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Effect of dates of sowing on seed yield and quality of chia (*Salvia hispanica* L.)

Asharani Guttedar, Ravi Hunje, Bharamaraj Badiger and Yashashwini Sharma

Abstract

A field experiment was conducted at MARS, UAS Dharwad to study the “Effect of dates of sowing on seed yield and quality of Chia” during *Rabi* 2022-23. The experiment was laid out in factorial randomized complete block design with three replications. There were eight treatment combinations comprised of four sowing dates under different fortnight intervals (first and second fortnight of October and November) & two varieties (CHIampion W-83, CHIampion B-1). Between the varieties, CHIampion W-83 has recorded significantly highest seed yield (301.40 kg/ha) compared to CHIampion B-1 (218.59 kg/ha). Among the dates of sowing seeds sown during first fortnight of October recorded significantly highest seed yield (354.93 kg/ha) compared to second fortnight of November (202.66 kg/ha). Among interactions, V₁D₁ recorded significantly highest seed yield/ha (397.10 kg/ha) and seed germination (90.33%), root length (4.65 cm), shoot length (9.35 cm), seedling dry weight (1.25 g), seedling vigour index – I (1264), lower electrical conductivity (0.34 dsm⁻¹), field emergence (80.33%) compared to delayed sowing dates.

Keywords: Chia, date of sowing, seed quality

Introduction

Chia (*Salvia hispanica* L.) a new crop being cultivated recently and is recognized as a “super food crop” due to abundant dietary fiber (18–30%), carbohydrates (26–41%), protein (15–25%), fatty acids (30–33%), ash (4–5%), vitamins, minerals and dry matter (90–93%) (Ixtaina *et al.*, 2008). Besides, it contains the highest (67.8%) concentrations of α - linolenic fatty acid (Ayerza and Coates, 2005) [4]. Chia crop is becoming more popular in the world due to its numerous health benefits, including the ability to prevent diseases such as obesity, diabetes and cardiovascular problems. Chia seeds are mainly cultivated in countries *viz.*, Australia, Argentina, Bolivia, Colombia, Guatemala, Mexico and Peru. Chia is cultivated in Karnataka, Andhra Pradesh, Uttar Pradesh and Madhya Pradesh. It is mainly cultivated in Mysuru, Chamarajanagar, Mandya, Belagavi, Yadgiri, Chitradurga, Bagalkot and Haveri Districts of Karnataka. CSIR-Central Food Technological Research Institute (CFTRI) Mysore, Karnataka introduced two high yielding varieties of Chia crop to Indian farmers for cultivation namely, CHIampion W-83 (Black seed) and CHIampion B-1 (white seed) (Patil *et al.*, 2020) [18]. Chia seeds are oval and colour varying from white to black, to grey and their sizes range from one to two mm (Bresson *et al.*, 2009) [6]. However, the economically important Chia seeds are found to be black spotted, followed by white seeds (Ayerza and Coates, 2005) [4]. The crop duration typically spans from 90 to 120 days, as it is a crop that is influenced by the length of the day. The crop has the ability to be cultivated under rainfed and irrigated conditions. An adequate amount of rainfall, ranging from 300 to 1000 mm, during the growing season proves advantageous for the Chia crop (Yeboah *et al.*, 2014) [24]. This crop is also emerging as an alternative to tobacco crop and many of the tobacco growing farmers have switched over to Chia crop in Mysuru district. Chia is a crop that require low input management practices and a remunerative price for the crop or produce, a good buy-back agreement and comes up very well under adverse climate conditions. However, research on seed production aspects in Chia is limited due to newly introduced crop in India and also to maximize the seed production of Chia by take up sowing at different dates under fluctuating environmental conditions, which helps us choose the optimum date of sowing for the Chia help us to maximize the productivity. With these views, the present investigation has been carried out to know the “Effect of dates of sowing on seed yield and quality of Chia.”

