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Effect of biostimulants on herbage yield and biotic stress management of sacred basil (*Ocimum sanctum* L.)

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Abstract
The experiment was conducted during 2021-22 & 2022-23 to study the effect of biostimulants on herbage yield and biotic stress management of sacred basil (*Ocimum sanctum* L.). The results revealed that the treatment T_6 - CIM- Ayu and Seaweed extract @ 10% (V_1B_6) recorded significantly less number of days taken for initiation of flowering (38.33, 36.67 and 37.50), days taken for 50% flowering (63.33, 65.67 and 64.50) and days taken for harvesting (90.33, 89.00 and 89.67) during the years 2021, 2022 and pooled, respectively. The treatment T_6 - CIM- Ayu and Seaweed extract @ 10% (V_1B_6) recorded significantly highest yield parameters like fresh herbage yield per plant (g/plant) (519.29, 529.57 and 524.43), fresh herbage yield per plot (Kg/plot) (19.47, 19.86 and 19.67), fresh herbage yield per hectare (t/ha) (32.46, 33.10 and 32.78), dry herbage yield per plant (g/plant) (249.42, 273.68 and 261.55), dry herbage yield per plot (Kg/plot) (9.35, 10.26 and 9.81), dry herbage yield per hectare (t/ha) (15.59, 17.11 and 16.35). With respect to pest and disease severity, there was no significant difference among different treatments in incidence of *Spodoptera exigua*. Among the treatments disease severity was, however, observed lowest (16.34, 16.74 and 16.54) in the treatment T_6 - CIM- Ayu and Seaweed extract @ 10% (V_1B_6) during the years 2021, 2022 and pooled, respectively.

Keywords: *Spodoptera exigua*, disease, yield, Chitosan, CIM-Ayu, Tulasi

1. Introduction

Tulasi is native to the Indian subcontinent and widely cultivated in Southeast Asian tropics (Staples and Kristiansen, 1999) [20]. 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) [21].

Regardless of nutrient content, any substance or microorganism applied to plants to improve nutrition efficiency, abiotic stress tolerance, and crop quality traits is considered to be a bio-stimulant (Patrick, 2015) [22]. They reduce the use of mineral fertilizers by enhancing the amount of micro and macronutrient uptake by the plants, improves root morphology and plant growth (Ziosi *et al.*, 2013) [26]. They also exhibit hormone-like activity and influence plant metabolism by engaging in physiological and biochemical processes like glycolysis and nitrogen assimilation. (Azcona *et al.*, 2011) [1]. Recent findings reveal that to decrease soil pollution the application of biostimulants has turned out to be safe, having similar roles of plant growth regulators, polyamines and vitamins. (Kowalczyk and Zielony, 2008) [11]. Plant biostimulant products are novel in the field of crop production. However, they are more effective in medicinal plants due to the potential of genetic manipulation in secondary metabolite synthesis pathways. (Rafiee *et al.*, 2016) [23].

2. Materials and Methods

2.1 Methods

The current investigation was carried out during 2021-22 & 2022-23 at SKLTGHU, Rajendranagar. The field experiment was laid out in factorial randomized block design with 14 treatments and 3 replications. Treatment details were $T_1(V_1B_1)$: 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) were tried and the observations were recorded in respect to yield, pest and disease incidence.

2.2 Pest and disease parameters

Spodoptera

Five plants were selected randomly from each plot and observations were recorded on number of larvae of *Spodoptera exigua* per plant.

Study of Pathogenicity

Ocimum leaves, twigs and stems showing leaf spot symptoms were collected from the Research field at College of Horticulture, Rajendra nagar and the causal agent was identified in the laboratory of Plant Pathology, Vegetable Research Station, Hyderabad. Generally, alternaria disease appears 30-40 days after sowing. Observations for disease severity were recorded on randomly selected five plants of upper, middle and lower leaves from each plot.

A standard scale (0-6 point) basing on the intensity of the disease appearance on *Ocimum* leaves was used for reading visual observations.

Percent disease incidence (PDI) was calculated by using the formulae given by Conn *et al.* (1990) [6].

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Total number of observations x Maximum disease rating}} \times 100$$

Chart 1: Showing scale, disease severity and disease incidence (Sibun kumar, 2017)

Sl. No	Scale (0-6)	Disease severity	Disease incidence
1	0	Immune	No incidence
2	1	Highly resistance	1-5% incidence
3	2	Resistant	6-10% incidence
4	3	Moderately resistant	11-25% incidence
5	4	Moderately Susceptible	26-50% incidence
6	5	Susceptible	51-75% incidence
7	6	Highly Susceptible	> 75% incidence

3. Results and Discussion

3.1 Days taken for initiation of flowering

The number of days taken for initiation of flowering was calculated from the date of transplanting (Table 1). Among the varieties, CIM - Ayu (V_1) recorded significantly less number of days taken for initiation of flowering (48.81, 48.10 and 48.45), where as more number of days taken for initiation of flowering (51.05, 50.71 and 50.88) was noticed in CIM - Angana (V_2) during the year 2021, 2022 and pooled, respectively. Application of biostimulants also declared significant effect on days taken for initiation of flowering and lowest (38.50, 37.17 and 37.83) was recorded in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (41.17, 39.33 and 40.25), B_2- Chitosan @ 0.5% (44.00, 43.83 and 43.92) and B_3 (50.83, 51.50 and 51.17) where as, more number of days taken for initiation of flowering (62.50, 64.83 and 63.67) was observed in B_7 - Water spray (control) during the year 2021, 2022 and in pooled, respectively. In the present study among the interactions, treatment T_6-CIM- Ayu and Sea weed extract @ 10% (V_1B_6) recorded significantly less number of days taken for initiation of flowering (38.33, 36.67 and 37.50), and was at par with T_{13} (V_2B_6) (38.67, 37.67 and 38.17) and T_4 (V_1B_4) (40.33, 38.33 and 39.33), where as, more number of days taken for initiation of flowering (66.00, 68.33 and 67.17) was noticed in T_{14} (V_2B_7)- CIM- Angana and Water spray (control).

