GROWTH RESPONSE OF TWO OIL PALM (*Elaeisguineensis* Jacq.) VARIETIES TO SELECTED GROWTH MEDIA AND CONTAINERS UNDER COASTAL CLIMATIC CONDITIONS OF SINDH PAKISTAN

[1]Memon, N.S., A.W. Gandahi[1], M.S. Sarki[1] and Q.A. Panhwar[2]

1. Department of Soil Science, Sindh Agriculture University Tandojam
2. Nuclear Institute of Agriculture (NIA), Tandojam

Abstract

The current experiment was conducted at Dalda Agriculture Research Station (DARS) Gharo, Thatta, Sindh, Pakistan during the year 2019. Two Malaysian oil palm varieties (3,way Cross and Yangambi PB 14) were tested against various potting media and container (peat moss in plastic vials, peat moss in polyethylene bags, river sand in polyethylene bags, and river sand in plastic vials) at a pre-nursery stage. Results revealed that the treatment comprised of peat moss in polyethylene bags significantly ($P<0.05$) increased plant height (36.83 cm), stem diameter (6.9167 cm), number of leaves seedling^{-1}(4.0 seedling^{-1}), chlorophyll content (64.0%), leaf N, P, K (2.35, 0.056, 0.96%) contents and uptake (0.198, 0.0047, 0.079 kg seedling^{-1}) Variety Yangambi PB 14 produced seedlings that were more promising in vigor and plant nutrient contents as compared to variety 3way cross. Vigor of these seedlings was markedly better when raised in polyethylene bags as compared to plastic vials regardless of potting media. Thus, variety Yangambi PB 14 × peat moss in polyethylene bags interaction proved to be an optimum combination as compared to variety 3way cross × river sand in plastic vials. Based on the results, it is therefore, recommended that the landowners of coastal belt of Sindh, Pakistan should be facilitated with all such facilities related to oil palm cultivation; preferring the oil palm variety Yangambi PB 14. It is further recommended that at pre-nursery stage, the seedlings may be raised in peat moss using polyethylene bags as container.

Keywords: Oil palm, growing medium, river sand, peat moss, plastic vials, polyethylene bags, pre-nursery stage

INTRODUCTION

Oil palm (*Elaeis guineensis)* is a potential source of quality edible oil, can be favorably cultivated under coastal climates of Pakistan. Plant media is crucial factor in supporting the growth of oil palm seedlings (Mira Ariyanti et al., 2018). Pakistan imported 2.754 million tons of edible oil (US$ 3.681 billion) during 2022, and local production of edible oil during this period was provisionally estimated at 0.460 million tons. This indicates that only 8.0 percent of the total edible oil consumption in Pakistan is locally produced and the remaining is imported (GoP, 2022).

Oil palm plant nurseries can be divided into two phases, namely the pre-nursery phase and the main nursery phase (Sirait et al., 2020). Worldwide, there has been a recent increase in interest in oil palms from both commercial and private collectors. The availability of more diverse oil palm species for cultivation has sparked interest in doing so. A high-quality growth medium is required for the creation of seedlings of superior grade. A growing medium's physicochemical and biological characteristics will have an impact on plant development and directly affect the development of roots. The planting medium also needs to be permeable and well-drained to allow free roots to penetrate, provide a strong anchorage, and have enough nutrients to promote crop growth (Khan et al., 2006).

Almost every horticulture production system includes growing medium. Growing media are the substrates on which plants will grow; they offer support for the roots of the plants, air gaps for respiration, and the ability to hold enough water to support plant growth (Ayoola and Adeyeye 2010). Sewage sludge, tobacco, sugar, sawdust, paper, biomass byproducts, leaf mould, straw products, loam sea weed, hop waste, wood waste, wasted mushroom compost, lignite, rice hulls, animal waste, and food processing wastes are a few examples of other growing media that can be employed (Agbo and Omaliko,2006). Plant performance in bare roots and container nursery production is recognized to be influenced by the growing media (Gajalakshmis, 2012).

In Sindh province, comparative study on river sand and peat moss used as growing media on oil palm seedlings in container nurseries has not been comprehensively investigated so far. In order to determine the best growing medium and container for oil palm seedling growth presented research was designed to assess peat moss and river sand in several replications filled in polyethylene bags and plastic vials for comparative effectiveness on seedling growth, plant nutrient contents, and nutrient uptakes of oil palm seedlings.

