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Effect of growth promoter on morpho-physiological, biochemical parameters and essential oil yield of mentha (*Mentha arvensis* L.)

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Abstract
A field experiment entitled "Effect of growth promoter on morpho-physiological, biochemical parameters and essential oil yield of mentha (*Mentha arvensis* L.)" The field experiment was carried out at Department of Plant Physiology, Agriculture Biochemistry and Medicinal and Aromatic Plants and Instructional Herbal Garden, IGKV, Raipur (C.G.) in *Mentha arvensis* L. during the *Rabi* season of 2020-21. Randomized block design (RBD) was used to conduct the experiment with three replications. There were 10 treatments T_1 (Control, Water Spray), T_2 (IAA @ 50 ppm), T_3 (IAA @ 70 ppm), T4 (IAA @ 90 ppm), T_5 (GA3 @ 50 ppm), T_6 (GA3 @ 70 ppm), T_7 (GA3 @ 90 ppm), T_8 (BAP @ 50 ppm), T_9 (BAP @ 70 ppm), T_{10} (BAP @ 90 ppm).
Experimental findings revealed that Herbage yield ranged from 18.07- 20.92 ton ha^{-1}. The highest herbage yield was recorded in T_8 (20.92 $tonha^{-1}$). Herbage yield in T_5 (20.88 $tonha^{-1}$) was statistically at par with $T_8$and the minimum herbage yield was observed in T_1 (18.07 ton ha^{-1}). Essential oil (%) ranged from 0.64-0.76%. The highest essential oil (%) was obtained in T_6 (0.76%) which was at par with T_9 (0.73%), and the lowest essential oil (%) was observed in T_1 (0.64%).

Keywords: Mentha, PGR, essential oil

Introduction
Mentha spp. L. is known as mint belongs to the family Lamiaceae. It is important essential oil bearing plant. Mentha cultivation has gain economic importance due to its essential oil. The major component of the mentha essential oil is menthol, which is used in good, cosmetics and pharmaceuticals. India being largest producer of the world in mentha oil share 80-85% of world production. China, Brazil, US and Japan are the other major mentha oil producing countries. India being the leader in production of menthe oil, exports around 20,000-21,000 tons annually and maintain 1st position in the mentha oil world market. Farmers of Chhattisgarh have started the cultivation of mentha in few pockets of Bastar region. The crop may be an alternate crop to the summer paddy.

Materials and Methods
A field experiment entitled "Effect of growth promoter on morpho-physiological, biochemical parameters and essential oil yield of mentha (*Mentha arvensis* L.)" The field experiment was carried out at Department of Plant Physiology, Agriculture Biochemistry and Medicinal and Aromatic Plants and Instructional Herbal Garden, IGKV, Raipur (C.G.) in *Mentha arvensis* L. during the *Rabi* season of 2020-21. Raipur is located in the central area, agro-climatic zone of Chhattisgarh at latitude 21.6' N and longitude 81.36' E with an altitude of 289.56' meters above the mean sea level. Raipur comes under dry, sub humid agro climatic region. The source of rainfall is south west monsoon. This region generally receives monsoon during June to September with annual rainfall of 1200-1400 mm and very little during October and February. The region had extreme temperature, May is the hottest and December is the coolest month of the year. The pattern of rainfall, particularly during June to September months has a great variation from year to year. The maximum temperature at Raipur goes up to 48 °C in summer while minimum temperature falls down up to 6 °C in winter season.

In this region the relative humidity is high from June to October, and wind velocity is high from May to August with its peak in June - July months.

The research trial was conducted in Randomized block design (RBD) There was 10 treatments T_1 (Control, Water Spray), T_2 (IAA @ 50 ppm), T_3 (IAA@70 ppm), T4 (IAA@ 90 ppm), T_5 (GA3 @ 50 ppm), T_6 (GA3 @ 70 ppm), T_7 (GA3 @ 90 ppm), T_8 (BAP @ 50 ppm), T_9 (BAP @ 70 ppm), T_{10} (BAP @ 90 ppm) and replicated trice. Nursery was raised in pro tray Coco peat and FYM were used as media for growing mentha cutting. The transplanting was done on 25th February, 2021. Transplanting were done as per requirement, healthy seedlings were transplanted with the flexible wire rope marked at specific interval (15x45 cm) with off colored cloth strips for maintaining spacing of (15x45 cm). Transplanting was done manually.

Five plants were selected as representative plant and tagged in each plot for recording growth as well as yield attributes. These plants were harvested separately for post-harvest observations and herbage yield and oil content were later added corresponding total yield per plot. Harvesting was done with the help of sickles by manual labors. All data obtained in the was statistically analyzed using *F*- test, the procedure given by Gomez & Gomez (1984) [28], critical difference (CD) values at *P*= 0.05 were used to determine the significance of differences between means.

