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Effect of growth regulators on growth and yield of Patchouli under agroforestry system

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Abstract

The experiment was conducted at Herbal Garden of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the month of November 2020 to May 2021. For this, the suitable experimental design was laid out on Randomize Block Design (RBD), wherein 8 Treatments and 3 Replications were carried out on the field, the treatments were divided into foliar application of NAA @ 20 ppm at 60 and 75 Days After Planting (DAP) NAA @ 40 ppm (at 60 and 75 DAP), Miraculan @ 100 ppm (at 60 and 75 DAP), Miraculan @ 200 ppm (at 60 and 75 DAP), GA @ 20 ppm (at 60 and 75 DAP), GA @ 40 ppm (at 60 and 75 DAP), Kinetin@200ppm (at 60 DAP+40 ppm at 75 DAP) and Control. The analysed results showed that the Plant growth regulators, such as NAA @ 20 ppm, NAA @ 40 ppm, GA @ 20 ppm, Kinetin @ 200 ppm + GA @ 40 ppm, and Miraculan@300 ppm, were found to be effective in improving the morpho-physiological and structural components of patchouli, as well as increasing the yield potential in the form of herbage and oil content, when compared to control.

Keywords: Agroforestry system, Patchouli (*Pogostemon cablin*), Growth regulators

Introduction

Agroforestry is a collective name for land use system and technologies where woody perennials (tree, shrubs, bamboos etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. Agroforestry, or the planting of tree species and agricultural crops, is a centuries-old and still widely practiced worldwide. It refers to a wide range of land-use policies and systems.

Patchouli is a plant that thrives in the shade. Patchouli (*Pogostemon cablin*) is a Lamiaceae plant famous for its medicinal and aromatic properties. Patchouli is cultivated for the essential oil it produces. Patchouli essential oil is derived primarily from steam distillation of shade dried leaves. It is well-known for its distinctive woody, earthy, camphoraceous odour, which lasts for a long time. It's particularly noteworthy because the essential oil extracted is significant and valuable on a global scale, primarily for the aromatherapy, perfumery, cosmetics, incense stick manufacturing, and food flavouring industries. It is a shrub by perennial plant that grows up to 1 metre (3 feet) in height. The 3 broad fragrant leaves are borne oppositely along the branching stems and are roughly oval in shape and irregularly toothed. The leaves and stems are also densely hairy. The tiny light purple to white flowers has long stamens and is arranged in thick woolly spikes. Cuttings are widely used to spread the plants. The crop can thrive in areas with moderately heavy and uniformly distributed rainfall, ranging from 150 to 300 cm per year. These are hardy plants that can adapt to a variety of soil conditions. Deep, well-drained, fertile, slightly acidic, deep loamy soil rich in humus and nutrients are needed.

Plant growth regulators are chemical substances that, when used in small quantities, alter plant growth and metabolism by stimulating or inhibiting a part of the natural growth regulatory system. Plant growth regulators (PGRs) are known to boost physiological performance, including the plant's photosynthetic potential, and play a key role in increasing crop yields. PGRs are also known to improve the source-sink relationship and stimulate photo assimilate translocation, resulting in increased productivity.

Materials and Methods: The experiment was carried out at Raipur is situated in Eastern Central part of C.G. at latitudes of 21° 16' N, longitude of 81° 36' E and 289.5 m above Mean Sea Level. The source of rainfall is south-western monsoon. It receives an average annual rainfall of 1326 mm (based on 80 years mean), mostly (85%) concentrated during the period of June to September. The weekly maximum temperature raised up to 46°C during summer and minimum temperature reaches as low as to 6°C during winter season. Experimental was laid out in a Randomized block design with 8 treatments T₁ NAA @ 20 ppm at 60 and 75 Days After Planting (DAP), T₂ NAA @ 40 ppm at 60 and 75 DAP, T₃ Miraculan/Triacontanol @ 100 ppm at 60 and 75 DAP, T₄ Miraculan /Triacontanol @ 200 ppm at 60 and 75 DAP, T₅ GA @ 20 ppm at 60 and 75 DAP, T₆ GA @ 40 ppm at 60 and 75 DAP, T₇ Kinetin@200ppm at 60 DAP+40

ppm at 75 DAP, T₈ Control. Patchouli was intercropped at spacing 40x30cm. Fertilizer were added in three split doses, as a basal dose half of the nitrogen (N) & potassium (K) and full phosphorus were applied in the field. Irrigation was given as per requirement according to field moisture and seasonal rains. The soil of experimental field was black clayey soil which belongs to the order Vertisols and it is locally known as Kanhar. The soil of experimental site was very rich in organic carbon and other nutrient because of the addition of litter in the soil every year.

