Effect of INM on Vegetative Growth, Flowering and Fruiting of *Andrographis Paniculata*

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**Abstract**  An experiment was conducted to find out the effect of INM on vegetative growth, flowering and fruiting of *Andrographis paniculata*. The experiment was followed in a randomized block design with 8 treatments. The different treatments were T<sub>1</sub>- no treatment, T<sub>2</sub>- vermicompost, T<sub>3</sub>- biofertilizers, T<sub>4</sub>- chemical fertilizers, T<sub>5</sub>- biofertilizers + vermicompost, T<sub>6</sub>- biofertilizers + chemical fertilizers, T<sub>7</sub>- chemical fertilizers + vermicompost, T<sub>8</sub>- biofertilizers + chemical fertilizers + vermicompost. The results indicated that maximum growth i.e. plant height, number of branches, number of leaves, leaf length and breadth, leaf area, land area occupied by per plant and leaf area index, number of flowers and fruits of *A. paniculata* was found in T<sub>8</sub> plot treatment compare to other plots. From the analysis of result it has concluded that integrated use of biofertilizers, chemical fertilizers and vermicompost treatments significantly increased growth parameters of *A. paniculata*.

**Keywords**  Biofertilizers, Chemical Fertilizers, Vermicompost, INM, *Andrographis paniculata*

1. Introduction

Medicinal plants offer alternative remedies with tremendous opportunities. Most of medicinal plants, even today are known to grow widely and naturally. Unfortunately, many of these plants are threatened by the hazard of extinction. Not surprisingly, wild plants species used for medicinal purposes are receiving ever increasing attention from the scientific community and commercial enterprises. It is necessary to initiate systematic cultivation of medicinal plants in order to conserve biodiversity and protect endangered species.

Agriculture has the greatest environmental impact of all types of economic activity, mainly because it is so land-intensive. Today, little undeveloped arable land remains on Earth. A wide variety of factors hinders the cultivation of new land, including low soil quality, arid climate, lack of infrastructure and environmental restrictions.

The application of an integrated plant nutrient supply system is becoming popular as it is scientifically sound and assures sustainable development in agriculture. The use of judicious combination of organic and inorganic fertilizer source is essential not only to maintain soil health but also sustain productivity (Malewar *et al.*, 1998).

*A. paniculata* has been used for centuries in Asia for the treatment of various ailments. It is one among the prioritized medicinal plant in India. The plant is known as ‘King of bitters’. it is one of the bitterest, annual herbaceous plant.

The plant contains a number of diterpenoid. Andrographolide (the diterpenoid lactones) is the main bitter principle found in high concentrations in the leaves of Kalmegh (*Tang.W.* *et al*., 1992). Andrographolide showed anticancer activity on diverse cancer cells representing different types of human cancers (*Kumar R.A.* *et al.*, 2004). Calabrese, *et al.*, (2000) has conducted a trial on HIV patients and found effective. Beyond this effects it is useful as an anti inflammatory (*Shen Y.C.* *et al.*, 2002), antiviral (*Wiart C.* *et al.*, 2005), antimalarial (*Mishra P.* *et al.*, 1992 and *Rahman, et al.*, 1999) hepatoprotective (*Handa S.S.* *et al.*, 1990) etc. Looking at the utility and importance of *A.paniculata*, it is need to make better by developing systematic agro-techniques. To achieve maximum growth, we should apply biofertilizers, chemical fertilizers and organic manures i.e. vermicompost. For sustainability, it’s important to incorporate bio-organisms and organic matter into the soil. The present investigation was, therefore, carried out to see the effect of INM on vegetative growth, flowering and fruiting of *Andrographis paniculata*.

2. Material and Method

The field experiment was conducted at Sarojini Naidu Govt. Girls P.G. (Autonomous) college, Bhopal, Madhya Pradesh. The experiment was conducted in a randomized block design (RBD) with 8 treatments and 3 replicas of each, using chemical fertilizers (NPK), vemicompost, and bio fertilizers (*Azotobacter*, phosphate solubilizing bacteria) in different combinations including one control treatment. The treatments were T<sub>1</sub> - control (no treatment), T<sub>2</sub>
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- Vermicompost 5 t ha⁻¹, T₃ - Biofertilizers (250g *Azotobacter* ha⁻¹ + 250g PSB ha⁻¹), T₄ - Chemical fertilizers (60:30:30kg NPK ha⁻¹), T₅ - BF + VC (125g *Azotobacter* + 125g PSB + 5t vermicompost ha⁻¹), T₆ - BF + CF [125g *Azotobacter* + 125g PSB + 50% NPK (RDF) ha⁻¹], T₇ - CF + VC (50% NPK + 5t vermicompost ha⁻¹) and T₈ - BF + CF + VC (250g bio fertilizers (125g *Azotobacter* + 125g PSB) + 50% NPK (RDF as 30:15:15 kg per ha⁻¹) + 5t VC.

