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Performance of garlic (*Allium sativum* L.) germplasm/ varieties as affected by the planting time in North Eastern India

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Abstract
A field experiment was conducted during the *rabi* 2013 and 2014 in the Experimental Farm of Department of Horticulture, Assam Agricultural University (AAU), Jorhat to study the optimization of best planting planting date in terms of yield of nine selected germplasm/ varieties of garlic (*Allium sativum* L.). The growth and yield attributing characters like plant height, leaves per plant, leaf area index, bulb weight, bulb diameter, clove per bulb, 100 clove weight, bulb yield, SPAD (Soil Plant Analysis Development) value (Chlorophyll), Ascorbic Acid content and TSS (Total Suspended Solids) decreased significantly with the delay in planting time. The interactive results revealed planting of garlic cloves on 15 October recorded the highest growth parameters and yield in case of Bhima Omkar variety (11.51 t ha^{-1}) which was *at par* with Ekfutia Assam (10.03 t ha^{-1}) followed by Assam Local (9.43 t ha^{-1}).

Keywords: Garlic, cultivar, planting time, yield attributing parameters

Introduction
Garlic (*Allium sativum* L.), a member of Amaryllidaceae family is the world's second most important widely cultivated bulbous crops after the onion. Garlic is a very important aromatic herbaceous, annual spice that has been cultivated for last 3000 years (Kurian, 1995; Allen, 2009) [24, 3]. It is also a good foreign exchange earner crop as fresh garlic is exported to over 38 countries. In the year 2020-21 (April - November), India has exported fresh garlic worth of 3.64 USD million. India ranks second after China in world's garlic production (Guevara Figueroaa *et al*., 2015; FAO Stats, 2019) [20, 16]. After the Covid-19 pandemic, its demand has grown many folds due to its numerous health beneficial compounds that have the potential to influence immunity (Batiha *et al*., 2020) [9]. Garlic is a source of various biologically active phytomolecules including polyphenols (phenols, flavonoids), alkaloids and vitamins. Major phenolics present in garlic are flavonoids and can be classified in different sub-classes (flavones, flavanones, flavonols, isoflavones, flavanonols, flavanols, chalcones and anthocyanins) according to the degree of unsaturation and degree of oxidation of the 3-carbon skeleton.

The growth period of garlic requires cool season (Del Pozo and Gozalez, 2005) [15]. The plant requires cool and moist period during growth and development stage and relatively dry period during maturity stage of bulbs. Temperature ranging from 20 °C or 25 °C and longer photoperiod (14 h) significantly enhanced the garlic bolting, bulbing and cloving with a shorter growth period and a higher bulb weight (Wu *et al*., 2015) [38]. A long photoperiod of more than two weeks is required for dormancy induction of axillary buds and bud formation. Long-photoperiod conditions trigger the initial elongation of flower stalks (Kamenetsky *et al*., 2004; Mathew *et al*., 2010) [21, 25]. Meanwhile, the bulbing and cloving of garlic are influenced by the length of the day (Bandara *et al*., 2000) [6]. In general, low initial temperatures followed by long days are essential for bolting and the formation of bulbs and cloves (Kolev, 1962[23]). Garlic is grown in many parts of North Eastern India, which is sub-tropical in nature, including Assam where it is mostly grown in *rabi* season. The mean winter temperature from October to March ranges from 16-17 °C and 25-28 °C. Thus, the life cycle of garlic from late plantings are extended to the period when temperature becomes high and rainfall starts, which hampers the growth and development. Moreover, growth and development of the garlic bulbs depend on the adequate translocation of photosynthetic substrates from leaves to bulbs which requires

warm temperature during that period for initiation of bulbing (Kamenetsky *et al*., 2004) [21]. But the change in climatic condition has resulted in early onset of warm temperature leading to early initiation of bulbing without proper vegetative growth which leads to lowerproduction and in some cases a percentage of the plant does not initiate bulbs at all. Among different factors effecting growth, yield and quality of garlic, time of planting and selection of cultivars appears to be the most important factors for maximizing growths and better quality garlic production (Singh *et al*. 2010) [34]. Weather condition and character of cultivars has a high bearing on sprouting of clove, growth of plant, bulb formation and bulb development and finally influencing the yield. Mechanization is also one of the important factors which provide time for sound farm management practices ultimately leads to increase in farm production (Barman and Deka, 2019) [19a]. The low production leads to wide range of price variation in the market. As such, the present investigation was aimed to study the response of some garlic germplasm/ varieties to different months of planting in Assam, India with an objective to find the most suitable date for garlic planting in the region.

