Original Research Article

Seedling growth, field performance and economics of production of early cauliflower as influenced by different sowing media and variety under greenhouse condition in Assam

ABSTRACT

An experiment was conducted at the greenhouse and in the field of the Experimental Farm, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat for two consecutive years (2018 and 2019) to assess the effect of sowing media and variety on growth of early cauliflower seedling and subsequent performance of seedling in the main field. The results revealed that seedlings raised in different sowing media surpassed the conventional sowing media (soil, sand and farm yard manure) for growth attributes and yield. The media M_1 i.e., cocopeat (60): vermiculite (20): perlite (20) recorded the highest seedling emergence whereas minimum days to transplanting and maximum leaf area was recorded in M_2 i.e.,cocopeat (50): vermicompost (50). Minimum days to 2-true leaf emergence was recorded in both M_2 and M_3 [cocopeat (50): vermicompost (50): microbial consortium@ 1:100] and M_3 recorded the highest seedling height in nursery. Minimum days for 2-true leaf emergence was recorded by variety V_2 (CFL1522) while highest leaf area was found in V_1(White Diamond). Among interactions, M_1V_1 recorded maximum emergence, M_2V_2 recorded minimum number of days for 2-true leaf stage and to transplanting respectively, maximum leaf area in M_2V_1 and M_3V_2 produced the tallest seedling. In field, the seedlings that were grown in M_3 media in nursery recorded significantly higher value of growth parameters and yield. Variety white Diamond took minimum days for establishment and recorded maximum leaf area index at 30 Days after transplanting (DAT) and at harvest. Though treatment combination, M_3V_2 recorded the highest curd yield the highest cost benefit ratio was obtained in M_3V_1 (3.95) and the lowest (2.42) in M_1V_1. Considering the cost benefit ratio, for producing good quality seedlings of early cauliflower under green house, which will further give best performance in field condition, cocopeat (50): vermicompost (50): microbial consortium (1:100) as sowing media and variety White Diamond can be used in Assam.

Key words: Sowing media, variety, growth, field, economics, early cauliflower

INTRODUCTION

Healthy seedling production is prerequisite for raising vigorous and profitable crops. Recently, the use of high quality seedlings produced in facilities where climatic conditions are kept under control has increased. In the production of ready-to-plant seedlings, climatic conditions as well as seed sowing media have quite significant impact. Seedling production with conventional methods causes stress in plants. Seeds are sown in different media, which plays a vital role in efficient production of horticultural seedlings. The use of suitable growing media or substrates for sowing of seeds directly affects the germination, development of functional shoot and root system of seedling, 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 [1].Seedlings obtained from a quality nursery significantly influences re-establishment and the eventual productivity in the main field [4].The use of soil less medium like cocopeat, perlite, vermiculite *etc.* is becoming very popular now a days. They are used in the horticultural industry because they provide good aeration and drainage, can retain and hold substantial amount of water and later release it as per the requirement. These are sterile and free from diseases, having a fairly neutral pH (especially perlite which is neutral), non-toxic, safe to use and relatively inexpensive. Vermiculite absorbs large quantities of water and also holds positively charged nutrients like potassium, magnesium and calcium because of its plate like structure. Cocopeat or coir an organic amendment improves physical properties and hold water up to nine times its weight. Likewise, vermicompost refers to a mixture of worm casting, organic material, humus, living earthworms, their cocoons and other organisms having good structure, moisture-holding capacity, relatively large amounts of available nutrients, and microbial metabolites that may act as plant growth regulators. 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 in general and transplanted vegetables in particular. 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. Plant growth is significantly increased when *Azospirillum* is used with phosphate solubilising bacteria [6]. Since no systematic research work on effect of media on quality seedling production of early cauliflower and the field performance of the seedlings afterwards has been conducted and documented, the present investigation was carried out.

