

Evaluation of different Organic manures on Growth and Yield of Chia (*Salvia hispanica* L.)

ABSTRACT

A field trial was conducted during *Rabi* 2020-21 and 2021-22 at Research Institute on Organic farming (RIOF), University of Agricultural sciences, GKVK, Bengaluru to find out the effect of organic manures on growth and yield of chia. A three factorial randomized block design was employed with first factor as nutrient sources *viz.*, S_1 = FYM (100%) on N equivalent basis, S_2 = FYM + vermicompost (50:50) ratio on N equivalent basis, S_3 = FYM+ vermicompost (75:25) ratio on N equivalent basis, second factor *viz.*, jeevamrutha levels J_0 = Without jeevamrutha, J_1 = With Jeevamrutha 1000 liters ha^{-1} and panchagavya levels P_0 = Without panchagavya, P_1 = With Panchagavya 5% foliar spray being third factor. Pooled data of two years revealed that higher seed and haulm yield of chia (920,1480 kg ha^{-1} respectively) was obtained with application of (S_2). Soil application of jeevamrutha (J_1) resulted in higher seed and haulm yield (984, 1598 kg ha^{-1} respectively) and among panchagavya levels foliar application of panchagavya (P_1) resulted in seed and haulm yield (952,1468 kg ha^{-1} respectively), besides the higher plant height, leaf area, dry matter accumulation and seed yield per plant were recorded with application of FYM+ Vermicompost (50:50) on N equivalent basis and among liquid organic manures application of jeevamrutha (1000 L ha^{-1}) and panchagavya 5% foliar spray resulted in higher growth and yield attributes.

Key words: Chia, Nutrient uptake, FYM, Vermicompost, Jeevamrutha, Panchagavya

1. INTRODUCTION

The success of industrial agriculture and the green revolution in recent decades has often masked significant externalities affecting natural resources and human health as well as agriculture itself [15]. Globally 795 million people are undernourished with a share of 12.9 percent of developing countries[7]. Currently only 150 plant species are commercialized on global level of which 12 species provide approximately 80% of calorie demand, while these grains are devoid of essential micronutrient [10]. To address this problem there is a need to broaden the field of research by exploiting neglected crop species, which have potential to gain high market value, which have traditionally played the key role in many cultures as staple food, but presently neglected as they percolated in small niches of global food system. Potential crops or underutilized crops or orphan

crops or neglected crops are considered as crops of 21st century as they possess high nutritional profile, besides they acts as life support species in extreme environmental conditions. Organic agriculture as a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Farm yard manure is one of the most commonly used organic manures in India since time immemorial. Vermicompost is the product of biodegradation of organic material through interaction between earth worms and microorganisms. It is made up of carbon, hydrogen and oxygen and contains macro and micro nutrients which exhibits similar effect as of inorganic fertilizers on plants. Liquid organic manure is the organic matter in liquid formulation mostly obtained from cattle dung and urine which could be used as organic fertilizer in agriculture. Jeevamrutha is considered as soil tonic as it has higher amount of microbes which results in intense biological activity in soil and improves the nutrient availability and uptake by crop. Panchagavya is the liquid organic manure obtained from fermentation of five products of viz., cow dung, cow urine, milk, curd and ghee from cow. It act as plant growth stimulant by activating the biological reactions in the soil and protects the plants from pest and disease incidence, improves the growth and vigor of crops and improves the shelf life of perishable fruits and vegetables.

