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Effect of soilless media on establishment and growth of perennial rye grass (*Lolium perenne* L.) in pro-tray

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Abstract
The aesthetic value of grasses is gained lot of importance on pleasure creation, sports field establishment and landscape gardening. Among the turf species, *Lolium perenne L.* commonly known as perennial rye grass native to Europe and Asia but commercially utilized in the landscape industries around the world. The experiment was laid out in Completely Randomized Design. The experiment was consisted with ten different soilless media combinations. Among the media combination (T_{10}), Coir pith + Vermicompost + Paddy husk (1:1:1) along with nutrient consortium was recorded the best results in germination character like days taken for germination, days taken for fifty per cent germination and germination percentage and the same combination was recorded the best results in plant height character observed in 25, 35, 45 DAS respectively, followed by other growth characters *viz*., root length, shoot length at 45 days after sowing. Similarly, the same media combination (T_{10}), was observed the best results in leaf characters *viz*., number of leaf blades per plant, leaf blade length, leaf blade width, leaf area, total chlorophyll content, dry weight of shoot and root and turf density were higher in T_{10}, whereas lowest values were recorded in all the above characters with T_3 (Red earth + FYM + Sand) in pro-tray.

Keywords: Coirpith, lawn establishment, nutrient consortium, paddy husk, rye grass, vermicompost

Introduction
Grasses are monocotyledon plants belong to the family of Poaceae. The value of grasses are recognized since pre-historic times but within the past 100^{+}years the aesthetic value of grasses as gained lot of importance on pleasure creation, sports field establishment and landscape gardening. In the recent times, it is an essential feature for any kind of garden design, It creates unity in garden and gives green carpet outlook throughout the year with proper maintenance (Desh Raj, 2008) [11]. In general, grasses should reduce noise, control Soil erosion and also other comprehensiveness of environmental benefits as well as improve our quality of life. In this context, selection of turf species for landscape gardening is depend on many factors *viz*., climate preference, type of establishment, appropriate cultural practices and maintenance skills etc. and also it has to withstand high temperature, winter months and also come across heavy rainy days. Hence, many of the home owners, nurseries and landscape professionals have generally prefer such species for successful establishment and greenery throughout the year.
Among the turf species, *Lolium perenne* L. commonly known as perennial rye grass native to Europe and Asia but commercially utilized in the landscape industries around the world. It has fibrous root system with thick main roots and thinner lateral branches with *Arbuscular mycorrhizal*, it helps plants to capture macro and micro nutrients from the soil and growing media (Bok-Rye Lee *et al*., 2012) [9]. It is used on the courts at the All England Lawn Tennis Club in Wimbledon, U.K since 2001. The courts have been sown with 100% perennial ryegrass to "improve durability and strengthen the sward to withstand better the increasing viewer of the modern game". It is an important species of grass for fodder and grazing livestock, where it has been planted at roadsides, footpaths, wasteland, riverbank and Sand dunes (McEvoy *et al.*, 2011). It affects the home owner's interest towards gardening and greenery development in smaller spaces.
In view of home owner's preferences, the present study was fixed with soilless media. There are several literatures available in soilless media with different crop plants have paved way to taken up in perennial rye grass. According to Sapna Kaushal and Poonam Kumari. (2020) [30], growing media is an integral part of most horticultural production systems. There is a wide range of media available for various purpose of growing. When selecting media, the grower needs to find the optimum balance between their requirements and plants to be grown. Among them vermicompost is one of the superior nutrient-rich materials among the other organic

amendments. Hence, incorporation of vermicompost helps to improve its physical properties of any growing media and supports the crop plants to produce better growth, yield and quality (Saranraj and Stella, 2012) [31]. Coir pith is extracted traditionally from the fibres of coconut husk. In order to reduce its C: N ratio the coconut husk is decomposed and then compressed into blocks of various sizes (600 g – 5 kg). Since it is obtained by decomposing, the C: N ratio of coir pith is 20:1 which is ideal for growing media, and pH is 6.5. The bulkiness of coir pith is very low and it supplies all the nutrients in the available form to the plants (Joshi *et al*., 2014) [14]. Paddy husk is the by-product of the rice milling industry. Although it is extremely light in weight, paddy husk is very effective at improving drainage and aeration.

However, nitrogen depletion is not a serious problem in growing media amended with paddy husk Sapna Kaushal and Poonam Kumari. (2020) [30]. According to Arnon. (1954) [3], a plants cannot complete its life cycle due to its macro and micro nutrient deficiencies, the deficiencies must be corrected only by supplying the element in equations and when the element is directly involved in the metabolism of the plant. Based on these criteria, such elements so far were identified as essential *viz*., nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and zinc etc., (Nalini pandey., 2018) [21]. They are free from pest and diseases and develop a good root system within 25-45 days (Kulveer Singh and Anurag Bajpay., 2019) [18]. With an emerging intention to increase the establishment and growth of perennial rye grass, the present investigation was carried out to study the effect of various growing media along with nutrient consortium in pro-tray. The present study carried out with the objective of study the effect of soilless media on establishment and growth of perennial rye grass in pro-tray.

