The Pharma Innovation Journal 2021; 10(10): 578-585

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 578-585

www.thepharmajournal.com
Received: 22-07-2021
Accepted: 29-09-2021

Elakiya N
Ph.D., Scholar, Department of Soil Science and Agricultural Chemistry, Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

Arulmozhiselvan K
Professor, Department of Soil Science and Agricultural Chemistry, Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

Corresponding Author:
Elakiya N
Ph.D., Scholar, Department of Soil Science and Agricultural Chemistry, Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India

Effect of salinity and composition of growing media on growth and yield of ribbed gourd in soilless culture under matric suction irrigation

Elakiya N and Arulmozhiselvan K

Abstract
Particulate organic/ mineral matter can be suitable substrates for composing soilless media, if the salinity and method of wetting the media are properly handled. To standardize an appropriate method, a soilless experiment was conducted in an open wasteland area in pandal system under matric suction irrigation during *Rabi* 2019–2020. Five growing media and three salinity levels were tested. For composing the growing media equal proportion (on weight basis) of substrates *viz*., coirpith, vermicompost, flyash, green manure (*Daincha*) and sand were mixed in different combination. Ribbed gourd CoH-1 was raised in growing media in containers that were interconnected by tubs and tubes to maintain moisture always by matric suction. The results revealed that the growing media having Coirpith: Vermicompost: Green Manure: Sand with salinity of 0.5–1.0 dS m^{-1} registered the highest fruit yield (8.884 kg pot-1) and water use efficiency (312.1 kg fresh fruit mm^{-1}). Growth and yield of crop decreased with increase in media salinity from 0.5 to 3.0 dS m^{-1}.

Keywords: Growing media, soilless substrates, ribbed gourd, salinity, matric suction

1. Introduction

India has a wide range of climate and physio-geographical conditions which are most appropriate for growing various kinds of horticultural crops. Owing to that India stands as the second largest producer of vegetable crops accounting for 8.6 per cent of the World production (FAO, 2021) [17]. In 2020-21, the vegetables production in India estimated was 196.3 million tones (DAFW, 2021) [14]. Vegetables are a major source of vitamins like niacin, riboflavin, thiamin, vitamin-A and vitamin-C. In addition, vegetables supply minerals like calcium and iron, proteins, and carbohydrates. Further, they are the important sources of dietary fiber and antioxidants (Craig and Beck, 1999; Wargovich 2000; Dias and Ryder, 2011) [13, 55, 15].

Luffa, the popular fibrous fruit vegetable in the family of Cucurbitaceae, is said to have originated in India and also grown throughout the country and in many parts of the World. Usually, it is called as ridge gourd or ribbed gourd in many regions. The green immature fruits are cooked as vegetable. Ribbed gourd fruits chemically constitute carbohydrates, carotene, fat, protein, phytin, flavonoids, saponin and amino acids. Fresh fruits can supply about 300 µg β-carotene and 1000 µg carotenoids per 100 g. Due to that it has various pharmacological actions like hepatoprotective, antidiabetic, antioxidant, abortifacient and antifungal activity. It is recommended for purifying blood, as laxative, cure for jaundice, reduce weight, as anti-inflammatory and antibiotic, strengthening the immune system, skin cure and for the health of stomach (Kandlakunta *et al*., 2008) [25].

Alternative to conventional soil based intensive agriculture, the most sustainable and environmentally friendly soilless culture are currently considered as convenient systems to conserve energy, nutrients and water. The biggest tasks handled in closed soilless systems are salinity of circulating solution, non-uniform nutrient supply, suppression of root pathogen, removal of undesired taste and ill-health related compounds in the product, etc. (Schwarz *et al*.,2009) [41]. As salinity is a major limiting factor for crop growth, managing salt concentration and nutrient supply for crops grown in closed soilless systems is very essential (Neocleous and Savvas, 2016) [33]. Particularly, by regulating fertigation solution volume and nutrient concentration as per crop need salinity related constraints can be removed and proper enhancement in yield and fertilizer use efficiency can be achieved without accumulating pollutants (Dufour and Guerin, 2005) [16].

For composing growing media traditionally organic substrates such as manures and composts are used for imparting beneficial properties of water retention, aeration and nutrient supply. Usually locally available bulky materials are preferred for constituting growing media at low cost. Among them coirpith and vermicompost are very popular. Green manures rich N and P readily decompose, hence can also be used as a substrate in the form of dry powder. Besides, flyash which is anoxidized inorganic material accumulating in pyrogenic industrial premises, has some desirable properties of substrate. Individually no single substrate qualifies to be fit for use as soilless media and notably in each there may be limitations. Common limitations associated with these substates are undesirable salinity, bulk density, aeration, water holding capacity, pH, etc. A judicious blend of different substrates can balance out these limitations.

Matric suction irrigation is a technique in which moisture is continuously supplied to the growing media from bottom to top throughout the crop period. The containers (plastic pots) containing growing media are placed inside the tubs having standing water. All tubs are interconnected by tubes. In each tub standing water is present to the same level. Water used up by evapotranspiration from tubs is immediately refilled from the storage tank. There is no loss of nutrients either by leaching or drainage of the water. Previously, the study conducted with growing media and methods of fertilization revealed that coirpith, vermicompost and fly ash as most suitable substrates for growing snake gourd in soilless culture (Kannan and Arulmozhiselvan, 2019) [26]. As a follow up, the present study aimed to evaluate the effect of salinity and composition of media on growth and yield of ribbed gourd in soilless culture under matric suction irrigation.

