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Standardization of Growbag Media with Nutriseed Pack Fertilization for Tomato Crop under Matric Suction Irrigation

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Abstract

A pot experiment was carried out with different growbag media with varying proportions of agricultural/ industrial residues such as Cocopeat, Vermicompost, Vermiculite, Fly ash, Pressmud, Rice husk and Groundnut shell, for selecting suitable materials for matric suction irrigation for enhancing the growth of tomato (*Solanum lycopersicum*). The results revealed that the plant height, number of main branches per plant, number of lateral branches per main branch and number of leaves per lateral branch were highest in media containing Cocopeat: Vermicompost: Pressmud in 1:1:1 ratio with Nutriseed Pack. The significantly highest fruit yield of tomato (1513 g/pot) was achieved in growbag media containing equal proportion of Cocopeat: Vermicompost: Pressmud in 1:1:1 ratio with NSP. Followed by, the higher yield of tomato (1379 g/pot) was recorded in case of Cocopeat: Vermicompost: Vermiculite (1:1:1) with Nutriseed Pack, which was at par with Cocopeat: Vermicompost: Vermiculite + Neem Seed Crush with Nutriseed Pack (1320 g/pot). The conventional pot mixture of Soil: Sand: FYM (1:1:1) with Nutriseed Pack gave moderate yield of tomato (622 g/pot). Besides, the promising effect of matric suction irrigation has been brought out in the present study as an alternative means for surface irrigation.

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Introduction

Vegetables play a major role in Indian agriculture. It provides food, nutrition and economic security and producing higher returns per unit area per time. Tomato is an annual horticultural crop with a worldwide distribution and high economic value. Growing of crops in soil in open field agriculture is now-a-days difficult. Because it involves large

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space, lot of labour and large volume of water. In big cities and metropolitan areas, soil is not available for crop cultivation at all, while in some areas, there is a scarcity of fertile cultivable lands due to their unfavourable geographical or topographical conditions. Soilless culture in which plants are raised without soil is becoming more relevant in the present scenario especially for vegetable crops.[1]

It is reported that about 600 MT of wastes have been generated in India from agricultural sources alone.[2] Unfortunately, much of these wastes are burnt leading to pollution of the environment. This waste can be effectively used to prepare grow bag media for plants. A good growing medium have to provide anchorage to the plant, serve as store house for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange among roots, media and atmosphere.

Top soil is used as a part of growing medium in many nursery establishments, which is however a non-renewable resource. Utilization of soil excavated from cultivable land for the purpose of pot media preparation otherwise means as an environmental deterioration due to mining of precious and quality topsoil and transporting it elsewhere. Hence, it is very appropriate to promote the utilization of soilless materials as pot/ growbag media for the production of crops.

Irrigation by matric suction is a new technique in which moisture is continuously supplied to growbag media without break from bottom to top. Water is circulated in pipes at the bottom of pots where grow bag is placed all the time. There is no drainage/ leaching leading to prevention of water loss as well as nutrients. Always moisture is kept at optimum range in growbag media from sowing to harvest. Fertilization is possible at right concentration by placing fertilizer pellet pack in the growbag media. Fertilization by fertilizer pellet pack has also been standardized recently as a new method for steady nutrient supply to crops.[3] In order to evaluate the effect of different grow bag media on growth and yield under Nutriseed Pack fertilization the present study was conducted in tomato crop under matric suction irrigation under greenhouse condition.

Materials and Methods

In the present study tomato crop was raised in pots in a green house with a set up to provide water to the pots by matric suction irrigation. In each pot grow bag media was filled and the crop was raised.

Components for Matric Suction Irrigation

Matric suction arises due to interaction of water with the matrix of solid particles. With the increase in media water content, matric suction decreases and water is more prone to free movement in the system. In unsaturated media, water moves in the direction of decreasing matric potential from a region of lower matric suction to a region with higher matric suction.

