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Impact of Biostimulants on Oil Yield and Composition of Sacred Basil (*Ocimum sanctum* L.)

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ABSTRACT: The present investigation entitled "Impact of biostimulants on oil yield and composition of sacred basil (*Ocimum sanctum* L.)" was carried out during 2021-22 & 2022-23 at College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with 14 treatments, replicated thrice. The treatments include two varieties (V_1 and V_2) and seven biostimulants (B_1, B_2, B_3, B_4, B_5, B_6 and B_7). The results conferred that among the treatments, maximum oil yield per plant (g/plant) (1.59, 1.65 and 1.62), Oil yield per plot (g/plot) (59.78, 62.05 and 60.91), Oil yield per hectare (Kg/ha) (99.63, 103.42 and 101.52), Quality parameters *viz.*, Eugenol content (38.65, 40.82 and 39.74), Methyl eugenol (24.17, 25.13 and 24.65), Caryophyllene (11.63, 12.10 and 11.87) and Chlorophyll content (46.64, 50.80 and 48.72) were recorded in T_6 - CIM- Ayu and Seaweed extract @ 10% (V_1B_6). Whereas the maximum content of Limonene (1.77, 1.82 and 1.79), Linalool (1.49, 1.54 and 1.51), Methyl chavicol (1.40, 1.45 and 1.42) and Beta elemene (14.19, 14.65 and 14.42) were recorded in T_{13} - CIM- Angana and Seaweed extract @ 10% (V_2B_6) during the years 2021, 2022 and pooled respectively.

Keywords: Biostimulants, eugenol, seaweed extract, caryophyllene.

INTRODUCTION

The 'sacred basil' or 'holy basil' *Ocimum sanctum* Linn (2n = 32) is an aromatic shrub belonging to the family Lamiaceae. Tulsi, the Queen of Herbs, the legendary 'Incomparable One' of India, is one of the most sacred and revered of the many healing and health-giving herbs of the Orient. Tulsi, the sacred basil, is revered for its religious and spiritual sanctity, as well as its importance in the East's traditional Ayurvedic and Unani systems of holistic health and herbal medicine. In Charaka Samhita, an Ayurvedic text, Charaka mentions it as a life-saving herb-"the elixir of life." Tulasi is native to the Indian subcontinent and widely cultivated in Southeast Asian tropics (Staples and Kristiansen 1999). The essential oils from the genus *Ocimum* have wide applications in the perfumery and cosmetic industries, as well as indigenous medical systems (Ved and Goraya 2008).

MATERIALS AND METHODS

The experiment was carried out with the two varieties *viz.*, CIM- Ayu and CIM- Angana which was procured from the Central Institute of Medicinal and Aromatic Plants (CIMAP), Boduppal, Hyderabad. The experiment was laid out in a Factorial randomized block design (FRBD) with 14 treatments and 3 replications. The treatments include two varieties CIM-Ayu (V_1) and CIM- Angana (V_2) and seven biostimulants B_1: Chitosan @ 0.1%, B_2: Chitosan @ 0.5%, B_3 : Humic acid @ 0.2%, B_4: Humic acid @ 0.4%, B_5 : Seaweed extract @ 5%, B_6 : Seaweed extract @ 10%, B_7 : Water spray (control). The treatment combinations includes $T_1(V_1B_1)$: CIM- Ayu + Chitosan @ 0.1 % , T_2 (V_1B_2): CIM- Ayu + Chitosan @ 0.5%, T_3 (V_1B_3) : CIM- Ayu + Humic acid @ 0.2%, T_4 (V_1B_4): CIM- Ayu + Humic acid @ 0.4 %, T_5 (V_1B_5) : CIM- Ayu + Seaweed extract @ 5%, T_6 (V_1B_6): CIM- Ayu + Seaweed extract @ 10%, T_7 (V_1B_7): CIM- Ayu + Water spray (control) , T_8 (V_2B_1): CIM- Angana + Chitosan @ 0.1 %, T_9 (V_2B_2): CIM- Angana + Chitosan @ 0.5%, T_{10} (V_2B_3): CIM- Angana + Humic acid @ 0.2%, T_{11} (V_2B_4): CIM- Angana + Humic acid @ 0.4 %, T_{12} (V_2B_5): CIM- Angana + Seaweed extract @ 5%, T_{13} (V_2B_6): CIM- Angana + Seaweed extract @

10%, T_{14} (V_2B_7): CIM- Angana + Water spray (control).