Statistical Analysis

The data of all parameters of Patchouli collected precisely was tabulated, computed and statistical analysis done by using word-excel spreadsheet a open Randomize block design.



Result and Discussion

Plant growth regulators function as chemical messengers for intercellular communication. They are currently five recognized groups of plant hormones: NAA, gibberellins, Miraculan, and Kinetin. They work together coordinating the growth and development of cells.

Patchouli is an aromatic crop that includes essential oil in its leaves, stems, and in certain species, flowers. Exogenous administration of PGRs can boost herbage as well as oil output.

Morpho-physiological and growth parameters

Plant growth regulators had a substantial impact on the morphological Characteristics of plant such as plant height, number of branches, and number of leaves. Plant height is mostly a genetically determined trait, however various research have shown that synthetic plant growth regulators can be used to raise or decrease plant height. However, in the present investigation significant differences in plant height were noticed

due to plant growth regulators. The significant variations in morpho-physiological yield attributing parameters and yield of patchouli as recorded among different plant growth regulators treatments.

1. Plant height (cm): The results related to plant height (cm) have been presented in Table 4.1 and Fig. 4.1. During 60 DAP, the plant height recorded with different treatments recorded non-significant. The plant height during 60 DAP was ranging from 38.65 to 33.34 cm with the grand mean of 35.93 cm. During 90 DAP the plant height was significantly higher NAA@20ppm (70.44 cm) and was least with control (35.05 cm) with the grand mean of 61.12 cm. During 120 DAP, significantly higher plant height was recorded in case of the treatment NAA@20ppm (80.30 cm) and similar treatment recorded was significantly higher plant height at the time of harvesting. The least plant height recorded was 63.60 cm and 65.05 cm with control during 120 DAP and at the time of harvesting.

Table 1: Impact of plant growth regulators on plant height (cm) in patchouli (*Pogostemon cablin*) in karanj based agroforestry system.

Treatments	60 DAP	90 DAP	120 DAP	Harves ting
T ₁ : NAA@20 ppm	35.16	70.44**	80.30**	81.58**
T ₂ : NAA@40 ppm	35.78	67.29	76.20	77.09
T ₃ : Miraculan @100ppm	38.65	56.34	65.51	71.17
T ₄ : Miraculan @300ppm	36.12	59.64	64.25	66.20
T ₅ : GA@ 20 ppm	33.34	62.36	73.58	77.22
T ₆ : GA@ 40 ppm	34.75	60.78	68.89	69.84
T ₇ : Kinetin@200ppm	38.60	66.84	71.28	74.02
T ₈ : Control	35.05	45.25	63.60	65.05
Mean	35.93	61.12	70.45	72.77
Sem	26.03	35.15	13.47	12.62
CV	14.199	9.701	5.209	4.882
CD@ 1%	NS	14.411	8.921	8.64
CD@ 5%	NS	10.384	6.428	6.22
**Significant @ 5%; NS: Non significant				