Seaweed extract would have also increased yield by increasing the availability of cytokinins, the accumulation of which in lateral buds would have made them an effective sink in the diversion of photoassimilates as well as other flower-inducing plant hormones, resulting in early flowering in ocimum. Similar findings were also reported by Pramod Kumar *et al.* (2000) [18] in bell pepper.

3.2 Days taken for 50% flowering

Among the varieties, CIM - Ayu (V_1) recorded significantly less number of days taken for 50% flowering (77.38, 77.86 and 77.62), where as more number of days taken for 50% flowering (78.43, 79.43 and 78.93) was noticed in CIM - Angana (V_2) during the year 2021, 2022 and in pooled, respectively (Table 1). Application of biostimulants also declared significant effect on days taken for 50% flowering and lowest (64.17, 66.33 and 65.25) was recorded in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (70.00, 70.67 and 70.33) where as, more number of days taken for 50% flowering (88.00, 89.83 and 88.92) was observed in B_7 - Water spray (control) during the year 2021, 2022 and in pooled, respectively. In the present study among the interactions, treatment T_6 (V_1B_6) recorded significantly less number of days taken for 50% flowering (63.33, 65.67 and 64.50) and was on par with T_{13} (V_2B_6) (65.00, 67.00 and 66.00), whereas, more number of days taken for 50% flowering (90.67, 92.33 and 91.50) was noticed in T_{14} (V_2B_7).

This could be due to increased synthesis and activity of cytokinins and auxin in root tissue as a result of translocation of seaweed sap transported to auxiliary buds, which would have resulted in faster source mobilization of assimilates from the source to sinks. This would have aided in the early stages of transformation and flower initiation. The induction of early spike emergence could have been influenced by the activation of such metabolic activity and the narrowing of the C: N ratio caused by the significant accumulation of carbohydrates. The nutrients would have moved from source to sink in a consistent manner, making the nutrient available to all plant parts for the rapid development of spike emergence (Mooney and Van staden, 1986) [13].

3.3 Days taken for harvesting

The results pertaining to days taken for harvesting as influenced by the varieties, biostimulants and their interaction are presented in Table 1. Among the varieties, CIM - Ayu (V_1) recorded less number of days taken for harvesting (103.10, 100.14 and 101.62), than CIM - Angana (V_2) (104.86, 102.05 and 103.45) during the year 2021, 2022 and in pooled, respectively. Biostimulants had a significant effect on days taken for harvesting. Among the biostimulants less number of days taken for harvesting

(91.33, 90.67 and 91.00) was recorded in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (97.50, 96.33 and 96.92) and B_2- Chitosan @ 0.5% (101.50, 98.83 and 100.17) where as, more number of days taken for harvesting (115.00, 112.83 and 113.92) was observed in B_7 - Water spray (control) during the year 2021, 2022 and in pooled, respectively. Among the interactions significantly less number of days taken for harvesting (90.33, 89.00 and 89.67) was recorded in T_6 (V_1B_6), where as, more number of days taken for harvesting (118.00, 115.33 and 116.67) was noticed in T_{14} (V_2B_7) during the year 2021, 2022 and in pooled, respectively (Fig 1).

Table 1: Effect of biostimulants on days taken for initiation of flowering, days taken for 50% flowering and days taken for harvesting of sacred basil (*Ocimum sanctum* L.)

Treatments	Days taken for initiation of flowering			Days taken for 50% flowering			Days taken for harvesting		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Varieties									
V_1	48.81	48.10	48.45	77.38	77.86	77.62	103.10	100.14	101.62
V_2	51.05	50.71	50.88	78.43	79.43	78.93	104.86	102.05	103.45
S.Em ±	0.36	0.30	0.22	0.35	0.35	0.31	0.36	0.24	0.26
CD at 5%	1.04	0.87	0.65	1.03	1.02	0.90	1.05	0.69	0.75
Biostimulants									
B_1	58.00	56.50	57.25	85.33	85.67	85.50	109.33	105.83	107.58
B_2	44.00	43.83	43.92	73.83	73.50	73.67	101.50	98.83	100.17
B_3	50.83	51.50	51.17	79.17	79.17	79.17	106.50	100.33	103.42
B_4	41.17	39.33	40.25	70.00	70.67	70.33	97.50	96.33	96.92
B_5	54.50	52.67	53.58	84.83	85.33	85.08	106.67	102.83	104.75
B_6	38.50	37.17	37.83	64.17	66.33	65.25	91.33	90.67	91.00
B_7	62.50	64.83	63.67	88.00	89.83	88.92	115.00	112.83	113.92
S.Em ±	0.67	0.56	0.42	0.66	0.65	0.58	0.68	0.44	0.48
CD at 5%	1.95	1.63	1.21	1.93	1.90	1.69	1.97	1.28	1.41
Interactions (Varieties and Biostimulants)									
V_1B_1	56.00	55.67	55.83	84.33	84.33	84.33	109.67	105.33	107.50
V_1B_2	43.00	41.33	42.17	74.33	73.00	73.67	100.67	98.33	99.50
V_1B_3	50.00	51.33	50.67	79.00	78.33	78.67	105.00	100.33	102.67
V_1B_4	40.33	38.33	39.33	69.33	70.00	69.67	97.00	95.33	96.17
V_1B_5	55.00	52.00	53.50	86.00	86.33	86.17	107.00	102.33	104.67
V_1B_6	38.33	36.67	37.50	63.33	65.67	64.50	90.33	89.00	89.67
V_1B_7	59.00	61.33	60.17	85.33	87.33	86.33	112.00	110.33	111.17
V_2B_1	60.00	57.33	58.67	86.33	87.00	86.67	109.00	106.33	107.67
V_2B_2	45.00	46.33	45.67	73.33	74.00	73.67	102.33	99.33	100.83
V_2B_3	51.67	51.67	51.67	79.33	80.00	79.67	108.00	100.33	104.17
V_2B_4	42.00	40.33	41.17	70.67	71.33	71.00	98.00	97.33	97.67
V_2B_5	54.00	53.33	53.67	83.67	84.33	84.00	106.33	103.33	104.83
V_2B_6	38.67	37.67	38.17	65.00	67.00	66.00	92.33	92.33	92.33
V_2B_7	66.00	68.33	67.17	90.67	92.33	91.50	118.00	115.33	116.67
S.Em ±	0.95	0.80	0.59	0.94	0.93	0.82	0.96	0.62	0.69
CD at 5%	2.75	2.31	1.72	2.73	2.69	2.39	2.78	1.81	1.99

