

**INFLUENCE ORGANIC MANURES AND GROWTH  
REGULATORS ON GROWTH AND YIELD OF COLEUS (*Coleus  
forskohlii Briq.*)**

Thesis submitted to the  
University of Agricultural Sciences, Dharwad  
in partial fulfillment of the requirements for the  
Degree of

**MASTER OF SCIENCE (AGRICULTURE)**

**in**

**HORTICULTURE**

**By**

**SUNILKUMAR G.S.**

**DEPARTMENT OF HORTICULTURE  
COLLEGE OF AGRICULTURE DHARWAD  
UNIVERSITY OF AGRICULTURAL SCIENCES  
DHARWAD – 580005**

**DECEMBER, 2005**

## ADVISORY COMMITTEE

Dharwad

(J.C. MATHAD)

DECEMBER, 2005

MAJOR ADVISOR

**Approved by:**

**Chairman :** \_\_\_\_\_

(J.C. MATHAD)

**Members : 1.** \_\_\_\_\_

(A.A. PATIL)

**2.** \_\_\_\_\_

(S.M. HIREMATH)

**3.** \_\_\_\_\_

(P.R. DHARMATTI)

**4.** \_\_\_\_\_

(A.S. BYADAGI)

# CONTENTS

Chapter No.	Title	Page No.
I.	INTRODUCTION	
II.	REVIEW OF LITERATURE	
III.	MATERIAL AND METHODS	
IV.	EXPERIMENTAL RESULTS	
V.	DISCUSSION	
VI.	SUMMARY	
VII.	REFERENCES	
	APPENDICES	

## LIST OF TABLES

Table No.	Title	Page No.
1.	Monthly meteorological data for experimental year 2004-05 of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad	
2.	Physical and chemical properties of the soil of the experimental site	
3.	Influence of organic manures and their combinations on plant height (cm) at different stages of plant growth	
4.	Influence of organic manures and their combinations on number of leaves per plant at different stages of plant growth	
5.	Influence of organic manures and their combinations on number of branches per plant at different stages of plant growth	
6.	Influence of organic manures and their combinations on plant spread-East-South direction (cm) at different stages of plant growth	
7.	Influence of organic manures and their combinations on plant spread-East-West direction (cm) at different stages of plant growth	
8.	Influence of organic manures and their combinations on leaf area (cm <sup>2</sup> ) at different stages of plant growth	
9.	Influence of organic manures and their combinations on yield, yield parameters and harvest index at different stages of plant growth	
10.	Influence of growth regulators on plant height (cm) at different stages of plant growth	
11.	Influence of growth regulators on number of leaves per plant at different stages of plant growth	
12.	Influence of growth regulators on number of branches per plant at different stages of plant growth	
13.	Influence of growth regulators on plant spread-North-South directions (cm) at different stages of plant growth	
14.	Influence of growth regulators on plant spread-East-West directions (cm) at different stages of plant growth	
15.	Influence of growth regulators on leaf area (cm <sup>2</sup> ) at different stages of plant growth	
16.	Influence of growth regulators on yield, yield parameters and harvest index at different stages of plant growth	

## LIST OF FIGURES

Figure No.	Title	Between Pages
1.	Plan of layout of the Experiment I	
2.	Plan of layout of the Experiment II	

## LIST OF APPENDICES

Appendix No.	Title	Page No.
I.	Price of inputs and returns	
II.	Economic analysis of coleus as influenced by different organic manures and their combination	
III.	Economic analysis of coleus as influenced by different growth regulators	

## LIST OF PLATES

Plate No.	Title	Between Pages
1.	General view of the experiment on organic manures during 2004-05 (Coleus var. K-8)	
2.	General view of the experiment on growth regulators during 2004-05 (Coleus var. K-8)	
3.	Growth of Coleus plants under control treatment	
4.	Coleus plants grown with vermicompost application	
5.	Growth of Coleus plants with poultry manure + vermicompost application	
6.	Yield of Coleus tubers under control treatment	
7.	Influence of vermicompost on tuber yield of Coleus	
8.	Influence of poultry manure + vermicompost on tuber yield of Coleus	
9.	Growth of Coleus plants under control treatment	
10.	Coleus plants with enhanced growth in response to CCC, 1000 ppm	
11.	Growth of Coleus plants with Mepiquat chloride, 1000 ppm	
12.	Yield of Coleus tubers under control treatment	
13.	Influence of CCC, 1000 ppm on tuber yield of Coleus	
14.	Influence of Mepiquat chloride, 1000 ppm on tuber yield of Coleus	

# I. INTRODUCTION

Medicinal plants encompass a huge number of plant species that are used in homeopathy and various Indian systems of medicines such as folk medicine, Ayurveda, Siddha and Unani. About 4500 species are used in different folk medicines, 1700 in Ayurveda, 1000 in Siddha, 700 in Unani and 500 in Homeopathy. The demand for the products obtained from these plants such as phytochemicals, steroids, biologically active compounds, alkaloids etc. is increasing in national and international market. To meet the demand, medicinal plants are being collected indiscriminately from forests resulting in dwindling supplies and endangering the survival of the species.

Recently WHO studies indicate that over 30 per cent of the world's plant species have at one time or another been used for medicinal purposes. Among 2,50,000 higher plant species on earth, more than 80,000 are medicinal. The products relating to about 20,000 higher plant species are being marketed world over. About 120 chemical compounds of plant origin have been developed into modern pharmaceuticals.

According to the convention of biological diversity report, there was US \$ 62 billion sales of herbal medicines in the world and which is expected to increase to US \$ 3 trillion by 2020. Export from India had increased from Rs. 460 crores in 1995 to 1200 crores in 2000 and is expected to reach Rs. 3000 crores by 2005 (Ghosh, 2000).

*Coleus forskohlii* Briq. Syn *Coleus barbatus* Benth. is a plant of Indian origin (Valdes *et al.*, 1987) belongs to family Lamiaceae (Labiata). It is most important species belongs to genus *Coleus* and is popularly known as Manganiberu or Makandiberu in Karnataka, Garmar in Maharashtra, Garmalu in Gujarathi, Patharchur in Sanskrit and Pashanbedi in Hindi.

*Coleus* has been distributed all over the tropical and subtropical regions of India, Pakistan, Sri Lanka, Tropical East Africa, Brazil, Egypt and Ehtiopia. In India it is found in Sub-tropical Himalayan regions from Kumaon to Nepal, Bihar and Deccan plateau of Southern India. It is also cultivated in parts of Rajasthan, Maharastra, Karnataka and Tamil Nadu for its fasciculated tuberous roots.

It is a massive plant having many medicinal properties. Traditionally the roots have been used for condiments and preparation of pickles in traditional growing areas (Anon, 1950). In Ayurvedic School of Medicine it has been used for many medicinal purposes. Root juice is given for the children suffering from constipation (Singh *et al.*, 1980). Kothas the native tribes of trichigadi in Nilgiris of South India consider decoction of tuberous roots as tonic (Abraham, 1981). The roots are consumed for curing cough and the paste prepared from roots with mustard oil is used in the treatment of skin infection by natives of Kumaon Himalaya. The leaves of *Coleus* are used for treating urinary, vaginal diseases and also for treating intestinal disorders. The essential oil from leaves is reported to possess antimicrobial activities. Tubers are used as antihelmentic for relief from constipation in infants. It is used to allay the burning sensation by the application of paste of fresh tubers. Among the veterinary uses, the fresh tubers (raw or cooked) mixed with milk is fed to stimulate breeding bulls in methujani betta in Tamil Nadu.

The pharmacological effect of *Coleus forskohlii* is diterpene active compound called forskolin (Bhat *et al.*, 1977). It is used for treating heart diseases, abdominal colic, respiratory disorders, painful urination, insomnia etc. (Ammon and Muller, 1985). The therapeutic properties of forskolin are in treating cardiomyopathy, hypertension, glaucoma, thrombosis, asthma and metastatic conditions (Seamon, 1984). Recently it has been used to reduce body weight and birth control in carrying womens. The novel feature of forskolin is its unique mechanism of generating cyclic adenosine monophosphate (AMP) in its cell through direct activation catalytic unit of adenylyate cyclase enzyme, which made the pharmaceutical industry to recognize the plant as most medicinally and economically important since after 1973. Due to the exclusiveness of the forskolin to this species, the indiscriminate collection of *Coleus forskohlii* from the wild has made the species vulnerable and has been included in the list of endangered species (Vishwakarma *et al.*, 1988; Gupta, 1988).

Though forskolin is patented, forskolin drugs are yet to be marketed. As a biochemical compound forskolin is marketed by Sigma chemical company, United States of

America, by virtue of its antihyperative, positive inotropic and adenylyl cyclase activating properties. As a biochemical agent forskolin is sold at US \$ 85.00 per 10 mg.

It is said that Indian herb *Coleus forskohlii* Briq. is the only source of forskolin (Desouza and Shah, 1988). Though almost all the plant parts are found to have traces of forskolin, roots are the main sources possessing 0.1-0.5 per cent and preferred for its extraction (Valdes *et al.*, 1987).

To protect these herbal medicine plants in their habitat, systematic agrotechniques need to be developed for economically important medicinal species. The cultural practices have not been standardized for *Coleus forskohlii* production and is being done as advocated in the report of Farooqi and Khan (1993). Among various cultural practices for enhancing tuberous roots yield, nutrient management plays an important role in enhancing the yield per unit area. In the recent past, research on fertilizer use in our country was mainly confined to nutritional requirement of individual crop. Generally fertilizer is being applied to every crop without considering their ill effects and non target biota on crop growth and yield. The organic manures found that to maintain higher level of fertility of soil and quality of the crop. When there is an increased awareness for the quality of economic product especially in crops like *Coleus forskohlii* there is need to give more emphasis on organic farming. With this intention present investigation has been carried out to know the influence of organic manures on growth and yield of *Coleus*.

Innumerable experiments aimed to manipulate spacing, nutrient management and improved varietal release has been conducted and nearly all the possibilities and potentialities have been exhausted. Of late a new breed of chemicals termed growth regulator is being exploited as a potential manipulator in tailoring plant growth towards exploiting the higher regime of untapped yield potential. These plant growth regulators are known to regulate several physiological processes associated with growth and development of Horticultural crops. It is necessary to determine the suitable growth regulators for the crop production of *Coleus*.

Keeping all these points in view, the investigation on "Influence of organics manures and growth regulators on growth and yield of *Coleus* (*Coleus forskohlii* Briq.)" under transitional conditions of Dharwad were undertaken encompassing the following objectives.

- 1) To find out the effect of the organic manures on growth and yield of *Coleus*.
- 2) To know the combination effect of different organic manures on growth and yield of *Coleus*.
- 3) To study the effect of growth regulators on growth and yield of *Coleus*.

## II. REVIEW OF LITERATURE

It is well documented that no single source of plant nutrient like organic manures, fertilizers, biofertilizers and other plant tonics (plant boosters) can meet the total nutrient requirement for sustainable crop production. The basic concept of organic farming is the maintenance of soil fertility and these organic manures supply an optimum level of micro and macro nutrients for sustaining the desired crop productivity through optimization of benefits from all available sources of plant nutrients.

In the same mode as that of organic manures, plant growth regulators also stimulate the desired effect on plant growth. These plant growth regulators are new generation chemicals which can modify the growth and yield of the plant. There are currently five recognized groups of plant growth regulators *viz.*, Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene. Besides the natural phytohormones, that are involved in growth and differentiation, auxiliary bud growth etc. there are several other synthetic bioregulators that regulate growth and development behaviour of plants without inducing malformative or phytotoxic effects. These bioregulators comprise of both retardants and promoters. If used in appropriate concentrations, these influences the plant architecture in a typical fashion.

The research work done in India and elsewhere in recent years on the effect of organic manures and growth regulators on growth and yield parameters of Coleus and related crops have been reviewed and presented here as under.

