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EFFECT OF DIFFERENT GROWING MEDIA AND SOWING DATES ON SEEDLING GROWTH OF BHUT JOLOKIA (*CAPSICUM CHINENSE* JACQ.)

Pritam Phonglo[1]*, Bhakta Prasad Gautam[1], Nayanmoni Buragohain[2], Ratna Kinkor Goswami[3] and Budha Bora[4]

[1]Department of Horticulture, Biswanath College of Agriculture, AAU, Biswanath Chariali-784 176, Assam, India.
[2]Department of Horticulture, Assam Agricultural University, Jorhat - 785 013, Assam, India.
[3]Department of Crop Physiology, Biswanath College of Agriculture, AAU, Biswanath Chariali - 784 176, Assam, India.
[4]Department of Plant Pathology, Biswanath College of Agriculture, AAU, Biswanath Chariali - 784 176, Assam, India.
*Corresponding author E-mail : pphonglo67@gmail.com

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ABSTRACT

The experiment aims to study the effect of different growing media and sowing dates on seedling growth of Bhut jolokia with the objectives to fi7nd out the suitable growing media and sowing dates of Bhut jolokia seedlings based on morpho-physiological parameters. The study revealed that the morphological, phenological and physiological traits were influenced by different sowing dates and growing media treatments. The germination per cent was significantly higher in S_3 (75.87%) and M_4 (84.25%). The Morphological parameters like seedling height at 20 and 30 DAE (days after emergence), number of green leaves per seedling at 40 DAS, shoot length (cm) at transplanting was observed to perform better under S_1 whereas seedling height at 10 DAE perform better under S_2 and root length at transplanting under S_3 and among the different growing media, all the morphological parameters were recorded highest in M_6. Similarly, the phenological parameters like days to seedling emergence (8 days) and days to emergence of 1st leaf (14.42 days) was lowest under S_1 whereas the number of days to transplanting (43.56 days) was found to be lowest in S_2. The physiological parameters like seedling vigour index perform better under S_3 and M_6. Fresh weight and leaf area was higher in S_2 and M_6, dry weight in S_1 and M_6, whereas RLWC and total leaf chlorophyll content perform better under S_3 and M_4. The above parameters in the study was observed to perform better in S_3 (Sowing in Middle of October'22), S_2 (Sowing in Middle of September'22), M_4 [Sand + Cocopeat + Vermicompost + Perlite (1:1:1:1)] and M_6 [(Control) Sand + Garden soil + decomposed cow dung (1:1:1)].

Key words : Bhut jolokia, Growing media, Sowing dates, Seedlings.

Introduction

Bhut Jolokia (*Capsicum chinense* Jacq) is a popular spice crop of India. It is from the genus Capsicum under solanaceae family. The number of chromosome (n) is 2n=24. The plant is semi-shrub, woody at the base and perennial in nature. It may grow up to a height of 0.45-1.2 m under favourable environmental conditions (Das *et al*., 2019). Bhut jolokia is native to the North East India which falls under the Indo-Burma centre of origin. It is grown extensively in NE India, mostly in the state of Assam, Manipur and Nagaland (Verma *et al*., 2013). The Bhut jolokia was recognized in the "Guinness book of world records" as the spiciest pepper in the world (with 10,01,304 SHU) in the year 2007 (Bosland and Baral, 2007), until it was replaced by Carolina Reaper in the year 2013. The Naga King chilli of Nagaland got the GI recognition in 2008.

Molecular analysis with RAPD markers showed that Bhut jolokia is an interspecies hybrid, mostly C. chinense with some C. frutescens genes (Bosland and Baral, 2007). It is popularly known as Bhut Jolokia ("Bhut" means "ghost" and "Jolokia" refers to "Capsicum pepper" in Assamese) in Assam (Talukdar *et al*., 2015). Bor-bhut (larger fruit with an average fruit weight of about 7g), Rani-bhot (medium size fruit with an average fruit weight of about 5g), Lota-bhot (the plants have a tendency to

climb and fruits are slender with average weight about 5g) are some of the varieties of Bhut jolokia recorded in Assam (Das *et al.*, 2019). It is rich in vitamins and minerals. It constitutes of, fibre (0.36 ± 0.25%), fat content (1.79 ± 0.28), protein (10.27 ± 0.96%), reducing sugar 1.26 ± 0.06 mg/g, TSS value (0.69 ± 0.02 mg/g). The total phenolic content is (410.76 ± 7.27 mg/g of PE) and carotenoid content is (3.99± 0.64) in dry fruit (Tholemfhuang, 2016). Bhut jolokia has higher capsaicin content (3-5% higher) than any other pepper found in India (Baruah *et al.*, 2014). Capsaicin possesses anti-inflamatory and antioxidant properties (Roy, 2016). Capsaicin also has anticancer properties. It has medicinal properties and is used in traditional remedy in NE India since time immemorial. The capsaicin content in Bhut jolokia may also vary due to geographical and climatic factors of the region (Baruah *et al.*, 2014).