MATERIAL AND METHODS

The investigation was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat (26.47 °N latitude and 94.12 °E longitude and at 86.8 m above MSL) during the month of July-November in two consecutive years, 2018 and 2019.The soil was sandy loam soil having p^H 5.00, organic carbon 0.55% and available N, P and K were 212.52 kg ha^{-1}, 40.45 kg ha^{-1} and 110.64 kg ha^{-1}. The experiment composed of four nursery media composition, M_1- Cocopeat (60): Vermiculite(20):Perlite (20); M_2- Cocopeat (50):Vermicompost(50); M_3- Cocopeat (50): Vermicompost(50): Microbial consortium @1g/100g of media and M_4: Conventional nursery (soil: sand: FYM)] and two variety (V_1- White Diamond and V_2 -CFL 1522).Thus, 8 treatment combinations were laid out in a 4x2 factorial arrangement in a Randomized Completely Block Design (RCBD) with three replications. The protrays were used for nursery raising with cocopeat, vermiculite, perlite, vermin compost and microbial consortium as growing media and seeds of early cauliflower hybrid variety 'White Diamond' and 'CFL-1522' were sown in protrays (one seed per cell) under green house in the second week of July. One conventional nursery was also raised for sowing same seeds with soil, sand and FYM as growing media. Microbial Consortium consisting of *Azotobacter*, *Azoospirullum* and Phosphate Solubilising Bacteria (PSB) was mixed with respective media at a ratio of 1:100 and mixed properly and sprinkled and heaped. Coco peat was soaked and washed before mixing with other media. Plots of 3.6 m x 2.7 m dimension were prepared and the treatments were allocated randomly. Healthy seedlings of 22-28 days old were selected and transplanted on 2nd week of August at a spacing of 45 cm x 45 cm. Recommended cultural and plant protection measures were followed equally in all the plots as and when required. Observations on seedlings emergence, seedling height and leaf area were noted following standard procedure. The phonological events like days to two true leaf stage and days to transplanting were recorded. Similarly, in the main field also the observations on growth and yield parameters were recorded following standard procedure. Yield per hectare was computed from plot yield and was expressed in quintals.Net return and B:C ratio was calculated based on the total cost of cultivation and gross income. Pooled data of two years was taken (2018 & 2019) for drawing conclusions after subjecting the same to statistical analysis using the statistical package SPSS (20.0) at 5% critical difference (CD) for testing the significant differences among the treatment means.

RESULTS AND DISCUSSION

All the growth parameters in nursery were significantly influenced by different media and the interaction of media and variety (Table1). The effect of variety was found to be significant only for days to 2-true leaf stage and seedling height. Based on two consecutive years' pooled data, M_1 recorded significantly higher value of maximum seedling emergence compared to other media. Among the treatment M_1V_1 comprising cocopeat: vermiculite: perlite and White Diamond recorded maximum emergence and the minimum was recorded in M_4V_2 (soil: sand: FYM and CFL1522). Higher cumulative emergence percentage recorded by the soilless media (cocopeat: vermiculite: perlite) could be attributed to physical qualities of growth media. Soil strength is one of the factors determining the seedling emergence which is defined by bulk density and moisture content, and which increases with decrease in soil moisture content. The soilless media had lower bulk densities but higher water holding capacities. As such, they could offer less resistance to seedling emergence while enhancing germination since one of the requirements for seed germination is adequate moisture content [5] also obtained higher percentage emergence of African breadfruit (*Treculia africana*) in soilless media compared to the soil based media. The highest emergence in the interaction of sowing media and variety in the treatment (M_1V_1) might be due to synergistic effect of better physico–chemical properties of media and genetical character of the var. White Diamond.

The number of days taken to 2-true leaf stage was found to be statistically different for sowing media. The minimum number of days for 2-true leaf stage was recorded in both M_2 and M_3. Significant effect of variety was recorded and the least number of days was observed in V_2 (CFL 1522). The interaction effect revealed significant variation among the treatments. Among the treatment combination, M_2V_2 recorded the minimum number of days and maximum days were taken by M_4V_1. Least days for 2-true leaf emergence in both M_2 (cocopeat: vermicompost) and M_3 (cocopeat, vermicompost & microbial consortium) might be due to the fact that their earlier emergence led to the development of 2-true leaf emergence. The production of chemicals in the vermicompost might have acted as growth promoting chemicals resulted in higher and early germination of seedlings. The microbial consortium supplying substantial amount of nutrient specially nitrogen, phosphorous and micro nutrients might have helped in early emergence of true leaves. The significant influence of vermicompost on seedling emergence of tomato was also reported by [14]. The least days for 2-true leaf emergence in var. CFL1522 might be due to its genetic potential. Similarly, M_2 recorded minimum days to transplanting followed by M_3. In the interaction the least number of days was recorded in M_2V_2. The reduction in number of days for 2-true leaf stage might have led to reduction in number of days for transplanting in the M_2. *i.e*. in cocopeat and vermicompost. This is in line with [7] and [2] who opined that since coir dust is low in nutrients when mixed with vermicompost, provides a better growth medium for plant establishment.

