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Effect of organic inputs on growth, yield and quality of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.)

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Abstract
The research was carried out in the Medicinal plants unit, Department of Horticulture, Annamalai University, Annamalai nagar, Chidambaram, Cuddalore district, Tamil Nadu, India during the year 2023-2024, to study the effect of organic inputs on growth, yield and quality of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.). The experiment was conducted for two seasons in factorial randomized block design (FRBD) with ten treatment combinations each replicated thrice comprising organic inputs and foliar supplements. The different organic inputs tried were vermicompost 5 t ha^{-1}, poultry manure 5 t ha^{-1}, neem cake 5 t ha^{-1}, commercial organic manure 10 kg ha^{-1} and farm yard manure 25 t ha^{-1} and foliar supplements tried were panchagavya 3% and seaweed extract 4%. Among them treatment combination, M_1S_1 (vermicompost 5 t ha^{-1} + panchagavya 3%) exhibited superior performance in both the seasons with respect to growth, yield and quality parameters such as plant height (71.12 and 70.29 cm), number of branches $plant^{-1}$ (10.51 and 10.09), number of flowers $plant^{-1}$ (63.47 and 59.98), number of fruits $plant^{-1}$ (39.02 and 34.62), individual fruit weight (12.48 and 12.36 g), fruit yield $plant^{-1}$ (464.27 and 448.33 g), chlorophyll content (48.57 and 47.21), root length (33.45 and 32.89 cm) and crude protein content (2.31 and 2.22%) followed by M_2S_1 (poultry manure 5 t ha^{-1} + panchagavya 3%). The highest percentage yield improvement was obtained in M_1S_1 which was 33.81% over control.

Keywords: *Solanum xanthocarpum*, vermicompost, panchagavya, poultry manure, FYM

1. Introduction
Yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.) is an important medicinal herb belonging to the family Solanaceae. Synonyms are *Solanum virginianum* L. and *Solanum surattense* Burm. In tamil it is called 'Kantankattiri', in sanskrit it is 'Kantkari' and in hindi it is 'Katali' or 'Chotikateri'. It is found in South East Asia, Malaysia, tropical Australia, Polynesia and Srilanka. In India, it is distributed in Uttar Pradesh, West Bengal, Assam, Mysore, Bihar and Punjab. It is a pricky bright green perennial herb.

The dried whole plant shows significant improvement in treatment of respiratory diseases like bronchial asthma. Roots are integral constituents of well-known Ayurvedic preparation "Dasmula Ashva" (Bhatt, 2011) [5]. The whole plant is useful in vitiated conditions of lumbago, helminthiasis, anorexia, epilepsy, inflammations, dental caries, constipation, dyspepsia, leprosy, skin diseases, hypertension, flatulence, cough, asthma, bronchitis, fever, hiccough, haemorrhoids, vata and kapha (Govindan *et al.*, 2004) [9].

Tribal and rural people of Orissa treat diabetes with a decoction made from the fruits (Parmar *et al.*, 2010) [24]. Unripe fruits of *Solanum xanthocarpum* are cooked and taken as food by the Irula tribes of Hasanur Hills, Erode district, Tamil Nadu (Revathi and Parimelazhagan, 2010) [32]. In Kerala, wild fruits and seeds of *Solanum xanthocarpum* are consumed by Kattunaikka, Paniya and Kuruma tribes of Wayanad district (Narayanan *et al.*, 2011) [19]. In the past two decades, phytoconstituents present in yellow berried nightshade are used by pharmaceutical industries for treating anti-fertility, anti-inflammatory and anti-allergic issues (Patil *et al.*, 2019) [27].

Solanum xanthocarpum fruit contains carpesterol, glucose, galactose, potassium chloride, a number of steroidal compounds and alkaloids mainly in the form of glycoalkaloids. The flavanoids quercitrin and apigenin glycosides were the major chemical constituents present in

the fruits of *Solanum xanthocarpum* (Abbas *et al.*, 2014) [1]. Alkaloids present in *Solanum xanthocarpum* includes solanine, solamargine, sapogenins and solasodine are also responsible for medicinal effect. Berries are the leading source of diosgenin and solasodine. The fruits contain few steroidal alkaloids such as solancarpine, solamargine, beta solamargine and solanocarpidine (Mahmood *et al.*, 2019) [17]. *Solanum xanthocarpum* is the superlative precursor for the discovery and development of molecular pharmaceuticals (Azhar *et al.*, 2020) [4]. Solasodine is a valuable natural precursor of several commercial steroidal drugs such as corticosteroids, antifertility drugs, anabolic steroids and sex hormones (Singh and Singh, 2023) [34].