### 2.1 EXPERIMENT-I : EFFECT OF ORGANIC MANURES ON GROWTH AND YIELD OF COLEUS

#### 2.1.1 Effect of FYM on growth and yield

Mohan Kumar and Muralidharan Nair (1979) reported that application of FYM, 20 t/ha recorded significantly higher yield in yellow yam over 10 and 15 tonnes per ha of FYM.

According to Grewal and Trehan (1984) application of FYM @ 15 and 30 t/ha recorded significantly increased tuber yield in potato crop by 39 and 42 per cent, respectively. They opined that higher yield was mainly due to improvement in tuber size.

Application of farmyard manure (50 t/ha) resulted in significantly higher yield of turmeric as compared to control (Shaha, 1988). Similar observations were also made by Balashanmugam *et al.* (1989).

The highest root yield of safed musli was recorded with the application of FYM 20 t per ha at Akola. The yield attributes such as number of roots, root girth and weight of roots per plant followed the same trend (Anon, 2003).

Vyas, *et al.* (1997) noted that application of FYM @ 10 t per ha significantly increased grain (44 q/ha) and straw yield (59.29 q/ha) over no FYM (38.10 and 51.06 q per ha grain and straw yield respectively) in wheat. Significantly higher plant height (111.7cm) and dry matter accumulation (1053.0 g) at harvest was recorded with the application of FYM @ 10 t per ha over no FYM application in maize (Rameshwar and Singh, 1998). Thakur *et al.* (1999) concluded that addition of FYM @ 10 t per ha resulted significantly higher values of yield (32.51q/ha) and yield attributing characters *viz.*, ear length (8.13 cm) grains per ear (41.68) than no organic manure application in sorghum. Sankar *et al.* (1999) observed that 12.5 t per ha FYM and phosphorous 30 kg per ha resulted the greater plant height (232.7 cm) and yield (3.31 kg/ha) in cassava. Katiyar and Singh (2003) reported that yield and yield attributes responded well to application of FYM @ 250 kg per ha in *Nigella sativa* plants.

Field experiments conducted at Rajasthan on safed musli with four levels of FYM (0,15,30 and 45 t/ha) showed that application of FYM @ 30 t per ha recorded significantly increased root yield. However, it is on par with the application of FYM @ 45 t per ha (Chouhan and Arunabh Joshi, 2002). Rodrigeus and Sumioka (2003) indicated that application of compost resulted in non-significant increase in rhizome yield of Yam.

#### 2.1.2 Effect of Vermicompost on growth and yield

The importance of vermicompost in agriculture was first reported by Hopp and Slates (1949). Later, Khan (1966) observed that the growth of maize was better in plants supplied with vermicompost as compared to control in loamy soil. Kale and Bano (1986) have recorded higher vegetative growth like shoot weight, root weight and root:shoot ratio by application of worm cast than the commercial fertilizer. Kale *et al.* (1987) observed an increased stem girth, LAI and flower diameter in aster when 2.5 t per ha vermicompost was applied. Brave (1992) reported that sole application of vermicompost was good for growth of grape plants.

Venkatesh (1995) reported that application of vermicompost @ 5 t per ha alone and in combination with RDF and FYM improved the yield of Thompson seedless grapes. Higher yield of turmeric was recorded when vermicompost (2.5 t/ha) was added along with RDF (Mannikeri, 1996).

Desai (1992) observed that application of basal dose of fertilizer resulted in significantly higher yield as compared to application of vermicompost in capsicum. Patil (1995) reported that application of vermicompost (4 t/ha) along with 50 per cent RDF recorded significantly increased the potato yield (34 t/ha) as compared to control (14.2 t/ha).

Stolyerenko *et al.* (1992) observed stimulated root and shoot growth in maize with the application of vermicompost. Application of vermicompost as potting mixture for cardamom resulted in significantly increased in height of plants, number of leaves per plant, number of roots per plant and length of roots (Vadiraj *et al.*, 1992). Balaji (1994) reported increased growth in china aster with the application of vermicompost @ 2.5 t per ha in combination with inorganic fertilizer. Baphana (1992) observed that application of vermicompost @ 2.5 t per ha recorded significantly increased yield as compared to control.

The number of leaves per plant in potato were significantly increased with vermicompost and 50 per cent RDF as compared to control (Patil, 1995). Kale *et al.* (1991) reported that application of vermicompost would be helpful in reducing basal dose of fertilizers to 25 per cent in radish and carrot.

Mannikeri (1996) observed higher fresh rhizome yield by application of RDF in combination with vermicompost as compared to vermicompost alone in turmeric crop. The cured rhizome yield (4.53 t/ha), curing percentage (18.82), harvest index and curcumin contents were also significantly higher with the application of RDF and vermicompost combination as compared to vermicompost alone (2.06 t/ha).

### 2.1.3 Effect of Sheep manure on growth and yield

Shivasupiramanian and Malik (1989) reported that increased tuber yield was obtained in potato crop when the crop was supplied with sheep manure.

Jecik and Ivanovski (1999) reported higher yield of hay with the application of 10 t/ha sheep manure in mountain pastures. Addition of sheep manure increased grain and straw yields as well as macro and micro nutrient content of wheat grains (El Marhraby, 1997).

Hill Man and Suwandi (1999) noted that highest yield of fruits 2.16 kg/plant was obtained with sheep manure @ 30 t/ha in tomato crop. Ikpe *et al.* (1999) found higher yield of pearl millet with sheep manure + urine application than other treatments.

### 2.1.4 Effect of Poultry manure on growth and yield

Singh *et al.* (1979) reported that application of poultry manure significantly increased the dry matter and grain yield of maize when compared to other treatments which did not receive poultry manure. In a similar way Fernandes *et al.* (1986) also observed that application of poultry manure increased the dry matter accumulation in maize and sorghum as compared to control. Obi and Ebo (1995) observed that the addition of poultry manure (10 t/ha) recorded significantly improved average plant height and grain yield in maize as compared to control. While investigating the effect of poultry manure on oilseed crop.

Banerjee and Singhamahapatra (1986) reported that higher yield of potato was recorded with the application of poultry manure (5 t/ha) and was on par with the application of FYM (20 t/ha). On the contrary, Yerriswamy *et al.* (1994) also noticed relatively higher

beneficial effect of poultry manure on plant height and total dry matter production in sorghum over FYM and other organic sources.

The effect of poultry manure alone and in different combinations with inorganic fertilizers on yield of groundnut revealed that application of poultry manure in graded doses viz., 1, 2 and 3 tonnes per hectare have significantly increased the dry pod yield by 2.1, 4.7 and 8.0 quintal per hectare, respectively over no application of poultry manure. Integrated use of fertilizer and poultry manure exhibited additive effect on groundnut yield (Talashilkar *et al.*, 1997). Stefanescur and Dasco (1998) noticed higher grain yield in wheat and maize by application of four tones of poultry manure.

In a study, Chezhiyan *et al.* (2003) indicated that highest number of branches per plant, number of leaves per plant, plant spread, leaf area, fresh weight per plant, dry weight of leaf per plant and dry weight of root per plant and yield were exhibited by poultry manure + *Azospirillum* (2 kg/ha) + phosphobacteria (2 kg/ha) at wider spacing in Bhumyamalaki.

### 2.1.5 Effect of Pressmud on growth and yield

Virendra Kumar and Mishra (1991) reported that in maize there was considerable increase in the dry matter yield per ha due to application of pressmud @ 10 t per ha.

Dubey (1992) noticed that yield of soybean was increased by 22.6 and 15.8 per cent with the application of FYM (6 t/ha) or pressmud (6 t/ha), respectively with *Bradyrhizobium* inoculation over control.

More (1994) observed increase in grain yield (18.2 q/ha) and straw yield (38.4 q/ha) of rice with the application of FYM @ 25 t per ha + pressmud @ 20 t per ha over three years. Similar trend was also noticed in case of wheat.

Singh *et al.* (1995) reported that application of pressmud @ 30 t per ha + 120 kg N per ha increased sugarcane ratoon yield by 32 per cent over recommended dose of 150 kg N per ha + 60 kg P<sub>2</sub>O<sub>5</sub> per ha + 50 kg K<sub>2</sub>O per ha.

Dang and Verma (1996) observed increased dry matter yield of rice with the application of sulphatation pressmud cake @ 10 t per ha with 150 kg N per ha (64.3 g/plot) over control (49.1 g/plot). They also observed similar trend in case of wheat.

Tompe and More (1996) in their study on the effect of pressmud cake on soil characteristics of a Vertisol at Marathwada Agricultural University concluded that the progressive increase in doses of pressmud cake resulted in increased water holding capacity but decreased the bulk density. Further, noticed that higher doses of pressmud decreased the pH and EC of soil. Maximum organic carbon content of soil was observed with application of 15 tonnes of pressmud cake per ha + 25 per cent RDF. Pressmud cake at 15 tonnes per ha recorded highest bacterial, fungal and *Azotobacter* population at all growth stages of sunflower.

Sharma *et al.* (1999) revealed that application of 180 kg N per ha through pressmud and urea in 1:1 ratio significantly increased the number of tillers, millable canes and yield per ha over other treatment combinations.

The effect of integrated use of N (0, 50, 75 and 100% of recommended N level) and pressmud cake (0, 2 and 4 t/ha) with or without *Azotobacter* (5 kg/ha) was studied on sugarcane for three seasons at RRS, Mandya. Integrated use of pressmud cake @ 4 t per ha and *Azotobacter* @ 5 kg per ha with 100 per cent of RDN fertilization resulted in increased cane and sugar yields to the tune of 11 and 9.85 per cent, respectively (Nagaraju *et al.*, 2000).

The application of 75% RDF + 5 and 4 t pressmud per ha were found most effective in increasing pod yield, number of pods per plant and 100-seed weight than RDF (Kadwe *et al.*, 2004).

### 2.1.6 Effect of Vermicompost + FYM combination on growth and yield

Application of FYM (25 t/ha) recorded higher yield of fresh rhizomes in turmeric (Balashanmugam *et al.*, 1989). Prabhu *et al.* (2002) reported that application of FYM and biofertilizers along with recommended dose of inorganic fertilizers was found to increase the yield and yield attributes in okra. The treatment combination of 2/3 RDF + FYM (10 t/ha) + *Azospirillum* + VAM resulted in highest yield and thereby suggesting a possibility of reducing about 1/3 RDF without any detrimental effect on yield.

Mohd. Rafi *et al.* (2002) revealed that application of 50 per cent recommended dose of fertilizer and FYM (12.5 t/ha) along with reduced level of recommended dose of fertilizer (50% RDF) resulted in highest vegetative growth and yield in tomato. The readymade organic fertilizer *i.e.*, clerich and teracare were inferior as compared to traditional organic manures *viz.*, FYM and vermicompost.

### 2.1.7 Effect of Vermicompost + Sheep manure combination on growth and yield

Vasanthi and Kumaraswamy (2000) attested that application of sheep manure or poultry manure @ 10 t per ha with 50 per cent recommended NPK resulted higher green and dry crop yield in cereal crops. Vasanti *et al.* (1998) reported that 10 tonnes of poultry manure or Sheep manure along with 100% RDF had produced almost equal yield and produced 25-30 tonnes per ha of green fodder at 60 DAS.

### 2.1.8 Effect of Poultry manure + FYM combination on growth and yield

Abou Hussein *et al.* (2003) reported that application of FYM with chicken manure improved the vegetative growth in terms of plant height and obtained highest yield with the same application in carrot.

### 2.1.9 Effect of N, P and K on growth and yield

Response of potassium in the presence of nitrogen and phosphoric acid amounts to 2779.00 lb of fresh ginger (47.1) for 100 lb K per ha and 2583.00 of fresh ginger (27) for 150 lb K<sub>2</sub>O per ha (Anon., 1962). However, Lokanath and Dash (1964) observed no significant interaction among the major nutrients. They obtained maximum yield of ginger (23.66 t/ha) with N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O combination of 150:100:150 lb per ha over control (6.87 t/ha) without fertilizer.

