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Effect of organic manures and biofertilizers on growth parameters of senna (*Cassia angustifolia* Vahl.)

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Abstract
The present study on the effect of organic manures and biofertilizers on growth parameters of senna (*Cassia angustifolia* Vahl.) for leaf production was carried out during the kharif season (June - November) in the year 2023 at ammaiyarpatti (Vembakottai Block), Virudhunagar district, Tamil Nadu. The field experiment was consisting of different combination of nutrients *viz.*, organic manures (VC, FYM, Neem cake) and biofertilizers (*Azospirillum* and Phosphobacteria). The experiment was laid out in Randomized Block Design (RBD) with thirteen treatments with three replications. Among various treatments, plants supplied with T_{11} - VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1} recorded maximum growth parameters such as plant height (cm), number of branches $plant^{-1}$ and leaf area (cm^2 $plant^{-1}$) at 90, 115, 140 DAS respectively.

Keywords: Senna, VC, FYM, neem cake, azospirillum, phosphobacteria

Introduction
Senna (*Cassia angustifolia* Vahl.) popularly known as Indian or Tinnevelly senna belongs to the family Fabaceae. Native to Yemen and Saudi Arabia. Senna is a legume but produces no nodules for fixing atmospheric nitrogen. Senna is cultivated in an area of about 25,000 hectares in India (Basak and Gajbhiye, 2018) [3], mainly in Tirunelveli, Ramanathapuram and Madurai. The leaves and pods of senna contain sennosides which are having high medicinal properties. India holds leading position in the production of senna crop and export of its produce to the world market, annually earning nearly 300 million Indian rupees and about 6000 tonnes of leaves and pods are exported from India to other countries every year (Kayina *et al*., 2012) [6] and thus regarded as 'South Indian Dollar Earning Crop'. Senna is grown for its medicinal value of leaves and pods which contain sennosides A, B, C, D, rhein, aloe-amine, kaempferein and iso-rhein in free and glycosides forms and it stimulates the muscular coat of the intestine and produces purgation, especially in case of habitual constipation also used for anemia, typhoid, cholera, jaundice, rheumatism, tumours, foul breath, bronchitis and probably in leprosy (Vali *et al*., 2020) [16].
Organic fertilizer management is a key factor in the successful cultivation of medicinal and aromatic plants. It enhances the soil fertility, soil structure, water holding capacity, physical and chemical properties of soil, microbial activity and nutrient availability without having undesirable effect on the environment. Taking all these factors into account, the current study was conducted to determine the effect of organic manures and biofertilizers on growth characteristics of senna.

Materials and Methods
A field experiment was laid out at Ammaiyarpatti (Vembakottai Block), Virudhunagar district, Tamil Nadu to study the influence of organic manures and biofertilizers on growth and yield of senna (*Cassia angustifolia* Vahl.). Seeds of senna were collected from Tirunelveli district (local variety). Organic inputs such as Vermicompost and Neem cake and Biofertilizers such as *Azospirillum* and Phosphobacteria were procured from Jeypee Farm, Arupukottai and FYM were collected from farmer's field in Ettaiyapuram town. The seeds were sown directly in a well-prepared field with a spacing of 45 x 30 cm under flood irrigation. The field was laid out in a randomized block design with three replications. The thirteen treatment combinations were T_1: FYM @ 11.25 t ha^{-1}; T_2: VC @ 10 t ha^{-1}; T_3: Neem cake @ 1.73 t ha^{-1}; T_4: FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}; T_5: VC @ 10 t ha^{-1} + *Azospirillum* 2.5 @ kg ha^{-1}; T_6: Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}; T_7: FYM @ 11.25 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}; T_8: VC @10 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}; T_9: Neem

cake @ 1.73 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}; T_{10}: FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}; T_{11}: VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}; T_{12}: Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1} and T_{13}: Control.

The observations were recorded on 90, 110, 140 days after sowing from the randomly tagged 5 existing plants and the mean was calculated. The plant height was measured from the ground level to the growing point, similarly the no. of branches was counted manually and the leaf area was measured by using leaf area meter with the transparent belt conveyor utilizing an electronic digital display. The observed data was analysed by using statistical method of Panse and Sukhatme (1985) [10].

Results and Discussion

Plant Height

The data recorded on the effect of organic manures and biofertilizers on plant height at (90, 110 and 140) days after sowing are furnished in the Table 1. The plant height was found to be increased at a greater rate between 50 to 90 days after sowing and at lowest rate between 115 to 140 days after sowing. Among the various treatments the maximum plant height (183.91 cm) was observed in VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1} (183.91 cm). The minimum plant height of (52.89 cm) at harvest was recorded in the treatment receiving control. The increase in plant height at harvest with organic manures and biofertilizers is due to vermicompost is known to enhance soil structure, water-holding capacity and microbial activity, leading to improved root development and nutrient uptake. Additionally, supplies essential nutrients such as nitrogen (N), phosphorus (P) and potassium (K) in an easily available form, which promotes vegetative growth including plant height (Pratibha *et al.*, 2010) [12]. Similar findings were reported by Suresh *et al.* (2014) [15], Singh and Gupta (2017) [14] and Kumar *et al*. (2019) [7] in senna.

Number of branches plant^{-1}

The data recorded on number of branches plant^{-1} at (90, 110 and 140) days after sowing are furnished in the Table 2. The number of branches steadily increased with the age of the crop reaching maximum at the final harvest (140 DAS). The number of branches at different stages of growth was significantly influenced by organic manures and biofertilizers. The number of branches was found to be the highest in VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1} (12.18, 16.52 and 20.07). The least number of branches plant^{-1} (3.65, 5.88 and 6.16) were observed in Control at 90, 115 and 140 days after sowing respectively. The increase in number of branches at harvest with organic manures and biofertilizers is due to the high nutrient content and growth-promoting substances, such as humic acids, present in vermicompost. These substances enhance root growth and nutrient uptake, which in turn promote overall plant vigour and branching (Arancon *et al*., 2003) [1]. Similar findings were reported by Mirawsaf *et al*. (2016) [9] in aloe vera, Pooja *et al*. (2018) [11] in ocimum and Jagadish *et al*. (2020) [17] in safedmusli.