Chia (*Salvia hispanica* L.) is nutri rich crop belongs to *Lamiaceae* family which played an important role in the diet of prehispanic Mexicans and had undeniable importance as rich source of nutrients. It is a pseudo cereal and its center of origin is between Mexico and Guatemala, it is becoming popular as “super food” as it is considered to be one of the greatest vegetarian source of omega (ω) 3 fatty acid (50 to 57 %) and omega (ω) 6 fatty acid (17 to 26%), oil (24.36 % to 35%), fiber (34% to 40%), protein(16.54% to 25%), carbohydrates(26.5% to 42.12%), moisture(5.8%), vitamin A and C, niacin, antioxidants along with higher content of minerals [11,12]. Chia crop is a new introduction to India by Central Food Technological Research Institute (CFTRI), Mysore to the rainfed farmers of Mysore and Chamrajnagar districts of Karnataka. With increase of public health awareness, the demand for organic food products in the market is increasing. So for the profitable cultivation of chia under organic production system there is need to standardize the organic nutrients required, for higher productivity with this background a field experiment was conducted to evaluate the effect of different organic manures on growth and yield of chia.

2. MATERIALS AND METHODS

The study was conducted during two consecutive years of *Rabi* 2020 and *Rabi* 2021 at research and demonstration block on Research Institute of Organic farming (RIOF), University of Agricultural Sciences, GKVK, Bangalore, Karnataka, India. Local variety of chia, developed by All India Coordinated Research Project(AICRP) on potential crops was selected as it is suitable for successful production in Bangalore. Direct sowing was done with spacing of 90 cm ×15 cm. The dimension of the plot was 5.4 m × 3.6 m. The nutrient sources used were Farm yard manure (FYM), vermicompost (VC), jeevamrutha (J) and panchagavya (P). A three factorial randomized block design was employed with three nutrient sources, viz., S₁ nutrients supplied through FYM alone (S₁ = FYM100%), S₂ 50 % nutrients supplied through FYM and 50 % nutrients supplied through vermicompost (S₂= FYM+ vermicompost 50:50), S₃ 75% nutrients supplied through FYM and 25 % nutrients applied through vermicompost (S₃=FYM+ vermicompost 75:25), two levels of jeevamrutha J₀ = without jeevamrutha, J₁= with jeevamrutha 1000 liters (L) ha⁻¹ soil application and two levels of panchagavya P₀= without panchagavya, P₁= With panchagavya 5% foliar spray. The treatments were replicated thrice. The basal dose of FYM 10 t ha⁻¹ was applied 20 days before sowing. Treatment wise FYM was applied 15 days before sowing, whereas VC was top dressed at 30Days after sowing (DAS). Soil application of jeevamrutha @1000 L ha⁻¹ and foliar spray of panchagavya (5%) was done at 20, 40 and 60 DAS according to treatment. Irrigation was supplied to each and every plot at every 15 to 20 days interval. Regular weeding was done till 35-40 DAS and earthing operation was done at 40 DAS. Nondestructive and destructive method of sampling was done to record the observations of growth and yield attributes from five randomly selected and tagged chia plants in each net plot at different intervals throughout the investigation period during two consecutive years of research. Experimental data collected was subjected to statistical analysis by adopting Fishers method of analysis of variance (ANOVA) as outlined by [4]. Critical difference values were calculated whenever the F -test was significant at 5 percent level. Wherever F- test was significant, for comparison between the treatment means, an appropriate value of critical difference (C. D.) was worked out.

Preparation of liquid organic manures

The preparation of liquid manures was done based on Subhas palekars method [9]

a. Preparation of jeevamrutha

Jeevamrutha was prepared by mixing 10 kg cow dung, 10 liters of cow urine, 2 kg organic jaggary, 2 kg pulse flour and hand full of soil collected from the field. All these were put in 200 liters' plastic

drum and mixed thoroughly and volume was made up to 200 liters by adding water. The mixture was stirred well in clock wise direction thrice a day and plastic drum was kept in shade covered with wet jute bag. Jeevamrutha fermented for 10 days was applied to the wet soil by diluting in water.

b. Preparation of panchagavya

Panchagavya was prepared by mixing 7 kg fresh cow dung and 1 kg cow ghee and incubated in a container for 2 days. On third day, 10 liters of desi cow urine and 10 liters of water were added, mixed thoroughly and incubated for fermentation for 13 days. Then, 3 liters of cow milk, 2 liters of cow curd, 3 liters of organic tender coconut water, 3 kg of organic jaggary and 12 ripened cavendish bananas were added and contents were incubated for 6 days. The mixture was stirred thoroughly thrice a day at morning, afternoon and evening. Container was kept in shade and it was covered with wet jute bag. After 21 days of fermentation mixture was filtered through a cotton cloth and used for spraying. 50 ml of panchagavya was diluted with water and sprayed by knapsack sprayer according to treatment.

