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Effect of spacings and vermicompost levels on growth and yield parameters of chia (*Salvia hispanica* L.)

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Abstract
A field trial was conducted at Nagarjuna Medicinal Plant Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra during *rabi* season 2024-25 to evaluated the effect of spacings and vermicompost levels on growth and yield parameters of Chia seed. The experiment was carried out in Factorial Randomized Block Design with nine treatments combinations which were replicated thrice. It consist three levels of spacings (S_1- 30 × 15 cm, S_2- 45 × 10 cm and S_3 - 60 × 10 cm) and three levels of vermicompost (V_1 - @ 1.5 t ha^{-1}, V_2 - @ 2 t ha^{-1} and V_3 - @ 2.5 t ha^{-1}). Full dose of vermicompost was applied as basal at the time of sowing. Result of the study revealed that spacings and vermicompost levels significantly influenced the performance of chia. Sowing at spacing S_3 - 60 × 10 cm showed the highest seed and stover yield. The vermicompost level V_3 - @ 2.5 t ha^{-1} showed the highest yield and stover yield. The present study concluded that cultivation of chia at spacing 60 × 10 cm with vermicompost level @ 2.5 t ha^{-1} could be considered the promising practice for reasonable seed yield.

Keywords: Chia seed, vermicompost level, spacing, growth, yield

Introduction

Chia (*Salvinia hispanica* L.) is annual herbaceous crop belong to Lamiaceae family and originated in Mexico and Guatemala (Ixtaina *et al.*,2008) [5]. The height of the chia crop can grow upto 1.5 meter and seed is the main edible part of chia (Karim *et al.*,2015) [3]. It is well known for its nutraceutical value. Chia leaves are oppositely arranged that are 4-8 cm long and 3-5 cm wide. Flowers are purple and white and produced in numerous clusters in spike at the end of each stem. Chia seed are small oval in shaped and approximately with 2 mm. diameter. They are mottle-coloured, with brown, gray, black, and white. The seeds are hydrophilic, absorbing upto twelve times the weight in liquid when soaked. While soaking, seeds develop a mucilaginous coating that gives chia based beverages a distinctive gelatinous texture. The cultivation of chia is gaining popularity among Asia because it is considered as good nutritional and healthy food. The cultivation of chia crop is is expected to rise in coming days. Chia requires less water as compared to other crops and chia is drought resistance crop.

The word “Chia” or “Chien” is derived from Spanish language which means “Oily” (Kulezynski *et al.*, 2019) [4]. Chia is pseudo cereal pack with nutrients which are beneficial for human body and brain. The chia seed contains 30 to 40 per cent oil with 60 per cent of it comprising omega (ω)-3 alpha linolenic acid. It is rich source of protein (15 to 20 per cent), fats (30 to 33 per cent), carbohydrates (26 to 41 per cent), highly dietary fiber (18 to 30 per cent), ash (4 to 5 per cent), minerals vitamins and high number of antioxidant so it is being popularized as “nutraceutical”. Apart from contributing to human nutrition chia seed help to prevent several long term diseases and it is considered as “Functional Food”. (Munoz *et al.*, 2013 and Prathyusha *et al.*, 2019) [9, 11].

Tropical and subtropical environment with maximum and minimum growth temperature of 11 ^oC and 36 ^oC respectively with an optimum range of 16 ^oC to 26 ^oC are most suitable for chia cultivation. Chia has mainly grown in mountainous area and has little tolerance to abiotic phenomenon. Such as freezing and sunless location. Chia grows well in sandy loam and clay loam soils with good drainage facility. Out of 900 species of genus *Salvinia*, only *Salvinia* *hispanica* can be grown domestically. Morphologically wild and domesticated plant differ very little and today chia has been classified within the cultivated land of Mesoamerica.

The leaves contain essential oil which act as repellent thus plant can be grown without pesticide or other chemical compounds. The duration of crop usually ranges from 140-180 days as it crop sensitive to day length and crop cycle depends upon the latitude where it is planted. The crop can be grown in rainfed and irrigated condition conditions. Rainfall ranging from 300 to 1000 mm during growing season is beneficial to chia crop.

Modern agriculture practices deteriorate the health of soil and lead to low crop productivity and quality besides, it is harmful to environment so the present agricultural research is concentrate on inventing sustainable, socially, economically viable and ecologically sound intervention and avoid the use of chemical fertilizer and pesticide (Pathak and Ram. 2006) [10]. Agronomic management is one of the most important aspects for the success of any crop with efficient use of all the resources. Nutrient management plays a vital role in enhancing the growth and overall development of crop. Among the various agro techniques, crop geometry and nutrient management are the supreme important agronomic practices for exploring higher yield of crops.