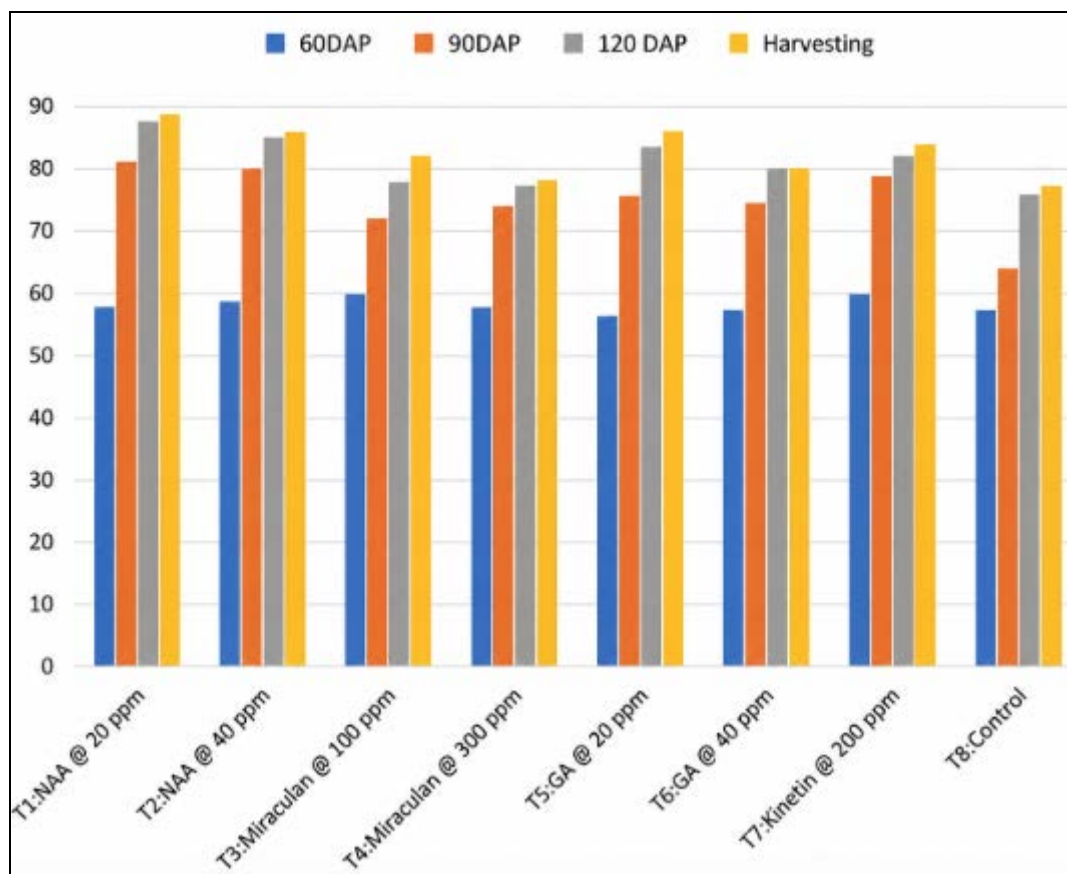


Fig. 1: Impact of plant growth regulators on plant height (cm) in patchouli (*Pogostemon cablin*) in karanj based agroforestry system

2. Collar diameter

The collar diameters of patchouli at 60 DAP recorded significantly higher with the treatment NAA@ 20 ppm (10.84 cm) and with NAA@ 40 ppm (10.83 cm). The least collar diameter was recorded with control (8.47 cm). At 90 DAP the collar diameter recorded non-significant among different treatments and was ranging from 11.26 cm to 15.21 cm. During 120 DAP the significantly higher collar diameter was recorded

with the treatment Kinetin@200 ppm (16.78 cm) and the least was recorded with the control (11.94 cm) with the grand mean of 14.51 cm. At the time of harvesting significantly higher collar diameter was recorded with the treatment NAA@90 ppm (20.37 cm) and with the treatment Kinetin@200ppm (20.93 cm) and the least was recorded with control (15.05 cm). The collar diameter at 60 DAPS, 90DAP, 120 DAP and at the time of harvesting are presented below in the table 4.2 and fig. 4.2.