Materials and Methods

The experiment was carried out at Floriculture Unit, Department of Horticulture, Annamalai University, Annamalai Nagar, Tamil Nadu during February to March, 2021. Perennial rye grass (*Lolium perenne* L.) seeds used for the present study were procured from commercial lawn consultant at Bangalore. The seeds are very light in weight and small in size as well as one gram contains 540-560 numbers of seeds. The experiment was carried out by Completely Randomized Design (CRD) having three replications and each replication having ten treatments.

The experiment was consisted with ten different soilless media combinations *viz*., T_1–Red earth + FYM + Sand (1:1:1) in direct soil, T_2–Red earth + FYM + Sand (1:1:1) along with nutrient consortium in direct soil and rest of the treatments in pro-tray *viz*., T_3– Red earth + FYM + Sand (1:1:1), T_4–Red earth + FYM + Sand (1:1:1) along with nutrient consortium, T_5– Coir pith + Paddy husk (3:1), T_6– Coir pith + Paddy husk (3:1) along with nutrient consortium, T_7– Vermicompost + Paddy husk (3:1), T_8– Vermicompost + Paddy husk (3:1) along with nutrient consortium, T_9– Coir pith + Vermicompost + Paddy husk (1:1:1), T_{10}– Coir pith + Vermicompost + Paddy husk (1:1:1) along with nutrient consortium. The nutrients consortium were applied along with soilless media combinations *viz*., Zinc (Zn @ 8 g / tray)), Magnesium (Mg @ 8 g/tray) and Ammonium Sulphate (NH4 So4 @ 4 g / tray) and also foliar application of 19:19:19 (1%) at 15 DAS and 25 DAS respectively.

The prepared soil media and soilless media combinations were filled in the pro-tray as per the proposition in each treatment. The pro-tray was made-up of standard plastic material with multiple drainage holes under the pro-tray and it's obtained from local source at Chidambaram and utilized in the experiment. The measurement of pro-tray at 60cm (length) × 30cm (width) × 3 cm (depth) and total area consist of two square feet per pro-tray. After that, uniform broadcasting of seeds (6 g per sq.ft) over the pro-tray was done and they were placed on the beds in shade house condition. All the pro-trays were covered with 75% shade net for the first to 7 days and life irrigation done through rose can. Throughout the experimentation, irrigation was done with the help of rose can (morning and evening).

The germinated seeds in each treatment were counted on randomly selected area (10 cm x 10 cm = 100 cm^2) at 20 days after sowing, Total numbers of germinated seeds were subtracted from total number of seeds sown and percentage of germination was calculated and it was expressed in percentage (%) per sq.ft. Germination percentage (%) = Number of seeds germinated/Total number of seeds sown × 100. The leaf area was calculated by using the following formula and it was observed in 45 days after sowing and expressed in cm^2. Leaf area = L×B×K Where, L = Leaf length, B = Leaf breadth, K = Constant (0.69). The turf density was calculated at 20 DAS from each treatment by calculating number of plants in an area of 900 cm^2 (30 cm × 30 cm) by placing a wooden frame (10 cm × 10 cm) at random in each treatment. The average value was computed and expressed in no. of plants per square feet. There are three strips of mat with the size 30 cm × 30 cm were cut at each treatment at 45-50 days after sowing for measuring the dry mat weight. The same three strips of dry mat sample irrigated with one litre of water and two hours later, Weight of the wet mat was measured using a precision balance. The mean weight was computed and expressed in kg per sq.ft. From seed sowing to termination of the experiment, the recommended nursery management practices done at regular intervals. Observations were recorded on three random samples each treatment for every biometric characters and fix up the judicious soilless media for producing the quality of turf mat.

Results and Discussion

Germination attributes

In the present study, germination attributes *viz*., days taken for seed germination (3.44 days), days taken for fifty per cent of the germination (8.61 days) and germination percentage (63.45 %) were significantly influenced by the treatment T_{10} followed by T_9 and T_6 whereas the treatment T_3 consistently recorded the highest days taken for germination and fifty per cent of the germination as well as lowest germination percentage when compared to other treatments. The results are in accordance with the findings of Prajapathi *et al.* (2017) in acid lime and Arvind. (2014) [5] in papaya. This might be due to soilless media combination, it provides aeration and moisture supply as well as sufficient porosity which permit gaseous exchange between media and seed. Bhardwaj. (2014) [8] reported that combination of vermicompost + sand + pond soil (1:1:1) with 2 cm filling with coir pith showed earliness in seed germination, fifty percentage of the germination and germination percentage. In corporation of vermicompost and coir pith in soilless media to enhance high organic matter content which increases the water and nutrient holding

capacity of the medium, which improves the water utilization capacity of the plant. Similar results were reported by Bachman and Metzgar (2008) [7] and Soepardi (1983) [34]. Abirami. (2010) [1] reported that the effect of different propagation media on seed germination, seedling growth and vigour of nutmeg. Further, reported that combination of Soil + Coir pith + Sand + Vermicompost (1:1:1:1) were found to be the best in terms of earliness in seed germination and germination percentage. Similar results were also reported by Rivai *et al*. (2015) [28]. Coir pith when amended with organic manure suits as the best media having good physical characteristics (Garcia and Daverede, 1994) [12] and also successfully tested as a growing medium in ornamentals (Van holm, 1993) [37]. Similar results were reported by Priyadharshini *et al*. (2006) [25] and Campos Mota *et al*. (2009) [10].

