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Role of Substrate Media in Growth and Development of Selected Microgreens

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ABSTRACT: Microgreens have emerged as a new concept of health building and nutritious functional foods. The present study on ten microgreens varieties belonging to Brassicaceae family and leafy salads aimed to study the effect of media on the growth related traits of microgreens and detailed the interaction between media and genotypes impacting visual quality of microgreens. Germination percentage was checked to determine the growth pattern of microgreens, revealing that turnip and kale microgreens germinated fastest, with a more uniform plant stand and also had better morphological quality in comparison with lettuce and broccoli microgreens which had more seedling length and yield respectively. Pusa Swarnima (turnip) and local kale emerged as the best microgreens to be grown in the media containing mixture of cocopeat, vermiculite and perlite in the ratio of 3:1:1, which performed significantly better than the same microgreens grown in vermicompost media. To conclude, media played an imperative role in the growth and development of microgreens and any alterations to the substrate will significantly affect not only the morphological characters but also the nutritional composition of microgreens.

Keywords: micro-scale, growth, media; seedling, health, nutrition.

INTRODUCTION

Vegetables are vital dietary ingredients, and are important sources of carbohydrates, proteins, minerals, vitamins, dietary fibres and various bioactive compounds like antioxidants, making them effective protective foods (Sharma *et al*., 2021). Due to the buzzing lifestyle and hustled behavior of the 21st century, dietary supplements, which are imperative for combating certain deficiency diseases and chronic health problems, may be absorbed poorly, because of which people have started resorting to chemical derivatives rather than the natural sources of these supplements (Kader *et al.*, 2000). In this light, the idea of raising microgreens to meet all the dietary and nutritional requirements of the people and supplementing the already existing staple diet with this nutrient boost can be very well explored.

Microgreens are an innovative concept in the field of micro-scale horticulture (Elbert, 2012). These are emerging foods consisting of young edible vegetables and herbs, which are harvested when cotyledonary leaves have fully developed and the first true leaves have emerged, which is usually 7–21 days after germination (Allegretta *et al*., 2019). Microgreen production is on the rise among homemade food preparations and ready-to-eat market and the dietary supplements industry (Galieni *et al.*, 2020). Microgreens may contain 4-40 times the amount of nutritional compounds as the mature vegetable plant would produce. Microgreens are valuable nutritional supplement to human diet as they require very little space, growth-time and chemical inputs and offer a lucrative solution to health-conscious consumers. Microgreens are considered as "Functional foods" which means the food products that possess particular health promoting or disease preventing properties that are additional to their normal nutritional values (Janovska *et al.*, 2010).

Researchers have provided a lot of information and reviews on the nutritional traits of microgreens, because they are affected by different cultivars or landraces, plant growth stages and environmental conditions (Kyriacou *et al.*, 2016). All of these compositionally-positive aspects are coupled with a relatively easy production process, as they only need water, light, and a substrate to grow on (Marchioni *et al*., 2021). They can be grown in greenhouses, high tunnels, shade structures or indoors. Microgreens are generally grown in a standard, sterile, loose, soil, and many mixes have been used successfully with peat, vermiculite, perlite, and bark (Kou *et al.*, 2013). Microgreens have a short growing cycle and may be produced hydroponically or semi-hydroponically (Tamilselvi and Arumugam 2018). The present study aims to apprehend the relationship of various growth and developmental traits of microgreens with the media in which they grow.

MATERIALS AND METHODS

The present investigation was carried out in the Department of Seed Science and Technology as well as the Department of Vegetable Science and Floriculture, College of Agriculture, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur during March- April, 2021.

Technical programme of work. All the vegetable microgreens *viz*; kale, broccoli, lettuce and turnip were raised in trays (45cm × 35cm × 7.5cm) using mixture of cocopeat, vermiculte and perlite as the first growing media and vermicompost as the second growing media. Seeds were broadcasted at the rate of 10g seed/tray. Shallow sowing of the seeds was done and the trays were watered daily for maintaining the optimum moisture level in the substrates. The experiment was conducted in completely randomized design (CRD) and the effect of interaction of different media and varieties on various growth and developmental traits of microgreens were studied. Table 1 describes the the source of various crop varieties which were used during the course of research work.

Table 1: Source of experimental material.

Crop	Crop variety	Source
Broccoli	Palam Vichitra	CSKHPKV, Palampur, H.P.
	Palam Kanchan	CSKHPKV, Palampur, H.P.
	Palam Samridhi	CSKHPKV, Palampur, H.P.
Kale	Pusa Kale- 64	IARI Regional Station, Katrain, Kullu, H.P.
	Local kale	Local market of Srinagar, J&K
Lettuce	Chinese Yellow	IARI Regional Station, Katrain, Kullu, H.P.
	Great Lakes	IARI Regional Station, Katrain, Kullu, H.P.
Turnip	Pusa Swarnima	IARI Regional Station, Katrain, Kullu, H.P.
	Pusa Chandrima	IARI Regional Station, Katrain, Kullu, H.P.
	Purple Top White Globe	IARI Regional Station, Katrain, Kullu, H.P.