MATERIALS AND METHODS

The current experiment on growth response of two oil palm (*Elaeis guineensis* jacq.) varieties to selected growth media and containers under coastal climatic conditions of Sindh Pakistan carried out at greenhouse of Dalda Agriculture Research Station (DARS) Mirpur Sakro district Thatta (Latitude N 24º39'58.24385" Longitude: E 67 º34'1.01598"). Analysis of soil, potting media and plant tissue was performed at the Laboratory of Soil Chemistry, Department of Soil Sciences, Sindh Agriculture University Tandojam.

Experimental design and treatments

In this study different potting media and containers were tested for healthy growth and vegetative traits of oil palm seedlings. There were four treatments in different potting media in dissimilar containers on the oil palm seedlings. The experimental details are given as under:
Experimental Design: Completely Randomize Design (CRD) Factorial
Replications: Three
Total no. of containers: 24

Factor-A: containers type and media (C) =04

C1= Peat mass in plastic vials

C2= Peat moss in poly begs

C3= Soil in poly bags (river sand)

C4= Soil in plastic vials

Factor-B: Oil palm varieties (V) =02

V1=3WAY CROSS

V2= YANGAMBI PB 14

Experimental Procedure

The germinated seeds were imported from FELDA Plantations Sdn. Bhd, Sungai Tekam, Jerantut, Pahang, Malaysia; and selection of seeds was based on appropriate size of plumule and radicle. Fertilization was carried out once a month. Plastic vials having 10" ×18" size were filled with 500 gram peat moss, while black colored polythene bags having 6" × 9" size with drainage holes were filled with 1.5 kg river sand. Irrigation was applied twice a day, which is in the morning and in the evening. In order to control pests, Malathion (insecticides) was applied to the seedlings.

Data collection was started in the second month after planting and was taken once a month until the fourth month. In each container one gram of Perlite and 3 g of NPK (13-13-13) was applied at the time of sowing of germinated seed. The experiment was terminated after 4 months. Root and shoot were carefully removed from the planting medium to prevent roots from being broken. The plants were cut into the shoot and root parts were thoroughly washed with distilled water. Thereafter, the plants were measured for fresh weight, before oven dried at 65℃ for 48-72 hours for determination of the plant total dry weight; and the root/shoot ratio was also determined.

River sand used in this study was analyzed for its physio-chemical properties such as texture, organic matter, EC, pH, before placing the seedlings in the polythene bags and vials. After termination of the experiment the soil samples were secured from all treatments and replications and were processed. The peat moss samples were collected from the concerned treatments and were analyzed for chemical properties. The leaf samples were analyzed for N (Ryan et al., 2001), P (Olsen and Sommers, 1982), K contents (Knudsen *et al*., 1982) and their uptake.

Data collection

Morphological parameters were observed at the time of termination of the experiment 4 months after planting. Morphological parameters observed were plant height, trunk diameter, Number of leaves seedling^{-1}, Chlorophyll content (SPAD). Biomass fresh and dry weight (g), Root, shoot dry weight, Root: shoot ratio, Leaf N, P, K content and uptake.

Using a regular measuring tape, the height was measured from the top of the planting media to the tip of the highest leaf. A digital Vernier calliper was used to measure the trunk diameter. Visual counting of leaves was done and thus number was counted in each treatment. A SPAD-502 meter was used to measure the amount of chlorophyll. Each leaf had three readings around its midrib, which were averaged. After 4 months, the seedlings were harvested. To avoid breaking the roots, the root and shoot from the planting material were carefully removed. The plants' shoot and root portions were cut off and carefully cleansed with distilled water. The plants were then weighed while still fresh, and their total dry weight was calculated after being oven-dried at 65°C for 48–72 hours. The root/shoot ratio was also calculated:

RSR= Total Root Dry Weight (g)/ Total Shoot Dry Weight (g) x 100

The Kjeldahl method was used to determine the nitrogen content of plant tissue (Bremner, 1996). Phosphorus and potassium content (%) in leaf samples were determined by acid wet digestion method (HClO4/HNO3) (Rowell, 1994) using a spectrophotometer and EEL flame photo meter, respectively.

NPK uptake was calculated as:

NPK uptake (g seedling^{-1}) (TDM x nutrient concentration in plant/100

Statistical analysis

The data were statistically analyzed using ANOVA and DMR test to examine the significance of the treatment effect and compare the treatment means, respectively as suggested by Steel and Terrie (1997).

RESULTS

Plant height (cm)

The effect of potting media and containers on plant height of oil palm varieties was significant ($P<0.05$); while interactive effect of potting media × varieties was insignificant ($P>0.05$). Peat moss when used as potting media in polyethylene bags produced oil palm seedlings with greater height (36.83 cm) than peat moss used in plastic vials (34.0 cm). Similarly, the river sand when used as potting media in polyethylene bags produced oil palm seedling with greater height (34.3 cm) as compared to river sand used in plastic vials (32.0 cm). It indicates that polyethylene bags filled either with peat moss or with river sand affected plant height more positively as compared to those grown in plastic vials. The varietal effect on plant height indicates that oil palm variety Yangambi PB 14 responded well to potting media (35.60 cm) over 32.95 cm plant height in 3way cross (Table 4).