Table 2: Impact of plant growth regulators on Collar Diameter (cm) of patchouli (*Pogostemon cablin*) in karanj based agroforestry system

Treatments	60DAP	90DAP	120DAP	Harvesting
T ₁ : NAA@20 ppm	10.84**	15.21	14.21	19.19
T ₂ : NAA@40 ppm	10.83**	12.10	13.57	18.34
T ₃ : Miraculan @100ppm	8.73	11.69	15.89	20.37**
T ₄ : Miraculan @300ppm	9.18	11.88	15.65	19.31
T ₅ : GA@ 20 ppm	9.84	11.26	14.76	16.84
T ₆ : GA@ 40 ppm	9.58	11.26	13.24	16.45
T ₇ : Kinetin@200ppm	10.09	12.09	16.78**	20.93**
T ₈ : Control	8.47	10.97	11.94	15.05
Mean	9.70	12.06	14.51	18.31
Sem	0.39	2.05	2.636	2.59
CV	6.437	11.875	11.19	8.798
CD@ 1%	1.52	NS	NS	3.92
CD@ 5%	1.09	NS	2.84	2.82

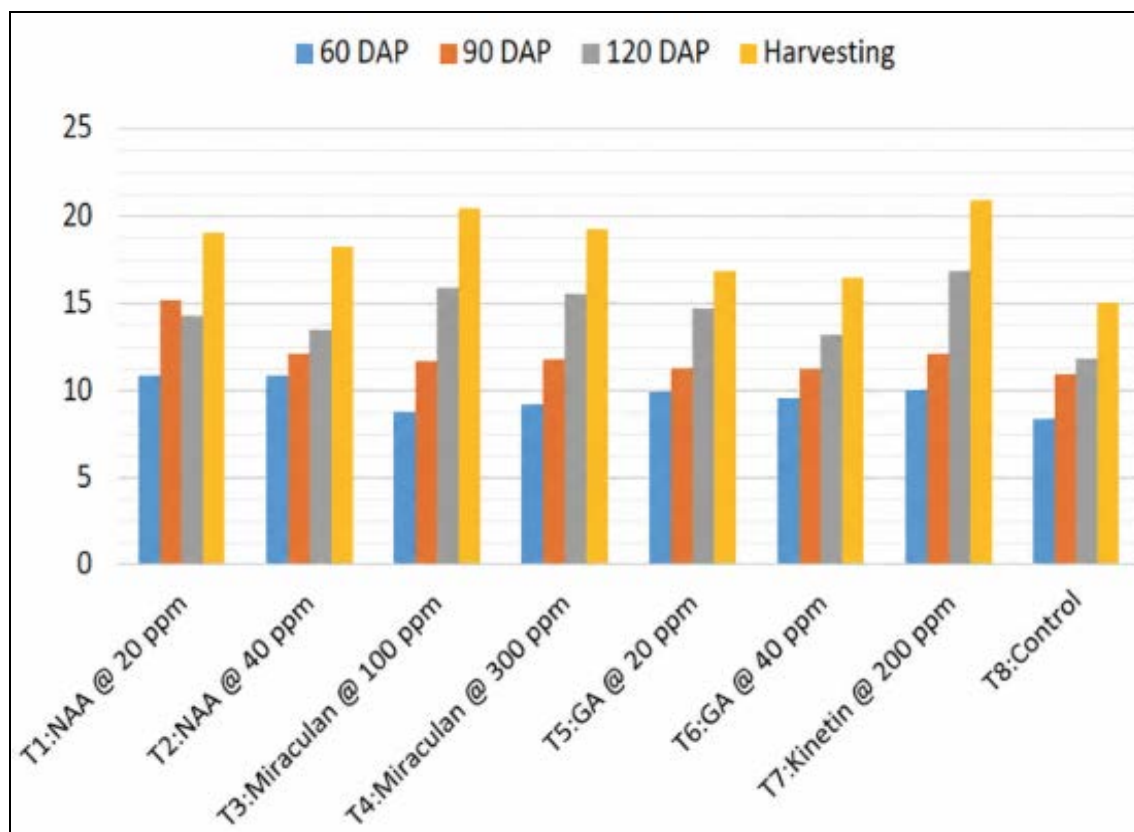


Fig 2: Impact of plant growth regulators on Collar Diameter (cm) of patchouli (*Pogostemon cablin*) in karanj based agroforestry system.