Application of 40 kg each of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per ha recorded maximum tuber yield (16.22 t/ha) of misrikand over control (Roy *et al.*, 1975).

Narayana *et al.* (1977) recommended that the application of 5 t FYM per ha and a basal dose of 20 kg N, 30 kg P<sub>2</sub>O<sub>5</sub> and 30 kg K<sub>2</sub>O per ha with a top dressing of 20 kg N per ha in two equal split doses for *Catharanthus roseus*. The highest crude alkaloid yield per ha in *Catharanthus roseus* when plants were fertilized with 150, 50 and 150 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively (Suresh, 1980) and also the combination was found to increase the plant height, fresh and dry weight of leaf, dry matter per cent and cumulative leaf yield.

Nair and Mohan Kumar (1984) reported that sweet potato tuber yield was increased significantly with increase in fertilizer level upto 75 kg N, 50 kg P<sub>2</sub>O<sub>5</sub> and 100 kg K<sub>2</sub>O per ha. Further increase reduced the yield.

Munshi *et al.* (1985) studied the effect of fertilizer levels on alkaloid content of *Catharanthus roseus* and reported that the dry matter of the plant increased with the increasing levels of fertilizers and was found to be maximum at 40:20:20 kg NPK per ha.

Prasad and Rao (1986) noticed that application of 75 kg N, 50 kg P<sub>2</sub>O<sub>5</sub> and 75 kg K<sub>2</sub>O per ha recorded significantly superior tuber yield of sweet potato over 50 kg N, 25 kg P<sub>2</sub>O<sub>5</sub> and 50 kg K<sub>2</sub>O per ha.

A study on the effect of major nutrients on the growth and tuber yield of *Coleus* revealed that combination of 40 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 50 kg K<sub>2</sub>O was found to be optimum for

maximum fresh (33.12 t/ha) and dry (3.982 t/ha) tuber yield. Further, increase in levels of NPK over this combination decreased the tuber yield (Veeraraghavathatham *et al.*, 1988).

Singh and Neopanay (1993) reported that NPK fertilizers applied to ginger at the rate of 150:80:60 kg per ha produced higher plant height, maximum number of leaves, tillers, higher length and breadth of rhizomes and higher yield.

There were significantly more number of tillers, leaves, higher dry matter production, yield components and fresh rhizome yield of turmeric at 150:125:150 and 200:175:300 NPK kg per ha over control (Venkatesh, 1994).

## 2.2 EXPERIMENT-II : EFFECT OF GROWTH REGULATORS ON GROWTH AND YIELD OF COLEUS

### 2.2.1 Effect of TIBA on growth and yield

Dastur and Prakash (1957) reported that there was decrease in plant height, internodal length and increased number of nodes and number of flowers due to application of TIBA in groundnut. Bhat *et al.* (1989) conducted an investigation to test the effects of GA<sub>3</sub>, CCC and TIBA on growth and yield in *Davana* which revealed that plant height, number of branches, plant spread and yield was significantly less by TIBA @ 400 ppm.

Thimmegowda *et al.* (1979) reported that foliar application of 10 to 20 ppm of TIBA increased the tuber weight and tuber yield in potato. Wurr (1976) confirmed that application of TIBA at the time of tuber initiation increased the yield of medium size (2.5-3.5cm) tubers up to 20 per cent but had no significant effect on total tuber yield. He concluded that TIBA helped in the proper distribution of photosynthates between tubers rather than increase in the total number of tubers. Shivkumar *et al.* (1994) observed that application of 'N' and foliar spray of TIBA has significantly increased the seed yield in sunflower.

Bhaskar *et al.* (1997) studied the influence of growth regulators such as TIBA and kinetin in 3 concentrations viz., 25, 50 and 100 ppm and 50, 100 and 200 ppm respectively on production and regeneration capacity of patchouli cultivator IIHR PP-1. They noted maximum fresh herbage yield of 3.23 t/ha in the first harvest with the application of TIBA at 100 ppm.

### 2.2.2 Effect of cycocel on growth and yield

Dyson and Humpshries (1966) reported that reduction in plant height, tuber weight and yield of potato plants by late application of CCC. Further CCC @ 500 ppm also decreased the plant height and internodal length in cv. Jaerla (Sharfuddin and Islam, 1977). Similar results were obtained in cv. Kerpondy @ 1000 ppm CCC by El-Ebed *et al.* (1980).

Fisher (1974) reported that 0.35 per cent CCC application at the bud formation stage increased tuber yield. Sharma and Kumar (2003) reported that CCC promoted maximum rooting in *Plumbago Zeylanica*.

According to Ezizondo and Martinez (1977) reported that total tuber yield without treatment was 30.79 t per ha, whereas CCC spray at 55 DAP yielded 40.79 t per ha. There was significantly higher yield (31.0 t/ha) than untreated control (28.0 t/ha) when spraying with CCC (125, 250, and 375 ml/ha) at 50 and 75 DAP in potato (Pandita and Hooda, 1979).

Waering (1982) reported that both growth regulators and growth retardants have been profitably employed favourably to influence the growth, yield and quality of potato. Sychora *et al.* (1975) observed that seed tuber treatment with cycocel reduced the height of potato plants. The plant height with cycocel (2500 ppm) was 26.85 cm while that of control was 27.85 cm. Choudhary *et al.* (1976) reported that number of branches, number of compound leaves and number of tubers per plant was increased but plant height was decreased by seed treatment of cycocel in potato crop. Higher number of leaves was recorded in treatment receiving 2500 ppm of cycocel in seed tuber treatment while lowest number of leaves was in control.

Govindakrishnan and Sahota (1984) at Shillong found a reduction of plant height in potato with cycocel spray but the difference between treated and untreated ones was found

non-significant. But Arora *et al.* (1988) found significant reduction in plant height of potato as compared to control by spraying with cycocel 250 ppm at 40 and 55 days after sowing. Banerjee and Das (1984) observed the reduced plant height in banana with the treatment of 1500 ppm cycocel as compared to control. Mannikeri (1996) studied the effect of CCC @ 2000 ppm reduced the plant height and increased the number of leaves and tillers, leaf area, rhizome yield due to significant improvement in number of primary, secondary and tertiary fingers and their size. He further noticed that the cured rhizome yield, curing percentage and harvest index were significantly higher with CCC in turmeric.

Shadeque and Pandita (1982) observed increased proportion of large sized tubers when crop was sprayed with CCC @ 500 ppm at 50 DAP in potato. Application of growth retardants recorded significant differences with respect to weight of tubers as compared to control and the higher tuber weight (668.59 g) per plant and maximum yield of 27.17 t per ha tubers was recorded with the spray of CCC @ 1000 ppm in potato (Gasti, 1994).

Mohan Das and Sampath (1985) made studies on the regulation of growth and yield of geranium with some hormonal sprays, where in height of the plant was much influenced by GA<sub>3</sub> and Alar sprays, significantly higher plant height was noted under GA<sub>3</sub> @ 250 ppm as compared to control. At concentrations of ethanol and CCC (400 ppm each) shortened it as against control. The foliage yield in general increased with CCC @ 1000 ppm.

Exogenous application of plant growth regulators are known to influence the growth, productivity and quality of several horticultural crops (Rao *et al.*, 1989). In root vegetables, treatment with growth regulators are known to hasten the tuberization and yield of underground storage organs and encouraging results were reported in commercial vegetables *viz.*, tapioca (Muthukrishnan *et al.*, 1947); potato (Baijal *et al.*, 1983) and onion (Singh *et al.*, 1983).

Ganiger (1992) reported that significant reduction in both fresh and dry leaf weight of potato with CCC application compared to control. There was a reduction of tuber bulking rate when concentration of cycocel increased from 500 to 1000 ppm and above (Haumadi, 1987).

Madalgeri (1996) reported that decrease in leaf area with growth retardants as compared to control in true potato seed variety HPS-1/13 and harvest index (24.1%) by spraying with growth retardants like cycocel, TIBA and mepiquat chloride against unsprayed control. Pirmowicz and Sangin (1978) also found that cycocel @ 500 ppm and 1000 ppm significantly increased the total tuber yield in potato either by foliar application or by tuber treatment. Phogat and Singh (1987) observed significant improvement in growth and length of rhizome, width of rhizome, number of rhizome bits per rhizome and rhizome yield of ginger with the treatment of cycocel @ 250 ppm and the per cent increase was to the tune of 18.79 per cent. Application of 400 ppm cycocel in turmeric leads to highest dry matter accumulation and showed significantly increased harvest index of turmeric (Satheesan and Ramadhasam, 1988).

Mandal *et al.* (1997) observed significant increase in number of branches per plant due to the application of CCC @ 1000 ppm in Greengram. Reddy and Patil (1981) showed that application of 1000-2000 ppm CCC to irrigated groundnut at 60 DAS recorded significantly decreased plant height. Kulkarni *et al.* (1995) indicated that application of CCC reduced the plant height in Sunflower. Wasnik and Bagga (1992) noticed that application of CCC @ 500 ppm has led higher seed yield in green gram.

Krishnamoorthy and Madalgeri (2000) noticed that application of GA<sub>3</sub> @ 300 ppm in ajowan increased the plant height and recorded maximum number of secondary branches and tertiary branches followed by CCC.

Praveen Prakash *et al.* (2001) indicated that decreased leaf area and plant height in potato but yield parameters was found highest with the application of CCC. And the highest tuber yield was recorded in cycocel @ 1000 ppm CCC (500 ppm). Bhat *et al.* (1989) conducted an investigation to test the effect of GA<sub>3</sub>, CCC and TIBA on growth, yield and essential oil content in *Davana* and results revealed that plant treated with CCC @ 4000 ppm showed suppressed plant height, number of branches, plant spread and fresh and dry weight of herbage.

### 2.2.3 Effect of Mepiquat chloride on growth and yield

Mepiquat chloride is a plant growth regulator which has been found to suppress vegetative growth in cotton (York, 1983). Mulder (1981) reported that spraying of mepiquat chloride (50, 75, 150 or 50 to 120 g a.i./ha) at early reproductive stage reduced the plant height slightly at all concentrations in potato. Canor and Pardo (1983) reported that mepiquat chloride (1 l/ha) reduced the plant height by 13 cm at flowering stage in cotton.

Ganiger (1992) reported that significant reduction in plant height of potato with mepiquat chloride treatment (100-150 ppm) and increased in number of leaves per plant, leaf area, leaf area index and chlorophyll content of potato leaves. Similarly Mepiquat chloride @ 250 ppm resulted highest number of tubers per plant when it was applied at 45 days after planting. Mepiquat chloride at 175 ppm recorded significantly higher number of tubers per hill (11.45) while the lower number (7.76) was in untreated control (Gasti, 1994).

Further Hassan *et al.* (1989) observed that Mepiquat chloride @ 250 ppm resulted in highest number of large, medium and small sized tubers of potato per plant when applied at 45, 66 and 87 DAP. Mepiquat chloride at the concentration of 600 ppm when sprayed at 30 DAT reduced the small tuber yield by 26.5 per cent and improved the medium and large tuber yield by 33.3 and 147.8 per cent, respectively as compared to unsprayed control check in TPS genotype HPS-1/13 (Madalgeri, 1996).

### III. MATERIAL AND METHODS

The detailed account of the material used and methods adopted in the study of "Influence of organic manures and growth regulators on growth and yield of *Coleus forskohlii* Briq.) was conducted during 2004-05 at Saidapur Farm, Medicinal and Aromatic Plant Unit, University of Agricultural Sciences, Dharwad are presented in this chapter.

