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Effect of potting media on chemical and yield attributes of sword fern (*Nephrolepis undulate* J. Sm) under protected condition

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Abstract
An experiment was conducted to study the effect of potting media on quality parameters of Nephrolepis undulate J. Sm under protected condition in Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere (Under University of Agricultural and Horticultural Sciences, Shivamogga) during 2018-19. The suckers were collected around the region of Mudigere and are planted in 12" pot. The experiment was consisted with ten different treatments viz., T_1 - Soil + Sand + FYM (2:1:1) (Control), T_2 - Soil + Cocopeat + Vermicompost (2:1:1), T_3 - Soil + Coir pith + Vermicompost (2:1:1), T_4 - Soil + Cocopeat + FYM + Vermicompost (2:1:1:1), T_5 - Soil + Perlite + Coir pith + Vermicompost (2:1:1:1), T_6 - Cocopeat + Sand + FYM (2:1:1), T_7 - Cocopeat + Vermicompost + Coir pith (2:1:1), T_8 - Cocopeat + Vermicompost + FYM (2:1:1), T_9 - Cocopeat + Perlite + Sand + Vermicompost (2:1:1:1) and T_{10} - Cocopeat + Perlite + Coir pith + Vermicompost (2:1:1:1). Each treatment was replicated thrice in Completely Randomized Design (CRD). The results revealed that the plants which are grown in the media containing Soil + Cocopeat + FYM + Vermicompost (2:1:1:1) recorded the maximum number of shoots (6.17), croziers (3.10), fronds (12.00), nitrogen (5.10 %), phosphorous (0.59 %) and potassium (2.65 %) compared standard check.

Keywords: *Nephrolepis* fern, potting media, nitrogen, phosphorous, potassium, pH, EC and OC

Introduction
A fern is a member of a group of vascular plants (plants with xylem and phloem) that reproduce *via* spores and have neither seeds nor flowers. They differ from mosses by being vascular *i.e*. having specialized tissues that conduct water and nutrients and in having life cycles in which the sporophyte is the dominant phase. Like other vascular plants, ferns have complex leaves called megaphylls, that are more complex than the microphylls of clubmosses. The ferns are homosporous, leptosporangiate ferns, sometimes referred to as true ferns found mostly in humid areas. The new leaves typically expand by the unrolling of a tight spiral called as a crozier or fiddlehead of the fern. This uncurling of the leaf is termed circinate vernation and that uncoil and expand into fronds (Olsen, 2007) [10]. Ferns are extremely diverse in their habitat, form and reproductive methods. The foliage of ferns ranges from dark green to light yellow and others with surprising colors of grey, silver, red and blue-green which increase their utility in different types of floral arrangements (Kavana *et al*., 2019) [5]. Besides the economic values, a large number of them are cultivated for their ornamental value either in indoors of the houses or outdoors in the botanical gardens due to their delicate beauty and grace, used as a hanging basket, greenhouses and conservatories and we find them in the smallest apartments to the largest homes (Poole *et al*., 1984). Growing media generally have three components *i.e*. mainly with water, dissolved nutrients, solid (33-50%) and gases (50-70%) with (12%) oxygen and this combination is good for stronger root and shoot growth. Nowadays potted plants are grown in soilless media because of their benefits *i.e*. good water holding capacity, porosity, aeration and free from water logging conditions and less weed growth, nematodes, pest and disease infestation (Abid *et al*., 2017) [1]. Ferns are extremely diverse in their habitat, form and reproductive methods. The foliage of ferns ranges from dark green to light yellow and others with surprising colors of grey, silver, red and blue-green which increase their utility in different types of floral arrangements. The genus *Nephrolepis* is commonly known as “sword fern” which are evergreen or semi-evergreen, either terrestrial or epiphytic species, distributed in tropical to subtropical regions around the world (Patil and Dongare, 2014) [11].