Bhut jolokia is grown under semi shade condition to obtain higher yield. Plants grown in unshade condition gives late, invariable and lesser yield (Baruah *et al.*, 2014). The health of the seedling considerably effect the performance of the plant. In NE India, bhut jolokia are generally grown by transplanting seedlings from the nursery. Direct sowing may be carried out in hilly areas where shifting cultivation (Jhum cultivation) is practiced. In Assam, seedlings are raised in nursery bed. The growing media mixture including garden soil, vermi-compost and sand or garden soil, dry/decomposed cow manure and sand are generally used by the farmers. August to February is generally considered a suitable period for Bhut jolokia seedling production in Assam. It is also to be noted that the different dates of sowing results in differences in temperature, relative humidity etc which in-turn result in variation in growth of the seedlings. The present investigation was carried out to study the effect of different growing media and dates of sowing on seedling growth of Bhut jolokia in Assam. So that a suitable growing media and the most suitable month for seedling production can be achieved in Assam's condition. The study will help the farmers in the state of Assam more precisely the North Bank Plain of the Brahmaputra region in producing a better quality Bhut jolokia seedlings.

Materials and Methods

The investigation was conducted at the Institutional cum Research farm, Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali, during the period from August 2022 to March 2023. The design of the experiment is Factorial RBD with 3 replications and 30 treatment combinations viz. 6 growing media [M_1: Sand + Cocopeat + decomposed cow dung (2:1:1), M_2: Sand + Cocopeat + Vermicompost (2:1:1), M_3: Sand + Cocopeat + Forest Soil (1:1:1), M_4: Sand + Cocopeat + Vermicompost + Perlite (1:1:1:1), M_5: Sand + Cocopeat + Vermicompost (1:1:1) inoculated with Microbial Consortium @ 1g/100g, M_6: (Control) Sand + Garden soil + decomposed cow dung (1:1:1)] and 5 sowing dates (S_1: Middle of August'22, S_2: Middle of September'22, S_3: Middle of October'22, S_4: Middle of November'22, S_5: Middle of December'22). Morphological parameters observed during the experiment includes, seedling height (cm) at 10 days interval after emergence to transplanting, Number of green leaves per seedling at transplanting, Root and shoot length at transplanting. Phenological parameters like Days to seedling emergence, Days to emergence of first leaf, Days to transplanting (5 leaves stage) and Physiological parameters like Seedling vigour index (SVI), Fresh weight of shoot and root (g), Seedling dry weight (g), Leaf area (cm^2) per seedling, Relative leaf water content (RLWC), Total leaf Chlorophyll content (mg g^{-1} fw) were observed respectively. The data pertaining to the present investigation were subjected to the statistical analysis of variance (ANOVA) by Factorial Randomized Block Design by calculating the respective "F" value in accordance with Panse and Sukhatme (1985). The significance of difference between mean values of the character of the treatment was tested by computing critical difference (CD) estimates.

Results and Discussion

Germination parameters

Percentage of seed emergence (%)

Dates of sowing and different growing media significantly influence the germination percentage, which is shown in (Table 1). A higher germination percentage was observed in S_3 (75.87%). In case of different growing media the maximum (84.25%) seed emergence was recorded in M_4 followed by M_6 (82.75%), M_3 (60.81%), M_5 (58.76%), M_2 (48.23%) and minimum (46.33%) seed emergence was recorded in M_1. However, there was no significant difference between M_4 (84.25%) and M_6 (82.75%). The effect of interaction between different growing media and dates of sowing on percentage of seed germination was found to be significant. Seed germination percentage was recorded highest (96.63%) in S_3M_4 and lowest (37.67%) in S_1M_1. Comparable findings was observed by Rosmaina *et al*. (2021) in chilli where lower temperature decreased the germination percentage significantly. Similar findings were stated by Kaymak (2014), who reported that the germination percentage of chilli and brinjal was found to be highest at

Table 1 : Effect of different dates of sowing and growing media on germination and morphological parameters of Bhut Jolokia (*Capsicum chinense* Jacq) seedlings.