Materials and Methods

The field experiment was conducted to study the effect of date of sowing on seed yield and quality of Chia during *rabi* 2022-23 at Main Agricultural Research Station, University of Agricultural sciences, Dharwad. Two varieties of Chia seeds (Black and white) were dibbled at a 60 × 45 cm spacing with three to four seeds per hill at a depth of one to two cm in the plots under factorial randomized block design. Sowing was taken on first and second fortnight of October and November respectively. Five randomly selected plants from each treatment were tagged with a label to record the plant height, number of branches per plant, number of leaves per plant at 30, 60, 90 DAS and at harvest stages. At the time of harvest, the number of spikes per plant was counted and mean seed yield per plant and seed yield per plot was recorded followed by harvested seeds were analysed for their Standard germination test was conducted as per the procedure given by International Seed testing Association (Anon., 2017) [3]. Further observation on seed quality parameters such as seedling shoot length (cm), root length (cm), seedling dry weight (g/seedling), seedling vigour index and field emergence values were measured and analysed statistically. The seedling vigour index was calculated as the formula suggested by Abdul-Baki and Anderson (1973) [1] by multiplying the germination percent with seedling shoot length and root length (cm). Electrical conductivity of seed leachate was determined by using five grams of seeds and 25 ml of distilled water was added to seeds and kept in the incubator maintained at 25 °C ± 1 °C temperature for twelve hours. The electrical conductivity of the leachate was measured in dsm^{-1} (Anon., 1995) [2].

Results and Discussion

Chia varieties, CHIAmpion W-83 (V₁) and CHIAmpion B-1 (V₂) were sown with varying sowing dates during the months of October and November. Among the varieties, CHIAmpion W-83 was found to be a significantly superior in plant height (34.57 cm), number of branches per plant (21.65) and number of leaves per plant (62.19) compared to CHIAmpion B-1 (31.87 cm, 20.05, 54.80) for each of the character respectively. Days to 50% flowering was found to be non-significant (Table 1). The genetic traits of plant height and number of branches per plant have showed variability among different varieties, ultimately resulting in variations in the accumulation of dry matter. These observation are consistent with the findings of Hawlader and Islam (1991) [11] in foxtail millet and Veeraputhiran *et al.* (2009) [23] in finger millet. Among the varying dates of sowing, first fortnight of October showed maximum plant height (43.27 cm), number of branches per plant (24.67) and number of leaves per plant (68.28). Chia plant growth might be influenced by favourable growth conditions and other environmental factors (Karim *et al.*, 2015 and Sharma, 2012) [14, 21]. The growth and development of plants may be facilitated by favourable temperature and adequate time for growth and development during earlier sowing may have facilitated healthy plant growth leading to early flowering and a shorter harvesting period. Conversely, the last date of sowing may have led to a decrease in temperature which have hindered plant growth resulting in a longer period for 50% flowering and harvesting. These results are in agreement with Karim *et al.* (2015) [14]

and Baginsky *et al.* (2016) [5] in Chia. Interaction between first fortnight of October with variety CHIAmpion W-83 increased plant height (48.53 cm), number of branches per plant (23.07), number of leaves per plant (71.89) and days to 50% flowering (69.67 DAS).

Further, Among the Chia varieties, CHIAmpion W-83 recorded more number of spikes (40.75) and test weight (1.64 g), seed yield per plant (5.19 g), seed yield per plot (0.49 kg) and ultimately, seed yield per hectare (301.42 kg) compared to CHIAmpion B-1 (Table 2). The difference of yield in Chia varieties was due to their varietal potential and their genetic yielding ability. Similar results were observed by Leila *et al.* (2008) [15] and Halikatti and Hugar (2001) [10] in small grain millets. Among the varying dates of sowing, a significant difference in the number of spikes per plant (42.73 g), 1000 seed weight (1.78 g), seed yield per plant (7.08 g) and seed yield per plot (0.58 kg) recorded maximum in first fortnight of October and was lower with second fortnight of November. The results presented were consistent with those of Karim *et al.* (2015) [14], who observed a decline in seed yield after delayed planting in Chia. Interaction between first fortnight of October with variety CHIAmpion W-83 (V₁) recorded significantly highest number of spikes per plant (45.40), test weight (1.81 g), seed yield per plant (7.08 g), seed yield per plot (0.64 kg/plot), seed yield per hectare (397.11 kg/ha). The similar results obtained with findings of (Upadhyay *et al.* 2001) [22] in pearl millet and (Revathi *et al.* 2017) in finger millet observed that lower seed yield in later sowing dates. The variety CHIAmpion W-83 recorded highest germination percentage (82.58%), root length (4.24 cm), shoot length (8.61 cm), seedling dry weight (0.95 g/10 seedlings), seedling vigour index-I (1067), seedling vigour index-II (79.80), EC (0.45 dsm^{-1}) and field emergence (72.50%) compared to CHIAmpion B-1 (Table 3). Higher germination rates (%) and test weight can be attributed to superior seed vigour, which is a result of an improved genetic composition and enhanced plant growth and development. The results were similar with findings of Jadhav *et al.* (2022) [13] and Gururaj *et al.* (2022) [9] in Chia.