Trunk girth (cm)

The trunk girth of oil palm seedlings was significantly influenced by potting media, varieties as well as by the interactive effect of potting media × varieties ($P<0.05$). The seedlings raised in polyethylene bags filled with peat moss resulted in thicker trunks (6.92 cm) as compared to peat moss in plastic vials (5.85 cm). Likewise, river sand filled in Polyethylene bags produced oil palm seedlings with thicker trunks (5.35 cm) as compared to river sand used as potting media in plastic vials (4.80 cm). Overall, the oil palm for its trunk girth responded more positively to peat moss as compared to river sand (Table 4). Moreover, polyethylene bags were more effective to produce oil palm seedlings with thicker trunks as compared to seedling raised in plastic vials. In case of oil palm varieties, the stem diameter was significantly ($P<0.05$) greater (6.03 cm) in variety Yangambi PB 14 as compared to 3way cross (5.43 cm).

Number of leaves seedling^{-1}

The analysis of variance described that number of leaves seedling^{-1} in oil palm was significantly affected by potting media, varieties as well as by interaction of potting media × varieties ($P<0.05$). The seedlings raised in polyethylene bags filled with peat moss produced plants with maximum number of leaves (4.0 seedling^{-1}), followed by peat moss in plastic vials and river sand in polyethylene bags with equally 3.5 average number of leaves seedling^{-1}, respectively (Table 4). However, the minimum number of leaves (3.0 seedling^{-1}) was counted in oil palm grown river sand filled in plastic vials. The oil palm in regards to number of leaves seedling^{-1}responded more positively to peat moss as compared to river sand; while, polyethylene bags were more effective to produce oil palm seedlings with more foliage as compared to those raised in plastic vials. The varietal effect indicated that the number of leaves was significantly ($P<0.05$) higher (3.67 seedling^{-1}) in variety Yangambi PB 14 as compared to variety 3way cross (3.33 seedling^{-1}).

Chlorophyll content

The chlorophyll content of seedlings was significantly affected by potting media and varieties ($P<0.05$); while interactive effect of potting media × varieties on chlorophyll content was insignificant ($P>0.05$). The peat moss filled in polyethylene bags as potting media provided the seedling leaves with maximum greenness (64.0%); while the peat moss when filled in plastic vials, the chlorophyll content decreased to 57.5 percent (Table 4). Comparatively, the river sand filled in Polyethylene bags as potting media averagely caused lower chlorophyll content (52.5%) and chlorophyll content was least (47.0 %) when river sand was filled in plastic vials. The chlorophyll content of leaves in oil palm seedlings was more positively influenced by peat moss as compared to river sand; while the seedlings raised in polyethylene bags showed increased chlorophyll content of leaves as compared to those raised in plastic vials. The varietal response to chlorophyll content in oil palm suggested that variety Yangambi PB 14 reflected more greenness of leaves (57.0 %) as compared to variety 3way cross (53.5 %).

Table 3. Plant height, trunk girth, leaves number and leaf chlorophyll of oil palm seedlings raised in different growing media

Treatments	Plant height (cm)	Trunk girth (cm)	No. of leaves seedling^{-1}	Chlorophyll content (SPAD)
Growing media and containers				
M_1=Peat moss in plastic vials	34.0^{AB}	5.8500^{B}	3.5^{B}	57.5^{B}
M_2=Peat moss in polyethylene bags	36.83^{A}	6.9167^{A}	4.0^{A}	64.0^{A}
M_3=River sand in plastic vials	32.0^{B}	4.8000^{D}	3.0^{C}	47.0^{C}
M_4=River sand in polyethylene bags	34.3^{AB}	5.3500^{C}	3.5^{B}	52.5^{BC}
LSD 0.05	*3.0886*	0.3419	0.4669	6.3000
Varieties				
V1=3way Cross	32.95^{B}	5.4325	3.33^{B}	53.5^{B}
V2= Yangambi PB 14	35.60^{A}	6.025	3.67^{A}	57.0^{A}
LSD 0.05	*1.6122*	0.1784	0.2437	3.2884
Significance				
Treatments (T)	**	**	**	**
Varieties (V)	**	**	**	**
T × V	NS	*	**	NS

*** = Significant at P=0.05 NS= Non-Significant ^{abc} Means followed by common letter are similar at 5% probability level.*

Biomass fresh weight (g)