For recording various biometric observations, five plants were randomly selected for sampling, and tagged for recording the growth parameters. After sowing, 30 DAS plant height, number of branches, number of leaves, leaf length and breadth, leaf area, land area occupied by per plant and leaf area index, no. of flowers and fruits were recorded.

### 3. Result and Discussion

**Table 1. Effect of different nutrient sources on morphological parts of A. paniculata at vegetative stage.**

| Plot No. | Treatment | 30 DAS Stage | Leaf length (LL) and Leaf breadth (LB)(cm) | Leaf area (cm²) | Land area occupied by per plant (cm) | Leaf area index |
|----------|-----------|--------------|----------------------------------------|----------------|-------------------------------------|----------------|
|          |           | Plant height (cm) | Number of branches per plants | Number of leaves per plant | LL LB |
| T₁       | NT        | 2.46 | 0.4 | 6.4 | 2.0 | 1.0 | 2.00 | 2.3 | 0.86 |
| T₂       | VC        | 5.38 | 1.2 | 9.2 | 2.8 | 1.2 | 3.36 | 3.5 | 0.96 |
| T₃       | BF        | 5.52 | 1.6 | 11.2 | 3.1 | 1.3 | 4.03 | 4.0 | 1.00 |
| T₄       | CF        | 3.48 | 0.8 | 7.2 | 2.6 | 1.1 | 2.86 | 3.0 | 0.95 |
| T₅       | BF+VC     | 6.68 | 2.8 | 12.8 | 3.8 | 1.8 | 6.84 | 6.4 | 1.06 |
| T₆       | BF+CF     | 6.42 | 2.4 | 12.0 | 3.6 | 1.6 | 5.76 | 5.5 | 1.04 |
| T₇       | CF+VC     | 5.82 | 2.0 | 11.6 | 3.5 | 1.4 | 4.90 | 4.8 | 1.02 |
| T₈       | BF+CF+VC  | 7.0  | 3.6 | 13.6 | 4.0 | 1.9 | 7.60 | 7.1 | 1.07 |
| SA Mean  |           | 5.3450 | 1.8500 | 10.5000 | 3.175 | 1.413 | 4.6688 | 4.5750 | 0.995 |
| SA SD    |           | 1.59176 | 1.06771 | 2.62515 | 0.678 | 0.327 | 1.96635 | 1.67992 | 0.0696 |
| SA SEm   |           | 0.56277 | 0.37749 | 0.92813 | 0.24 | 0.116 | 0.69521 | 0.59394 | 0.0246 |
| SA 95% confidence interval of the difference | | **Lower** | 4.0143 | 0.9574 | 8.3053 | 2.608 | 1.139 | 3.0248 | 3.1705 | 0.936 |
|          |           | **Upper** | 6.6757 | 2.7426 | 12.6947 | 3.742 | 1.686 | 6.3127 | 5.9795 | 1.053 |

Leaf area was calculated by the formula:-

Leaf Area = leaf length × leaf breadth

Leaf area index was worked out by the formula (Sesak et al., 1971).

\[
\text{Leaf area of per plant} = \frac{\text{LL} \times \text{LB}}{2}
\]

\[
\text{LAI} = \frac{\text{Land area occupied by per plant}}{\text{Leaf area index}}
\]

The results were statistically analyzed by using SPSS software, version 20, 2011.
**Table 2.** Effect of different nutrient sources on morphological parts of 
*Andrographis paniculata* at Harvesting stage.

