The Pharma Innovation Journal 2023; 12(12): 4264-4269

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
TPI 2023; 12(12): 4264-4269

www.thepharmajournal.com
Received: 24-10-2023
Accepted: 28-11-2023

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Effect of different growing media on germination and seedling growth of walnut (*Juglans regia* L.)

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Abstract
This study was carried out to explore the effect of growing media on seed germination and seedling growth of walnut (*Juglans regia* L.). The research was conducted at research block of fruit plant nursery, Poonch, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, J&K, India during the year 2022-23. The treatment combination of different growing media were T_1: sandy soil 100%; T_2: Sandy soil with 1 cm cocopeat; T_3: Sandy soil with 2 cm cocopeat; T_4: FYM+ sandy soil (1:1) without cocopeat; T_5: FYM+ sandy soil (1:1) with 1 cm cocopeat; T_6: FYM+ sandy soil (1:1) with 2 cm cocopeat; T_7: Vermicompost + sandy soil (1:1) without cocopeat; T_8: Vermicompost + sandy soil (1:1) with 1 cm cocopeat and T_9: Vermicompost + sandy soil (1:1) with 2 cm cocopeat. The results showed that the medium of vermicompost +sandy soil (1:1) with 2 cm cocopeat in top of the poly bags recorded minimum days taken for germination (25.15) and maximum germination percentage (81.40). The medium was also found to be the best medium for the growth of walnut seedlings as it gave the highest parameters in terms of seedling height (13.12 cm, 60 DAS), (27.63 cm, 90 DAS), (40.20 cm, 120 DAS), (51.55 cm, 150 DAS) and (62.25 cm, 180 DAS); shoot diameter (8.82 mm), number of leaves (7.22), leaf area (321.12 cm^2), survival percentage (93.16), mortality rate(6.84), fresh shoot weight (10.15 g), dry shoot weight (3.71 g), length of tap root (20.13 cm), fresh weight of root (15.22 g) and dry weight of root (6.65 g).

Keywords: Walnut, growing media, seed germination, seedling growth

Introduction
Walnut (*Juglans regia* L.), king of nut crop belongs to family Juglandaceae, is standout cultivation in Jammu and Kashmir, India and has increased logarithmically during recent decades. Favourable soil media and macro, micronutrients are the utmost important factors that aid the growth and yield of walnut. Since walnut is propagated through asexual propagation. However the suitable rootstocks ready for propagation takes 2-3 years to attain the desirable thickness (George, 1995) [17]. The quality rootstock are very important for success of budding of various methods of vegetative propagation, patch budding, shield budding, grafting, top working are the methods of walnut propagation (Singh *et al.*, 2020) [35]. As the walnut plants are vegetatively propagated through asexually and each plant is made up of the rootstock which provides root system and the scion forming the tree canopy. Both of these parts play an equally vital role in the life of a tree. The rootstock has great influence on the vigour, longevity and productivity of the scion variety (Manthri and Bharad, 2017) [22]. Qualities of a good growing media includes, the medium should be firm enough to hold propagating material, it should have ability to retain and supply sufficient moisture, it should have sufficient nutrition for the growth of plant *etc*. Supplementing of the sand is aimed to make media more porous while the organic matter (FYM, sheep manure, neemcake and vermicompost) is added so as to enrich adequate nutrient for the seedling (Barela *et al.*, 2019) [7]. Moreover, the use of suitable growing media or substrates for sowing seeds directly affects the germination, development, and functional rooting system (Meena *et al.*, 2017) [23]. A good growing media provides adequate anchors or support to the plant, a reservoir for nutrients and water allows the release of oxygen to the roots and gas exchange between the roots and the atmosphere outside the roots substrate (Abad *et al.*, 2002) [1]. The growing medium vermicompost+ pond soil+ sand (1:1:1) with 2 cm cocopeat was considered the best media as the germination, seedling growth and development parameters of papaya seedlings were higher as compared to other media (Bhardwaj, 2012) [10]. (Gebregiorgs *et al.*, 2021) [16] reported that the mango seed germination,

seedling growth and establishment with soil potting media combinations of top soil: FYM: sand in the ratio of 3:2:1 for improving productivity and food security. The quality of seedlings is greatly affected by the growth media under nursery (Agbo and Omaliko, 2006) [3]. The quality of the seedlings obtained from a nursery affects the re-establishment in the field and the final productivity of the orchard (Baiyeri and Mbah, 2006) [6]. Soil, peat moss, and vermiculite are generally used as a basic medium for sowing seeds in nurseries because it is cheap and easy to procure supplementing the soil to make media more porous and adequate source to the nutrients for the seedlings.