2. Materials and Methods

The location of experiment is Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu ($10^0$45.205'N, $78^0$36.141' E, Altitude: 85 m MSL), which belongs to Cauvery delta agro climatic zone of Tamil Nadu having tropical climate with an annual average rainfall of 860 mm. The soilless container study (pot experiment) was conducted in open wasteland area with the test crop of ribbed gourd (*Luffa acutangula* L.), in a pandal structure (climber support) equipped with matric suction irrigation system (Figure 1). The pandal structure was established for the spread of vine at about 6 feet height by fixing 30 Nos. of concrete pillars and connecting on top by steel wires.

2.1 Assembly of matric suction irrigation system

The setup of soilless container culture with matric suction irrigation was established using the design and materials originally described for open land soilless system (Kannan and Arulmozhiselvan, 2019) [26]. In the method of irrigation by matric suction moisture is continuously supplied to growing media without break from bottom to top. Matric suction of growing media is the force with which water is adsorbed on the physical surfaces of substrate particles. In the present study coirpith, vermicompost, flyash, green manure and sand were used as substrates. Standing water is present all the time in tubs which wets the bottom of containers and in turn the growing media is wetted.

Fig 1: View of soilless media experiment in pandal system

The components (Figure 2) of this system were (1) Overhead water tank, (2) Steady water level tub with ball valve assembly, (3) Series of plastic tubs interconnected through 20 mm black HDPE tubes and (4) Plastic 20 L capacity container filled with growing media. The series of tubs placed on level platforms were linked through the steady water level tub to the storage tank. By this arrangement all tubs were aligned to the same level thereby uniform filling of water was ensured by gravitational flow to all tubs all the time.

The plastic 20 L container has 8 holes (10 mm diameter) at bottom. At inside bottom of each container, a nylon mesh (No. 400) with a square dimension of 18 x 18 inch was placed and filled over with manufactured sand (m-sand) as the base media to a height of 4 inch. Base media was partly submerged in the water maintained in tub. Above the base media, again a nylon mesh (No. 400) with a square dimension of 18 x 18 inch was placed to arrest the downward movement of particles of growing media. Over the mesh, growing media was filled up to a height of 9 inches. Through matric and capillary suction, the base media gets moistened first by contact with water, later maintains almost a state of saturated moisture content. Successively, the growing media was moistened by the virtue of only matric suction. The base media is always at lower matric suction. Due to evaporation or transpiration, when growing media particle surfaces are devoid of water, higher matric suction results. This situation creates a matric suction gradient which acts as a driving force causing upward movement of water from the base media to the growing media by particle-to-particle contact.

Adjoining to the 30 concrete poles fixed for pandal structure (6 lines x 5 rows) with a spacing of 10 feet on either side, concrete slabs (2 x 2 feet) were placed over a brick work. The concrete slabs were set rigidly at a uniform height alignment, by adopting the tube level. The tubs were placed on the concrete slabs. Within each tub a growing media container was placed. According to randomization of treatments growing media was filled in each container.

a) Overhead water tank b) Steady water level tub c) Container inside plastic tub

Fig 2: Components of matric suction irrigation assembly

The treatments imposed were categorized in two factors *viz*., salinity of media (3 levels) and composition of media (5 Combinations). Accordingly, the containers were arranged in factorial completely randomized design, with 3 replications. The test crop of ribbed gourd (hybrid CoH1) was raised in the season *Rabi* 2019–2020.

In the water storage overhead tank non-saline water (EC 0.34dS m^{-1}) was maintained for continuous irrigation. From the tank, water was circulated to all the tubs and containers. Once in a week the height of standing water inside the tank was measured using a graduated scale. Based on the drop in height of water from previous measurement the volume of water consumed for cropping was calculated for a period (area of tankx drop in height).The salinity of the media was monitored every time of fertilizer application, one day before and one day after. Low levels of salinity in growing media were established initially using pre-washed coirpith. High levels of salinity of growing media were brought in by the addition of calculated amounts of sodium chloride. Salinity of the growing media was estimated by measuring electrical conductivity in the filtrate collected by cloth filtering the suspension prepared by adding two gram of growing media in 100 mL of distilled water and soaking for 30 minutes. The measured electrical conductivity was multiplied by 10 to express the results in dS $m^{-1}$for 1:5 substrate-water ratio. In the same filtrate pH was measured using the pH meter and expressed results by deducting one unit of pH from measured value for compensating the dilution.

2.2 Treatment details

S - Salinity of Media (dS m^{-1})		M - Composition of Media	
S_1	0.5 –1.0	M_1	CP+VC+FA (1:1)
S_2	1.5 – 2.0	M_2	CP+VC+FA+S (1:1:1)
S_3	2.5 – 3.0	M_3	CP+VC+S (1:1:1)
		M_4	CP+VC+GM (1:1:1)
		M_5	CP+VC+GM+S (1:1:1:1)
	CP - Coirpith VC - Vermicompost GM - Green manure	FA - Fly ash S- Sand () - Ratio of mixing on weight basis	
Salinity expressed as electrical conductivity of 1:5 substrate-water suspension			

2.3 Fertilization of crop: For this soilless experiment with ribbed gourd crop, the dose of primary nutrients adopted was 125g N,25g P_2O_5 and25gK_2O per container. The calculated quantity of water-soluble fertilizers *viz*., urea, mono ammonium phosphate (MAP) and muriate of potash (MOP) were taken and applied to each container in 19 split doses at 5 days intervals. The fertilizer doses were split according to the growth stages of the crop. For supplying secondary and micronutrients commonly, a nutrient solution was prepared by taking 30 g of fertilizer mixture comprising 5 g $MgSO_4$, 5 g $CaCl_2$, 3 g $FeSO_4$, 3 g $ZnSO_4$, 2 g $CuSO_4$, 2 g $MnSO_4$ and 10 g Citric acid and dissolving in 1 L of water. At weekly intervals 100 ml of this nutrient solution was added to water in the storage overhead tank.