2. Materials and Method

The experiment was carried out in the Experimental Farm of Department of Horticulture, Assam Agricultural University, Jorhat (26°47'N latitude and 94°12"E longitude and an elevation of 86.6 m above mean sea level), Assam during the year 2013-14 and 2014-15. Seven garlic germplasm (*viz.*, Ekfutia Assam, Assam Local, Local Meghalaya 1, Local Meghalaya 2, Local Nagaland 1, Local Nagaland 2, Local Manipur) were collected from local races of Assam, Manipur, Meghalaya and Nagaland, and two varieties (*viz.*, Bhima Omkar and Bhima Purple) from Directorate of Onion and Garlic Research, Nashik, India. The crop was planted in three different dates (*viz.*, 15 October, 15 November and15 December) following the standard recommended agronomic practices (Anonymous, 2009) [4]. The experiment was laid out in Factorial Randomized Block Design with three replications.

The meteorological data during the period of experimentation were obtained from the Department of Agrometeorology, AAU, Jorhat (Fig. 1 and 2). The plant height, leaves per plant and leaf area index were taken at 30 days intervals up to 120 days from ten randomly selected plants plot^{-1}and other yield attributing characters (such as bulb weight, bulb diameter, clove/bulb, 100 clove weight, bulb yield, SPAD value, Ascorbic acid and TSS) were recorded during harvesting of the crop. Ascorbic acid was determined by the 2, 6-dichlorophenol indophenol (DCPIP) titration procedures based on the method of Casanas *et al.* (2002) [13]. Total soluble solid of garlic bulbs was determined according to AOAC (2003) [5] using hand Refractometer, and were expressed as ºBrix. The area of fresh green leaves for each treatment was measured using SPAD -502 Plus. Harvesting was done when plants become yellowish and break at neck portion and start drying. All corresponding observations made during the two years of experimentation and data obtained from laboratory analyses were pooled and subjected to analysis of variance by F test given by Panse and Sukhatme (1967) [36]. The critical difference (CD) values were calculated at 5 per cent level.