#### 3.1 GEOGRAPHICAL LOCATION OF THE EXPERIMENTAL SITE

Dharwad is situated in Northern transitional zone (zone-8) with latitude 15°25' North latitude, 76°07' East longitude and at an altitude of 678 m above mean sea level.

#### 3.2 CLIMATE

Dharwad has the benefit of both south-west and north-east monsoons. The rainfall is confined to the monsoon period from May to November with an occasional showers in pre-monsoon months of April and May. During the period of experimentation, the total rainfall received were 352.7 mm during growth regulators experimentation (July-December, 2004-05) and 115.6 mm during the period of November to April, 2004-05 (organic manures experimentation).

The highest rainfall was received in August (117.9 mm) during plant growth regulators experimentation and in March (40.6 mm) during organic manures experimentation. The mean maximum temperature during the period of growth regulator experimentation ranged between 26.6°C (August) to 30.7°C (October) and 30.2°C (December) to 36.3°C (April) during organic manures experimentation. The minimum temperature during the said period of experimentation ranged between 14.4°C (December) to 21.3°C (July) during growth regulators experimentation and 14.4°C (December) to 21.3°C (April) during organic manures experimentation.

The mean relative humidity ranged between 47 per cent (December) to 82 per cent (August) during growth regulator experimentation and 47 per cent (December) to 53 per cent (April and March) during organic manures experimentation (Table 1).

#### 3.3 SOIL CHARACTERISTICS

The experimental site consisted of red sandy loam. The composite soil samples were collected from the experimental site before imposing the treatments and were analyzed for their physico-chemical properties which are furnished in Table 2.

Totally two experiments were conducted during the course of study.

- I. Effect of organic manures on growth and yield of *Coleus forskohlii* Briq.
- II. Effect of plant growth regulators on growth and yield of *Coleus forskohlii* Briq.

#### 3.4 EXPERIMENTAL DETAILS

##### 3.4.1 Experiment-I : Effect of organic manures on growth and yield of *Coleus forskohlii* Briq.

###### 3.4.1.1 Experimental material

Organic manures viz., FYM, vermicompost, poultry manure, sheep manure and press mud were provided by Department of Horticulture and Animal Husbandry, University of Agricultural Sciences, Dharwad and MK Hubli Sugar Factory. The inorganic fertilizers (RDF) used for experimentation was obtained from Department of Horticulture, University of Agricultural Sciences, Dharwad.

Table 1: Monthly meteorological data for experimental year 2004-05 of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

Month	Normal (67 years)		2004-05		2004-05	2004-05	
	Rainfall (mm)	No. of rainy days	Rainfall (mm)	No. of rainy days	Relative humidity (%)	Temperature (°C)	
						Max.	Min.
May - 2004	82.4	8	44.6	2	62	34.9	23.0
June- 2004	104.5	13	106.2	9	80	29.6	21.9
July- 2004	137.5	23	45.6	10	79	28.4	21.3
August- 2004	92.5	21	117.9	18	82	26.6	20.5
September- 2004	108.0	12	30.8	4	73	29.8	20.0
October- 2004	123.1	11	117.8	0	67	30.7	20.4
November- 2004	34.0	3	3.2	11	62	30.5	17.1
December- 2004	7.1	0.8	0	0	47	30.2	14.4
January - 2005	2.0	0	0	0	52	30.3	16.2
February – 2005	2.0	0	0	0	51	33.9	18.0
March – 2005	5.9	0.7	37.4	4	53	35.2	20.2
April- 2005	46.4	3	75.0	6	53	36.3	21.3
<b>Total</b>	<b>744.5</b>	<b>95.1</b>	<b>578.5</b>	<b>65</b>	-	-	-

**Table 2: Physical and chemical properties of the soil of the experiment site**

Particulars	Values (%)			Method employed
<b>Particle size analysis</b>				
Coarse sand (%)	29.84			International pipette method (Piper, 1966)
Fine sand (%)	9.54			
Silt (%)	42.96			
Clay (%)	17.63			
Soil texture	Loamy			
<b>Physical properties</b>				
	Depth (cm)			
	0-15	15-30	30-45	
Apparent specific gravity (mg/m <sup>3</sup> )	1.41	1.40	1.43	Core sampler method (Dastane, 1967)
Field capacity (%)	20.80	21.50	19.92	Field method (Dastane, 1967)
Permanent wilting percentage (%)	9.2	9.4	8.7	Pressure plate apparatus 15 bar
<b>Chemical properties</b>				
Available nitrogen (kg/ha)	220			Alkaline permanganate method (Subbaiah and Asija, 1956)
Available phosphorus (kg/ha)	21.5			Olsen's method (Jackson, 1967)
Available potassium (kg/ha)	232			Flame photometer method (Jackson, 1967)
Available sulphur (kg/ha)	19.5			Turbidimetric method (Tandon, 1993)
Organic carbon (%)	0.79			Wet oxidation method (Jackson, 1967)
pH (1:2.5)	6.93			Buckman's pH meter (Piper, 1966)
EC (ds/m)	0.65			Jackson (1973)

Table 2: Physical and chemical properties of the soil of the experiment site

## LEGEND

T1 – Control

T2 – Control check, RDF (40:60:50 Kg/ha)

T3 – FYM (30 t / ha)

T4 – Vermicompost (6 t / ha)

T5 – Sheep manure (6t / ha)

T6 – Poultry manure (2.281 t / ha)

T7 – Press mud (1.57 t / ha)

T8 – Vermicompost + PYM (1 : 10)

T9 – Vermicompost + Sheep manures (1 : 1)

T10 – Poultry manure + FYM (1 : 16.85)

T11 – Press mud + FYM (1 : 10.9)

T12 – Poultry manure + Vermicompost (1 : 3.37)

<b>R-I</b>	<b>R-II</b>	<b>R-III</b>
T4	T5	T10
T11	T1	T3
T8	T12	T6
T10	T2	T1
T9	T4	T5
T3	T10	T2
T6	T8	T11
T7	T9	T12
T5	T11	T8
T12	T6	T7
T2	T3	T4
T1	T7	T9

**Fig. 3.1: Plan of layout of the Experiment I**

Fig. 3.1 : Plan of layout of the Experiment I

### 3.4.1.2 Treatment exposure

The required quantity of organic manures as per the treatments scheduled was applied one week before transplanting and thoroughly incorporated into the soil. NPK fertilizers were applied as per the treatment schedule (for control check, RDF). Fifty per cent of nitrogen and entire quantity of phosphorous and potash were applied as basal dose at the time of transplanting. Remaining 50 per cent nitrogen was top dressed 30 days after transplanting.

### 3.4.1.3 Treatment details

Treatments	Manure/fertilizer schedule
T <sub>1</sub>	Control
T <sub>2</sub>	Control check, RDF (40:60:50 Kg/ha)
T <sub>3</sub>	FYM (30 t/ha)
T <sub>4</sub>	Vermicompost (6 t/ha)
T <sub>5</sub>	Sheep manure (6 t/ha)
T <sub>6</sub>	Poultry manure (2.281 t/ha)
T <sub>7</sub>	Press mud (1.57 t/ha)
T <sub>8</sub>	Vermicompost + FYM (1:10)
T <sub>9</sub>	Vermicompost + Sheep manure (1:1)
T <sub>10</sub>	Poultry manure + FYM (1:16.85)
T <sub>11</sub>	Press mud + FYM (1:10.9)
T <sub>12</sub>	Poultry manure + Vermicompost (1:3.37)

## 3.4.2 Experiment-II : Effect of plant growth regulators on growth and yield of *Coleus forskohlii*

### 3.4.2.1 Experimental material

The growth regulator viz., CCC, TIBA and mepiquat chloride were provided by Department of Horticulture and Department of Crop Physiology, University of Agricultural Sciences, Dharwad.

### 3.4.2.2 Treatment exposure

Application of growth regulators as per the treatment at two different concentrations were sprayed to the Coleus crop with the help of hand sprayer in the form of fine spray till the plants were wetted at the age of 60 days after plant growth.

### 3.4.2.3 Treatment details

Treatments	Growth regulators
T <sub>1</sub>	Control
T <sub>2</sub>	TIBA (25 ppm)
T <sub>3</sub>	TIBA (50 ppm)
T <sub>4</sub>	Cycocel (500 ppm)
T <sub>5</sub>	Cycocel (1000 ppm)
T <sub>6</sub>	Mepiquat chloride (500 ppm)
T <sub>7</sub>	Mepiquat chloride (1000 ppm)

## 3.4.3 Design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications and the plan of layout is presented in Fig. 1 and 2.

## 3.4.4 Plot size

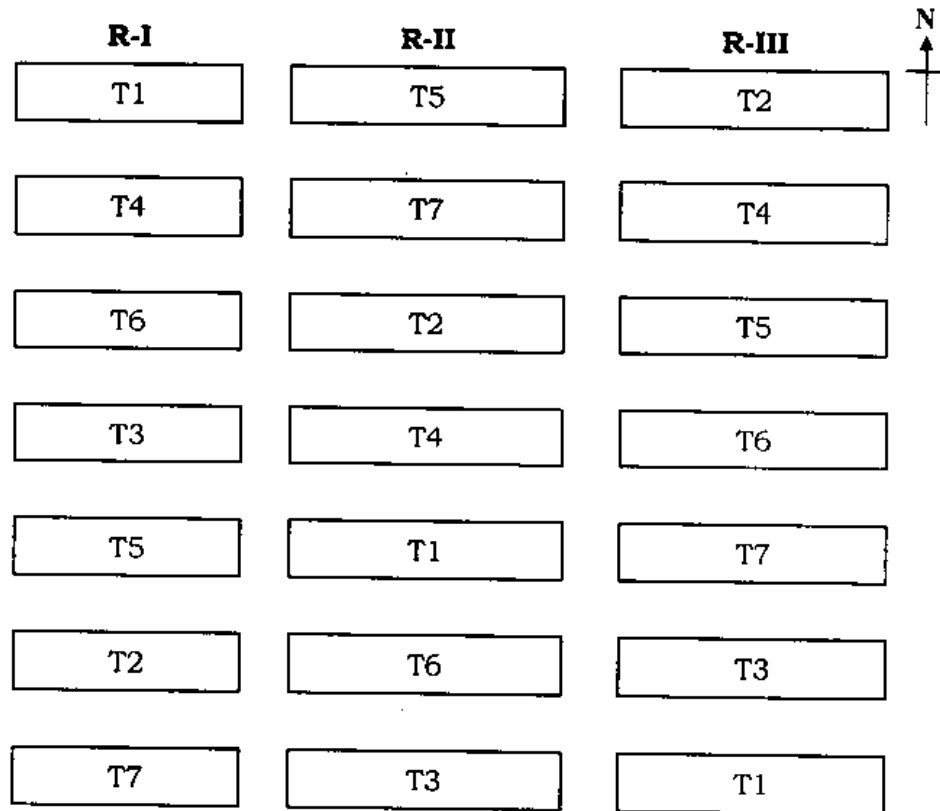
Gross - 3.6 x 2.4 m

Net - 3.0 x 2 m

Spacing : 60 cm × 30 cm

LEGEND

- T1 – Control
- T2 – TIBA (50 ppm)
- T3 – Tiba (100 ppm)
- T4 – Cycocel (500 ppm)
- T5 – Cycocel (1000 ppm)
- T6 – Mepiquat chloride (500 ppm)
- T7 – Mepiquat chloride (1000 ppm)



**Fig. 3.2: Plan of layout of the Experiment II**

Fig. 3.2 : Plan of layout of the Experiment II



**Plate-1. General view of the experiment on organic manures during 2004-05 (Coleus var. K-8)**



**Plate-2. General view of the experiment on growth regulators during 2004-05 (Coleus var. K-8)**

Plate – 1. General view of the experiment on organic manures during 2004-05  
(Coleus var. K – 8)

Plate. 2. General view of the experiment on growth regulators during 2004-05  
(Coleus var. K-8)

### 3.5 NURSERY

The unrooted cuttings from terminal portion of the accession k-8 were planted in polythene bags filled with 1:1 mixture of well decomposed farm yard manure (FYM) and red soil. Cuttings were dipped in 500 ppm Indole butyric acid before planting in polythene bags. They were later shifted to mist house and kept for a span of one month and then transplanted in the main field after perfect rooting.