3. Results

The effect of salinity and composition of media was studied by relating initial properties of substrates to the growth, yield, nutrient uptake and water use performances of the crop. At harvest stage vegetative parameters *viz*., leaf width, vine length and vine drymatter and yield parameters *viz*., fruit length, number of fruits harvested and fruit drymatter were recorded (Table 2). The yield of fruits was recorded on fresh weight basis for every container (pot). Harvest Index was calculated as the ratio of fruit drymatter to total (vine + fruit) drymatter. Water productivity was calculated by dividing fresh weight of harvested fruits (in kg ha^{-1}) by the total amount of water consumed (in mm).

3.1 Initial characteristics of growing media

The different growing media studied were prepared from substrates which had wide variability in their physico-chemical properties (Table 1). Among the substrates, the content of soluble salts was high in daincha (EC 13.43 dS m^{-1}) and coirpith (EC 8.43 dS m^{-1}), whereas moderate soluble salt content was found in vermicompost (EC 1.86 dS m^{-1}) and flyash (EC 1.14 dS m^{-1}). The reaction of coirpith and daincha were near slight acidic where as vermicompost and flyash were slight alkaline. The total dissolved solids (TDS) estimated was highest in daincha (6612 mg L^{-1}) and moderate in coirpith (4292 mg L^{-1}). Very high content total N was present in daincha (22.412 g kg^{-1}). High total P was estimated in vermicompost (5.065 g kg^{-1}). Total K was abundant in daincha (4.082 g kg^{-1}), followed by coirpith and flyash.

Table 1: Physico-chemical properties and nutrient content of substrates

Physical properties and chemical composition						
S. No.	**Parameter**	**Unit**	**Coirpith**	**Vermicompost**	**Flyash**	**Daincha**
1.	Bulk density	Mg m^{-3}	0.118	0.592	1.059	0.255
2.	Water holding capacity	%	426.31	52.85	46.48	56.85
3.	Total Carbon	%	33.84	16.62	0.78	35.64
4.	TDS (1:5 dilution)	mg L^{-1}	4296	886	516	6612
5.	pH (1:5 dilution)	pH	6.49	7.46	7.88	6.59
6.	EC (1:5 dilution)	dS m^{-1}	8.53	1.86	1.14	13.43
7.	C/N Ratio	-	52.9	25.1	16.2	17.7
Nutrient Composition						
8.	Total N	g kg^{-1}	2.821	11.265	1.134	22.412
9.	Total P	g kg^{-1}	0.193	5.065	0.699	3.810
10.	Total K	g kg^{-1}	2.324	1.162	0.456	4.082

3.2 Vegetative parameters

The effect of treatments on growth of ribbed gourd vine was estimated by recording leaf width, vine length and vine drymatter at harvest stage (Table 2). The highest leaf width (18.17 cm), vine length (3.75 m) and vine drymatter (1110.2 g pot^{-1}) were recorded with plant raised in the growing media (Figure 3) containing of Coirpith: Vermicompost: Green Manure: Sand (M_5). Growing media consisting of Coirpith: Vermicompost: Green Manure (M_4) showed relatively high growth in leaf width (16.50 cm), vine length (3.35 m) and vine dry matter (1011.4 g pot^{-1}). The lowest leaf width (13.83 cm), vine length (3.03 m) and vine drymatter (909.8 g pot^{-1}) was registered in growing media comprising Coirpith: Vermicompost: Sand (M_3).

Salinity of the media significantly affected growth by limiting growth at high salinity levels. The highest leaf width (21.55 cm), vine length (4.10 m) and vine drymatter (1310.1 g pot^{-1}) was observed with low salinity level of EC 0.5–1.0 dS m^{-1} (S_1). At high salinity level with EC of 2.5 – 3.0 dS m^{-1} (S_3) the lowest leaf width (9.28 cm), vine length (2.42 m) and vine drymatter (605.0 g pot^{-1}) were found.

3.3 Yield parameters

Yield and yield parameters declined drastically with increasing levels of salinity(Table 2). The highest yield (8.884 kg pot^{-1}) was recorded at low salinity level (EC 0.50 - 1.0 dS m^{-1}). At moderate salinity (EC 1.5 -2.0 dS m^{-1}) yield was lower (6.004 kg pot^{-1}) and at high salinity (EC 2.5 -3.0 dS m^{-1}) yield was lowest (2.811 kg pot^{-1}).

Fig 3: Growth of ribbed gourd at yielding stage

Growing media with Coirpith: Vermicompost: Green Manure: Sand (M_5) registered the highest fruit length (29.0 cm), number of fruits per pot (19.5), fruit yield (6.679 kg pot^{-1})and fruit drymatter (460.5 g pot^{-1}), which was closely followed by growing media having Coirpith: Vermicompost: Green Manure (M_4).

3.4 Nutrient uptake

The effect of growing media and salinity on uptake of nutrients in vine and fruit of ribbed gourd at final harvest stagewas significantly different (Table 3). The highest amount of total N(19.926 g pot^{-1}), total P (1.858 g pot^{-1}) and total K (30.250 g pot^{-1}) uptake was observed in the growing media comprising of Coirpith: Vermicompost: Green Manure: Sand (M_5).

