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Effect of different growing media on seedling quality and field performance of Cabbage (*Brassica oleracea* var. *capitata* L.)

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Abstract
Healthy seedlings are the first and essential requirement for achieving full yield potential of any vegetable crop. The present investigation was carried out at AAU, Jorhat, Assam, India during rabi season of 2018-19 and 2019-20 to access the impact of different growing media on growth, quality and vigour of cabbage seedling and subsequent performance in the main field. The treatments consisted of four different nursery media composition *viz*., M_1: Cocopeat (60): Vermiculite (20): Perlite (20), M_2: Cocopeat (50): vermicompost (50), M_3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media), M_4: Conventional nursery (soil: sand: FYM). The results revealed that cabbage seedlings raised in plug trays with seed sowing media coconut (50): vermicompost (50): microbial consortium *i.e.* M3 recorded higher seedling emergence percentage (92.67), stem diameter (3.12 mm), root length (12.01 cm), leaf area (9.15 cm^2), seedling vigour index (2358.43), seedling fresh weight (1.72 g), seedling dry weight (0.38 g) and total chlorophyll content (0.99 mg g^{-1}fw). The same seedling raised media showed better performance in the main field of Experimental Farm, Dept of Horticulture, AAU and farmer's field, recorded less days to seedling establishment (3.34), higher leaf area index (12.16), root length (22.07 cm), less days required to head initiation (41.64) and harvesting (62 days), higher head weight (1.58 kg), head compactness (4.09) and head yield per hectare (77.42 t) and B:C ratio of 3.88.

Keywords: Cabbage, growing condition, cocopeat, vermicompost, perlite, vermiculite, microbial consortium, yield

1. Introduction

Cabbage (*Brassica oleracea* L.), biennial but generally grown as annuals, is a vegetable crop, an excellent source of vitamin C, some B vitamins, potassium and calcium. The full potential of a transplanted vegetable can be achieved by establishing an uniform stand of healthy vigorous seedlings. Traditionally cabbage seedlings are raised in the open field nursery, which confronts several adverse situations like uneven seed germination, acute seedling competition for nutrient, light and water, attack of soil borne pest and pathogens that lead to variable seedling stand. To get more viable seedlings, farmers usually practice high density sowing that increases seed cost and wastage of resources. With the adoption of hybrid variety, cost of seed has increased manifold and farmers are searching new ways to reduce seedling mortality and to get quality seedling.

In view of the high cost of seeds, some vegetable crops like tomato, brinjal, capsicum and cucurbits are being transplanted after growing nursery under protected conditions to achieve maximum germination count and healthy plant establishment. While seedling production was common for vegetables such as tomato, pepper, cucumber and eggplant in the past, it has been used for cabbage and lettuce-like vegetables in recent years. In the production of seedling ready for planting, climatic conditions as well as seed sowing media have quite significant impacts on seedling development. In vegetative production, seedling stage is an important stage that has influences on growth and development, early yield, total yield and fruit per plant. Seedling production with conventional methods causes stress in plants. Seedlings are grown in different growth media, which plays a vital role in efficient production of horticultural seedlings in nurseries (Sterrett, 2001) [14]. The use of suitable growing media or substrates for sowing of seeds directly affects the germination, development and functional rooting system.

A good growing medium provides sufficient anchorage or support to the plant, serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (Abad *et al.*, 2002) [1]. The quality of seedlings is very much influenced by growing media under nursery (Agbo and Omaliko, 2006) [1]. The quality of seedlings obtained from a nursery influences re-establishment in the field and the eventual productivity of an orchard (Baiyeri, 2006) [4].

Plug trays are emerging as suitable seedling raising technology, as tray cavities allow proper nourishment of seedling through uniform utilization of the light, water and nutrients among all the plants. Again growing media contributed significant role on seed germination, seedling growth and initial seedling performance. Apart from farmyard manure, vegetable growers are gradually adopting vermicompost, Cocopeat, vermiculite, perlite, and microbial consortium as growing media for raising seedling of different vegetable crops.