Treatments	Germination percentage	Seedling height at 10 DAE	Seedling height at 20 DAE	Seedling height at 30 DAE	No. of leaves at 40 DAS	Root length	Shoot length
S_1	50.89	2.59	3.64	4.51	4.33	8.38	4.98
S_2	62.47	2.63	3.50	4.31	4.07	8.50	4.91
S_3	75.87	2.37	2.96	3.28	3.82	8.62	4.08
S_4	65.66	2.23	2.56	3.00	3.70	6.83	3.10
S_5	62.71	2.35	2.77	3.19	3.56	7.20	3.61
SEd(±)	**1.79**	**0.06**	**0.09**	**0.12**	**0.14**	**0.36**	**0.15**
CD at 5%	**3.60**	**0.12**	**0.19**	**0.25**	**0.28**	**0.73**	**0.30**
M_1	46.33	1.94	2.36	2.68	3.39	7.09	3.13
M_2	48.22	2.13	2.64	3.12	3.85	8.11	3.96
M_3	60.81	2.22	2.65	2.79	3.09	6.91	3.14
M_4	84.25	2.81	3.91	4.91	4.34	8.40	5.24
M_5	58.76	2.38	2.85	3.27	3.96	7.22	3.75
M_6	82.74	3.12	4.10	5.19	4.76	9.70	5.61
SEd(±)	**1.96**	**0.07**	**0.10**	**0.14**	**0.16**	**0.40**	**0.16**
CD at 5%	**3.94**	**0.13**	**0.21**	**0.27**	**0.31**	**0.80**	**0.33**
S_1M_1	37.67	2.00	2.50	2.97	3.83	7.23	3.33
S_1M_2	42.67	2.33	3.03	3.63	4.33	8.90	4.80
S_1M_3	47.67	2.50	2.90	3.37	4.00	7.40	3.47
S_1M_4	54.33	3.10	5.00	6.43	4.33	8.20	6.90
S_1M_5	50.00	2.43	3.10	3.93	4.50	7.27	4.27
S_1M_6	73.00	3.19	5.33	6.73	5.00	11.30	7.17
S_2M_1	44.85	1.93	2.67	3.10	3.47	8.00	3.60
S_2M_2	50.70	2.36	2.97	3.97	3.73	9.17	5.08
S_2M_3	61.07	2.55	2.83	2.63	4.00	7.33	3.17
S_2M_4	80.67	3.29	4.91	6.21	4.67	8.58	6.40
S_2M_5	57.89	2.47	3.09	3.71	3.75	7.10	4.25
S_2M_6	79.65	3.19	4.51	6.26	4.83	10.77	7.00
S_3M_1	55.18	2.03	2.35	2.49	3.33	8.47	3.80
S_3M_2	54.68	1.99	2.48	2.84	3.52	7.57	3.57
S_3M_3	76.54	2.01	2.56	2.67	2.77	8.03	3.37
S_3M_4	96.63	2.55	3.41	4.08	4.67	11.08	4.74
S_3M_5	83.83	2.47	2.97	3.16	3.83	6.78	3.72
S_3M_6	88.36	3.17	4.01	4.47	4.83	9.78	5.28
S_4M_1	46.29	1.73	2.10	2.20	3.17	5.60	2.33
S_4M_2	46.67	1.93	2.30	2.53	3.83	7.03	2.82
S_4M_3	63.09	2.03	2.40	2.59	2.53	5.90	2.70
S_4M_4	95.43	2.70	3.00	3.83	4.00	7.30	3.73
S_4M_5	52.47	2.07	2.43	2.70	4.10	6.50	3.00
S_4M_6	90.00	2.93	3.13	4.07	4.55	8.63	4.00
S_5M_1	47.65	2.00	2.20	2.53	3.17	6.15	2.60
S_5M_2	46.42	2.07	2.43	2.60	3.82	7.87	3.53
S_5M_3	55.68	2.02	2.56	2.70	2.17	5.88	3.00
S_5M_4	94.20	2.43	3.23	4.00	4.01	6.83	4.43
S_5M_5	49.63	2.47	2.67	2.87	3.62	8.45	3.51
S_5M_6	82.72	3.10	3.53	4.43	4.58	8.04	4.60
SEd(±)	**4.39**	**0.15**	**0.23**	**0.31**	**0.35**	**0.89**	**0.37**
CD at 5%	**8.81**	**0.30**	**0.46**	**0.61**	**0.70**	**1.79**	**0.74**

25-30°C and it decreased above 30°C *i.e*. as the atmospheric temperature rise above optimum. So the difference is atmospheric temperature might be a possible reason affecting the germination percentage. Similarly for different growing media, comparable findings were stated by Mahala and Sharma (2022), who reported significantly higher germination percentage (71.11%) in chilli in the growing media consisting of vermiculite + perlite + vermicompost (1:1:2). The results are also in congruence with the findings of Nagu (2020), who also reported high germination percentage (80 %) in perlite media. The higher water holding capacity of cocopeat along with proper aeration in perlite media provided a favourable condition which might be the reason for higher germination in the present experiment.

Morphological parameters

Seedling height (cm) at 10, 20 and 30 days after emergence

Table 1 revealed that there were significant differences in seedling height among the different dates of sowing. The seedling height was significantly higher in S_2 (2.63 cm), which was at par with S_1 (2.59 cm) at 10 (Days after emergence) DAE, in S_1 (3.64 cm) and S_1 (4.51 cm) at 20 and 30 DAE. While the seedling height was lowest in S_4 (2.23 cm, 2.56 cm, 3.00 cm) at 10, 20 and 30 DAE and there was not much variation between them. Similarly significant differences in the seedling height with respect to the different growing media treatments were observed. The seedling height was significantly higher in M_6 (3.12 cm, 4.10 cm, 5.19 cm) at 10, 20 and 30 DAE. The lowest (1.94 cm, 2.36 cm, 2.68 cm) seedling height was recorded in M_1 at 10, 20 and 30 DAE. The effect of interaction between different growing media and sowing dates on seedling height was found to be significantly different. The seedling height was recorded significantly higher in S_2M_4 (3.29 cm) at 10 DAE, while at 20 and 30 DAE in S_1M_6 (5.33 cm, 6.73 cm). The lowest (1.73 cm, 2.10 cm, 2.20 cm) seedling height was recorded in S_4M_1 at 10, 20 and 30 DAE. Similarly findings were observed by Rosmaina et al. (2021) who reported that the height of chilli seedlings was significantly higher (6.61 cm) at 37°C and decreased above 37°C temperature. The seedling height also decreased at very low temperature. The difference in temperature is due to the difference in dates of sowing. For different growing media, comparable study were given by, Shashikant (2021) reported that in chilli the rootstock and scion height was significantly higher in media cocopeat (75%) + vermicompost (25 %) at 7, 14, 21, 28, 35, 42 and 49 (days after germination) DAG and lowest in media (cocopeat 75% + sawdust 25%). Similarly, Mathowa *et al*. (2017) also revealed that the height of pepper seedling in cocopeat based media was significantly low.