Table 1: Nutrient composition of different manures used in the experiment (2020 &2021)

Nutrient sources	2020			2021		
	N (%)	P ₂ O ₅ (%)	K ₂ O (%)	N (%)	P ₂ O ₅ (%)	K ₂ O (%)
FYM	0.50	0.15	0.61	0.50	0.17	0.65
Vermicompost	1.00	0.65	0.80	1.01	0.69	0.81
Jeevamrutha	1.09	0.19	0.29	0.89	0.12	0.28
Panchagavya	1.21	0.16	0.29	1.01	0.15	0.27

3. RESULTS AND DISCUSSION

A. Growth attributes of chia as influenced by different sources of organic nutrients

Growth parameters of chia viz., Plant height, Leaf area and dry matter accumulation were significantly influenced organic manure application are presented in Table 2.

Plant height (cm) of chia at harvest

Plant height of chia varied significantly due to application of solid and liquid organic manures. Significantly higher plant height of chia (80.51 cm) was recorded due to application of 50 per cent N equivalent through FYM and 50 per cent N equivalent through VC and was found on par with application of 75 per cent N equivalent through FYM 25 per cent N equivalent vermicompost (78.79 cm), whereas lower plant height was observed with application of N equivalent 100 percent through

FYM (74.53 cm). Soil application of jeevamrutha 1000 L ha⁻¹ recorded higher plant height of (83.56 cm) as compared to without application of jeevamrutha (72.33 cm). Foliar spray of 5% panchagavya recorded higher plant height (81.29 cm) as compared to without application of panchagavya (74.60 cm). Plant height of chia did not vary significantly due to the interaction of nutrient sources, jeevamrutha and panchagavya at harvest. **The significant increase in plant height of chia might be due to readily available nutrient present in the manures. Application of FYM and vermicompost along with liquid organics might have accelerated the soil microbial activities that helped to continuous mineralization leading to better availability of nitrogen, besides hormones like IAA and GA₃ in liquid organics which might have enhanced rapid cell division and reflected in the increase of chia plant height. Similar results were reported by Kanimozhi [6].**

Leaf area (cm²) of chia at 60 DAS

Leaf area of chia differed significantly due to application of bulky and liquid organic. Maximum leaf area (1083.32 cm²) was recorded with the application 50 per cent N equivalent through FYM and 50 per cent N equivalent through VC and was found on par with application of 75 per cent N equivalent through FYM 25 per cent N equivalent vermicompost (1037.72 cm²), whereas lower leaf area (1011.63 cm²) was recorded with application of N equivalent 100 percent through FYM. Application of jeevamrutha 1000 L ha⁻¹ recorded higher leaf area (1102.88 cm²) as compared to without application of jeevamrutha (985.56 cm²) and foliar spar of 5% panchagavya recorded higher leaf area (1085.72 cm²) as compared to without application of panchagavya (1002.73 cm²). Leaf area of chia did not differ significantly due to interaction effect of solid and liquid organic manures at 60 DAS. The increase of leaf area is due to more number of branches and number of leaves per plant. Application of FYM and vermicompost and jeevamrutha might have improved the biological efficiency of chia crop by creating the greater source and increase of photosynthetic efficiency of plants. **The effective conversion of Fe, Mg and Zn at sight of photosynthesis and presence of kinetin in panchagavya might have increased the chlorophyll content of leaf which resulted in more leaf area. This was also in conformity with Subramanian [13].**