RESULTS

A. Oil yield per plant (g/plant)

It is evident from the data that varieties, biostimulants and their combination had significant impact on oil yield during the years 2021, 2022 and pooled is presented in the Table 1. Among the varieties maximum oil yield per plant was recorded in CIM – Ayu (V_1) (1.07, 1.08 and 1.08) than CIM - Angana (V_2) (1.02, 1.00 and 1.01) during the years 2021, 2022 and pooled respectively. The application of biostimulants also showed a significant effect on oil yield per plant during both the years and pooled, in which the maximum (1.58, 1.59 and 1.59) oil yield per plant was recorded in B_6, followed by B_4 (1.39, 1.38 and 1.39), B_2 (1.19, 1.21 and 1.20) and B_3 (1.07, 1.05 and 1.06) during 2021, 2022, and pooled respectively. Likewise, the minimum oil yield per plant was recorded in B_7(control) (0.53, 0.52 and 0.53) during 2021, 2022 and pooled respectively.

The interaction effect between varieties and biostimulants was observed to be significant during the year 2021. The maximum oil yield per plant(1.59) was registered in T_6 (V_1B_6) and was on par with T_{13} (V_2B_6) (1.57) Whereas, the lowest oil yield per plant(0.51) was registered in T_{14} (V_2B_7) and it was on par with T_7 (V_1B_7) (0.55). During the year 2022 and pooled significantly maximum oil yield per plant (1.65 and 1.62) was recorded in T_6 (V_1B_6) followed by T_{13} (V_2B_6) (1.52 and 1.55), T_4 (V_1B_4) (1.38 and 1.40) and was at par with T_{11} (V_2B_4) (1.38 and 1.37) during 2022 and pooled respectively. Whereas, the minimum oil yield per plant (0.49 and 0.50) was recorded in T_{14} (V_2B_7) during the year 2022 and pooled, respectively.

B. Oil yield per plot (g/plot)

Among the varieties, maximum oil yield per plot (40.23, 40.40 and 40.32) was recorded in V_1 than V_2 (38.20, 37.38 and 37.79) during the year 2021, 2022 and in pooled, respectively. It has been found from the results that the application of biostimulants had a considerable influence on oil yield per plot. Among the biostimulants, B_6- recorded maximum (59.41, 59.51 and 59.46) oil yield per plot followed by B_4 (52.08, 51.80 and 51.94), B_2 (44.70, 45.36 and 45.03), B_3 (39.98, 39.41 and 39.69) and the lowest oil yield per plot was recorded in B_7 - Water spray (control) (19.89, 19.54 and 19.71) during 2021, 2022 and pooled respectively.

The interaction effect between varieties and biostimulants was observed to be significant during the year 2021. Maximum oil yield per plot(59.78) was recorded in T_6 (V_1B_6) and was on par with T_{13} (V_2B_6) (59.05) Whereas, the lowest oil yield per plot (19.10) was recorded in T_{14} (V_2B_7) and it was on par with T_7 (V_1B_7) (20.68).During the year 2022 and pooled significantly maximum oil yield per plot (62.05 and 60.91) was recorded in T_6 (V_1B_6) followed by T_{13} (V_2B_6) (56.98 and 58.01) during 2022 and pooled respectively. Whereas, the minimum oil yield per plot (18.48 and 18.79) was recorded in T_{14} (V_2B_7) during the year 2022 and pooled, respectively.

C. Oil yield per hectare (Kg/ha)

Among the varieties maximum oil yield per hectare was recorded in V_1 (67.05, 67.33 and 67.19) than V_2 (63.67, 62.29 and 62.98) during the years 2021, 2022 and pooled respectively. The application of biostimulants also showed a significant effect on oil yield per hectare during both the years and pooled, in which the maximum (99.02, 99.19 and 99.10) oil yield per hectare was recorded in B_6, followed by B_4 (86.79, 86.33 and 86.56), B_2 (74.50, 75.60 and 75.05) and B_3 (66.63, 65.69 and 66.16) Likewise, the minimum oil yield per hectare was recorded in B_7 (33.15, 32.56 and 32.85) during 2021, 2022 and pooled respectively.

The interaction effect between varieties and biostimulants was observed to be significant during the year 2021. The maximum oil yield per hectare(99.63) was registered in T_6 (V_1B_6) and was on par with T_{13} (V_2B_6) (98.42) Whereas, the lowest oil yield per hectare(31.83) was registered in T_{14} (V_2B_7) and it was on par with T_7 (V_1B_7) (34.46). During the year 2022 and pooled significantly maximum oil yield per hectare(103.42 and 101.52) was recorded in T_6(V_1B_6) followed by T_{13} (V_2B_6) (94.96 and 96.69) during 2022 and pooled respectively. Whereas, the minimum oil yield per hectare (30.79 and 31.31) was recorded in T_{14} (V_2B_7) during the year 2022 and pooled, respectively.