Number of green leaves per seedling at 40 Days after sowing

The number of leaves per seedling was significantly influenced by the different sowing dates and growing media (Table 1). The maximum (4.33) number of leaves were obtained in S_1 followed by S_2 (4.07), S_3 (3.82) and S_4 (3.70). And the lowest (3.56) value was recorded in S_5. Among the different growing media, the highest (4.76) value was observed in M_6 followed by M_4 (4.34), M_5 (3.96), M_2 (3.85), M_1 (3.39) and the least (3.09) value was observed in M_3. There was significant variation among all the interaction. The number of leaves per seedling varied from the highest (5.00) in S_1M_6 to the lowest (2.17) in S_5M_3. The most probable reason assigned for variation in leaf number might be related to difference in the atmospheric temperature at different dates of sowing. For different growing media, Mahala and Sharma (2022) reported significantly higher number of leaves (5.62) in chilli in the growing media (Vermiculite + Perlite + Vermicompost) followed by 5.01 number of leaves in the media (Sand + Soil + Farmyard manure). Similarly, Ramadani *et al*. (2012) reported significantly higher number of leaves (4.57) in chilli in the growing media, Peat + Perlite (3:1) and the least number of leaves (2.78) in media (Peat+ Perlite, 1:1). In another study, Demir *et al*. (2010) revealed that the number of leaves was significantly higher (6.35) in growing media Turf + Zeolite + Perlite (2:1:1) followed by 4.85 in media Turf + perlite (3:2) and 3.65 in media (100% perlite). A higher number of leaves is generally found in media mixture containing perlite and other organic media.

Root and Shoot length (cm) of seedling at transplanting

The variation in the root length of seedling (Table 1) was found to be statistically different. It was observed that maximum (8.62 cm) root length was recorded in S_3 which was at par with S_2 (8.50 cm) and S_1 (8.38 cm), whereas the minimum (6.83 cm) value was recorded in S_4. The root length was significantly influenced by the different growing media. The highest (9.70 cm) root length was observed in M_6 followed by M_4 (8.40 cm), M_2 (8.11 cm), M_5 (7.22 cm), M_1 (7.09 cm) whereas, the least (6.91 cm) value was observed in M_3 and it was at par with M_1 (7.09 cm). The effect of interaction between the growing media and dates of sowing also showed a significant difference (Table 1). The root length varied from 11.30 cm (highest) in S_1M_6 to 5.60 cm (lowest) in S_4M_1 among

all the treatment combinations. With regards to sowing dates, significantly higher (4.98 cm) shoot length was recorded in S_1 followed by S_2 (4.91 cm), S_3 (4.08 cm) and S_5 (3.61 cm). The lowest shoot length was observed in S_4 (3.10 cm). Among the different growing media, the significantly higher (5.61 cm) shoot length was observed in M_6 followed by M_4 (5.24 cm), M_2 (3.96 cm), M_5 (3.75 cm) and M_3 (3.14 cm). The lowest (3.13 cm) shoot length was recorded in M_1. The effect of interaction between the different growing media and sowing dates showed a significant difference. The shoot length varied from 2.33 cm (lowest) in S_4M_1 to 7.17 cm (highest) in S_1M_6 among all the treatment combination. The variation in root and shoot length at the time of transplanting (5 leaf stage) might be due to variation in atmospheric temperature at different sowing dates, Similar result was recorded by Rosmaina *et al*. (2021), where the shoot and root length in chilli was significantly higher at 39°C and decreases at temperature above and below 39°C. Comparable findings were observed for different growing media. Mahala and Sharma (2022) reported that the height of the chilli seedling was significantly higher (9.8 cm) in the growing media consisting of vermiculite + perlite + vermicompost (1:1:2) followed by 8.41 cm in media farm yard manure + sand + soil (2:1:1), and minimum (7.01 cm) in cocopeat + vermiculite + perlite (2:1:1). Shashikant (2021) also reported that the seedling height of chilli rootstock was significantly higher (12.49 cm) in media cocopeat (75%) + vermicompost (25 %) and lowest (8.53) in media (cocopeat 75% + sawdust 25%) at 49 days after germination. Some study also proves that the pepper seedling emerged in cocopeat media but remains stunted with minimal growth (Mathowa *et al.*, 2017).