Cocopeat has good physical properties, high total pore space, high water content, low shrinkage, low bulk density and slow biodegradation (Prasad, 1997). Perlite and vermiculite provide aeration and drainage; they can retain and hold substantial amount of water and later release it as needed. Vermicompost contains macro and micronutrients. It also contains humic acids, plant growth promoting substances like auxins, gibberellins and cytokinins. N-fixing and P-solubilizing bacteria, enzymes and vitamins, which increases the availability of plant nutrients resulting in increased growth, higher yield and better quality produce (Atiyeh *et al*., 2001) [3].

A pre-sowing inoculation of planting material as well as the planting medium with the consortia of beneficial microorganisms is an innovative approach for production of quality and healthy seedlings in horticultural production. A microbial consortium is a carrier-based product containing nitrogen fixing, phosphorus and potassium solubilising and plant growth promoting microorganisms in a single formulation. The synergistic effect of the formulated microbes can help in providing healthy and vigorous seedlings and considerably reducing the cost of cultivation by reducing fertilizer requirement of vegetables.

The literatures are meagre for comparative study on seedling performance in open nursery and plug tray as well as on different growth media under greenhouse condition in Assam. Based on the fact, the present investigation was designed to study the impact of different seed sowing media on growth, quality and vigour of cabbage seedling and subsequently their influence on yield and yield attributing parameters of cabbage in the main field.

2. Materials and Methods

The field experiments were conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India during rabi season of 2018-2019 and again repeated in 2019-20. The experimental site AAU, Jorhat is situated at 26.47°N latitude and 94.12°E longitude and at an elevation of 86.8 m above mean sea level. The soil was well drained sandy loam having pH 5.20, organic carbon 0.93% and available N, P and K were 212.21 kg ha-1, 20.34 kg ha-1 and 118.42 kg ha-1 respectively. The treatments consisted of four different nursery media composition *viz*., M_1: Cocopeat (60): Vermiculite (20): Perlite (20), M_2: Cocopeat (50): vermicompost (50), M_3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media), M_4: Conventional nursery (soil: sand: FYM). Design used was Randomized Block Design (RBD) with three replications.

Different seedling attributes namely seedling emergence percentage, days to 2-true leaf stage, seedling height, stem diameter, leaf area, days to transplant, root length, seedling vigour index, seedling fresh weight, seedling dry weight and total chlorophyll content were recorded just before transplanting. The chlorophyll content of leaves was measured by using portable leaf chlorophyll meter. The seedling vigour was calculated by multiplying the germination percentage with seedling dry weight (Abdul-Bakki and Anderson, 1973).

The economics of the treatments was worked out on the basis of benefit: cost (B:C) ratio derived from net return and cost of production as per existing market rate. Healthy seedlings were transplanted in the main field at 3.0 m x 2.7 m plots at 45 cm spacing within and between rows. The field crop received a uniform dose of farmyard manure (20 t ha-1) along with inorganic fertilizers at 130 kg N, 80 kg P_2O_5 and 80 kg K_2O per hectare. Recommended cultural and plant protection measures were followed equally in all the plots as and when required. In the main field the observations were recorded on ten randomly selected plants from each plot. Two years data from different treatments were subjected to statistical analysis. The data for individual year was computed and pooled mean was worked out. The treatment means were compared using least significant difference (LSD) test at 0.05 level of significance. All analyses were performed using INDOSTAT version 8.0 statistical package

3. Results and Discussion

3.1. Performance of seedlings

The results revealed significant differences among the different seed sowing media (Table 1, 2 & Fig 1). Growing media M3 [Cocopeat (50): vermicompost (50): Microbial consortium] recorded higher seedling emergence percentage (92.67%), stem diameter (3.12 mm), leaf area (9.15 cm^3), root length (12.01 cm), seedling vigour index (2358.43), seedling fresh weight (1.72 g), seedling dry weight (0.38 g) and total chlorophyll content (0.99 mg g^{-1} fw). Higher seedling emergence percent might be due to media M3 [Cocopeat (50): vermicompost (50): Microbial consortium] having good water holding capacity and moisture supply as well as sufficient porosity which permits adequate moisture and gaseous exchange between media and seed which helps better seedling emergence. Moreover, under greenhouse condition proper temperature was maintained which helps in emergence of seedling. Similar result was also obtained by Zaller (2007) [17].