Organic farming has a positive influence on soil texture and water holding capacity. Farmyard manure seems to act directly in increasing crop yields by supplying nitrogen, phosphorus, potash and micronutrients in available forms to the plants through biological decomposition. Application of FYM showed a decrease in bulk density and increase in water holding capacity, porosity and infiltration rate. Besides, electrical conductivity of soil was high with increasing level of FYM resulting in increased organic carbon content (Patil *et al.*, 2003) [28]. Vermicompost is supposed to increase the soil organic matter, soil water retention, transmission and other physical properties of soil like decrease in bulk density and increased aggregation (Zebarth *et al.*, 1999) [38]. It is an effective organic fertilizer that can be utilized to improve the quality of the soil (Joshi *et al*., 2022) [11]. Poultry manure is an excellent source of nutrients and minerals and has less soluble salts, neutral in pH, greater cation exchange capacity and humic acid. Neem cake performs the dual function of both fertilizer and pesticide, acts as a soil enricher, reduces the growth of soil pest and bacteria, provides all macro nutrients essential for plant growth, helps to increase the yield of plants in the long run. It is eco-friendly and is an excellent soil conditioner (Lokanadhan *et al.*, 2012) [16].

Foliar supplements are nutrients applied directly to the leaves of the plant. It promote faster growth, improved flowering and higher yield and also recover plants from stress factors. It also acts as a natural defence against pests and diseases. Panchagavya enhances the biological efficiency of crop plants and has improved the quality of harvested produce. Since it is rich in nutrients, plant hormones like auxins, gibberellins and microbial load which induce vigor in plants (Pathak and Ram, 2002) [25, 30]. Panchagavya contains microorganisms in addition, that boost the plant growth, metabolic activities and resistance to pest and diseases (Rakesh *et al.*, 2017) [29]. Another foliar supplement, seaweed extract, particularly from brown seaweed (*Ascophyllun nodosum*) are rich in phenolic compounds. Phenolics are secondary metabolites that protect the cells and cellular components. Seaweed extracts also trigger early flowering and increased fruit set in a variety of crop plants. Such an increase in flower numbers and fruit set lead to higher yield (Ali *et al.*, 2021) [2]. Hence the present investigation was carried out to study the effect of organic inputs on growth, yield and quality of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.).

2. Materials and Methods

The seeds were extracted from the fruits and shade dried. Before sowing in the nursery bed, the seeds were soaked in the tap water for 24 hours. Only healthy seeds (sinkers) were sown in the nursery and after 75 days of care in the nursery bed the seedlings were transplanted to the main field. A raised nursery bed measuring 2 x 1 m was prepared and the seeds were line sown at a distance of 10 cm between lines. The bed was then watered immediately after sowing, using a rose can. To prevent weed growth and to promote faster germination, beds were mulched with paddy straw immediately after planting. Plots of 2 m × 1.5 m were prepared and incorporated with 2.5 kg/m^2 of FYM as a basal dose. Organic fertilisers were applied to different beds 15 days after transplanting as per treatment combination and foliar spray of panchagavya 3% and seaweed extract 4% were sprayed at 60 and 90 DAP before flowering and fruit setting respectively, according to the treatments described in table 1. Fruits were ready for harvest after 5 months of planting. The harvesting maturity was indicated by a shift in berry colour from green to yellow. When the berries reached ripeness, they were severed with secateurs.

The field experiment was laid out in factorial randomized block design (FRBD) with ten treatment combination each replicated thrice comprising organic inputs and foliar supplements in two different seasons (June-October, 2023 and Nov-April, 2024). The different organic inputs tried were vermicompost 5 t ha^{-1}, poultry manure 5 t ha^{-1}, neem cake 5 t ha^{-1}, commercial organic manure 10 kg ha^{-1} and farm yard manure 25 t ha^{-1} and foliar supplements tried were panchagavya 3% and seaweed extract 4%. Five plants were randomly tagged in each treatment as per replication and data was recorded according to growth, yield and quality parameters *viz*., plant height, number of branches plant^{-1}, number of flowers plant^{-1}, number of fruits plant^{-1}, individual fruit weight, fruit yield plant^{-1}, chlorophyll content, root length and crude protein content. Varying bioactive compounds were also analysed by GC-MS with the fruit extracts of *Solanum xanthocarpum* from M_1S_1.