Results and Discussion

Growth Parameters

The observations were recorded before the treatment and 15 days after the treatment. Recorded data was analyzed using the standard statistical tools. From the results, it can be inferred that the plant height ranged from 37-58 cm. The maximum plant height was observed in T_7 (58.00 cm) which was statistically similar with T_6 (55.33 cm), and the minimum plant height was observed in T_1 (37 cm). Leaves plant^{-1} ranged from 59.61-96.07. The number of leaves per plant maximum was observed in T_8 (96.07) which was statistically similar with T_5 (95.93), the number of leaves per plant minimum was observed in T_1 (59.61). Number of branches per plant ranged from 4.45-7.80. The number of branches per plant was observed maximum in T_8 (7.80) which was statistically similar with T_5 (7.27), and the number of branches plant^{-1} was observed minimum in T_1 (4.45). Fresh weight Plant^{-1} ranged from 6.80-11.33 gm. The highest fresh weight plant^{-1} was recorded in T_8 (11.32 gm) which was at par with T_{10} (10.71 gm), and the lowest fresh weight plant^{-1} was recorded in T_1 (6.80 gm). Dry weight plant^{-1} ranged from 2.16-3.73 gm. The highest dry weight plant^{-1} was observed in T_8 (3.73 gm) which was at par with T_2 (3.16 gm), and the lowest dry weight plant^{-1} was observed in T_1 (2.16 gm). Leaf area plant^{-1} was ranged from 267.65-612.04 cm^2. The maximum leaf area plant^{-1} was recorded in T_8 (612.04 cm^2) which was at par with T_5 (552.12 cm^2), and the minimum leaf area plant^{-1} was recorded in T_1 (267.65 cm^2) Leaf area index ranged from 2.78-5.43. The maximum leaf area index was recorded in T_8 (5.43) which was at par with T_2 (4.79) and T_4 (4.79). The minimum leaf area index was recorded in T_1 (2.78). Specific leaf area ranged from 264.73-548.44. The maximum specific leaf area was recorded in T_8 (548.44) which was at par with T_3 (539.10), and the minimum specific leaf area was recorded in T_1 (264.73). Specific leaf weight ranged from 0.19-0.35. The maximum specific leaf weight was recorded in T_8 (0.35) which was at par with T_4 (0.33), and the minimum specific leaf weight was recorded in T_1 (0.19). Total chlorophyll content ranged from 0.84-1.09 (mg g^{-1} fresh wt.). The maximum total chlorophyll content was recorded in T_6 (1.09) which was at par with T_9 (1.05), and the minimum total chlorophyll was recorded in T_1 (0.84).

Herbage yield ranged from 18.07- 20.92 ton ha^{-1}. The highest herbage yield was recorded in T_8 (20.92 tonha^{-1}). Herbage yield in T_5 (20.88 tonha^{-1}) was statistically at par with $T_8$and the minimum herbage yield was observed in T_1 (18.07 ton ha^{-1}). Essential oil (%) ranged from 0.64-0.76%. The highest essential oil (%) was obtained in T_6 (0.76%) which was at par with T_9 (0.73%), and the lowest essential oil (%) was observed in T_1 (0.64%).

Yield attributes

Herbage yield ranged from 18.07- 20.92 ton ha^{-1}. The highest herbage yield was recorded in T_8 (20.92 tonha^{-1}). Herbage yield in T_5 (20.88 tonha^{-1}) was statistically at par with $T_8$and the minimum herbage yield was observed in T_1 (18.07ton ha^{-1}). Essential oil (%) ranged from 0.64-0.76%. The highest essential oil (%) was obtained in T_6 (0.76%) which was at par with T_9 (0.73%), and the lowest essential oil (%) was observed in T_1 (0.64%), Similar result was found by (Singh *et al*., 1999 [48].

Table 1: Effect of growth promoter on growth attributes of Mentha (*Mentha arvensis* L.)

Treatments	Growth attributes							
	Pre treatment				Post treatment			
	Plant height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Fresh weight Plant^{-1} (g)	Plant height (cm)	Number of leaves plant^{-1}	Number of branches plant^{-1}	Fresh weight Plant^{-1} (g)
T_1 Control	35.20	51.02	3.90	1.25	37.00	59.61	4.45	6.80
T_2 IAA @ 50 ppm	35.37	47.03	3.93	2.90	39.00	69.93	6.87	9.81
T_3 IAA @ 70 ppm	35.63	47.60	3.93	3.12	43.00	76.84	6.83	9.35
T_4 IAA @ 90 ppm	33.40	48.70	3.90	3.24	38.67	86.33	6.97	10.03
T_5 GA_3 @ 50 ppm	34.63	48.92	3.87	3.78	54.33	95.93	7.27	10.42
T_6 GA_3 @ 70 ppm	34.37	47.83	3.90	3.89	55.33	63.43	7.10	9.33
T_7 GA_3 @ 90 ppm	34.13	47.09	3.87	3.01	58.00	66.93	6.47	8.55
T_8 BAP @ 50 ppm	34.60	49.52	3.80	3.67	44.00	96.07	7.80	11.32
T_9 BAP @ 70 ppm	34.87	47.00	3.77	3.90	41.00	70.83	4.73	10.29
T_{10} BAP @ 90 ppm	35.33	48.16	4.00	3.67	40.67	63.87	5.77	10.71
S.Em±	1.78	1.51	0.10	0.94	3.59	7.72	0.71	0.84
CD=0.05%	NS	NS	NS	NS	10.67	22.93	2.12	2.51

Table 2: Effect of growth promoter on growth attributes of Mentha (*Mentha arvensis* L.)