Keeping all these point in view and order to developed standard protocol for chia cultivation and evaluate the influence of crop geometry and organic nutrient levels through vermicompost on growth indices of chia this experimental trial was initiated on "Effect of spacings and vermicompost levels in chia seed (*Salvia hispanica* L.)".

Materials and Methods

A field experiment was conducted during *rabi* season of 2024-25 at experimental field Nagarjuna Medicinal Plant Garden. Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola. The crop variety used in the experiment was local seed. Experimental site was situated at a latitude of 20°42' North and a longitude of 72°02' East, with an altitude of 307.41 meters above mean sea level. Soil of experimental was belonged to clayed texture. The experiment was laid out in factorial randomized block design with nine treatment combinations and three replications. The treatment consist of three spacings S_1- 30 × 15 cm, S_2- 45 × 10 cm and S_3 - 60 × 10 cm and three vermicompost levels V_1 - @ 1.5 t ha^{-1}, V_2 - @ 2 t ha^{-1} and V_3 - @ 2.5 t ha^{-1}. The crop geometry was maintained as per the spacing prescribed for particular treatment. Full dose of vermicompost were applied as basal at the time of sowing.

Table 1: Nutrient composition of vermicompost used for experimentation.

Sr No.	Manure Nutrient composition	Nutrients composition%		
		N	P	K
i	Vermicompost	1.5	0.5	1.2

Five plants were selected at random and labelled in each net plot for recording observations on growth and yield parameters at 30 DAS, 60 DAS, 90 DAS and at harvest. The data on yield attributing character were recorded at harvest.

Results and Discussion

The data on growth parameters at harvest as influenced by spacing and vermicompost levels are presented in Table 2. Spacing play important role in crop production as non-monetary input. Closer spacing of 30 × 15 cm was attained significantly higher plant height (83.52 cm) and statistically superior over other spacing 45 × 15 cm and 60 × 10 cm. This was apparently because individual plant with narrow spacing did not get opportunity to proliferate laterally due the less lateral space. Hence plant was compelled to grow more in an upward direction for the fulfilment of the light. Significant increase in plant height from early stages of crop growth under closer spacing 30 × 15 cm might be due to mutual shading because of the dense population which might have decreased the availability of light to plants. These results are in close agreement with the findings of Yeboah *et al.* (2014) [12], Mary *et al.* (2018a) [6].

The wider spacing of 60 × 10 cm produced a significantly higher number of branches $plant^{-1}$ (12.11), Dry matter accumulation $plant^{-1}$ (24.69 g)as compared to 45 × 10 cm and 30 × 15 cm spacing at the harvest stage. Plant at wider spacing received higher growth inputs (sunlight, water and nutrient) and availability of more space for spreading of branches which helped in more interception of light due to higher leaf surface area with lesser competition as compared to plants grown under closer spacing. This resulted in an increased number of branches this in turn resulted in the production of more leaves per plant and total dry matter accumulation $plant^{-1}$ due to more inter row and intra row spacing (60 × 10 cm). The results were in agreement with the findings of Kailash and Kushwaha (2013) [2] in basil, Yeboah *et al*. (2014) [12] in chia and Mary *et al.* (2018a) [6] in chia.

Among the vermicompost levels, application of V3 @ 2.5 t ha^{-1} noticed significantly higher plant height (86.36 cm), number of branches $plant^{-1}$ (18.67) and dry matter accumulation $plant^{-1}$ (22.05 g). The increased growth component might due to be nitrogen which triggers the growth of meristematic tissue and efficient utilization of resources by plants manifested in the production of more branches plant due to the availability of nitrogen in optimum quantities. The outcomes of these studies agreed with the findings of Mounika *et al.* (2021) [8] in sacred basil. Treatment combinations of spacing and vermicompost level did not attain the level of significance with respect to plant height, branches dry matter accumulation.

Table 2: Plant height, number of branches $plant^{-1}$ and dry matter accumulation $plant^{-1}$ of chia as influenced by spacing and vermicompost levels

Treatments	Plant height (cm)	Number of branches $plant^{-1}$	Dry matter accumulation $plant^{-1}$
Spacings (S)			
S_1- 30 × 15 cm	85.56	8.17	18.26
S_2- 45 × 10 cm	83.31	10.08	21.31
S_3- 60 × 10 cm	81.69	12.11	24.69
SE (m) ±	0.47	0.07	0.27
CD at 5%	1.40	0.21	0.80
Vermicompost levels (V)			
V_1- @ 1.5 t ha^{-1}	81.29	16.09	20.98

V_2 - @ 2 t ha^{-1}	82.91	17.18	21.24
V_3- @ 2.5 t ha^{-1}	86.36	18.67	22.05
SE (m) ±	0.47	0.15	0.27
CD at 5%	1.40	0.46	0.80
Interaction (SxV)			
SE (m) ±	0.80	0.12	0.46
CD at 5%	NS	NS	NS