The data pertaining to the effect of sowing media, variety and their interaction on seedling height presented in Table 1 showed that the highest seedling height was in M_3 which was statistically different from other treatments whereas, M_4 recorded the lowest seedling height Maximum seedling height was recorded in the interaction M_3V_2. The increase in plant height in M_3 having cocopeat, vermicompost and microbial consortium might be due to the fact that media inoculation with biofertilizer have enhanced the efficacy of the vermicompost and improved the seedling growth attributes over uninoculated treatments, which suggests secretion of certain growth promoting substances like auxin, gibberellic acid and enzymes by bacterial inoculants and increased availability of nitrogen that might have led to better root development, uptake and transportation of water and nutrients and resulted in enhanced seedling growth. The increase in height of seedling with inoculation of *Azotobacter* might be due to fact that it stimulates nutrient uptake especially nitrogen which has role in the assimilation of numerous amino acids that are subsequently incorporated in proteins and nucleic acid, which provides framework for chloroplast, mitochondria and other structures in which most of the biochemical reactions occurs [3]. The positive impact of vemicompost on increased height of chilli transplants was also highlighted by [11]. Similar results were also obtained by [8] in tomato using vermicompost and biofertilizer as a source of nutrition which gave maximum germination and maximum seedling height. The highest seedling length was also observed by [12] with combined application *Azotobacte*r + PSB in okra. Similar results were also observed by [10] and [13].

Data presented in Table1 confirms significant effect of sowing media and variety on leaf area of seedling. The highest leaf area was recorded in M_2 and V_1 (White Diamond). Although M_2V_1 recorded the maximum leaf area but was not statistically superior to M_1V_1, M_2V_2, M_3V_1, M_3V_2, M_4V_1 and M_4V_2 and the minimum leaf area was in M_1V_2. Increased leaf area in M_2 with cocopeat and vermicompost can be attributed to general

improvement in the physical and chemical properties of the rooting medium, so increased absorption of nutrients might had accelerated the process of cell division, differentiation and better nutrient availability leading to higher production of photo synthetically functional leaves with increased leaf area. Similar results were recorded by [11] in chili transplants with highest leaf area and by [9] in sweet pepper (cv. California Wonder) transplants. More leaf area in variety White Diamond (V_1) might be due to its inherited capacity which might have improved because of the proper physical, chemical and nutritional environment provided by the media.

Table 1: Effect of sowing media on growth parameters of cauliflower seedling in nursery

Media(M)	**Seedling emergence** (%)	**Days to 2-true leaf stage**	**Days to transplanting**	**Seedling height** (cm)	**Leaf area** (sq cm)
M_1 (3Cp:1Vm:1Pr)	93.00	11.42	26.33	10.98	7.80
M_2 (1Cp: 1Vc)	88.48	10.00	22.25	12.41	11.14
M_3 (1Cp:1Vc:MC)	92.58	10.00	23.92	14.52	10.02
M_4 (Soil :Sand: FYM)	83.88	13.33	27.75	9.52	10.95
S.Ed.(±)	0.69	0.53	0.67	0.77	0.91
CD(0.05)	1.41	1.08	1.36	1.57	1.84
Variety(V)					
V_1 (White Diamond)	89.66	11.63	25.21	11.31	10.86
V_2 (CFL 1522)	89.31	10.75	24.92	12.41	9.10
S.Ed.(±)	0.49	0.38	0.48	0.55	0.64
CD(0.05)	NS	0.76	NS	NS	1.30
Interaction (M xV)					
$T_1(M_1V_1)$	93.79	12.67	26.50	11.90	9.38
$T_2(M_1V_2)$	92.20	10.17	26.17	10.06	6.23
$T_3(M_2V_1)$	88.91	10.50	22.33	12.38	11.97
$T_4(M_2V_2)$	88.04	9.50	22.17	12.44	10.31
$T_5(M_3V_1)$	91.88	9.83	24.50	11.98	10.42
$T_6(M_3V_2)$	93.29	10.17	23.33	17.05	9.61
$T_7(M_4V_1)$	84.05	13.50	27.50	8.97	11.66
$T_8(M_4V_2)$	83.70	13.17	28.00	10.08	10.24
S.Ed.(±)	0.98	0.75	0.95	1.10	1.28
CD(0.05)	1.99	1.53	1.93	2.22	2.60

Cp: Cocopeat, Vm: Vermicullite, Pr: perlite, Vc: Vermicompost MC: Microbial Consortia