D. Essential oil profiling

The results pertaining to the essential oil profiling as influenced by varieties, biostimulants and their interaction during 2021 is presented in Table 2. There was a significant effect of varieties on the essential oil profiling during 2021. Among the varieties V_1 recorded maximum (31.42, 20.27 and 9.96 respectively) content of eugenol, methyl eugenol and caryophyllene respectively, than V_2 (23.94, 3.87 and 9.58 respectively). In case of limonene, linalool, methyl chavicol and β-elemene, the maximum content was recorded in V_2 (1.64, 1.37, 1.26 and 13.38 respectively) compared to V_1 (1.28, 0.24, 0.51 and 6.74).

The application of biostimulants was found to be significant on the essential oil profiling. The maximum content of limonene, linalool, methyl chavicol, eugenol, methyl eugenol, β-elemene and caryophyllene respectively was observed by the application of B_6 (1.66, 0.89, 1.00, 33.07, 14.17, 10.64 and 10.95 respectively), while, the minimum content of limonene, linalool, methyl chavicol, eugenol, methyl eugenol, β-elemene and caryophyllene was observed in B_7 (1.28, 0.71, 0.73, 23.18, 10.02, 9.16 and 8.83 respectively).

In the present study among the interactions, Treatment T_6(V_1B_6) recorded significantly maximum content of (38.65, 24.17 and 11.63 respectively) eugenol, methyl eugenol and caryophyllene respectively, followed by T_4 (V_1B_4) (35.47, 23.07 and 11.18), while the minimum (20.19, 3.67 and 8.73 respectively) was recorded in T_{14} (V_2B_7). In case of limonene, linalool, methyl chavicol and β-elemene maximum content (1.77, 1.49, 1.40 and 14.19 respectively) was noticed in T_{13} (V_2B_6), while, the minimum (1.11, 0.18, 0.41 and 6.16 respectively) was recorded in T_7 (V_1B_7).

The results pertaining to the essential oil profiling as influenced by varieties, biostimulants and their interaction during 2022 is presented in Table 3. There was a significant effect of varieties on the essential oil profiling during 2022. Among the varieties, V_1 recorded maximum (33.59, 21.23 and 10.43 respectively) content of eugenol, methyl eugenol and caryophyllene respectively, than V_2 (26.16, 4.78 and 10.06 respectively). In case of limonene, linalool, methyl chavicol and β-elemene, the maximum content was recorded in V_2 (1.69, 1.42, 1.30 and 13.86 respectively) compared to V_1 (1.31, 0.29, 0.56 and 7.20).

The application of biostimulants was found to be significant on the essential oil profiling. The maximum content of limonene, linalool, methyl chavicol, eugenol, methyl eugenol, β-elemene and caryophyllene respectively was observed by the application of B_6 (1.63, 0.93, 1.04, 35.23, 15.13, 11.10 and 11.42 respectively), while, the minimum content of limonene, linalool, methyl chavicol, eugenol, methyl eugenol, β-elemene and caryophyllene was observed in B_7 (1.35, 0.75, 0.77, 25.53, 10.79, 9.70 and 9.33 respectively).

In the present study among the interactions, Treatment $T_6(V_1B_6)$ recorded significant maximum content of (40.82, 25.13 and 12.10 respectively) eugenol, methyl eugenol and caryophyllene respectively, followed by T_4 (V_1B_4) (37.64, 24.03 and 11.65), while the minimum (22.72, 4.25 and 9.26 respectively) was recorded in T_{14} (V_2B_7). In case of limonene, linalool, methyl chavicol and β-elemene maximum content (1.82, 1.54, 1.45 and 14.65 respectively) was noticed in $T_{13}(V_2B_6)$, while, the minimum (1.16, 0.23, 0.46 and 6.62 respectively) was recorded in $T_7\,(V_1B_7)$.

The results concerned to the essential oil profiling as influenced by varieties, biostimulants and their interaction during Pooled analysis over two years is presented in Table 4. Among the varieties, V_1 recorded maximum (32.50, 20.75 and 10.20 respectively) content of eugenol, methyl eugenol and caryophyllene respectively, than V_2 (25.05, 4.32 and 9.82 respectively). In case of limonene, linalool, methyl chavicol and β-elemene, the maximum content was recorded in V_2 (1.67, 1.40, 1.28 and 13.62 respectively) compared to V_1(1.30, 0.26, 0.54 and 6.97).

The application of biostimulants was found to be significant on the essential oil profiling. The maximum content of limonene, linalool, methyl chavicol, eugenol, methyl eugenol, β-elemene and caryophyllene respectively was observed by the application of B_6 (1.64, 0.91, 1.02, 34.15, 14.65, 10.87 and 11.18 respectively), while, the minimum content of limonene, linalool, methyl chavicol, eugenol, methyl eugenol, β-elemene and caryophyllene was observed in B_7(1.32, 0.73, 0.75, 24.36, 10.41, 9.43 and 9.08 respectively).