With increasing salinity, the uptake of nutrients decreased significantly. The plants raised with the growing media consisting of Coirpith: Vermicompost: Green Manure: Sand (M_5) with low salinity (EC 0.5 – 1.0 dSm^{-1}) registered the highest total N (24.771 g pot^{-1}), total P (2.357 g pot^{-1}) and total K (38.686 g pot^{-1}) uptake.

3.5 Harvest Index and Water productivity

Harvest index is an indication of the ability of the plant to divert the total drymatter to form the economic part. Harvest index decreased with increase in salinity. Comparably, very high harvest index was realized in growing media containing Coirpith: Vermicompost: Green Manure in combination with sand (0.288) and without sand (0.291).

For the total duration of the crop of 120 days water consumed by the crop (214 L pot^{-1}) was 23.3 mm on hectare basis (1090 pots ha^{-1}). The water productivity computed as weight of fresh fruit produced per mm of consumed water was highest to the tune of 312.1 kg mm^{-1} in growing media containing Coirpith: Vermicompost: Green Manure: Sand (M_5)whereas in other media it ranged from 233.8 to 285.5 kg mm^{-1}. There was a drastic reduction in water productivity from 389.4 to 131.3 kg mm^{-1}when the salinity of growing media increased from 0.5 to 3.0 dS m^{-1}.

Table 2: Effect of treatments on vegetative and yield parameters of ribbed gourd

Treatment Notation	Vegetative parameters			Yield parameters			
	Leaf width (cm)	Vine length (m)	Vine drymatter (g pot^{-1})	Fruit length (cm)	No. of fruits harvested	Fruit Yield kg pot^{-1}	Fruit drymatter g pot^{-1}
Salinity							
S_1	21.55	4.10	1310.1	35.5	23.2	8.333	567.1
S_2	16.38	3.36	1029.6	27.0	18.6	6.004	410.7
S_3	9.28	2.42	605.0	14.4	11.2	2.811	192.2
Media							
M_1	14.63	3.08	914.7	23.4	16.4	5.003	329.2
M_2	15.54	3.25	961.5	24.8	17.7	5.776	387.7
M_3	13.83	3.03	909.8	23.5	16.0	5.012	345.6
M_4	16.50	3.35	1011.4	27.4	18.7	6.110	426.9
M_5	18.17	3.75	1110.2	29.0	19.5	6.679	460.5
SEd							
Salinity	0.38	0.07	11.8	0.69	0.26	0.112	4.97
Media	0.24	0.04	7.4	0.44	0.17	0.071	3.14
CD (P=0.05)							
Salinity	0.67**	0.12**	20.6**	1.21**	0.46**	0.196**	8.71**
Media	0.42**	0.08**	13.0**	0.76**	0.29**	0.124**	5.51**

Table 3: Effect of treatments on nutrient uptake, harvest index and water productivity

Treatment Notation	Total nutrient uptake (g pot^{-1})			Harvest index	Water productivity (kg fresh fruit mm^{-1} of water)
	N	P	K		
Salinity					
S_1	24.771	2.357	38.686	0.302	389.4
S_2	17.204	1.593	25.704	0.284	280.6

S_3	7.936	0.696	11.520	0.238	131.3
Media					
M_1	14.668	1.319	21.951	0.254	233.8
M_2	16.104	1.553	25.137	0.278	269.9
M_3	14.612	1.349	22.330	0.263	234.2
M_4	17.875	1.665	26.848	0.291	285.5
M_5	19.926	1.858	30.250	0.288	312.1
SEd					
Salinity	0.374	0.026	0.595	0.0036	5.23
Media	0.236	0.016	0.376	0.0023	3.31
CD (P=0.05)					
Salinity	0.655**	0.045**	1.043**	0.0063**	9.17**
Media	0.414**	0.029**	0.660**	0.0040**	5.80**

4. Discussion

Growing vegetable crops give greater remuneration to farmers due to their faster growth, prolonged yielding period and quick marketability. When availability of productive land for vegetable production becomes a limitation, systems like soilless culture may be an alternative approach. Present study was carried out to standardize the soilless culture method for the production of pandal vegetable crop in the plain wasteland area using commonly organic/ mineral substrates available nearby the farmers holdings. Every substrate has one or more appreciable properties. Coirpith can hold large amount of water. Vermicompost contains substantial nutrients and carbon for the support of plant and microorganisms. Flyash contains enormous potassium. The drymatter of daincha contains abundant amounts of N and K. These substrates can be mixed in various combination with or without sand so that optimization of properties like bulk density, water holding capacity, nutrient availability, aeration, microbial activity can be brought in a soilless growing media.

With this purpose the present soilless culture (pot experiment) was carried out in open wasteland field area. The results were focused on crop productivity by recording growth, fruit yield, uptake of nutrients and water use efficiency. It was inferred that among the different growing media tested Coirpith: Vermicompost: Green manure: Sand (M_5) mixed in equal proportion on dry weight basis exhibited distinguishing performance in crop productivity. Closely its performance was followed by Coirpith: Vermicompost: Green Manure (M_4) and Coirpith: Vermicompost: Flyash (M_1).

Organic substrates are loose and lightweight materials having bulk density<1 Mg m^3. Growing media primarily function as a physical support for anchoring roots and facilitating root proliferation. Poor root anchorage may affect absorption and transport water and cause breakage of branches of roots and root hairs. Addition of sand in media composition was aimed to bring optimum bulk density in media, promote adequate aeration and moisture retention.