| Plot No. | Treatment | Plant height (cm) | Number of branches per plants | Number of leaves per plant | Leaf length (LL) and Leaf breadth (LB)(cm) | Leaf area (cm²) | Land area occupied by per plant (cm) | Leaf area index |
|----------|-----------|-------------------|------------------------------|---------------------------|------------------------------------------|----------------|-------------------------------------|----------------|
| T₁       | NT        | 26.26             | 38.0                         | 78.4                      | 4.4                                      | 1.7            | 7.48                                | 6.8            |
| T₂       | VC        | 42.26             | 47.6                         | 84.4                      | 8.3                                      | 2.1            | 17.43                               | 15.3           |
| T₃       | BF        | 45.22             | 50.4                         | 86.0                      | 8.5                                      | 2.2            | 18.70                               | 16.4           |
| T₄       | CF        | 38.6              | 42.0                         | 80.0                      | 6.1                                      | 1.9            | 11.59                               | 10.4           |
| T₅       | BF+VC     | 48.34             | 62.0                         | 91.2                      | 9.6                                      | 2.6            | 24.96                               | 20.1           |
| T₆       | BF+CF     | 48.28             | 60.0                         | 90.4                      | 9.3                                      | 2.4            | 22.32                               | 18.1           |
| T₇       | CF+VC     | 45.5              | 58.4                         | 89.6                      | 9.1                                      | 2.3            | 20.93                               | 17.6           |
| T₈       | BF+CF+VC  | 51.64             | 66.0                         | 91.6                      | 9.8                                      | 2.7            | 26.46                               | 20.3           |
| SA       | Mean      | 43.2625           | 53.0500                      | 86.4500                   | 8.138                                    | 2.238          | 18.7338                             | 15.6250        |
| SA       | SD        | 7.94450           | 10.07160                     | 5.14670                   | 1.907                                    | 0.338          | 6.49755                             | 4.74786        |
| SA       | SEm       | 2.80881           | 3.56085                      | 1.81963                   | 0.674                                    | 0.119          | 2.29723                             | 1.67862        |

Abbreviations:- NT- No Treatment, BF- Biofertilizers, CF- Chemical Fertilizers, LL- Leaf Length, LB- Leaf Breadth, VC- Vermicompost, SD- Standard Deviation, SEm- Standard Error mean, SA- Statistical Analysis, INM- Integrated Nutrient Management, N- nitrogen, P- phosphorus, K- Potassium, PSB- phosphate solubilising bacteria.

**Table 3.** Effect of different nutrient sources on reproductive part of 
*Andrographis paniculata* at vegetative and harvesting stage.

| Plot No. | Treatments | 30 DAS | 135 DAS |
|----------|------------|--------|---------|
|          |            | Number of Flowers | Number of Fruits | Number of Flowers | Number of Fruits |
| T₁       | NT         | -      | -       | 50.6    | 15.5    |
| T₂       | VC         | -      | -       | 64.2    | 19.4    |
| T₃       | BF         | -      | -       | 66      | 20.0    |
| T₄       | CF         | -      | -       | 60.8    | 17.2    |
| T₅       | BF+VC      | -      | -       | 72.4    | 25.5    |
| T₆       | BF+CF      | -      | -       | 71.6    | 23.2    |
| T₇       | CF+VC      | -      | -       | 69      | 22.4    |
| T₈       | BF+CF+VC   | -      | -       | 75.2    | 27.8    |
| SA       | Mean       | 0.000  | 0.000   | 66.2250 | 21.3750 |
| SA       | SD         | 0.000  | 0.000   | 7.86489 | 4.14755 |
| SA       | SEm        | 0.000  | 0.000   | 2.78066 | 1.46638 |

Abbreviations:- NT- No Treatment, BF- Biofertilizers, CF- Chemical Fertilizers, LL- Leaf Length, LB- Leaf Breadth, VC- Vermicompost, SD- Standard Deviation, SEm- Standard Error mean, SA- Statistical Analysis, INM- Integrated Nutrient Management, N- nitrogen, P- phosphorus, K- Potassium, PSB- phosphate solubilising bacteria.
In the present research, it was found that, at 30 DAS, maximum plant height (7.0 cm), number of branches (3.6), number of leaves (13.6), leaf length and breadth (4.0 cm LL, 1.9 cm LB), leaf area (7.60 cm²), land area occupied by per plant (7.1 cm) and leaf area index (1.07) was recorded in T₈ plot followed by T₅ plot treatment (Table 1) whereas no flowering was seen (Table 3). Similarly, at 135 DAS Maximum plant height (51.64 cm), number of branches (66.0), number of leaves (91.6), leaf length and breadth (9.8 cm LL, 2.7 cm LB), leaf area (26.46 cm²), land area occupied by per plant (20.3 cm) and leaf area index (1.30) was recorded in T₈ plot (Table 2). Maximum number of flowers (75.2) and fruits (27.8) were also recorded in T₈ plot (Table 3) follower by T₅ plot treatment.

The present study reveals that maximum growth of morphological and reproductive parts of plants increases in T₈ plot as compared to other plots. Same results has been already reported by Tara DW and MS Fatima., 2008 in Cowpea; Sarhan T.Z., G.H. Mohammed and J.A. Teli (2011). Effect of INM on Vegetative Growth, Flowering and Fruiting of Andrographis paniculata. J. Ethnopharmacol. 64: 249-254.

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