### 3.6 CULTURAL OPERATIONS

The land was ploughed by using iron plough and later by tractor drawn cultivator to get fine tilth and to facilitate easy removal of weeds and those weeds were collected and burnt. The ridges and furrows were made in all the plots and drains were made for removal of excess water.

### 3.7 TRANSPLANTING

After 30 days in the nursery, the rooted cuttings were planted in the main field at a spacing of 60 × 30 cm in all plots. The polythene bags were removed without disturbing the root system and were planted in the main field with minimum damage to root system.

In the hills where plants failed to establish the root system and not grow normally were gap filled at 15 days after transplanting.

#### 3.7.1 Irrigation, weeding and plant protection

The plots were irrigated immediately after transplanting. At initial stage of crop growth the plots were irrigated once in three days and the irrigation frequency was reduced once in seven to ten days at later stages.

The experimental plots were kept free from weeds by hand weeding.

After 30 days of transplanting, the plants were applied with carbofuron granules @ 15 g/plant to control nematodes and drenched with vitavax @ 1 g/lit twice for the control of *Sclerotium*.

### 3.8 COLLECTION OF EXPERIMENTAL DATA

Observation on growth parameters

For recording various biometric observations, five plants were selected at random from each net plot and observations were recorded at 30, 60, 90, 120, DAT and at harvest.

#### 3.8.1 Plant height (cm)

The plant height (cm) was measured from bottom of the plant to the base of the newly opened leaves at the top.

#### 3.8.2 Number of leaves per plant

The number of fully opened leaves was counted from the randomly selected plants and the mean was worked out.

#### 3.8.3 Number of branches per plant

Total number of branches per plant were counted from each of the five randomly selected plants and the mean was worked out.

#### 3.8.4 Plant spread (North-South) and (East-West)

The maximum plant spread along the North-South and East-West directions was recorded and expressed in centimeter.

### 3.8.5 Leaf area (cm<sup>2</sup>)

The leaf area per plant was recorded from the five randomly selected plants. Leaf area was recorded by using disc method.

### 3.8.6 Yield parameters

#### 3.8.6.1 Number of tubers per plant

Total number of tuberous roots were counted from each of five selected plants and expressed as mean number of tuberous roots per plant.

#### 3.8.6.2 Length of tubers per plant (cm)

Length was measured (cm) from the base to tip of the tuberous roots from five plants and their mean length was calculated.

#### 3.8.6.3 Diameter of tubers (cm)

Diameter at the center of tuberous roots was measured (cm) with a thread and then stretched on the scale for tubers of five plants and mean was worked out.

#### 3.8.6.4 Volume of tubers (cc)

Volume of tubers was measured (cc) by using water displacement method for randomly selected five plants and mean was worked out.

#### 3.8.6.5 Fresh weight of tubers per plant (g/plant)

The fresh weight of the tuberous roots per plant and then weight was recorded by using a balance.

#### 3.8.6.6 Dry weight of tubers per plant (g/plant)

After taking fresh weight, the tuberous roots were sun dried and then dried in hot air over at 65-70°C till the constant weight was reached and later the mean dry weight per plant was recorded.

#### 3.8.6.7 Yield of tuber per hectare

The tuberous roots obtained from the plant were separated and dried. Their weight was recorded and calculated the tuber yield per hectare.

#### 3.8.6.8 Harvest Index

Harvest index was calculated as the ratio of the economic yield to the biological yield.

$$\text{H.I. (\%)} = \frac{\text{Economic yield}}{\text{Total biological yield}} \times 100$$

## IV. EXPERIMENTAL RESULTS

### EXPERIMENT-I: EFFECT OF ORGANIC MANURES ON GROWTH AND YIELD OF COLEUS

Results of experiments conducted during the year 2004-05 at Saidapur Farm, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad on "Influence of Organics and Growth regulators on growth and yield of Coleus (*Coleus forskohlii* Briq.) are presented here with.

#### 4.1 GROWTH PARAMETERS

The different growth parameters recorded at 30 days after transplanting were found non-significant except for number of leaves per plant.

##### 4.1.1 Plant height (cm)

The data recorded on height of Coleus plant at different growth stages as influenced by different organic manures and their combination are presented in Table 3.

The data showed that in general, application of organic manures singly recorded higher plant height (51.28 – 59.84 cm) as compared to control at harvest. The highest (59.84 cm) plant height was observed with vermicompost, 6 t/ha as compared to lowest (51.28 cm) plant height with FYM, 30 t/ha. The plant height with pressmud, 1.57 t/ha (55.69 cm), poultry manure, 2.281 t/ha (55.38 cm), sheep manure, 6 t/ha (53.24 cm) were on par with superior treatment vermicompost, 6 t/ha.

The study showed significant differences on plant height with respect to application of organic manures in combination treatment schedule. The plant height noted among different combination of manures were observed to be in the range of 61.44 – 75.74 cm at the end of experimentation. The treatment poultry manure + vermicompost, 1:3.37 registered highest (75.74 cm) values with regard to plant height and was on par with vermicompost + sheep manure, 1:1 (69.80 cm) as against lowest (61.44 cm) values observed in pressmud + FYM, 1:10.9.

The plant height in control check, RDF (72.78 cm) was significantly higher as compared to control (35.24 cm). It was observed that the plant height was linearly increased with the age of the crop in all the treatments.

##### 4.1.2 Number of leaves per plant

The influence of different organic manures and their combination schedule on number of leaves per plant in Coleus at different growth stages are shown in Table 4.

The perusal of data exhibited significantly higher number of leaves per plant with sole application of organic manures as compared to control at the end of 120 DAT. The number of leaves per plant was observed to be in the range of 308.66–425.93. With respect to application of organic manures singly, the highest (425.93) number of leaves per plant was observed with vermicompost, 6 t/ha as compared to lowest (308.66) number of leaves per plant in FYM, 30 t/ha. The number of leaves per plant observed with pressmud, 1.57 t/ha (371.53) was next in the order in sole application of organic manures.

The perusal of mean data indicated significant differences among different combination treatments at the end of 120 DAT. The number of leaves per plant was observed to be in the range of 373.46 – 467.06. It was observed that highest (467.06) number of leaves per plant was recorded with poultry manure + vermicompost, 1:3.37 and it was on par with vermicompost + sheep manure, 1:1 (442.33). The lowest (373.46) number of leaves per plant was recorded with pressmud + FYM, 1:10.9.

However, significant effect of control check, RDF (439.66) was observed over control (223.06). Control check, RDF and poultry manure + vermicompost, 1:3.37 were at par with each other at all stages of crop growth.

Table 3. Influence of organic manures and their combinations on plant height (cm) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	25.34	28.22	30.62	32.87	35.24
2	Control check, RDF	27.25	44.13	51.68	60.06	72.78
3	FYM, 30 t/ha	24.15	37.82	45.10	46.65	51.28
4	Vermicompost, 6 t/ha	22.36	41.72	48.23	53.65	59.84
5	Sheep manure, 6 t/ha	21.21	39.51	45.48	48.89	53.24
6	Poultry manure, 2.281 t/ha	24.10	37.93	46.17	49.97	55.38
7	Pressmud, 1.57 t/ha	23.86	39.81	47.04	50.30	55.69
8	Vermicompost + FYM, 1:10	22.12	41.49	49.58	54.20	67.74
9	Vermicompost + Sheep manure, 1:1	24.12	42.35	49.81	55.11	69.80
10	Poultry manure + FYM, 1:16.85	22.86	40.51	47.45	50.70	62.12
11	Pressmud + FYM, 1:10.9	21.93	40.93	47.04	50.32	61.44
12	Poultry manure + Vermicompost, 1:3.37	24.11	44.08	53.04	66.29	75.74
SEm ±		1.378	1.543	2.913	2.104	2.542
CD at 5%		NS	4.524	8.540	6.170	7.450

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

DAT – Days after transplanting

Table 4. Influence of organic manures and their combinations on number of leaves per plant at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	27.80	146.40	218.26	223.06	144.86
2	Control check, RDF	32.20	216.13	418.93	439.66	244.53
3	FYM, 30 t/ha	34.20	179.53	330.93	308.66	239.86
4	Vermicompost, 6 t/ha	38.66	195.80	377.46	425.93	254.46
5	Sheep manure, 6 t/ha	30.46	183.20	342.53	312.73	244.93
6	Poultry manure, 2.281 t/ha	28.40	180.3	342.53	326.53	246.13
7	Pressmud, 1.57 t/ha	29.33	188.46	343.13	371.53	246.20
8	Vermicompost + FYM, 1:10	28.26	199.53	388.26	426.20	255.86
9	Vermicompost + Sheep manure, 1:1	30.33	209.83	395.66	442.33	261.46
10	Poultry manure + FYM, 1:16.85	30.76	195.80	349.86	398.73	247.30
11	Pressmud + FYM, 1:10.9	30.46	190.80	349.86	373.46	247.30
12	Poultry manure + Vermicompost, 1:3.37	28.83	210.00	406.40	467.06	270.93
SEm ±		1.756	5.594	12.457	10.896	10.519
CD at 5%		5.151	16.404	36.552	31.952	30.846

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

DAT – Days after transplanting

Table 5. Influence of organic manures and their combinations on number of branches per plant at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	11.96	23.06	32.63	42.20	43.53
2	Control check, RDF	13.26	36.90	67.70	81.10	82.10
3	FYM, 30 t/ha	13.23	27.90	40.30	64.50	64.20
4	Vermicompost, 6 t/ha	12.90	33.70	56.30	83.36	87.23
5	Sheep manure, 6 t/ha	12.46	28.60	42.56	72.70	73.10
6	Poultry manure, 2.281 t/ha	13.10	29.30	44.36	74.00	74.90
7	Pressmud, 1.57 t/ha	12.80	32.30	52.13	76.70	77.20
8	Vermicompost + FYM, 1:10	11.43	37.80	58.20	87.40	88.80
9	Vermicompost + Sheep manure, 1:1	12.10	36.60	60.20	88.73	91.80
10	Poultry manure + FYM, 1:16.85	12.03	35.40	54.00	87.3	83.10
11	Pressmud + FYM, 1:10.9	10.0	32.90	51.56	79.30	80.50
12	Poultry manure + Vermicompost, 1:3.37	11.767	39.60	64.30	91.40	92.50
SEm ±		0.832	1.195	2.124	2.729	2.605
CD at 5%		NS	3.504	6.230	8.004	7.640

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

DAT – Days after transplanting

#### 4.1.3 Number of branches per plant

The data pertaining to number of branches per plant of Coleus in relation to different organic manures and their combination schedule are presented in Table 5.

The application of organic manures singly showed significantly higher number of branches per plant (64.20 – 87.23) at harvest as compared to control. The highest (87.23) number of branches per plant was recorded with vermicompost, 6 t/ha followed by pressmud, 1.57 t/ha (77.20) and poultry manure, 2.281 t/ha (74.90) as against lowest (64.20) number of branches per plant with FYM, 30 t/ha.

The data on the effect of organic manures in combination treatments showed significantly higher (80.50 – 92.50) number of branches per plant as compared to control. The highest (92.50) number of branches was observed with poultry manure + vermicompost, 1:3.37 as compared to lowest (80.50) number of branches per plant with pressmud + FYM, 1:10.9. The number of branches per plant recorded with vermicompost + FYM, 1:10 (88.80) and vermicompost + sheep manure, 1:1 (91.80) were on par with treatment poultry manure + vermicompost, 1:3.37 being the highest.