The biomass fresh weight in oil palm at pre-nursery stage was significantly affected by potting media, varieties as well as by interaction of potting media × varieties (P<0.05). The fresh weight was higher in seedlings raised in polyethylene bags filled with peat moss (22.4 g), followed by peat moss in plastic vials and river sand in polyethylene bags with 18.95 g and 17.20 g fresh weight, respectively. However, the least biomass fresh weight (14.22 g) was measured in oil palm seedlings grown under river sand in plastic vials. The oil palm in regards to biomass fresh weight responded more positively to peat moss as compared to river sand; while, polyethylene bags were more efficient to produce oil palm seedlings with greater biomass fresh weight as compared to the seedlings rose in plastic vials. In oil palm varieties, the shoot and root fresh weight was significantly (P<0.05) higher (19.5 g) in variety Yangambi PB 14 as compared to variety 3way cross (16.88 g). The greater shoot and root fresh weight of oil palm seedlings was linked with the increased plant height, thicker stems, more leaves and higher chlorophyll content.

Biomass dry weight

The statistical analysis indicated that shoot and root dry weight at pre-nursery stage was significantly affected by potting media and varieties (P<0.05); while interactive effect of potting media × varieties on biomass dry weight was insignificant (P>0.05). The nursery raised in polyethylene bags filled with peat moss produced seedlings with maximum biomass dry weight (8.37 g), followed by peat moss in plastic vials and river sand in polyethylene bags with 7.15 g and 6.40 g average biomass dry weight, respectively. However, the least biomass dry weight (5.43 g) was recorded in oil palm seedlings grown under river sand in plastic vials. The oil palm in relation to biomass dry weight responded more positively to peat moss as compared to river sand; and similarly, polyethylene bags were more effective to produce seedlings with greater biomass dry weight as compared to plastic vials. The varietal effect indicated that the biomass dry weight was significantly (P<0.05) higher (7.46 g) in variety Yangambi PB 14 than the variety 3way cross (6.23 g). The greater biomass dry weight of oil palm seedlings was mainly associated with the greater plant height, thicker stems, more leaves and higher greater biomass fresh weight.

Root dry weight (g)

The root dry weight in oil palm at pre-nursery stage was significantly affected by potting media, varieties as well as by interaction of potting media × varieties (P<0.05). The root dry weight was markedly higher in seedlings raised in peat moss in polyethylene bags (2.95 g), followed by peat moss in plastic vials and river sand in polyethylene bags with 2.45 g and 2.13 g average root dry weight, respectively. The least root dry weight (1.55 g) was recorded in oil palm seedlings grown in plastic vials using river sand. The root dry weight was remarkably improved when seedlings were raised in peat moss as compared to river sand; and similarly, using polyethylene bags for raising seedlings was more beneficial in regards to root dry weight as compared to plastic vials. In varieties, the root dry weight was higher (2.57 g) in Yangambi PB 14 as compared to variety 3way cross (1.98 g). This greater root dry weight of oil palm seedlings under peat moss in polyethylene bags for variety Yangambi PB 14 was mainly associated with increased values for plant height, stem diameter, leaves seedling^{-1}, chlorophyll, shoot and root fresh weight; and shoot and root dry weight.

Shoot dry weight (g)

The shoot dry weight at pre-nursery stage was significantly affected by potting media and varieties (P<0.05); while the interactive effect of potting media × varieties on this parameter was statistically non-significant (P>0.05). The shoot dry weight was higher under peat moss in polyethylene bags (5.42 g), and it decreased under peat moss in plastic vials (4.70 g) and river sand in polyethylene bags (4.27 g); the lowest shoot dry weight (3.88 g) was noted in oil palm seedlings grown in river sand using plastic vials. It was observed that shoot dry weight higher case of peat moss as compared to river sand; while using polyethylene bags for growing oil palm seedlings were more effective than plastic vials so far, the shoot dry weight is concerned. The varietal effect suggested that shoot dry weight was greater (4.89 g) in variety Yangambi PB 14 than shoot dry weight of variety 3way cross (4.24 g). This higher shoot dry weight of oil palm seedlings under peat moss in polyethylene bags for variety Yangambi PB 14 had direct association with higher values for plant height, stems diameter, leaves seedling^{-1}, chlorophyll, shoot and root fresh/dry weight and root dry weight.