Table 3: Seed Yield (g plant^{-1}), Seed yield (kgha^{-1}) test weight (g), stover yield (kg ha^{-1}) harvest index of chia as influenced by spacing and vermicompost levels

Treatment	Seed yield (g) plant^{-1}	Seed yield (kg ha^{-1})	Test weight (g)	Stover yield (kg ha^{-1})	Harvest index
Spacing(S)					
S_1- 30 × 15 cm	4.26	794	1.33	1927	29.18
S_2- 45 × 10 cm	4.68	865	1.34	2027	29.95
S_3- 60 × 10 cm	6.78	980	1.35	2254	30.3
SE (m) ±	0.18	34	0.01	87	-
CD at 5%	0.54	103	-	261	-
Vermicompost level (V)					
V_1- @ 1.5 t ha^{-1}	4.93	817	1.33	1931	29.67
V_2 - @ 2 t ha^{-1}	5.20	858	1.34	2018	29.85
V_3- @ 2.5 t ha^{-1}	5.60	965	1.35	2260	29.91
SE (m) ±	0.18	34	0.01	87	-
CD at 5%	0.54	103	-	261	-
Interaction (S × V)					
SE (m)±	0.31	59.68	0.01	151.03	-
CD at 5%	NS	NS	NS	NS	-

The data on growth parameters at harvest as influenced by spacing and vermicompost levels are presented in Table 3. The crop planted at a spacing 60 × 10 cm resulted in maximum seed yield (g plant^{-1}) and seed yield (kg ha^{-1}) than other spacing levels of 45 × 10 and 30 × 15 cm. Among the vermicompost level V_3- @ 2.5 t ha^{-1} has produced significantly greater number of seed yield plant^{-1} which was statistically superior over the V_2 - @ 2 t ha^{-1} and V_1- @ 1.5 t ha^{-1}. Treatment combination of wider spacing 60 × 10 cm and vermicompost level V_3- @ 2.5 t ha^{-1} produced significantly higher seed yield plant^{-1} as compared to other levels. This yield attributing characters may be attributed to greater input resulted in profused branching which in turn production of higher number of spike plant and also ascribed to the increase in branching and translocation of photosynthates to reproductive parts. The similar finding of Mary *et al.* (2018b) [7]. Production of seed yield plant^{-1} due to the release of macro and micro nutrients during microbial decomposition Arakanti *et al.* (2022) [1]. who found that the vermicompost benefited the crop growth throughout the entire growth period serve as a source of energy ultimately boosting seed yield. However, spacing and vermicompost level failed to register a significant difference in test weight (1000 seed weight) though the maximum test weight was recorded when the crop was maintained wider spacing at 60 ×10 cm.

Stover yield of chia varied significantly as influenced by spacing. Spacing 60 × 10 cm recorded higher stover yield and the lowest stover yield recorded in the spacing 30 × 15 cm. Stover yield at harvest mainly depend on the dry matter production of plant. Increase in dry matter production could be attributed to increase in number of branches and number of spike plant^{-1}. Stover yield of chia varied significantly as influenced by vermicompost level V_3- @ 2.5 t ha^{-1} it recorded higher stover yield. Among various treatment increasing vermicompost level with wider spacing recorded higher seed yield, stover yield and harvest index, respectively whereas V_1- @ 1.5 t ha^{-1} vermicompost level and narrow spacing 30 × 15 showed lower seed yield, stover yield and harvest index.

Interaction of spacing and vermicompost level found non significant on seed yield (g plant^{-1}), seed yield (kg ha^{-1}), stover yield and harvest index.

Conclusion

The study's findings highlighted several significant outcomes regarding chia crop growth and yield based varying spacing and vermicompost levels. Wider spacing of 60 × 10 cm demonstrated superior results in various aspects. It lead increased number of branches plant^{-1} (12.11), dry matter accumulation plant^{-1} (24.69 g), seed yield plant^{-1} (6.78 g), overall seed yield (980 kg ha^{-1}) and stover yield (2254 kg ha^{-1}). This wider spacing outperformed the 45 × 10 cm and 30 × 15 cm spacing configurations. However, the narrower spacing 30 × 15 cm resulted in notable advantage including taller plant height (85.56 cm) when compared to other spacing level.

When evaluating vermicompost levels, applying V_3- @ 2.5 t ha^{-1} led to advantageous outcomes. It produced more number of branches plant^{-1} (18.67), higher dry matter accumulation, higher seed yield plant^{-1} (5.60 g), overall seed yield (965 kg ha^{-1}) and stover yield (2260 kg ha^{-1}).

The study emphasized the significant impact of spacing and vermicompost levels of chia crop on growth and seed yield with wider spacing and appropriate vermicompost level application leading to enhanced overall performance, while narrower spacing and different fertilizer ratios offered specific advantages in terms of plant height.

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