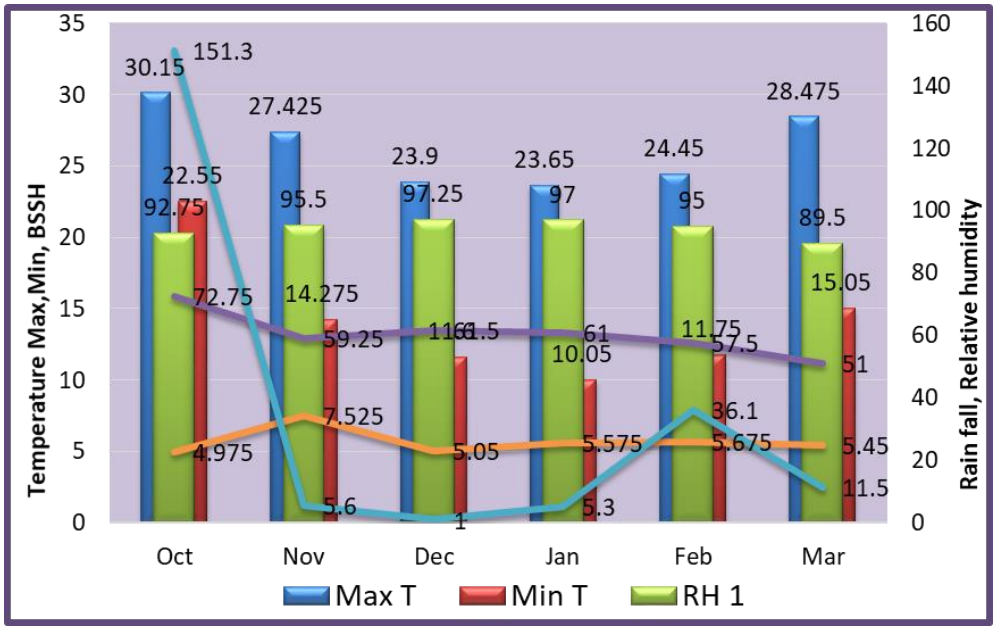

Fig 1: Meteorological parameter, 2013-14

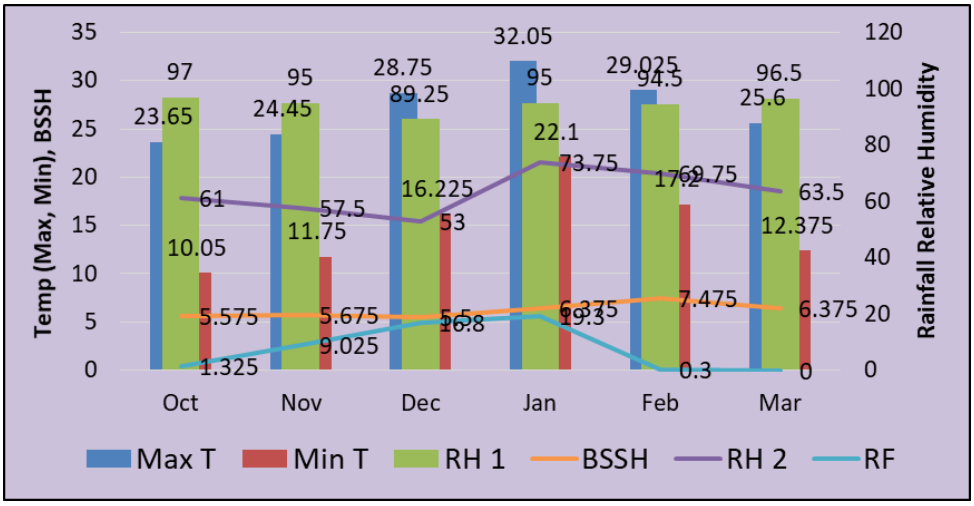

Fig 2: Meteorological parameter, 2014-15

3. Results and Discussion

The planting of garlic cloves on 15 October significantly increased the yield attributing parameters like plant height (7.94, 11.82, 20.57 and 20 60 cm), leaves per plant (3.59, 5.18, 6.00 and 6.63) at 30, 60, 90 and 120 days after planting (DAP) (Table 1). This significantly higher plant height and leaves per plant at 30, 60, 90 and 120 DAP attributed to early date of planting of garlic *i.e.* October as compared to the other dates of planting *viz*., 15 November and 15 December. These significant variations are the result of vigorous vegetative growth due to the favourable climatic conditions like temperature, humidity and rainfall during the October sowing. These significant variations in growth characters may be attributed to vigorous vegetative growth during the early date of October sowing, which resulted from favourable climatic conditions including temperature, humidity and photo period, the most important environment factors for growth of crops. (Teshale and Tekeste, 2021) [36].

The vigorous vegetative growth in garlic plants resulted in production of more leaves which helped in the synthesis of more photosynthates. This resulted in increased accumulation of carbohydrates and other metabolites which ultimately determined the size and weight of bulbs. The cloves planted on 15 November and 15 December resulted in poor growth characters. This might be due to the unfavorable climatic conditions like low temperature, less humidity and no rainfall during this period which caused reduced photosynthetic activity thus lesser foliage area which resulted in lower yield of bulbs. In late planting of garlic, there is rise in temperature during the growth period which increases the rate of respiration resulting in more utilization of carbohydrates and other products of photosynthesis for plant growth. This resulted in availability of lesser quantity of assimilates for translocation from source to sink during the bulbing period thus reducing the yield.

From these findings it is apparent that these germplasms/ varieties were either better suited to existing climatic conditions or were having characteristics of producing higher plant height, more leaves, in any given environment. The growth, development and yield of crop are determined by the function of number of biological and climatological factors working either independently or interacting together. The various biological factors are beyond control yet some are tamed but the climatic factors are not controllable under field conditions. Thus, the better adaptability of these cultivars are evidenced by the poor performance shown by germplasm collected from some neighbouring North Eastern states of Assam. High range of variability among garlic genotypes has been well demonstrated by several researchers (Tiwari *et al*., 2002; Singh and Chand, 2003; Girinaik *et al*., 2005; Shashidhar *et al*., 2005; Khar *et al*., 2006; Futane *et al*., 2006; Choudhary and Chatterjee, 2009) [37, 35, 18, 31, 22, 17, 14]. Gowda *et al*. (2007) [19] also reported the superiority of local genotypes with respect to plant height, stem girth and leaf number to other genotypes.