Table 4. Biomass fresh and dry weight, root dry weight and shoot dry weight of oil palm seedlings raised in different growing media

Treatments	Biomass fresh weight (g)	Biomass dry weight(g)	Root dry weight (g)	Shoot dry weight (g)
Growing media and containers				
M_1=Peat moss in plastic vials	18.95^{B}	7.15^{ab}	2.45^{AB}	4.70^{AB}
M_2=Peat moss in polyethylene bags	22.40^{A}	8.37^{a}	2.95^{A}	5.42^{A}
M_3=River sand in plastic vials	14.22^{D}	5.43^{c}	1.55^{C}	3.88^{B}
M_4=River sand in polyethylene bags	17.20^{C}	6.40^{bc}	2.13^{B}	4.27^{B}
LSD 0.05	1.6292	1.4170	0.5821	0.9930
Varieties				
V1=3way Cross	16.88^{B}	6.23^{B}	1.98^{B}	4.24^{B}
V2= Yangambi PB 14	19.5^{A}	7.46^{A}	2.57^{A}	4.89^{A}
LSD 0.05	0.8504	0.7397	0.3051	0.5204
Significance				
Treatments (T)	**	**	**	**
Varieties (V)	**	**	**	**
T × V	**	NS	NS	NS

*** = Significant at P=0.05 NS= Non-Significant ^{abc} Means followed by common letter are similar at 5% probability level*

Root: shoot ratio

The root: shoot ratio in oil palm seedlings was significantly affected by potting media and varieties (P<0.05); while their interactive effect (potting media × varieties) on root: shoot ratio was insignificant (P>0.05). The data indicated that potting media (peat moss) in polyethylene bags resulted in highest root: shoot ratio (0.54), followed by peat moss in plastic vials (0.52) and river sand in polyethylene bags (0.50); while the least root: shoot ratio (0.40) was recorded in oil palm grown in river sand filled in plastic vials. In case of varieties, the root: shoot ratio was higher (0.52) in variety Yangambi PB 14 as compared to variety 3way cross (0.46). The greater root: shoot ratio in oil palm seedlings had main association with all the traits mentioned earlier in this experiment.

Leaf N content

Leaf N content in oil palm was significantly affected by potting media and varieties ($P<0.05$); while their interactive effect on leaf N content was insignificant ($P>0.05$). Leaf N content was significantly ($P<0.05$) higher in seedlings raised in peat moss in polyethylene bags (2.35 %), followed by peat moss in plastic vials and river sand in polyethylene bags with average leaf N content of 1.75% and 1.55 %, respectively. The least leaf N content (1.25 %) was recorded in oil palm seedlings grown in plastic vials using river sand. In varieties, the leaf N content was higher (1.80 %) in Yangambi PB 14 than variety 3way cross (1.65 %). Such greater leaf N concentration in oil palm seedlings under peat moss in polyethylene bags and variety Yangambi PB 14 had a linear association with all the traits studied.

Leaf P content

The leaf P content in oil palm at pre-nursery stage was significantly influenced by potting media and varieties ($P<0.05$); while the interaction comprised of potting media × varieties showed insignificant effect on leaf P content ($P>0.05$). The leaf P was significantly higher ($P<0.05$) in seedlings raised in peat moss in polyethylene bags (0.056 %), followed by peat moss in plastic vials(0.042 %) and river sand in polyethylene bags (0.039 %); while the least leaf P content (0.039 %) was determined in seedlings grown in plastic vials using river sand. This indicates that peat moss as potting media was markedly effective than that of river sand; while potting media filled in polyethylene bags proved to be more efficient to produce seedlings with higher leaf P content as compared to potting media filled in plastic vials. The leaf P content was higher (0.047 %) in variety Yangambi PB 14; and it was least (0.040 %) in variety 3way cross.

3.4 Leaf K content

The leaf K content in oil palm seedlings was significantly influenced by potting media and varieties ($P<0.05$); while the interaction comprised of potting media × varieties showed insignificant effect on leaf K content ($P>0.05$). Leaf K was significantly higher ($P<0.05$) in seedlings raised in peat moss in polyethylene bags (0.96%), followed by peat moss in plastic vials(0.82%) and river sand in polyethylene bags (0.81%); while the least leaf K content (0.77%) was found in seedlings grown in river sand potted in plastic vials. The leaf K was higher (0.87 %) in variety Yangambi PB 14 than the leaf K content in variety 3way cross (0.80 %). Similar trend of treatments effectiveness was noticed for leaf K content and other traits in this experiment considering superiority of peat moss in polyethylene bags and variety Yangambi PB 14 over river sand in plastic vials and variety 3way cross.