Leaf area increased because of microbial activity. Microbial consortium contained azotobacter, azospirillum and phosphate solubilizing bacteria and vermicompost also contain beneficial microorganisms which having the ability in producing the regulated growth material, which results in leaf area increase. Similar result was obtained by Subbaiah *et al.* (2018) [15, 16] in brinjal. More stem diameter might be due to better nutrient availability leading to immense production of photosynthetically functional leaves in this treatment (M3) and finally resulting in better girth of seedling.

Microorganisms present in vermicompost and microbial consortium synthesize plant growth hormone mainly auxin, gibberellin and cytokinin. The maximum root growth might be due more availability of auxin in this growing media (M3). The obtained results are agreed in somewhat with Ngaatendwe *et al*. (2015) [8].

Higher vigour index was found media (M3) might be due to increased germination and seedling height which have contributed to greater vigour index. The results of study are in close agreement with the findings of Prajapati *et al.* (2017) [11] and Parasana *et al.* (2013) [9].

These results (higher seedling emergence percent, less days for 2-true leaf stage, leaf area, stem diameter, root length, seedling vigour index etc) can be attributed to a reason that production of plant growth promoting substances by plant growth promoting microbes which were known to cause enhanced cell division and root

development higher nitrogen fixation by nitrogen fixing bacteria, phosphorous solubilization by phosphorous solubilizing bacterium was responsible for early germination, healthy, vigorous and quality seedlings. the present study was also

supported by the findings of Sarvanan *et al.* (2012) [12] in *Casuarina equisetifolia* seedlings (Shenoy and Kalagudi, 2002) [13] and Jayashree *et al*. (2016) [6].

Combination of this media (M3) enhanced airflow, porosity, drainage and also vermicompost had a positive effect on root development. The obtained results are agreed in somewhat with Ngaatendwe *et al*. (2015) [8]. More root dry weight might be due more dry matter accumulation in the root. Due to more leaf area more photosynthesis took place and more photosynthates transferred to root zone. The obtained results are agreed in somewhat with Ngaatendwe *et al*. (2015) [8]. The leaves of seedling raised in M3 has higher chlorophyll content due to presence of nitrogen in vermicompost which might certainly upgrade the photosynthetic rate, dry matter production and there by more fresh weight and dry weight of seedling. Similar result was obtained by Subbaiah *et al*. (2018) [15, 16] in brinjal.

The minimum fresh weight and dry weight might be due the media combination of Cocopeat (60): Vermiculite (20): Perlite (20) *i.e.* M1 where primary nutrients (NPK) are not there for proper growth and development. In this media only water availability is good but along with water plant need nutrients also. The conventional nursery (soil: sand: FYM) seedlings showed better result than media M1 *i.e.* Cocopeat (60): Vermiculite (20): Perlite (20) which might be due to availability of N, P and K from FYM along with water though it is under open field condition.

Table 1: Seedling emergence (%), days to 2-True leaf stage, seedling height and stem diameter (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Seedling emergence (%)	Days to 2-True leaf stage	Seedling height (cm)	Stem diameter (mm)	Leaf area (cm^2)
M1: Cocopeat (60): Vermiculite (20): Perlite (20)	83.56	12.72	7.08	2.01	4.68
M2: Cocopeat (50): vermicompost (50)	90.45	10.59	10.90	3.02	8.87
M3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media)	92.67	10.21	10.35	3.12	9.15
M4: Conventional nursery (soil: sand: FYM)	91.78	13.66	9.15	2.56	8.04
S.Ed (±)	2.38	0.39	0.59	0.07	0.77
CD (0.05)	5.95	0.87	1.26	0.21	1.46

