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Influence of fermented cocopeat on seedling vigour in some vegetables, marigold and pigeon pea

S.C. Kotur*
Division of Soil Science and Agricultural Chemistry
ICAR-Indian Institute of Horticultural Research
Hesaraghatta Lake Post, Bengaluru - 560 089, India
E-mail : sckotur@gmail.com

ABSTRACT

Seedlings of four solanaceous, two cruciferous, five cucurbitaceous vegetables, and, marigold and pigeon pea were grown in pro-trays filled with 'Arka Fermented' coco-peat or on conventional raised bed. Seedlings grown on raised bed were superior in all the crops excepting capsicum. Pigeon pea recorded significantly longer tap root in pro-trays with the root getting matted at the base of the coco-peat plug. The plug is rendered redundant at transplanting. To enhance the vigour of 'Arka Ananya' tomato seedlings in pro-trays, modification in growth medium was attempted by blending soil in various proportions and adding 0.2% humic acid to the irrigation water. Blending cocopeat:soil at 3:1 ratio caused some improvement compared to that with cocopeat alone or 1:1 and 1:3 blends of cocopeat:soil. Soil alone, placed in the pro-tray, also failed to equal the high seedling vigour produced by conventional raised bed method. Addition of 0.2% humic acid in water used for irrigating pro-trays showed no improvement in seedling vigour. Reduced vigour of seedlings raised in pro-trays in several vegetables, and poor performance of such seedlings in tomato, cabbage and cauliflower crops in the field, indicates a need for further improvement in the technology.

Key words: Seedling vigour, cocopeat, pro-tray, raised bed, humic acid, vegetables, marigold, pigeon pea

INTRODUCTION

Growing seedlings in pro-trays using fermented cocopeat as a growth medium has become highly popular among farmers. Seedlings from pro-trays are easy to grow, uniform in growth, easy to transport and suffer no transplantation shock. Above all, this obviates on-farm raising of seedlings by farmers (Prabhakar *et al*., 2004). In crops like hybrid capsicum, tomato and marigold where seed costs are high, pro-trays are a boon and give assured germination. As these seedlings differ from those conventionally grown in raised bed using soil, production practices also differ. A comparison of pro-tray and raised-bed grown seedlings of 'Indra' capsicum showed that the former were more vigorous and went on to yield 33% higher when transplanted, compared to that in the latter (Kotur, 2008). The reverse was true in the case of 'Tetris' cauliflower (Kotur, 2013a), 'Omphalus' cabbage (Kotur, 2013b) and 'Arka Ananya' tomato (Kotur, 2014). These studies showed that vigour of the seedling at transplantation was the key to final crop performance. To resolve this disparity, different solanaceous, cruciferous and cucurbitaceous vegetable crops besides marigold and pigeon pea (which are also raised in nurseries) were evaluated.

MATERIAL AND METHODS

Solanaceous crops, viz., capsicum, chilli, brinjal and tomato; crucifers, viz., cabbage and cauliflower; cucurbits, viz., cucumber, bottle gourd, ridge gourd, bitter gourd and water melon; also, marigold and pigeon pea, were sown simultaneously in March 2012 in (i) pro-trays using 'Arka Fermented' cocopeat and (ii) conventional raised beds. The pro-trays were made of moulded, recycled high-impact polystyrene (HIPS), 27×53cm in outer size, with 98 plugs/ holes/ conical cavities of 3.0 × 2.0 × 4.5cm dimension (volume 20cm^3), arranged in a grid of 14 × 7 holes with perforation provided at the bottom for drainage. Microbial consortium, containing N-fixers, P-solubilizers and plant growth promoters, was applied to 6-day old seedlings @ 10g litre^{-1} irrigation water in pro-trays and @ 20g litre^{-1} in raised beds. Observations were recorded on 16-day old seedlings in cucurbitaceous crops, marigold and pigeon pea, and on 25-day old seedlings in solanaceous crops, this being