Data presented in Table 2 revealed in the main field all the growth parameters like days to establishment, plant height, leaf number and leaf area index (at 30 DAT & at harvesting), curd weight and curd yield were significantly influenced by seedlings grown in different media. Media M_3 consisting of cocopeat (50): vermicompost (50): microbial consortium@1:100 performed best for all the growth attributes as well as for curd yield. Effect of variety was not found to be significant in all parameters except days to establishment and leaf area index (at 30 DAT and at harvesting). Early and successful establishment in main field is the most important prerequisite for high yield The reason for least days taken by seedlings of M_3 for establishment in main field might be as the seedlings in M_3 took least days for 2-true leaf emergence with good early emergence, maximum height with well-developed root system helping in quick absorption of water and nutrients and with sufficient chlorophyll content in leaves at nursery stage. Quality of seedlings transplanted influenced their re-establishment in an orchard. Increased plant height might be attributed to increased seedling height recorded in nursery also reflected in the field after transplanting. A higher leaf area with maximum chlorophyll content in the leaves of seedlings in M_3 might have led to increased leaf number in field also. Because of higher root length the plant might have absorbed maximum nutrients for which the production of leaves increased. The factors associated with increased leaf numbers in field might be associated with higher leaf area index of crops in M_3 in field.

The least days for establishment and maximum leaf area index at 30 DAT and at harvesting, respectively was recorded in V_1 can be attributed to higher fresh and dry weight of seedlings, higher seedling growth index along with higher root length helped in establishment in the field. Again, the well-developed root system minimizes the root damage and helps easy establishment in the main field.

Significant effect of interaction of media and variety were observed on growth parameters. Minimum days for establishment, the maximum plant height and the highest leaf area index both at 30 DAT and at harvesting stage were recorded in the treatment combination M_3V_1.The treatment combination M_3V_2 recorded highest number of leaves which can be attributed to the combination of factors associated with the more production of leaves in M_3 and genetical characters of variety. Nursery growth of seedlings can be taken as an indicator of survival and potential growth when planted in field.

The observations recorded at curd harvest stage (Table 2) revealed that media had significant influence on curd weight and curd yield. The heaviest curd (0.41 kg) and maximum curd yield (200.22 q/ha) were recorded M_3 which were significantly higher than all other treatments The lightest curds (0.27 kg) and lowest total yield were obtained (132.47 q/ha) in M_4 plots. Varieties did not bring about significant effect on the curd weight and yield while significant interaction effects were observed among different treatments. Maximum curd weight (0.41 kg) and curd yield (202.13 q/ha) was observed in M_3V_2. Maximum curd weight and yield obtained in M_3 could be attributed to proper nourishment and favourable nutrient medium that encouraged healthy growth and more plantable seedling. Again healthy seedling growth could have enhanced the plant vigour and physiological processes resulting in higher metabolic, higher carbohydrate synthesis and faster loading and mobilization of carbohydrates that ultimately enhanced the yield components and head yield as observed by [8] in cabbage. They reported similar results in cabbage by applying vermicompost and biofertlizer.

Table 2: Effect of sowing media and variety on growth parameters and curd yield in field

Media(M)	Days to establishment	Plant height (cm)		Leaf number		Leaf area index		Curd weight (kg)	Curd yield (q/ha)
		At 30 DAT	At harvest	At 30 DAT	At harvest	At 30 DAT	At harvest		
M_1(3Cp:1Vm:1Pr)	7.00	21.78	33.46	8.89	17.76	0.63	2.35	0.32	158.09
M_2(1Cp: 1Vc)	5.67	25.15	36.38	9.67	19.17	0.85	2.43	0.35	173.42
M_3(1Cp:1Vc:MC)	5.42	25.73	39.13	12.81	22.31	1.64	2.83	0.41	200.22
M_4(Soil:Sand: FYM)	8.58	17.03	25.36	8.00	15.57	0.76	1.95	0.27	132.47
S.Ed.(±)	0.25	0.15	0.45	0.14	0.36	0.13	0.12	0.01	3.52
CD(0.05)	0.50	0.31	0.92	0.29	0.72	0.26	0.25	0.01	7.14
Variety(V)									
V_1 (White Diamond)	6.43	22.48	33.71	9.80	18.50	1.10	2.52	0.33	164.85
V_2 (CFL 1522)	6.90	22.37	33.45	9.88	18.90	0.83	2.26	0.34	167.25
S.Ed.(±)	0.17	0.11	0.32	0.10	0.25	0.09	0.09	0.01	2.49
CD(0.05)	0.35	NS	NS	NS	NS	0.18	0.17	NS	NS
Interaction (MXV)									
T_1 (M_1V_1)	7.17	19.99	31.78	8.33	17.07	0.78	2.63	0.29	144.86
T_2 (M_1V_2)	6.83	23.57	35.15	9.44	18.44	0.47	2.07	0.35	171.32
T_3 (M_2V_1)	5.33	25.87	37.05	10.39	19.28	0.78	2.52	0.37	185.04
T_4 (M_2V_2)	6.00	24.43	35.70	8.94	19.06	0.92	2.35	0.33	161.81
T_5 (M_3V_1)	4.89	26.75	39.96	12.44	21.67	2.02	2.92	0.40	198.31
T_6 (M_3V_2)	5.94	24.71	38.30	13.17	22.94	1.26	2.73	0.41	202.13
T_7 (M_4V_1)	8.33	17.29	26.06	8.06	15.98	0.83	2.00	0.27	131.19
T_8 (M_4V_2)	8.83	16.78	24.67	7.94	15.17	0.68	1.90	0.27	133.74
S.Ed.(±)	0.35	0.22	0.64	0.20	0.50	0.18	0.17	0.01	4.98
CD(0.05)	0.71	0.44	1.30	0.41	1.02	0.37	0.35	0.02	10.10