The system consists of components (Figure 1) such as water tank, water level maintaining basin, series of interconnected basins filled with water connected through the tubes in alignment with water leveling basin. Each of water basins contained one pot having holes at the bottom and supplied with a constant level of water. Each pot contained two slowly degradable cloth bags filled with media. The bag at the bottom was filled with sand, which is called as base media. Base media was partly submerged in the water

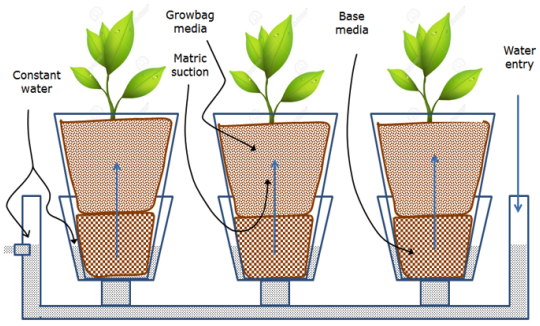

Fig. 1: Diagrammatic representation of matic suction irrigation in pots

Fig. 2: Experimental arrangements of pots under matric suction irrigation

maintained in basin, which was located at bottom of each pot. Another bag, which was placed in the pot, over the base bag, is called growbag, which contained growbag media. Through capillary suction, the base bag gets moistened first by contact with water, later maintained almost saturated moisture content. Successively the growbag gets moistened by the virtue of only matric suction.

Fertilization by Nutriseed Pack

Nutriseed Pack technique is a new method of improving the efficiency of fertilizer nutrients by spot placement of Nutriseed Pack in the root zone of crop at the time of sowing itself. Nutriseed Pack technique has been well tested in research trials and demonstration plots on crops viz., maize, rice, cotton, cauliflower, carnation and marigold. Each Nutriseed Pack contains seed at top, enriched manure in the middle and encapsulated fertilizer at bottom. Nutriseed Pack gives support for each plant in the root zone in terms of optimum nutrient supply, biological activity, release of biopesticide, etc. and consequently enables the fullest utilization of nutrients by plants.

In the present study tomato crop was raised using Nutriseed Packs. Since tomato is propagated by seedling, the Nutriseed Pack used in the pot experiment contained manure and fertilizer components. At the time of transplanting, the seedling was planted after implanting the Nutriseed Pack in horizontal orientation at 5 cm depth in a small pit in the growbag media. The manure pellet consists of vermicompost. Fertilizer pellet was made up of mixture of NPK fertilizers and encapsulated in biodegradable polymer coated paper pouch. The nutrients in fertilizer pellet are equal to the amount as per treatments. Each Nutriseed Pack was assembled by combining these 2 parts together and wound in paper as a roll. No top dressing of fertilizers was done.

Experimental set up and treatments

The experiment was conducted in pot culture unit of the Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University (TNAU), Coimbatore. Each pot was filled with growbag media of different composition at equal weight basis. Fertilization was done by the placement of Nutriseed Pack containing calculated quantities of fertilizer NPK using the sources of Urea, Single Super Phosphate (SSP), Di Ammonium Phosphate (DAP) and Muriate of Potash (MOP) fertilizers. Finally

Treatment details of pot experiment with tomato crop

Treatment. No.	Treatments
T_1	Standard Cocopeat with NSP
T_2	Cocopeat : Vermicompost (1:1) with NSP
T_3	Cocopeat : Vermicompost : Vermiculite (1:1:1) with NSP
T_4	Cocopeat : Vermicompost : Fly ash (1:1:1) with NSP
T_5	Cocopeat : Vermicompost : Pressmud (1:1:1) with NSP
T_6	Cocopeat : Vermicompost : Rice husk (1:1:1) with NSP
T_7	Cocopeat : Vermicompost : Groundnut shell (1:1:1) with NSP
T_8	Cocopeat : Vermicompost : Recycle-media (1:1:1) with NSP
T_9	Cocopeat : Vermicompost : Saw dust (1:1:1) with NSP
T_{10}	Cocopeat : Vermicompost : Municipal compost (1:1:1) with NSP
T_{11}	Cocopeat : Vermicompost : Charcoal (1:1:1) with NSP
T_{12}	Pot mixture – Soil : Sand : FYM (1:1:1) with NSP
T_{13}	Cocopeat : Vermicompost : Vermiculite (1:1:1) + Neem (2%) with NSP
T_{14}	Sand with NSP
T_{15}	Cocopeat : Vermicompost (1:1:1) without NSP (Control)