Cocopeat a byproduct of cutting and shifting of coconuts for fiber production. It is becoming very popular propagating and growing medium because it has an excellent pore space (25-30 percent) and fine structure required for proper growth and development of seedlings. It is a rich source of nutrients and can easily be mixed with other growing media. Cocopeat is considered as a growing medium component with acceptable pH, EC and other chemical attributes (Abad *et al.*, 2002) [1]. Cocopeat has good physical properties, high total pore space, high water content, low shrinkage, low bulk density and slow biodegradation (Evans *et al.*, 1996; Prasad, 1997) [15, 29]. Vermicompost represents a very suitable medium for plant growth showing improved growth for many plant species (Ebrahimi *et al.*, 2021) [14]. (Parkhe *et al.*, 2018) [28]. Vermicompost probably contributed to the increased seed germination and growth. It maintains the soil in a proper homeostatic state. It also removes excessive amounts of heavy metals such as copper and lead and there by served as a means of detoxification (Saranraj *et al.*, 2012) [33]. Vermicompost could promote early and vigorous growth of seedlings. It has been found to effectively enhance the root formation, elongation of stem and production of bio- mass (Abirami *et al.*, 2010) [2]. The objective of this study was to test the different growing media combinations to produce seedling rootstocks at an early stage for production of elite planting material of improved walnut varieties.

Materials and Methods

Experimental site

The experiment was conducted in open field conditions over a period of two years (2022-2023) at the Fruit Plant Research Station Poonch, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Jammu & Kashmir, (India). The experimental site is located in the highlands of the Southern Himalayas of Pir-Panchal region of Jammu & Kashmir state, with the latitude and the longitude of 33.766987, & 74.092468. The soil reaction of the steady area was slightly acidic (pH value: 6.65) with a sandy loam texture. High summer and low winter temperatures are characteristic and the mean annual cloudiness is about 8 (octa). Pir-Panchal region has a continental rainfall regime 1200-1400 mm with 56-73 average rainy days and the vegetation period is characterized by dry and rainy periods of different durations and intensity, with more rain in May-July, and then slightly less in August. In the warm part of the year, there is plenty of summer rain, and occasionally hail, but the snow cover in winter is not thick, and often in winter there is no snow.

Experimental details

The experiment was performed in a completely randomized block design with a factorial combination of treatments and with three repetitions of each treatment combination. Walnut seeds obtained from local walnut growers in Poonch district of Jammu & Kashmir, North India were sown in different growing media. The growing media treatment combinations used were T_1: sandy soil 100%; T_2: Sandy soil with 1 cm cocopeat; T_3: Sandy soil with 2 cm cocopeat; T_4: FYM+ sandy soil (1:1) without cocopeat; T_5: FYM+ sandy soil (1:1) with 1 cm cocopeat; T_6: FYM+ sandy soil (1:1) with 2 cm cocopeat; T_7: Vermicompost + sandy soil (1:1) without cocopeat; T_8: Vermicompost + sandy soil (1:1) with 1 cm cocopeat and T_9: Vermicompost + sandy soil (1:1) with 2 cm cocopeat. Each growth medium was represented by 50 polythene bags per replicate. One seed was sown per bag after disinfected by a fungicide and irrigation on intervals basis. In addition to this, all other cultural practices were completed according to the requirements of nursery. Days taken for germination was measured after the seed sowing, seed germination percentage of walnut was measured as number of seeds that produced a seedling from each seeds group and expressed as percentage. Stem length was measured 60, 80, 90, 150 and 180 days after sowing, number of leaves/seedling, leaf area, stem diameter of 5 cm above the soil surface, root length, stem fresh weight, stem dry weight, root fresh weight, and root dry weight were measured for all plants. Data recorded in the experiment was statistically analyzed using Duncan's multiple range tests.

Germination percentage (%)

Germination percent was recorded by counting the germinated seeds till germination process completed (up to 60 days of sowing) and germination percent was calculated by using the following formula.

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \text{ x } 100$$

Survival percentage (%)

Survival percent was recorded by counting the survived plant after germinated (after 30 days or up to 45 days of sowing) and survival percent was calculated by using the following formula

$$\text{Survival (\%)} = \frac{\text{Number of survived plants}}{\text{Total number of germinated seeds}} \text{ x } 100$$

Results

Days taken for seed germination and percentage.

