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Effect of planting time and spacing on the growth, flowering and yield of *Glebionis coronaria* under the agro-climatic conditions of Jorhat, Assam

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ABSTRACT

The present investigation was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India, from October 2021 to January 2022 to evaluate the effect of planting time and spacing on the growth, flowering, and yield of garland chrysanthemum (*Glebionis coronaria*) under the agro-climatic conditions of Jorhat. The experiment was laid out in a Factorial Randomized Block Design with three replications, comprising four planting dates viz., D_1 : 15 October, D_2 : 15 November, D_3 : 15 December, and D_4 : 15 January, and two spacing treatments viz., S_1 : 30×30 cm and S_2 : 45×30 cm. The earliest planting (15 October) combined with closer spacing (30×30 cm) produced the tallest plants (145.67 cm), while most vegetative attributes, including plant spread, number of lateral branches, main stem diameter, number of leaves plant⁻¹, and leaf area, were superior under the 15 November planting with wider spacing (45×30 cm). The crop planted on 15 January with closer spacing recorded the earliest bud initiation and 50% flowering. The 15 November planting combined with wider spacing resulted in maximum flower diameter, flower weight, number of flowers plant⁻¹, and flower yield plant⁻¹, whereas the highest flower yield ha⁻¹ was obtained under closer spacing (30×30 cm). The longest flowering duration and maximum shelf life were recorded in the crop planted on 15 October. Overall, the results demonstrated that planting time and spacing substantially influenced the growth, flowering, and productivity of garland chrysanthemum under the agro-climatic conditions of Jorhat, Assam.

Keywords: *Glebionis coronaria*, Garland chrysanthemum, Planting time, Spacing, Flowering, Flower yield

Introduction

Glebionis coronaria (L.) Cass. ex Spach, commonly known as garland chrysanthemum, crown daisy, or annual chrysanthemum, belongs to the family Asteraceae. The species was formerly classified as *Chrysanthemum coronarium*. The name *Chrysanthemum* is derived from the Greek words *chrysos*, meaning gold, and *anthemon*, meaning flower, while *coronaria* originates from the Latin word *corona*, meaning crown, referring to the characteristic crown-like arrangement of its inflorescence (Grigoros *et al.*, 2021) [1]. It is a hardy, fast-growing annual flowering plant predominantly cultivated during the winter season. The crop produces attractive yellow and white flowers and has considerable potential as a loose flower for garland making, pot culture, bedding, and other ornamental purposes (Shah *et al.*, 2022) [2].

The species is native to the Mediterranean region, where it is commonly found as a naturalized plant or weed. Owing to its wide geographical distribution and diverse uses, *G. coronaria* is known by several vernacular names across different countries. In China, it is commonly known as Tong Ho or Shungiku, while in Japan it is referred to as Kikuna. In Korea, it is known as Ssukgat, and in Vietnam as Tan O (Liu *et al.*, 2020) [3]. In India, the crop is also recognized by different regional names, including Bijilee in Nagpur (Meshram *et al.*, 2008) [4], Babona in Haryana (Mishra *et al.*, 2002) [5], Gandhi in Uttar Pradesh (Arora, 1990) [6], and Babori in Assam. Commercial cultivation of garland chrysanthemum is undertaken in several parts of India, particularly in Maharashtra, Uttar Pradesh, and Rajasthan, where its attractive flowers are utilized extensively as loose flowers (Vyshnavi *et al.*, 2023) [7]. Its short crop duration and suitability for seasonal production have further contributed to its popularity among flower growers, particularly during festive occasions (Shree *et al.*, 2023) [8]. The plants are also suitable for herbaceous borders and other landscape applications (Singh *et al.*, 2023, Teja *et al.*, 2019) [9]. Furthermore, garland chrysanthemum can be incorporated as a companion crop in organic farming systems (Grigoros *et al.*, 2021) [1].