Table 2: Days to transplant, Root length, Seedling vigour index, Seedling fresh weight, Seedling dry weight and Total Chlorophyll content (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Days to transplant	Root length (cm)	Seedling vigour index	Seedling fresh weight (g)	Seedling dry weight (g)	Total Chlorophyll content (mg g^{-1} fw)
M1: Cocopeat (60): Vermiculite (20): Perlite (20)	27.19	5.68	1264.61	0.72	0.14	0.80
M2: Cocopeat (50): vermicompost (50)	22.62	8.82	2175.26	1.64	0.36	0.93
M3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media)	22.54	12.01	2358.43	1.72	0.38	0.99
M4: Conventional nursery (soil: sand: FYM)	29.57	4.51	1384.83	1.18	0.23	0.78
S.Ed (±)	1.65	1.23	42.68	0.06	0.03	0.03
CD (0.05)	4.10	3.46	101.50	0.15	0.07	0.06

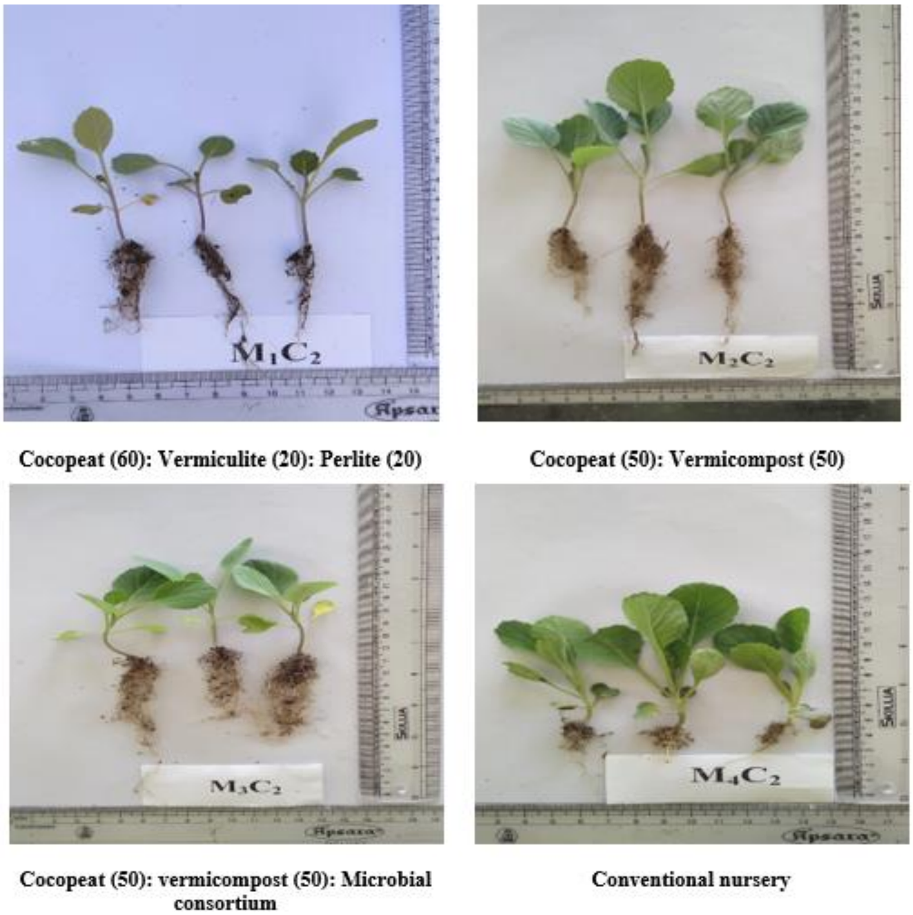

Fig 1: Seedling growth under different growing media

3.2 Performance of seedling in the main field

The seedling raised media M3 [Cocopeat (50): vermicompost (50): Microbial consortium] under greenhouse condition showed better performance in the main field, recorded less days to seedling establishment (3.34), more plant height (21.84 cm) after 30 days of transplanting, higher leaf area index (12.16), higher root length (22.07 cm), higher no. of wrapping leaves (37.45), less days required to head initiation (41.64) and harvesting (62 days), higher head weight (1.58 kg), higher head diameter (15.91 cm), head compactness (4.09) and higher head yield per hectare (77.42 t) and B:C ratio (3.88). (Table 3,4 and 5)