Cp: Cocopeat Vm: Vermicullite ,Pr: perlite, Vc: Vermicompost MC: Microbial Consortia

The ultimate aim of any field experiment is to gain maximum profit along with high yield and quality. It is evident from Table 3 that the highest benefit: cost ratio was obtained in T_5 followed by T_6 and the lowest was obtained in the T_1. The higher cost benefit ratio in T_5 *i.e.* M_3V_1 having cocopeat (50):vermicompost (50):microbial consortium and variety White Diamond due to higher curd yield and slightly lesser cost of cultivation than M_3V_2 (cocopeat (50): vermicompost (50): microbial consortium and variety CFL 1522) as the seed price of V_1 was slightly lower than V_2.. The lowest cost benefit ratio in T_1 *i.e* M_1V_1 (cocopeat (60): vermiculite (20): perlite (20) and White Diamond) was due to lower yield and higher cost of cultivation than T_8 *i.e*. M_4V_2 (conventional media and CFL 1522)

Table 3: Economics of production of early cauliflower in field

Treatment	**Yield** (q/ha)	**Gross return** (Rs)	**Total cost of cultivation** (Rs)	**Net return** (Rs)	**Benefit: Cost Ratio**
T_1 (M_1V_1)	144.86	5,79,440.00	1,69,212.52	4,10,227.48	2.42
T_2 (M_1V_2)	171.32	6,85,280.00	1,73,693.02	5,11,586.98	2.95
T_3 (M_2V_1)	185.04	7,40,160.00	1,60,251.52	5,79,908.48	3.62
T_4 (M_2V_2)	161.81	6,47,240.00	1,64,732.02	4,82,507.98	2.93
T_5 (M_3V_1)	198.31	7,93,240.00	1,60,406.02	6,32,833.98	3.95
T_6 (M_3V_2)	202.13	8,08,520.00	1,64,886.52	6,43,633.48	3.90
T_7 (M_4V_1)	131.19	5,24,760.00	1,43,720.02	3,81,039.98	2.65
T_8 (M_4V_2)	133.74	5,34,960.00	1,48,200.52	3,86,759.48	2.61

CONCLUSION

From the experiment it was observed that Both M_2 [cocopeat (50): vermicompost (50)] & M_3 [cocopeat (50): vermicompost (50): microbial consortium@1:100] media were more or less equal in performance in nursery than M_1 [Cocopeat (60): Vermiculite (20): Perlite (20)] and M_4 [conventional nursery].But in main field M_3 [cocopeat (50): vermicompost (50): microbial consortium] performed best. Variety white diamond (V_1) was found better than V_2 (CFL 1522) in main field.Among interactions, though M_3V_2 [cocopeat (50): vermicompost (50): microbial consortium @1:100 and CFL 1522] produced maximum yield but considering the B:C ratio M_3V_1 [cocopeat (50): vermicompost (50): microbial consortium@1:100and White Diamond]can be used for producing good quality seedlings in the nursery under protected condition that will subsequently give better performance in field. The media M_3 [cocopeat (50): vermicompost (50): microbial consortium@1:100] under protected condition can be a better alternative for raising seedling of early cauliflower than traditional nursery media in open condition. There is further scope of studying the varietal influence by taking more numbers of varieties for having more statistical significance with respect to different parameters.

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