Early date of planting on 15 October significantly increased the yield parameters like fresh bulb weight (12.71 g), dry bulb weight (5.22 g), bulb diameter (2.63 cm), number of cloves/bulb (8.59), 100 clove weight (103.15 g) and bulb yield (7.46tonnesha^{-1}) in comparison to later months of sowing (Table 2). The early date of sowing significantly influenced the fresh bulb weight, dry bulb weight, bulb diameter, number of cloves/bulb, 100 clove weight and bulb yield. The significant improvement in yield attributes of garlic with the date of planting could be ascribed to overall improvement in vigour and crop growth. Since an early date of sowing is considered important in promoting rapid vegetative growth like plant height, number of leaves/plant and LAI thereby increasing the sink size in terms of bulb size. Thus, vigorous growth in garlic means production of more leaves, which helped in the synthesis of more photosynthates and thus resulting in increased accumulation of carbohydrates and other metabolites which ultimately determined the size and weight of bulbs. Late planted crops made poor vegetative growth, thus causing reduced photosynthetic activity due to lesser foliage area which resulted lower yield of bulbs in crops planted on 15 November and 15 December. The results showed that different dates of sowing provided the variable atmosphere to the crop, thus affecting the yield significantly. Earliest planting gave the highest bulb weight may be due to plant received cool temperature for longer period which possibly increased the vegetative growth and yield of bulb. The present trend of increase in bulb yield of garlic with the early date of planting is in close conformity with the findings of Rahim *et al.* (2003) [28], Rahman *et al.* (2004) [29] and Singh *et al*. (2010) [34].

Planting garlic on 15 October recorded significantly taller plants with more number of functional leaves in comparison to other planting dates. The other morphological traits of yield component, *viz*. bulb diameter, clove number and yield were

also found to be significantly influenced by planting dates. The increase in plant height and leaf number recorded in 15 October planting may be due to more favourable climatologic conditions as obtained by garlic in respect of higher and longer maximum and minimum temperatures, higher rainfall and longer bright sunshine hours which exerted beneficial effects on yield attributing traits which was found evident by increase in bulb fresh and dry weight, bulb diameter, cloves bulb^{-1}, 100 clove weight, and yield. Singh *et al.* (2010) [34] and Rahman *et al*. (2004) [29], also reported that planting date effects on the growth and yield and also found that bulbing of garlic is controlled by the day length and temperature due to which it remains dormant during initiation and development. Rahim *et al*. (2003) [28] reported that 40% yield reduction in garlic when planting was delayed by 40 days after October 31. Siddique and Rabbani (1985) [32] also reported that growth, bulb size and yield were reduced due to delay in planting. The results are in conformity with the findings of Abedi *et al*. (2013) [1] and Abou El-Magd *et al.* (2013) [2]. Again sowing, irrigation and intercultural operations etc. has inverse relationship with farm mechanization and in case of mechanized and bullock operated farm labour employment and farm size has negative correlation (Barman and Deka, 2019b).

Early date of planting of cloves on 15 October significantly increased the TSS content and ascorbic acid content of bulb under present study. SPAD value (32.54), TSS content (33.90 ^{o}B) and ascorbic acid (0.33 mg g^{-1}) significantly increased with the early date of planting. This may be due to the vigorous vegetative growth and imparted deep green colour to the foliage which favour higher photosynthetic activity of the plants. So, there was greater accumulation of food material, carbohydrates in the bulb and there was more synthesis of TSS content and ascorbic acid content of bulb. Late planted crops, *i.e.*15 November and 15 December made poor vegetative growth, thus causing reduced photosynthetic activity due to lesser foliage area, which resulted in lower quality of bulb