Successful production of any flower crop depends considerably on appropriate agronomic and management practices. Among these, planting time and plant spacing are important factors influencing vegetative growth, flowering behaviour, flower quality, and overall productivity. Planting at an appropriate time enables the crop to utilize favourable environmental conditions, whereas optimum spacing facilitates efficient utilization

of light, nutrients, water, and available growing space. An appropriate combination of planting time and spacing can therefore enhance individual plant performance as well as productivity per unit area. Considering the ornamental and commercial potential of garland chrysanthemum, along with the need to identify suitable production practices for eastern India, the present investigation was undertaken to evaluate the influence of planting time and spacing on the growth, flowering, and yield of *Glebionis coronaria* under the agro-climatic conditions of Jorhat, Assam.

Materials and Methods

The present investigation was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India (26°43' N latitude, 94°12' E longitude, and 86.6 m above mean sea level) during the winter season of 2021–2022. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications, comprising four planting dates (*D*) viz., *D*₁: 15 October, *D*₂: 15 November, *D*₃: 15 December, and *D*₄: 15 January, and two plant spacings (*S*) viz., *S*₁: 30 × 30 cm and *S*₂: 45 × 30 cm. The garland chrysanthemum cultivar 'Shubra' was used for the experiment, and seeds were procured from Indus Seed Company. For recording observations, five plants were randomly selected and tagged in each experimental plot. Observations were recorded on various growth, flowering, and yield-related parameters, including plant height, plant spread, number of lateral branches, main stem diameter, number of leaves plant⁻¹, leaf area, days to flower bud initiation, days to 50% flowering, days to first flower harvest, duration from flower opening to fading on the plant, flower diameter, number of flowers branch⁻¹, number of flowers plant⁻¹, flower weight, flower yield plant⁻¹, total flower yield, flowering duration, and flower shelf life.

Results and Discussion

Vegetative parameters

Plant height (cm)

Plant height was significantly influenced by planting time, spacing, and their interaction (Tables 1 and 2). The tallest plants (142.67 cm) were recorded in the crop planted on 15 October, whereas the shortest plants (80.17 cm) were observed with planting on 15 January. The greater plant height under early planting may be attributed to the favourable environmental conditions prevailing during the initial stages of crop growth, particularly temperature, relative humidity, rainfall, and sunshine duration (Fig. 1), which promoted vigorous vegetative development. Similar observations were reported by Jane *et al.* (2001) [10] in annual chrysanthemum.

Plant spacing also significantly affected plant height. Plants grown at closer spacing (30 × 30 cm) attained a greater height (116.03 cm) than those at wider spacing (45 × 30 cm). The maximum plant height (145.67 cm) was recorded when planting was done on 15 October at 30 × 30 cm spacing (Table 2). The greater height under closer spacing may be associated with increased competition among plants for light, space, and nutrients, resulting in enhanced vertical growth as plants compete for available resources. Comparable findings have been reported in *Chrysanthemum coronarium* (Mali *et al.*, 2017) [11], China aster (Kumar *et al.*, 2014) [12], and African marigold (Nain *et al.*, 2017) [13].

Plant spread (cm)

Plant spread was significantly affected by planting time, spacing, and their interaction (Tables 1 and 2). The maximum plant spread (53.35 cm) was recorded in the crop planted on 15 November, while the minimum (37.38 cm) was observed with planting on 15 January. The greater plant spread under relatively early planting may be attributed to favourable environmental conditions that promoted active vegetative growth. Similar observations have been reported in marigold (Mohanty *et al.*, 2015) [14].

Among the spacing treatments, wider spacing of 45 × 30 cm resulted in greater plant spread (47.66 cm) than closer spacing of 30 × 30 cm.

The interaction between 15 November planting and 45 × 30 cm spacing produced the maximum plant spread (55.55 cm). Wider spacing provides greater availability of physical space and reduces interplant competition for light, nutrients, and other resources, thereby favouring lateral growth and canopy expansion. Similar findings were reported in *Chrysanthemum coronarium* (Dorajeerao *et al.*, 2012) [15].

Number of branches plant⁻¹

A significant effect of planting time and spacing was observed on the number of branches plant⁻¹ (Tables 1 and 2). The highest number of branches (20.83 plant⁻¹) was recorded in the crop planted on 15 November, whereas the lowest (13.60 plant⁻¹) was observed with planting on 15 January. The greater branching under earlier planting conditions may be attributed to favourable environmental conditions that supported vigorous vegetative growth and branch development.