Days taken for germination and germination percentage were significantly affected by the different growing medium combinations (Table 1). The minimum days (25.15) taken for germination were recorded in treatment vermicompost + sandy soil (1:1) with 2 cm cocopeat and the maximum days (43.15) were recorded under the treatment Sandy soil (100%). Whereas, maximum germination (81.40%) of walnut seeds were observed under the treatment vermicompost + sandy soil (1:1) with 2 cm cocopeat. However, the minimum germination (62.20%) was recorded under the treatment Sandy soil (100%). The minimum days taken and maximum germination percentage might be due to good water holding capacity and moisture supply as well as sufficient porosity which permit adequate moisture, soil temperature and gaseous exchange between media and seeds. Another reason that

media containing organic manures possess organic acid within them. Therefore, more available moisture and some acids may have helped in minimum days to germination and better germination percentage.These results are in conformity with (Sajana *et al.*, 2018), who reported that the growing media of vermicompost + sand + pond soil with 2 cm cocopeat results highest germination percentage and early germination of marking nut. Similar findings were reported by (Parasana *et al.*, 2013) [27] where a combination of Soil: FYM: Sand (2:1:1), resulted in early days to germination in mango. Similar results were also obtained by (Arvind *et al.*, 2015; Nagar *et al.*, 2016) [5, 26] in papaya.

Tables 1: Effect of different growing media on days taken for germination and germination percentage of walnut seedlings

Treatments	Days taken for germination	Germination%
Sandy soil (100%)	43.15^{d}	65.20^{d}
Sandy soil with 1 cm cocopeat	38.30^{c}	70.40^{c}
Sandy soil with 2 cm cocopeat	34.41^{b}	74.50^{b}
FYM+ sandy soil (1:1)without cocopeat	39.15^{c}	71.35^{c}
FYM+ sandy soil (1:1) with 1 cm cocopeat	35.13^{b}	75.45^{b}
FYM+ sandy soil (1:1) with 2 cm cocopeat	29.52^{c}	77.50^{b}
Vermicompost + sandy soil(1:1) without cocopeat	34.45^{b}	73.30^{c}
Vermicompost + sandy soil (1:1) with 1 cm cocopeat	30.22^{b}	78.25^{b}
Vermicompost + sandy soil (1:1) with 2 cm cocopeat	25.15^{a}	81.40^{a}

Seedling stem length

Data revealed in table 2 showed that the seedling stem length was significantly influenced by different growing media. The maximum of seedling stem length 13.12 cm, 27.63 cm, 40.20 cm, 51.55 cm and 62.25 cm at 60 DAS, 90 DAS, 120 DAS, 150 DAS and 150 DAS, respectively was recorded in treatment vermicompost + sandy soil (1:1) with 2 cm cocopeat (Table 2). The lowest stem seedling length 5.35, 11.25 cm, 20.21 cm, 28.33 cm and 32.15 cm at 60 DAS, 90 DAS, 120 DAS, 150 DAS and 150 DAS, respectively was recorded in treatment sandy soil (100%). The increase in seedling stem length might be due to cocopeat and vermicompost provides adequate nutrients and enhances both the physical and biological properties and the water holding capacity of soil (Soegiman, 1982) [36]. A similar result was also reported by (Bhardwaj, 2014). These results are in conformity with (Sahni *et al.*, 2008) [31], who reported that the combined application of vermicompost and cocopeat showed significant effect on seedling growth parameters and plant biomass probably due to the synergistic combinations of these factors improving the physical conditions of the media and nutritional factors.

Tables 2: Effect of growing media at different days after sowing on seedling height (cm) of walnut