Phenological parameters

Days to seedling emergence

There was significant variation in days to seedling emergence. Data presented in (Table 2) revealed that among the different dates of sowing, S_1 required the shortest period (8 days) for seedling emergence followed by S_2 (8.28 days), S_3 (8.5 days), S_4 (13.72 days) and S_5 (16.22 days). And among the different growing media, the seeds were observed to emerge earlier in M_6 (8.8 days) followed by M_4 (9.2 days), M_2 (10.47 days), M_1 (12.33 days), M_3 (12.33 days) and M_5 (12.93 days) required the longest period for seedling emergence. The interaction between dates of sowing and growing media also significantly affected the number of days required for emergence of seedlings. Depending upon the treatment combinations, days required for seed emergence ranged from 6.33 days (S_1M_6) to 19.33 days (S_5M_5). Seeds sown in mid-August (S_1) required lesser time and in mid-December (S_6) required maximum time for seed emergence irrespective of the growing media, which might be due to the higher temperature prevailing in the month of August and decreased steadily up to December. In a similar study, Soltani et al. (2006) reported significantly lower (5.80) days to seedling emergence in August in chickpea and highest (18.1 days) in December. For different growing media, similar results were observed by Shashikant (2021) where the days to emergence was significantly higher (8 days) in cocopeat media and lower (7 days) in cocopeat+ vermicompost media in chilli.

Days to emergence of first leaf

The data presented in Table 2 on the number of days required for emergence of first leaf showed significant variation among the dates of sowing S_5 recorded significantly longer period (27.70 days) for emergence of first leaf, which was at par with S_4 (25.16 days). The shortest period for emergence of first leaf was recorded in S_1 (14.42 days). Application of different growing media significantly influenced the days to emergence of first leaf. M_1 recorded the longest period (23.48 days). And the shortest duration was observed in M_6 (15.94 days). The interaction among the dates of sowing and growing media had significant influence on the days to emergence of first leaf. Among all the treatment combinations, S_1M_6 records the minimum days (10.87 days) for emergence of first leaf, and it was at par with S_2M_6 (11.33 days) and S_2M_4 (11.67 days). The most probable reason for variation in the number of days required for emergence of first leaf might be due to the decrease in atmospheric temperature from the month of August to December, 2022. In the present experiment, media with higher proportion of cocopeat show delay in growth in bhut jolokia seedlings. Similarly, Mathowa *et al*. (2017) reported that the chilli seedlings germinate in cocopeat media but the growth of the seedling were delayed and sometimes remain stunted. And a further study in the matter is required.

Days to transplanting

In regards to the number of days required for transplanting (5 leaves stage), the differences among the dates of sowing showed highly significant results as presented in Table 2. The longest (70.63 days) number of days required for transplanting was recorded in S_4 followed by S_5 (67.72 days), S_3 (58.55 days) and the minimum number of days was recorded in S_2 (43.56 days) which was at par with S_1 (44.03 days) and it varied significantly from the other dates of sowing. The growing media, M_1 recorded significantly the longest period (61.51

Table 2 : Effect of different dates of sowing and growing media on the phenological parameters of Bhut Jolokia (*Capsicum chinense* Jacq) seedlings.

Treatments	Days to seedling emergence	Days to emergence of first leaf	Days to transplanting
S_1	8.00	14.42	44.03
S_2	8.28	14.56	43.56
S_3	8.50	19.17	58.55
S_4	13.72	25.16	70.63
S_5	16.22	27.70	67.72
SEd(±)	**0.32**	**0.40**	**1.00**
CD at 5%	**0.65**	**0.80**	**2.01**
M_1	12.13	23.48	61.51
M_2	10.47	20.61	57.67
M_3	12.13	21.75	60.22
M_4	9.20	16.91	51.31
M_5	12.93	22.51	58.86
M_6	8.80	15.94	51.81
SEd(±)	**0.35**	**0.44**	**1.10**
CD at 5%	**0.71**	**0.88**	**2.20**
S_1M_1	8.67	18.67	49.00
S_1M_2	7.67	13.00	43.00
S_1M_3	9.00	17.07	47.40
S_1M_4	6.67	11.90	39.90
S_1M_5	9.67	15.00	44.67
S_1M_6	6.33	10.87	40.20
S_2M_1	8.67	18.67	50.33
S_2M_2	9.00	15.00	43.33
S_2M_3	9.33	15.33	45.00
S_2M_4	6.67	11.67	40.33
S_2M_5	9.33	15.33	42.33
S_2M_6	6.67	11.33	40.00
S_3M_1	9.00	20.89	65.22
S_3M_2	9.33	21.87	63.20
S_3M_3	8.67	20.03	63.03
S_3M_4	7.33	16.10	48.10
S_3M_5	9.33	20.32	62.66
S_3M_6	7.33	15.78	49.11
S_4M_1	16.67	28.83	72.00
S_4M_2	11.33	24.83	70.71
S_4M_3	16.33	27.83	74.17
S_4M_4	11.00	21.10	66.76
S_4M_5	17.00	29.67	73.67
S_4M_6	10.00	18.67	67.00
S_5M_1	17.67	30.33	71.00
S_5M_2	15.00	28.33	68.67
S_5M_3	17.33	28.50	71.50
S_5M_4	14.33	23.77	61.43
S_5M_5	19.33	32.22	71.00
S_5M_6	13.67	23.06	62.72
SEd (±)	**0.79**	**0.98**	**2.45**
CD at 5%	**1.58**	**1.97**	**4.92**