Wider spacing of 45 × 30 cm produced more branches (17.72 plant⁻¹) than closer spacing of 30 × 30 cm. The maximum number of branches (21.73 plant⁻¹) was recorded with 15 November planting combined with 45 × 30 cm spacing. The enhanced branching at wider spacing may be due to reduced competition among plants, providing greater access to light, nutrients, and growing space, which favoured lateral shoot development.

Main stem diameter (cm)

Main stem diameter was significantly influenced by planting time and spacing (Tables 1 and 2). The maximum stem diameter (1.72 cm) was recorded in the crop planted on 15 November, whereas the minimum (1.08 cm) was observed with planting on 15 January. Wider spacing of 45 × 30 cm produced thicker stems (1.52 cm) compared with closer spacing of 30 × 30 cm. The interaction between 15 November planting and 45 × 30 cm spacing resulted in the maximum stem diameter (1.84 cm). The greater stem thickness under wider spacing may be attributed to reduced interplant competition, allowing more efficient utilization of available light, nutrients, and growing space.

Number of leaves plant⁻¹

Planting time and spacing markedly influenced the number of leaves plant⁻¹. The maximum number of leaves (1067.17 plant⁻¹) was recorded in the crop planted on 15 November, whereas the minimum (736.83 plant⁻¹) was observed with planting on 15 January. Wider spacing of 45 × 30 cm resulted in a greater number of leaves (963.83 plant⁻¹) than closer spacing. The maximum number of leaves (1093.00 plant⁻¹) was recorded under the combination of 15 November planting and 45 × 30 cm spacing. The superior leaf production under favourable planting conditions and wider spacing may be associated with reduced competition and enhanced vegetative development.

Leaf area (cm²)

Leaf area varied considerably with planting time and spacing. The maximum leaf area (35.00 cm²) was recorded in the crop planted on 15 November, whereas the minimum (13.62 cm²) was observed with planting on 15 January. Among the spacing treatments, wider spacing of 45 × 30 cm produced a greater leaf area (24.56 cm²) than closer spacing. The interaction of 15 November planting with 45 × 30 cm spacing resulted in the maximum leaf area (35.37 cm²). The greater leaf area under favourable planting conditions and wider spacing may have contributed to enhanced light interception and photosynthetic activity, thereby supporting overall plant growth.

Reproductive parameters

Days to bud initiation

Planting time and spacing significantly influenced the number of days required for flower bud initiation (Tables 2 and 3). The earliest bud initiation (28.17 days) was recorded in the crop planted on 15 January, whereas the 15 October planting required the maximum period (51.00 days). The accelerated bud initiation under later planting may be associated with the prevailing temperature and other environ-

mental conditions during the reproductive phase, which may have promoted the transition from vegetative to reproductive growth. Closer spacing of 30×30 cm resulted in earlier bud initiation (38.08 days) than wider spacing. This response may be associated with increased interplant competition under closer spacing, which can restrict vegetative growth and promote earlier physiological maturity. Similar observations were reported by (Pratibha *et al.*, 2018) [16] in French marigold.

Days to 50% flowering

The number of days required to attain 50% flowering was significantly affected by planting time and spacing. The earliest 50% flowering (50.83 days) was recorded in the 15 January planting, whereas the maximum duration (70.00 days) was observed in the 15 October planting. Closer spacing of 30×30 cm resulted in earlier 50% flowering (59.67 days) compared with wider spacing. The interaction of 15 January planting with 30×30 cm spacing resulted in the earliest 50% flowering (70.67 days).

Flower diameter (cm)

Flower diameter was strongly influenced by planting time and spacing (Table 3). The maximum flower diameter (7.45 cm) was recorded in the crop planted on 15 November, whereas the minimum (5.48 cm) was observed in the 15 January planting. The larger flower diameter under the 15 November planting may be attributed to favourable environmental conditions that enhanced photosynthetic activity and the subsequent translocation of assimilates towards developing flowers. Wider spacing of 45×30 cm produced larger flowers (6.77 cm) than closer spacing of 30×30 cm. The maximum flower diameter (7.57 cm) was recorded when 15 November planting was combined with 45×30 cm spacing. Reduced competition for light, nutrients, water, and space under wider spacing may have promoted greater assimilate accumulation and translocation towards the floral sinks, resulting in larger flowers. Similar observations have been reported in marigold (Ghosh *et al.*, 2008) [17] and annual chrysanthemum (Sainath *et al.*, 2012) [18].