Before sowing the seeds into trays with the mentioned growth media, the germination percentage was calculated using top of paper method as per the procedure given by the International Seed Testing Association (Anonymous, 2019), where the seeds were germinated on the top of one layer paper enclosed in transparent petri dishes, with the addition of appropriate quantity of water in the beginning of the test. These petri plates were then kept in the germinator at 20±1°C. Readings were taken twice (4 DAS and 8 DAS). Germination % age was calculated using the formula:

Germination (%) = 100 × (No. of normal seedlings)/ (No. of seeds kept for germination)

The root length, shoot length, leaf length and leaf breadth were measured using centimeter scale. 100 seedling weight was computed using digital electronic balance and yield was calculated in kilograms per metre square of the area of trays in which microgreens were sown. All data was taken on four harvest intervals, *i.e.*, 7 DAS, 14 DAS, 21 DAS and 28 DAS in replications of three and displayed as averages, with a clear distinction between the two media used for cultivating the microgreens under study.

Statistical analysis. All data obtained was analysed based on simple ANOVA as three factor factorial and comparison of CDs was done using the software OPSTAT (Sheoran *et al.*, 1998).

Table 2: Growth pattern of selected microgreens.

Variety	Germination %-age	Germination time	Visual quality	Seedling colour
Palam Vichitra	96%	3 DAS	Excellent	Purple- green
Palam Kanchan	96%	3 DAS	Good	Green
Palam Samridhi	97%	4 DAS	Good	Dark green
Pusa Kale- 64	98%	4 DAS	Excellent	Purple- green
Local kale	98%	4 DAS	Excellent	Dark green
Chinese Yellow	70%	6 DAS	Fair	Light green
Great Lakes	30%	7 DAS	Fair	Yellowish green
Pusa Swarnima	99%	2 DAS	Excellent	Green
Pusa Chandrima	99%	2 DAS	Excellent	Green
Purple Top White Globe	94%	3 DAS	Fair	Dark green

RESULTS AND DISCUSSIONS

Seeds of turnip varieties Pusa Swarnima and Pusa Chandrima had the highest germination percentage (99%), followed by Pusa Kale- 64 and local kale varieties of kale (98%) and then Palam Samridhi (97%), Palam Vichitra (96%) and Palam Kanchan (96%) varieties of broccoli seeds. Similar observations were made in Indian mustard varieties, cotton, sunflower and peralmillet (Rai *et al.*, 2017; Chritiansen and Rowland 1981; Pallavi *et al.*, 2003; Gupta *et al.*, 2005). Lettuce seeds germinated the slowest, with the Great Lakes variety having 30% germination percentage. Results in a study on six different lettuce varieties also revealed low germination percentages like in the present research (Penaloza *et al.*, 2005).

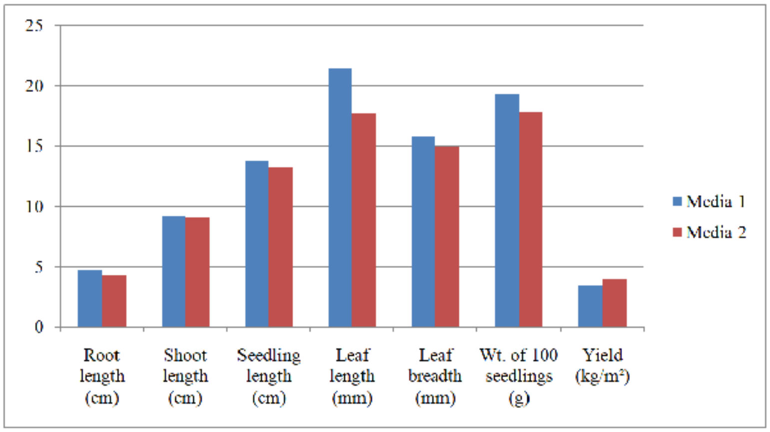

Fig. 1. Performance of microgreens in different media for morphological characters.

From Fig. 1, it was inferred that for all the morphological traits for microgreens under study, the best media was cocopeat, vermiculite and perlite mixed in the ratio of 3:1:1 (media 1), owing to its greater porosity which meant higher root and shoot length, thus greater seedling height and improved visual characters. A significant impact of growth media has been reported on the growth characteristics of microgreens in literature (Di Gioia *et al*., 2017). A similar trend in mustard, leaf mustard, radish and cabbage microgreens grown in four different growing media has been reported, with highest values obtained in soil plus cowdung media (Efendi *et al.*, 2020). These results were attributed to the chemical properties of the soil (pH, cation exchange capacity, total N and available P) and physical properties of the soil media *viz*., bulk density, porosity and water holding capacity (Di Gioia *et al*., 2019). Wild cosmos microgreens grown in two different planting media also exhibited similar observations, where plant height, leaf area and root length showed significantly different values in various media, with highest plant height in biochar grown microgreens. However, yield was found to be greater in the media containing vermicompost as the growth substrate (media 2). This may be due to more number of seedlings in media 1, that resulted in more intraspecific competition for growth and development which eventually led to lesser yield in comparison to media 2 where a proper crop stand was obtained. Substrate biofortification also plays an imperative role in the morphometry of microgreens (Lee *et al.*, 2004), thus proving that the media in which the microgreens are grown not only alters the nutritional composition but also the visual characteristics of the microgreens.