3. Number of leaves per plant: The number of leaves per plant was recorded during 60 DAP, 90 DAP, 120 DAP and at the time of harvesting are presented in the Table 4.3 and fig. 4.3. During 60 DAP the number of leaves per plant recorded non-significant among different treatments, it was ranging from 88.23 to 111.10 with the grand mean of 94.07. During 90 DAP, 120 DAP and the time of harvesting significantly higher number of leaves per

plant was recorded with the treatment Kinetin@20ppm (501.87, 820 and 1250.13, respectively). The least number of leaves per plant during 90 DAP, 120 DAP and at the time harvesting was recorded with control is 396.15, 665.60 and 955.27, respectively, Bhattacharya and Thimmappa reported that IBA (200ppm) in talc on stem cuttings of patchouli resulted in between 0 and 6 leaves and 10-20 cm in length.

Table 3: Impact of plant growth regulators on number of leaves plant⁻¹ of patchouli (*Pogostemon cablin*) in karanj based agroforestry system

Treatments	60 DAP	90 DAP	120 DAP	Harvesting
T ₁ : NAA@20ppm	88.64	430.00	757.00	1041.53
T ₂ : NAA@40ppm	86.38	452.77	715.43	1043.95
T ₃ : Miraculan @100ppm	94.37	427.20	702.40	997.35
T ₄ : Miraculan @300ppm	96.50	378.33	692.30	935.23
T ₅ : GA@ 20 ppm	89.37	408.33	669.67	1046.45
T ₆ : GA@ 40 ppm	97.97	443.33	746.33	1248.13
T ₇ : Kinetin@200ppm	111.10	501.87**	820.00**	1250.22**
T ₈ : Control	88.23	396.15	665.60	955.27
Mean	94.07	429.75	721.09	1064.77
Sem	142.4	1445.9	941.99	14121.24
CV	12.685	8.848	4.256	11.16
CD@ 1%	NS	NS	74.603	NS
CD@ 5%	NS	66.595	53.753	208.122
**Significant@ 5%; NS: Non significant				