NSP: Nutriseed Pack containing Fertilizer Pellet Pack and manure pellet

pots in entire experimental set up was randomized and maintained under matric suction irrigation. Two plants were maintained per pot.

As per the design for matric suction irrigation the pots were arranged on the platforms of the green house (Figure 2). The water trays at bottom were connected by tubes for maintaining continuous supply of water from the constant level water tub. Pots were placed over the tray for getting continuous irrigation by matric suction. In the Nutriseed Pack, fertilizers viz., Urea, DAP, SSP and MOP were mixed to contribute NPK as per plant requirement (4000:5000:2500 mg pot^{-1} N, P_2O_5 and K_2O).

The experiment was carried with 15 treatment combinations (as given below), replicating three times in a completely randomized design. The tomato crop (cv. Co TH3) was sown on 1st February, 2016 and was harvested on 5th June, 2016

The results of analysis of plant growth and yield parameters of crops were subjected to analysis of variance to find out the performance of tomato crop on different treatments.[4]

Results

The performance of tomato crop evaluated for different growbag media with varying composition under matric suction irrigation by Nutriseed Pack fertilization was found to be different in terms of crop growth and yield in the cropping period.

Initial Characteristics of Experimental Media

The different growbag media used for the greenhouse experiment were collected from different places and its physico-chemical properties viz., pH and EC and total N, P, K were analyzed and given in Table 1.

Plant Growth Parameters

Growth parameters such as plant height, number of main branches per plant, number of lateral branches per main branches and number of leaves per lateral branch were observed during vegetative, first flowering, first fruit setting stages of the crop. In all the three stages the plant growth parameters were highest for the media containing Cocopeat: Vermicompost: Pressmud in 1:1:1 ratio with Nutriseed Pack (T_5).

The growth parameters for first fruit setting stage are given in Table 2. The plant height of 114.5 cm was observed in the media Cocopeat: Vermicompost: Pressmud in 1:1:1 ratio with Nutriseed Pack (T_5) and the lowest plant height (66.5 cm) was recorded for control (T_{15}), which was at par growbag media

Table 1: Initial growbag media characteristics of greenhouse experiment

S. No.	Treatment	pH	EC (dsm^{-1})	Total N (%)	Total P (%)	Total K (%)
1	Cocopeat	6.64	0.21	0.27	0.06	1.24
2	Vermicompost	7.68	0.62	1.1	0.22	0.4
3	Vermiculite	8.66	0.05	0.16	1.82	0.9
4	Fly ash	7.37	0.03	0.05	0.23	0.43
5	Press mud	7.09	0.23	1.3	2.25	1.45
6	Rice husk	5.88	0.2	0.6	0.38	1.28
7	Groundnut shell	6.2	0.37	1.42	0.1	0.13
8	Recycle media	7.78	0.43	1.14	0.42	0.1
9	Saw dust	5.71	0.09	0.3	0.1	0.8
10	Municipal compost	8.6	0.7	1.48	0.43	0.66
11	Charcoal	8.4	0.22	1.45	0.15	0.48
12	Soil	8.58	0.05	0.19	0.21	0.01
13	Sand	7.4	0	0.02	0.06	0
14	FYM	7.61	0.42	0.5	0.2	0.5

that contains Cocopeat: Vermicompost: Saw Dust in 1:1:1 ratio with Nutriseed Pack (T_9). The number of main branches per plant varied among the treatments between 1.0 and 7.7 and the highest was recorded (7.7) for the media containing of Cocopeat: Vermicompost: Pressmud with Nutriseed Pack (T_5). The same trend was observed for number of lateral branches per main branch. It ranged from 1.6 to 7.2, whereas number of leaves per lateral branch varied from 7.8 to 16.0.