Among the dates of sowing first fortnight of October recorded the highest germination percentage (89.00%), root length (4.57 cm), shoot length (8.93 cm), seedling dry weight (1.13 g/10 seedlings), seedling vigour index-I (1201), seedling vigour index-II (100.4), low EC (0.41 dsm^{-1}) and field emergence (79%) compared to second fortnight of November. The probable reason for the highest seed quality during early date of sowing will be longer duration available for proper maturity of seeds and decrease in seed quality in late sowing might be due to high temperature during last phases of growth which ultimately resulted in forced maturity of developing seeds in short time. The findings were support with Nass *et al.* (1974) [16], Sarkar and Trofadar (1992) [20], Phadnawis and Saini (1986) [17], Chaudhary *et al.* (1998) [7] in wheat. Interaction between the Variety CHIAmpion W-83 (V₁) with first fortnight of October recorded the highest seed quality parameters *viz.*, germination percentage (90.33%), root length (4.65 cm), shoot length (9.35 cm), seedling dry weight (1.25 g/10 seedlings), seedling vigour index-I (1264), seedling vigour index-II (112.6), EC (0.34 dsm^{-1}) and field emergence (80.33%). The findings were supported by Desai *et al.* (2018) [8] in *Mentha arvensis*.

Table 1: Effect of dates of sowing and varieties on growth parameters of Chia

Varieties (V)	Plant height (cm)				No. of branches per plant				No. of leaves per plant				Days to 50% flowering (DAS)
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	
V ₁ : CHIAmpion W-83	7.37	27.05	34.57	34.57	6.20	8.38	21.65	23.15	8.12	43.32	62.19	36.63	72.16
V ₂ : CHIAmpion B-1	6.16	24.20	31.87	31.87	5.84	8.32	20.05	22.05	7.90	37.72	54.80	36.63	72.67
S.Em±	0.02	0.13	0.15	0.29	0.05	0.01	0.12	0.14	0.05	0.3	0.08	1.14	0.20
CD (0.05)	0.06	0.38	0.45	0.86	0.15	0.04	0.35	0.43	0.15	0.91	0.24	NS	NS
Dates of sowing (D)													
D ₁ : 1 st fortnight of October	7.73	26.73	43.27	43.22	7.72	9.70	22.87	24.67	9.57	56.77	68.28	37.33	70.00
D ₂ : 2 nd fortnight of October	6.66	25.60	33.73	33.73	6.30	8.73	21.00	22.70	8.30	41.87	62.77	37.20	71.60
D ₃ : 1 st fortnight of November	6.45	25.30	28.67	29.13	5.43	7.80	19.70	21.77	7.47	37.67	53.17	36.17	73.00
D ₄ : 2 nd fortnight of November	6.25	24.87	27.20	27.20	4.63	7.17	19.83	21.27	6.70	25.77	49.77	35.83	75.00
Mean	6.77	25.62	33.21	33.32	6.02	8.35	20.85	22.60	8.01	40.52	58.49	36.63	72.40
S.Em±	0.03	0.18	0.21	0.40	0.07	0.02	0.16	0.2	0.07	0.43	0.12	1.62	0.27
CD (0.05)	0.09	0.54	0.64	1.21	0.21	0.06	0.49	0.61	0.22	1.28	0.35	NS	NS
Interactions (V×D)													
V ₁ D ₁	7.83	28.13	48.53	48.44	8.00	9.87	23.07	24.53	9.40	59.20	71.89	37.33	69.67
V ₁ D ₂	7.31	26.87	31.80	31.80	6.80	8.27	22.33	23.60	8.67	48.47	67.53	37.20	71.33
V ₁ D ₃	7.20	26.80	29.73	30.67	5.33	8.07	20.33	22.60	7.60	40.40	57.87	36.17	73.00
V ₁ D ₄	7.17	26.40	28.20	28.20	4.67	7.33	20.87	21.87	6.80	25.20	51.47	35.83	74.67
V ₂ D ₁	7.62	25.33	38.00	38.00	7.43	9.53	22.67	24.80	9.73	54.33	64.67	37.33	70.33
V ₂ D ₂	6.00	24.33	35.67	35.67	5.80	9.20	19.67	21.80	7.93	35.27	58.00	37.20	72.00
V ₂ D ₃	5.70	23.80	27.60	27.60	5.53	7.53	19.07	20.93	7.33	34.93	48.47	36.17	73.00
V ₂ D ₄	5.33	23.33	26.20	26.20	4.60	7.00	18.80	20.67	6.60	26.33	48.07	35.83	75.33
Mean	6.77	25.62	33.21	33.32	6.02	8.35	20.85	22.60	8.00	40.51	58.49	36.63	72.40
S.Em±	0.04	0.25	0.30	0.57	0.10	0.03	0.23	0.29	0.10	0.60	0.16	2.28	0.39
CD (0.05)	0.13	0.76	0.90	1.72	0.30	0.09	0.69	0.87	0.31	1.81	0.49	NS	NS