Table1: Details of treatment combination

Treatment	Treatment combination
M_1S_1	Vermicompost 5 t ha^{-1} + Panchagavya 3%
M_1S_2	Vermicompost 5 t ha^{-1} + Seaweed extract 4%
M_2S_1	Poultry manure 5 t ha^{-1} + Panchagavya 3%
M_2S_2	Poultry manure 5 t ha^{-1} + Seaweed extract 4%
M_3S_1	Neem cake 5 t ha^{-1} + Panchagavya 3%
M_3S_2	Neem cake 5 t ha^{-1} + Seaweed extract 4%
M_4S_1	Commercial organic manure 10 kg ha^{-1} + Panchagavya 3%
M_4S_2	Commercial organic manure 10 kg ha^{-1} + Seaweed extract 4%
M_5S_1	Farm yard manure 25 t ha^{-1} + Panchagavya 3%
M_5S_2	Farm yard manure 25 t ha^{-1} + Seaweed extract 4%

2.1 Statistical analysis

The statistical analysis of data was done by adopting the standard procedure of Panse and Sukhatme (1985) [23]. The significant effect of treatment was judged with the help of 'F' (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. The statistical analysis was performed through WASP 2.0 software and the respective results of the data are presented in tables and graphs.

3. Results

3.1 Growth characters

The data recorded on growth parameters *viz*., plant height, number of branches plant^{-1}, chlorophyll content and root length at the time of harvest (150 DAP) as influenced by organic manures, foliar supplements and their interactions on yellow berried nightshade shows significant variation among different treatment combinations in both the seasons (Table. 2 and 3).

Among different organic treatments M_1 (vermicompost 5 t ha^{-1}) recorded highest plant height (68.49 and 67.65 cm), number of branches plant^{-1} (10.07 and 9.66), chlorophyll content (46.53 and 45.12) and root length (32.25 and 31.68 cm).

With respect to foliar supplements S_1 (panchagavya 3%)

recorded highest plant height (61.81 and 61.32 cm), number of branches plant^{-1} (9.06 and 8.72), chlorophyll content (41.74 and 40.36) and root length (29.32 and 28.81 cm).

The interaction effect of organic manures and foliar supplements had significantly influenced the growth parameters. The treatment combination, M_1S_1 (vermicompost 5 t ha^{-1} + panchagavya 3%) recorded highest plant height (71.12 and 70.29 cm), number of branches plant^{-1} (10.51 and 10.09), chlorophyll content (48.57 and 47.21) and root length (33.45 and 32.89 cm).

Table 2: Effect of organic inputs on plant height and number of branches plant^{-1} of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.

Treatment	Plant height (cm)									Number of branches plant^{-1}								
	Season I			Season II			Pooled data			Season I			Season II			Pooled data		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
M1	71.12	65.87	68.49	70.29	65.02	67.65	70.70	65.44	68.07	10.51	9.63	10.07	10.09	9.24	9.66	10.29	9.43	9.86
M2	68.48	63.34	65.90	67.53	62.61	65.07	68.00	62.97	65.48	10.04	9.17	9.60	9.65	8.84	9.24	9.84	9.00	9.42
M3	60.73	59.12	59.92	60.01	58.74	59.37	60.36	58.92	59.64	8.78	8.62	8.70	8.44	8.40	8.42	8.61	8.50	8.56
M4	56.49	54.83	55.66	56.03	55.46	55.74	56.26	55.14	55.70	8.25	8.11	8.18	8.02	7.86	7.94	8.13	7.98	8.05
M5	52.26	51.07	51.66	52.78	50.39	51.58	52.51	50.72	51.62	7.74	7.29	7.51	7.40	6.94	7.17	7.57	7.11	7. 34
Mean	61.81	58.84	60.32	61.32	58.44	59.88	61.56	58.64	60.10	9.06	8.56	8.81	8.72	8.25	8.48	8.89	8.40	8.64

	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S
SE(m) ±	0.56	0.35	0.80	0.56	0.35	0.79	0.56	0.35	0.79	0.08	0.05	0.11	0.08	0.05	0.10	0.08	0.05	0.10
CD @ 5%	1.70	1.07	2.40	1.69	1.06	2.39	1.69	1.07	2.39	0.25	0.15	0.35	0.24	0.15	0.34	0.24	0.15	0.34

Table 3: Effect of organic inputs on chlorophyll content and root length of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.)