Leaf Area plant^{-1} (cm^2)

The data recorded on number of branches plant^{-1} at (90, 110 and 140) days after sowing are furnished in the Table 3. Maximum increase in leaf area plant^{-1} was observed between 90 to 115 days after sowing and a steep decrease in leaf area was observed between 115 to 140 DAS. The plants supplied with VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1} recorded the highest leaf area plant^{-1} (109.96 cm^2, 125.09 cm^2 and 120.95 cm^2). The least values of leaf area (58.24 cm^2, 62.53 cm^2 and 60.25cm^2) were observed in Control at 90, 115 and 140 days after sowing respectively. The increase in leaf area at harvest with organic manures and biofertilizers is due to rich in essential macro and micronutrients, which play a key role in promoting vegetative growth and increasing leaf area by vermicompost while, biofertilizers enhance nutrient absorption by increasing root colonization with beneficial microbes. This combination results in enhanced root architecture, greater root mass and a more extensive shoot system (Das *et al.*, 2018) [4]. Similar findings were reported by Mansour (2002) [8] in senna, Basak *et al.* (2019) [2] in kalmegh, Sharma *et al*. (2020) [3] in aloe vera.

Table 1: Effect of organic manures and biofertilizers on plant height (cm) in senna (*Cassia angustifolia* Vahl.)

Treatment	Plant height (cm)		
	90 DAS	115 DAS	140 DAS
T_1 - FYM @ 11.25 t ha^{-1}	62.35	85.46	113.52
T_2 - VC @ 10 t ha^{-1}	66.12	90.49	120.20
T_3 - Neem cake @ 1.73 t ha^{-1}	58.43	80.12	107.17
T_4 - FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	92.02	115.85	155.66
T_5 - VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	96.03	126.01	162.57
T_6 - Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	74.69	100.35	133.23
T_7 - FYM @ 11.25 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	79.14	105.85	140.39
T_8 - VC @ 10 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	87.23	110.86	148.45
T_9 - Neem cake @ 1.73 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	70.12	95.46	126.53
T_{10} - FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	104.13	136.55	176.64
T_{11} - VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	109.04	141.60	183.91
T_{12} - Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	99.95	131.03	169.77
T_{13} - Control	52.89	75.18	100.09
S.Ed	1.741	2.290	3.023
CD (P= 0.05)	3.565	4.691	6.191

Table 2: Effect of organic manures and biofertilizers on number of branches plant^{-1} in senna (*Cassia angustifolia* Vahl.)

Treatment	Number of branches plant^{-1}		
	90 DAS	115 DAS	140 DAS
T_1 - FYM @ 11.25 t ha^{-1}	5.03	7.59	8.04
T_2 - VC @ 10 t ha^{-1}	5.45	8.25	8.82
T_3 - Neem cake @ 1.73 t ha^{-1}	4.46	6.65	7.21
T_4 - FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	8.11	12.66	15.85
T_5 - VC @ 10 t ha^{-1} + *Azospirillum* 2.5 @ kg ha^{-1}	9.08	13.46	16.68
T_6 - Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	6.28	9.56	10.82
T_7 - FYM @ 11.25 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	7.01	10.08	12.54
T_8 - VC @ 10 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	7.45	11.84	14.97
T_9 - Neem cake @ 1.73 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	5.83	8.94	9.52
T_{10} - FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	11.56	15.77	19.28
T_{11} - VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	12.18	16.52	20.07
T_{12} - Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	10.23	14.55	18.09
T_{13} - Control	3.65	5.88	6.16
S.Ed	0.172	0.243	0.296
CD (P= 0.05)	0.352	0.498	0.607

Table 3: Effect of organic manures and biofertilizers on leaf area plant^{-1} (cm^2) in senna (*Cassia angustifolia* Vahl.)

Treatment	Leaf area plant^{-1} (cm^2)		
	90 DAS	115 DAS	140 DAS
T_1 - FYM @ 11.25 t ha^{-1}	67.12	72.01	70.76
T_2 - VC @ 10 t ha^{-1}	71.26	76.56	75.21
T_3 - Neem cake @ 1.73 t ha^{-1}	62.95	67.54	66.60
T_4 - FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	91.00	101.25	99.80
T_5 - VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	96.86	108.56	105.23
T_6 - Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1}	79.11	86.23	84.57
T_7 - FYM @ 11.25 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	83.04	92.09	89.53
T_8 – VC @ 10 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	86.97	96.56	94.02
T_9 - Neem cake @ 1.73 t ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	75.23	81.14	80.09
T_{10} - FYM @ 11.25 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	105.50	120.49	115.58
T_{11} - VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	109.96	125.09	120.95
T_{12} - Neem cake @ 1.73 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1}	100.98	113.86	111.09
T_{13} - Control	58.24	62.53	60.25
S.Ed	1.789	1.993	1.939
CD (P= 0.05)	3.664	4.083	3.972

Conclusion

Based on the observation recorded, it could be concluded that among the various treatments of organic manures and biofertilizers of senna (*Cassia angustifolia* Vahl.), the maximum growth parameters were observed on the plants treated with (T_{11}) VC @ 10 t ha^{-1} + *Azospirillum* @ 2.5 kg ha^{-1} + Phosphobacteria @ 2 kg ha^{-1} can be considered the most effective treatment for improving the growth characteristics of senna.

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