Materials and Methods
The experiment was carried out at the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere (Under University of Agricultural and Horticultural Sciences, Shivamogga) during 2018-19. The experiment was laid out in Completely Randomized Design with 10 treatments and 3 replications [T_1 - Soil + Sand + FYM (2:1:1) (Control), T_2 - Soil + Cocopeat + Vermicompost (2:1:1), T_3 - Soil + Coir pith + Vermicompost (2:1:1), T_4 - Soil + Cocopeat + FYM + Vermicompost (2:1:1:1), T_5 - Soil + Perlite + Coir pith + Vermicompost (2:1:1:1), T_6 - Cocopeat + Sand + FYM (2:1:1), T_7 - Cocopeat + Vermicompost + Coir pith (2:1:1), T_8 - Cocopeat + Vermicompost + FYM (2:1:1), T_9 - Cocopeat + Perlite + Sand + Vermicompost (2:1:1:1) and T_{10} - Cocopeat + Perlite + Coir

pith + Vermicompost (2:1:1:1)]. Each component of the mixture was added on the basis of volume while preparing the potting mixture which was added to earthen pots of 12" and the suckers were planted which are collected in the Mudigere region. The intercultural operations like weeding and irrigation were done as and when necessary. Potting media was evaluated for the chemical properties such as pH, electrical conductivity (EC), organic carbon (%), nitrogen (%), phosphorus (ppm), organic matter (%). A pH meter (digital ion analyzer) was used to measure the pH of the potting media and EC was measured in ds m^{-1} with a conductivity meter. The total nitrogen in the soil sample was determined by distillation in Kjeldahl's apparatus and titration was carried out with standard H_2SO_4. Olsen's method was used to determine the available phosphorus in the media. The observations were recorded at grand growth stage and were statistically analyzed. Potassium permanganate method for potassium estimation.

Results and Discussion

The media was analysed for pH, EC, OC, N, P and K content before and after planting. The results were significantly varied among the treatments. The treatments containing media *i.e*. soil + cocopeat + vermicompost (2:1:1), soil + cocopeat + FYM + vermicompost (2:1:1:1) and soil + perlite + coir pith + vermicompost (2:1:1:1) soil condition (6.47, 6.13 and 6.20) was acidic and EC was also lowest (0.24) in the media soil + cocopeat + FYM + vermicompost (2:1:1:1) while media containing soil + sand + FYM (2:1:1) was alkaline (7.60) condition and having maximum EC (0.76), and also OC, N, P and K content significantly varies the maximum (0.78, 1.19, 1.41 and 1.43 %) in the treatment having soil + cocopeat + FYM + vermicompost (2:1:1:1) and minimum (0.54, 0.50, 0.52 and 0.56 %) in soil + sand + FYM (2:1:1) (Table 1). Usually ferns require acidic condition for their growth and also due to effect of media combination, if there is increase in pH and EC, there is induced reduction in N, K and P contents of potting media. These results are in conformity with earlier findings *i.e*. Mehmood *et al*. (2013) [7] in antirrhinum, Handrek (1992) in ferns, Younis (2007) [16] in dahlia, and Naggar and Nasharty (2009) [8] in hippeastrum.

Overall response of ferns based on different yield parameters like number of shoots, croziers and fronds are varied with the chemical constituents of the media *i.e.* N, P and K. The maximum number of shoots (6.17) and croziers (3.10) was recorded in the plants which are raised in the media containing soil + cocopeat + FYM + vermicompost in 2:1:1:1 which was statistically on par with soil + perlite + coir pith + vermicompost (2:1:1:1) (6.07 and 2.48) while, the minimum (3.53 and 1.60) in media soil + sand + FYM (2:1:1) (control) (Table 2). This is due to improve in the physical properties of substrate, such as bulk density, container capacity, electrical conductivity, microbial activity and nitrate concentrations which are helpful for increasing the number of croziers and also due to the superiority of vermicompost and FYM, which having ability to supply nutrients like N, P, K, Ca and Mg in available form. Similar results are obtained earlier by Nair *et al*. (2015) [9] in leather leaf fern and Singh and Nair (2003) [4] in dieffenbachia, Jawaharlal *et al*. (2001) in anthurium and Dhananjaya and Sulladmath (2003) [2] in anthurium.