Table 5. Root: shoot ratio and leaf nutrient concentrations of oil palm seedlings raised in different growing media

Treatments	Root: shoot ratio	Leaf N content (%)	Leaf P content (%)	Leaf K content (%)
Growing media and containers				
M_1=Peat moss in plastic vials	0.52^{A}	1.75^{B}	0.042^{B}	0.82^{B}
M_2=Peat moss in polyethylene bags	0.54^{A}	2.35^{A}	0.056^{A}	0.96^{A}
M_3=River sand in plastic vials	0.40^{B}	1.25^{C}	0.035^{C}	0.77^{C}
M_4=River sand in polyethylene bags	0.50^{AB}	1.55^{B}	0.039^{BC}	0.81^{BC}
LSD 0.05	0.1132	0.2185	4.252	0.0429
Varieties				
V1=3way Cross	0.46^{B}	1.65^{B}	0.040^{B}	0.80^{B}
V2= Yangambi PB 14	0.52^{A}	1.80^{A}	0.047^{A}	0.87^{A}
LSD 0.05	0.0593	0.1145	2.229	0.0225
Significance				
Treatments (T)	**	**	**	**
Varieties (V)	*	**	**	**
T × V	NS	NS	NS	NS

*** = Significant at P=0.05 NS= Non-Significant ^{abc} Means followed by common letter are similar at 5% probability level.*

N-uptake (kg plant^{-1})

The N-uptake of oil palm seedlings at pre-nursery stage was significantly affected by potting media, varieties and potting media × varieties interaction (P<0.05). The oil palm seedlings raised in peat moss potted in polyethylene bags had maximum N-uptake efficiency (0.198 g), followed by peat moss in plastic vials and river sand in polyethylene bags, where the N-uptake efficiency was 0.123 g and 0.100 g seedling^{-1}, respectively. However, the lowest N-uptake (0.068 g seedling^{-1}) was determined when river sand as potting media was used in plastic vials. The variety Yangambi PB 14 recorded greater N-uptake (0.141 kg seedling^{-1}) than its companion variety 3way cross (0.104 kg seedling^{-1}).

P-uptake (g plant^{-1})

The analysis of variance described that P-uptake of oil palm seedlings at pre-nursery stage was significantly influenced by potting media, varieties as well as the interaction of potting media × varieties ($P<0.05$). The peat moss using polyethylene bags maximized their P-uptake efficiency (0.0047 g), followed by peat moss in plastic vials and river sand in polyethylene bags, where the P-uptake efficiency was 0.0029 g and 0.0025 g seedling^{-1}, respectively; whereas, the least P-uptake efficiency (0.0019 g seedling^{-1}) was analyzed when river sand as potting media was used in plastic vials. The P-uptake efficiency of variety Yangambi PB 14 was greater (0.0035 g seedling^{-1}) than its counterpart 3way cross (0.0025 g seedling^{-1}). The P-uptake efficiency showed a straight link with the traits representing the seedling growth, nutrient concentration and N-uptake efficiency mentioned earlier.

K-uptake (g plant^{-1})

ANOVA demonstrated that K-uptake efficiency of oil palm seedlings at pre-nursery stage was significantly affected by potting media and varieties ($P<0.05$); while their interactive effect on K-uptake was insignificant ($P>0.05$). The peat moss potted in polyethylene bags maximized K-uptake efficiency of oil palm seedlings (0.079 g), followed by peat moss potted plastic vials and river sand in polyethylene bags resulting seedling K-uptake efficiency of 0.059 g and 0.052 g seedling^{-1}, respectively; while, the minimum K-uptake efficiency (0.042 g) was determined in seedlings raised under river sand in plastic vials. In varieties, the K-uptake of seedlings of variety Yangambi PB 14 was higher (0.065 g) as compared to variety 3way cross (0.050 g seedling^{-1}). Moreover, variety Yangambi PB 14 showed its quality as compared to variety 3way cross for K-uptake.

Table 6. Nutrients uptake of oil palm seedlings raised in different growing media

Treatments	N-uptake (g plant^{-1})	P-uptake (g plant^{-1})	K-uptake (g plant^{-1})
Growing media and containers			
M_1=Peat moss in plastic vials	0.123^{B}	0.0029^{B}	0.059^{B}
M_2=Peat moss in polyethylene bags	0.198^{A}	0.0047^{A}	0.079^{A}
M_3=River sand in plastic vials	0.068^{D}	0.0019^{D}	0.042^{C}
M_4=River sand in polyethylene bags	0.100^{C}	0.0025^{C}	0.052^{BC}
LSD 0.05	0.0401	0.0494	0.0164
Varieties			
V1=3way Cross	0.104^{B}	0.0025^{B}	0.050^{B}
V2= Yangambi PB 14	0.141^{A}	0.0035^{A}	0.065^{A}
LSD 0.05	0.0210	0.0258	0.0086
Significance			
Treatments (T)	**	**	**
Varieties (V)	**	**	**
T × V	*	*	NS