Treatment	Chlorophyll content									Root length (cm)								
	Season I			Season II			Pooled data			Season I			Season II			Pooled data		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
M1	48.57	44.49	46.53	47.21	43.03	45.12	47.89	43.75	45.82	33.45	31.05	32.25	32.89	30.46	31.68	33.16	30.75	31.96
M2	46.43	42.37	44.40	45.22	40.97	43.10	45.82	41.66	43.74	32.26	29.86	31.06	31.68	29.17	30.43	31.96	29.51	30.74
M3	40.32	39.87	40.10	38.84	38.49	38.67	39.57	39.17	39.37	28.59	28.47	28.53	27.98	27.83	27.91	28.28	28.15	28.21
M4	37.92	37.64	37.78	36.48	36.03	36.26	37.20	36.83	37.01	27.21	27.06	27.14	26.57	26.32	26.45	26.88	26.68	26.78
M5	35.44	33.21	34.33	34.05	31.96	33.01	34.74	32.58	33.66	25.07	23.83	24.45	24.95	23.15	24.05	25.01	23.49	24.25
Mean	41.74	39.52	40.63	40.36	38.10	39.23	41.04	38.80	39.92	29.32	28.05	28.68	28.81	27.39	28.10	29.06	27.71	28.38

	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S
SE(m) ±	0.38	0.24	0.54	0.37	0.23	0.52	0.37	0.23	0.53	0.27	0.17	0.38	0.26	0.16	0.37	0.26	0.16	0.37
CD @ 5%	1.15	0.73	1.63	1.11	0.70	1.58	1.13	0.71	1.60	0.81	0.51	1.14	0.79	0.50	1.12	0.80	0.50	1.13

3.2 Yield and quality parameters

The data recorded on yield and quality parameters *viz*., number of flowers plant^{-1}, number of fruits plant^{-1}, individual fruit weight, fruit yield plant^{-1} and crude protein content as influenced by organic manures, foliar supplements and their interactions on yellow berried nightshade shows significant variation among different treatment combinations in both the seasons (Table. 4, 5 and 6).

Among different organic treatments M_1 (vermicompost 5 t ha^{-1}) recorded increase in number of flowers plant^{-1} (61.21 and 57.89), number of fruits plant^{-1} (37.66 and 33.41), individual fruit weight (12.05 and 11.93 g), fruit yield plant^{-1} (447.05 and 432.16 g) and crude protein content (2.14 and 2.06%).

With respect to foliar supplements S_1 (panchagavya 3%) recorded increase in number of flowers plant^{-1} (56.01 and 53.16), number of fruits plant^{-1} (34.56 and 30.66), individual fruit weight (11.05 and 10.96 g), fruit yield plant^{-1} (407.18 and 390.41 g) and crude protein content (1.76 and 1.70%).

The interaction effect of organic manures and foliar supplements had significantly influenced the yield and quality parameters. The treatment combination, M_1S_1 (vermicompost 5 t ha^{-1} + panchagavya 3%) recorded increase in number of flowers plant^{-1} (63.47 and 59.98), number of fruits plant^{-1} (39.02 and 34.62), individual fruit weight (12.48 and 12.36 g), fruit yield plant^{-1} (464.27 and 448.33 g) and crude protein content (2.31 and 2.22%).

Table 4: Effect of organic inputs on number of flowers plant^{-1} and number of fruits plant^{-1} of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.)