The number of branches in control check, RDF (82.10) was significantly higher as compared to control (43.53). It was observed that number of branches per plant was increased with the age of the crop in all the treatments.

#### 4.1.4 Plant spread North-South (cm)

The results regarding the plant spread in North-South direction as influenced by different organic manures and their combination schedule at different growth stages of Coleus are presented in Table 6.

The data showed that application of organic manures singly recorded significantly higher plant spread at the end of experimentation and was found in the range 54.16 – 65.94 cm. The highest (65.94 cm) plant spread was observed with vermicompost, 6 t/ha as compared to lowest 54.16 cm plant spread with FYM, 30 t/ha. The plant spread with pressmud, 1.57 t/ha (55.80 cm) and poultry manure, 2.281 t/ha (55.00 cm) were next in the order.

Among organic manures in combination treatments the data showed significantly higher plant spread and was found in the range of 65.20 – 68.10 cm as compared to control. The highest (68.10 cm) plant spread was observed with poultry manure + vermicompost, 1:3.37 and vermicompost + sheep manure, 1:1 (68.10 cm) followed by vermicompost + FYM, 1:10 (68.10 cm) as compared to lowest (65.20 cm) with pressmud + FYM, 1:10.9 at the end of experimentation. At 120 DAT, the highest (67.53 cm) plant spread was noticed with treatment vermicompost + sheep manure, 1:1.

Significant difference was observed with respect to plant spread between control check, RDF (67.60 cm) and control (34.30 cm).

#### 4.1.5 Plant spread East-West (cm)

The results obtained regarding the plant spread in East-West direction as influenced by various organic manures and their combination schedule at different growth stages are presented in Table 7.

The data on plant spread showed that in general, sole application of organic manures recorded significantly higher plant spread and was found to be in the range of 65.86 – 75.70 cm as compared to control at harvest. The highest (75.70 cm) plant spread was recorded with vermicompost, 6 t/ha as against lowest (65.86 cm) plant spread with application of FYM, 30 t/ha. The plant spread observed with pressmud, 1.57 t/ha (73.10 cm) was on par with vermicompost, 6 t/ha.

With respect to organic manures in combination treatments, the plant spread varied significantly over control and was in the range of 73.00 – 78.00 cm. The highest (78.00 cm)

Table 6. Influence of organic manures and their combinations on plant spread-East-South direction (cm) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	17.10	24.23	28.80	33.10	34.30
2	Control check, RDF	18.93	37.46	54.10	66.90	67.60
3	FYM, 30 t/ha	17.20	33.80	48.60	54.10	54.16
4	Vermicompost, 6 t/ha	18.73	36.90	52.50	65.94	65.94
5	Sheep manure, 6 t/ha	17.80	34.00	48.80	54.40	54.40
6	Poultry manure, 2.281 t/ha	18.06	34.90	48.90	55.00	55.00
7	Pressmud, 1.57 t/ha	17.60	34.90	50.50	55.80	55.80
8	Vermicompost + FYM, 1:10	18.567	36.13	52.50	66.10	68.10
9	Vermicompost + Sheep manure, 1:1	18.167	37.30	52.60	67.53	68.10
10	Poultry manure + FYM, 1:16.85	17.967	36.10	52.50	65.20	67.83
11	Pressmud + FYM, 1:10.9	17.967	35.50	51.70	60.10	65.20
12	Poultry manure + Vermicompost, 1:3.37	18.867	37.30	54.60	67.10	68.10
SEm ±		0.442	1.207	1.846	1.807	1.739
CD at 5%		NS	3.539	5.412	5.299	5.100

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

DAT – Days after transplanting

Table 7. Influence of organic manures and their combinations on plant spread-East-West direction (cm) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	18.16	28.53	34.66	38.86	39.20
2	Control check, RDF	19.16	48.06	62.46	79.73	79.76
3	FYM, 30 t/ha	18.33	38.70	56.53	62.10	65.86
4	Vermicompost, 6 t/ha	18.43	42.50	59.33	72.43	75.70
5	Sheep manure, 6 t/ha	18.13	40.26	57.86	63.50	66.70
6	Poultry manure, 2.281 t/ha	18.56	41.53	58.16	64.46	68.20
7	Pressmud, 1.57 t/ha	18.43	44.50	61.56	74.06	73.10
8	Vermicompost + FYM, 1:10	18.10	41.83	58.53	66.43	74.00
9	Vermicompost + Sheep manure, 1:1	18.66	42.53	61.167	72.80	74.40
10	Poultry manure + FYM, 1:16.85	18.96	42.36	58.43	71.06	74.10
11	Pressmud + FYM, 1:10.9	18.50	42.40	58.60	70.36	73.00
12	Poultry manure + Vermicompost, 1:3.37	19.0	45.80	61.86	77.53	78.00
SEm ±		0.593	1.211	1.740	2.145	2.35
CD at 5%		NS	3.551	5.103	6.290	6.896

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

DAT – Days after transplanting

plant spread was recorded with poultry manure + vermicompost, 1:3.37 as against lowest (73.00 cm) plant spread with pressmud + FYM, 1:10.9.

Significant effect was observed between control check, RDF (79.76 cm) and control (39.20 cm). Poultry manure + vermicompost, 1:3.37 and control check, RDF were on par with each other at all stages of growth.

#### 4.1.6 Leaf area (cm<sup>2</sup>)

The data with respect to leaf area as influenced by organic manures and their combination schedule at different growth stages of Coleus are presented in Table 8.

The data on organic manures applied singly exhibited significantly higher leaf area and was found to be in the range of 5407.70 – 6608.70 cm<sup>2</sup> as compared to control at 120 DAT. The highest (6608.70 cm<sup>2</sup>) leaf area was observed with vermicompost, 6 t/ha as compared to lowest (5407.70 cm<sup>2</sup>) leaf area with treatment FYM, 30 t/ha. The leaf area 6172.30 cm<sup>2</sup> and 6172.30 cm<sup>2</sup> recorded with organic manure pressmud, 1.57 t/ha and poultry manure 2.281 t/ha, respectively were on par with highest leaf area treatment vermicompost, 6 t/ha.

With respect to organic manures applied in combination, the leaf area was ranged from 6314.83 – 7689.06 cm<sup>2</sup> as compared to control. The highest (7689.06 cm<sup>2</sup>) leaf area was observed with treatment poultry manure + vermicompost, 1:3.37 followed by vermicompost + sheep manure 1:1 (6979.30 cm<sup>2</sup>) which was next in the order as compared to lowest (6314.83 cm<sup>2</sup>) leaf area with pressmud + FYM, 1:10.9.

The differences with respect to leaf area observed between control (3780.50 cm<sup>2</sup>) and control check, RDF (7498.00 cm<sup>2</sup>) was found significant. It was observed that at harvest leaf area was reduced ridiculously due to defoliation of leaves.

#### 4.1.7 Yield parameters

##### 4.1.7.1 Number of tubers per plant

The data recorded on number of tubers per plant in relation to organic manures and their combination schedule are furnished in Table 9.

The data revealed that the organic manures applied singly recorded significantly higher (15.26 – 21.02) number of tubers per plant as compared to control. The highest number (21.02) of tubers per plant was observed with vermicompost, 6 t/ha as compared to lowest (15.26) number of tubers per plant with FYM, 30 t/ha. The number of tubers (19.82) developed with application of pressmud, 1.57 t/ha was on par with superior treatment applied with vermicompost, 6 t/ha.

It was observed that the organic manures applied in combination generally influenced the number of tubers (21.14-24.70) which differed significantly over control. The highest (24.70) number of tubers per plant were observed with treatment poultry manure + vermicompost, 1:3.37 as against lowest (21.14) number of tubers per plant with pressmud + FYM, 1:10.9. The number of tubers (24.39; 24.65; 22.14) per plant developed with application of vermicompost + FYM, 1:10, vermicompost + sheep manure, 1:1 and poultry manure + FYM, 1:16.85, respectively were found on par with superior treatment poultry manure + vermicompost, 1:3.37 .

Among the treatments control check, RDF (25.35) and control (13.00) the effect was found significant. Control check, RDF was on par with all treatments where organic manures applied in combination except with pressmud + FYM, 1:10.9.

##### 4.1.7.2 Length of tubers (cm)

The data with respect to length of tubers as influenced by different organic manures and their combination schedule at different growth stages of Coleus during experimentation are shown in the Table 9.

Table 8. Influence of organic manures and their combinations on leaf area (cm<sup>2</sup>) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	425.66	1864.73	2426.73	3780.53	1647.43
2	Control check, RDF	427.73	3325.26	6805.10	7498.00	3139.46
3	FYM, 30 t/ha	422.93	2162.40	4658.13	5407.70	2022.43
4	Vermicompost, 6 t/ha	427.26	2801.50	5587.20	6608.70	2929.53
5	Sheep manure, 6 t/ha	427.13	2238.86	4758.36	5849.60	2925.63
6	Poultry manure, 2.281 t/ha	433.50	2257.70	4933.86	6172.30	2910.76
7	Pressmud, 1.57 t/ha	430.56	2419.50	5434.83	6172.30	2923.56
8	Vermicompost + FYM, 1:10	418.53	2844.80	6113.26	6675.66	3154.36
9	Vermicompost + Sheep manure, 1:1	424.96	3030.16	6328.56	6979.30	3074.96
10	Poultry manure + FYM, 1:16.85	427.16	2823.73	5514.06	6539.06	3014.80
11	Pressmud + FYM, 1:10.9	429.53	2509.93	5435.20	6314.83	2979.76
12	Poultry manure + Vermicompost, 1:3.37	425.93	30.67.93	6256.56	7689.06	3274.76
SEm ±		3.257	85.612	165.666	191.180	257.152
CD at 5%		NS	251.064	485.829	560.650	754.117

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

DAT – Days after transplanting

Table 9: Influence of organic manures and their combinations on yield, yield parameters and harvest index at different stages of plant growth

Sl. No.	Treatment	No. of tubers per plant	Length of tuber (cm)	Diameter of tuber (cm)	Volume of tuber (cc)	Fresh weight of tubers (gm/plant)	Dry weight of tubers (gm/plant)	Yield of tuber (t/ha)	Harvest index (%)
1	Control	13.00	13.21	1.167	114.76	107.61	18.58	1.33	25.1
2	Control check, RDF	25.35	28.78	1.653	228.76	241.46	43.14	3.34	33.0
3	FYM, 30 t/ha	15.26	15.10	1.297	171.20	147.53	27.70	2.41	25.0
4	Vermicompost, 6 t/ha	21.02	18.72	1.597	199.43	179.27	38.41	2.70	27.0
5	Sheep manure, 6 t/ha	16.62	15.70	1.433	177.13	154.37	32.56	2.43	26.0
6	Poultry manure, 2.281 t/ha	17.64	17.50	1.527	185.96	161.54	32.81	2.44	26.7
7	Pressmud, 1.57 t/ha	19.82	18.60	1.560	198.50	167.66	35.68	2.68	26.7
8	Vermicompost + FYM, 1:10	24.39	22.88	1.617	206.56	229.78	40.29	3.14	31.7
9	Vermicompost + Sheep manure, 1:1	24.65	23.78	1.633	223.66	229.88	42.23	3.29	29.0
10	Poultry manure + FYM, 1:16.85	22.14	21.98	1.693	203.46	223.52	39.84	3.05	28.0
11	Pressmud + FYM, 1:10.9	21.14	20.27	1.597	203.33	179.27	39.65	3.04	28.0
12	Poultry manure + Vermicompost, 1:3.37	24.70	25.05	1.850	242.03	247.44	45.03	3.44	33.2
	SEm ±	1.170	0.723	0.47	6.64	3.967	1.24	0.106	1.2
	CD at 5%	3.432	2.121	0.138	19.50	11.633	3.66	0.309	3.4

RDF – Recommended dose of fertilizer (40:60:50 kg/ha)

NS – non-significant

The data on effect of organic manures applied singly exhibited significantly higher tubers length and was found to be in the range of 15.10-18.72 cm as compared to control at harvest. The maximum (18.72 cm) length of tubers was found with vermicompost, 6 t/ha as compared to minimum (15.10 cm) length of tubers recorded with FYM, 30 t/ha. The length of tubers (18.60; 17.50 cm) recorded with pressmud, 1.57 t/ha and poultry manure, 2.281 t/ha were on par with superior treatment vermicompost, 6 t/ha.