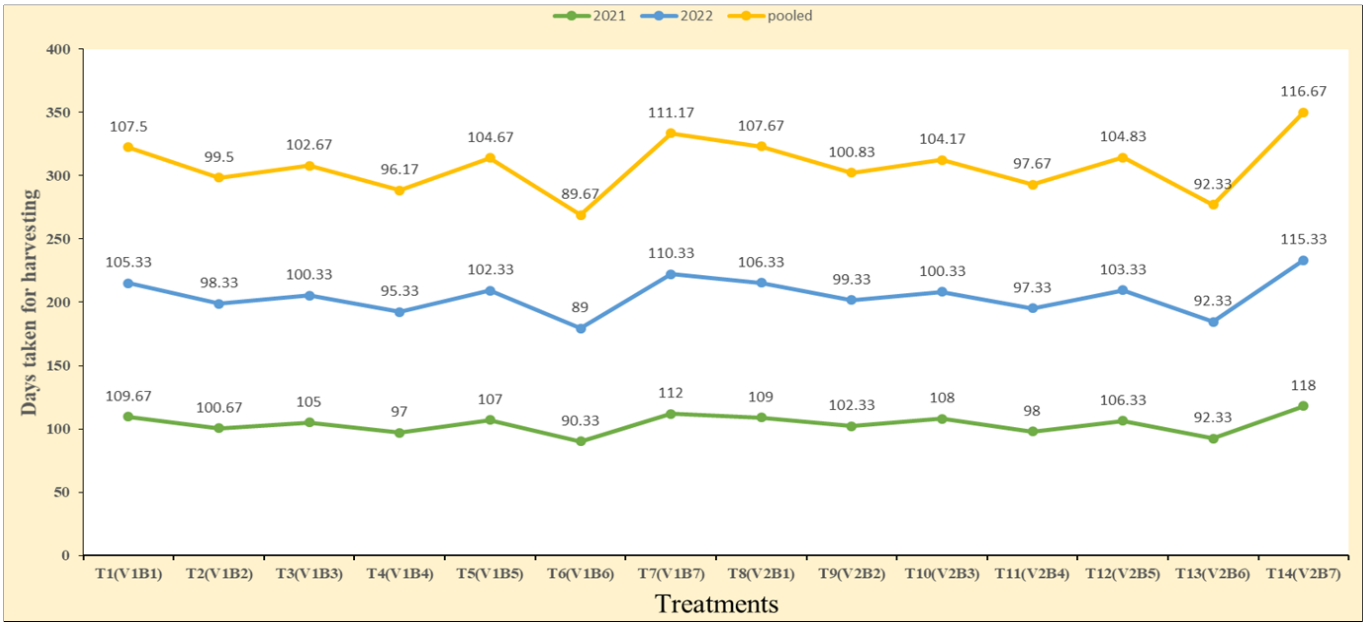

Fig 1: Effect of biostimulants on days taken for harvesting of sacred basil

3.4 Fresh herbage yield per plant (g)

Data on fresh herbage yield per plant as influenced by varieties, biostimulants and their interactions are presented in Table 2. Among the varieties, significantly maximum fresh herbage yield per plant (400.88, 405.57 and 403.22) was recorded in CIM - Ayu (V_1) than CIM - Angana (V_2) (383.81, 387.21 and 385.51) during the year 2021, 2022 and in pooled, respectively. Application of biostimulants also revealed significant effect on fresh herbage yield per plant and maximum (508.50, 518.12 and 513.31) was recorded in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (483.10, 490.99 and 487.04), B_2 (454.20, 464.18 and 459.19) and B_3 (421.82, 424.38 and 423.10) where as, minimum fresh herbage yield per plant (230.90, 235.10 and 233.00) was recorded in B_7 during the year 2021, 2022 and in pooled, respectively. In the present study among the interactions, Treatment T_6 (V_1B_6) recorded significantly maximum fresh herbage yield per plant (519.29, 529.57 and 524.43), followed by T_{13} (V_2B_6) (497.71, 506.66 and 502.19), T_4 (V_1B_4) (484.17, 491.95 and 488.06) and was on par with T_{11} (V_2B_4) (482.03, 490.02 and 486.03) whereas, minimum fresh herbage yield per plant (226.04, 224.57 and 225.31) was noticed in T_{14} (V_2B_7) during the year 2021, 2022 and in pooled, respectively.

The increase in yield and yield-attributing character could be attributed to the development of a better root system as influenced by endogenous auxins and other compounds in the extract (Crouch and Van Staden, 1992) [7], with a higher root-to-shoot ratio, making the plants more able to absorb adequate nutrients from the deeper layer of soil, resulting in increased overall plant growth and vigor. The increase in yield could be attributed to the mineral elements found in seaweed sap extract, which increases the photosynthetic rate or delays leaf senescence. Another reason could be significant increase in the leaf chlorophyll content thereby enhancing the Photosynthesis rate (Blunden *et al.*, 1996) [3].

