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A review on effect of different soil less growing media on vegetable production

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Abstract

Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. Today, it is used widely in research facilities as a technique for studying plant nutrition. Crops grown under soil are tomato, capsicum, cucumber, peas and cauliflower. Substrates used in soil less culture must be lost cost, disease free, easily available and should be able to provide sufficient nutrients to crop plants grown in it. Studies reported that vegetables grown in soil less media is a feasible method for reducing the cost of cultivation of vegetable crops under protected conditions without loss of yield and fruit quality.

Keywords: Soilless culture, less growing, vegetable production

Introduction

Soilless culture is an artificial means of providing plants with support and a reservoir for nutrients and water. Today, it is used widely in research facilities as a technique for studying plant nutrition. (Michael Raviv and Heiner Lieth. 2007) [21] Various modifications of pure-solution culture have occurred. Gravel or sand is sometimes used in soilless systems to provide plant support, and retain some nutrients and water. Since the major constituent of the media in artificial growing systems may be solid or liquid, it is appropriate to use the term *soil less culture* in reference to this general type of growing system and reserve the term *hydroponics* for those in which water is the principal constituent. (Lakkireddy K. 2012) [18]. It is well known that soilless culture offers an advantage over soil culture where serious soil and water problems (i.e., soil borne pests, soil and water salinity, chemical residues in soil, water salinity, lack of fertile soil, water shortage, etc.), create difficulties in production. The main merits of soilless culture are the most accurate control over the supply of water, nutrients, pH, root temperature, etc., which increase the productivity due to easier and more accurate control of production factors, reduction of labour requirement, no need for soil sterilization, more crops per year, etc. Disadvantages of soil less culture which mainly includes the higher initial capital investment for the construction and maintenance of the soil less setup, the risk of disease infections mainly in the recirculating (close) systems, occasionally the increase of labour requirement and the need for higher standard of management and skill compared to crops growing in soil. Hydroponics is a technology for growing plants in nutrient solutions (water containing fertilizers) with or without the use of an artificial medium (sand, gravel, vermiculture, Rockwool, perlite, peat moss, coir, or sawdust) to provide mechanical support. Aggregate systems have a solid medium of support. It does not harm our environment as runoff from fertilized soil and very little water is lost to evaporation (Linden J. *et al.* 2000) [20]. Crops to Grow with Soil-less Culture are Lettuce, Head lettuce, Tomato, Egg Plant, Green bean, Beet, Winged bean, Capsicum, Bell pepper, Cabbage, Cauliflower, Cucumbers, Melons, Radish.

The main criteria for selection of a particular substrate, should be based on agronomic characteristics of the substrates, technical level of cultivation, environmental conditions which can be provided (structure, controls and other facilities), effect of substance on crop susceptibility to diseases, economic situation of the farm business, scientific support to the grower or level of education of the grower, Substrates used commonly in soilless culture are Peat, Cocopeat, Perlite, Vermiculite, Hydrogel, Rockwool: (Olympus, CM 1992) [28] The Advantages of Soil-less Culture are land is not necessary, clean working environment, no need of making beds, weeding, watering, etc., continuous cultivation is possible, no soil borne diseases or nematode damage. Off-season production is possible, vegetable cultivation can be done with leisure sense, many plants were found to give yield early in hydroponics system., Higher yields possible with correct management practices, Easy to hire labour as Soil less system is more attractive and easier than cultivation in soil, no need of electricity, pumps, etc. for the non-circulating systems of solution culture, water wastage is reduced to minimum, possible to grow plants and rooted cuttings free from soil particles for export.

Effect of soil less growing media on plant growth contributing factors

Bagyaraj and Sreeramulu (1982) [5] obtained significantly higher ascorbic acid content (166 mg) in fruits of chilli, when inoculated with VA mycorrhiza along with 50 per cent of recommended phosphorus. Chung and Shimure (1983) [10] found that nursery application of bark compost and soil (1:1 proportion) produced more vigorous seedlings which had highest solid phase ratio with good plant height and dry weight compared to carbonized rice husk and soil (1:3) and peat and soil (1:3) in pimento pepper.