In the present study among the interactions, Treatment T_6 (V_1B_6) recorded significantly maximum content of (39.74, 24.65 and 11.87 respectively) eugenol, methyl eugenol and caryophyllene respectively, followed by T_4 (V_1B_4) (36.56, 23.55 and 11.42), while the minimum (21.45, 3.96 and 9.00 respectively) was recorded in T_{14} (V_2B_7). In case of limonene, linalool, methyl chavicol and β-elemene maximum content (1.79, 1.51, 1.42 and 14.42 respectively) was noticed in $T_{13}(V_2B_6)$, while, the minimum (1.13, 0.20, 0.43 and 6.39 respectively) was recorded in $T_7\,(V_1B_7)$.

E. Chlorophyll content (SPAD value)

It is evident from the data that varieties, biostimulants and their interaction had a significant impact on chlorophyll content during the years 2021, 2022 and pooled is presented in the Table 5. Among the varieties, maximum chlorophyll content (34.90, 37.32 and 36.11) was recorded in V_1 than V_2 (33.60, 35.70 and 34.65) during the year 2021, 2022 and in pooled, respectively

It has been found from the results that application of biostimulants had a considerable influence on chlorophyll content. Among the biostimulants, B_6 recorded maximum (45.80, 48.76 and 47.28) chlorophyll content followed by B_4 (40.78, 42.59 and 41.68), B_2 (35.86, 38.10 and 36.98) and B_3 (33.50, 35.65 and 34.57) during 2021, 2022, and pooled respectively. Likewise, the minimum chlorophyll content was recorded in B_7 (26.21, 28.38 and 27.29) during 2021, 2022 and pooled respectively. Among the interactions, Treatment T_6 (V_1B_6) recorded maximum chlorophyll content (46.64, 50.80 and 48.72), followed by T_{13} (V_2B_6) (44.96, 46.71 and 45.84), T_4 (V_1B_4) (42.10, 43.58 and 42.84) and T_{11} (V_2B_4) (39.45, 41.60 and 40.52), Whereas the minimum chlorophyll content (26.06, 28.25 and 27.16) was recorded in T_{14} (V_2B_7) and it was on par with T_7 (V_1B_7) (26.35, 28.50 and 27.43) during the year 2021, 2022 and pooled, respectively.

DISCUSSION

Mafakheri (2017) reported that using Seaweed extract increased the percentage and yield of essential oil (EO) in an experiment on the fenugreek plant. In parsley (*Petroselinum crispum* (Mill.) Fuss), chlorophyll content, seed yield, EO percentage and yield were significantly affected by SWE foliar spray (Aly *et al.,* 2021). Mostafa (2015) found that foliar application of SWE increased yield, yield components and EO content (EOC) of fennel (*F. vulgare*) when compared to control plants. The reason for improving the performance of plants with biological stimuli can be related to the improvements in the biochemical processes in the plants and soil, the activation of some growth-stimulating enzymes, the transfer of ions and as a result, the promotion of photosynthesis potential (Haeusler *et al.,* 2018).

Seaweed extracts can be applied directly to the soil or as a foliar spray. The increase in plant yield caused by seaweed fertilizer application is linked to hormonal components, specifically cytokinins found in seaweeds (Featon by-Smith and Van Staden 1984). On the other hand, it was reported that when seaweed extract was applied as a foliar spray, the application positively affected root growth, allowing plants to get more water and nutrients from the soil, resulting in increased yield (Mancuso *et al*., 2006). In this study, plant height, chlorophyll content, fresh herbage yield and essential oil yield increased because of seaweed application. The increase in Ocimum plant growth could be attributed to the presence of micro and macronutrients, cytokinins, auxins and betaines in seaweed extracts, which increase photosynthetic rate and aid in vegetative growth (Devi and Mani 2015). The application of seaweed increased essential oil ratios and similar results were also claimed by Jhariya and Jain (2017) in coriander, Garg (2007), for fennel and Gharib *et al.* (2008) for marjoram. Moreover, in this study, it was found that by seaweed application, an increase in the oil content of Ocimum plants was achieved.

The presence of major and trace elements, as well as secondary metabolite elicitors, in *A. nodosum* extracts may have contributed to the increase in essential oil content and modified chemical composition in the study. Major elements such as nitrogen and phosphorus, as well as trace elements such as zinc and boron, were found in the composition analysis of *A. nodosum* SWE, which may stimulate growth and enrich the composition of treated plants. The presence of nitrogen and phosphorus has been linked to increased oil production and improved essential oil quality in a variety of medicinal plants (Singh *et al*., 2002; Anwar *et al.,* 2005; Sotiropoulou and Karamanos 2010; Chrysargyris *et al*., 2016). Trace elements such as boron have been associated with carbohydrate metabolism and hormone functions in plants (Dordas and Brown 2005). Misra and Sharma (1991) reported that Zinc concentration in nutrient application was important for oil yield and menthol concentration in *Mentha arvensis* L.