Daincha, the most preferred green manure crop, grows well even in saline and alkaline soils. Bhuiyan *et al.* (1988) [10] reported that about eight weeks old *dhaincha* plants had 3 per cent N in addition to other nutrients. The inclusion of Daincha as dry powder in addition to vermicompost and coirpith showed significant increase in growth and yield parameters. This enhancement in the growth might have been due to supply of essential plant nutrients as the combination containing green manure showed higher uptake of nutrients by the ribbed gourd. Earlier study showed that incorporation of *dhaincha* in field remarkably increased soil organic matter, N, P, K and S compared to initial soil status and attained a peak level at 50 days after incorporation (Sontosh Chandra Chanda *et al.*, 2021) [48]. Similarly, the goat manure in combination with *Azolla* and *Sesbania* improved organic C, N, and C/N ratio of the soil over the initial value (Setiawati *et al.,* 2020) [42].

Availability of adequate N in vegetative phase might promote many physiological and metabolic processes, as it is closely related to protein formation, tissue growth, physiological function, substance synthesis and distribution (Maathuis, 2009; Zhong *et al*., 2017; Souri and Hatamian, 2019) [28, 58, 50]. In the present study regular fertilization of plants in split doses with water soluble fertilizers might have supported sufficient growth of plants. Besides additional supply of nutrients made through substrates, particularly daincha and vermicompost would have enhanced higher vine length and dry matter production in ribbed gourd. Especially, within the growing media the proximate constituents *viz.*, ash, crude protein and crude fibre contributed by *daincha* could have increased the availability of nutrients (Shi, 2013; Kabir *et al.*, 2018) [45, 22].

After the available nutrients from media gradually decline from initial stages of the crop, the application of fertilizer solution would supply the necessary nutrients to the crop is in accordance with the findings of Sangeeta Shree *et al*. (2018) [39]. Sontosh Chandra Chanda *et al.* (2021) [48] observed that combined application of vermicompost and inorganic fertilizers increased fruit weight and yield of bitter gourd. Similar findings were reported by Anuja and Poo*viz*hi (2009) [5] in cucumber and Kameswari *et al*. (2011) [24] in sponge gourd.

Part of growing media containing vermicompost may provide essential nutrients for the growth of crop since the nutrients in vermicompost are present in readily available forms such as nitrates, exchangeable P, K, Ca, and Mg (Orozco *et al.*, 1996) [35]. Some of these main mineral forms are converted into soluble forms which are used for plant uptake (Nair *et al.*, 2006) [32]. In the present study the identified role of vermicompost has been utilized positively by including it as a component in all growing media tested.

Increased vegetative growth and yield of celery and red cabbage upto 20 per cent resulted when vermicompost was added to sand + rice husk substrate (Sayed H. Ahmed *et al.*, 2017) [40]. Similarly, addition of vermicompost as a substrate showing impact on growth and yield of sweet paper, snap bean, lettuce, strawberry, celery, salad cabbage and red cabbage has been reported (Abul-Soud *et al*., 2015a and 2015b) [1,2]. Besides nutrient supply presence of substances like humic acid in vermicompost could have caused direct encouraging effect on the growth and yield was justified by Arancon *et al.* (2005) [8] in ribbed gourd and by Nuhaa Soobhany *et al.* (2017) [49] in green beans. As vermicompost is having rich organic matter, it would have improved the physical and chemical properties of growing media, besides supplying nutrients as elucidated in studies conducted by Arancon *et al.* (2002) [7] on tomato and peas and Arancon *et al.* (2004) [6] on strawberry.

The presence of sand in significant proportion in the growing media with Coirpith: Vermicompost: Green Manure: Sand might have increased overall bulk density of the growing media thereby increased total pore space, aeration and water retention. Raviv and Lieth (2008) [38] reported that increase in bulk density of soilless media resulted after mixing with sand. Arunadevi (2021) [9] reported that bulk density and aeration porosity were maximized in the mixture of Coirpith: Vermicompost: Sand, which might have favored the healthy growth of nursery. Likewise, Rashidha *et al.* (2021) [37] reported greater plant height, highest fresh weight of leaves, fresh and dry weight of roots and root volume in potted foliage plant in growing media containing sand in the combination of Cocopeat (70%), rice husk (10%), vermicompost (10%) and sand (10%).

Encouragingly the growth and yield of ribbed gourd were appreciable in the growing media containing flyash in its composition. Flyash enhanced the crop yield and biomass (Thind *et al.*, 2012; Ukwattage *et al.*, 2013) [52, 54] and hence it is used as fertilizer to improve the productivity of many crops (Ahmad *et al.*, 2017a; Haris *et al.*, 2019) [3, 20] as it contains vital nutrients like K, Mg, and S (Yousuf *et al.* 2020) [57]. Application of flyash increases the availability of nutrients such as Cu, Fe, Al, Si, P, S, K, Mg, and Ca, etc. (Haris *et al.*, 2019) [20]. The beneficial impact of flyash on plant growth and biomass production were studied in wheat (Ochecova *et al.*, 2014) [34], rice (Bisoi *et al.*, 2017) [11], carrot (Haris *et al.*, 2019) [20], radish (Sharma and Singh 2019) [44], safedmusli (Hadke *et al.*, 2019) [18]. Shakeel *et al.* (2020) [43] reported about 15 per cent increase in terms of shoot length, shoot fresh and dry weight, number of leaves and leaf area in beetroot with fly ash application.