Suitability of different substrates for capsicum grown in unheated structures was studied by Buczkowska and Kassowski (1987) [7], who reported high yields in low moor peat and low moor peat + sawdust mixed in the ratio of 1:1, and in turn low yield with poor quality of produce in low moor peat + sawdust at 1:2. However, no significant differences in plant height, stem thickness, plant weight/total dry matter in plants of *Capsicum annuum* L. were reported by Cantville and Paranjpe (1988) when seeds were sown in 100 % peat, 65 % peat + 35 % field soil + 20 % sand. Amrithalingum and Balakrishnan (1988) [2] noticed increased plant height in the chilli cultivar K-1 when inoculated with *Azospirillum* in addition to 75 per cent recommended nitrogen.

Parmaguru and Natarajan (1993) [29] observed the *Azospirillum* as a seed treatment and soil application combined with 56 kg urea/ha increased the plant height, number of branches and fruit yield in capsicum plants. Murumkar and Patil (1996) [24] reported that application of Azotobacter, Azospirillum and Vesicular Arbuscular Mycorrhiza (VAM) mixture in capsicum production, showed higher uptake of nitrogen (23.5 kg/ha), phophorus (2.1 kg/ha) and produced higher fruit yield (19.1 t/ha). Jasvir singh *et al.* (1997) [15] recorded greater plant height in chilli with the application of Vermicompost at the rate of 2.0t/ha.

Ribeiro *et al*. (2000) [32] conducted a greenhouse pot experiment on sweet pepper (*Capsicum annuum*) cv. Nacional AG 506. The plants were given 12 t Vermicompost/ha (equal to 600 g/pot) or 20t cattle manure/ha (1000 g/pot) with or without NPK alone. In the greenhouse, above ground dry matter increased with the increasing Vermicompost rate up to 600 g and root dry matter up to 400 g, then decreased. In the field, yield was greater with organic than mineral fertilizer, but did not differ between organic sources. Addition of NPK had no significant effect in the greenhouse or in the field trial.

In the studies conducted by Uzun *et al*. (2000) [37] on the effect of different organic wastes used as growing media on the growth, development and yield of some vegetable crops grown in unheated glasshouse during late autumn season revealed that growing medium influenced plant growth (height, stem diameter, leaf development, number of fruits and crop yield) and among the various media tested, mixture of sand with FYM and rice husk were suitable in capsicum production. Similarly, Samawat *et al.* (2001) [35] reported in 100% Vermicompost treatment, fruit weight and fruit number and shoot and root weight was three, five and nine times more than the control treatment, respectively. The effect of Vermicompost was higher in root growth than in shoot growth. The enriched Vermicompost, combined with the highest level of chemical fertilizers led to higher root and shoot weights. The Vermicompost x fertilizer interaction had no significant effect on fruit number. However, fruit weight, as well as root and shoot growth were significantly affected by this interaction.

Salas and Ramirez (2001) [34] observed maximum plant dry weight and fresh fruit weight in capsicum treated with organic manure like chicken manures, compost and vermicompost treatment than inorganic fertilizers and also resulted in increased microbial biomass production under the field conditions. Arancon *et al.* (2003) [3] applied Vermicompost produced commercially from cattle manure, market food waste and recycled paper waste in small replicated field plots planted with tomatoes (*Lycopersicon esculentum*) and bell peppers (*Capsicum annuum* var *grossum*) at rates of 10 t ha^{-1} and 20 t ha^{-1} in 1999 and at rates of 5 t ha^{-1} and 10 t ha^{-1} in 2000. There were significant increase in shoot weights, leaf areas and total and marketable fruit yields of pepper plants from plots treated with Vermicomposts compared to those from plots treated with inorganic fertilizer only. In studies on different media for greenhouse soilless grown peppers by Cantliffe *et al*. (2003) [8] it was found that the percentage of marketable pepper fruits from plants grown in peat mix were greater when 2 irrigation events per day were given.

Shehata *et al.* (2004) [36] observed that the treatments receiving NPK +chicken manure+ compost at the rate of (1/3 + 1/3 + 1/3) increased plant height, number of leaves and stems as well as their fresh weight, length, weight of fruits, total yield, flesh thickness and increased concentration of N, P and K in leaves and stems of sweet pepper plant.