Successful establishment of a seedling in the main field is the first critical step for crop production. Early establishment might be due to more root length which quickly absorb water and nutrients and high seedling vigour index. This active root system allow more uniform and faster growth, with little or no transplant shock. Increase in number of leaves might be mainly due to corresponding increase in plant height (Govind and Chandra, 1993) [5] and also may be due to better nutrient availability leading to immense production of photo synthetically functional leaves in these treatments (Patel *et al*, 2019) [10]. LAI is an important parameter in plant ecology. Because it tells how much foliage is there, it is a measure of the photosynthetic active area. More LAI might be due more leaf number in the plant. Roots are lifeline of a plant, taking up air (O_2), water and nutrient from soil and moving them upto the leaves. More root length might be due to more photosynthates transferred to the root because leaf area index is more in this this treatment and more leaf area index more photosynthesis i.e more food production for plant. The more head weight might be due to production of more wrapping and non-wrapping leaves. More leaf area index was also found in this treatment M3 due to which photosynthesis increased and finally increased the head weight. Due to production of more number of wrapping leaves and proper plant spacing head diameter increased. Similar result was given by Jett *et al.*, (1995) [7] in broccoli.

Table 3: Days to establishment, Plant height at 30 and 60 days after transplanting, leaf number, leaf area and leaf area index (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Days to establishment	Plant height (cm) at 30 DAT	Plant height (cm) at 60 DAT	Leaf numbers	Leaf area index (LAI)
M1: Cocopeat (60): Vermiculite (20): Perlite (20)	4.29	17.00	26.27	38.03	8.89
M2: Cocopeat (50): vermicompost (50)	3.36	21.35	29.73	48.03	10.39
M3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media)	3.34	21.84	29.27	49.18	12.16
M4: Conventional nursery (soil: sand: FYM)	5.41	17.69	26.68	39.52	9.31
S.Ed (±)	0.54	0.65	0.71	4.68	0.86
CD (0.05)	1.17	1.40	1.61	10.68	1.84

Table 4: Root length, root dry weight, no. of non-wrapping and wrapping leaves, days to head initiation and days to harvesting (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Root length (cm)	Root dry weight (g)	No. of non-wrapping leaves	No. of wrapping leaves	Days to head initiation	Days to harvesting
M1: Cocopeat (60): Vermiculite (20): Perlite (20)	17.28	12.83	10.01	28.02	43.41	67.23
M2: Cocopeat (50): vermicompost (50)	20.29	15.25	11.48	36.55	41.89	62.77
M3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media)	22.07	16.20	11.73	37.45	41.64	62.00
M4: Conventional nursery (soil: sand: FYM)	17.02	12.21	10.13	29.39	42.73	65.89
S.Ed (±)	0.61	0.82	0.68	0.53	0.77	2.21
CD (0.05)	1.33	1.83	1.53	1.15	1.58	5.16

Table 5: Head weight, head diameter, head compactness, head yield and B:C ratio (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Head weight (kg)	Head diameter (cm)	Head compactness	Head yield (t ha^{-1})	B:C ratio
M1: Cocopeat (60): Vermiculite (20): Perlite (20)	1.21	13.08	6.12	59.29	2.54
M2: Cocopeat (50): vermicompost (50)	1.51	14.87	5.13	73.99	3.67
M3: Cocopeat (50): vermicompost (50): Microbial consortium (6g/ kg media)	1.58	15.91	4.09	77.42	3.88
M4: Conventional nursery (soil: sand: FYM)	1.31	13.01	6.85	64.43	3.55
S.Ed (±)	0.12	0.47	0.49	0.96	-
CD (0.05)	0.26	1.04	1.07	2.08	-

4. Conclusion

The result of the present investigation revealed that seedling raising in cocopeat (50): vermicompost (50): Microbial consortium i.e media M3 in greenhouse are an efficient and superior alternative to traditional open field seedling raising (M4: conventional nursery) for cabbage. These method offers great potential for healthy and vigorous seedlings production in cabbage which finally shows better performance in the main field in terms of yield and yield attributing characters.

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