days) for transplanting followed by M_3 (60.22 days) and M_5 (58.86 days). While M_4 recorded the shortest period (51.31 days) for transplanting, and was at par with M_6 (51.81 days). Among the interaction between dates of sowing and growing media, S_1M_4 recorded the minimum days (39.90 days) to transplanting and it was at par with S_2M_6 (40.00 days), S_1M_6 (40.20 days), S_2M_4 (40.33 days) and S_2M_5 (42.33 days). It was observed that the transplanting time gradually increases in November, 2022 and December, 2022 sowing, which might be due to the decline in atmospheric temperature in winter months which lowered seedling growth. Thus, more days is required for attaining transplanting size. For different gowing media, in a similar experiment Shashikant (2021) found that under controlled environment condition the scion seedling of chilli grown in 100% cocopeat and 75% cocopeat + 25% vermicompost media attain transplanting stage at 35- 42 days after germination and in rootstock seedling 42-49 days after germination.

Physiological parameters

Seedling vigour index

From Table 3, it was revealed that the seedling vigour index vary significantly among the different dates of sowing. Among the different sowing dates, the highest (981.90) seedling vigour was obtained in S_3 (October, 2022) followed by S_2 (September, 2022) and S_1 (August, 2022), which might be due to the favourable atmospheric conditions. It decreased as the atmospheric temperature drops in S_4 (November, 2022) and S_5 (December, 2022).

It was observed that the seedling vigour index showed significant variation. Among the various growing media, the highest (1,255) SVI was recorded in M_6 (Control) Sand + Garden soil + decomposed cow dung followed by (1,135) in M_4 (Sand + Cocopeat + Vermicompost + Perlite). Similarly, Alam *et al*. (2014) revealed that the SVI of tomato seedling was significantly higher (2351) in Tricho-compost followed by (1899) in vermicompost and

the least (587.9) value was recorded in kitchen compost. Atif *et al*. (2016) revealed that the seedling vigour index in tomato seedling was significantly higher (3325) in peat + compost + traditional practicing media (1:1:1) followed by 3204 in peat + traditional practicing media (1/2:1) and the least was recorded in Traditional practicing media (*i.e.* Soil + Sand + FYM, 1:1:1).

There was significant variation in the seedling vigour index due to the interaction effects between the different dates of sowing and growing media. Seedling vigour index in S_3M_4 was significantly higher (1528.57) among all the treatment combinations, and it was at par with S_2M_6 (1,414.42). And the minimum (367.17) seedling vigour index was recorded in S_4M_1.

Fresh weight and dry weight of seedling

The sowing dates and growing media significantly influence the seedling fresh and dry weight, which is shown in Table 3. Among the different sowing dates, S_2 (September) significantly showed highest (0.791 g) seedling fresh weight followed by S_3 (0.745), S_1 (0.620 g), S_5 (0.433 g) and S_4 (November) records lowest (0.312 g) seedling fresh weight. This result is corroborated with the finding of Nafees *et al*. (2019), where that the fresh weigh of 10 days old tomato seedling was highest (0.236 g) at 40°C (primed seeds) and lowest (0.190 g) at 10°C temperature in non-primed seeds. Here the atmospheric temperature along with other factors influences the seedling fresh weight. For different growing media, higher (1.110 g) seedling fresh weight were obtained in M_6 followed by M_4 (0.897 g), M_5 (0.449 g), M_2 (0.444 g), M_3 (0.353 g) and M_1 (0.227 g). Significantly, the lowest (0.227 g) seedling fresh weight was obtained in M_1. These findings are in conformity with Rahimi *et al*. (2013), who found that the seedling fresh weight in cocopeat + sand was 0.39 g, which was almost similar to (0.353 g) recorded in M_3 (Sand + Cocopeat + Forest Soil) in the present experiment. Among the interactions, the highest (1.509 g) seedling fresh weight was recorded in S_2M_6 and the lowest (0.112 g) seedling fresh weight was recorded in S_4M_3. The fresh weight is largely influenced by the water state in the plant. So, variation might be due to the difference in water uptake by the seedlings, atmospheric temperature, relative humidity etc.