Dry matter accumulation of chia at harvest

Significantly higher dry matter accumulation was recorded with application of 50 per cent N equivalent through FYM and 50 per cent N equivalent through VC (130.53 g) and was found on par with application of 75 per cent N equivalent through FYM 25 per cent N equivalent vermicompost

(124.48 g), whereas lower leaf area was recorded with application of N equivalent 100 percent through FYM (114.93 g). Application of jeevamrutha 1000 L ha⁻¹ recorded higher dry matter (141.88 g) as compared to without application of jeevamrutha (104.74 g) and foliar spar of 5% panchagavya recorded higher dry matter (131.79 g) as compared to without panchagavya (114.84g). Dry matter accumulation of chia did not differ significantly due to interaction effect of solid and liquid organic manures. The dry matter production is the function of growth attributes, where the carbon substrates provided by FYM, vermicompost along with application of fermented liquid organics which might have steadily maintained the enzymatic and biological activity for favourable soil bio chemical reaction. Thereby creating favourable environment for mineralization and continuous supply of essential macro and micro nutrients, which reflected in increased dry matter production of chia. Similar results were observed by Yadav [15].

B. Yield attributes and yield of chia as influenced by different sources of organic nutrients

Yield attributes and yield of chia *viz.*, Seed yield per plant, Seed and haulm yield were significantly influenced organic manure application are presented in Table 3.

Seed yield per plant (g) of chia

Seed yield per plant of chia differed significantly due to application of organic manures. Significantly higher seed yield per plant was with 50 per cent N equivalent through FYM and 50 per cent N equivalent through VC (24.50 g) and was found on par with application of 75 per cent N equivalent through FYM 25 per cent N equivalent vermicompost (23.68 g), whereas lesser seed yield per plant of chia was recorded with application of N equivalent 100 percent through FYM (22.43g). Application of jeevamrutha 1000 L ha⁻¹ recorded higher seed yield per plant (27.48 g) as compared to without jeevamrutha (19.23 g) and foliar spar of 5% panchagavya recorded higher seed yield per plant (26.32 g) as compared to without panchagavya (20.76 g). Interaction of jeevamrutha and panchagavya resulted in significantly higher seed yield per plant (31.80 g). The other interactions of FYM and vermicompost with jeevamrutha and panchagavya were found to be non-significant. Increase in seed yield per plant might be associated to more efficient sink formation, greater sink size and greater carbohydrates translocation from vegetative parts to seeds. Humic substances of vermicompost which is known for induction of lateral root growth by stimulation of H⁺-ATPase activity in the plasma membrane and might have enhanced the uptake and transfer of nutrients and finally resulted in good source to sink relationship as per Dotaniya et. al. [3].

Seed yield (kg ha⁻¹) of chia

Significantly higher seed yield of chia was due to application 50 per cent N equivalent through FYM and 50 per cent N equivalent through VC (920 kg ha⁻¹) and was found on par with application of 75 per cent N equivalent through FYM 25 per cent N equivalent vermicompost (901kg ha⁻¹), whereas lesser seed yield of chia was recorded with application of N equivalent 100 percent through FYM (867 kg ha⁻¹). Application of jeevamrutha 1000 L ha⁻¹ recorded seed yield (984 kg ha⁻¹) as compared to without jeevamrutha (809 kg ha⁻¹) and foliar spar of 5% panchagavya recorded higher seed yield (952 kg ha⁻¹) as compared to without panchagavya (841 kg ha⁻¹). Seed yield of chia did not differ significantly due to interaction effect of solid and liquid organic manures. The improvement in yield is due to faster mineralization of nutrients to soil which increases the soil available nutrients and enhanced the sink potential and in turn production and translocation of photosynthates to spikes .When jeevamrutha and panchagavya are applied at regular intervals (2-3 times) during crop growth period they act as a stimulus in plant and in turn produce growth regulators and hormones in cell system increasing the biomass by sustaining the availability and nutrient uptake of applied and native soil nutrients which ultimately reflected in increase of yield. Similar findings were observed by Devakumar et. al. [2] and Gopinath et. al. [5].