Seedling parameters

With regards to seedling characters, *viz*., plant height (25 DAS (9.21 cm), 35 DAS (11.51 cm) and 45 DAS (14.27 cm), shoot length (14.21 cm) and root length (7.31 cm), fresh (100.53 g) and dry (18.63 g) weight of plant, fresh and dry weight of shoot (62.63 g & 11.34 g) and root (37.90 g & 7.62 g), the present study revealed that different growing media significantly influenced the seedling parameters in perennial rye grass. The treatment T_{10} consistently recorded higher values for the all these traits, closely followed by T_9 and T_6. Whereas the treatment T_3 consistently observed the lower values for these traits. This result agrees with the findings of Compos Mota *et al*. (2009) [10] suggested that coir pith generally with low in nutrients when it is mixed with vermicompost, provides a better growth for plant establishment. Therefore, the medium with vermicompost and coir pith is more suitable than vermicompost alone because of the better physical properties and enhanced nutrient level. The findings of Abirami *et al*. (2010) [1] higher nutrients in soilless media resulted in greatest plant height, root and shoot length agreed with present results. This results accordance to the findings of Gawankar *et al*. (2019) [13] and Sahini *et al*. (2008). Similarly, Swetha *et al*., (2014) [36] reported that higher nitrogen content available to plants through soilless medium could be the reason for greatest plant height. Coir pith and paddy husk allows air, nutrients and water to reach bottom of root surface, which may be another reason for the rapid and vigorous growth. Such phenomenon is decided by division of cell, expansion and elongation of cell which are naturally under the influence of auxins, cytokines and gibberellins within the plant. The promoter effect imported by the particular growth media warrants that these components favour production of natural growth promoting substances like auxins, cytokines and gibberellins (Ramteke Vikas, 2015) [26]. But a number of reports on favourable response with coir pith, vermicompost and paddy husk along with nutrient consortium in other crops like carnation by Renuka and Sekhar (2017) [27] and in *Coreopsis tinctoria* (Sarita *et al*., 2020) [32] support the usefulness as found in the present study.

Leaf parameters

From the investigation, leaf attributes *viz*., number of leaf blades per plant (4.50), leaf blade length (10.01 cm), leaf blade width (0.45 cm), leaf area (3.11 cm^2) and total chlorophyll content (2.01 mg g^{-1}) were significantly influenced by the treatment T_{10} followed by T_9 and T_6. Whereas the treatment T_3 consistently recorded the highest values for these traits when compared to other treatments. The finding of Arunesh. (2020) [4] is accordance with the present investigation. According to Gawankar *et al*. (2019) [13], combination of soil + coir pith + vermicompost + paddy husk was reported to be the best media for jack fruit seeds. Similarly, Anandamurthy *et al*. (2020) [2] found that maximum leaf area and maximum number of leaves in ridge gourd was reported by application of 19:19:19 (1%) as foliar spray. This might be due to maximum absorption and translocation of nutrients, which resulted in increased cell size, cell elongation, cell multiplication and enhanced net assimilation rate. Nitrogen is being a very important constituent of chlorophyll, proteins and enzymes and has a prominent role in cell division which produces a greater number of leaves and leaf area. Phosphorus is being a very essential nutrient for root development. The results accordance with Padhiyar *et al*. (2017) [23] and Kameshwari *et al*. (2014) [15] in chrysanthemum. Further, the findings of Khandaker *et al*. (2018) [16] support the usage of coir pith and vermicompost in ornamental plants establishment. The findings of Nazari *et al*. (2011) [22] reported that the effect of potting media on growth flowering and physiological characteristics of hyacinth. They reported that maximum chlorophyll content was reported by coir pith. The superiority of coir pith characteristics including higher total pore space (TPS) and water holding capacity coir pith is a good moisture retentive material, in most cases particularly bulbous plant, aeration is a pre-requisite as well. Moisture availability and nutrition status of the medium is provided by coir pith. Similar results were reported by Khayyat *et al*. (2007) [17].

Turf quality attributes

Any turf establishment, there could be serious consideration on quality stuff *viz*., turf density and turf mat weight. It has greater importance towards marketable price. From this present investigation, there are lots of outcomes in these traits. The present study revealed that different growing media significantly influenced these traits in perennial rye grass. The treatment T_{10} consistently recorded higher values in the turf density (2093.85 no. of plants/sq.ft) depicted through (fig. 1), closely followed by T_9 and T_6. Whereas soil media treatment combinations *viz*., T_3, T_4, T_2 and T_1 consistently observed on par lower values for these traits. A contrast observation was found on turf mat weight (dry & wet basis) in the present investigation. The treatment combinations, T_6 followed by T_5 and T_{10} were consistently observed lesser turf mat weight (dry & wet basis) depicted through (fig. 2 & 3) whereas T_3 followed by T_4, T_2 and T_1 were consistently observed nearer or on par higher values for this trait. This is because of bulk density of soilless media, it could be the reason for lesser weight and gives more volume to fill the space in pro-tray when compared to soil mixtures.