A. nodosum is a brown macroalgae composed of polysaccharides such as alginates, fucans, laminarin, and carrageenan, which play an important role in activating salicylic acid, jasmonic acid, and ethylene signaling pathways in plants (Vera *et al*., 2012). Early studies revealed that metabolic elicitors bind to receptor proteins on plant cell membranes, resulting in increased production of secondary metabolites such as essential oils (Vera *et al.,* 2012; Sharma *et al.,* 2014). Elicitors include polysaccharides like alginic acid, laminarans, and carrageenans, which are the main components of polysaccharides in several commercial seaweed liquid fertilizers like *A. nodosum*. These carbohydrates have been linked to higher levels of secondary metabolites in plants, such as saponins, essential oils, and phytoalexins (Gururaj *et al.,* 2012; Hashmi *et al.,* 2012).

At the vegetative stage, *A. nodosum* application resulted in increased chlorophyll content of leaves, which was most likely due to inhibition of chlorophyll degradation caused by betaines present in the extract (Blunden *et al.,* 1996 ; Whapham *et al.,* 1993). These betaine compounds in seaweed extracts prevent the loss of photosynthetic activity by inhibiting chlorophyll degradation (Genard *et al.,* 1991). Similarly, asparagus plants treated with *A. nodosum* showed a significant increase in chlorophyll content, stomatal conductance, photosynthetic rate, and transpiration rates.

Table 1: Impact of biostimulants on oil yield of sacred basil (*Ocimum sanctum* L.).

Treatments	Oil yield per plant (g/plant)			Oil yield per plot (g/plot)			Oil yield per ha (Kg/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Varieties									
V_1	1.07	1.08	1.08	40.23	40.40	40.32	67.05	67.33	67.19
V_2	1.02	1.00	1.01	38.20	37.38	37.79	63.67	62.29	62.98
S.Em ±	0.01	0.01	0.005	0.24	0.22	0.19	0.40	0.37	0.31
CD at 5%	0.02	0.02	0.014	0.71	0.64	0.54	1.18	1.06	0.91
Biostimulants									
B_1	0.67	0.67	0.67	25.16	25.03	25.09	41.94	41.71	41.82
B_2	1.19	1.21	1.20	44.70	45.36	45.03	74.50	75.60	75.05
B_3	1.07	1.05	1.06	39.98	39.41	39.69	66.63	65.69	66.16
B_4	1.39	1.38	1.39	52.08	51.80	51.94	86.79	86.33	86.56
B_5	0.89	0.84	0.86	33.30	31.56	32.43	55.50	52.60	54.05
B_6	1.58	1.59	1.59	59.41	59.51	59.46	99.02	99.19	99.10
B_7	0.53	0.52	0.53	19.89	19.54	19.71	33.15	32.56	32.85
S.Em ±	0.01	0.01	0.009	0.45	0.41	0.35	0.76	0.68	0.58
CD at 5%	0.04	0.03	0.027	1.32	1.19	1.02	2.20	1.99	1.69
Interactions (Varieties and Biostimulants)									
V_1B_1	0.73	0.73	0.73	27.45	27.38	27.41	45.75	45.63	45.69
V_1B_2	1.21	1.23	1.22	45.53	45.98	45.75	75.88	76.63	76.25
V_1B_3	1.07	1.14	1.10	39.95	42.88	41.41	66.58	71.46	69.02
V_1B_4	1.43	1.38	1.40	53.45	51.73	52.59	89.08	86.21	87.65
V_1B_5	0.93	0.86	0.89	34.80	32.20	33.50	58.00	53.67	55.83
V_1B_6	1.59	1.65	1.62	59.78	62.05	60.91	99.63	103.42	101.52
V_1B_7	0.55	0.55	0.55	20.68	20.60	20.64	34.46	34.33	34.40
V_2B_1	0.61	0.60	0.61	22.88	22.68	22.78	38.13	37.79	37.96
V_2B_2	1.17	1.19	1.18	43.88	44.75	44.31	73.13	74.58	73.85
V_2B_3	1.07	0.96	1.01	40.00	35.95	37.98	66.67	59.92	63.29
V_2B_4	1.35	1.38	1.37	50.70	51.88	51.29	84.50	86.46	85.48
V_2B_5	0.85	0.82	0.84	31.80	30.93	31.36	53.00	51.54	52.27
V_2B_6	1.57	1.52	1.55	59.05	56.98	58.01	98.42	94.96	96.69
V_2B_7	0.51	0.49	0.50	19.10	18.48	18.79	31.83	30.79	31.31
S.Em ±	0.02	0.02	0.013	0.64	0.58	0.49	1.07	0.97	0.82
CD at 5%	0.05	0.04	0.038	1.87	1.68	1.44	3.11	2.81	2.40