Treatment	Number of flowers plant^{-1}									Number of fruits plant^{-1}								
	Season I			Season II			Pooled data			Season I			Season II			Pooled data		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
M1	63.47	58.94	61.21	59.98	55.79	57.89	61.72	57.36	59.54	39.02	36.29	37.66	34.62	32.19	33.41	36.81	34.24	35.52
M2	61.21	56.66	58.94	57.88	53.68	55.78	59.54	55.17	57.35	37.66	34.93	36.30	33.41	30.98	32.20	35.53	32.95	34.24
M3	54.41	54.08	54.25	51.58	51.42	51.50	52.99	52.74	52.86	33.56	33.42	33.49	29.76	29.62	29.69	31.66	31.51	31.58
M4	51.80	51.41	51.61	49.32	49.14	49.23	50.55	50.27	50.41	32.06	31.89	31.98	28.41	28.29	28.35	30.23	30.08	30.15
M5	49.16	46.98	48.07	47.05	44.95	46.00	48.10	45.96	47.03	30.52	29.16	29.84	27.08	25.85	26.47	28.79	27.50	28.15
Mean	56.01	53.61	54.81	53.16	51.00	52.08	54.58	52.30	53.44	34.56	33.14	33.85	30.66	29.39	30.02	32.60	31.25	31.92

	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S
SE(m) ±	0.51	0.32	0.72	0.48	0.30	0.69	0.50	0.31	0.70	0.31	0.20	0.44	0.28	0.17	0.39	0.29	0.18	0.42
CD @ 5%	1.54	0.97	2.18	1.46	0.92	2.07	1.50	0.95	2.12	0.95	0.60	1.34	0.84	0.53	1.19	0.89	0.56	1.27

Table 5: Effect of organic inputs on individual fruit weight (g) and fruit yield plant^{-1} of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.)

Treatment	Individual fruit weight (g)									Fruit yield plant^{-1}								
	Season I			Season II			Pooled data			Season I			Season II			Pooled data		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
M1	12.48	11.62	12.05	12.36	11.50	11.93	12.42	11.56	11.99	464.27	429.82	447.05	448.33	415.98	432.16	456.30	422.89	439.59
M2	12.05	11.19	11.62	11.92	11.07	11.50	11.98	11.12	11.55	448.21	413.55	430.88	432.07	398.65	415.36	440.13	406.09	423.11
M3	10.76	10.68	10.72	10.65	10.61	10.63	10.70	10.64	10.67	397.48	391.14	394.31	381.67	375.44	378.56	389.57	383.28	386.43
M4	10.25	10.16	10.21	10.19	10.08	10.14	10.22	10.11	10.16	374.38	368.22	371.30	358.97	347.22	353.10	366.67	357.71	362.19
M5	9.72	9.29	9.51	9.66	9.24	9.45	9.69	9.26	9.47	351.56	332.78	342.17	331.03	314.56	322.80	341.29	323.67	332.48
Mean	11.05	10.59	10.82	10.96	10.50	10.73	11.00	10.54	10.77	407.18	387.10	397.14	390.41	370.37	380.39	398.79	378.73	388.76

	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S	M	S	M*S
SE(m) ±	0.10	0.06	0.14	0.10	0.06	0.14	0.10	0.06	0.14	3.75	2.37	5.31	3.60	2.28	5.10	3.67	2.32	5.20
CD @ 5%	0.30	0.19	0.43	0.30	0.19	0.42	0.30	0.19	0.42	11.23	7.10	15.88	10.78	6.82	15.25	11.00	6.96	15.56

Table 6: Effect of organic inputs on crude protein content (%) of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.)

Treatment	Crude protein content (%)								
	Season I			Season II			Pooled data		
	S1	S2	Mean	S1	S2	Mean	S1	S2	Mean
M1	2.31	1.96	2.14	2.22	1.89	2.06	2.26	1.92	2.09
M2	2.14	1.81	1.98	2.08	1.78	1.93	2.10	1.79	1.94
M3	1.65	1.62	1.64	1.62	1.58	1.60	1.63	1.60	1.61
M4	1.43	1.41	1.42	1.38	1.34	1.36	1.40	1.37	1.38
M5	1.25	1.10	1.18	1.18	1.07	1.13	1.21	1.08	1.14
Mean	1.76	1.58	1.67	1.70	1.53	1.61	1.72	1.55	1.63

	M	S	M*S	M	S	M*S	M	S	M*S
SE(m) ±	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.02
CD @ 5%	0.05	0.03	0.07	0.04	0.03	0.07	0.05	0.03	0.07

3.3 GC-MS analysis

The investigation of bioactive phytoconstituents in fruit extract of yellow berried nightshade was carried out in Gas Chromatography-Mass Spectrometry (GC-MS) and the identification of unknown compounds was done via NIST library and Mass Hunter software (fig. 1). Name of obtained bioactive compound, formula, retention time, peak area and area percentage are presented in table 7.