The findings of Kulveer Singh and Anurag Bajpay (2019) [18], support the pro-tray intervention in the present study. Further, reported that pro-tray nursery is a popular technique for quality seedling production where seedlings are produced under shade net and open field condition. Such seedlings have better germination and vigour in growth and establishment. They are all free from pest and diseases and develop a good root system within 25-45 days. The findings observed by Ashkiani *et al*. (2020) [6] and Marie *et al*. (2020) [19] accordance with present investigation, reported that maximum

dry matter weight in annual rye grass was reported by the application of nitrogen dose with combination of lower Zn dose. Hence, it is clearly evident that enforced nutrient consortium also played a major role along with the soilless media to enhance the establishment and growth parameters. The findings of Sherya. (2020) in onion and Soundhararajan. (2020) in annona corroborated the findings of the present study.

Table 1: Effect of soilless media on germination percentage, turf density, plant height, leaf parameters, root and shoot length and total chlorophyll content of perennial rye grass (*Loliumperenne*L.) in pro-tray.

Treatments	Germination percentage @ 20 DAS (%)	Turf Density (Sq.ft)	Plant height (cm)			No. of Leaf blades per plant	Leaf Blade length (cm)	Leaf blade Width (cm)	Leaf Area (cm^2)	Root Length (cm)	Shoot Length (cm)	Total Chlorophyll content (mg g^{-1})
			20 DAS	30 DAS	40 DAS							
T_1	38.57	1262.81	5.44	8.06	10.36	4.11	5.21	0.38	1.29	3.24	10.36	1.20
T_2	41.93	1368.69	6.38	8.92	11.32	4.20	5.81	0.40	1.48	4.26	11.32	1.47
T_3	36.20	1182.60	4.97	7.63	9.89	4.05	5.14	0.39	1.35	2.73	9.89	1.11
T_4	39.16	1292.28	5.91	8.49	10.85	4.15	6.41	0.40	1.72	3.75	10.85	1.38
T_5	54.02	1782.66	7.79	10.21	12.77	4.35	8.22	0.42	2.38	6.31	12.77	1.74
T_6	58.52	1931.16	8.26	10.64	13.25	4.40	8.81	0.43	2.61	6.52	13.25	1.83
T_7	46.07	1516.31	6.85	9.35	11.81	4.25	7.01	0.41	1.93	4.76	11.81	1.56
T_8	49.56	1635.48	7.32	9.78	12.29	4.30	7.61	0.41	2.15	5.28	12.29	1.65
T_9	60.99	2012.67	8.73	11.07	13.72	4.45	9.42	0.44	2.86	6.81	13.72	1.92
T_{10}	63.45	2093.85	9.21	11.51	14.21	4.50	10.01	0.45	3.11	7.31	14.21	2.01
CD (p=0.05)	1.83	60.32	0.26	0.36	0.45	0.16	0.29	0.02	0.08	0.20	0.45	0.05
S.Ed	0.87	28.71	0.12	0.17	0.21	0.08	0.14	0.007	0.04	0.09	0.21	0.02

T_1 – Red soil + FYM + Sand (1:1:1) (control), T_2 – Red soil + FYM + Sand (1:1:1) along with nutrient consortium, T_3 – Red soil + FYM + Sand (1:1:1) (In tray), T_4 – Red soil + FYM + Sand (1:1:1)along with nutrient consortium, T_5 – Coir pith + Paddy husk (3:1), T_6 – Coir pith + Paddy husk (3:1)along with nutrient consortium, T_7 – Vermicompost + Paddy husk (3:1), T_8 – Vermicompost + Paddy husk (3:1)along with nutrient consortium, T_9 – Coir pith + Vermicompost + Paddy husk (1:1:1), T_{10} – Coir pith + Vermicompost + Paddy husk (1:1:1)along with nutrient consortium

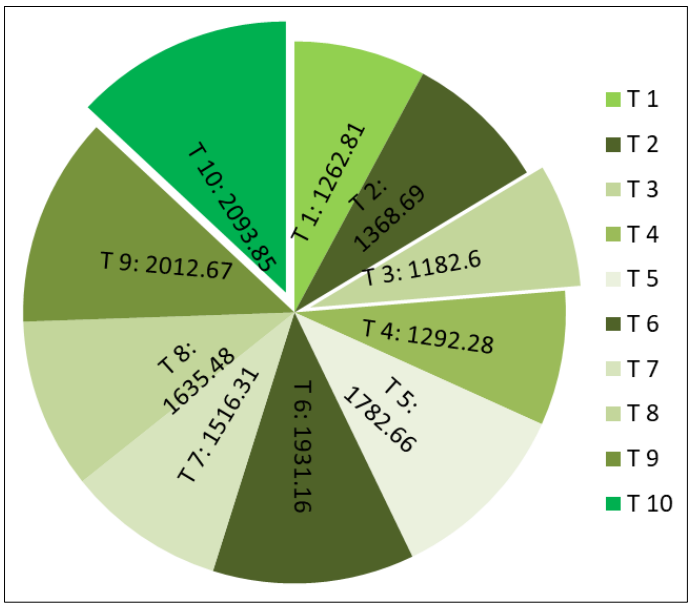


Fig 1: Effect of soilless media on turf density (no. of plants/sq.ft) of perennial rye grass (*Lolium perenne* L.) in pro-tray

Table 2: Effect of soilless media on fresh and dry weight of root, shoot and plant and wet and dry weight of turf mat of perennial rye grass (*Loliumperenne* L.) in pro-tray.

