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Impact of intercropping on morphological growth pattern of Bhringraj (*Eclipta alba*) under *Psidium guajava* based agroforestry system

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Abstract
The current research entitled "Impact of Intercropping on Growth and Productivity of BHRINGRAJ (*Eclipta alba*) Under *Psidium guajava* Based Agroforestry System at Kanker" was conducted during 2024-25 at experimental field of Krishi Vigyan Kendra Kanker. The experiment was conducted using a Randomized Block Design (RBD) with eight treatments and three replications. The test plots were established within a mature *Psidium guajava* plantation. Each plot measured 2 x 3 meters, and plots designated for intercropping (T_1-T_7) were designed to have an equal number of trees, ensuring consistent shade and resource competition across treatments. The eighth treatment (T_8), serving as a control, was located in an open area to observe the growth of Bhringraj as a monocrop. Growth parameters, including plant height, number of leaves, number of branches, and collar diameter, were significantly affected by the organic nutrient sources. The highest growth was consistently achieved with the 100% Mahua cake application (T_6), which recorded a maximum plant height (65.15 cm), number of leaves (69.90), number of branches (48.98), and collar diameter (0.48 cm). This superior performance is attributed to the synchronized and prolonged release of nutrients, especially nitrogen, from the Mahua cake.

Keywords: Bhringraj, *Psidium guajava*, treatment, intercropping, agroforestry

Introduction
Agroforestry is a land management system which integrates trees, crops, and sometimes livestock on the same land, optimizes resource use and enhances overall farm productivity. This integrated approach has gained significant popularity, particularly fruit tree-based agroforestry systems, due to its potential to improve soil fertility, alleviate environmental stress, and increase yields. One promising application of agroforestry involves the intercropping of medicinal plants. *Eclipta alba* (Bhringraj), a widely recognized medicinal plant from the Asteraceae family, holds significant value in Ayurvedic medicine for its hepatoprotective, anti-inflammatory, and hair growth-promoting properties. The growth pattern of plants of *E. alba* is mainly influenced by environmental factors such as shade intensity, soil water, and nutrient availability. Intercropping of *E. alba* with *Psidium guajava* (guava) offers several synergistic benefits. Guava, a globally cultivated fruit tree, is economically, nutritionally, and medicinally valuable. Its adaptability to diverse climatic conditions and its canopy architecture makes it an ideal overstory species in intercropping systems, providing suitable light and space for understory crops. This integration can enhance soil fertility through litter fall and nutrient cycling, regulate the microclimate, and maximize the efficient utilization of natural resources, potentially leading to enhance growth of the crop of *E. alba*.

Materials and Methods
The experiment was conducted using a Randomized Block Design (RBD) with eight treatments and three replications. The study investigated the effect of varying light conditions by growing Bhringraj (*Eclipta alba*) as an intercrop under the canopy of guava trees (*Psidium guajava*) and also as a monocrop in an open field without tree shelter. The test plots were established within a mature *Psidium guajava* plantation.

Each plot measured 2 x 3 meters, and plots designated for intercropping (T_1-T_7) were designed to have an equal number of trees, ensuring consistent shade and resource competition across treatments. Prior to sowing, all plots received their designated nutrient inputs, which were uniformly applied as a single basal application to ensure a consistent nutrient supply for the entire cropping season. The eighth treatment (T_8), serving as a control, was located in an open area to observe the growth of Bhringraj as a monocrop.