Factor I :Varieties Factor II : Biostimulants

V_1 : CIM - Ayu **B_1 :** Chitosan @ 0.1% **B_5 :** Seaweed extract @ 5%

V_2 : CIM - Angana **B_2 :** Chitosan @ 0.5% **B_6 :** Seaweed extract @ 10%

B_3 : Humic acid @ 0.2% **B_7 :** Water Spray (Control)

B_4 : Humic acid@ 0.4%

Table 2: Impact of biostimulants on essential oil profiling of sacred basil (*Ocimum sanctum* L.) during the year 2021.

Treatments	Essential oil profiling						
	Limonene	linalool	Methyl chavicol	eugenol	Methyl eugenol	β elemene	Caryophy-llene
Varieties							
V_1	1.28	0.24	0.51	31.42	20.27	6.74	9.96
V_2	1.64	1.37	1.26	23.94	3.87	13.38	9.58
S.Em ±	0.01	0.01	0.01	0.02	0.02	0.01	0.01
CD at 5%	0.03	0.03	0.03	0.07	0.07	0.03	0.03
Biostimulants							
B_1	1.36	0.76	0.83	24.95	10.35	9.62	9.11
B_2	1.5	0.84	0.94	28.81	13.08	10.38	9.89
B_3	1.47	0.82	0.90	27.57	12.12	10.20	9.69
B_4	1.54	0.87	0.96	30.83	13.58	10.53	10.65
B_5	1.42	0.78	0.86	25.39	11.20	9.90	9.26
B_6	1.66	0.89	1.00	33.07	14.17	10.64	10.95
B_7	1.28	0.71	0.73	23.18	10.02	9.16	8.83
S.Em ±	0.02	0.02	0.02	0.04	0.04	0.02	0.02
CD at 5%	0.05	0.05	0.05	0.12	0.12	0.05	0.05
Interactions (Varieties and Biostimulants)							
V_1B_1	1.16	0.21	0.46	27.90	17.10	6.53	9.11
V_1B_2	1.31	0.27	0.55	32.17	22.16	6.87	9.89
V_1B_3	1.28	0.25	0.52	30.94	20.35	6.79	9.71
V_1B_4	1.35	0.27	0.56	35.47	23.07	7.02	11.18
V_1B_5	1.22	0.22	0.49	28.62	18.68	6.72	9.26
V_1B_6	1.55	0.28	0.59	38.65	24.17	7.09	11.63
V_1B_7	1.11	0.18	0.41	26.17	16.37	6.16	8.93
V_2B_1	1.56	1.31	1.19	21.99	3.59	12.71	9.11
V_2B_2	1.69	1.41	1.32	25.44	3.99	13.88	9.89
V_2B_3	1.66	1.38	1.28	24.19	3.89	13.61	9.67
V_2B_4	1.73	1.46	1.36	26.19	4.09	14.03	10.11
V_2B_5	1.62	1.34	1.23	22.15	3.72	13.08	9.26
V_2B_6	1.77	1.49	1.40	27.48	4.17	14.19	10.26
V_2B_7	1.46	1.23	1.05	20.19	3.67	12.16	8.73
S.Em ±	0.02	0.02	0.03	0.06	0.06	0.02	0.02
CD at 5%	0.07	0.07	0.08	0.17	0.17	0.07	0.07

Factor I :Varieties Factor II : Biostimulants

V_1: CIM - Ayu **B_1:**Chitosan @ 0.1% **B_5:** Seaweed extract @ 5%

V_2: CIM - Angana **B_2:**Chitosan @ 0.5% **B_6:** Seaweed extract @ 10%

B_3: Humic acid @ 0.2% **B_7:** Water Spray (Control)

B_4: Humic acid@ 0.4%

Table 3: Impact of biostimulants on essential oil profiling of sacred basil (*Ocimum sanctum* L.) during the year 2022.