*Former Principal Scientist (Soil Science)

Table 1. Seedling vigour in various crops as influenced by germination on conventional raised seed bed using soil, or in pro-tray using 'Fermented cocopeat'

Crop / Variety	Girth (mm)		Length of shoot (cm)		Length of root (cm)		Dry matter of shoot (mg)		Dry matter of root (mg)	
	Soil	Coco peat	Soil	Coco peat	Soil	Coco peat	Soil	Coco peat	Soil	Coco peat
Solanaceous vegetable crops										
Capsicum (Indra)	2.6 (± 2.24)	3.4 (±0.31)	21.5 (± 3.21)	25.1 (± 2.11)	7.8 (± 1.82)	9.4 (± 0.67)	61.2 (± 8.92)	75.8 (±9.71)	10.4 (± 2.81)	16.9 (± 2.97)
t-stat	**		**		**		**		**	
Chilli (Arka Lohit)	2.3 (± 0.31)	1.6 (± 0.15)	20.5 (± 2.25)	22.5 (± 2.59)	8.3 (± 2.31)	9.5 (± 1.83)	219.9 (± 29.81)	77.9 (± 4.95)	40.2 (± 4.81)	19.1 (± 1.49)
t-stat	**		**		**		**		**	
Tomato (Arka Ananya)	4.0 (± 0.43)	2.5 (± 0.29)	17.2 (± 1.18)	20.6 (± 3.39)	12.4 (± 2.18)	7.3 (± 2.07)	222.1 (± 17.72)	152.0 (± 19.81)	10.4 (± 2.81)	21.3 (± 2.04)
t-stat	**		**		**		**		**	
Brinjal (Nidhi)	2.3 (± 0.80)	2.1 (± 0.28)	9.9 (± 1.09)	13.5 (± 3.67)	7.9 (± 1.64)	8.3 (± 0.64)	142.3 (± 21.93)	126.5 (± 3.67)	40.2 (± 4.81)	15.2 (± 0.98)
t-stat	**		**		**		**		**	
Cruciferous vegetable crops										
Cauliflower (Tetris)	2.7 (± 0.34)	2.3 (± 0.19)	13.2 (± 3.42)	12.6 (± 1.22)	10.1 (± 1.52)	8.6 (± 1.45)	354.3 (± 35.41)	89.1 (± 9.1)	55.6 (± 6.81)	14.5 (± 2.62)
t-stat	**		**		**		**		**	
Cabbage (Omphalus)	3.0 (± 0.45)	2.1 (± 0.21)	8.8 (± 2.27)	10.2 (± 2.28)	13.5 (± 4.88)	11.5 (± 1.19)	512.2 (± 34.72)	111.8 (± 9.81)	79.4 (± 9.13)	18.9 (± 4.12)
t-stat	**		**		**		**		**	
Cucurbitaceous vegetable crops										
Cucumber (Delicious)	2.2 (±0.23)	1.9 (± 0.18)	14.2 (± 0.96)	19.2 (± 1.14)	8.2 (± 0.62)	11.3 (± 1.01)	221.4 (±19.14)	95.2 (± 0.79)	14.2 (± 1.21)	9.2 (± 0.81)
t-stat	**		**		**		**		**	
Bottle gourd (Arka Bahar)	3.8 (± 0.40)	3.3 (± 0.46)	16.9 (± 1.45)	21.0 (± 1.49)	8.9 (± 0.75)	12.2 (± 3.97)	375.9 (± 16.38)	112.7 (± 10.15)	27.9 (± 8.88)	10.5 (± 3.08)
t-stat	**		**		**		**		**	
Ridge gourd (Arka Sujata)	4.9 (± 0.54)	3.5 (± 0.50)	18.3 (± 6.33)	21.7 (± 5.79)	6.8 (± 0.98)	12.2 (± 4.26)	402.1 (± 21.60)	143.7 (± 7.93)	18.6 (± 4.88)	45.3 (± 3.41)
t-stat	**		**		**		**		**	
Bitter gourd (Arka Harit)	4.4 (± 0.28)	3.4 (± 0.91)	15.6 (± 3.47)	19.7 (± 5.95)	5.2 (± 1.08)	8.3 (± 0.64)	262.7 (± 16.38)	161.8 (± 9.61)	12.1 (± 5.24)	28.6 (± 6.10)
t-stat	**		**		**		**		**	
Water melon (Arka Manik)	3.9 (± .47)	2.7 (± 0.50)	20.2 (± 6.23)	10.7 (± 1.03)	5.2 (± 0.64)	6.2 (± 1.97)	406.8 (± 20.87)	78.0 (± 4.98)	13.4 (± 2.62)	15.1 (± 4.21)
t-stat	**		**		**		**		**	
Other crops										
Marigold (MG-25)	2.4 (± 0.43)	1.6 (± 0.11)	16.3 (± 2.04)	10.7 (± 1.23)	9.9 (± 2.71)	8.6 (± 1.68)	181.5 (± 7.76)	43.6 (± 2.97)	14.9 (± 6.17)	11.8 (± 3.99)
t-stat	**		**		**		**		**	
Pigeon pea (Rural Local)	1.6 (± 0.13)	1.5 (± 0.27)	20.4 (± 1.99)	20.9 (± 2.03)	10.1 (± 2.63)	19.1 (± 6.9)	210.7 (± 15.63)	148.0 (± 5.46)	30.0 (± 2.56)	34.1 (± 1.59)
t-stat	**		**		**		**		**	