The significant effect of seaweed extract and humic acid on the shoot system could explain the increase in yield characteristics. Humic acid is distinguished by its ability to improve plant growth either directly or indirectly by acting as a biostimulant. Jensen (2004) [10] found that humic acid promotes plant growth by improving soil texture and the ability of plant roots to enter and penetrate the soil. Humic acid is essential as a transmission medium for nutrition from soil to plant, as it increases soil water retention and stimulates soil microorganism activity.

3.5 Fresh herbage yield per plot (kg/plot)

Data on fresh herbage yield per plot as influenced by varieties, biostimulants and their interactions are presented in Table 2. Among the varieties, significantly maximum fresh herbage yield per plot (15.03, 15.21 and 15.12) was recorded in CIM - Ayu (V_1) than CIM - Angana (V_2) (14.39, 14.52 and 14.46) during the year 2021, 2022 and in pooled, respectively. Application of biostimulants also showed significant effect on fresh herbage yield per plot and maximum (19.07, 19.43 and 19.25) was recorded in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (18.12, 18.41 and 18.26), B_2- Chitosan @ 0.5% (17.03, 17.41 and 17.22) and B_3 (15.82, 15.91 and 15.87). In the present study among the interactions, treatment T_6 (V_1B_6) recorded significantly maximum fresh herbage yield per plot (19.47, 19.86 and 19.67), followed by T_{13} (V_2B_6) (18.66, 19.00 and 18.83), T_4 (V_1B_4) (18.16, 18.45 and 18.30) and was on par with T_{11} (V_2B_4) (18.08, 18.38 and 18.23) where as, minimum fresh herbage yield per plot (8.48, 8.42 and 8.45) was noticed in T_{14} (V_2B_7) during the year 2021, 2022 and in pooled, respectively.

3.6 Fresh herbage yield per hectare (t/ha)

The data on the fresh herbage yield per hectare as influenced by varieties, biostimulants and their combinations during the years 2021, 2022 and pooled are presented in the table 2. The highest fresh herbage yield per hectare was recorded in CIM - Ayu (V_1) (25.05, 25.35 and 25.20) than CIM - Angana (V_2) (23.99, 24.20 and 24.09) during the years 2021, 2022, and pooled, respectively. Application of biostimulants also showed a significant effect on the fresh herbage yield per hectare, in which the maximum (31.78, 32.38 and 32.08) fresh herbage yield per hectare was observed in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (30.19, 30.69 and 30.44), B_2- Chitosan @ 0.5% (28.39, 29.01 and 28.70) and B_3 (26.36, 26.52 and 26.44) during 2021, 2022 and pooled, respectively. Among the interactions highest fresh herbage yield per hectare (32.46, 33.10, 32.78) was registered in T_6 (V_1B_6), followed by T_{13} (V_2B_6) (31.11, 31.67 and 31.39), T_4 (V_1B_4) (30.26, 30.75 and 30.50) and was on par with T_{11} (V_2B_4) (30.13, 30.63 and 30.38). Whereas, the lowest (14.13, 14.04 and 14.08) was registered in T_{14} (V_2B_7) during the year 2021, 2022 and pooled, respectively.

In the present investigation, biostimulant has significantly increased fresh herbage yield as it regulates plant bio-physiological activities such as enhanced chlorophyll content, nutrient uptake, photosynthetic activity and synthesis of plant growth regulators during plant growth and development, which might have resulted in increased yield per hectare. The results are in close conformity with the findings of Sayan Sau *et al*. (2016) [24] in guava, El-Shamma *et al.* (2017) [8] in avocado.

The application of humic acid improves the overall development of plant growth and increases root biomass resulting in higher water and nutrient uptake. Transpiration might have decreased resulting in increased carbon dioxide availability through the stomatal opening resulting in net increase in photosynthetic rate. The combined effect of all of these factors could have resulted in increase in total yield as opined by Sangeetha and Singaram (2007) [17] in onion.

Table 2: Effect of biostimulants on fresh herbage yield of sacred basil (*Ocimum sanctum* L.)

Treatments	Fresh herbage yield								
	Fresh herbage yield per plant (g/plant)			Fresh herbage yield per plot (kg/plot)			Fresh herbage yield per hectare (t/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Varieties									
V_1	400.88	405.57	403.22	15.03	15.21	15.12	25.05	25.35	25.20
V_2	383.81	387.21	385.51	14.39	14.52	14.46	23.99	24.20	24.09
S.Em ±	1.35	1.17	0.81	0.05	0.04	0.03	0.08	0.07	0.05
CD at 5%	3.91	3.40	2.35	0.15	0.13	0.09	0.24	0.21	0.15