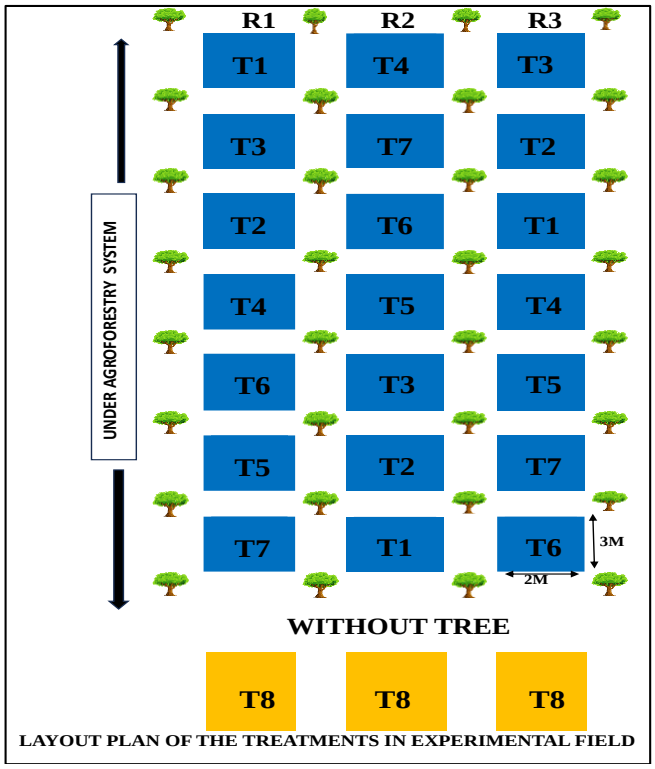
Field preparation

Cutting planting in the experimental plot

Weeding

Table 1: Details of the treatments undertaken

S. No.	Treatment details	Notations used
1	FYM 100%	T_1
2	VERMICOMPOST 100%	T_2
3	KOSAM CAKE 100% *Schleichera oleosa*	T_3
4	JATROPA CAKE 100% *Jatropha curcas*	T_4
5	KARANJ CAKE 100% *Millettia pinnata*	T_5
6	MAHUVA CAKE100% *Madhuca longifolia*	T_6
7	JEEVAMRUT BIO FERTILIZER 100%	T_7
8	SOLE CROP WITHOUT TREE 100% RDF	T_8



Results and Discussion

Growth of Bhringraj results viz. plant height, leaf number and collar Diameter is explained in this section. The performance of growth of *Eclipta alba* was greatly affected by the use of different combination and doses of organic manures and biofertilizers applied under guava-based agroforestry system. All the growth parameters like height of the plant, leaves per plant, number of branches, collar diameter, and overall growth rate showed considerable variation as it is clear from the F-test results.

Field visit at KVK Kanker

Plant Height (cm)

The maximum plant height was seen in T_6 (Mahua cake 100%) with a height of 65.15 cm, much better than all other treatments. It may be due to synchronized release of nutrients and possibly increased nitrogen content in Mahua cake leading to vegetative growth of the plants. The treatment T_8 (RDF without tree) as a sole crop also recorded a good plant height of 58.85 cm, probably because there was no competition from the roots of the tree and greater availability of sun light. The least plant height (44.93 cm) was observed under T_1 (100% FYM), which indicated comparatively slower nutrient release as required by the crop. These results align closely with the findings of Kumar

et al. (2023) [1], who observed that various growth parameters of *Eclipta alba*, particularly plant height, were significantly influenced by both nutrient source and cropping system. Kumar and Sood (2020) [2] indicated that the plant height of *Linum usitatissimum* was significantly influenced by the application of various organic manures and chemical fertilizers under the peach-based agroforestry system. These findings are in accordance with, reported by the above worker that integration of medicinal plants under tree-based systems can be beneficial both agronomically and economically.

Observation recording of *Eclipta alba* during time interval

Number of Leaves per Plant

The results revealed a statistically significant difference ($P<0.05$) in number of leaves due to different fertilizer treatments throughout the growth stages, as confirmed by the F-test. The maximum number of leaves (69.90) was also recorded in T_6 (Mahua cake 100%), followed by T_8 (62.18) and T_2 (Vermicompost 100%), reflecting the positive impact of these treatments on foliage development. The minimum leaf count (49.58) was found in T_5 (Karanj cake 100%), which may indicate relatively lower nutrient assimilation or slower decomposition of cake. Nayak *et al.*, (2023) [3] reported that the number of leaves per plant in *Aloe vera* was significantly influenced by the different treatment combinations. These findings are in agreement with the observations of, above worker reported significant variations in leaf development of *Aloe vera* under different agroforestry combinations confirm with the present investigation. Similar observations were observed in present investigation that intercropping under Guava based agroforestry with Bhringraj almost leaf morphological variation is related with the treatment as reported by above worker confirm the results. Malek *et al*., (2020) [4]

Number of Branches per Plant

Branching showed highly significant differences. The highest number of branches (48.98) was observed in T_6 (Mahua cake 100%), followed by T_8 (40.63). This suggests that Mahua cake promotes lateral vegetative growth effectively, contributing to bushier plant architecture. The lowest number of branches (24.80) was seen in T_1 (FYM 100%), indicating less vigor. These findings are in agreement with Kumar *et al.* (2023) [1], who also observed enhanced branching in Bhringraj with integrated nutrient management under agroforestry systems. The interaction of organic and inorganic inputs, along with beneficial tree-crop interactions, appears to support more vigorous plant architecture growth and biomass.