Treatments	Essential oil profiling						
	Limonene	linalool	Methyl chavicol	eugenol	Methyl eugenol	β elemene	Caryophy-llene
Varieties							
V_1	1.31	0.29	0.56	33.59	21.23	7.20	10.43
V_2	1.69	1.42	1.30	26.16	4.78	13.86	10.06
S.Em ±	0.01	0.01	0.01	0.04	0.03	0.02	0.01
CD at 5%	0.03	0.03	0.03	0.11	0.08	0.05	0.03
Biostimulants							
B_1	1.43	0.81	0.88	27.11	11.31	10.08	9.58
B_2	1.55	0.88	0.98	30.97	14.04	10.84	10.36
B_3	1.52	0.86	0.95	29.73	13.08	10.66	10.16
B_4	1.59	0.91	1.01	33.00	14.54	10.99	11.12
B_5	1.47	0.83	0.91	27.55	12.16	10.36	9.73
B_6	1.63	0.93	1.04	35.23	15.13	11.10	11.42
B_7	1.35	0.75	0.77	25.53	10.79	9.70	9.33
S.Em ±	0.02	0.02	0.02	0.07	0.05	0.03	0.02
CD at 5%	0.05	0.05	0.06	0.21	0.14	0.09	0.05
Interactions (Varieties and Biostimulants)							

V_1B_1	1.24	0.27	0.52	30.07	18.06	6.99	9.58
V_1B_2	1.36	0.31	0.60	34.34	23.12	7.33	10.36
V_1B_3	1.33	0.30	0.57	33.11	21.31	7.25	10.18
V_1B_4	1.40	0.31	0.61	37.64	24.03	7.48	11.65
V_1B_5	1.27	0.27	0.54	30.79	19.64	7.18	9.73
V_1B_6	1.44	0.32	0.64	40.82	25.13	7.55	12.10
V_1B_7	1.16	0.23	0.46	28.34	17.33	6.62	9.40
V_2B_1	1.61	1.36	1.24	24.15	4.55	13.17	9.58
V_2B_2	1.74	1.46	1.37	27.60	4.95	14.34	10.36
V_2B_3	1.71	1.43	1.33	26.35	4.85	14.07	10.14
V_2B_4	1.78	1.51	1.41	28.35	5.05	14.49	10.58
V_2B_5	1.67	1.39	1.28	24.31	4.68	13.54	9.73
V_2B_6	1.82	1.54	1.45	29.64	5.13	14.65	10.73
V_2B_7	1.54	1.27	1.07	22.72	4.25	12.77	9.26
S.Em ±	0.02	0.03	0.03	0.10	0.07	0.04	0.03
CD at 5%	0.07	0.08	0.08	0.30	0.20	0.12	0.07

Factor I :Varieties Factor II : Biostimulants

V_1: CIM - Ayu **B_1:**Chitosan @ 0.1% **B_5:** Seaweed extract @ 5%

V_2: CIM - Angana **B_2:**Chitosan @ 0.5% **B_6:** Seaweed extract @ 10%

B_3: Humic acid @ 0.2% **B_7:** Water Spray (Control)

B_4: Humic acid@ 0.4%

Table 4: Impact of biostimulants on essential oil profiling (pooled) of sacred basil (*Ocimum sanctum* L.).

Treatments	Essential oil profiling						
	Limonene	linalool	Methyl chavicol	eugenol	Methyl eugenol	β elemene	Caryophy-llene
Varieties							
V_1	1.30	0.26	0.54	32.50	20.75	6.97	10.20
V_2	1.67	1.40	1.28	25.05	4.32	13.62	9.82
S.Em ±	0.01	0.01	0.01	0.03	0.02	0.01	0.01
CD at 5%	0.03	0.01	0.03	0.07	0.06	0.03	0.03
Biostimulants							
B_1	1.39	0.79	0.85	26.03	10.83	9.85	9.35
B_2	1.52	0.86	0.96	29.89	13.56	10.61	10.13
B_3	1.49	0.84	0.92	28.65	12.60	10.43	9.93
B_4	1.56	0.89	0.98	31.91	14.06	10.76	10.88
B_5	1.44	0.81	0.89	26.47	11.68	10.13	9.50
B_6	1.64	0.91	1.02	34.15	14.65	10.87	11.18
B_7	1.32	0.73	0.75	24.36	10.41	9.43	9.08
S.Em ±	0.02	0.02	0.02	0.05	0.04	0.02	0.02
CD at 5%	0.05	0.02	0.05	0.14	0.12	0.06	0.05
Interactions (Varieties and Biostimulants)							
V_1B_1	1.20	0.24	0.49	28.99	17.58	6.76	9.35
V_1B_2	1.33	0.29	0.57	33.26	22.64	7.10	10.13
V_1B_3	1.30	0.27	0.54	32.03	20.83	7.02	9.95
V_1B_4	1.37	0.29	0.58	36.56	23.55	7.25	11.42
V_1B_5	1.24	0.25	0.52	29.71	19.16	6.95	9.50
V_1B_6	1.50	0.30	0.61	39.74	24.65	7.32	11.87
V_1B_7	1.13	0.20	0.43	27.26	16.85	6.39	9.17
V_2B_1	1.58	1.33	1.21	23.07	4.07	12.94	9.35
V_2B_2	1.71	1.43	1.34	26.52	4.47	14.11	10.13
V_2B_3	1.68	1.40	1.30	25.27	4.37	13.84	9.91
V_2B_4	1.75	1.48	1.38	27.27	4.57	14.26	10.35
V_2B_5	1.64	1.36	1.25	23.23	4.20	13.31	9.50
V_2B_6	1.79	1.51	1.42	28.56	4.65	14.42	10.50
V_2B_7	1.50	1.25	1.06	21.45	3.96	12.47	9.00
S.Em ±	0.02	0.02	0.02	0.07	0.06	0.03	0.02
CD at 5%	0.07	0.03	0.07	0.20	0.17	0.08	0.07