The number of fronds per plant is one of the important characters in *Nephrolepis* fern, as they play a key role in deciding the ultimate yield of cut foliages. The number of fronds (Table 2) varied significantly the maximum number of fronds (12.00) was noted in media soil + cocopeat + FYM + vermicompost (2:1:1:1) which was statistically on par with soil + perlite + coir pith + vermicompost (2:1:1:1) (11.33) while, the minimum number of fronds (8.63) was noticed in soil + sand + FYM (2:1:1) (control). This may be due to the vermicompost, in appropriate quantities to potting media has synergistic effects and cocopeat was found to improve the physical properties of the substrate, decrease compaction and enable better growth and production which was beneficial for increasing the number of fronds. These results are in conformity with earlier by Nair *et al*. (2015) [9] in leather leaf fern, Sandeep *et al*. (2018) [13] in *Nephrolepis* fern and Kavana *et al*. (2019) [6] in *Nephrolepis* fern.

Significantly maximum (5.10, 0.59 and 2.65 %) amount of N, P and K (%) content was noticed in the media soil + cocopeat + FYM + vermicompost (2:1:1:1) while, the minimum (1.80, 0.29 and 0.78 %) amount of N, P and K content was recorded in soil + sand + FYM (2:1:1) (Fig. 1.). This might be due to high nutrient provided by the vermicompost, media amended with cocopeat had higher nitrogen, phosphorous and potassium content which increases the N, K uptake and availability of P could be result of more P exchange sites or higher activity of P- solubilizing organisms. These findings are in conformity with Scagel (2003) in rhododendron and Swetha *et al*. (2014) [15] in aglaonema.

In conclusion, the plants which are grown in the media containing soil + cocopeat + FYM + vermicompost (2:1:1:1) recorded the optimum range of pH, EC, OC, N, P and K content. This results in increased uptake of nutrients by the plants which increases the yield of the plant.

Table 1: The pH, EC (ds/m), OC, N, P and K (%) content of the potting media under protected condition

Treat. No.	Treatment details	Before planting						After planting					
		pH	EC (ds/m)	OC (%)	N (%)	P (%)	K (%)	pH	EC (ds/m)	OC (%)	N (%)	P (%)	K (%)
T_1	Soil + Sand + FYM (2:1:1) (control)	7.60	0.76	0.54	0.50	0.52	0.56	7.07	0.61	0.51	0.40	0.41	0.42
T_2	Soil + Cocopeat + Vermicompost (2:1:1)	6.47	0.38	0.64	0.83	0.91	0.93	5.87	0.25	0.58	0.71	0.81	0.82
T_3	Soil + Coir pith + Vermicompost (2:1:1)	6.80	0.63	0.65	1.00	1.12	1.13	6.10	0.52	0.63	0.73	0.91	0.92
T_4	Soil + Cocopeat + FYM + Vermicompost (2:1:1:1)	6.13	0.24	0.78	1.19	1.41	1.43	5.80	0.21	0.72	0.80	1.21	1.22
T_5	Soil + Perlite + Coir pith + Vermicompost (2:1:1:1)	6.20	0.31	0.71	1.13	1.21	1.23	5.87	0.23	0.69	0.77	1.07	1.10
T_6	Cocopeat + Sand + FYM (2:1:1)	6.23	0.56	0.64	0.93	1.00	1.13	5.93	0.41	0.57	0.51	0.91	0.92
T_7	Cocopeat + Vermicompost + Coir pith (2:1:1)	7.10	0.39	0.66	0.83	0.73	0.83	7.07	0.30	0.63	0.50	0.61	0.71
T_8	Cocopeat + Vermicompost + FYM (2:1:1)	6.23	0.44	0.68	0.97	0.90	0.93	6.00	0.31	0.65	0.60	0.81	0.85
T_9	Cocopeat + Vermicompost + FYM (2:1:1)	6.53	0.62	0.60	0.93	1.03	1.09	6.23	0.48	0.58	0.70	0.93	0.93
T_{10}	Cocopeat + Perlite + Coir pith + Vermicompost (2:1:1:1)	6.93	0.32	0.62	0.73	0.81	0.84	6.27	0.28	0.59	0.61	0.70	0.71

	S. Em ±	0.10	0.01	0.01	0.03	0.02	0.02	0.10	0.01	0.01	0.02	0.01	0.02
	CD @ 1%	0.40	0.04	0.04	0.10	0.10	0.09	0.42	0.04	0.05	0.06	0.05	0.09