Collar Diameter (cm)

The maximum collar diameter was noted under T_6 (0.48 cm), followed by T_8 (0.39 cm) and T_5 (0.33 cm). This implies improved stem robustness and potential biomass accumulation in the plants. The lowest collar diameter was observed in T_3 (Kosam cake 0.28 cm), suggesting lesser lignification or stem strength under this treatment may be some allelopathic effect of alkaloid present in this cake. Chandrawanshi Subhadra (2016) [5] MSc Thesis [5] reported in his experiment that the Collar diameter of Patchouli increased progressively with crop age and was significantly influenced by different treatments. The highest collar diameter was recorded under the agroforestry system with different organic manures, ranging from 1.78 cm at 15 DAT to 3.66 cm at 120 DAT, with a mean value of 2.57 cm, which was superior to all other treatments. Kumar *et al.*, (2023) [1] also reported that the collar diameter (16.25, 17.49, 14.94) was obtained with treatment T 100% FYM+ 20 days 12 Irrigation followed by T 100% Vermicompost + 10 Days 13 Irrigation under teak, poplar and open based agroforestry system.

Observation recorded 120 DAT from different plots

Table 2: Effect of organic manure and inorganic fertilizer treatment on growth and productivity of Bhringraj (*Eclipta alba*) intercropped under *Psidium guajava* based Agroforestry System at Kanker (C.G.)

Treatment	Plant height	No. Of Leaf/Plant	No. of Branches	Collar Diameter
T_1 FYM 100%	44.93	54.68	24.80	0.31
T_2 VERMICOMPOST 100%	51.08	57.08	25.93	0.30
T_3 KOSAM CAKE 100%	51.43	54.20	27.48	0.28
T_4 JATROPA CAKE 100%	49.73	52.60	31.50	0.32
T_5 KARANJ CAKE 100%	50.70	49.58	37.40	0.33
T_6 MAHUVA CAKE 100%	65.15	69.90	48.98	0.48
T_7 JEEVAMRUT 100%	49.08	50.53	32.30	0.31
T_8 WITHOUT TREE WITH 100% RDF	58.85	62.18	40.63	0.39
F-test	S	S	S	S
SE(m)	1.91	3.02	1.90	0.024
SE(d)	2.67	4.21	2.68	0.036
CD(at 5%)	5.78	9.22	5.81	0.073
CV	7.10	10.88	8.74	12.08

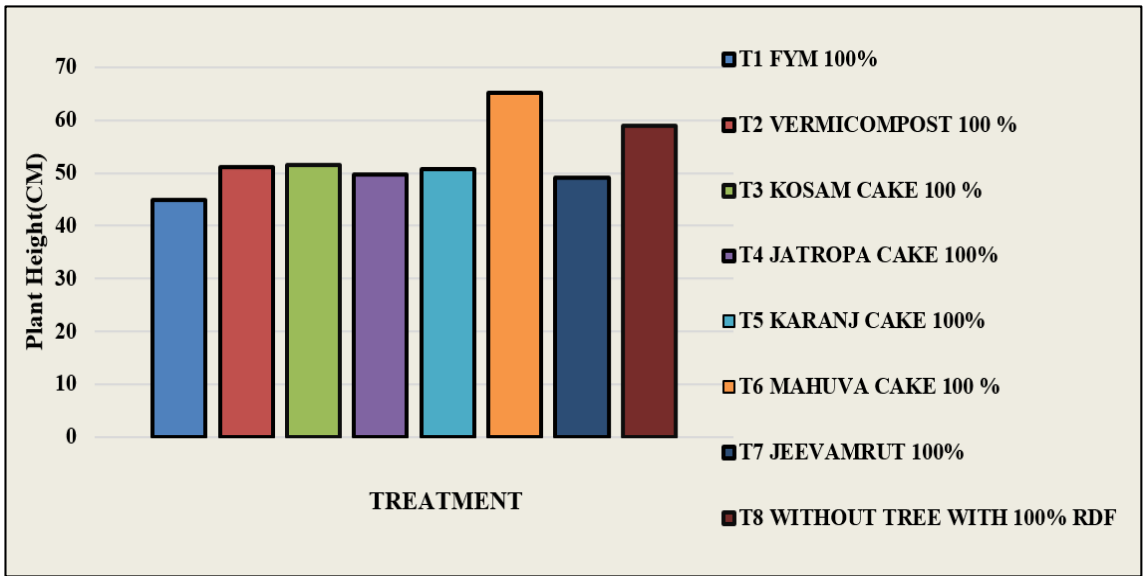


Fig 1: Effect of organic manure and inorganic fertilizer treatments on plant height of Bhringraj *(Eclipta alba*) intercropped under *Psidium guajava* based Agroforestry System at Kanker (C.G.)