Sushmita Munda *et al.* (2016) [51] reported that application biochar and flyash produced higher number of tillers per plant in rice which could be due to the increase in very high porosity and water holding capacity. The absolute hollow silt-sized particles in flyash might promote transport and supply water molecules (Skousen *et al.*, 2013) [47]. In trials with bottle gourd and sponge gourd application of flyash at 120 and 180 Mg ha^{-1} respectively made about 10-15 per cent yield increase (Parab *et al.*, 2012) [36]. Fly ash application improving soil bacteria count and enzyme activity of dehydrogenase, urease and alkaline phosphatase has been reported (Yeledhalli *et al.*, 2007) [56].

Many organic substrates contain significant quantity of soluble salts which limit considerably the growth of plants. Coirpith obtained from coastal regions contain enormous soluble salts when compared to coirpith obtained from inland plantations. Washing of coirpith substrate with low saline water can reduce its salt content, particularly sodium salts, thereby make it suitable for use as growing medium. This process costs labour and uses a large volume of water. Used up water is a waste which pollutes the environment. Washing of other substrates containing enormous soluble salts like vermicompost, daincha, etc., is not preferable as it may remove all soluble organic compounds and plant nutrients along with salts and make them unproductive. In the present study attempt has been made to use vermicompost, flyash and daincha as substrates of growing media without washing. The levels of salinity were maintained in treatments by combining with washed coirpith at the lowest levelof salinity, and addition of sodium chloride salt at higher levels of salinity.

The inhibitory effect of salinity was observed in all the measured growth and yield parameters which was reflected in nutrient uptake and yield of the ribbed gourd as well. This would be due to inhibition of growth through reduced water absorption, reduced metabolic activities due to Na^+ and Cl^- toxicity, and nutrient deficiency caused by ionic interference as reported in previous studies (Jacoby, 1994; Marschner, 1995) [21, 30]. The high concentration of Na^+ and Cl^- ions may disrupt membrane integrity and function as well as affect the internal solute balance that also affects nutrient uptake, resembling nutrient deficiency symptoms that occur in the absence of salinity (Munns and Tester, 2008) [31].

The salinity threshold of the majority of vegetable crops is reported to be low, ranging from 1.0 to 2.5 dS m^{-1} in saturated soil extracts (Machado and Serralheiro, 2017) [29]. Excessive concentrations of salt ions also injure photosynthetically active leaves and may lead to chlorosis and early leaf senescence (Hanin *et al.*, 2016) [19]. If salt stress reduces growth in an early phase of plant development, the yield would strongly decline (Khan *et al.*, 2017; Ahmad *et al.*, 2017b; Kaleem *et al.*, 2018) [27, 4, 23]. Reduction in plant fresh and dry weights in response to salt stress has been reported for other crops, such as melon (Sivritepe*et al.*, 2005) [46], musk melon (Bustan *et al.*, 2005) [12], cucumber (Trajkova *et al.*, 2006) [53].

5. Conclusions

Matric suction irrigation is a method devised for growing plants in containers on a leveled wasteland area or terrace. Particularly it is suitable for growing vegetable crops in containerized soilless growing media. In the present study, the results indicated that the commonly available substrates having substantial soluble salts can very well be used as a ready-to-compose material for aggregating soilless growing media provided the water available for irrigation is low saline (EC <0.5 dS m^{-1}). Pre-washing treatment is not required for substrates except coirpith. As the growing media is always under moist conditions throughout the cropping period due to matric suction, the injury by salt concentrations of media is minimized. Growing media containing coirpith, vermicompost, daincha, and sand achieved the highest the growth and yield of ribbed gourd. Overall, the study has identified a suitable growing media for soilless culture in pandal system under matric suction irrigation.

6. Acknowledgments

Authors would like to thank the Dean, Anbil Dharmalingam Agricultural College and Research Institute, Trichy for facilitating the research by making provision for the pandal structure.

7. References

1. Abul-Soud M, Emam MSA, Abd El-Rahman NG. The potential use of vermicompost in soilless culture for producing strawberry. Int. J. Pl. and Soil Sci 2015a;8(5):1 – 15.
2. Abul-Soud M, Emam MSA, Hawash AH, Hassan, Yahia MZ. The utilize of vermicomposting outputs in ecology soilless culture of lettuce. J. Agric. and Ecol. Res 2015b;5(1):1-15.
3. Ahmad G, Khan AA, Ansari S. Interaction of a fly ash and rootknot nematode pathogens on pumpkin (*Cucurbita moschata* Duch. ex Lam.). Trop. Plant Res.