Yield Parameters

The data on yield and yield attributing parameters were presented in Table 3 and 4. As recorded for growth parameters the number of fruiting clusters per pot was highest (9.3) for the media containing Cocopeat: Vermicompost: Pressmud with Nutriseed Pack (T_5). The number of fruits per cluster recorded ranged from 3.2 (T_{15}) to 6.6 (T_5). The number of fruits per pot varied between 9.80 and 60.6. The highest fruit weight (26.3 g) was recorded for the media containing Cocopeat: Vermicompost: Pressmud with Nutriseed Pack (T_5). The total fruit yield per pot ranged from 165 to 1513 g. Fruit yield of more than 1000g fruit/ pot was produced in the media in the decreasing order - Cocopeat: Vermicompost: Vermiculite with Nutriseed Pack (1379 g/pot), Cocopeat: Vermicompost: Vermiculite + Neem seed crush with Nutriseed Pack (1320 g/pot), Cocopeat: Vermicompost: Fly ash with Nutriseed

Table 2: Effect of grow bag media with Nutriseed Pack fertilization on growth attributing parameters at different growth stages of tomato

Treatments		No. of main branches per plant	No. of lateral branches per main branch	No. of leaves per lateral branch	Plant height (cm)
T_1	CP	6.4	4.7	9.8	95.2
T_2	CP:VC	6.6	4.9	10.9	95.5
T_3	CP:VC:VL	7.3	7.1	14.6	108.6
T_4	CP:VC:FA	6.9	6.5	13.4	104.5
T_5	CP:VC:PM	7.7	7.2	16	114.5
T_6	CP:VC:RH	6.8	5.1	13.3	98.6
T_7	CP:VC:GS	6.8	5.1	11.5	96.3
T_8	CP:VC:RM	6.1	4.6	9.6	94.5
T_9	CP:VC:SD	2.3	2.2	7.9	68.1
T_{10}	CP:VC:MC	5.6	4.2	9.5	91.3
T_{11}	CP:VC:CC	4.8	4.1	9.2	89.4
T_{12}	Soil:Sand:M	3.1	3.6	9.1	78.3
T_{13}	CP:VC:VL+NE	7.2	6.9	13.8	107.5
T_{14}	Sand	2.8	3.6	8.9	71.5
T_{15}	Control	1	1.6	7.8	66.5
	SEd	0.18	0.17	0.4	2.7
	CD (P=0.05)	0.37	0.35	0.81	5.5

CP	Cocopeat	PM	Pressmud	SD	Saw dust
VC	Vermicompost	RH	Rice husk	MC	Municipal compost
VL	Vermiculite	GS	Groundnut shell	CC	Charcoal
FA	Fly ash	RM	Recycle-media	M	FYM
NE	Neem		Control - CP : VC (without Nutriseed Pack)		

All treatments contained Nutriseed Pack (NSP) except control

Pack (1241 g/pot), Cocopeat; Vermicompost: Rice husk with Nutriseed Pack (1202 g/pot), Cocopeat: Vermicompost: Groundnut shell with Nutriseed Pack (1158 g/pot), Cocopeat: Vermicompost with Nutriseed Pack (1116 g/pot), Cocopeat alone with Nutriseed Pack (1071 g/pot), Cocopeat: Vermicompost: Recycle media with Nutriseed Pack (1014 g/pot). The whole plant fresh weight per pot was recorded at the harvest which varied from 455 to 956 g/pot.