Treatments	Fresh Weight of Plant (g)	Dry Weight of Plant (g)	Fresh weight of Root (g)	Dry weight of Root (g)	Fresh weight of Shoot (g)	Dryweight of Shoot (g)	Mat Weight (Wet) (kg/sq.ft)	Mat Weight (Dry) (kg/sq.ft)
T_1	33.39	5.67	11.33	2.09	22.06	3.42	1.573	1.343
T_2	55.89	9.00	19.23	3.51	36.66	5.49	1.695	1.366
T_3	29.70	4.05	9.99	1.47	19.71	2.43	1.816	1.441
T_4	48.33	7.47	16.77	2.91	31.56	4.59	1.938	1.448
T_5	78.21	13.95	29.12	5.49	49.09	8.46	0.890	0.590
T_6	85.68	15.57	30.72	6.12	54.96	9.45	0.906	0.606
T_7	63.27	10.71	23.95	4.16	39.32	6.48	1.229	0.883
T_8	70.74	12.33	26.63	4.81	44.11	7.47	1.351	0.896
T_9	93.15	17.19	34.31	6.82	58.84	10.44	1.145	0.733

T_{10}	100.53	18.63	37.90	7.62	62.63	11.34	1.198	0.741
CD (p=0.05)	2.66	0.48	0.99	0.19	1.66	0.29	0.06	0.05
S.Ed	1.27	0.23	0.47	0.09	0.76	0.13	0.03	0.02

T_1 – Red soil + FYM + Sand (1:1:1) (control), T_2 – Red soil + FYM + Sand (1:1:1) along with nutrient consortium, T_3 – Red soil + FYM + Sand (1:1:1) (In tray), T_4 – Red soil + FYM + Sand (1:1:1)along with nutrient consortium, T_5 – Coir pith + Paddy husk (3:1), T_6 – Coir pith + Paddy husk (3:1)along with nutrient consortium, T_7 – Vermicompost + Paddy husk (3:1), T_8 – Vermicompost + Paddy husk (3:1)along with nutrient consortium, T_9 – Coir pith + Vermicompost + Paddy husk (1:1:1), T_{10} – Coir pith + Vermicompost + Paddy husk (1:1:1)along with nutrient consortium.

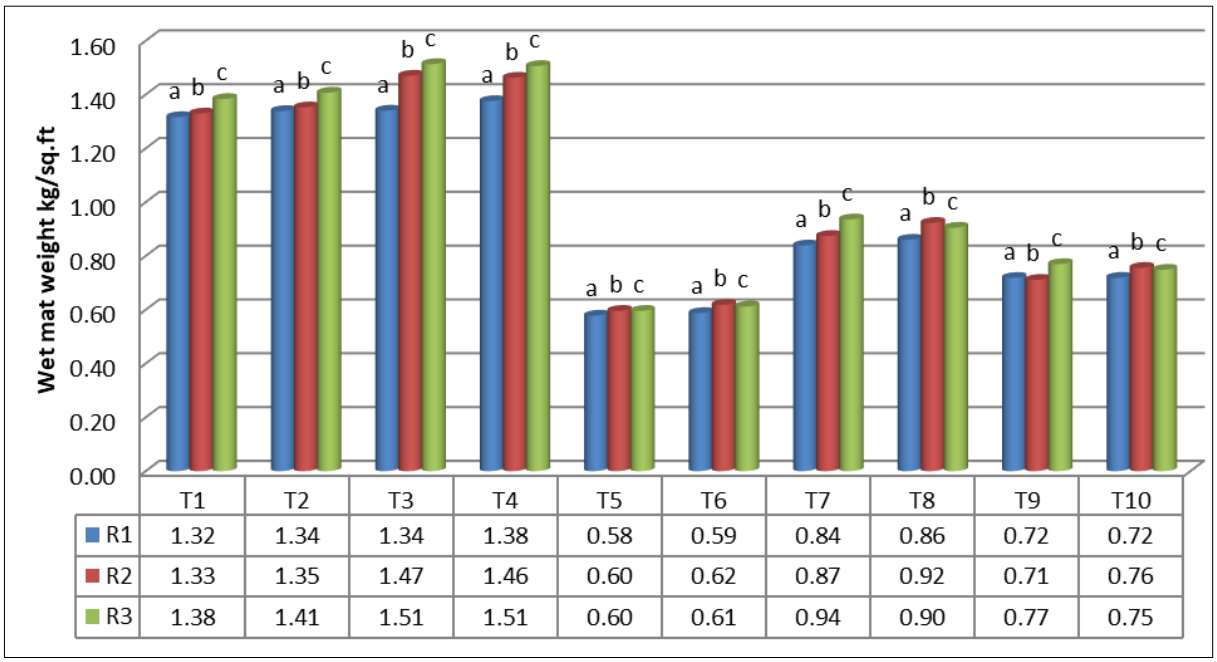


Fig 2: Effect of soilless media on wet weight of turf mat (kg/sq.ft) perennial rye grass (*Lolium perenne* L.) in pro-tray