Treatments	Growth attributes							
	Pre treatment				Post treatment			
	Dry weight plant^{-1} (g)	Leaf Area plant^{-1} (cm^2)	Leaf area index	SLA) (cm^2/gm)	Dry weight plant^{-1} (g)	Leaf Area plant^{-1} (cm^2)	Leaf area index	SLA) (cm^2/gm)
T_1 Control	0.95	159.92	1.82	190.83	2.16	267.65	2.78	264.73
T_2 IAA @ 50 ppm	1.12	157.97	1.90	291.69	3.16	500.32	4.79	446.48
T_3 IAA @ 70 ppm	1.06	163.75	1.77	223.71	2.79	512.67	5.01	539.10
T_4 IAA @ 90 ppm	1.00	165.71	1.70	258.84	2.56	529.40	4.79	478.12
T_5 GA_3 @ 50 ppm	1.13	154.61	1.75	301.43	2.47	552.12	3.19	398.41
T_6 GA_3 @ 70 ppm	1.11	162.30	1.79	195.42	2.39	437.82	3.00	360.37
T_7 GA_3 @ 90 ppm	1.01	162.10	1.73	186.38	2.26	485.67	3.54	446.46
T_8 BAP @ 50 ppm	1.30	160.99	1.71	228.04	3.73	612.04	5.43	548.44
T_9 BAP @ 70 ppm	1.08	160.94	1.85	247.22	2.36	464.51	2.85	441.01
T_{10} BAP @ 90 ppm	1.02	169.05	1.79	267.15	2.45	449.50	3.16	385.87
S.Em±	0.03	1.3	0.03	5	0.37	6.0	0.53	50.9
CD=0.05%	NS	NS	NS	NS	1.10	8.4	0.56	151.5

Table 3: Effect of growth promoter on biochemical attributes of Mentha (*Mentha arvensis* L.)

Treatments	Biochemical attributes					
	Pre treatment			Post treatment		
	Chlorophyll content			Chlorophyll content		
	Chlorophyll a	Chlorophyll b	Total chlorophyll	Chlorophyll a	Chlorophyll b	Total chlorophyll
T_1 Control	0.61	0.19	0.8	0.64	0.20	0.84
T_2 IAA @ 50 ppm	0.59	0.22	0.81	0.79	0.22	1.01
T_3 IAA @ 70 ppm	0.64	0.35	0.99	0.74	0.21	0.95
T_4 IAA @ 90 ppm	0.62	0.34	0.96	0.68	0.21	0.89
T_5 GA_3 @ 50 ppm	0.61	0.26	0.87	0.71	0.21	0.92
T_6 GA_3 @ 70 ppm	0.65	0.26	0.91	0.83	0.29	1.12
T_7 GA_3 @ 90 ppm	0.63	0.34	0.97	0.80	0.22	1.02
T_8 BAP @ 50 ppm	0.64	0.26	0.9	0.76	0.21	0.97
T_9 BAP @ 70 ppm	0.55	0.24	0.79	0.82	0.23	1.05
T_{10} BAP @ 90 ppm	0.62	0.29	0.91	0.69	0.21	0.90
S.Em±	0.04	0.06	0.27	0.03	0.01	0.04
CD=0.05%	NS	NS	NS	0.10	0.03	0.12

Table 4: Effect of growth promoter on growth attributes of Mentha (*Mentha arvensis* L.)

Treatments	Herbage yield (kg/plot)	Herbage yield (t ha^{-1})	Essential oil (%)	Essential oil kg/ha
T_1 Control	4.07	18.07	0.64	112.00
T_2 IAA @ 50 ppm	4.53	20.14	0.70	125.52
T_3 IAA @ 70 ppm	4.60	20.44	0.67	122.67
T_4 IAA @ 90 ppm	4.67	20.73	0.65	112.15
T_5 GA_3 @ 50 ppm	4.70	20.88	0.66	120.04
T_6 GA_3 @ 70 ppm	4.20	18.66	0.76	146.26
T_7 GA_3 @ 90 ppm	4.37	19.40	0.71	132.14
T_8 BAP @ 50 ppm	4.93	20.92	0.69	125.34
T_9 BAP @ 70 ppm	4.53	20.16	0.73	139.87
T_{10} BAP @ 90 ppm	4.23	18.81	0.66	119.86
S.Em±	0.08	0.36	0.08	3.20
CD=0.05%	0.25	1.07	0.25	9.50

Conclusion

The experiment was conducted first time at Instructional Herbal Garden hence, any concrete conclusion cannot be drawn from the data of one year experiment; however the following important inference may be drawn from the results of present investigation.

It is concluded from the study that T_8 (BAP @ 50 ppm) is the best treatment for morpho-physiological growth of mentha crop for getting higher herbage yield Treatment T_6 (GA_3 @ 70 ppm) is found to be superior for obtaining higher essential oil yield and economic value.

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