(t-stat at *P=0.01*)

the suitable age for field transplantation. Seedlings grown in pro-trays were hardened a week prior to sampling by shifting the pro-trays to outside the glasshouse in which they were raised. The seedlings were carefully extracted and washed in running tap water, taking care to preserve the root mass.

In another study, 'Arka Ananya' tomato was grown in Completely Randomized Factorial experiment, with 3 replications. Factor 1 consisted of tomato seedlings grown both in pro-trays and raised beds, and irrigated with (i) ordinary irrigation water and (ii) 0.2% humic acid (v/v) dissolved in irrigation water. Factor 2 comprised 6

Table 2. Physico-chemical properties of growth media composed of soil, cocopeat and their blend in different proportions

Growth media (Cocopeat: soil bed)	Moisture (%)	Bulk density (g cm^{-3})	pH (1:2.5)$_w$	EC (dSm^{-1})	Organic carbon (%)	P (Bray-I) (kg ha^{-1})	Exchangeable cation (cmol kg^{-1})			Available S (kg ha^{-1})	DTPA extractable (µg g^{-1})			
							K	Ca	Mg		Fe	Mn	Zn	Cu
Cocopeat only (4:0)	325	0.17	5.90	0.621	0.68	21.8	0.24	1.85	0.41	78	48	63	5.6	1.7
Cocopeat: Soil (3:1)	59	0.26	6.21	0.512	2.3	16.7	0.58	2.40	0.47	60	41	57	5.5	1.9
Cocopeat: Soil (1:1)	61	0.39	6.61	0.485	7.6	14.4	1.04	3.45	0.65	41	36	40	5.0	2.0
Cocopeat: Soil (1:3)	74	0.77	6.92	0.306	9.2	14.2	1.92	5.93	1.17	30	26	30	4.8	2.7
Soil only (0:4)	25	1.64	7.12	0.247	12.5	14.1	2.31	7.15	1.34	21	23	16	3.8	2.9