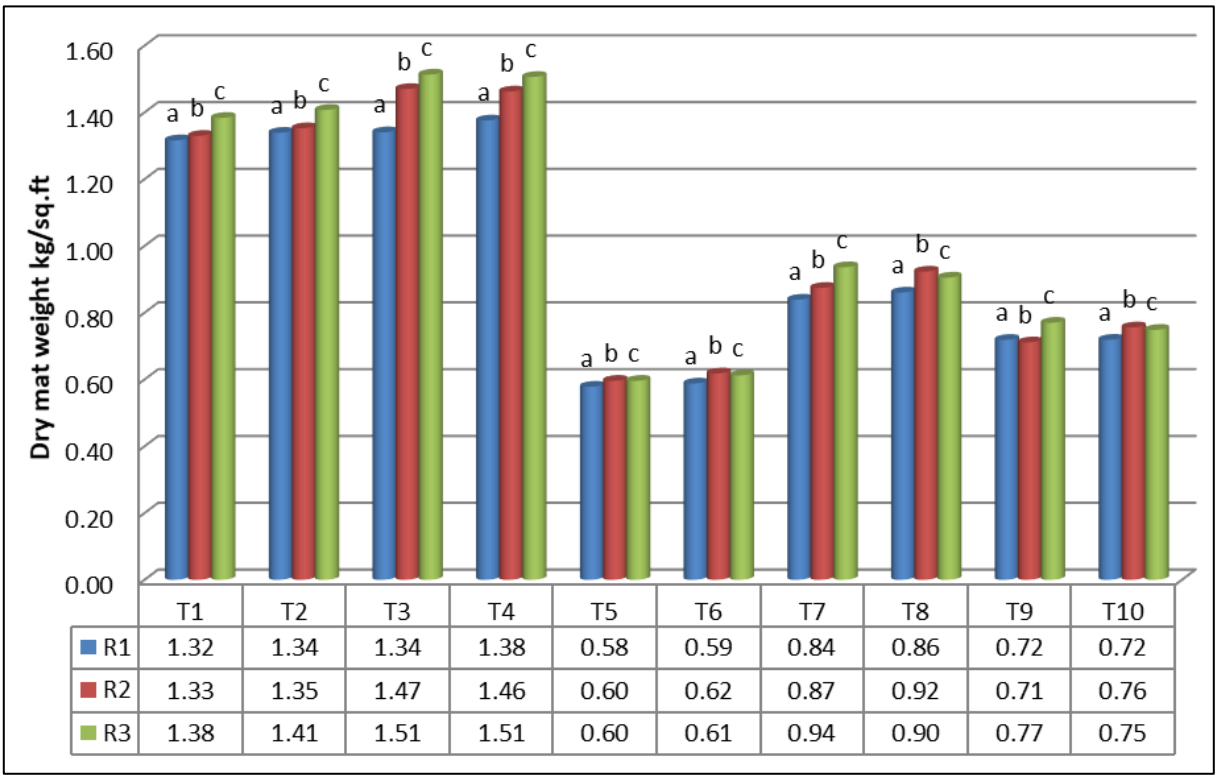
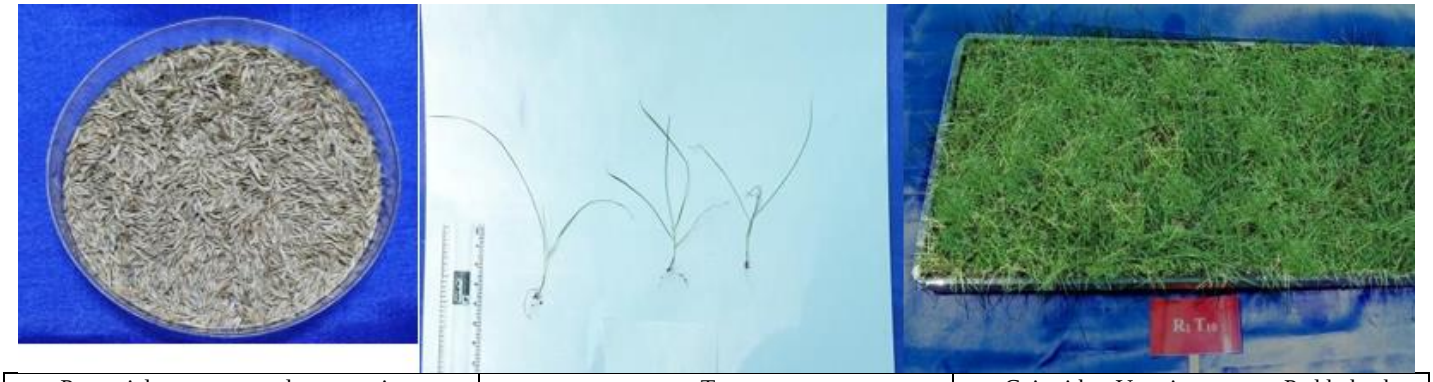
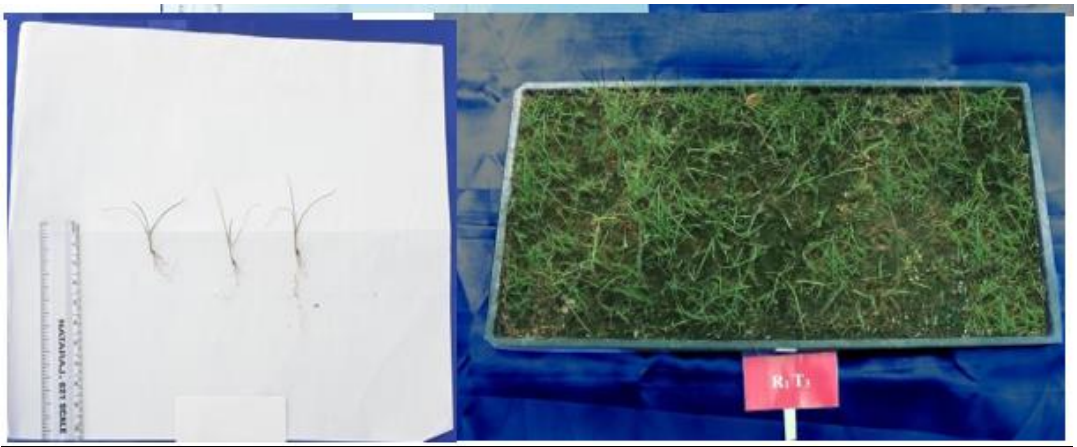


