic fertilizer (Akambi *et al*,.2005).

Effect of Organic nutrient management practices on quality parameters of vegetables

Application of recommended dose of nitrogen in the form of poultry manure recorded highest pH, total soluble solids, titrable acidity, reducing sugar, non-reducing sugar, crude protein and ascorbic acid content in tomato fruit (Prabakaranr and Pichai, 2002). Dipping the chilli seedlings root in beejamruth, soil application of jeevamruth(500 l ha $^{-1}$) at 10 DAT and foliar application of panchagavya @ 3% at the time of flowering recorded higher ascorbic acid and capsaicin content in chilli fruits (Sreenivasa *et al.,* 2010). Oleoresin per cent in chilli increased by 13.89, 6.80, 3.70 and 2.30 percent with application of poultry manure(7.5 t ha $^{-1}$), vermicompost(10 t ha $^{-1}$), FYM(50%) + vermicompost(50%), FYM(50%) + neem cake(50%) over RDF alone (Thimma Naik, 2006). Application of green manure (sunnhemp) + neem cake @2 t ha $^{-1}$ +Azospirillum @ 2 kg ha $^{-1}$ + burnt ash(crop residue) + phosphobacteria recorded highest oleoresin content and capsanthin content over RDF alone(Bharathi *et al.,* 2011). Vermiwash application had a positive effect in bringing colour to tomato fruits, since nitrogen is the main component for synthesis of lycopene along with other micronutrients (Adams, P., 1986). Organically grown tomato has higher content of vitamin C, vitamin A and potassium over conventionally grown tomato (Pither and Hall, 1990).

Effect of Organic nutrient management practices on nutrient uptake

Vermicompost besides being a rich source of micronutrients also acts as chelating agent and regulates the availability of metallic micronutrients to the plants and increases the plant growth and yield by providing nutrients in the available form and based on crop demand. Application of organics *viz*., FYM@ 10 t ha $^{-1}$ resulted in higher fruit yield and uptake of nutrients like N,P,K,Ca,S and Fe over RDF alone (Kattimani, 2004).

Effect of liquid organic manures on growth, yield parameters and yield

Panchagavya applied @ 3 percent spray 4 times with poultry manure augmented the yield in okra which was comparable to inorganic nutrient application with pesticide spray (Lourduraj *et al.,* 2005).The interaction between humic acid and bread yeast spray in brinjal significantly increased plant height, branch number, total chlorophyll, mineral content (N,P,K) in leaves, the yield in terms of fruit number plant^{-1} , fruit length, fruit diameter, fruit weight, plant yield and total yield (Sarhan *et al.,* 2011). Humic acid source positively affected both germination and harvesting, enhancing root length and biomass in broad bean. Humic acid caused significant increase of fresh and dry weights of broad bean roots (Ahmet and Birsen 2009). (Gad *et al.,* 2012) noticed that foliar application of humic acid@ 2 g l $^{-1}$ increased N% and protein% of seeds and recorded higher plant height, plant dry weight , pod diameter, fresh seeds weight pod^{-1}, number of fresh seeds pod^{-1}, green pod yield, seeds weight dry pod^{-1}, dry seed yield, N,P and protein percent of pea seeds.

Effect of organic nutrient management on soil properties

A study on effect of FYM on soil pH revealed that soil pH decreased from 7.99 to 7.65 with each increment of FYM, the soil pH reduced significantly due to organic acid production during its decomposition (Patil *et al*, 2003).

The pH of the sodic soil was reduced significantly with application of FYM @ 5 t ha^{-1} which was on par with the value that had been reduced by 50 percent gypsum requirement. Similarly, EC was also found to be reduced significantly by application of FYM (Rathod *et al.*,2003). Application of organic manures and crop residues like FYM, press mud compost, wheat straw and sugarcane trash@ 5 t ha^{-1} reduced the bulk density over the control in vertisols (Bonde *et al.*, 2004). The maximum water holding capacity of soil decreased with application of fly ash while it was increased due to increasing level of FYM (Patil *et al.*, 2003). (Halemani *et al.*, 2004). Reported at Dharwad, application of FYM@ 10 t ha^{-1} decreased the bulk density, increased the infiltration rate and water holding capacity of soil.

Effect of organic nutrient management on available soil nitrogen, phosphorus and potassium

Higher levels of available nitrogen, phosphorus and potassium was observed with application of either vermicompost alone or in combination with FYM in deep vertisols (Balaji,1994). FYM treated plots showed an increase in available phosphorus than inorganic fertilizers which was due to the coating of sesquioxides by organic materials that reduced phosphorus fixing capacity of soil (Bharadwaj and Omanwar,.1994). Application of organic manures such as FYM,vermicompost, crop residues enhanced the soil available nitrogen, phosphorus and potassium as compared to recommended dose of fertilizers (Patil *et al.*,2003). The vermicompost application significantly improved available P,K and DTPA-extractable Zn,Fe ad Mn content in the soil after harvest(Singh *et al.*, 1997).

Effect of organic nutrient management on soil enzymes

(Nath and Yadav, 2011) reported that application of FYM,coir pith waste, pressmud, digested sludge and poultry manure equivalent to 120 kg N ha^{-1} showed higher activity of dehydrogense and alkaline phosphatase activity.

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