Discussion

The pot experiment conducted to study the effect of grow bag media with Nutriseed Pack fertilization on tomato crop under matric suction irrigation showed better results with the treatment receiving the media containing Cocopeat: Vermicompost: Pressmud in 1:1:1 ratio with Nutriseed Pack. The better performance of Pressmud in terms of enhancing plant height was due to the effect of the organic fraction of Pressmud than contains substantial fibre (15-30%), crude protein (5-15%), sugar (5-15%), crude wax and fats (5-15%) as well as ash (10-20%) comprising of oxides of Si, Ca, P, Mg and K.[5]

Such increase in growth parameters was also attributed to continuous supply of nutrients by Nutriseed Pack in media of Cocopeat: Vermicompost: Pressmud.[6] The plant height, internodal length, number of branches, number of leaves and leaf area of tomato were significantly influenced by the application of Vermicompost and Pressmud along with foliar application of *panchagavya*.[7] The growth and biomass production of tomato plant was

Table 3: Effect of grow bag media with Nutriseed Pack fertilization on yield attributing parameters of tomato

Treatments		No. of Fruiting Clusters / pot	No. of fruits / pot	Weight of single fruit (g)	Total weight of fruit/pot(g)
T_1	CP	44.1	24.6	7.4	1071
T_2	CP:VC	45.8	24.6	7.4	1116
T_3	CP:VC:VL	54.5	25.6	8.9	1379
T_4	CP:VC:FA	52.8	25.1	8.5	1241
T_5	CP:VC:PM	60.6	26.3	9.3	1513
T_6	CP:VC:RH	48.2	25.1	8.0	1202
T_7	CP:VC:GS	45.9	24.8	7.6	1158
T_8	CP:VC:RM	43.3	24.5	7.1	1014
T_9	CP:VC:SD	13.3	19.5	3.7	265
T_{10}	CP:VC:MC	40.0	24.1	7.0	933
T_{11}	CP:VC:CC	34.4	24.1	6.6	821
T_{12}	Soil:Sand:M	27.9	22.8	5.5	622
T_{13}	CP:VC:VL+NE	52.5	25.3	8.6	1320
T_{14}	Sand	19.4	21.1	4.3	408
T_{15}	Control	9.8	17.6	3.1	165
	SEd	0.15	0.5	0.22	37
	CD (P=0.05)	3.00	1.1	0.45	74.5

CP	Cocopeat	PM	Pressmud	SD	Saw dust
VC	Vermicompost	RH	Rice husk	MC	Municipal compost
VL	Vermiculite	GS	Groundnut shell	CC	Charcoal
FA	Fly ash	RM	Recycle-media	M	FYM
NE	Neem	Control - CP : VC (without Nutriseed Pack)			

All treatments contained Nutriseed Pack (NSP) except control

significantly increased when grown in Pressmud media containing arbuscular mycorrhizal fungi and indole acetic acid compared to non-inoculated plants.[8]

The result on the fruit yield of tomato clearly indicated the importance of fertilization and right composition of growbag media for quality tomato fruit production. All the growbag media with Nutriseed Pack treatments except growbag media containing Cocopeat: Vermicompost: Saw dust with Nutriseed Pack significantly increased the yield of fruits over control. The yield recorded was highest in the media having Cocopeat: Vermicompost: Pressmud as this media would have provided good anchorage and supply of most of the nutrients from Nutriseed Pack particularly high amount of potassium. In a field experiment all treatments receiving Nutriseed Pack exhibited a yield increase of more than 50 per cent compared to control.[6] Application of 3.75 tonnes ha^{-1} Pressmud in combination with recommended fertilizers tomato yield significantly improved up to 30.6 tonnes per hectare, which was 44.1 per cent higher than control.[9]

The superior influence of Nutriseed Pack placement on dry matter production from vegetative stage to harvest stage finally resulted in enhanced fruit yield. Significant increase in yield was due to deep placement of fertilizer N, P and K in the root zone.[10,11,12]

The media treatment (T_5) also contains vermicompost that provides nutrients for the growth of crop.