Fig 3: Effect of soilless media on Dry weight of turf mat (kg/sq.ft) perennial rye grass (*Lolium perenne* L.) in pro-tray
The data are represented by mean ± SD from three independent experiments



Perennial rye grass seeds comparison between best and least treatments	T_{10}	– Coir pith + Vermicompost + Paddy husk (1:1:1) along with nutrient consortium



T_3	T_3 – Red Earth + FYM + Sand (1:1:1)

Conclusion

Hence, the treatment T_{10} (Coir pith+ Vermicompost + Paddy husk (1:1:1) along with nutrient consortium (ZnSo4 @ 8 g + MgSo4 @ 8 g + NH4 So4 @ 4 g) + foliar spray of 19:19:19 (1 %) @ 15 & 25 DAS respectively) could be recommended for maximising growth and establishment of perennial rye grass in pro-tray. Further, the present investigation revealed that there is a major scope for future thrust area to investigate like high-tech nursery establishment, high density turf mat, standardization of soilless media, nutrients and microbial consortium, pro-tray nursery protocol, more area coverage, efficient post care, cost economics and do-it-yourself lawn at home.

References

1. Abirami K, Rema J, Mathew PA, Srinivasan V, Hamza S. Effect of different propagation media on seed germination, seedling growth and vigour of nutmeg (*Myristica fragrans* Houtt.). Journal of Medicinal PlantsResearch. 2010;4:2054-2058.
2. Ananda Murthy HC, Nair AK, Anjanappa M, Kalaivanan D, Shankara Hebbar S, Laxman RH. Growth and fruit yield of hybrid ridge gourd [*Luffa acutangula* L. roxb] arkavikram in relation to NPK frtigation. International Journal of Current Microbiology and Applied Sciences. 2020;9(06):3954-3963.
3. Arnon DI. Criteria of essentiality of inorganic micronutrients for Plants. The Chronica Botanica. 1954, 31–39.
4. Arunesh A, Ajish Muraleedharan K, Sha S, Kumar Joshi JL, Praveen Sampath Kumar, Babu Rajan E. Studies on the effect of different growing media on growth and flowering of Gerbera cv. Goliath. Plant Archives. 2020;20:653-657.
5. Arvind RK. Effect of different growing media and containers on seed germination and seedling growth of papaya (*Carica papaya* L.) cv. Madhubindu.M. Sc. (Agri.) thesis. Anand Agricultural University, Anand, Gujarat. 2014.
6. Ashkiani Ashkan, Saeed Sayfzadeh, Amir Hossein Shirani Rad, Alireza Valadabadiand Esmaeil Hadidi Masouleh. Effects of foliar zinc application on yield and oil quality of rapeseed genotypes under drought stress. Journal of Plant Nutrition. 2020;43(11):1594-1603.
7. Bachman GR, Metzger JD. Growth of bedding plants in commercial potting substrate amended with vermicompost. Bioresource Technology. 2008;99:3155-3161.
8. Bhardwaj RL. Effect of growing media on seed germination and seedling growth of papaya cv. Red lady. African Journal of Plant Science. 2014;8(4):178-184.
9. Bok-Rye Lee, Sowbiya Muneer, Jean-Christophe Avice, Woo-Jin Jungand Tae-Hwan Kim. Mycorrhizal colonisati on and P-supplement effects on N uptake and N assimilation inperennial ryegrass under well-watered and drought-stressed conditions. Mycorrhiza. 2012;22:525–534.
10. Campos Mota L, Van Meeteren U, Blok C. Comparison of physical property of Vermicompost from paper mill sludge and green compost as substitutes for peat based potting media. Acta Horticulture. 2009;819:227-234.
11. Desh Raj. Floriculture at Glance, Lawn management: 2008, 313-319.