Flower weight (g)

Flower weight was highest (5.27 g) in the crop planted on 15 November and lowest (2.92 g) in the 15 January planting (Table 3). Wider spacing of 45×30 cm resulted in greater flower weight (4.47 g) compared with closer spacing. The maximum flower weight (5.45 g) was obtained with 15 November planting combined with 45×30 cm spacing (Table 4). The superior flower weight under wider spacing may be attributed to reduced competition among plants, facilitating greater availability of assimilates for flower development.

Number of flowers plant⁻¹

The maximum number of flowers (148.78 plant⁻¹) was recorded in the crop planted on 15 November, whereas the minimum (51.19 plant⁻¹) was observed in the 15 January planting (Table 3). The greater flower production under the 15 November planting may be attributed to favourable environmental conditions that promoted vigorous vegetative growth and the development of a greater number of flowering shoots.

Wider spacing of 45×30 cm produced more flowers (106.97 plant⁻¹) than closer spacing of 30×30 cm. Reduced interplant competition under wider spacing may have favoured vegetative growth and consequently increased the number of flowering sites. Similar results were reported in French marigold (Pratibha *et al.*, 2018) [16] and China aster (Khobragade *et al.*, 2012) [19]. The maximum number of flowers (154.97 plant⁻¹) was recorded with 15 November planting combined with 45×30 cm spacing (Table 4).

Flower yield plant⁻¹ (kg)

Flower yield plant⁻¹ was highest (0.74 kg) in the crop planted on 15 November and lowest (0.15 kg) in the 15 January planting (Table 3). Wider spacing of 45×30 cm resulted in greater flower yield plant⁻¹

(0.48 kg) than closer spacing. The interaction between 15 November planting and 45×30 cm spacing produced the maximum flower yield plant⁻¹ (0.78 kg) (Table 4). The greater yield per plant under wider spacing may be attributed to enhanced vegetative growth, greater flower production, and larger individual flowers resulting from reduced competition among plants.

Flower yield hectare⁻¹ (q)

Flower yield per hectare was significantly influenced by planting time and spacing (Table 3). The maximum flower yield (604.35 q ha⁻¹) was recorded in the 15 November planting, whereas the minimum (121.96 q ha⁻¹) was observed with planting on 15 January. Closer spacing of 30×30 cm produced higher flower yield per hectare (425.71 q ha⁻¹) than wider spacing of 45×30 cm. The higher productivity under closer spacing can primarily be attributed to the greater number of plants accommodated per unit area, which compensated for the lower yield per individual plant. Similar findings were reported in annual chrysanthemum (Mali *et al.*, 2017) [11].

The interaction between 15 November planting and 30×30 cm spacing resulted in the highest flower yield per hectare (686.27 q ha⁻¹) (Table 4).

Flowering duration (days)

Flowering duration was significantly influenced by planting time (Table 3). The longest flowering duration (64.94 days) was recorded in the crop planted on 15 November, whereas the shortest duration (48.12 days) was observed in the 15 January planting. The prolonged flowering period under the 15 November planting may be associated with favourable environmental conditions that supported continuous assimilate production and sustained flower development. Similar findings were reported by Sharma *et al.* (2015) [20] in Gaillardia. In contrast, spacing had no significant effect on flowering duration.

Shelf life (days)

Shelf life of the flowers was significantly influenced by planting time (Table 3). The maximum shelf life (4.05 days) was recorded in the crop planted on 15 November, whereas the minimum (2.95 days) was observed in the 15 January planting. The comparatively longer shelf life under favourable planting conditions may be associated with the prevailing lower temperatures during the harvesting period, particularly during January and February. Lower temperature generally reduces respiration and transpiration rates, thereby slowing the depletion of stored assimilates and delaying flower senescence. Spacing did not exert a significant effect on flower shelf life.