Among various germplasm/ varieties, 'Ekfutia Assam' exhibited maximum plant height at 30, 60, 90 and 120 days after sowing (11.97, 19.84, 34.98and 34.28 cm, respectively), leaves/plant (3.83, 6.00, 7.55 and 7.94 respectively)at 30, 60, 90 and 120 days after planting of cloves, respectively. A perusal of data indicated that 'Ekfutia Assam' was significantly superior compared with 'Bhima Omkar', 'Bhima Purple' and 'Assam Local' with respect to growth parameters, *viz.*: plant height and leaves/plant at30, 60, 90 and 120 days after planting. This might be due to difference in their genotypic potential and adaptability to soil and climate. The variation in plant height and number of leaves, which are indication of the growth, might be due to varietal behaviour in a particular climatic condition. 'Ekfutia Assam' significantly increased the yield parameters like bulb diameter (3.90 cm), number of cloves/bulb (12.11) and bulb yield (8.87 tonnes ha^{-1}) in comparison to other germplasm/ varieties. Perusal of data in Table 2 revealed that yield-attributing characters namely bulb diameter, number of cloves/bulb were higher in 'Ekfutia Assam' as compared to 'Bhima Omkar', 'Bhima Purple' and 'Assam Local' which might be due to variation in genetic potential of the germplasm/varieties. The higher value for growth parameters recorded in germplasm Ekfutia Assam is one of the reasons to contribute directly or indirectly towards yield and yield attributing characters. These results are in close conformity with the findings of Rahim *et al.* (2003) [28].

A perusal of data indicated that 'Local Meghalaya 2' was significantly superior in respect to TSS content and 'Assam Local' in ascorbic acid content of bulb as compared to 'Bhima Omkar', 'Bhima Purple' and 'Ekfutia Assam'. This might be due to the difference in their genotypic potential and adaptability to soil and climate (Table 2).The interaction effect of month of sowing and cultivar was found significant for neck thickness, bulb diameter, bulb yield, and quality attributes, like TSS content and ascorbic acid content of bulb. Maximum value for bulb diameter observed in Ekfutia Assam, bulb yield was observed in Bhima Omkar, TSS content in Local Meghalaya 2 and ascorbic acid content in Assam Local were observed with treatment combination and cultivar sown on 15 October (Table 3). Although the month of sowing and cultivar independently brought significant increase in yield attributes but interaction of both showed that response to sowing was governed by cultivar and *vice-versa*, exhibiting their interdependence for obtaining higher value of these parameters. Thus, it is clear that 15 October planting in combination with 'Ekfutia Assam, Bhima Omkar, Assam Local and Local Meghalaya 2'cultivars showed the positive response regarding the yieldand yield-attributing characters as obtained in the present study. Different dates of planting provided the variable atmosphere to the crop thus affecting the yield significantly. Similarly, the variation among the cultivars for different dateis due to the fact that these are adapted to variable environments. Similar findings have also been reported by Rahman *et al.* (2004) [29].

The increase on the above traits in the different germplasm/ varieties may also be attributed to climatic factor which forced to grow better and produce higher yields. The favourable influence of climatic factor has also been reflected in high values in bulb diameter, cloves bulb^{-1}and yield. The differential performance of genotype in respect of different field parameters, in garlic have been reported by Gowda *et al*. (2007) [19], Futane *et al*. (2006) [17], Khar *et al*. (2006) [22] and Shashidhar *et al*. (2005) [31]. Similar results in garlic were also reported by Tiwari *et al*. (2002) [37] and Gririnaik *et al*. (2005) [18].

The significant variations in quality parameters in different Cultivar of garlic might be owing to differences in their genetic inheritance and also due to soil nutrient content which is ultimately responsible to such qualitative variations. The results are also in consonance with the finding of Singh and Tiwari (1995) [33] and Zahedi *et al.* (2007) [39] who showed that all of the morphological and quality characters in garlic germplasm/ varieties were different from each other and differ significantly for bulb yield.

From the above discussion, it is evident that favourable climatological conditions during October planting have significantly exerted better growth and development and yield as evidenced by increase in growth and yield parameters in all the germplasm/ varieties planted on 15 October compared to the germplasm/ varieties planted during 15 November and 15 December.