Haulm yield (kg ha⁻¹) of chia

Haulm yield of chia differed significantly due to application of organic manures. Application of 50 per cent N equivalent through FYM and 50 per cent N equivalent through VC resulted significantly higher haulm yield (1480 kg ha⁻¹) and was found on par with application of 75 per cent N equivalent through FYM 25 per cent N equivalent vermicompost (1405 kg ha⁻¹), whereas lesser haulm yield of chia was recorded with application of N equivalent 100 percent through FYM (1295 kg ha⁻¹). Application of jeevamrutha 1000 L ha⁻¹ recorded haulm yield (1598 kg ha⁻¹) as compared to without jeevamrutha (1190 kg ha⁻¹) and foliar spar of 5% panchagavya recorded higher haulm yield (1486 kg ha⁻¹) as compared to without panchagavya (1302 kg ha⁻¹). Haulm yield of chia did not differ significantly due to interaction effect of solid and liquid organic manures. Haulm yield of any crop is a function of growth attributes of a crop. Mineralization of organic sources might have provided ample opportunity for availability of soil nutrients rather than fixation in soil. The extensive root system leads to increase of vegetative growth, besides hormonal influence of panchagavya along with photosynthetic activity which might have

developed better source-sink relationship and reflected in increase of growth attributes. The results are in conformity with findings of Negi et. al. [8].

Conclusion

The results of this trial could enlighten the knowledge on importance of adding solid organic manures by integrating with liquid organic manure in order to enhance the growth and yield of chia crop. From the present study it was concluded that among the different nutrient sources S₂ (50 per cent N equivalent through FYM and 50 per cent N equivalent through VC) resulted in higher growth, yield attributes and yield of chia crop and was found on par with S₃, whereas lower growth, yield attributes and yield of chia was with S₁. Soil application of jeevamrutha @ 1000 L ha⁻¹ and panchagavya foliar spray 5% resulted in significantly higher growth, yield attributes and yield of chia crop as compared to without application of jeevamrutha and panchagavya.

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Treatments	Plant height (cm)			Leaf area (cm ²)			Dry matter accumulation(g)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Nutrient sources (S)									
S ₁	67.45	81.61	74.53	957.78	1065.47	1011.63	100.02	129.85	114.93
S ₂	75.34	85.69	80.51	1001.45	1165.20	1083.32	109.51	151.55	130.53
S ₃	74.20	83.39	78.79	997.47	1077.97	1037.72	104.70	144.25	124.48
Mean	72.33	83.56		985.56	1102.88		104.74	141.88	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
S	1.49	4.36		16.12	47.29		2.88	8.45	
J	1.21	3.56		13.17	38.61		2.35	6.90	
S X J	2.10	NS		22.80	NS		4.07	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
S ₁	70.97	78.09	74.53	971.75	1051.50	1011.63	103.08	126.79	114.93
S ₂	76.86	84.17	80.51	1025.28	1141.37	1083.32	123.08	137.98	130.53
S ₃	75.98	81.61	78.79	1011.16	1064.28	1037.72	118.36	130.59	124.48
Mean	74.60	81.29		1002.73	1085.72		114.84	131.79	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
S	1.21	3.56		13.17	38.61		2.35	6.90	
S X P	2.10	NS		22.80	NS		4.07	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	68.40	76.25	72.33	953.92	1017.21	985.56	97.41	112.08	104.74
J ₁	80.80	86.32	83.56	1051.54	1154.22	1102.88	132.28	151.49	141.88
Mean	74.60	81.29		1002.73	1085.72		114.84	131.79	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J X P	1.72	NS		18.62	NS		3.33	NS	
Interaction									
S X J X P									
S ₁	J ₀	62.32	72.58	905.82	1009.73	90.48	109.56		
	J ₁	79.61	83.60	1037.68	1093.27	115.67	144.02		
S ₂	J ₀	71.44	79.23	978.98	1023.91	104.71	114.32		
	J ₁	82.27	89.11	1071.58	1258.82	141.46	161.65		
S ₃	J ₀	71.44	76.95	976.95	1017.99	97.03	112.37		
	J ₁	80.51	86.26	1045.36	1110.58	139.70	148.81		
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
S X J X P	2.97	NS		32.25	NS		5.76	NS	