Treatments	Seedling stem length (cm)				
	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
Sandy soil (100%)	5.35^{e}	11.25^{e}	20.21^{e}	28.33^{e}	32.15^{e}
Sandy soil with 1 cm cocopeat	8.68^{d}	18.33^{d}	31.54^{d}	41.86^{d}	50.20^{d}
Sandy soil with 2 cm cocopeat	10.13^{c}	20.52^{c}	35.25^{c}	45.23^{c}	55.10^{c}
FYM+ sandy soil (1:1)without cocopeat	9.05^{d}	19.33^{d}	30.33^{d}	41.25^{d}	46.72^{d}
FYM+ sandy soil (1:1) with 1 cm cocopeat	10.45^{c}	21.22^{c}	33.40^{c}	44.23^{c}	52.25^{c}
FYM+ sandy soil (1:1) with 2 cm cocopeat	12.22^{b}	23.15^{b}	37.56^{b}	47.63^{b}	58.13^{b}
Vermicompost + sandy soil(1:1) without cocopeat	11.10^{c}	22.42^{c}	32.66^{c}	43.35^{c}	51.12^{c}
Vermicompost + sandy soil (1:1) with 1 cm cocopeat	12.14^{b}	24.55^{b}	35.21^{b}	46.41^{b}	56.20^{b}
Vermicompost + sandy soil (1:1) with 2 cm cocopeat	13.12^{a}	27.63^{a}	40.20^{a}	51.55^{a}	62.25^{a}

Stem diameter

Stem diameter was significantly affected by different growing media. The greater stem diameter (8.82 mm) was recorded under treatment Vermicompost + sandy soil (1:1) with 2 cm cocopeat (Table 3). The lowest stem diameter (4.25 mm) was recorded in the treatment sandy soil only. Increase in stem diameter may be due to better nutrient availability leading to higher production of photosynthetically functional leaves in these treatments finally resulting in better girth of seedling (Borah *et al.*, 2008) [11]. Similar results were also obtained by (Gebregiorgs *et al.*, 2021; Parasana *et al.*, 2014) [16] in mango and (Meena *et al.*, 2017) [23] in papaya.

Number of leaves

The higher number of leaves/seedling (7.22) was noted with the treatment vermicompost + sandy soil (1:1) with 2 cm cocopeat and the least number of leaves/ seedling (3.25) was found on 100% sandy soil (Table 3). It might be due to better nutrient availability leading to higher production of photo synthetically functional leaves due to growing media (Borah *et al.*, 2008) [11]. Similar results were reported by (Anjanawe *et al.* 2013) in papaya and (Parasana *et al.* 2014) in mango. Another reason might be that adequate amount of farmyard manure added to the soil with vermicompost, which improved efficiency of nutrient status of the soil (Subbiah, 1990) [37]. Similar observations on number of leaves were observed by Devachandra *et al.*, (2008) [12] in jamun, Muralidhara *et al.* (2014) [25] in mango, (Mishra *et al.*, 2017) [24] in papaya and (Dipmala *et al.*, 2023) [13] in Aonla.

Leaf area

A perusal of data given in table 3 revealed that leaf area was also significantly influenced by use of different growing media. The highest leaf area (321.12 cm^{2}) was observed under treatment vermicompost + sandy soil (1:1) with 2 cm cocopeat (Table 3). The lowest leaf area (232.14 cm^{2}) was recorded with the treatment 100% sandy soil. it might be due to adequate nutrients and enhances both the physical and the

water holding capacity. Similar result was also reported by (Supriyanto *et al.*, 1990) [38] in orange and Dipmala *et al.*, 2023) [13] in Aonla.

Survival and mortality percentage

Data given in table 3 revealed that the survival and mortality percentage of walnut seedling was significantly influenced by different growing media. The maximum survival percentage (93.16) and minimum mortality rate (6.86%) was recorded with the treatment combination vermicompost + sandy soil (1:1) with 2 cm cocopeat. The lowest survival (62.12%) and highest mortality (37.88%) was recorded with the treatment 100% sandy soil. It might be due to good physical and nutritional conditions in cocopeat and vermicompost had positive effect on root development and physiological activities, which is helpful in increased survival percentage and decrease mortality rate of walnut seedling. These findings are supported by (Shamet *et al.*; 1994) [34] in Chilgoza pine, (Prasana *et al.* 2014) in mango, Hota *et al.*; 2018 [19] in jamun and Dipmala *et al.*; 2023 [13] in Aonla

Tables 3: Effect of growing media on growth, survival and mortality percentage of walnut seedling