treatments in which the first five consisted of seedlings grown in pro-trays filled with various growth media: (i) cocopeat alone, (ii) cocopeat : soil in 3:1 proportion, (iii) cocopeat : soil in 1:1 proportion, (iv) cocopeat : soil in 1:3 proportion and (v) soil alone. The sixth treatment was conventional raised-bed (1m × 3m, raised to 20cm height) in the field. Microbial consortium was applied to 6-day old seedlings @ 10g litre^{-1} irrigation water in pro-trays and @ 20g litre^{-1} water in raised beds as explained earlier. Each treatment unit was raised as a single pro-tray (96 seedlings), or as 100 seedlings on a raised bed. Twenty five randomly selected seedlings were sampled and length of the shoot and root measured. The girth of the seedling was determined at ground level using a pair of Vernier callipers. Physico-chemical properties of various growth media were determined using standard analytical procedures (Jackson, 1973). The seedlings were separated into shoot and root portions and dried in an oven at 70°C for 48 hours to determine dry matter. Mean values for each seedling were analyzed statistically as described by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Vigour parameters (in respect of length of shoot and root, Table 1) of seedlings grown in soil (on raised-bed in the field) and in pro-trays using fermented cocopeat revealed that in all the crops, excepting 'Indra' capsicum and 'Nidhi' brinjal were superior in the raised-bed. The differences were statistically significant in respect of most parameters and for most crops. The root system in pro-tray grown seedlings showed profuse growth of secondary roots but failed to match the overall root system observed in raised-bed seedlings. In the raised-bed, seedlings were more robust, thicker and had a prominent tap root. In the case of brinjal too, the raised-bed seedlings showed significantly higher dry matter in shoot and root. In 'Omphalus' cauliflower, the root of seedlings from raised-bed was shorter than that in pro-tray grown seedlings; but, in respect of rest of the parameters, raised-bed seedlings were superior. In pigeon pea, roots were nearly twice as long in pro-tray grown seedlings as in raised-bed, but, were coiled and matted to a thickness of about 2-3mm at the base of the plug in the pro-tray. This extra-long root is likely to be useless, as, the farmer is unlikely to unfurl the root mass and transplant the tap root deeply. Observation of the seedlings in cucurbits revealed the shoot portion ending abruptly at the ground level, from which roots appeared to emanate as adventitious roots along a weak tap-root. In seedlings grown on raised-bed, however, the tap-root was more prominant. The highly porous and favourably moist cocopeat, in comparison to soil, did not favour proper root growth in most cases except in capsicum in terms of overall vigour, and in pigeon pea, for length of tap root.

In the second experiment, 0.2% humic acid in the irrigation water was included, as, humic acid is known to favour root proliferation and growth leading to higher crop yield (Ravichandran, 2011). In the present study, no significant improvement in vigour of tomato seedlings was seen in terms of length and dry weight of shoot and root, and girth of the seedlings, with inclusion of humic acid in irrigation water (Table 3). Blending cocopeat with soil in proportions of 3:1 to 1:3 improved bulk density, pH$_w$, exchangeable Ca and Mg, but reduced the moisture content at field capacity, available P and S, and all the DTPA-extractable micronutrients in growth medium (Table 2). Blending soil with cocopeat was done to impart soil-like structural properties to cocopeat assuming, that, this would promote root growth. Significant improvement in seedling vigour was achieved in cocopeat:soil medium ratio of 3:1, compared to cocopeat alone, in respect of seedling girth and dry weight of shoot and root; But, the effect diminished as the proportion of soil in the medium increased. Vigour of the seedlings in raised-bed was significantly superior

Table 3. Effect of application of humic acid and various growing media on the success percentage and vigour of 'Arka Ananya' tomato seedlings