The different dates of sowing significantly influenced the seedling dry weight. The seedling dry weight was maximum (0.092 g) in S_2 (September, 2022) and minimum (0.036 g) in (December, 2022) which might be due to the gradual decrease in atmospheric temperature from September to December. Similarly, Nafees *et al*. (2019) also reported significantly higher (0.016 g) dry weight of 10 days old tomato seedling at 40°C (primed seeds) and lowest (0.013 g) at 10°C temperature in non-primed seeds. Among the different growing media, significantly higher (0.102 g) dry weight was recorded in M_6 (Control) (Sand + Garden soil + decomposed cow dung) and the lowest (0.037 g) was recorded in M_1 (Sand + Cocopeat + decomposed cow dung). In a similar experiment, Rahimi *et al*. (2013) found that the dry weight of sweet pepper grown in cocopeat was (0.00 g), sand + cocopeat (0.00 g), sand (0.02 g), field soil + sand (0.01 g) and field soil was (0.02 g) at transplanting stage. And seedling dry weight of 0.032 g in cocopeat (100%) and 0.019 g in cocopeat (75%) + vermicompost (25%) in chilli was observed by Shashikant (2021).

Leaf area (cm^2) per seedling

The present study revealed that the total leaf area was significantly highest (16.04 cm^2) in S_2 (September, 2022) followed by S_3 (October, 2022) (15.58 cm^2) and S_1 (August, 2022) (15.54 cm^2), and it decreased considerably in S_4 (November, 2022). Similarly, Kirtikumar (2009) reported that the total leaf area of papaya seedling was significantly higher in 1st August sowing and lowest in 15th July sowing. He concluded that the results might be due to the prevailing favourable temperature (25.2°C minimum and 31.9°C maximum), relative humidity and low wind velocity. The difference in leaf area in the present experiment might be due to the different atmospheric environment at different sowing dates.

Among the different growing media, the leaf area was found to be significantly higher (20.73 cm^2) in M_6 (Control) (Sand + Garden soil + decomposed cow dung) followed by 20.69 cm^2 in M_4 (Sand + Cocopeat + Vermicompost + Perlite) and the minimum value (7.63 cm^2) was recorded in M_1 (Sand + Cocopeat + decomposed cow dung). In a similar experiment, Ramadani *et al*. (2012) found that the leaf area of a single leaf in chilli grown in peat + perlite + organic matter (1:1:2) was 3.62 cm^2, which was similar to the present experiment (in M_4) as far as single leaf of a seedling is concern.

The effect of interaction between the growing media and sowing dates showed a significant difference. The highest (25.56 cm^2) leaf area was recorded in S_2M_6 followed by S_3M_4 (25.21 cm^2), S_2M_4 (25.13 cm^2), S_5M_2 (23.37 cm^2) and S_3M_6 (23.14 cm^2) which was at par with each other. The leaf area was lowest (3.25 cm^2) in S_4M_3 and was found to be at par with S_4M_1 (4.77 cm^2), S_5M_3 (5.10 cm^2), S_2M_1 (5.20 cm^2) and S_5M_1 (5.74 cm^2).

Relative leaf water content

Relative leaf water content (RLWC) is an important

Table 3 : Effect of different sowing dates and growing media on the physiological parameters of Bhut Jolokia (*Capsicum chinense* Jacq) seedlings.

Treatments	Seedling Vigour Index	Fresh weight of seedling	Dry weight of seedling	Leaf Area	RLWC	Total Chlorophyll
S1	705.76	0.620	0.092	15.54	83.00	0.195
S2	859.79	0.791	0.086	16.04	86.08	0.175
S3	981.90	0.745	0.085	15.58	86.69	0.270
S4	676.17	0.312	0.036	9.55	79.50	0.134
S5	690.81	0.433	0.050	14.81	81.33	0.151
SEd(±)	**31.10**	**0.019**	**0.003**	**0.52**	**2.01**	**0.005**
CD at 5%	**62.42**	**0.038**	**0.006**	**1.04**	**4.03**	**0.010**
M1	475.27	0.227	0.037	7.63	80.70	0.157
M2	581.21	0.444	0.076	14.92	83.73	0.186
M3	611.66	0.353	0.041	8.04	81.37	0.145
M4	1135.30	0.897	0.090	20.69	87.63	0.212
M5	638.89	0.449	0.073	13.81	80.40	0.189
M6	1255.00	1.110	0.102	20.73	86.10	0.222
SEd(±)	**34.07**	**0.021**	**0.003**	**0.57**	**2.20**	**0.006**
CD at 5%	**68.38**	**0.042**	**0.007**	**1.14**	**4.41**	**0.011**
S1M1	395.60	0.246	0.044	10.75	77.17	0.184
S1M2	586.87	0.552	0.112	22.98	85.67	0.204
S1M3	519.73	0.457	0.070	12.63	76.17	0.104
S1M4	821.77	0.943	0.103	16.85	87.83	0.234
S1M5	565.83	0.432	0.097	13.64	82.83	0.243
S1M6	1344.77	1.088	0.124	16.41	88.33	0.204
S2M1	520.54	0.299	0.059	5.20	85.33	0.132
S2M2	721.39	0.482	0.102	8.30	84.67	0.146
S2M3	636.23	0.536	0.082	11.70	81.00	0.144
S2M4	1211.48	1.405	0.111	25.13	91.33	0.208
S2M5	654.66	0.517	0.064	20.34	82.33	0.217
S2M6	1414.42	1.509	0.097	25.56	91.83	0.200
S3M1	676.52	0.319	0.052	11.70	87.33	0.233
S3M2	609.13	0.451	0.092	12.66	85.67	0.253
S3M3	862.31	0.539	0.025	7.53	80.00	0.255
S3M4	1528.57	1.061	0.090	25.21	89.33	0.338
S3M5	884.26	0.654	0.123	13.24	86.17	0.234
S3M6	1330.64	1.446	0.127	23.14	91.67	0.308
S4M1	367.17	0.132	0.013	4.77	72.67	0.159
S4M2	459.54	0.201	0.026	7.27	75.00	0.110
S4M3	544.16	0.112	0.012	3.25	86.67	0.118
S4M4	1052.72	0.487	0.065	15.28	90.17	0.138
S4M5	496.46	0.255	0.033	9.97	73.17	0.075
S4M6	1137.00	0.683	0.066	16.77	79.33	0.205
S5M1	416.53	0.142	0.016	5.74	81.00	0.078
S5M2	529.11	0.535	0.049	23.37	87.67	0.218
S5M3	495.85	0.119	0.015	5.10	83.00	0.106
S5M4	1061.94	0.589	0.081	20.98	79.50	0.140
S5M5	593.26	0.389	0.048	11.88	77.50	0.174
S5M6	1048.18	0.825	0.094	21.76	79.33	0.193
SEd(±)	**76.19**	**0.046**	**0.008**	**1.27**	**4.92**	**0.013**
CD at 5%	**152.91**	**0.093**	**0.015**	**2.55**	**9.87**	**0.025**