*** = Significant at P=0.05 NS= Non-Significant ^{abc} Means followed by common letter are similar at 5% probability level.*

DISCUSSION

The study results showed that at pre-nursery stage potting media and container had significant (P<0.05) influence on growth and development of the seedlings; plant fresh and dry weights, plant nutrient contents, and nutrient uptakes of oil palm seedlings varied under different management practices. Peat moss, a fibrous material, forms in peat bogs passes through varied natural decomposition processes was highly effective when potted in polyethylene bags as compared to river sand to develop oil palm at pre-nursery stage. The research findings indicated that the treatment comprised of peat moss in polyethylene bags maximized plant height (36.83 cm), stem diameter (6.9167 cm), leaves number (4.0 seedling^{-1}), chlorophyll (64.0%), leaf N, P, K (2.35, 0.056, 0.96%), and plant N, P, K uptakes (0.198, 0.0047, 0.079 kg seedling^{-1}), respectively (P<0.05). Noordiana et al. (2007) reported that the growth medium for oil palm has an important role in the production of healthy seedlings. In another study, the researchers argued that oil palms develop slowly, particularly during their early phases, resulting in plant death or long-term, irreversible damage to the roots and stems. Hence the world is turning to alternative growth medium as a solution to soil concerns since it has the potential to boost the total yield of the plant in many cases (Paranjpe *et al*., 2003).

A soilless growing medium such as peat moss, vermiculite, or perlite may thus be a feasible alternative for young plants in this situation (Van and Postma, 2000). The root dry weight of seedlings in this medium was found to have a significant impact on their growth. Herviyanti *et al*. (2021) reported that growing medium in palm oil seedlings significantly influenced stem diameter, and nutrient concentrations (N, P, and K) in the total biomass of the plant. However, the pre-nursery potting media may have adequate nutrients during vegetative growth, the photosynthetic process will be active, allowing cell division, elongation, and differentiation to occur smoothly (Mahmud and Chong, 2022).

The study further showed that oil palm variety Yangambi PB 14 responded more positively to potting media as compared to companion variety for all the growth, plant nutrient and uptakes. Polyethylene bags as containers of pre-nursery seedlings were more effective than plastic vials regardless of the potting media; as polyethylene bags filled either with peat moss or with river sand showed superiority over plastic vials. Thus, variety Yangambi PB 14 should be the preference of growers when adopted for development of oil palm orchards. However, initially, better to use peat moss as media in polyethylene rather to use any other media, because peat moss produced healthy seedlings with high chlorophyll content and high foliage over other potting media and container type.

CONCLUSIONS

Peat moss was highly effective when potted in polyethylene bags as compared to river sand to develop oil palm at the pre-nursery stage. Variety Yangambi PB 14 responded more positively to potting media as compared to variety 3way cross for all the seedling growth, plant nutrient contents and nutrient uptakes It is recommended that the variety Yangambi PB 14 should be raised in polyethylene bags filled with peat moss at the pre-nursery stage in the coastal area of Sindh, Pakistan.

REFERENCES

Adekunle SM. (2014). Influence of fertilizer rates on growth of selected immature rubber (*Hevea brasiliensis* Muell.) clones grown on two soil series. M.Sc. Thesis. UPM, Malaysia.

Agbo, C.U, Omaliko, C.M (2006) Initiation and growth of shoots of *Gorgoneia latifolia* Benth stem cuttings in different rooting media. Africa Journal of Biotechnology (5), 425-428.

Ayoola and Adeyeye (2010). Evaluation of *Carica papaya* (Pawpaw) leaves, International Journal of Pharmacy and Pharmaceutical sciences (4), 27-33.

Baiyeri, K.P., and Mbah, B.N. (2006): Effects of soilless and soil-based Nursery media on seedling Emergency, Growth and Response to Water stress of African breadfruit (*Treculia cfricana* decne). African Journal Biotechnology 5:1400-1405.

Bremner, J. M. (1996) Nitrogen-total, 1st ed. Sparks D.L, Bartels J.M and Bigham J.M Madison: Wiscosin., 1996, ch. 3, p. 1085-1121.

Dawn, (2020). Edible oils need attention. Daily Dawn Newspaper, 10th February. https://www.dawn.com/news/1533443.

Donough, C.R., C. Witt, and T.H. Fairhurst. (2010). In Proceedings of the International Oil Palm Conference held in Jogjakarta from 1-3 June, 2010. IOPRI, Jogjakarta, Indonesia.

Gajalakshmis (2012). Phytochemical and pharmacological properties of (*Annona muricata* L.). International Journal of Pharmacy and Pharmaceutical Science (4): 3-6.