Disease incidence (%)

Disease incidence varied considerably with planting time (Fig. 2). The highest disease incidence (71.67%) was recorded in the crop planted on 15 January, followed by 15 December planting (49.17%), whereas the lowest incidence was observed in the 15 October planting. The greater disease incidence under late planting may be associated with environmental conditions prevailing during the crop period, particularly high relative humidity and rainfall which can favour pathogen development, multiplication, and infection. Thus, early planting appeared to provide comparatively lower disease pressure under the prevailing agro-climatic conditions of Jorhat.

Conclusion

Among the treatments, planting on 15 November combined with a spacing of 30×30 cm resulted in superior overall performance, particularly with respect to flower yield per unit area. Therefore, 15 November planting with 30×30 cm spacing may be recommended as a suitable production practice for commercial loose-flower production of garland chrysanthemum under the agro-climatic conditions of Jorhat, Assam.

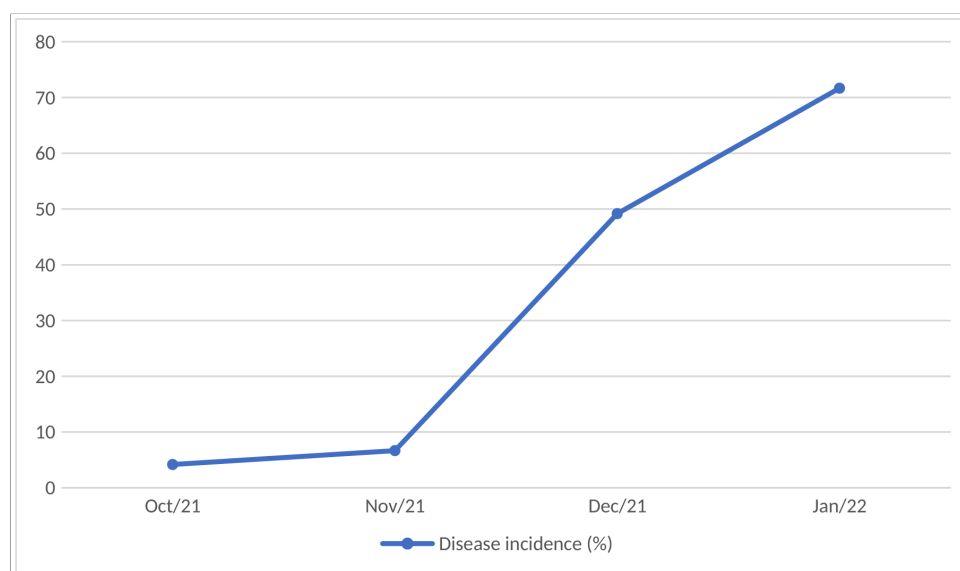


Figure 1. Effect of planting time on Disease incidence (%)

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Table 1. Effect of planting time and spacing on the vegetative growth.

	Plant height (cm)	Plant spread (cm)	Number of branches/plant	Main stem diameter (cm)	Number of leaves/plant	Leaf area (cm ²)
Planting time (<i>D</i>)						
15 th October (<i>D</i> ₁)	142.67	50.85	17.43	1.55	1031.00	29.94
15 th November (<i>D</i> ₂)	119.05	53.35	20.83	1.72	1067.17	35.00
15 th December (<i>D</i> ₃)	110.50	42.29	15.75	1.41	934.33	18.13
15 th January (<i>D</i> ₄)	80.17	37.38	13.60	1.08	736.83	13.62
SEd (±)	2.08	1.50	0.78	0.05	3.81	1.28
CD (0.05)	4.51	3.21	1.68	0.11	8.25	3.87
Spacing (<i>S</i>)						
30 cm x 30 cm (<i>S</i> ₁)	116.03	44.28	16.09	1.36	920.83	23.78
45 cm x 30 cm (<i>S</i> ₂)	110.17	47.66	17.72	1.52	963.83	24.56
SEd (±)	1.47	1.06	0.55	0.04	2.69	1.28
CD (0.05)	3.19	2.27	1.19	0.08	5.83	2.74

Table 2. Interaction effect of planting time and spacing on the vegetative growth.