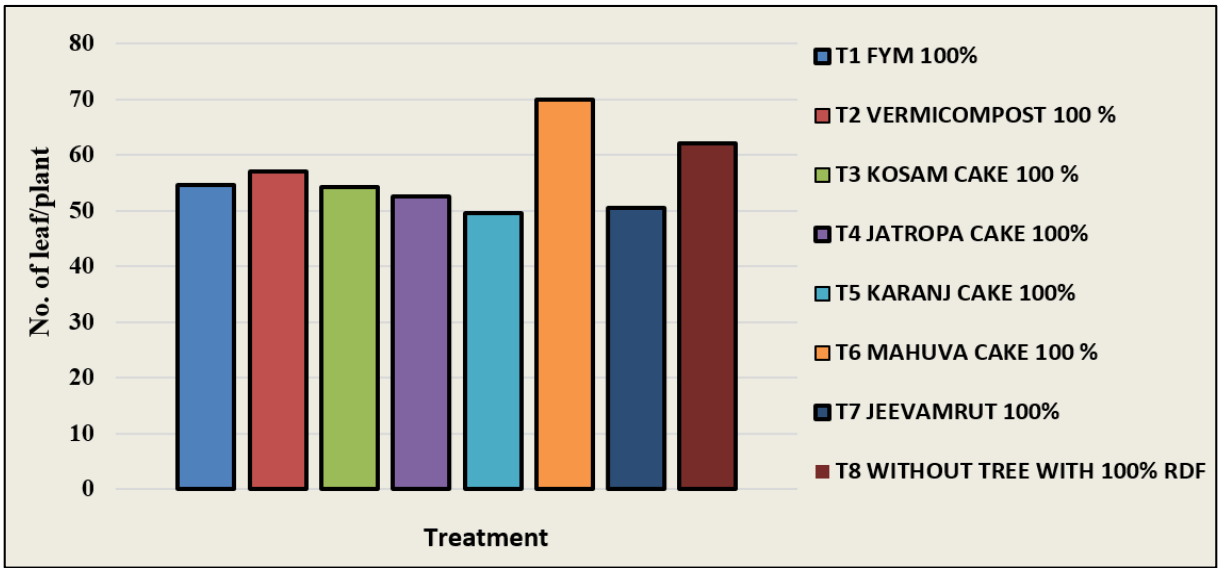


Fig 2: Effect of organic manure and inorganic fertilizer treatments on number of leaves of Bhringraj *(Eclipta alba*) intercropped under *Psidium guajava* based Agroforestry System at Kanker (C.G.)