2017a;4:449-455.
4. Ahmad R, Jamil S, Shahzad M, Zörb C, Irshad U, Khan N *et al*. Metabolic profiling to elucidate genetic elements due to salt stress. Clean - Soil Air Water 2017b;45(12):1600574.
5. Anuja S, Poo*vi*zhi K. Effect of organic nutrients on yield and yield attributes of cucumber (*Cucumis sativus*) cv. Long green. Vegetable Science 2009;6(2):163-166.
6. Arancon NQ, Edwards CA, Atiyeh R, Metzger JD. Effects of vermicomposts produced from food waste on the growth and yield of greenhouse peppers. Bioresource Technol. 2004;93:139-144.
7. Arancon NQ, Edwards CA, Bierman P, Metzger J, Lee S, Welch C. Applications of vermicomposts to tomatoes and peppers grown in the field and strawberries grown under high plastic tunnels. Proc. Int. Earthworm Symposium, Cardiff Wales 2002.
8. Arancon NQ, Edwards CA, Bierman P, Metzger JD, Lucht C. Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yields of peppers in the field. Pedobiologia 2005;49:297-306.
9. Arunadevi K. Evaluation of Physical Characteristics and Matric Potential of Soil Less Media. Environment and Ecology 2021;39(1):42-47.
10. Bhuiyan NI, Zaman SK, Panaullah GM. Dhaincha green manure: A potential nitrogen source for rain-fed lowland rice. Proceedings of Workshop, International Rice Research Institute, Philippines 1988, 108.
11. Bisoi SS, Mishra SS, Barik J, Panda D. Effects of different treatments of fly ash and mining soil on growth and antioxidant protection of Indian wild rice. Int. J Phytoremediation 2017;19:446-452.
12. Bustan A, Shabtai Cohen, Yoel De Malach, Philip Zimmermann, Rami Golan, Moshe Sagi, Dov Pasternak. Effects of timing and duration of brackish irrigation water on fruit yield and quality of late summer melons. Agricultural water management 2005;74(2):123-134.
13. Craig W, Beck L. Phytochemicals. Health Protective Effects. Canadian Journal of Dietetic practice and Research 1999;60:78-84.
14. DAFW (Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare), Second Advance Estimates 2020-21**,** Government of India. https://agricoop.nic.in/en/statistics/state-level
15. Dias JS, Ryder EJ. World vegetable industry: production, breeding, trends. Horticultural Reviews 2011;38:299-356.
16. Dufour L, Guérin V. Nutrient solution effects on the development and yield of *Anthurium andreanum* Lind in tropical soilless conditions. Sci. Hort 2005;105:269-282.
17. FAO - Food and Agriculture Organization of the United Nations. http://www.fao.org/india/fao-in-india/india-at-a-glance/en/ 2021.
18. Hadke PB, Wankhade SG, Ingle SN. Consequence of FYM and fly ash application on yield, nutrient uptake, and quality of safedmusli grown on inceptisols. Int. J Curr. Microbiol. Appl. Sci 2019;8:263-273.
19. Hanin M, Ebel C, Ngom M, Laplaze L, Masmoudi K. New insights on plant salt tolerance mechanisms and their potential use for breeding. Frontiers in Plant Science, 2016; 7:1787.
20. Haris M, Ahmad G, Shakeel A, Khan AA. Utilization of fly ash to improve the growth and the management of root-knot nematode on carrot. Haya Saudi J. Life Sci. 2019; 4: 221–226.
21. Jacoby B. Mechanisms involved in salt tolerance by plants. In: Pessarakli, M. (Ed), Handbook of plant and crop stress. Marcel Dekker, New York, 1994, 97-123.
22. Kabir AKMA, Moniruzzaman M, Gulshan Z, Rahman ABMM, Sarwar AKM Golam. Biomass yield, chemical content and *in vitro* gas production of different dhaincha(*Sesbania* spp.) accessions from Bangladesh. Indian Journal of Animal Nutrition. 2018; 35: 397-402. DOI: 10.5958/2231-6744.2018.00060.9.
23. Kaleem F, Shabir G, Aslam K, Rasul S, Manzoor H, Shah SM, Khan AR. An overview of the genetics of plant response to salt stress: Present status and the way forward. Applied Biochemistry and Biotechnology. 2018; 1-29. DOI: 10.1007/s12010-018-2738-y.
24. Kameswari M, Lalitha P, Narayanamma S, Riazuddin A, Charturvedi A. Influence of integrated nutrient management in ridge gourd (*Luffa acutangula* (Roxb.) L.). Vegetable Science, 2011; 38(2): 209-211.
25. Kandlakunta B, Rajendran A, Thingnganing L. Carotene content of some common (cereals, pulses, vegetables, spices and condiments) and unconventional sources of plant origin. Food Chem. 2008; 106: 85–89.
26. Kannan B, Arulmozhiselvan K. Effect of growing media and fertilization methods on growth and yield of snake gourd grown under matric suction irrigation. The Pharma Innovation Journal. 2019; 8 (11): 163-170.
27. Khan A, Tan DKY, Afridi MZ, Luo H, Tung SA, Ajab M, Fahad S. Nitrogen fertility and abiotic stresses management in cotton crop: a review. Environmental Science and Pollution Research. 2017; 24: 14551–14566.
28. Maathuis FJM. Physiological functions of mineral macronutrients. Curr. Op. Plant Biol. 2009; 12(3): 250–8.
29. Machado RMA, Serralheiro RP. Analysis of salt tolerance in nine leafy vegetables irrigated with saline drainage water. J Am. Soc. Hortic. Sci. 2017; 125: 658–664.
30. Marschner, H. Saline soil in: mineral nutrition of higher plants, Academic Press, New York, 1995, 657-680.
31. Munns R, Tester M. Mechanisms of salinity tolerance. Annu. Rev. Plant Biol. 2008; 59: 651-681.
32. Nair J, Sekiozoic V, Anda M. Effect of pre-composting on vermicomposting of kitchen waste. Bioresour. Technol. 2006; 97: 2091– 2095.
33. Neocleous D, Savvas D. NaCl accumulation and macronutrient uptake by a melon crop in a closed hydroponic system in relation to water uptake. Agric. Water Manag. 2016; 165: 22-32.
34. Ochecova P, Tlustos P, Szakova J. Wheat and soil response to wood fly ash application in contaminated soils. Agron. J. 2014;206:995-1002.
35. Orozco FH, Cegarra J, Trujillo LMAR. Vermicomposting of coffee pulp using the earthworm *Eisenia fetida*: effects on C and N contents and the availability of nutrients. Biol. Fertil. Soils. 1996;22:162-166.
36. Parab N, Seema Mishra, Bhonde SR. Prospects of Bulk Utilization of Fly Ash in Agriculture for Integrated Nutrient Management. Bulletin of the National Institute of Ecology 2012;23:31-46.
37. Rashidha CK, Mini Sankar, Sreelatha U, Anupama TV, Prameela P. Standardization of soilless growth media for raising potted ornamental foliage plants for export purpose. J. of Tropical Agriculture 2021;59(1):118-123.
38. Raviv M, Lieth J. In: Soilless culture: Theory and