Table 2. Growth attributes of chia as influenced by different organic manures application at harvest

Note: CD at 5%, J₀ = Without Jeevamrutha, J₁ = With Jeevamrutha 1000 liters ha⁻¹, P₀ = Without Panchagavya, P₁ = With Panchagavya 5%,

S₁ = FYM (100%), S₂ = FYM + vermicompost (50:50), S₃ = FYM + vermicompost (75:25), DAS = Days After Sowing, NS = non-significant

Table3: Yield attributes and yield of chia as influenced by different organic manures application

Treatments	Seed yield per plant			Seed yield (kg ha ⁻¹)			Haulm yield (kg ha ⁻¹)		
	J ₀	J ₁	Mean	J ₀	J ₁	Mean	J ₀	J ₁	Mean
Nutrient sources (S)									
S ₁	17.55	27.32	22.43	778	957	867	1085	1506	1295
S ₂	20.70	28.30	24.50	829	1012	920	1281	1679	1480
S ₃	19.45	27.92	23.68	819	982	901	1204	1607	1405
Mean	19.23	27.84		809	984		1190	1598	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
S	0.45	1.32		12.70	37.23		36.43	106.85	
J	0.37	1.08		10.37	30.40		29.75	87.24	
S X J	0.64	NS		17.95	NS		51.52	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
S ₁	19.76	25.11	22.43	806	929	867	1216	1375	1295
S ₂	21.44	27.56	24.50	867	974	920	1359	1602	1480
S ₃	21.08	26.29	23.68	850	951	901	1331	1480	1405
Mean	20.76	26.32		841	952		1302	1486	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
S	0.37	1.08		10.37	30.40		29.75	87.24	
S X P	0.64	NS		17.95	NS		51.52	NS	
	P₀	P₁	Mean	P₀	P₁	Mean	P₀	P₁	Mean
J ₀	17.63	20.84	19.23	760	857	809	1091	1288	1190
J ₁	23.89	31.80	27.84	921	1046	984	1513	1683	1598
Mean	20.76	26.32		841	952		1302	1486	
	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
J X P	0.52	1.53		14.66	NS		42.07	NS	
Interaction S X J X P	P₀	P₁		P₀	P₁		P₀	P₁	
S ₁	J ₀	16.31	18.79	713	843		1000	1169	
	J ₁	23.20	31.43	899	1016		1433	1580	
S ₂	J ₀	18.41	22.99	792	865		1162	1400	
	J ₁	24.48	32.13	941	1083		1555	1803	
S ₃	J ₀	18.16	20.73	776	863		1111	1296	
	J ₁	23.99	31.84	924	1040		1550	1665	
S X J X P	S.Em ±	C.D.		S.Em ±	C.D.		S.Em ±	C.D.	
	0.90	NS		25.39	NS		72.86	NS	

Note: CD at 5%, J₀ = Without Jeevamrutha, J₁ = With Jeevamrutha 1000 liters ha⁻¹, P₀ = Without Panchagavya, P₁ = With Panchagavya 5%,

S₁ = FYM (100%), S₂ = FYM + vermicompost (50:50), S₃ = FYM + vermicompost (75:25), DAS = Days After Sowing, NS = non-significant

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