Treatment	% Success	Girth of seedling	Length of seedling (cm)		Dry weight (mg)	
			Shoot	Root	Shoot	Root
Irrigation water used						
Water	87.6	3.14	19.0	9.3	192	29
Humic acid (0.02%)	84.1	3.10	18.6	9.1	189	28
SEm (±)	1.22	0.66	0.67	0.74	1.2	0.7
CD (*p*=0.05)	NS	NS	NS	NS	NS	NS
Seedling raising media						
Protray grown seedlings						
Cocopeat alone	97.3	2.75	20.5	8.9	152	21
Cocopeat:soil (3:1) (1:4)	96.8	3.10	19.8	8.8	198	30
Cocopeat: soil (1:1)	89.0	2.90	18.5	8.8	185	29
Cocopeat: soil (1:3)	74.5	2.89	18.4	9.0	171	27
Soil alone	63.2	2.74	18.1	7.8	171	26
Raised bed grown seedlings	94.3	4.35	17.5	12.2	268	42
SEm (±)	1.53	0.65	0.55	0.82	5.7	2.1
CD *(P=0.05)*	4.54	1.94	1.63	2.45	17.0	6.2

compared to that in all the growth media containing cocopeat, and also those grown in soil alone filled in pro-trays. Success percentage of the seedlings was the highest and *at par* in cocopeat only placed in pro-trays, and in raised-bed with only soil (97.3 and 94.3%, respectively), but, sharply decreased as the proportion of the soil in cocopeat:soil medium increased from 3:1 to 1:3 (96.3 to 74.3%). This was lowest in pro-trays filled with soil alone. This was due to the fact that the medium filled into cavities of the tray collapsed with, time leading to hardening and caking of the medium which eventually turned hostile to the roots of seedlings. Poor growth of the seedlings, their root system in particular, in cocopeat may be due to presence in the medium of some biochemical compounds. These impediments need to be overcome before the desirable physical properties of this growth medium can be exploited. In earlier studies (Kotur, 2013a; Kotur, 2013b; Kotur, 2014), it was observed that weaker pro-tray grown seedlings (Figures 1-3) transplanted to the field of 'Ananya' tomato, 'Tetris' cauliflower and 'Omphalus' cabbage, recorded yield reduction of 20, 17 and 22%, respectively, compared to seedlings grown on conventional raised-bed. Pro-tray seedlings on being transplanted showed poor growth in the field, especially poor root system, at harvest (Figures 4-6). This is a disturbing prospect considering the widespread popularity of pro-tray raised seedlings grown in cocopeat in a wide range of crops, including important commercial crops like tobacco and sugarcane. The large area covered using this technology, and the resultant effect on production, is difficult to ignore. Results of this study indicate that cocopeat used in pro-trays, in general, adversely affects seedling vigour in many vegetable crops, and in pigeon pea and marigold. Blending the soil with cocopeat in any proportion and/or irrigating pro-trays with 0.2% humic acid, failed to improve seedling vigour vis-a-vis seedlings grown conventionally on raised-beds. Under these circumstances, there is an imminent need to: (i) enhance the growth and vigour of seedlings in cocopeat-based nursing of seedlings using alternatives like compost tea, which is reported to increase significantly shoot and root length in tomato seedlings (Anon., 2013-14), or, to modify the growth medium differently than attempted in this study to ensure parity at least with conventional raised-bed grown seedlings; and (ii) assess comparative performance in the field of the crop raised from the two kinds of seedling to determine efficacy of the pro-tray seedling technology.

Fig 1. Pro-tray grown (left) and raised-bed grown (right) seedlings of 'Arka Ananya' tomato at transplanting

Fig 2. Pro-tray grown (left) and raised-bed grown (right) seedlings of 'Omphalos' cabbage at transplanting

Fig 3. Pro-tray grown (left) and raised-bed grown (right) seedlings of 'Tetris' cauliflower at transplanting

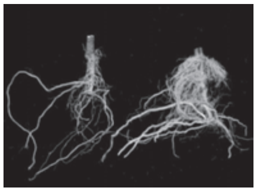

Fig 4. Roots of pro-tray grown (left) and raised-bed grown (right) seedlings of 'Arka Ananya' tomato at harvest

Fig 5: Roots of 'Omphalos' cabbage plants at harvest from pro-tray grown (left) and raised-bed grown seedlings

Fig 6: Roots of plants at harvest grown from pro-tray grown (left) and raised-bed grown seedlings of 'Tetris' cauliflower

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