The interactive results revealed that planting of garlic cloves on 15 October recorded the highest growth parameters and yield in the germplasm/ varieties: Bhima Omkar (11.51 t ha^{-1}) followed by Ekfutia Assam (10.03 t ha^{-1}), Assam Local (9.43 t ha^{-1}) and Bhima Purple (8.94 t ha^{-1}). October month can be considered as the most suitable time for planting of garlic in Assam. The interaction effect of date of planting and yield

attributes was found significant for chlorophyll content in leaves at 60 and 90 days after sowing, bulb diameter, dry weight of bulb, dry weight of 20 cloves, bulb yield, and quality attributes, like TSS content, volatile oil content and ascorbic acid content of bulb. Maximum value for chlorophyll content in leaves at 60 and 90 days after sowing, neck thickness, bulb diameter, dry weight of bulb, dry weight of 20 cloves, bulb yield, TSS content, volatile oil content and ascorbic acid content were observed with treatment combination germplasm/ varieties Ekfutia Assam planted during 15 October (Table 3). Although the date of planting and germplasm/ varieties independently brought significant increase in yield attributes but interaction of both showed that response to planting of cloves was governed by germplasm/ varieties and *vice-versa*, exhibiting their interdependence for obtaining higher value of these parameters. Thus, it is clear that 15 October planting in combination with Ekfutia Assam germplasm/ varieties showed the positive response regarding the yield and yield-attributing characters as obtained in the present study. Different date of planting provided the variable atmosphere to the crop thus affecting the yield significantly. Similarly, the variation among the germplasm/ varieties for different date is due to the fact that these are adapted to variable environments. Similar findings have also been reported by Rahman *et al.* (2004) [29]. However, weather factors also play a vital role in incidence of insect pests and natural enemies of bhut jalokia (Begam *et al*., 2016) [10]; mustard (Pradhan *et al*, 2020) [27]; brinjal (Saikia *et al*., 2020; Borkakati & Saikia, 2020; and Borkakati *et al*., 2021) [30, 11, 12] which also possess direct link with the production of the crop.

From the above discussion it was observed that the effect of 15 October time of planting on different parameters considered under study were almost similar in both the years. Therefore, a correlation study was carried with the pooled data of both the years to ascertain the relationship of different parameters considered under the study. The correlation study revealed that the Plant height and no of leaves of garlic is positively correlated with the LAI, SPAD, Bulb Diameter, Bulb dry weight, 100 clove weight, Bulb yield and Ascorbic acid and found to be significant. This might be due to increase in Plant height and number of garlic leaves which caused increase in the LAI, SPAD, Bulb Diameter, Bulb dry weight, 100 clove weight, Bulb yield and Ascorbic acid content. The correlation study revealed that the Plant height and no of leaves of garlic is negatively correlated with the TSS and found to be significant. Correlation coefficient of Plant height and no of leaves of garlic with LAI, SPAD, Bulb Diameter, Bulb dry weight, 100 clove weights, Bulb yield and Ascorbic acid was found to be significant at 5 % levels of significance, whereas TSS found significant at 1% level of significance.

Table 1: Effect of different months of sowing on growth and yield attributes of different garlic germplasm/ cultivars

Treatment	Plant height (cm)				Leaves per plant				Leaf Area Index (LAI)			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
Month of sowing												
Oct	7.94	11.82	20.57	20.60	3.59	5.18	6.00	6.63	0.289	0.634	0.910	0.820
Nov	6.18	10.39	18.35	17.90	3.02	4.40	5.03	5.42	0.179	0.570	0.703	0.649
Dec	5.31	8.93	16.47	16.19	2.83	3.76	4.31	4.87	0.157	0.461	0.560	0.497
CD *(p= 0.05)*	0.13	0.27	0.37	0.32	0.29	0.24	0.26	0.21	0.01	0.02	0.03	0.02
Cultivars												
Ekfutia Assam	11.97	19.84	34.98	34.28	3.83	6.00	7.55	7.94	0.378	1.193	1.486	1.318
Assam Local	7.81	14.65	28.30	28.36	3.50	5.78	6.55	7.33	0.298	0.971	1.122	1.016
Local Meghalaya1	3.11	5.54	6.85	6.06	2.67	3.44	4.22	4.44	0.087	0.082	0.302	0.314
Local Meghalaya2	2.22	4.31	7.79	7.94	2.33	3.22	3.66	3.83	0.087	0.067	0.270	0.227
Local Nagland 1	3.69	4.74	7.39	7.40	2.28	3.55	4.39	4.72	0.090	0.251	0.219	0.201
Local Nagaland 2	3.18	4.16	8.15	8.34	3.11	4.05	4.05	4.22	0.097	0.063	0.161	0.132
Local Manipur	4.17	5.05	7.41	7.53	2.78	3.06	3.67	3.83	0.118	0.089	0.302	0.260
Bhima Omkar	11.45	18.87	34.02	32.55	4.33	5.72	7.22	7.50	0.375	1.213	1.426	1.303
Bhima Purple	10.67	16.27	31.29	31.60	3.50	5.22	6.50	6.94	0.343	1.066	1.230	1.126
CD *(p= 0.05)*	0.23	0.23	0.42	0.43	0.29	0.42	0.42	0.37	0.02	0.04	0.05	0.03