Table 7: Bioactive phytoconstituents in fruit extracts of yellow berried nightshade (*Solanum xanthocarpum* Schrad. & Wendl.) by GCMS analysis

Sl. No.	R.T. (min)	Compound name	Formula	Peak area	Area (%)
1	11.0592	2-Methoxy-4-vinylphenol	C9H10O2	424526	0.55
2	14.1107	Dodecanoic acid	C12H24O2	379048	0.49
3	14.2564	Phenol, 4-ethenyl-2,6-dimethoxy-	C10H12O3	168089	0.22
4	14.8427	Quinic acid	C7H12O6	4991067	6.49
5	16.3502	Tetradecanoic acid	C14H28O2	583014	0.76
6	17.3990	Pentadecanoic acid	C15H30O2	399634	0.52
7	18.0617	Hexadecanoic acid, methyl ester	C17H34O2	2661793	3.46
8	18.4878	n-Hexadecanoic acid	C16H32O2	23816514	30.99
9	19.0413	Hexadecanoic acid, 14-methyl-, methyl ester	C18H36O2	202739	0.26
10	19.3690	Heptadecanoic acid	C17H34O2	273335	0.36
11	19.7113	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	C19H34O2	4312426	5.61
12	19.7587	9-Octadecenoic acid (Z)-, methyl ester	C19H36O2	1719324	2.24
13	19.8752	Phytol	C20H40O	96345	0.13
14	19.9298	1,3,4-Oxadiazole-2(3H)-thione, 5-(2-bromophenyl)-3- benzyl(methyl)aminomethyl-	C17H16BrN3 OS	81560	0.11
15	19.9772	Methyl stearate	C19H38O2	2634842	3.43
16	20.3522	Octadecanoic acid	C18H36O2	18949309	24.65
17	20.6071	Benzamide, N-(2-cyanocyclopent-1-enyl)-3,4- dimethoxy	C15H16N2O 3	320116	0.42
18	21.3828	2-(4-Chlorophenoxy)-N-[2-(dimethylamino)ethyl]-2- methylpropanamide	C14H21ClN2 O2	297501	0.39
19	21.4884	Glycidyl palmitate	C19H36O3	835274	1.09
20	21.7360	Eicosanoic acid, methyl ester	C21H42O2	99338	0.13
21	22.5590	9,12-Octadecadienoic acid (Z,Z)-, 2,3-dihydroxypropyl ester	C21H38O4	324071	0.42
22	22.9544	9,12-Octadecadienoic acid (Z,Z)-, 2-hydroxy-1- (hydroxymethyl)ethyl ester	C21H38O4	4384715	5.70
23	23.1525	Glycidol stearate	C21H40O3	165683	0.22
24	23.2399	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester	C19H38O4	1784014	2.32
25	23.5604	Bis(2-ethylhexyl) phthalate	C24H38O4	157333	0.20
26	24.6310	9,12-Octadecadienoic acid (Z,Z)-, 2-hydroxy-1- (hydroxymethyl)ethyl ester	C21H38O4	4870173	6.34
27	24.8021	Octadecanoic acid, 2,3-dihydroxypropyl ester	C21H42O4	794342	1.03
28	25.2719	13-Docosenamide, (Z)-	C22H43NO	478629	0.62
29	25.6069	Squalene	C30H50	456272	0.59
30	26.0330	Heptacosane	C27H56	198482	0.26