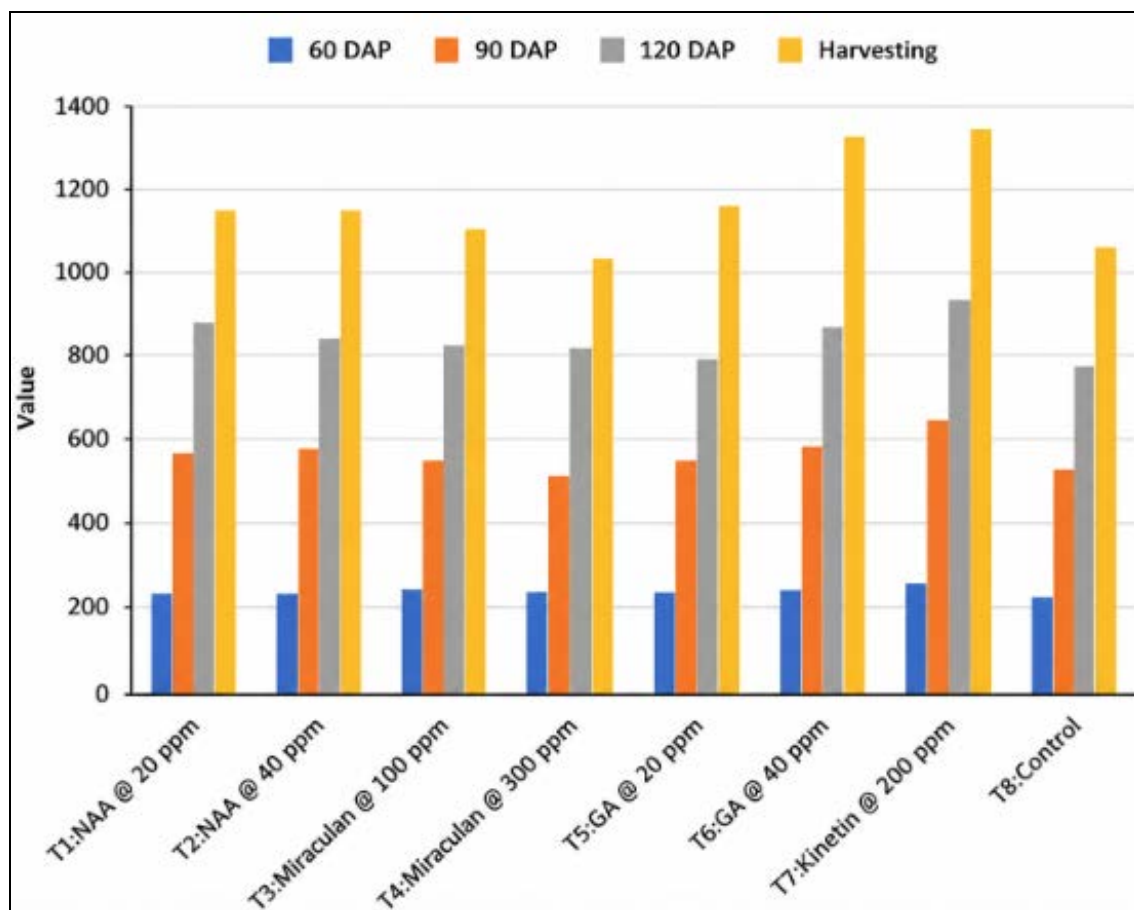


Fig 3: Impact of plant growth regulators on number of leaves plant⁻¹ of Patchouli (*Pogostemon cablin*) in karanj based agroforestry system

4. Leaf area (cm² plant⁻¹)

The leaf area of patchouli was recorded for 60 DAP, 90 DAP, 120 DAP and at the time of harvesting are presented in the Table 4.4 & Fig. 4.4. During 60 DAP significantly higher leaf area was recorded with the treatment NAA@20 ppm (989.46 cm² plant⁻¹) and the least was recorded with control (926.93 cm² plant⁻¹) with

the grand mean of 957.30 cm² plant⁻¹. But in case 90 DAP, 120 DAP and at the time of harvesting treatment Kinetin@200ppm recorded significantly higher leaf area of 4779.09, 5196.643 & 6088.74 cm² plant⁻¹, respectively and the least was observed with control 3426.22, 3990.92 and 4315.4 cm² plant⁻¹, respectively.

Table 4: Impact of plant growth regulators on leaf area (cm² plant⁻¹) of patchouli (*Pogostemon cablin*) in karanj based agroforestry system

Treatments	60 DAP	90 DAP	120 DAP	Harvesting
T ₁ : NAA@20 ppm	989.46**	4468.55	5021.607	6000.91
T ₂ : NAA@40 ppm	965.41	4220.71	4813.61	5524.35
T ₃ : Miraculan@100ppm	971.18	4373.62	4973.973	5522.11
T ₄ : Miraculan@300 ppm	961.36	3974.28	4381.663	4991.69
T ₅ : GA@ 20 ppm	941.32	4405.33	4799.107	5520.93
T ₆ : GA@ 40 ppm	946.05	4087.26	4606.2	5424.74
T ₇ : Kinetin@ 200 ppm	956.64	4779.09**	5196.643**	6088.74**
T ₈ : Control	926.93	3426.22	3990.92	4315.41
Mean	957.30	4216.88	4722.965	5423.61
Sem	314.337	69480.8	91518.4	129715
CV	1.852	6.251	6.405	6.641
CD@1%	NS	640.716	735.339	875.443
CD@5%	31.051	461.651	529.829	630.777
**Significant @ 5%; NS: Non significant				