Table 2: Effect of different months of sowing on growth and yield attributes of different garlic germplasm/ cultivars

Treatment	Bulb weight (g)		Bulb diameter (cm)	Clove/ bulb	100 Clove wt (g)	Bulb yield (t/ ha)	SPAD Value (Chlorophyll)	Ascorbic Acid content (mg g^{-1})	TSS (°B)
Month of sowing	Fresh	Dry							
Oct	12.71	5.22	2.74	8.59	103.15	7.46	32.54	0.33	33.90
Nov	11.73	4.77	2.52	7.73	96.06	6.83	24.78	0.33	31.49
Dec	8.34	3.39	2.24	6.79	86.09	4.85	22.57	0.32	29.40
CD *(p= 0.05)*	0.36	0.09	0.06	0.22	2.02	0.25	1.04	0.01	1.02
Variety									
Ekfutia Assam	15.23	6.20	3.90	12.11	149.35	8.87	40.82	0.37	33.11
Assam local	14.52	5.91	2.84	10.05	139.44	8.45	32.21	0.42	33.21
Local Meghalaya 1	8.09	3.29	1.79	5.50	84.21	4.71	17.10	0.36	36.46
Local Meghalaya 2	5.06	2.60	1.20	4.00	27.17	3.72	14.17	0.23	40.31
Local Nagland 1	7.09	2.89	1.62	4.33	104.93	4.13	17.79	0.27	29.08
Local Nagaland 2	8.81	3.59	2.08	4.94	35.95	5.13	18.10	0.35	31.17
Local Manipur	9.07	3.29	1.23	4.22	25.17	4.70	18.91	0.32	29.06
Bhima Umkar	16.36	6.66	3.82	12.61	147.05	9.52	44.24	0.32	29.96
Bhima Purple	14.09	5.73	3.45	11.55	142.64	8.20	36.32	0.31	27.72
CD *(p= 0.05)*	0.41	0.11	0.13	0.49	3.16	0.26	1.01	0.02	1.01

Table 3: Combined effect of different month of sowing on growth and yield attributes of different garlic germplasm/ cultivars