Table 4. Fresh weight and dry matter of plant at harvest (g pot-1)

Treatments		Fresh	Drymatter of Plant		Dry matter of fruit	
		weight	Haulms	Root	Pulp	Juice
T_1	CP	901	98.6	7.52	24	1.36
T_2	CP:VC	906	101.2	7.56	26	1.39
T_3	CP:VC:VL	935	115.2	10.23	33.8	1.43
T_4	CP:VC:FA	914	111.4	8.24	33.1	1.38
T_5	CP:VC:PM	956	121.5	14.25	35.8	1.53
T_6	CP:VC:RH	909	105.2	7.89	30.5	1.36
T_7	CP:VC:GS	908	104.1	7.65	29.7	1.37
T_8	CP:VC:RM	875	96.5	4.25	27.0	1.27
T_9	CP:VC:SD	461	58.7	1.86	5.0	1.06
T_{10}	CP:VC:MC	856	95.5	3.91	23.8	1.34
T_{11}	CP:VC:CC	845	93.2	3.8	21.5	1.26
T_{12}	Soil:Sand:M	723	84.6	3.56	10.5	1.19
T_{13}	CP:VC:VL+NE	923	115.2	9.62	33.6	1.43
T_{14}	Sand	623	61.6	2.28	7.8	1.08
T_{15}	Control	455	56.2	1.28	4.8	1.00
	SEd	23	3.0	0.34	0.8	0.03
	CD (P=0.05)	47	6.1	0.7	1.7	0.07

CP	Cocopeat	PM	Pressmud	SD	Saw dust
VC	Vermicompost	RH	Rice husk	MC	Municipal compost
VL	Vermiculite	GS	Groundnut shell	CC	Charcoal
FA	Fly ash	RM	Recycle-media	M	FYM
NE	Neem	Control - CP : VC (without Nutriseed Pack)			

All treatments contained Nutriseed Pack (NSP) except control

Vermicompost contains most nutrients in plant available forms such as nitrates, phosphates, exchangeable calcium and soluble potassium.[13] There was marked decrease in total N in soils without vermicompost application in comparison with vermicompost treated soils due to larger amounts of total C and N in vermicompost that could have provided a larger source of N for mineralization.[14] Addition of vermicompost increased plant height and yield of tomatoes significantly.[15]

Fresh weight of the tomato plant was highest in the growbag media having Cocopeat: Vermicompost: Pressmud with Nutriseed Pack. This might be due to the high amount of nutrient uptake by the plants in treatments containing growbag media with Pressmud as composition. Addition of vermicompost at rate of 15 t ha^{-1} significantly increased growth and yield of tomato.[16] Addition of vermicompost with rate of 15 t ha^{-1} significantly enhanced growth and fruit dry matter as well as it also enriches tomato fruit juice with sugar and total soluble salt content.[17]

There was a significant difference in dry matter production among the treatments. The results on dry matter production clearly indicated the highest dry matter production of root, haulms, pulp and juice in the treatment having media consisting Cocopeat: Vermicompost: Pressmud with Nutriseed Pack. This might be due to the continuous release of nutrients by Nutriseed Pack and good anchorage provided by the media containing Pressmud. Similar results were also obtained in maize revealed that addition of Pressmud and N application increased dry matter production.[18] The lowest dry matter yield in control might be due to inadequate supply of nutrients without application of Nutriseed Pack.

The promising effect of matric suction irrigation has been identified in the present study as an alternative means for surface irrigation. Matric suction irrigation reduces the labour cost and suits for easy maintenance, as one-time installation of the set up provides year-round crop with low quantity water. Water is circulated in pipes at the bottom of pots all the time where growbag is placed. There is no drainage/leaching leading to prevention of water loss as well as nutrients. Always moisture is kept at optimum range in grow bag media. There is no drying cycle from sowing to harvest. Based on these advantages, it is concluded that crop production by matric suction irrigation using the growbag media identified in the present study may suit well for terrace garden as well as in levelled wastelands.

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