Field experiments were also conducted by Jaipaul *et al.* during 2006 [14] observed that Application of poultry manure (5 tonnes/ha) + biofertilizer produced capsicum plant biomass and yield at par with integrated nutrient management (recommended NPK + farmyard manure@10 tonnes/ha + biofertilizer). Highest ascorbic acid content (25.23 mg/100 g) was recorded with integrated nutrient management, and followed by poultry manure+ biofertilizer (19.26 mg/100 g) and combined use of farmyard manure + poultry manure + Vermicompost + biofertilizer (18.83 mg/100 g). Incidence of Fusarium root rot was lower in poultry manure + biofertilizer (11.42%) and FYM treatments (12.06%) compared to integrated nutrient management (46.75%). Highest B:C ratio was recorded with poultry manure+ biofertilizer for capsicum too. Similarly, Kumar & Srivastava (2006) observed that the highest yield was obtained in the treatment with PSB + 75% P and full doses of N and K through fertilizers (220.09 q/ha), followed by the treatment with the recommended doses of NPK through fertilizers and pea straw (213.14 q/ha).

Asawalam *et al.* (2007) [4] reported that the treatments comprising of an inorganic fertilizer @ 20g/plant (NPK 15:15:15), goat manure and poultry manure (each 50 g/plant) and the soil amendments showed a significant ($p<0.05$)

effects on pepper height, flower number, fruit number and yield. Dass *et al*. (2008) [11] reported that vermicompost appeared to be the best soil additive in both crops in terms of yield, net economic return and water use efficiency (WUE). In bell pepper, use of VC + 50% recommended rate of synthetic fertilizers (RRF) produced significantly higher yield over 100% RRF, with a net return increase of 29.8%. In the 50% RRF + VC treatment, WUE was 32.6% higher in bell pepper and 6.2% higher in cabbage over treatment with 100% RRF. Bulk density of the surface soil after 3 years was reduced, its organic carbon and available N and P status improved due to treatment with 100% RRF, Bulk density of the surface soil after 3 years was reduced, its organic carbon and available N and P status improved due to treatment with CM and VC. The data indicate that 5 Mt/ha of VC can meet 50% of the fertilizer requirement of bell pepper and cabbage while providing higher productivity, income and residual soil fertility.

Similarly, Mohammed *et al.* (2009) [22] observed that plant heights were significantly greater in all evaluated media 1, 2 and 3. Higher number of fruits per plant, higher fruit weight and higher fruit yield was recorded by plants grown in medium1, which suggest that this treatment is best for growing bell pepper in CIPS. Similarly addition of animal manure increased soluble solids, ascorbic acid, total phenols, crude fiber and intensity of red colour as compared with soil that produced fruits with higher titrable acidity, water content and lycopene content. was observed by Abu Zahra (2011) [1] Narkhede *et al*. (2011) [26] studied the effect of chemical fertilizer and Vermicompost on *Capsicum annuum* crop. And observed a significant increase in plant height, leaf length and fruit yield of pepper plants was observed in plots treated with Vermicompost.

Nikos *et al*. [27] recorded that Plant growth was increased in municipal solid waste compost (MSWC) and fertigation enhanced mainly the plant height. Fruit number increased in MSWC 80:20 without fertilizer. Plant biomass increased as MSWC content increased. The addition of MSWC increased the value of N, P, K and organic matter of the substrate resulting in increased EC.

Effect of soil less growing media on yield contributing factors

Nair and Peter (1990) [25] reported the beneficial effect of combined application of organic and inorganic sources which increased fruit number, fruit weight/plant and fruit yield of chilli compared with either organic or inorganic fertilizer applied alone.

Hseih Chingfang and Hsu Kuonan (1994) [13] observed that the effect of organic manures (poultry manure + microbial supplement, pig manure + microbial supplement; fermented waste oil, fermented waste oils + rice hulls; fermented waste oil + rice straw) applied at different rates to give 150 kg/ha N have significantly recorded higher plant height, fruit size, fruit number and yield of sweet pepper than with the chemical fertilizer (NPK). Similarly, studies on sweet pepper production using different organic and soilless substrates compared to soil under high plastic tunnels were carried out by Popescu *et al*. (1995) [31], who found that plants grown on the organic substrates produced twice the yields more than grown in soil. Patil (1995) [30] reported that application of vermicompost (4 t/ha) along with 50 per cent RDF recorded significant increase in the potato yield (34 t/ha) as compared to control (14.2 t/ha).