	Plant height (cm)	Plant spread (cm)	Number of branches/plant	Main stem diameter (cm)	Number of leaves/plant	Leaf area (cm ²)
<i>D</i> ₁ <i>S</i> ₁	145.67	48.10	16.83	1.47	1013.67	29.17
<i>D</i> ₁ <i>S</i> ₂	139.67	53.60	18.03	1.64	1048.33	30.72
<i>D</i> ₂ <i>S</i> ₁	121.77	51.15	19.93	1.59	1041.33	34.63
<i>D</i> ₂ <i>S</i> ₂	116.33	55.55	21.73	1.84	1093.00	35.37
<i>D</i> ₃ <i>S</i> ₁	112.67	41.42	14.67	1.34	916.33	17.82
<i>D</i> ₃ <i>S</i> ₂	108.33	43.17	16.83	1.48	952.33	18.43
<i>D</i> ₄ <i>S</i> ₁	84.00	36.43	12.92	1.03	712.00	13.50
<i>D</i> ₄ <i>S</i> ₂	76.33	38.33	14.23	1.13	761.67	13.73
SEd(±)	2.95	2.12	1.11	0.07	5.39	2.55
CD (0.05)	6.32	4.55	2.37	0.16	11.56	5.48

(continued on next page)

Table 3. Effect of planting time and spacing on the reproductive growth

	Days to bud initiation	Days to 50% flowering	Flower diameter (cm)	Flower Weight (g)	Number of flowers per plant	Flower yield per plant (kg)	Flower yield per hectare (q)	Flowering duration (days)	Shelf life (days)
Planting time (D)									
15 th October (D ₁)	51.00	70.00	7.14	4.83	130.38	0.63	515.13	64.94	4.05
15 th November (D ₂)	43.17	66.00	7.45	5.27	148.78	0.74	604.35	53.57	3.83
15 th December (D ₃)	32.50	54.17	6.51	4.29	82.28	0.31	256.12	54.60	3.19
15 th January (D ₄)	28.17	50.83	5.48	2.92	51.19	0.15	121.96	48.12	2.95
SEd (±)	0.72	0.71	0.07	0.14	4.06	0.04	37.97	0.64	0.15
CD (0.05)	1.56	1.53	0.15	0.31	8.79	0.09	81.31	1.38	0.33
Spacing (S)									
30 cm x 30 cm (S ₁)	38.08	59.67	6.52	4.18	99.35	0.43	425.71	57.38	3.52
45 cm x 30 cm (S ₂)	39.33	60.83	6.77	4.47	106.97	0.48	323.07	58.23	3.49
SEd (±)	0.51	0.50	0.05	0.10	2.87	0.03	0.06	0.45	0.11
CD (0.05)	1.09	1.08	0.10	0.22	6.21	0.07	0.13	NS	NS

Table 4. Interaction effect of planting time and spacing on the reproductive growth

	Days to bud initiation	Days to 50% flowering	Flower diameter (cm)	Flower weight (g)	Number of flowers per plant	Flower yield per plant (kg)	Flower yield per hectare (q)	Flowering duration (days)	Shelf life (days)
D ₁ S ₁	50.33	69.33	7.00	4.63	126.53	0.58	578.11	64.60	4.07
D ₁ S ₂	51.67	70.67	7.27	5.02	134.22	0.68	452.15	65.28	4.03
D ₂ S ₁	42.67	65.33	7.33	5.10	142.60	0.69	686.27	63.00	3.83
D ₂ S ₂	43.67	66.67	7.57	5.45	154.97	0.78	522.43	64.13	3.83
D ₃ S ₁	32.00	54.00	6.35	4.20	78.67	0.30	299.20	54.32	3.20
D ₃ S ₂	33.00	54.33	6.68	4.38	85.90	0.32	213.03	54.89	3.17
D ₄ S ₁	27.33	50.00	5.40	2.81	49.59	0.14	139.25	47.62	2.97
D ₄ S ₂	29.00	51.67	5.56	3.04	52.78	0.16	104.66	48.62	2.94
SEd (±)	1.02	1.01	0.09	0.20	4.06	0.06	53.61	0.90	0.22
CD (0.05)	2.18	2.16	0.20	0.44	12.30	0.13	114.99	NS	NS

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