Plant morphology largely depends on its genetics. Many species germinate easily and grow promptly while others are slow and perform poor in comparison (Paradiso *et al.*, 2018). The morphological characters measured in the present study revealed that in general, kale microgreens (Pusa Kale- 64 and local kale) performed better morphologically than the other microgreens and Purple Top White Globe turnip gave poor results for most of the morphological parameters under observation (Table 3). Highest shoot length (11.68 cm) and leaf length (38.92 mm) was calculated in Chinese Yellow lettuce, maximum seedling length (16.34 cm) was obtained in Pusa Swarnima variety of turnip microgreens and highest root length (5.16 cm) was measured in Palam Vichitra broccoli. However, maximum value of leaf breadth (21.25 mm) and 100 seedling weight (29.64 g) was measured in local kale microgreens. Palam Samridhi gave the highest yield (7.30 kg/m^2) among all the microgreens under study. This revealed that different microgreen varieties performed significantly different in the two growth media. Similar observations have been made by various scientists in other microgreens (Efendi *et al.*, 2020; Lenzi *et al.*, 2019; Sinha and Thilakavathya 2021; Ghoora *et al.*, 2020; Sharma *et al.*, 2013). These observations may be reasoned with germination related traits and vigor index which is inherent for different varieties of microgreens under study (Di Bella *et al.*, 2021). Apart from the growth media, genotypes significantly affected the growth related traits of the microgreens, as revealed by our study. This observation was supported by another research on three microgreens belonging to Brassicaceae, where the genotype had significant impact on the leaf length, leaf breadth, weight and yield of microgreens.

Table 3: Effect of media on various morphological characters of microgreens.

Parameter	Root length (cm)		Shoot length (cm)		Seedling length (cm)		Leaf length (mm)		Leaf breadth (mm)		Wt. of 100 seedlings (g)		Yield (kg/m²)	
Variety	Media 1	Media 2	Media 1	Media 2	Media 1	Media 2	Media 1	Media 2	Media 1	Media 2	Media 1	Media 2	Media 1	Media 2
Palam Vichitra	5.16	3.78	6.81	8.76	11.76	12.26	18.67	16.50	17.50	15.25	23.07	21.97	3.84	4.08
Palam Kanchan	4.88	3.91	7.13	9.05	11.92	12.83	19.50	19.83	18.25	17.58	25.39	25.13	5.08	3.92
Palam Samridhi	4.94	4.09	7.11	8.68	11.98	12.69	20.50	21.17	18.75	20.83	24.50	22.27	2.19	7.30
Pusa Kale- 64	4.74	4.44	9.21	10.36	13.83	14.61	16.42	14.58	16.75	14.50	16.26	13.92	3.17	2.42
Local Kale	4.76	3.98	8.73	11.43	13.48	15.21	27.08	22.67	19.75	21.25	29.64	25.76	3.65	2.60
Chinese Yellow	4.19	4.48	11.68	6.94	15.77	11.29	38.92	23.00	13.17	11.08	18.96	15.71	3.67	3.62
Great Lakes	4.38	4.49	10.96	7.88	15.14	12.28	30.92	18.50	12.25	8.92	17.46	15.57	4.65	3.34
Pusa Swarnima	4.80	4.53	11.66	11.16	16.34	15.55	15.00	12.92	14.42	15.83	13.87	13.18	1.91	6.67
Pusa Chandrima	4.62	4.61	10.36	8.68	14.56	13.14	15.17	15.17	15.33	12.83	11.89	13.53	2.80	2.79
Purple Top White Globe	4.64	4.46	8.39	7.83	12.87	12.15	12.42	12.83	11.50	11.00	11.42	10.65	3.25	2.53

CONCLUSION

Microgreens are the super foods of the future. They are the healthiest, fully- organic and completely fresh dietary supplements available in the markets, that target heath conscious consumers as well as small scale growers and agricultural entrepreneurs. The popularity of microgreens is one the rise owing to their easy spatial and temporal management when compared to the nutrition that they offer. Selection of media exerts a significant impact on the growth and development of microgreens, as do the different genotypes, also affecting their nutrient profile. Thus, specific microgreens grown in specific media for the said time intervals may serve as a nutrient packed dietary food for people fighting deficiency diseases, chronic illness or for their overall health and well being as protective foods. Many researches are being undertaken on this novel food and various recommendations being made for the adequate demand and supply of microgreens to consumers and popularizing them among masses. Substrate biofortification is a new concept in this light for enhancing the visual quality and biochemical profile of the microgreens and can improve the overall quality of microgreens when incorporated effectively.

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Conflicts of Interest. None.

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