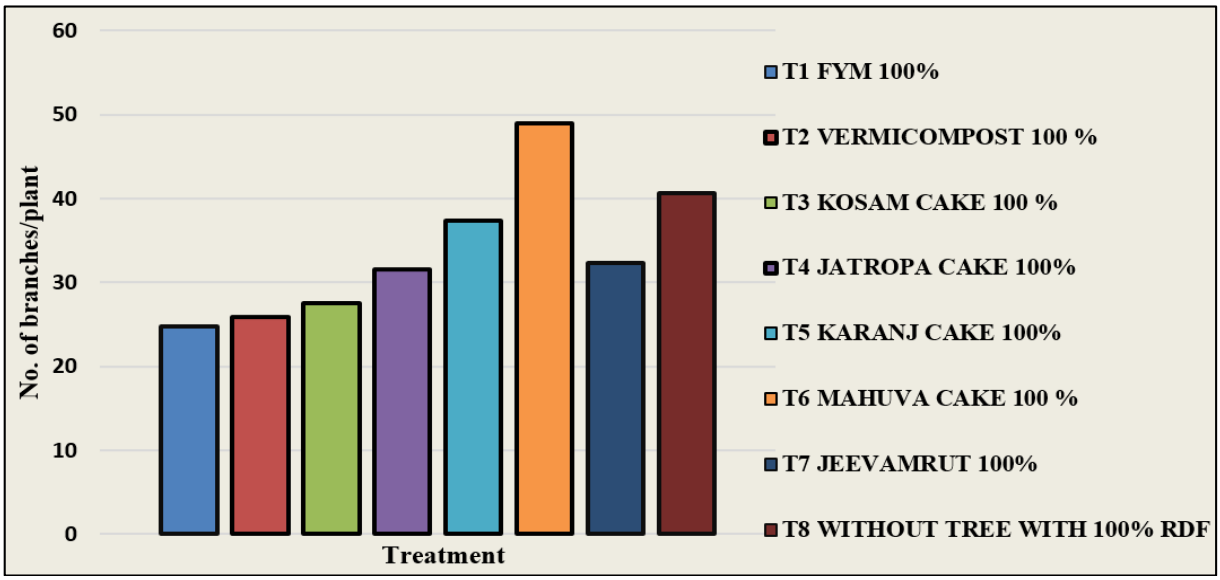


Fig 3: Effect of organic manure and inorganic fertilizer treatments on number of branches of Bhringraj *(Eclipta alba*) intercropped under *Psidium guajava* based Agroforestry System at Kanker (C.G.)

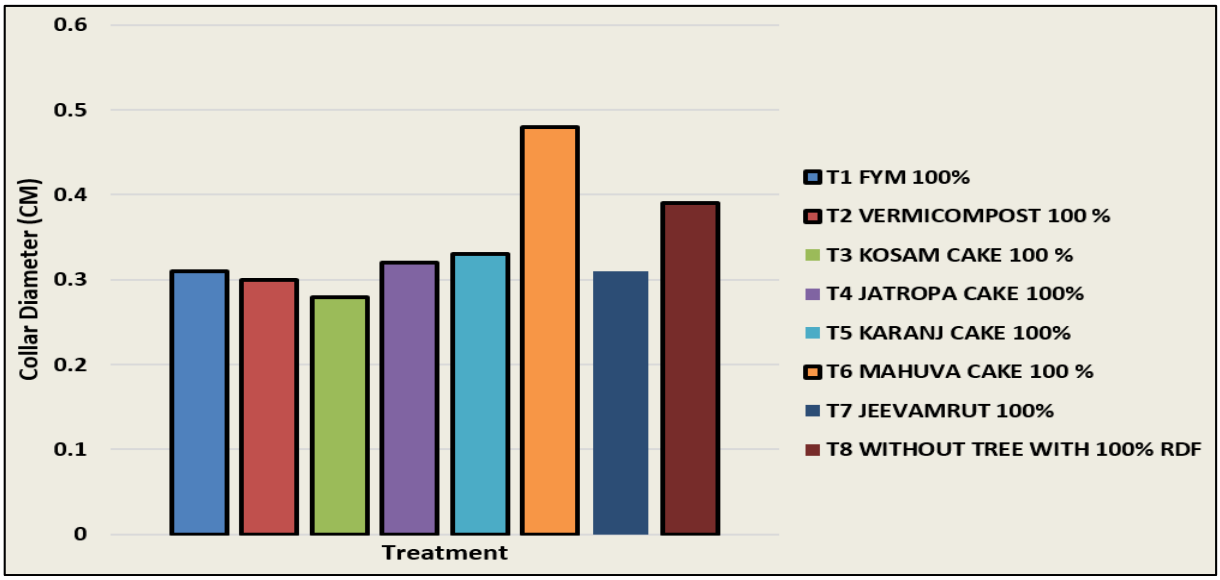


Fig 4: Effect of organic manure and inorganic fertilizer treatments on collar diameter of Bhringraj *(Eclipta alba*) intercropped under *Psidium guajava* based Agroforestry System at Kanker (C.G.)

Conclusion

The plant height of *Eclipta alba* was recorded maximum under treatment T_6 (100% mahuva), cake *Madhuca latifolia* followed by T_8 (without tree with 100% RDF), while the minimum height was observed in T_1 (100% FYM).The maximum number of leaves per plant was also recorded in under treatment T_6 (100% mahuva), followed by T_8 (without tree with 100% RDF), while the minimum height was observed in T_3 (100% kosam cake).The maximum number of branches per plant was also recorded in under treatment T_6 (100% mahuva), followed by T_8 (without tree with 100% RDF), while the minimum height was observed in T_2 (100% vermicompost).The maximum collar diameter was recorded in in under treatment T_6 (100% mahuva), followed by T_8 (without tree with 100% RDF), while the minimum height was observed in T_3(100% kosam cake). Mahuva cake (T_6) emerged as the most effective treatment in terms of overall growth performance, registering the highest plant height (65.15 cm), number of leaves (69.90), number of branches (48.98), and collar diameter (0.48 cm).

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