Biostimulants									
B_1	280.36	291.99	286.18	10.51	10.95	10.73	17.52	18.25	17.89
B_2	454.20	464.18	459.19	17.03	17.41	17.22	28.39	29.01	28.70
B_3	421.82	424.38	423.10	15.82	15.91	15.87	26.36	26.52	26.44
B_4	483.10	490.99	487.04	18.12	18.41	18.26	30.19	30.69	30.44
B_5	367.54	349.98	358.76	13.78	13.12	13.45	22.97	21.87	22.42
B_6	508.50	518.12	513.31	19.07	19.43	19.25	31.78	32.38	32.08
B_7	230.90	235.10	233.00	8.66	8.82	8.74	14.43	14.69	14.56
S.Em ±	2.52	2.19	1.51	0.09	0.08	0.06	0.16	0.14	0.09
CD at 5%	7.32	6.35	4.40	0.27	0.24	0.17	0.46	0.40	0.28
Interactions (Varieties and Biostimulants)									
V_1B_1	289.50	301.65	295.57	10.86	11.31	11.08	18.09	18.85	18.47
V_1B_2	461.61	470.64	466.13	17.31	17.65	17.48	28.85	29.42	29.13
V_1B_3	430.54	439.95	435.24	16.15	16.50	16.32	26.91	27.50	27.20
V_1B_4	484.17	491.95	488.06	18.16	18.45	18.30	30.26	30.75	30.50
V_1B_5	385.28	359.60	372.44	14.45	13.48	13.97	24.08	22.47	23.28
V_1B_6	519.29	529.57	524.43	19.47	19.86	19.67	32.46	33.10	32.78
V_1B_7	235.75	245.63	240.69	8.84	9.21	9.03	14.73	15.35	15.04
V_2B_1	271.22	282.33	276.78	10.17	10.59	10.38	16.95	17.65	17.30
V_2B_2	446.79	457.72	452.26	16.75	17.16	16.96	27.92	28.61	28.27
V_2B_3	413.10	408.82	410.96	15.49	15.33	15.41	25.82	25.55	25.68
V_2B_4	482.03	490.02	486.03	18.08	18.38	18.23	30.13	30.63	30.38
V_2B_5	349.80	340.35	345.08	13.12	12.76	12.94	21.86	21.27	21.57
V_2B_6	497.71	506.66	502.19	18.66	19.00	18.83	31.11	31.67	31.39
V_2B_7	226.04	224.57	225.31	8.48	8.42	8.45	14.13	14.04	14.08
S.Em ±	3.56	3.09	2.14	0.13	0.12	0.08	0.22	0.19	0.13
CD at 5%	10.35	8.98	6.23	0.39	0.34	0.23	0.65	0.56	0.39

3.7 Dry herbage yield per plant (g)

The results pertaining to the dry herbage yield per plant as influenced by the varieties, biostimulants and their interaction during the years 2021, 2022 and pooled are presented in the table 3. The highest dry herbage yield per plant was recorded in CIM - Ayu (V_1) (156.19, 172.50 and 164.34) than CIM - Angana (V_2) (143.47, 157.94 and 150.70) during the years 2021, 2022, and pooled, respectively. The application of biostimulants also showed a significant effect on the dry herbage yield per plant during both the years and pooled, in which the maximum (242.48, 269.20 and 255.84) dry herbage yield per plant (g/plant) was observed in B_6 - Sea weed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (206.02, 243.79 and 224.90), B_2- Chitosan @ 0.5% (172.90, 193.83 and 183.36) and B_3 (142.07, 145.52 and 143.80) during 2021, 2022, and pooled respectively. Among the interactions highest dry herbage yield per plant (g/plant) (249.42, 273.68 and 261.55) was recorded in T_6 (V_1B_6), followed by T_{13} (V_2B_6) (235.55, 264.71 and 250.13), T_4 (V_1B_4) (220.13, 256.30 and 238.21) and T_{11} (V_2B_4) (191.91, 231.27 and 211.59). Whereas, the lowest dry herbage yield per plant (g/plant) (77.23, 81.15 and 79.19) was registered in T_{14} (V_2B_7) during the year 2021, 2022 and pooled, respectively.

Pramanick *et al.*, (2013) [17] also obtained maximum dry matter accumulation with 15% sap concentration of *Kappaphycus sap* in green gram. The increase in dry matter with application of sap might be due to increase in chlorophyll content and increase in magnesium content of the plant which found to be a constituent of chlorophyll. Increase in chlorophyll content may also be attributed to the presence of betaines in seaweed extract which prevent degradation of chlorophyll which ultimately improves photosynthetic process (Blunden *et al.*,1986) [2].

3.8 Dry herbage yield per plot (kg/plot)

Results concerned to the dry herbage yield per plot as effected by the varieties, biostimulants and their interaction during the years 2021, 2022 and pooled are presented in the table 3. Among the varieties highest dry herbage yield per plot was recorded in CIM - Ayu (V_1) (5.86, 6.47 and 6.16) than CIM - Angana (V_2) (5.38, 5.92 and 5.65) during the years 2021, 2022, and pooled, respectively. The application of biostimulants also revealed a significant effect on the dry herbage yield per plot during both the years and pooled, in which the maximum (9.09, 10.09 and 9.59) dry herbage yield per plot was recorded in B_6 - Seaweed extract @ 10%, followed by B_4 - Humic acid @ 0.4% (7.73, 9.14 and 8.43). Likewise, the lowest dry herbage yield per plot was recorded in B_7 - Water spray (control) (2.94, 3.16 and 3.05) during 2021, 2022 and pooled, respectively. The maximum dry herbage yield per plot (9.35, 10.26 and 9.81) was recorded in T_6 (V_1B_6), followed by T_{13} (V_2B_6) (8.83, 9.93 and 9.38), T_4 (V_1B_4) (8.25, 9.61 and 8.93) and T_{11} (V_2B_4) (7.20, 8.67 and 7.93). Whereas the minimum dry herbage yield per plot (2.90, 3.04 and 2.97) was recorded in T_{14} (V_2B_7) and it was on par with T_7 (V_1B_7) (2.99, 3.28 and 3.14) during the year 2021, 2022 and pooled, respectively.

3.9 Dry herbage yield per hectare (t/ha)

It is evident from the data that varieties, biostimulants and their combination had a significant impact on dry herbage yield per hectare (Table 3). Among the varieties, maximum dry herbage yield per hectare (9.76, 10.78 and 10.27) was recorded in CIM - Ayu (V_1) than CIM - Angana (V_2) (8.97, 9.87 and 9.42) 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 dry herbage yield per hectare. Among the biostimulants, B_6 - Seaweed extract @ 10% recorded maximum (15.16, 16.82 and 15.99) dry herbage yield per hectare followed by B_4 - Humic acid @ 0.4% (12.88, 15.24 and 14.06), B_2- Chitosan @ 0.5% (10.81, 12.11 and 11.46) and B_3 (8.88, 9.09 and 8.99). Likewise, the lowest dry herbage yield per hectare was recorded in B_7 - Water spray (control) (4.91, 5.27 and 5.09) during 2021, 2022 and pooled, respectively. Among the interactions, Treatment T_6 - CIM- Ayu and Seaweed extract @ 10% (V_1B_6) recorded maximum dry herbage yield per hectare (15.59, 17.11 and 16.35), followed by T_{13} (V_2B_6) (14.72, 16.54 and 15.63), T_4 (V_1B_4) (13.76, 16.02 and 14.89) and T_{11} (V_2B_4) (11.99, 14.45 and 13.22). Whereas the minimum dry herbage yield per hectare (4.83, 5.07 and 4.95) was recorded in T_{14} (V_2B_7) and it was on par with T_7 (V_1B_7) (4.98, 5.47 and 5.23) during the year 2021, 2022 and pooled, respectively.