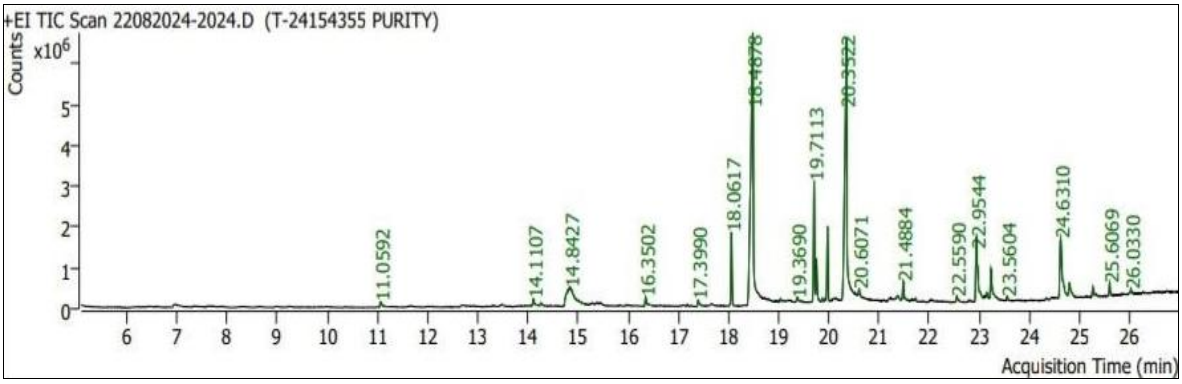

Fig 1: Gas Chromatography-Mass Spectrometry (GC-MS) analysis

4. Discussion

In the field trial, there was a significant positive impact on growth, yield and quality parameters of *Solanum xanthocarpum* plants due to incorporation of vermicompost, poultry manure, neem cake, commercial organic manure and farm yard manure in order. It is an established fact that vermicompost improve the physical structure of the soil such as porosity, aeration, drainage, resistance to corrosion and infiltration, thus providing a better medium for root growth (Chaoui *et al*., 2003) [6]. In addition to nutrients, vermicompost also contains hormones such as auxin, gibberellin and cytokinin. As such, freshly harvested vermicompost not only act as a source of nutrients and hormones but also increase the size, biodiversity and activity of the microbial population in soil. Therefore vermicompost incorporated soil becomes rich with enzymes that helps in microbial load improvement retaining its nutrients over longer period of time without having any adverse impact on the environment. To summarize the treatment effect of various organic inputs, as indicated in figure 1, higher percentage of yield improvement (26.18%) was obtained due to vermicompost. This finding is in consonant with the earlier reports of Khan *et al.* (2019) [12] in chilli and Nithya *et al.* (2024) [21] in tomato. This was followed by incorporation of poultry manure (21.63%) and then by neem cake (12.18%).

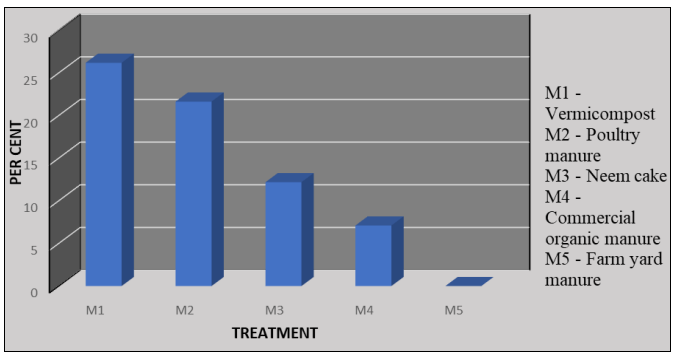

Fig 2: Yield (%) improvement due to incorporation of organic manures

Foliar spraying of panchagavya 3% had shown significant improvement in growth, yield and quality parameters of *Solanum xanthocarpum*. This may be due to the influence of growth promoting hormones auxin and kinetin, which accelerate the mobility of photosynthates and application as foliar spray, favoured the plants to produce a greater number of fruits plant^{-1} and due to the metabolic activity, which results in the active translocation of more carbohydrates for the development of the fruits, which helps in improving the yield of the plant. Panchagavya contains macronutrients (nitrogen, phosphorus and potassium) and micronutrients which are required for the growth and development of plants and also contains various amino acids, vitamins, growth regulators like auxins, gibberellins and also beneficial microorganisms like pseudomonas, azatobacter and phosphobacteria etc (Ram, 2017) [30]. Panchagavya, as a foliar supplement, aids in the easy movement of nutrients to plants and the amounts of IAA and GA present in panchagavya may have caused stimuli in the plant system, which in turn stimulated the production of growth regulators in the cell system (Kumbar and Devakumar, 2016) [15]. Ultimately would have boosted growth and development in *Solanum xanthocarpum*, leading to better yield. The improvement in crude protein content is due to higher uptake of nitrogen during growth period which increased photosynthesis, synthesis of protoplasm and protein (Patil *et al*., 2012) [26]. Comparable results were obtained by Swarnam *et al.* (2016) [36] in eggplant, Uthirapandi *et al.* (2018) [37] in holy basil and Jadav (2023) [10] in fenugreek. Spraying of panchagavya has shown marked improvement in economic yield of medicinal plants like black nightshade (Sivakumar *et al*., 2011) [35] and ashwagandha (Ankad *et al*., 2018) [3].