With respect to organic manures in combination treatment schedule, the length of tubers recorded was significant and was in the range of 20.27-25.05 cm as compared to control. The maximum (25.05 cm) length of tubers was observed with treatment poultry manure + vermicompost, 1:3.37 followed by vermicompost + sheep manure, 1:1 (23.78 cm) as compared to minimum (20.27 cm) with pressmud + FYM, 1:10.9.

The differences observed with respect to length of tubers between control (13.21 cm) and control check, RDF (28.78 cm) were found significant and the control check, RDF was on par with superior treatment in combination treatments *i.e.*, poultry manure + vermicompost, 1:3.37 .

#### 4.1.7.3 Diameter of tubers (cm)

The data with respect to diameter of tubers as influenced by different organic manures and their combination schedule at different growth stages of Coleus during experimentation are shown in the Table 9.

The effect of application of organic manure singly showed significantly higher diameter (1.297 – 1.597 cm) of tubers as compared to control. The highest (1.597 cm) diameter of tubers was recorded with vermicompost, 6 t/ha as against lowest 1.297 cm with the application of FYM, 30 t/ha. The diameter of tubers (1.560 cm; 1.527 cm) observed with application of pressmud, 1.57 t/ha and poultry manure, 2.281 t/ha, respectively were on par with vermicompost, 6 t/ha.

The perusal of data showed that diameter of tubers differed significantly when crop was applied with different combination of organic manures during the study. The diameter of tubers was found to be in the range of 1.597 – 1.850 cm where in the highest (1.850 cm) diameter of tubers was noticed in vermicompost + poultry manure 1:3.37 , 6 t/ha followed by vermicompost + sheep manure, 1:1 (1.633 cm) compared to lowest (1.597 cm) diameter of tubers in pressmud + FYM, 1:10.9.

The Differences between control check, RDF (1.653 cm) and control (1.167 cm) were found to be significant for diameter of tubers.

#### 4.1.7.4 Volume of tubers (cc)

The data obtained regarding the volume of tubers as influenced by different organic manures and their combination schedules at different growth stages are furnished in Table 9.

The organic manures applied singly exhibited significantly higher volume of tubers and was found in the range of 171.20-199.43 cc as compared to control. The highest volume of tubers (199.20 cc) was recorded with vermicompost, 6 t/ha as compared to lowest (171.13 cc) with FYM, 30 t/ha. The volume of tubers 198.50 and 185.96 cc produced with application of pressmud, 1.57 t/ha and poultry manure, 2.281 t/ha respectively were on par with superior treatment vermicompost, 6 t/ha.

The volume of tubers with the application of different organic manures in combination treatments recorded significantly higher volume and was in the range of 203.33-242.03 cc as compared to control. The highest volume (242.03 cc) of tubers was observed with poultry manure + vermicompost, 1:3.37 and it was on par with vermicompost + sheep manure, 1:1 (223.66 cc) as against lowest (203.33 cc) volume of tubers with pressmud + FYM, 1:10.9.

Significant difference was observed with respect to volume of tubers between control check, RDF (228.76 cc) and control (114.76 cc).

#### 4.1.7.5 Fresh weight of tubers per plant (g)

The data obtained regarding the fresh weight of tubers as influenced by different organic manures and their combination schedules at different growth stages are furnished in Table 9.

The mean data on fresh weight of tubers per plant recorded under sole application of organic manure treatments was significantly higher (147.53-179.27 g) as compared to control. The highest (179.27 g) fresh weight of tubers was recorded with vermicompost, 6 t/ha as compared to lowest (147.53 g) fresh weight with FYM, 30 t/ha. The fresh weight of tubers (167.66 g) with pressmud, 1.57 t/ha was on par with superior treatment vermicompost, 6 t/ha.

With regard to combination treatments, the fresh weight of tubers per plant recorded significantly higher (179.27 – 247.44 g) fresh weight as compared to control. The maximum (247.44 g) fresh weight of tubers was observed to be with poultry manure + vermicompost, 1:3.37 as against 179.27 g with pressmud + FYM, 1:10.9. The fresh weight of tubers with vermicompost + sheep manure, 1:1 and vermicompost + FYM, 1:10 (229.88 and 229.78 g, respectively) which were next in the order.

Significant effect was observed with control check, RDF (241.46 g) as compared to control (107.61 g).

#### 4.1.7.6 Dry weight of tubers per plant (g)

The data with respect to dry weight of tubers as influenced by different organic manures and their combination schedule at different growth stages of Coleus during experimentation are shown in the Table 9.

The data on dry weight of tubers per plant recorded with application of organic manures singly was significantly higher (27.70-38.41 g) dry weight as compared to control. The highest (38.41 g) dry weight of tubers per plant was recorded with vermicompost, 6 t/ha followed by pressmud, 1.57 t/ha (35.68 g) as against lowest (27.70 g) dry weight with treatment FYM, 30 t/ha.

With regard to dry weight of tubers influenced by organic manures applied in combination recorded significantly higher (39.65-45.03 g) dry weight as compared to control. The maximum (45.03 g) dry weight of tubers was recorded in treatment vermicompost + poultry manure 1:3.37 as against lowest (39.65 g) dry weight with pressmud + FYM, 1:10.9.

The differences with respect to dry weight of tubers observed between control (18.58 g) and control check, RDF (43.14 g) was found significant.

#### 4.1.7.7 Yield of tubers (t/ha)

The data pertaining to yield of tubers of Coleus in relation to different organic manures and their combination schedule are presented in Table 9.

The mean data showed that the total yield of tubers as influenced by sole application of organic manures as compared to control was found to be in the range of 2.41-2.70t/ha. The highest (2.70 t/ha) yield of tubers was observed with vermicompost, 6 t/ha as compared to lowest (2.41 t/ha) yield of tubers with application of FYM, 30 t/ha.

With regard to organic manures applied in combination exhibited significantly higher (3.04-3.44 t/ha) yield of tubers as compared to control. The highest(3.44 t/ha) yield of tubers was recorded with poultry manure + vermicompost, 1:3.37 as compared to lowest (3.04 t/ha) yield of tubers with pressmud + FYM, 1:10.9. The yield of tubers (3.29; 3.14 t/ha) was observed with treatment vermicompost + sheep manure, 1:1 and vermicompost + FYM, 1:10, respectively were on par with superior treatment poultry manure + vermicompost, 1:3.37 .

Significant effect was observed with control check, RDF (3.34 t/ha) as compared to lowest (1.33 t/ha) yield of tubers with control.

#### 4.1.7.8 Harvest index

The data obtained regarding the harvest index as influenced by different organic manures and their combination schedules at different growth stages are furnished in Table 9.

It was observed that the sole application of organic manures influenced the harvest index (25.0-27.0 %) significantly over control. The highest (27.0 %) harvest index was observed with application of vermicompost, 6 t/ha as against lowest (25.0 %) harvest index with FYM, 30 t/ha.

With respect to organic manures applied in combination, the harvest index (28.0 – 33.2%) differed significantly as compared to control. The highest (33.2%) harvest index was observed with poultry manure + vermicompost, 1:3.37 as compared to lowest (28.0%) harvest index with pressmud + FYM, 1:10.9. The harvest index (31.7%) was observed with vermicompost + FYM, 1:10 was on par with superior treatment.

Among the control check, RDF (33.0%) and control (25.0%) the analysis of variance recorded the significant effect.

## EXPERIMENT–II : EFFECT OF PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF COLEUS

The different growth parameters recorded upto 60 days after transplanting were found non-significant.

### 4.2.1 Plant height (cm)

The data on the influence of different growth regulators on plant height of Coleus at different stages of plant growth are presented in Table 10.

The data showed that all the growth regulators namely TIBA, Cycocel (CCC) and Mepiquat Chloride reduced the plant height significantly as compared to control at harvest. The height of the plant was observed to be in the range of 57.33 – 49.43 cm as compared to control. The highest (57.33 cm) plant height was recorded with treatment TIBA, 500 ppm as compared to lowest (49.43 cm) with CCC, 1000 ppm. Significantly the higher plant height (58.30 cm) was found in control as compared to other growth regulator treatments.

### 4.2.2 Number of leaves per plant

The data on number of leaves per plant recorded in relation to growth regulators are presented in Table 11.

It was noted that all the growth regulators significantly increased the number of leaves as against the control at end of 120 DAT. The effect of growth regulators on number of leaves per plant was observed to be in the range of 350.30 – 411.30 as against then lowest in (326.86) control. The highest number of leaves (411.30) were registered with CCC, 1000 ppm as against lowest (350.30) with TIBA, 50 ppm. Significantly lower number of leaves per plant was observed with control (326.86) as compared to all other growth regulator treatments.

### 4.2.3 Number of branches per plant

The data on number of branches per plant effected by different growth regulators in Coleus are presented in Table 12.

The data indicated that all the growth regulators increased the number of branches per plant. The number of branches per plant was in the range of 68.73–85.93 as against 65.93 branches in control. The highest (85.93) number of branches per plant was recorded in CCC, 1000 ppm and was on par with (79.30 ; 77.43) with mepiquat chloride, 1000 ppm and CCC, 500 ppm as compared to lowest (68.73) number of branches per plant observed in treatment TIBA, 50 ppm. Control treatment recorded the lowest (65.93) number of branches per plant as compared to other growth regulator treatment and it was on par with TIBA, 50 ppm.

### 4.2.4 Plant spread North-South (cm)

The plant spread in North–South direction as influenced by different growth regulators at different stages of plant growth are furnished in Table 13.