practice, Elsevier Science Ltd.Linacre House, Jordan Hill, Oxford OX2 8DP, UK. 2008.
39. Sangeeta Shree, Champa Lal Regar, Fiza Ahmad, Vijay Kumar Singh, Ritu Kumari, Amrita Kumari. Effect of organic and inorganic fertilizers on growth, yield and quality attributes of hybrid bitter gourd (*Momordica charantia*L.). Int. J. Curr. Microbiol. App. Sci. 2018;7(4): 2256-2266.
40. Sayed H, Ahmed P, Emam MSA, Abul-Soud M. Effect of different vermicompost rates and pot volume on producing celery and red cabbage under urban horticulture conditions. Zagazig J. Agric. Res 2017;44(4).
41. Schwarz D, Franken P, Krumbein A, Kläring H, Bar-Yosef B. Nutrient management in soilless culture in the conflict of plant, microorganism, consumer and environmental demands. Acta Hort 2009;843:27-34.
42. Setiawati MR, Muhamad Khais Prayoga, Silke Stöber, Kustiwa Adinata, Tualar Simarmata. Performance of rice paddy varieties under various organic soil fertility strategies. Open Agriculture 2020;5:509-515. DOI:10.1515/opag-2020-0050.
43. Shakeel A, Abrar Ahmad Khan, Khalid Rehman Hakeem. Growth, biochemical, and antioxidant response of beetroot (*Beta vulgaris* L.) grown in fly ash‑ amended soil. SN Applied Sciences 2020;2:1378. DOI: 10.1007/s42452-020-3191-4.
44. Sharma B, Singh RP. Physiological, biochemical, growth, and yield responses of Radish (*Raphanus sativus* L.) plants grown on different sewage sludge-fly ash mixture (SLASH) ratios. In: Ghosh S (ed) Waste valorisation and recycling. Springer, Singapore 2019, 539-552.
45. Shi J. Decomposition and Nutrient Release of Different Cover Crops in Organic Farm Systems. MS thesis, University of Nebraska – Lincoln, New Zealand 2013, 1-75. http://digitalcommons. unl.edu/natresdiss/75
46. Sivritepe HO, Sivritepe N, Eris A, Turhan E. The effects of NaCl pre-treatments on salt tolerance of melons grown under long term salinity. Sci. Hortic 2005;106:568-581.
47. Skousen J, Yang JE, Lee JS, Ziemkiewicz P. Review of fly ash as a soil amendment. Geosys Eng 2013;16:249-256.
48. Sontosh Chandra Chanda, Rafiqul Islam M, Golam Sarwar AKM. Organic Matter Decomposition and Nutrient Release from Different Dhaincha (*Sesbania* spp.) Genotypes**.** The Journal of Agricultural Sciences 2021;16(2):192-202. DOI: 10.4038/jas.v16i2.9323.
49. Soobhany N, Romeela Mohee, Vinod Kumar Garg. A comparative analysis of composts and vermicomposts derived from municipal solid waste for the growth and yield of green bean (Phaseolus vulgaris). Environ Sci Pollut Res 2017;24:11228-11239. DOI 10.1007/s11356-017-8774-2.
50. Souri MK, Hatamian M. Aminochelates in plant nutrition; areview. J Plant Nutr. 2019;42(1):67-78.
51. Sushmita Munda E, Nayak AK, Mishra PN, Bhattacharyya P, Sangita Mohanty, Anjani Kumar *et al*. Combined application of rice husk biochar and fly ash improved the yield of lowland rice. Soil Research 2016;54:451-459. DOI:10.1071/SR15295.
52. Thind HS, Yadvinder-Singh, Bijay-Singh, Varinderpal-Singh, Sharma S, Vashistha M *et al*. Land application of rice husk ash, bagasse ash and coal fly ash: effects on crop productivity and nutrient uptake in rice-wheat system on an alkaline loamy sand. Field Crop. Res 2012;135:137-144.
53. Trajkova F, Nicolas Papadantonakis, Dimitrios Savvas. Comparative effects of NaCl and $CaCl_2$ salinity on cucumber grown in a closed hydroponic system. Hort Science 2006;41(2):437-441.
54. Ukwattage NL, Ranjith PG, Bouazza M. The use of coal combustion fly ash as a soil amendment in agricultural lands (with comments on its potential to improve food security and sequester carbon). Fuel 2013;109:400-408.
55. Wargovich MJ. Anticancer properties of fruits and vegetables. Hort Science. 2000;35(4):573-575.
56. Yeledhalli NA, Prakash SS, Gurumurthy SB, Ravi MV. Coal fly ash as modifier of physico-chemical and biological properties of soil. Karnataka J. Agric. Sci. 2007;20:531-534.
57. Yousuf A, Manzoor SO, Youssouf M, Malik ZA, Khawaja KS. Fly ash: production and utilization in India - an overview. J Mater Environ Sci. 2020;11(6):911-921.
58. Zhong LC, Cao X, Hu J, Zhu L, Zhang J, Huang J *et al*. Nitrogen metabolism in adaptation of photosynthesis to water stress in rice grown under different nitrogen. Front Plant Sci 2017;8:1079.