Treatments	Stem dia.(mm)	No of leaves	Leaf area (cm^2)	Survival (%)	Mortality (%)
Sandy soil (100%)	4.25^{e}	3.25^{e}	232.14^{d}	62.12^{d}	37.88^{a}
Sandy soil with 1 cm cocopeat	5.33^{d}	4.87^{d}	270.13^{c}	71.62^{c}	28.38^{a}
Sandy soil with 2 cm cocopeat	6.14^{c}	5.32^{c}	292.20^{b}	75.33^{c}	24.67^{b}
FYM+ sandy soil (1:1)without cocopeat	6.54^{c}	5.10^{c}	272.36^{c}	82.63^{b}	17.37^{c}
FYM+ sandy soil (1:1) with 1 cm cocopeat	7.13^{b}	5.99^{c}	290.71^{b}	86.60^{b}	13.14^{d}
FYM+ sandy soil (1:1) with 2 cm cocopeat	7.54^{b}	6.75^{b}	301.23^{b}	89.85^{b}	10.15^{d}
Vermicompost + sandy soil(1:1) without cocopeat	7.10^{b}	5.72^{c}	281.40^{c}	85.46^{b}	14.54^{dc}
Vermicompost + sandy soil (1:1) with 1 cm cocopeat	8.23^{a}	6.33^{b}	295.33^{b}	88.18^{b}	11.82^{d}
Vermicompost + sandy soil (1:1) with 2 cm cocopeat	8.82^{a}	7.22^{a}	321.12^{a}	93.16^{a}	6.84^{e}

Stem fresh and dry weight

Results in Table 4 indicated that stem fresh and dry weight of walnut seedlings influenced significantly as a result of different growing media. The maximum stem fresh and dry weight was recorded with vermicompost + sandy soil (1:1) with 2 cm cocopeat (10.15 and 3.71 gm). However, the minimum stem fresh and dry weight (5.12 and 1.43 gm) were noted when seeds were sown in sandy soil 100%, respectively. It might be due to improved soil fertility, thereby rendering more availability of nutrients required for plant growth and development (Vasantha *et al.*, 2014) [39]. The findings are supported by Ratan and Reddy (2004) [30] in annona, (Hota *et al.* 2018) [19] in jamun and Dipmala *et al.*, 2023 [13] in aonla.

Root parameters

Perusal of data presented in Table 4 indicated that the tap root length, fresh and dry weight of roots was significantly affected by different growing media. The highest tap root length (20.13 cm), fresh weight of roots (15.22 g) and dry weight of roots (6.65 g) was recorded with the treatment combination vermicompost + sandy soil (1:1) with 2 cm cocopeat. While, minimum tap root length (11.32 cm), fresh weight of root (7.05 g) and dry weight of root (2.25 g) was observed in sandy soil 100%. This might be due to favourable medium for better growth of the seedling, particularly for good development of root system. These results are in close agreement with (Abirami *et al.*, 2010) [2] in Nutmeg, (Mishra *et al.* 2017) [24] in papaya, (Lepakshi and Reddy, 2021) [21] in Jamun and (Dipmala *et al.*, 2023) [13] in Aonla.

Tables 4: Effect of growing media on shoot and root characteristics of walnut seedling

Treatments	Fresh stem wt (g)	Dry stem wt (g)	Length of tap root (cm)	Fresh wt of root (g)	Dry wt of root (g)
Sandy soil (100%)	5.12^{f}	1.43^{e}	11.32^{f}	7.05^{f}	2.25^{e}
Sandy soil with 1 cm cocopeat	6.23^{e}	1.82^{d}	14.45^{e}	8.46^{e}	2.76^{e}
Sandy soil with 2 cm cocopeat	6.85^{e}	1.95^{d}	16.66^{dc}	9.11^{e}	3.10^{d}
FYM+ sandy soil (1:1)without cocopeat	7.30^{d}	2.01^{c}	17.14^{c}	10.45^{d}	4.02^{c}
FYM+ sandy soil (1:1) with 1 cm cocopeat	7.86^{d}	2.25^{cb}	18.16^{c}	11.42^{d}	4.45^{c}
FYM+ sandy soil (1:1) with 2 cm cocopeat	8.02^{c}	2.48^{b}	19.42^{b}	13.25^{c}	5.16^{b}
Vermicompost + sandy soil(1:1) without cocopeat	8.25^{c}	2.55^{b}	18.33^{cb}	13.41^{c}	5.43^{b}
Vermicompost + sandy soil (1:1) with 1 cm cocopeat	9.10^{b}	2.68^{b}	19.10^{b}	14.25^{b}	6.12^{a}
Vermicompost + sandy soil (1:1) with 2 cm cocopeat	10.15^{a}	3.71^{a}	20.13^{a}	15.22^{a}	6.65^{a}

Conclusion

Walnut is a potential high value nut crop contributing greatly to the improvement of nutritional and health of the Indian society. In the study area, the nut crop is contributing significantly to the livelihoods and food security of the walnut growers. Despite its potential for food and nutrition security, its productivity is very low. Walnut rootstock is an important component for production of elite planting material of improved walnut varieties. However, the suitable growing media for early root stock generation play a great role in improving its productivity. Generation of early stage walnut rootstocks suitable for production of quality planting material under growing media combination vermicompost + sandy soil (1:1) with 2 cm cocopeat gave better walnut seed germination and seedling growth in the study area. Accordingly, the treatment is recommended for improving productivity of walnut in the study area.