indicator of the water status in plants. It maintains an equilibrium between the water supply and the rate of transpiration in a leaf (Lugojan and Ciulca, 2011). The relative leaf water content showed significant variation among the different sowing dates and growing media used. The maximum (86.69%) RLWC was observed in S_3 (October, 2022) and minimum (79.50%) in S_4 (November, 2022), which might be due to various factors including, atmospheric temperature, moisture content in the media, relative humidity etc. It was observed that M_4 (Sand + Cocopeat + Vermicompost + Perlite) recorded the highest (86.69%) RLWC which might be due to its porous structure (perlite) and better water retention capacity (cocopeat) of the media.

The relative leaf water content showed significant variation among the interaction between the sowing dates and growing media. S_2M_6 recorded the maximum (91.83%) relative leaf water content among all the treatment combinations, while S_4M_1 recorded the minimum (72.67%) relative leaf water content.

Total leaf Chlorophyll content (mg g^{-1} f w)

Chlorophyll is produced from photosynthesis under favourable condition for growth. The results in Table 3 indicate that the total leaf chlorophyll content was maximum (0.270 mg g^{-1} fw) in S_3 (October) and was minimum (0.134 mg g^{-1} fw) in S_5 (December). Among the different growing media, the total leaf chlorophyll content was maximum (0.222 mg g^{-1} fw) in M_6 (Control) (Sand + Garden soil + decomposed cow dung) followed by (0.212 mg g^{-1} fw) in M_4 (Sand + Cocopeat + Vermicompost + Perlite). The seedling growth was also higher in M_6 and M_4. The minimum value (0.157 mg g^{-1} fw) was recorded in M_3 (Sand+ Cocopeat +Forest soil). The interaction between different growing media and dates of sowing on the total chlorophyll content was found to be significantly different. The total chlorophyll content was recorded highest (0.338 mg g^{-1}fw) in S_3M_4 and lowest (0.075 mg g^{-1}fw) in S_4M_5. The total chlorophyll content was recorded to be very low for all the treatments, which might be due to non-attainment of the active growth of the crop.

Incidence of diseases and pests

From the present investigation, damping off of seedlings was recorded irrespective of the different growing media used. The maximum disease incidence was recorded in S_3 (October, 2022) which might be due to the prevailing favourable condition for the pathogen i.e. rainfall, temperature and higher relative humidity during the month of October, 2022.

The seedlings were infested with aphid and whitefly during the month of December, 2022, January and February, 2023 which might be due to the favourable condition (temperature) prevailing during these months. The seedlings were not severely infested as the insect pest were controlled at the earliest by spraying 3% Neem oil.

Conclusion

The present findings revealed that there was significant variation of germination, morpho-physiological and phenological parameters among the different sowing dates and growing media in Bhut jolokia seedlings. The seedlings from S_3 (October, 2022) were found to be superior or at par for most of the characters studied viz. germination per cent, days to seedling emergence, root length, leaf area, seedling vigour index, RLWC, total chlorophyll content and was followed by S_2 (September, 2022). It was also found that the disease incidence was higher in S_3 (October, 2022) than the other sowing dates. Among different growing media, the performance of M_6 (Control) (Sand + Garden soil + decomposed cow dung) and M_4 (Sand + Cocopeat + Vermicompost + Perlite) were found better and almost equivalent. In contrast, the benefit cost ratio was higher in M_6 (Sand + Garden soil + decomposed cow dung). Therefore, from the study it may be concluded that the best sowing time for nursery production of Bhut jolokia seedlings in Assam is September and the best growing media combination of (Sand + Garden soil + decomposed Cow dung, 1:1:1). may be recommended.

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