Factor I :Varieties Factor II : Biostimulants

V_1: CIM - Ayu **B_1:**Chitosan @ 0.1% **B_5:** Seaweed extract @ 5%

V_2: CIM - Angana **B_2:**Chitosan @ 0.5% **B_6:** Seaweed extract @ 10%

B_3: Humic acid @ 0.2% **B_7:** Water Spray (Control)

B_4: Humic acid@ 0.4%

Table 5: Impact of biostimulants on chlorophyll content (SPAD value) of sacred basil (*Ocimum sanctum* L.)

Treatments	Chlorophyll		
	2021	2022	Pooled
V_1	34.90	37.32	36.11
V_2	33.60	35.70	34.65
S.Em ±	0.14	0.20	0.16
CD at 5%	0.78	0.59	0.46
B_1	27.53	29.86	28.69
B_2	35.86	38.10	36.98
B_3	33.50	35.65	34.57
B_4	40.78	42.59	41.68
B_5	30.08	32.23	31.16
B_6	45.80	48.76	47.28
B_7	26.21	28.38	27.29
S.Em ±	0.27	0.38	0.29
CD at 5%	0.42	1.10	0.85
V_1B_1	27.78	30.30	29.04
V_1B_2	36.15	38.49	37.32
V_1B_3	34.57	36.72	35.65
V_1B_4	42.10	43.58	42.84
V_1B_5	30.68	32.83	31.76
V_1B_6	46.64	50.80	48.72
V_1B_7	26.35	28.50	27.43
V_2B_1	27.27	29.42	28.35
V_2B_2	35.56	37.71	36.63
V_2B_3	32.42	34.57	33.49
V_2B_4	39.45	41.60	40.52
V_2B_5	29.48	31.63	30.55
V_2B_6	44.96	46.71	45.84
V_2B_7	26.06	28.25	27.16
S.Em ±	0.38	0.54	0.41
CD at 5%	1.11	1.56	1.21

Factor I :Varieties Factor II : Biostimulants

V_1: CIM - Ayu B_1:Chitosan @ 0.1% B_5: Seaweed extract @ 5%

V_2: CIM - Angana B_2:Chitosan @ 0.5% B_6: Seaweed extract @ 10%

B_3: Humic acid @ 0.2% B_7: Water Spray (Control)

B_4: Humic acid@ 0.4%

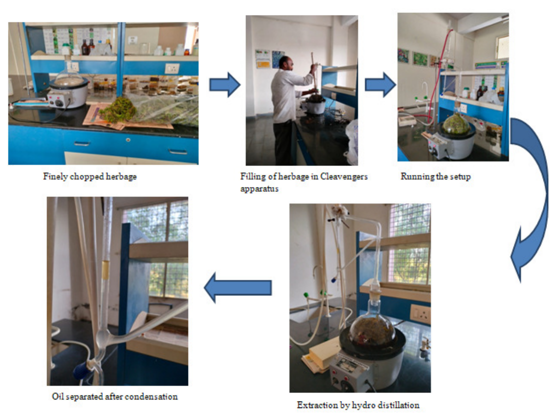

Plate 1. Extraction of oil from *Ocimum sanctum.*

CONCLUSIONS

The studies on different biostimulants and varieties revealed that the oil yield and composition of sacred basil were influenced by biostimulants. The present study indicated that crop grown with T_6 - CIM- Ayu and Seaweed extract @ 10% (V_1B_6) recorded significantly highest yield parameters like Oil yield per plant (g/plant), Oil yield per plot (g/plot) and Oil yield per hectare (Kg/ha), Quality parameters *viz*., maximum content of Eugenol, Methyl eugenol, Caryophyllene and Chlorophyll content (SPAD meter reading) during the years 2021, 2022 and pooled respectively. Whereas the maximum content of Limonene, Linalool, Methyl chavicol and β – elemene were recorded in T_{13} - CIM-Angana and Seaweed extract @ 10% (V_2B_6) during the years 2021, 2022 and pooled respectively.

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