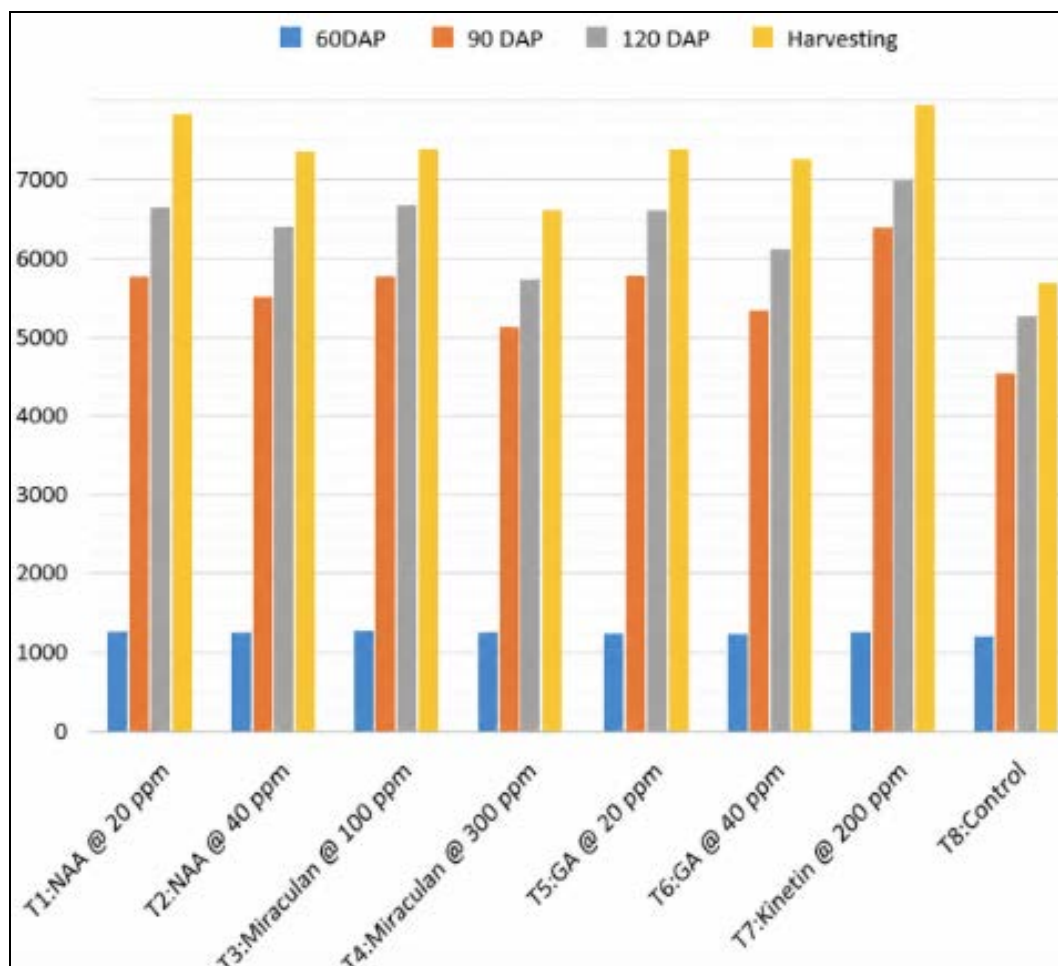


Fig 4: Impact of plant growth regulators on leaf area (cm² plant⁻¹) of patchouli (*Pogostemon cablin*) in karanj based agroforestry system

5. Total herbage and oil content in Patchouli

The fresh weight of patchouli was recorded significantly higher with the treatment Miraculan@100ppm (32.55) and kinetin @ 200 ppm (29.75) and the least were recorded with control (12.28). The dry weight recorded non-significant among different treatments which was ranging from 1.80 to 3.64. The oil content was significantly higher with the treatment Kinetin@200ppm (9.91) and the least was recorded with control

(4.80) (Table 4.5 & Fig 4.5).

Saeid *et al.* (1994) reported the effect of growth regulators on herb, oil yield and hormonal content of lemongrass in dictated that application of mepiquat chloride (125-500 ppm) and IBA (25-100 ppm) reduced the herb yield and oil yields plant⁻¹ but percentage of oil contents were slightly increased compared to control.

Table 5: Impact of plant growth regulators on total herbage (q ha⁻¹) and oil content in patchouli (*Pogostemon cablin*) in karanj based agroforestry system

Treatments	Fresh weight	Dry weight	Oil content
T ₁ : NAA@20 ppm	29.67	3.64	9.53
T ₂ : NAA@40 ppm	27.38	2.99	8.49
T ₃ : Miraculan @100ppm	32.55**	4.07	7.96
T ₄ : Miraculan @300ppm	21.84	2.97	3.49
T ₅ : GA@ 20 ppm	18.73	2.39	6.84
T ₆ : GA@ 40 ppm	23.87	2.88	8.07
T ₇ : Kinetin@200ppm	29.75**	3.20	9.91**
T ₈ : Control	12.28	1.80	4.80
Mean	24.51	2.99	7.39
Sem	39.36	0.817	2.531
CV	25.598	30.206	21.537
CD@ 1%	NS	NS	3.867
CD@ 5%	10.988	NS	2.786
**Significant @ 5%; NS: Non significant			