S – Significant, NS – Non significant

Varieties

V₁: CHIAmpion W-83.

V₂: CHIAmpion B-1.

D₃: 1st Fortnight of November.

D₄: 2nd Fortnight of November.

Date of sowing:

D₁: 1st Fortnight of October.

D₂: 2nd Fortnight of October.

Table 2: Effect of dates of sowing and varieties on yield parameters of Chia

Varieties (V)	No. of spikes per plant	Test weight (g)	Seed yield/plant (g)	Seed yield/plot (kg)	Seed yield/ha (kg)
V ₁ : CHIAmpion W-83	40.75	1.64	5.19	0.49	301.42
V ₂ : CHIAmpion B-1	36.12	1.62	4.65	0.35	218.59
S.Em±	0.24	0.01	0.01	0.0014	0.89
CD (0.05)	0.70	0.02	0.03	0.07	2.66
Dates of sowing (D)					
D ₁ : 1 st fortnight of October	42.73	1.78	7.08	0.58	354.93
D ₂ : 2 nd fortnight of October	40.90	1.70	4.52	0.41	255.12
D ₃ : 1 st fortnight of November	37.80	1.61	4.14	0.37	227.32
D ₄ : 2 nd fortnight of November	32.30	1.42	3.86	0.25	202.66
Mean	38.43	1.62	4.90	0.40	259.75
S.Em±	0.33	0.01	0.01	0.002	1.26
CD (0.05)	1.00	0.02	0.04	0.01	3.77
Interactions (V×D)					
V ₁ D ₁	45.40	1.81	7.08	0.64	397.11
V ₁ D ₂	44.33	1.74	4.76	0.47	292.14
V ₁ D ₃	42.00	1.63	4.62	0.43	265.40
V ₁ D ₄	31.27	1.35	4.29	0.41	251.02
V ₂ D ₁	40.27	1.74	7.06	0.51	312.75
V ₂ D ₂	37.27	1.66	4.28	0.35	218.09
V ₂ D ₃	33.60	1.58	3.66	0.31	189.23
V ₂ D ₄	33.33	1.49	3.43	0.25	154.30
Mean	38.43	1.62	4.89	0.42	260.00
S.Em±	0.47	0.01	0.02	0.05	1.78
CD (0.05)	1.41	0.03	0.05	0.14	5.33

S- Significant

Varieties

V₁: CHIAmpion W-83.

V₂: CHIAmpion B-1.

D₃: 1st Fortnight of November.

D₄: 2nd Fortnight of November

Date of sowing:

D₁: 1st Fortnight of October.

D₂: 2nd Fortnight of October.