Nelson and Van (1984) [15] reported that seaweed contains auxins that stimulate cell enlargement and cell elongation by increasing cell wall plasticity, permeability and amylase activity leading to higher dry matter production.

Table 3: Effect of biostimulants on dry herbage yield of sacred basil (*Ocimum sanctum* L.)

Treatments	Dry herbage yield								
	Dry herbage yield per plant (g/plant)			Dry herbage yield per plot (Kg/plot)			Dry herbage yield per hectare (t/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Varieties									
V_1	156.19	172.50	164.34	5.86	6.47	6.16	9.76	10.78	10.27
V_2	143.47	157.94	150.70	5.38	5.92	5.65	8.97	9.87	9.42
S.Em ±	1.11	1.35	0.94	0.04	0.05	0.04	0.07	0.08	0.06
CD at 5%	3.22	3.93	2.74	0.12	0.15	0.10	0.20	0.25	0.17
Biostimulants									
B_1	90.76	102.81	96.79	3.40	3.86	3.63	5.67	6.43	6.05
B_2	172.90	193.83	183.36	6.48	7.27	6.88	10.81	12.11	11.46
B_3	142.07	145.52	143.80	5.33	5.46	5.39	8.88	9.09	8.99
B_4	206.02	243.79	224.90	7.73	9.14	8.43	12.88	15.24	14.06
B_5	116.09	117.03	116.56	4.35	4.39	4.37	7.26	7.31	7.29
B_6	242.48	269.20	255.84	9.09	10.09	9.59	15.16	16.82	15.99
B_7	78.48	84.35	81.42	2.94	3.16	3.05	4.91	5.27	5.09
S.Em ±	2.07	2.53	1.76	0.08	0.09	0.07	0.13	0.16	0.11
CD at 5%	6.02	7.35	5.12	0.23	0.28	0.19	0.38	0.46	0.32
Interactions (Varieties and Biostimulants)									
V_1B_1	92.14	104.05	98.09	3.46	3.90	3.68	5.76	6.50	6.13
V_1B_2	178.87	208.20	193.53	6.71	7.81	7.26	11.18	13.01	12.10
V_1B_3	149.59	155.52	152.56	5.61	5.83	5.72	9.35	9.72	9.53
V_1B_4	220.13	256.30	238.21	8.25	9.61	8.93	13.76	16.02	14.89
V_1B_5	123.46	122.20	122.83	4.63	4.58	4.61	7.72	7.64	7.68
V_1B_6	249.42	273.68	261.55	9.35	10.26	9.81	15.59	17.11	16.35
V_1B_7	79.73	87.55	83.64	2.99	3.28	3.14	4.98	5.47	5.23
V_2B_1	89.38	101.58	95.48	3.35	3.81	3.58	5.59	6.35	5.97
V_2B_2	166.93	179.47	173.20	6.26	6.73	6.49	10.43	11.22	10.82
V_2B_3	134.56	135.51	135.03	5.05	5.08	5.06	8.41	8.47	8.44
V_2B_4	191.91	231.27	211.59	7.20	8.67	7.93	11.99	14.45	13.22
V_2B_5	108.73	111.86	110.30	4.08	4.19	4.14	6.80	6.99	6.89
V_2B_6	235.55	264.71	250.13	8.83	9.93	9.38	14.72	16.54	15.63
V_2B_7	77.23	81.152	79.19	2.90	3.04	2.97	4.83	5.07	4.95
S.Em ±	2.93	3.57	2.49	0.11	0.13	0.09	0.18	0.22	0.16
CD at 5%	8.52	10.39	7.24	0.32	0.39	0.27	0.53	0.65	0.45

3.10 Spodoptera (Number/plant)

The population of *Spodoptera exigua* larvae per plant is presented in Table 4. Among the varieties, incidence of *Spodoptera exigua* was observed lowest (0.91, 0.93 and 0.92) in CIM - Ayu (V_1) than CIM - Angana (V_2) (0.97, 1.03 and 1.00) during the year 2021, 2022 and in pooled, respectively. The data presented in Table 4 indicated that the foliar application of biostimulants *viz*. chitosan, humic acid and seaweed extract at various concentrations on sacred basil reduced the incidence of *Spodoptera exigua* significantly over control. The pest incidence was, however, observed lowest (0.63, 0.67 and 0.65) in the plots sprayed with Sea weed extract @ 10% (B_6), followed by the plots sprayed with Humic acid @ 0.4% (B_4) with 0.69, 0.76 and 0.73 during 2021, 2022 and pooled, respectively. Whereas, the control plots (E_7) showed the highest incidence (1.57, 1.58 and 1.57) of *Spodoptera exigua* during 2021, 2022 and pooled, respectively. The observation indicated that, there was no significant difference among different treatments in incidence of *Spodoptera exigua* on sacred basil.

The results obtained in the present investigation with respect to incidence of spodoptera in sacred basil revealed significant influence of foliar application of sea weed extract. According to Carolina Feitosa de Vasconcelos and Helena Garofalo Chaves (2019) [4], Chen *et al.* (2019) [5] seaweed extracts were able to significantly reduce infestation caused by borers, aphids, and thrips in sugarcane thus preventing great economic loss. This reduction in infestation can be due to the antifeedant effects, growth inhibition, and also cytotoxicity on ovarian tissue cells of the pests. For example, an acyclic diterpenoid isolated from Sargassum had growth repellent effects against pink bollworm (Kubo *et al.* 1985) [12].