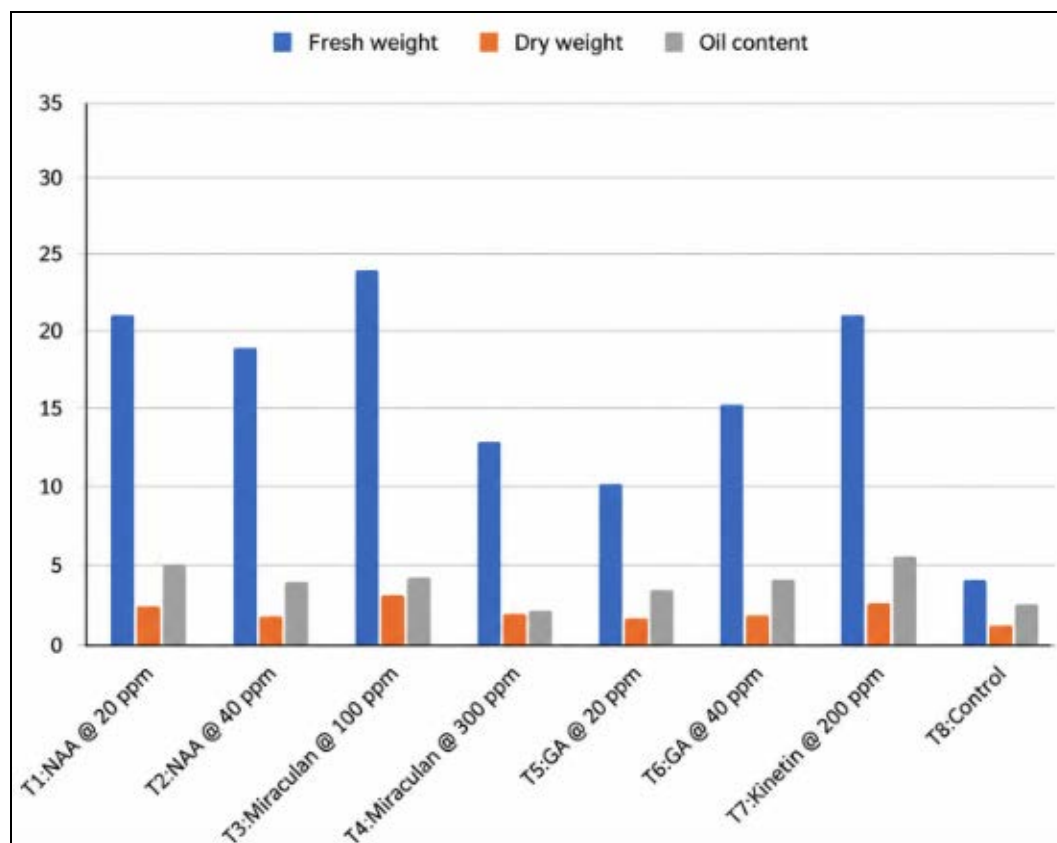


Fig 4.5: Impact of plant growth regulators on total herbage (q ha⁻¹) and oil content in patchouli (*Pogostemon cablin*) in karanj based agroforestry system

Conclusion

It may be concluded from the present in visitation that plant growth regulators especially NAA@20ppm, NAA @ 40 ppm, GA @ 20 ppm, Kinetin @ 200 ppm + GA @ 40 ppm and Miraculan @ 300ppm was proved to be potent PGR to enhance the different morpho-physiological and structural components of patchouli and increasing the yield potential form of herbage as well as oil content over control. Also karanj inter cropped with patchouli recorded significantly yield attributes.

Suggestions for Further Work

The following suggestions may be made for further studies on plant growth regulators in patchouli.

1. To conclude the results experiment should be repeated.
2. There are number of commercial formulations of plant growth regulators which need to be tested at different concentrations to identify suitable growth regulators and its concentration for improving future studies in patchouli.
3. The need to study the combine defect of plant growth regulators and micronutrients spray on growth, physiology and yield of patchouli.

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