References

1. Abad M, Noguere P, Puchades R, Maquieira A, Noguera V. Physio-chemical and chemical properties of some coconut dusts for use as a peat substitute for containerized ornamental plants. Bioresource Technology. 2002; 82:241-245.

2. 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 Plants Research. 2010;4:2054-2058.
3. Agbo CV, Omaliko, CM. Initiation and growth of shoots of Gongronema latifolia Benth stem cutting in different rooting media. African Journal Biotechnology. 2006;5:425-428.
4. Anjanawe SR, Kanpure RN, Kachouli BK, Mandloi DS. Effect of plant growth regulators and growth media on seed germination and growth vigour of Papaya. Annals Plant Soil Res. 2013;15(1):31-34.
5. Arvind K, Ritesh KM, Upadhyay NV. Effect of different growing media and containers on germination and establishments of seedlings of papaya (*Carica papaya* L.) cv. Madhubindu. Trends in Biosciences. 2015; 8(1):227-235.
6. Baiyeri KP, Mbah BN. Effects of soilless and soil-based nursery media on seedling emergence, growth and response to water stress of African Breadfruit (*Treculia africana* Decne). African Journal of Biotechnology. 2006;5(15):1405-1410.
7. Barela B, Kumar KM, Mandloi DS, Kumar A. Effect of different concentrations of organic manures with Azotobacter on seed germination and early seedling growth of *Moringa oleifera* L. J Pharmacogn Phytochem. 2019; 8(6):610-613.
8. Bhardwaj RL. Effect of growing media on seed germination and seedling growth of Papaya cv. 'Red lady'. Acad J. 2014;8(4):178-84.
9. 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.
10. Bhardwaj RL. Effect of growing media on seed germination and seedling growth of papaya (*Carica papaya*) cv. 'Red Lady. Journal of Applied Horticulture. 2012;14(2):118-123.
11. Borah AS, Nath A, Ray AK, Bhat R, Maheswarappa HP, Subramanian P, *et al*. Evaluation of potting mixture for raising arecanut seedling in polybags. Journal of Plantation Crops. 2008;36(2):137-139.
12. Devachandra N, Patil CP, Patil PB, Swamy GSK, Durgannavar MP. Screening of different arbuscular mycorrhizal fungi for raising jamun (*Syzygium cuminii*) rootstocks. Mycorrhiza News. 2008;20(3):5-7.
13. Vyas D, Priyamvada Sonkar RN, Kanpure PK, Nilesh Ninama, Suresh. Effect of Soil Propagation Media and Bio-fertilizers on Seedling Germination and Seedling Vigour in Aonla (*Emblica officinalis* Gaertn.). International Journal of Environment and Climate Change. 2023;13(10):3962-3973.
14. Ebrahimi M, Souri MK, Mousavi A, Sahebani N. Biochar and vermicompost improve growth and physiological traits of eggplant (*Solanum melongena* L.) under deficit irrigation. Chemical and Biological Technologies in Agriculture. 2021;8(1):1-14.
15. Evans MR, Konduru S, Stamps RH. Source variation in physical and chemical properties of coconut coir dust. Horticulture Science. 1996;3:965-967.
16. Gebregiorgs G, Negasi T, Berhan M. Germination and seedling growth response of mango (*Mangifera Indica* L.) cultivars to different nursery potting media. Agriculture and food security. 2021;10:62-63.
17. George R. McEachern. Evaluating pecan problems. Texas cooperative Extension, Texas A&M University, college station, TX-77842; c1995.
18. Hall T. Propagation of walnuts, almonds and pistachios in California. Comb Proc. Int. Plant Prop Soc. 1975;25:53-57.
19. Hota SN, Karna AK, DakhadBK, Jain PK. Influence of Growing media on Germination, growth and survival of jamun (*Syzygium cumini* L. Skeels). Bull. Env. Pharmacol. Life Sci. 2018;7(11):130-133.
20. Kaur S. Effect of growing media mixtures on seed germination and seedling growth of different mango (*Mangifera Indica* L.) cultivars under sub mountainous conditions of Punjab. Chem. Sci. Rev. Lett. 2017;6(23):1599-1603.
21. Lepakshi P, Reddy VK. Effect of different growing media on seed germination and seedling growth of jamun (*Syzygium cumunii* L). International Journal of Agricultural Sciences. 2021;17:138-141.
22. Manthri K, Bharad SG. Effect of pre sowing seed treatments on growth pattern of guava variety l-49. Intl J of Chem Studies. 2017;5(5):1735-1740.
23. Meena AK, Garhwal OP, Mahawar AK, Singh SP. Effect of Different Growing Media on Seedling Growth Parameters and Economics of Papaya (*Carica papaya* L) cv. Pusa Delicious. Int. J Curr. Microbiol. App Sci. 2017;6(6):2964-2972.
24. Mishra U, Bahadur V, Prasad VM, Verty P, Kumar Singh AK, Mishra S, *et al*. Influence of GA3 and Growing Media on Growth and Seedling Establishment of Papaya (*Carica papaya* L.) cv. Pusa Nanha. Int. J Curr. Microbiol. Appl. Sci. 2017;6(11):415-422.
25. Muralidhara BM, Reddy YTN, Venugopalan A, HJ, Shivprasad MK. Effect of VA Mycorrhiza on seedling growth and vigour of mango. BIOINFOLET. 2014;11(2 B):536-538.
26. Nagar SK, Vihol NJ, Arvind RK, Shashi. Effect of different growing media on germination and establishment of seedlings of papaya (*Carica papaya* L.) Cv. Madhubindu under net house conditions. International Quarterly Journal of Life Sciences. 2016;11(3):1465-1468.
27. Parasana JS, Leua HN, Ray NR. Effect of different growing Media mixture on the germination and seedling growth of mango (*Mangifera Indica* L) cultivars under net house conditions. Bioscan. 2013;8(3):897-900.
28. Parkhe S, Megha D, Ekta N, Sweta G. Study of different potting mixture on hardening of banana tissue culture plantlets: its field performance. Int. J Curr. Microbiol. App. Sci. 2018;(Special Issue-6):1941-1947.
29. Prasad M. Physical, chemical and biological properties of coir dust. Acta Horticulturae. 1997;450:21-29.
30. Ratan PB, Reddy YN. Influence of gibberellic acid in custard apple (*Annona squamosa* L.) seed germination and subsequent seedling growth. J Res ANGRAU. 2004;32(2):93-95.
31. Sahani S, Sharma BK, Singh DP, Singh HB, Singh KP. Vermicompost enhances performance of plant growth-promoting Rhizobacteria in Cicer arietinum rhizosphere against *Sclerocium rolfsii*. Crop Protection. 2008;27:369-376.