12. Garcia M, Daverede C. Dust from coir fibres, new substrate for soilless culture. PHM Revue Horticole. 1994;348:7-12.
13. Gawankar MS, Haldankar PM, Haldavanekar PC, Salvi BR, Jamadagni BM. Studies on seed germination and seedling growth in Jackfruit (*Artocarpus heterophyllus* Lam.) as influenced by media. International Journal of Chemical Studies. 2019;7(5):1699-1705.
14. Joshi E, Gautam P, Kumar M, Lal B. Coir Compost: A Source of Plant Nutrient in Organic Farming. Popular Kheti. 2014;1:142–145.
15. Kameswari PL, Girwani A, Padmavathamma AS. Effect of different potting media mixtures on growth and flowering of Chrysanthemum (*Dendranthem agrandiflora* T.). Progressive Horticulture. 2014;46(2):304-308.
16. Khandaker MM, Rahmat S, Alias N, Mohd KS, Mat N. The Effects of different growing media on growth, flowering and quality of *Petunia grandiflora*. Journal of Agricultural Science. 2018;25(3):373-383.
17. Khayyat M, Nazari F, Salehi H. Effects of different pot mixtures onpothos (*Epipremnum aureum* Lindl. and Andre 'Golden Pothos') growth and development. A Eurasian Journal of Agriculture and Environmental Science. 2007;2:341-348.
18. Kulveer Singh Yadav, Anurag Bajpay. Nursery pro-trays and its importances in horticulture. The Journal of the Greens and Gardens. 2019;1(2):27-28.
19. Marie Skolnikova, PetrSkarpa, Eliska Rumpova, Peter Kovacik. The effect of zinc application on annual ryegrass (*Lolium multiflorum*) under drought stress. Acta Fytotechnicaet Zootechnica. 2020;23(4):198–204.
20. McEvoy M, Donovan M, Shalloo L. Development and application of an economic rankingindex for perennial ryegrass cultivars. Journal of Dairy Science. 2011;94:1627-1639.
21. Nalini Pandey. Role of Plant Nutrients in Plant Growthand Physiology. Plant Nutrients and Abiotic Stress Tolerance. 2018, 51-93.
22. Nazari F, Homayoun F, Morteza KK, Hassan S. Effects of coir as a component of potting media on growth, flowering and physiological characteristics of Hyacinth. International Journal of Agricultural and Food Science. 2011;1(2):34-38.
23. Padhiyar BM, Bhatt DS, Desai KD, Patel VH, Chavda JR. Influence of different potting media on growth and flowering of pot Chrysanthemum var. Ajin purple. International Journal of Chemical Studies. 2017;5(4):1667-1669.
24. Prajapati DG, Satodiya BN, Desai AB, Nagar PN. Influence of storage period and growing media on seed germination and growth of Acid Lime seedlings (*Citrus aurantifolia* Swingle) cv.Kagzi. Journal of Pharmacognosy and Phytochemistry. 2017;6(4):1641-1645.
25. Priyadarshani BWN, Senerathne S, De Dilva NAK. Lakmini WGD. Media properties of different vermicompost and coir dust mixtures. Proceedings of the International Forestry and Environmental Symposium., Department of Forestry and Environment Science, University of Sri Jayewardenepura, Sri Lanka, 2006, 42.
26. Ramteke Vikas DH, Paithankar P, Ekta Ningot, Vivek K. Effect of GA_3 and propagation media on germination, growth and vigour of papaya cv.Coorg Honey Dew. The Bioscan. 2015;10(3):1011-1016.
27. Renuka K, Sekhar RC. Studies on the effect of different media and their combinations on rooting of Carnation (*Dianthus caryophyllus* L.) cuttings of cv. Keiro under polyhouse conditions. Plant Archives. 2017;17(1):509-512.
28. Rivai RR, Wardani FF, Devi MG. Germination and breaking seed dormancy of *Alpinia malaccensis*. Nusantara Bioscience. 2015.7: 67-72.
29. Sahni S, Sarma BK, Singh DP, Singh HB, Singh KP. Vermicompost enhances performance of plant growth promoting Rhizobacteria in *Cicer arietinum* rhizosphere in *Sclerotium rolfsii*. Crop Protection. 2008;27:369-376.
30. Sapna Kaushal, Poonam Kumari. Growing media in floriculture crops. Journal of Pharmacognosy and Phytochemistry. 2020;9(2):1056-1061.
31. Saranraj P, Stella D. Vermicomposting and its importance in improvement of soil nutrients and agricultural crops. Journal of Natural Sciences Research. 2012,1(1).
32. Sarita Patel, Sashikala Beura, Lilymoony Tripathy, Abhiram Dash, Geeta Pandey, Sonali Priyadarshani. Effect of different levels of Nanomax (4% NPK) and Polyfeed (19:19:19 NPK) on *Coreopsis tinctoria*. International Journal of Chemical Studies, 2020;8(5):1850-1853.
33. Shreya Mondal, Ghosh GK, Joydip Mandal. Effect of graded levels of sulphur as magnesium sulphate on yield and quality of onion (*allium cepa*L.) in red and lateritic soils of West Bengal, India. International Journal of Current Microbiology and Applied Sciences. 2020;9(4):2858-2866.
34. Soepardi G. Sifatdan cirri tanah. Department Ilmu-ilmu Tanha, IPB. Bogor. 1983.
35. Sounderarajan M. Seed propagation studies in soursop (*Annon amuricata* L.). M.Sc Thesis. Annamalai University, Tamil Nadu. 2020.
36. Swetha S, Padmalatha T, Rao KD, Shankar AS. Effect of potting media on growth and quality in Aglaonema. Journal of Horticultural Science. 2014;9(1):90-93.
37. Van Holm L. Coir as a growing medium 7thfloricultural symposium, October 11. Institute at fundamental studies. Hantana, Kandy, Srilanka, 1993, p. 1-23.