Table 3: Effect of dates of sowing and varieties on seed quality parameters of Chia

Varieties (V)	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling dry weight (g/10 seedlings)	SVI-I	SVI-II	EC (ds m ⁻¹)	Field emergence (%)
V ₁ :CHIAMPION W-83	82.58 (65.3)*	4.24	8.61	0.95	1067	79.80	0.45	72.50 (58.5)*
V ₂ :CHIAMPION B-1	80.50 (63.9)*	3.98	8.19	0.84	984	68.20	0.54	70.50 (57.1)*
S.Em±	0.13	0.02	0.02	0.0036	2.59	0.33	0.0048	0.11
CD (0.05)	0.39	0.05	0.07	0.01	7.77	0.99	0.014	0.32
Dates of sowing (D)								
D ₁ : 1 st fortnight of October	89.00 (70.6)*	4.56	8.93	1.13	1201	100.4	0.41	79.00 (62.7)*
D ₂ : 2 nd fortnight of October	83.50 (66.0)*	4.25	8.83	0.92	1093	76.86	0.42	73.50 (58.9)*
D ₃ : 1 st fortnight of November	80.00 (63.4)*	4.03	8.24	0.81	982	64.90	0.53	70.00 (56.7)*
D ₄ : 2 nd fortnight of November	73.60 (59.1)*	3.61	7.60	0.73	826	53.9	0.61	63.66 (52.9)*
Mean	81.5 (64.49)*	4.11	8.40	0.89	1025	74.01	0.49	71.54 (57.73)*
S.Em±	0.18	0.02	0.03	0.01	3.66	0.46	0.005	0.15
CD (0.05)	0.55	0.07	0.10	0.02	10.98	1.41	0.014	0.46
Interactions (V×D)								
V ₁ D ₁	90.33 (71.8)*	4.65	9.35	1.25	1264	112.6	0.34	80.33 (63.6)*
V ₁ D ₂	84.67 (66.9)*	4.53	9.23	0.96	1165	80.90	0.35	74.60 (59.7)*
V ₁ D ₃	80.67 (63.8)*	4.13	8.22	0.88	996	70.70	0.52	70.60 (57.1)*
V ₁ D ₄	74.67 (59.7)*	3.67	7.63	0.74	843	55.01	0.57	64.60 (53.5)*
V ₂ D ₁	87.67 (69.4)*	4.48	8.50	1.01	1138	88.20	0.47	77.60 (61.7)*
V ₂ D ₂	82.33 (65.1)*	3.97	8.43	0.88	1021	72.70	0.49	72.30 (58.2)*
V ₂ D ₃	79.33 (62.9)*	3.93	8.27	0.75	967	59.23	0.54	69.30 (56.3)*
V ₂ D ₄	72.67 (58.4)*	3.57	7.57	0.73	809	52.80	0.66	62.60 (52.3)*
Mean	81.5 (64.49)*	4.11	8.40	0.90	1025	74.01	0.49	71.49 (57.70)*
S.Em±	0.25	0.03	0.05	0.01	5.18	0.66	0.0095	0.21
CD (0.05)	0.77	0.1	0.14	0.02	15.53	1.99	0.03	0.64

S- Significant

Varieties

V₁: CHIAMPION W-83.V₂: CHIAMPION B-1.D₃: 1st Fortnight of November.D₄: 2nd Fortnight of November

*Figures in parenthesis indicates arcsine values

Date of sowing:

D₁: 1st Fortnight of October.D₂: 2nd Fortnight of October.

Conclusion

Both the varieties of Chia performed better when sown in first fortnight of October. In order to establish a more precise sowing date, it is necessary to undertake a thorough investigation of the sowing period, which includes early and late sowing dates in both *kharif* and *rabi* seasons. It was observed that sowing the CHIAMPION W-83 variety during the initial fortnight of October resulted in a significantly higher seed yield of 397.33 kg/ha and also highest seed quality parameters *viz.*, germination percentage (90.33%), root length (4.65 cm), shoot length (9.35 cm), seedling dry weight (1.25 g/10 seedlings), seedling vigour index-I (1264), seedling vigour index-II (112.6, EC (0.34 dsm⁻¹) and field emergence (80.33%).

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