Seaweed extracts have been shown to activate a variety of plant defense mechanisms against biotic stressors. Some of these resistant responses in plants are conferred by seaweed cell wall polysaccharides such as ulvans, laminarins, and carrageenans, as well as their derived oligosaccharides (Vera *et al.*, 2011) [25]. These bioactive molecules have been shown to activate various defense pathways via salicylic acid, jasmonic acid, and ethylene. This chain of events then results in the accumulation of pathogenesis-related proteins (PR proteins), various defense enzymes such as chitinases and glucanases, and an increase in phenolic compounds, which results in increased protection against a wide range of pathogens.

3.11 Alternaria
The field experiments were carried out in two consequent seasons (2021 and 2022) to estimate the disease severity and presented in Table 4. Among the varieties, disease severity was observed lowest (22.20, 22.61 and 22.40) in CIM - Ayu (V_1) than CIM - Angana (V_2) (23.17, 23.61 and 23.39) during the year 2021, 2022 and in pooled, respectively. The disease severity was, however, observed lowest (16.40, 16.82 and 16.61) in the plots sprayed with Seaweed extract @ 10% (B_6), followed by the plots sprayed with Humic acid @ 0.4% (B_4) with 17.50, 17.93 and 17.72 percent disease index during 2021, 2022 and pooled, respectively. Whereas, the control plots (B_7) showed the highest disease severity of 33.20, 33.60 and 33.40% respectively. In the present study among the interactions, disease severity was, however, observed lowest (16.34, 16.74 and 16.54) in the treatment T_6 (V_1B_6) followed by T_{13} (V_2B_6) (16.46, 16.89 and 16.68), T_4 (V_1B_4) (17.17, 17.57 and 17.37) and T_{11} (V_2B_4) (17.83, 18.29 and 18.06). Whereas, the treatment T_{14} (V_2B_7) showed the highest (34.20, 34.63 and 34.41) disease severity, followed by T_7 (V_1B_7) (32.21, 32.58 and 32.39) during 2021, 2022 and pooled, respectively.

Seaweed extracts also act as elicitors of plant defense responses against harmful bacterial, fungal, and viral pathogens, protecting crops from major economic damage caused by diseases (Fei *et al* 2017) [9]. Extracts of various brown, red, and green macroalgae were found to have strong antibacterial and fungal pathogen eliciting effects. Seaweed extracts were used to treat a variety of fungal and bacterial diseases. The reduction in infection levels is due to increased vigor of seaweed extract-treated plants, preformed resistance, induced systemic or systemic acquired resistance, or enhanced soil suppressiveness due to altered microbial dynamics.

Table 4: Effect of biostimulants on control of spodoptera and Alteraria of sacred basil (*Ocimum sanctum* L.)

Treatments	Spodoptera (Number/Plant)			Alternaria (PDI)		
	2021	2022	Pooled	2021	2022	Pooled
V_1	0.91	0.93	0.92	22.20	22.61	22.40
V_2	0.97	1.03	1.00	23.17	23.61	23.39
S.Em ±	0.01	0.01	0.01	0.013	0.01	0.01
CD at 5%	0.02	0.02	0.02	0.038	0.04	0.04
Biostimulants						
B_1	1.11	1.16	1.14	26.80	27.20	27.00
B_2	0.77	0.81	0.79	18.97	19.38	19.17
B_3	0.86	0.90	0.88	21.17	21.62	21.40
B_4	0.69	0.76	0.73	17.50	17.93	17.72
B_5	0.93	0.97	0.95	24.76	25.20	24.98
B_6	0.63	0.67	0.65	16.40	16.82	16.61
B_7	1.57	1.58	1.57	33.20	33.60	33.40
S.Em ±	0.01	0.01	0.01	0.025	0.03	0.02
CD at 5%	0.04	0.04	0.04	0.072	0.08	0.07
Interactions (Varieties and Biostimulants)						
$T_1(V_1B_1)$	1.08	1.11	1.09	25.80	26.23	26.02
$T_2(V_1B_2)$	0.74	0.77	0.75	18.64	19.06	18.85
$T_3(V_1B_3)$	0.84	0.87	0.86	20.62	21.05	20.84
$T_4(V_1B_4)$	0.67	0.72	0.69	17.17	17.57	17.37
$T_5(V_1B_5)$	0.90	0.92	0.91	24.62	25.01	24.82
$T_6(V_1B_6)$	0.61	0.61	0.61	16.34	16.74	16.54
$T_7(V_1B_7)$	1.52	1.51	1.51	32.21	32.58	32.39
$T_8(V_2B_1)$	1.15	1.21	1.18	27.79	28.17	27.98
$T_9(V_2B_2)$	0.80	0.86	0.83	19.29	19.70	19.50
$T_{10}(V_2B_3)$	0.88	0.93	0.90	21.73	22.19	21.96
$T_{11}(V_2B_4)$	0.72	0.80	0.76	17.83	18.29	18.06
$T_{12}(V_2B_5)$	0.96	1.02	0.99	24.91	25.39	25.15
$T_{13}(V_2B_6)$	0.64	0.72	0.68	16.46	16.89	16.68
$T_{14}(V_2B_7)$	1.61	1.65	1.63	34.20	34.63	34.41
S.Em ±	0.022	0.02	0.02	0.035	0.04	0.03
CD at 5%	NS	NS	NS	0.102	0.11	0.09

Conclusion
The present study demonstrated that varietal differences and biostimulant applications significantly influenced yield attributes, and biotic stress responses in *Ocimum sanctum* L. Among the tested varieties, CIM-Ayu consistently outperformed CIM-Angana by exhibiting earlier flowering, shorter crop duration, and superior fresh and dry herbage yields. Foliar application of biostimulants, particularly seaweed extract @ 10%, markedly enhanced yield at plant, plot, and hectare levels while significantly reducing the incidence of *Spodoptera exigua* and Alternaria disease severity. Humic acid @ 0.4% also showed notable benefits by improving root development and biomass accumulation. The interaction CIM-Ayu × seaweed extract @ 10% (V1B6) emerged as the most effective treatment combination. Overall, the integration of elite varieties with biostimulant-based interventions offers a sustainable and eco-friendly strategy for enhancing productivity and resilience in sacred basil cultivation.