GOP, Economic Survey of Pakistan. (2021). Area production and yield of cotton in Pakistan. Pakistan Economic Survey (2020-2021), Food & Agriculture Ministry, Govt. of Pakistan, Islamabad.

GOP, Economic Survey of Pakistan. (2022). Government of Pakistan, Ministry of Food, Agriculture and Livestock, Agriculture & Livestock Division (Economic Wing), Islamabad.

FAO (2000). Proceedings of the 2000 National Seminar on Palm Oil Milling, Refining Technology, Quality and Environment, Lembaga Minyak Sawit Malaysia.

Herviyanti, H., Maulana, A., Prasetyo, T. B., Darfis, I., Hakim, L., & Ryswaldi, R. (2021). Activation of sub-bituminous coal with dolomite to improve chemical properties and palm oil growth on ultisols. In IOP Conference Series: Earth and Environmental Science,741(1), p. 012032). IOP Publishing.

Kenneth, R., Muhammad, A., Cheema, S., Atiqur, R.C. & Rahman Khan (2020) Bioelectricity in Malaysia: economic feasibility, environmental and deforestation implications. The Australian Journal of Agricultural and Resource Economics, 64 (2), 294-321.

Khan, M. M., Khan, M. A., Abbas, M., Jaskani, M. J., Ali, M. A. and Abbas, H.(2006). Evaluation of potting media for the production of rough lemon nursery stock." Pakistan Journal of Botany. 38(3): 623–629.

Mahmud, M. S., & Chong, K. P. (2022). Effects of liming on soil properties and its roles in increasing the productivity and profitability of the oil palm industry in Malaysia. Agriculture, 12(3), 322.

Mira Ariyanti, Intan Ratna Dewi, Yudithia Maxiselly, Yudha Arief. 2018. The growth of oil palm (*Elaeis Guineensis* jacq.) seedling with different plant media and watering interval. Indonesian Journal of Oil Palm Research. 26(1): 11-22.

Munawar, O. (2022). Oil palm: a crop of the future: Model farming. Published online https://www.pakissan.com/english/advisory/oil.palm.crop.of.the.future.html. (Accessed 22 July 2022).

Noordiana, N., Omar, S., Shamshuddin, J., Aziz, N. M., and Cocoa, M., 2007. Effect of organic-based and foliar fertilizers on cocoa (*Theobroma cacao* L.) grown on an Oxisol in Malaysia. Malaysian J. Soil Sci. 11, 29-43.

Pajak, K., Kormanek, M., Małek, S. and Banach. 2022. Effect of Peat-Perlite Substrate Compaction in Hiko V265 Trays on the Growth of *Fagus sylvatica* L. Seedlings. Sustainability, 14, 4585. https:// doi.org/10.3390/su14084585.

Paranjpe, A. V., Cantliffe, D. J., Lamb, E. M., Stoffella, P. J., and Powell, C.H.A.R.L. E. S. (2003). Proceedings from '116: Florida State Horticulture Society.

PODB (2021). Local oilseeds cultivation and production in the country during 2019-20. Prospects of Oilseed Crops in Pakistan (2nd Ed.), pp. 66.

Rowell, D. L. (1994). The preparations of saturation extracts and the analysis of soil salinity and sodicity. In soil science methods and applications. Ed. D.L. Rowell. Longman Group, UK.

Salisu, M. A., Daud, W. N., Halim, R. A., and Sulaiman, Z. (2016). Effect of soilless media on growth and some physiological traits of rubber (*Hevea brasiliensis*) seedlings. International J of Agriculture, Forestry and Plantation, 7 (9), 1373- 1378.

Salisu, M. A., Noordin, W. D., Sulaiman, Z., and Halim, R. A. (2017). Influence of soilless potting media on growth and vegetative traits of immature rubber (*Hevea brasiliensis* mull. Arg.). Bangladesh Journal of Botany, 46(1), 451-457.

Seman, R. N. A. R., Azam, M. A., & Ani, M. H. (2018). Graphene/transition metal dichalcogenides hybrid supercapacitor electrode: status, challenges, and perspectives. *Nanotechnology*, *29*(50), 1-4.

Sirait, A. B, Imelda Man A, Samosir O M, Marpaung R G, . N and Manalu C. 2020. Growth Palm Oil Seedling (*Elaeis guineensis* Jacq.) via NPK Fertilization and Different Frequency of Watering. J. Agron.20 1–8.

Van Os, E. A., & Postma, J. (2000). Prevention of root diseases in closed soilless growing systems by microbial optimization and slow sand filtration. In: International symposium on chemical and non-chemical soil and substrate. Acta horticulturae. 532-*10*, 97-102.