32. Sajana S, Munde GR, Shirsath AH. Effect of growing media on seed germination and seedling growth of marking nut (*Semecarpus anacardium*), Plant Archives. 2018;18:19-26.
33. Saranraj P, Stella D, Reetha D. Microbial cellulases and its applications: A review. Int. J Biochem Biotech Sci. 2012;1:1-12.
34. Shamet GS, Chauhan PS, Sood R. Nursery-studies on potting mixture, mulching and fertilizer requirements of chilgoza pine (*Pinus gerardiana* Wall.). Indian J Forestry. 1994;17(3):225-229.
35. Singh KK, Chauhan JS. A review on vegetative propagation of grape (*Vitis vinifera* l) through cutting. G.J.B.B. 2020;9(2):50-55.
36. Soegiman IT, Terjemahan D. The nature and properties of soils. Buckman and Brady. Bhatara Karya Aksara. Jakarta, 788 hal; c1982.
37. Subbiah K. Nitrogen and Azospirillum interaction on fruit yield and nitrogen use efficiency in tomato. S Ind Hortic. 1990;38:342-344.
38. Supriyanto A, Emawanto QD, Setiono dan. Hortic Res. Citrus Nursery Growing Media. 1990;5:1-8.
39. Vasantha PT, Vijendrakumar RC, Guruprasad TR, Mahadevamma M, Santhosh KV. Studies on effect of growth regulators and Biofertilizers on seed germination and seedling growth of Tamarind (*Tamarindus indica* L.). Plant Arch. 2014;14(1):155-160.