Table 2: Effect of potting media on N, P, K and yield of *Nephrolepis undulate* J. Sm at grand growth stage

Treatment No.	Treatment details	Plant analysis			Number of shoots	Number of croziers	Number of fronds
		N (%)	P (%)	K (%)			
T_1	Soil + Sand + FYM (2:1:1) (control)	1.80	0.29	0.78	3.53	1.60	8.63
T_2	Soil + Cocopeat + Vermicompost (2:1:1)	3.56	0.36	1.66	3.77	2.10	9.47
T_3	Soil + Coir pith + Vermicompost (2:1:1)	2.59	0.43	0.88	3.60	2.30	9.03
T_4	Soil + Cocopeat + FYM + Vermicompost (2:1:1:1)	5.10	0.59	2.65	6.17	3.10	12.00
T_5	Soil + Perlite + Coir pith + Vermicompost (2:1:1:1)	2.90	0.47	1.77	6.07	2.48	11.33
T_6	Cocopeat + Sand + FYM (2:1:1)	2.01	0.46	1.16	3.97	2.10	10.50
T_7	Cocopeat + Vermicompost + Coir pith (2:1:1)	2.43	0.44	1.59	3.10	2.03	10.97
T_8	Cocopeat + Vermicompost + FYM (2:1:1)	3.33	0.39	1.48	4.37	1.70	10.67
T_9	Cocopeat + Perlite + Sand + Vermicompost (2:1:1:1)	2.20	0.38	1.18	4.30	2.20	9.17
T_{10}	Cocopeat + Perlite + Coir pith + Vermicompost (2:1:1:1)	3.41	0.38	1.69	3.83	1.97	10.17
	S. Em ±	0.06	0.01	0.02	0.10	0.06	0.25
	CD @ 1%	0.25	0.04	0.08	0.40	0.24	0.99

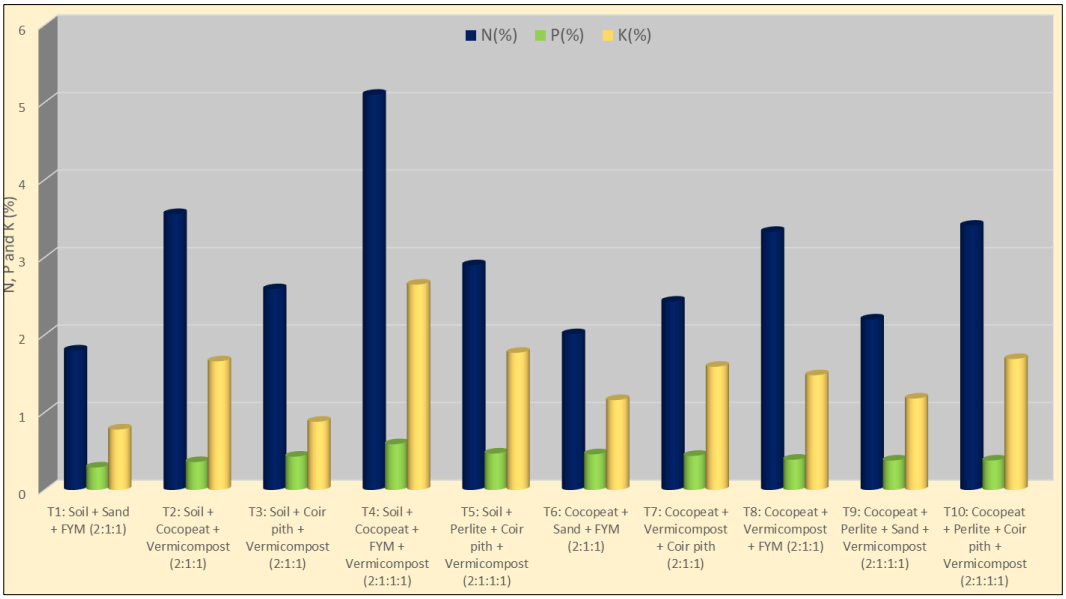

Fig 1: Effect of potting media on N, P and K content of *Nephrolepis undulate* J. Sm at grand growth stage

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