Treatment combination		Plant height				Leaf No. 120 DAS	LAI 120 DAS	SPAD Value	Bulb diameter (cm)	Bulb Dry weight (g)	100 clove wt (g)	Bulb Yield (t/ Ha)	Ascorbic Acid content (mg g^{-1})	TSS (oB)
		30 DAS	60 DAS	90 DAS	120 DAS									
Month	Cultivars													
Oct	Ekfutia Assam	15.77	23.88	39.535	38.6	9.495	1.623	46.07	4.23	7.02	168.12	10.03	0.38	39.02
Oct	Assam local	9.27	16.55	30.255	30.385	8.66	1.1205	34.65	3.29	6.60	153.91	9.43	0.43	37.55
Oct	Local Meghalaya 1	3.27	6.23	7.275	7.5	5.66	0.3695	21.28	1.84	4.01	88.56	5.73	0.36	41.80
Oct	Local Meghalaya 2	2.13	4.34	9.05	9.195	4.165	0.3215	17.59	1.44	3.71	26.97	5.31	0.23	43.39
Oct	Local Nagland 1	4.35	5.13	7.92	7.895	5.495	0.2535	26.14	1.77	3.37	111.21	4.81	0.28	29.90
Oct	Local Nagaland 2	3.40	4.08	9.35	9.47	5	0.1715	24.15	2.18	4.36	37.33	6.23	0.35	32.00
Oct	Local Manipur	4.38	5.54	8.39	8.565	4.495	0.3515	25.55	1.26	3.62	25.90	5.18	0.32	29.78
Oct	Bhimaumkar	15.66	21.58	38.27	38.145	8.83	1.628	55.01	3.99	8.05	168.34	11.51	0.32	30.76
Oct	Bhima purple	13.23	19.09	35.075	35.615	7.83	1.543	42.43	3.68	6.25	158.01	8.94	0.32	28.80
Nov	Ekfutia Assam	11.03	20.20	35.045	33.525	7.16	1.3175	41.07	3.94	6.29	152.48	8.99	0.36	35.72
Nov	Assam local	7.37	14.49	28.275	28.025	6.83	1.01	31.55	2.90	6.17	142.57	8.82	0.42	35.08
Nov	Local Meghalaya 1	3.29	5.52	7.095	4.23	4.165	0.35	15.97	1.82	3.56	86.68	5.08	0.35	35.89
Nov	Local Meghalaya 2	2.17	4.35	7.825	7.97	3.83	0.216	12.80	1.21	2.57	26.80	3.67	0.24	40.69
Nov	Local Nagland 1	3.41	4.61	7.28	7.28	4.665	0.2005	14.23	1.67	2.88	111.23	4.11	0.27	29.22
Nov	Local Nagaland 2	3.08	4.24	8.155	8.65	4.165	0.122	15.23	2.07	4.44	37.33	6.35	0.35	30.20
Nov	Local Manipur	4.38	4.89	7.54	7.595	3.83	0.2435	16.43	1.26	4.25	25.90	6.08	0.32	27.97
Nov	Bhimaumkar	10.85	18.90	33.1	33.07	7.33	1.28	41.90	3.80	7.09	143.63	10.14	0.33	30.31
Dec	Bhima purple	10.02	16.28	30.855	30.73	6.83	1.0985	33.83	3.46	5.72	138.18	8.18	0.31	27.63
Dec	Ekfutia Assam	9.10	15.45	30.37	30.7	7.165	1.0135	35.31	3.53	5.30	126.42	7.58	0.37	24.58
Dec	Assam local	6.78	12.91	26.355	26.675	6.495	0.917	30.44	2.35	4.97	120.56	7.10	0.42	27.01
Dec	Local Meghalaya 1	2.77	4.88	6.19	6.46	3.495	0.222	14.05	1.71	2.32	87.43	3.31	0.36	31.70
Dec	Local Meghalaya 2	2.38	4.24	6.485	6.64	3.495	0.143	12.13	0.96	1.52	26.05	2.18	0.23	36.86
Dec	Local Nagland 1	3.33	4.47	6.97	7.015	3.995	0.15	13.00	1.43	2.42	93.99	3.46	0.26	28.14
Dec	Local Nagaland 2	3.06	4.17	6.93	6.9	3.495	0.1035	14.92	2.00	1.96	37.25	2.79	0.34	31.32
Dec	Local Manipur	3.74	4.71	6.31	6.415	3.15	0.1835	14.75	1.16	1.99	25.48	2.84	0.32	29.44
Dec	Bhimaumkar	7.85	16.13	30.675	26.43	6.33	1.002	35.82	3.67	4.84	133.62	6.92	0.31	28.80
Dec	Bhima purple	8.77	13.45	27.935	28.46	6.165	0.735	32.70	3.22	5.24	131.93	7.49	0.31	26.74
	CD (p= 0.05)	0.40	0.41	0.67	0.49	0.64	0.08	1.98	0.23	0.29	5.48	0.46	0.02	0.95

4. Conclusion

A field experiment was conducted during the *rabi* season of 2013-14 and 2014-2015 in the Experimental Farm of Department of Horticulture, Assam Agricultural University (AAU), Jorhat on screening of nine (9) germplass/varieties of garlic (*Allium sativum* L.). Seven numbers of germplasm/varieties collected from four North Eastern states (viz. Assam, Meghalaya, Nagaland and Manipur) along with two National varieties from Directorate of Onion and Garlic Research (DOGR), Nashik were studied in field condition to optimize the best planting date in terms of yield of selected germplasm/varieties. The growth and yield attributing characters like plant height, leaves per plant, leaf area index, bulb weight, bulb diameter, clove per bulb, 100 clove weight (g), bulb yield (t ha^{-1}), SPAD value (Chlorophyll), Ascorbic Acid content mg g^{-1}) and TSS (^{o}B) decreased significantly with the delay in planting time. The interactive results revealed planting of garlic cloves on 15 October recorded the highest growth parameters and yield in the germplasm/ varieties Bhima Omkar (11.51 t ha^{-1}) which was *at par* with Ekfutia Assam (10.03 t ha^{-1}) followed by Assam Local (9.43 t ha^{-1}).

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