References

1. Azcona I, Pascual I, Aguirreolea J, Fuentes M, Garcia Mina JM, Sanchez-Diaz M. Growth and development of pepper are affected by humic substances derived from composted sludge. J Plant Nutr Soil Sci. 2011;174:916-924.
2. Blunden G, Cripps AL, Gordon SM, Mason TG, Turner CH. The characterization and quantitative estimation of betaines in commercial seaweed extracts. Bot Mar. 1986;29:155-160.
3. Blunden G, Jenkins T, Liu YW. Enhanced leaf chlorophyll levels in plants treated with seaweed extract. J Appl Phycol. 1996;3:13-19.
4. Vasconcelos CF, Chaves HGC. Biostimulants and their role in improving plant growth under abiotic stresses. In: Biostimulants in Plant Science. London (UK): IntechOpen; 2019. p. 71-77.
5. Chen D, Huang Y, Shen D, Zhou W, Ao J, Jiang Y, *et al*. Effects of seaweed extracts on promoting growth and improving stress resistance in sugarcane. Asian J Agric Res. 2019:69-76.
6. Conn KL, Tewari JP, Aswasthi RP. A disease assessment key for Alternaria black spot in rapeseed and mustard. Can Plant Dis Surv. 1990;70:19-22.
7. Crouch IJ, Van Staden J. Effect of seaweed concentrate on the establishment and yield of greenhouse tomato plants. J Appl Phycol. 1992;4:291-296.
8. El-Shamma MS, Mona EM, Helal MA, Maksoud FH, Khalil, Mansour AEM. Effect of some biostimulants on nutritional status, yield and fruit quality of avocado cv. Fuerte. Middle East J Agric Res. 2017;6(3):692-699.
9. Fei H, Crouse M, Papadopoulos Y, Vessey JK. Enhancing the productivity of hybrid poplar (*Populus* × *hybrid*) and switchgrass (*Panicum virgatum* L.) by application of beneficial soil microbes and a seaweed extract. Biomass Bioenergy. 2017;107:122-134.
10. Jensen E. Seaweed fact or fancy. Organic Broadcaster. 2004;12(3):164-170.
11. Kowalczyk K, Zielony T. Effect of aminoplant and asahi on yield and quality of lettuce grown on rockwool. In: Proc Conf Biostimulators in Modern Agriculture; 2008 Feb 7-8; Warsaw, Poland.
12. Kubo I, Matsumoto T, Ichikawa N. Absolute configuration of crinitol, an acyclic diterpene insect growth inhibitor from the brown algae *Sargassum tortile*. Chem Lett. 1985;14:249-252.
13. Mooney PA, Van Staden J. Effect of seaweed concentrate on the growth of wheat under conditions of water stress. S Afr J Sci. 1986;82:623-633.
14. El-Sheekh MM, Alaa Eldin F, El-Saied. Effect of seaweed extracts on seed germination, seedling growth and some metabolic processes of faba bean (*Vicia faba* L.). J Phycol Soc. 1999;38:55-64.
15. Nelson WR, Van Staden J. The effect of seaweed concentrate on growth of nutrient-stressed greenhouse cucumbers. HortScience. 1984;19(1):81-82.
16. Ali O, Ramsubhag A, Jayaraj J. Biostimulant properties of seaweed extracts in plants: implications towards sustainable crop production. Plants (Basel). 2021;10(3):531. doi:10.3390/plants10030531.
17. Pramanick B, Brahmachari K, Ghosh A. Effect of seaweed saps on growth and yield improvement of green gram. Afr J Agric Res. 2013;8(3):1180-1185.
18. Kumar P, Dube SD, Chauhan VS. Photosynthetic response of bell pepper to biozyme in relation to fruit yield. Veg Sci. 2000;27(1):54-56.
19. Sangeetha M, Singaram P. Effect of lignite humic acid and inorganic fertilizers on growth and yield of onion. Asian J Soil Sci. 2007;2(1):108-110.
20. Staples GM, Kristiansen S. Ethnic culinary herbs. Honolulu: University of Hawaii Press; 1999.
21. Ved DK, Goraya GS. Demand and supply of medicinal plants in India. Dehradun (India): Bishen Singh Mahendra Pal Singh; 2008.
22. Patrick DJ. Plant biostimulants: definition, concept, main categories and regulation. Sci Hortic. 2015;196:3-14.
23. Rafiee H, Naghdi Badi H, Mehrafarin A, Qaderi A, Zarinpanjeh N, Sekara A. Application of plant biostimulants as a new approach to improve biological responses of medicinal plants: a critical review. J Med Plants. 2016;15(59):6-39.
24. Sau S, Sukamal S, Tanmay S, Tapas S, Bikash G. Influential role of biozyme on yield, leaf nutrient and quality of guava cv. Allahabad Safeda. Bioscan. 2016;11(4):2679-2682.
25. Vera J, Castro J, Gonzalez A, Moenne A. Seaweed polysaccharides and derived oligosaccharides stimulate defense responses and protection against pathogens in plants. Mar Drugs. 2011;9:2514-2525.
26. Ziosi V, Zandoli R, Di Nardo A. Biological activity of different botanical extracts as evaluated by means of an array of *in vitro* and *in vivo* bioassays. Acta Hortic. 2013;1009:61-66.