In 1996, Salama and Mohammedien [33] conducted an experiment on productivity of sweet pepper grown on agricultural wastes under protected cultivation conditions and found that plant height and number of fruits per plant were increased significantly when grown on rice straw and/or legume (pea and bean) wastes under a 10 cm layer of clay over control (grown in clay soil). All waste treated treatments led to significant increase in early and total yields as compared to control.

In 2002, Gunadi *et al*. [12] reported that Vermicompost treatment in the pepper plots increased the marketable yields significantly. The mean yield of marketable pepper fruits ranged from 14 to 16 t/ha. Similarly, Mohammad *et al.* (2002) revealed that application of 50 per cent recommended dose of fertilizer and FYM (12.5 t/ha) along with reduced level of recommended dose of fertilizer (50% RDF) resulted in highest vegetative growth and yield in tomato. The readymade organic fertilizer i.e. clerich and teracare were inferior as compared to traditional organic manures *viz*. FYM and vermicompost.

Basavaraja *et al.* (2003) [6] reported that the treatments receiving 50% FYM + Azospirillum root dipping + 50% RDF + 50% vermicompost has significant and highest yield (21.49 t/ha) of capsicum, irrespective of growing conditions. This could be attributed to the significant increase in the components *viz*., plant height (59.49 cm), number of secondary branches/plant (2.33) number of fruits per plant (3.99) and yield per plant (7.76 k g). The least yield (17.36 t/ha) was noticed in treatment having RDF + FYM. Lee Anchion and Liao Fangshin (2007) [19] conducted research trial on sweet pepper grown under plastic house in basket culture with sugarcane residue compost substrate and reported higher sweet pepper yield (66.56 t/ha) when compared to chicken dung compost substrate, Taoki no. 3 substrate, cattle dung compost substrate and hog dung compost substrate.

Kumar and Verma (2009) [16] recorded that for greenhouse capsicum production.the growing media having Soil: Farm Yard Manure (FYM): Sand (2:1:1), irrigation regime of 20 kPa, fertigation with water soluble fertilizers at the rate of 250 kg/ha NPK and use of black polythene mulch recorded highest plant height (102.60 cm), more number of fruits per plant (18.03) and higher productivity (1.08 kg/plant and 8.64 kg/m^2).

Kumari *et al*. (2009) [17] reported that application of Vermicompost @ 5 t/ha along with 75% recommended nitrogen as inorganic, improved fruit quality and marketable yield of pepper in Andhra Pradesh.

Similarly, Mohammed *et al.* (2009) [22] conducted a greenhouse experiment to evaluate the effect of three substrates on the growth and yield of two cultivars of sweet peppers (*Capsicum annuum* cv. The *Capsicum annuum* cultivars were grown in CIPS (Closed Insulated Pallet System). Results showed that plant heights were significantly greater in all evaluated media 1, 2 and 3. Higher number of fruits per plant, higher fruit weight and higher fruit yield was recorded by plants grown in medium1, which suggest that this treatment is best for growing bell pepper in CIPS.

Yaser Majdi *et al*. (2012) [38] conducted an experiment to know the effectiveness of substrate and select suitable cultivar with high yield in hydroponic cultivate system and recorded peat + perlite had most effect on growing traits and yield of green pepper. Kumar *et al*. 2017 [39] conducted an experiment to studied the effect of organic, inorganic and biofertilizers. The application of T9 (FYM 50%+ Azospirillium 50%) were giving the maximum yield (410.43q/ha) Negi *et al.* 2017 [40] recorded the maximum yield of (39.25 t/ha) with the application of farm yard manure and biofertilizer in case of brocolli. Shree *et al*. 2017 [41] studied the effect of different sources of nutrients which included organic, inorganic and bio fertilizer alone or in combinatrion and notef that 50% N:P:K (recommended dose)+FYM @2T/ha+Azospirilium.

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