The interaction effect of organic manure and foliar supplement (M x S) produced significantly better results in promoting growth, yield and quality parameters of *Solanum xanthocarpum* plants. The treatment combination, M_1S_1 (vermicompost 5t/ha + panchagavya 3%) was identified as best in promoting growth, yield and quality in *Solanum xanthocarpum*. In the current research carried out for two seasons, *Solanum xanthocarpum* had responded to a tune of 33.81% yield improvement (fig. 2) due to vermicompost 5 t ha^{-1} and panchagavya 3%. This result is in accordance with the findings of Rao *et al.* (2015) [31] and Rohith *et al.* (2021) [33] in chilli. This might be due to the adequate supply of nutrients, increased photosynthetic activity, nitrogen metabolism and auxin content. Higher branch counts may be attributed to increased rates of photosynthesis and photosynthates, as well as higher chlorophyll content and flower production. Vermicompost improves soil aeration, water retention and drainage while panchagavya adds organic matter, contributing to better soil structure. This creates a more favourable environment for root development. Due to the presence of natural plant growth hormones, root, shoot and overall growth of the plant gets improved and also enhanced root biomass and vigour along with higher nutrient and water uptake efficiency. This combination contain beneficial microorganism that enhance soil health and fertility. The combination supports a thriving microbial community, improving nutrient cycling and organic matter decomposition. It also help the plants to attain maximum growth and yield due to the slow release of major nutrients to the plant especially nitrogen and also application of panchagavya supplies almost all

essential plant nutrients for the growth and development of a plant. Increase in number of fruit might be due to an increased allocation of photosynthates (Patil *et al.*, 2012) [26]. The favourable effect of panchagavya on fruit yield may be due to the fact that panchagavya acts as growth promoter and immunity booster. Congruent results were obtained by Rao *et al.* (2015) [31] in chilli, Kumar *et al.* (2016) [14] in chilli, Rohith *et al.* (2021) [33] in chilli, Chitra (2023) [7] in Japanese mint and Krishnaveni *et al.* (2023) [13] in brinjal and chilli. Secondly, *Solanum xanthocarpum* had responded to a tune of 29.14% yield improvement due to poultry manure 5 t ha^{-1} and panchagavya 3% and similar findings were observed in tomato (Dixit *et al.*, 2018) [8] and brinjal (Palia *et al.*, 2021) [22] and followed by vermicompost 5 t ha^{-1} and seaweed extract 4% (24.45% yield improvement) and in concordant with sweet Nassar *et al.* (2020) [20] in sweet marjoram and Muetasam *et al.* (2022) [18] in thyme.

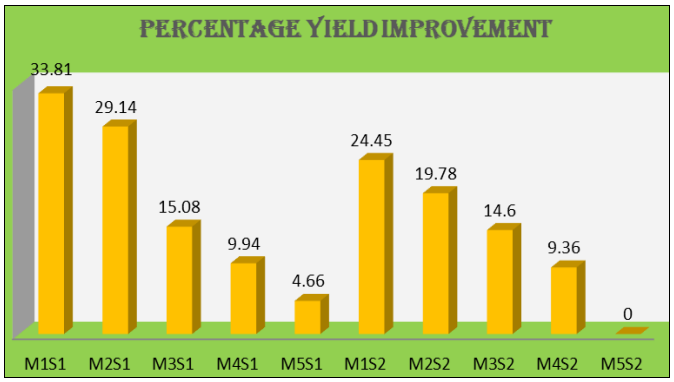

Fig 3: Yield (%) improvement due to combined application of organic inputs and foliar supplements

5. Conclusion

From the present investigation it is concluded that the incorporation of vermicompost 5 t ha^{-1} and spraying panchagavya 3% twice at 60 and 90 DAP is beneficial to improve growth, yield and quality parameters. Further, where ever poultry manure is available in plenty, this can also be incorporated @ 5 t ha^{-1} combined with foliar application of panchagavya 3% twice at 60 and 90 DAP for tapping higher yield of berries.

6. Declaration

The authors do not have any conflict of interest.

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