Table 10. Influence of growth regulators on plant height (cm) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	20.20	42.80	53.71	57.13	58.30
2	TIBA, 25 ppm	20.36	43.10	48.90	52.44	57.33
3	TIBA, 50 ppm	20.16	42.63	49.21	50.82	54.30
4	CCC, 500 ppm	20.33	42.93	48.10	51.33	53.56
5	CCC, 1000 ppm	20.10	42.96	44.067	46.28	49.43
6	Mepiquat chloride, 500 ppm	20.26	44.26	49.23	52.58	54.18
7	Mepiquat chloride, 1000 ppm	20.33	42.13	47.87	47.98	52.50
SEm ±		0.094	1.457	1.470	1.667	1.934
CD at 5%		NS	NS	4.531	5.137	5.988

NS – Non-significant

DAT – Days after transplanting

Table 11. Influence of growth regulators on number of leaves per plant at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	61.40	207.96	299.63	326.86	186.03
2	TIBA, 25 ppm	61.33	209.66	314.20	350.30	192.60
3	TIBA, 50 ppm	61.53	212.60	326.16	367.13	201.43
4	CCC, 500 ppm	61.46	209.4	343.86	376.36	207.70
5	CCC, 1000 ppm	61.56	212.26	374.00	411.30	257.80
6	Mepiquat chloride, 500 ppm	61.46	210.30	335.10	365.10	206.23
7	Mepiquat chloride, 1000 ppm	61.33	209.05	353.26	397.43	216.96
SEm ±		0.757	1.737	9.978	11.211	7.282
CD at 5%		NS	NS	30.756	34.554	22.445

NS – Non-significant

DAT – Days after transplanting

**Table 12.** Influence of growth regulators on number of branches per plant at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	12.0	35.53	57.03	65.13	65.93
2	TIBA, 25 ppm	12.13	37.63	57.53	67.30	68.73
3	TIBA, 50 ppm	11.80	38.50	58.23	68.60	71.76
4	CCC, 500 ppm	12.16	37.23	60.061	75.46	77.43
5	CCC, 1000 ppm	12.00	38.06	72.23	84.93	85.93
6	Mepiquat chloride, 500 ppm	11.86	38.13	59.20	73.53	75.36
7	Mepiquat chloride, 1000 ppm	12.33	38.10	62.43	78.20	79.30
	SEm ±	0.232	0.882	2.927	3.050	3.236
	CD at 5%	NS	NS	9.027	9.021	9.976

NS – Non-significant

DAT – Days after transplanting

Table 13. Influence of growth regulators on plant spread-North-South directions (cm) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	18.76	34.40	37.30	39.96	41.06
2	TIBA, 25 ppm	18.66	35.60	38.63	40.90	42.33
3	TIBA, 50 ppm	18.73	34.73	38.80	42.43	42.90
4	CCC, 500 ppm	18.76	34.70	43.00	48.23	49.40
5	CCC, 1000 ppm	18.70	35.26	52.10	61.56	66.70
6	Mepiquat chloride, 500 ppm	18.46	35.36	42.60	46.80	48.63
7	Mepiquat chloride, 1000 ppm	18.76	35.76	45.26	55.60	49.86
SEm ±		0.222	0.684	2.595	2.198	2.228
CD at 5%		NS	NS	7.999	6.774	6.867

NS – Non-significant

DAT – Days after transplanting

It was noted that all the growth regulators increased the plant spread at harvest. The spread of the plant as influenced by different growth regulators was in the range of 42.33 – 66.70 cm as against the control (41.06 cm). The growth regulator CCC, 1000 ppm recorded the highest (66.70 cm) plant spread followed by plant spread with mepiquat chloride, 1000 ppm (49.86 cm) and CCC, 500 ppm (49.40 cm) as compared to lowest plant spread with TIBA, 50 ppm (42.33).

Significantly lowest (41.06 cm) plant spread was recorded with control as compared to plants treated with different growth regulators and was on par with TIBA, 50 ppm and TIBA, 100 ppm.

#### 4.2.5 Plant spread East-West (cm)

The data on plant spread in East-West direction in relation to different growth regulators at various stages of plant growth are shown in Table 14.

All growth regulators increased the plant spread in East-West direction at the end of experimentation. The plants treated with growth regulators recorded plant spread in the range of 54.86 – 75.40 cm as against 54.26 cm in control. The growth regulator CCC, 1000 ppm noted the highest (75.40 cm) plant spread as against lowest (54.86 cm) in TIBA, 50 ppm. Mepiquat chloride, 1000 ppm and CCC, 500 ppm were next (62.73; 62.06 cm) in the order as compared to treatment CCC, 1000 ppm.

Control treatment recorded significantly lowest (54.26 cm) plant spread and was on par with treatments mepiquat chloride, 500 ppm (59.56 cm), TIBA, 100 ppm (57.96 cm) and TIBA, 50 ppm (54.86 cm).

#### 4.2.6 Leaf area (cm<sup>2</sup>)

The data collected on leaf area per plant in relation to different growth regulators are presented in Table 15.

It was found that all the growth regulators increased the leaf area per plant (5119.30 – 6893.56 cm<sup>2</sup>) as against the control (4862.76 cm<sup>2</sup>) at the end of 120 DAT. The growth regulator CCC, 1000 ppm registered significantly highest leaf area (6893.56 cm<sup>2</sup>) followed by mepiquat chloride, 1000 ppm (5939.10 cm<sup>2</sup>) and CCC, 500 ppm (5912.80 cm<sup>2</sup>) as against lowest (5119.30 cm<sup>2</sup>) leaf area with TIBA, 50 ppm.

The lowest (4862.76 cm<sup>2</sup>) leaf area was recorded in control treatment and was on par with TIBA, 50 ppm (5119.30 cm<sup>2</sup>) and TIBA, 100 ppm (5241.86 cm<sup>2</sup>).

The leaf area at harvest reduced ridiculously due to defoliation of leaves.

#### 4.2.7 Yield parameters

The data on yield parameters as influenced by different growth regulators are presented in Table 16.

##### 4.2.7.1 Number of tubers per plant

It was observed that all the growth regulators increased the number of tubers per plant as compared to control and was in the range of 26.92 – 30.48. The significantly highest (30.48) number of tubers per plant was observed with CCC, 1000 ppm as against lowest (26.92) in TIBA, 50 ppm. The number of tubers per plant with growth regulators mepiquat chloride, 1000 ppm (29.08) and CCC, 500 ppm (28.29) were next in the order as compared to higher number of tubers per plant in CCC, 1000 ppm.

Control treatment recorded significantly lowest number of tubers per plant (26.55) and was on par with TIBA, 50 ppm (26.92).

##### 4.2.7.2 Length of tubers (cm)

All the growth regulators except with TIBA, 50 ppm and TIBA, 100 ppm exhibited significantly higher length of tubers as compared to control. The length of tuber as influenced

Table 14. Influence of growth regulators on plant spread-East-West directions (cm) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	22.66	46.13	48.03	52.10	54.26
2	TIBA, 25 ppm	22.60	46.10	49.86	53.80	54.86
3	TIBA, 50 ppm	23.20	45.80	50.73	55.33	57.96
4	CCC, 500 ppm	22.60	45.76	56.56	62.13	62.06
5	CCC, 1000 ppm	22.66	45.20	61.83	74.80	75.40
6	Mepiquat chloride, 500 ppm	22.46	45.36	55.20	56.10	59.56
7	Mepiquat chloride, 1000 ppm	22.76	45.46	58.63	62.83	62.73
SEm ±		0.274	0.372	2.142	1.817	1.91
CD at 5%		NS	NS	6.601	5.601	5.89

NS – Non-significant

DAT – Days after transplanting

Table 15. Influence of growth regulators on leaf area (cm<sup>2</sup>) at different stages of plant growth

Sl. No.	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
1	Control	471.73	3077.93	4125.06	4862.76	2541.50
2	TIBA, 25 ppm	476.53	3078.96	4421.43	5119.30	2826.53
3	TIBA, 50 ppm	468.86	3077.86	4472.56	5241.86	2921.00
4	CCC, 500 ppm	474.06	3078.23	5086.76	5912.80	3120.26
5	CCC, 1000 ppm	473.13	3080.50	6321.13	6893.56	3654.50
6	Mepiquat chloride, 500 ppm	473.73	3078.96	4890.20	5739.30	3021.56
7	Mepiquat chloride, 1000 ppm	473.83	3078.86	5268.56	5939.10	3470.63
	SEm ±	2.718	4.055	155.389	187.223	123.558
	CD at 5%	NS	NS	478.942	577.0	380.852

NS – Non-significant

DAT – Days after transplanting

Table 16. Influence of growth regulators on yield, yield parameters and harvest index at different stages of plant growth

Sl. No.	Treatment	No. of tuber per plant	Length of tubers (cm)	Diameter of tuber (cm)	Volume of tuber (cm)	Fresh weight of tuber (g/plant)	Dry weight (g/plant)	Yield of tuber (t/ha)	Harvest index (%)
1	Control	26.55	21.61		202.63	240.93	38.57	2.35	32.7
2	TIBA, 25 ppm	26.92	22.82	1.633	210.40	250.64	40.68	2.51	38.3
3	TIBA, 50 ppm	28.12	23.95	1.780	219.83	247.33	41.68	2.54	43.3
4	CCC, 500 ppm	28.29	24.54	1.800	241.20	258.92	43.95	2.66	45.0
5	CCC, 1000 ppm	30.48	27.85	1.960	246.96	260.28	46.55	2.77	47.3
6	Mepiquat chloride, 500 ppm	27.44	24.57	1.757	223.43	252.92	42.54	2.56	44.3
7	Mepiquat chloride, 1000 ppm	29.08	26.36	1.813	240.33	259.74	44.09	2.67	46.7
	SEm ±	0.314	0.891	0.083	6.665	0.799	1.502	0.032	1.8
	CD at 5%	0.969	2.748	0.255	20.544	2.464	4.630	0.098	5.6

by different growth regulators was found in the range of 22.82 – 27.85 cm as compared to control (21.61 cm). Where in the highest length (27.85 cm) was recorded with CCC, 1000 ppm and was on par with mepiquat chloride, 1000 ppm (26.36 cm) as against lowest (22.82 cm) in TIBA, 50 ppm in growth regulators experimentation.

Significantly lowest (21.61 cm) length of tubers was observed with control as compared to other growth regulator treatments.

#### 4.2.7.3 Diameter of tubers (cm)

The diameter of tubers was increased significantly in all growth regulators except TIBA, 50 ppm as compared to control. The diameter of tubers as influenced by different growth regulators was observed to be in the range of 1.633 – 1.960 cm as against the control (1.380 cm). The growth regulator CCC, 1000 ppm recorded the highest (1.960 cm) diameter of tubers followed by mepiquat chloride, 1000 ppm (1.813 cm), CCC, 500 ppm (1.800 cm) and mepiquat chloride, 500 ppm (1.757 cm). The lowest diameter of tubers was recorded with TIBA, 50 ppm (1.633 cm).

Control treatment recorded lowest 1.380 cm diameter of tubers as compared to other growth regulator treatments.

#### 4.2.7.4 Volume of tubers (cc)

It was observed that all the growth regulators except TIBA, 50 ppm and TIBA, 100 ppm promoted the volume of tubers as compared to control (202.63 cc). In the plants treated with growth regulators the volume of tubers was found to be in the range of 210.40 – 246.96 cc. The highest (246.96 cc) volume of tubers was observed in the treatment CCC, 1000 ppm and was on par with CCC, 500 ppm (241.20 cc) and mepiquat chloride, 1000 ppm (240.33 cc) as against lowest (210.40 cc) volume of tubers with TIBA, 50 ppm.

Control treatment recorded lowest (202.63 cc) volume of tubers as compared to growth regulator treatments.

#### 4.2.7.5 Fresh weight of tubers per plant (g)

The mean data noted that all the growth regulators increased the fresh weight of tubers as compared to control. The fresh weight of tubers per plant was observed to be in the range of 250.64 – 260.28 g in the plants treated with growth regulators as against 240.93 g in control. The highest (260.28 g) fresh weight was recorded with treatment CCC, 1000 ppm and which was on par with mepiquat chloride, 1000 ppm (259.74 g) and CCC, 500 ppm (258.92 g) as against lowest (250.64 g) with TIBA, 50 ppm.

Significantly lowest (240.93 g) fresh weight was observed with control treatment as compared to other growth regulator treatments.

#### 4.2.7.6 Dry weight of tubers per plant (g)

The data showed increased dry weight of tubers as against control. The dry weight of tubers was observed to be in the range of 40.68 – 46.55 g as compared to control (38.57 g). The highest (46.55 g) dry weight was observed in plants treated with CCC, 1000 ppm as against lowest (40.68 g) in TIBA, 50 ppm. In plants treated with mepiquat chloride, 1000 ppm (44.09 g), CCC, 500 ppm (43.95 g) and mepiquat chloride, 500 ppm (42.54 g) were on par with superior treatment CCC, 1000 ppm.

The lowest (38.57 g) dry weight was observed in control and was on par with TIBA, 50 ppm and 100 ppm (40.68 ; 41.68 g, respectively).

#### 4.2.7.7 Yield of tubers (t/ha)

Tuber yield per hectare among different growth regulators were found to be higher as compared to control. The plants treated with growth regulators exhibited higher tuber yield and was found to be in the range of 2.51 – 2.77 t/ha, where in the highest (2.77 t/ha) tuber yield was observed with CCC, 1000 ppm followed by mepiquat chloride, 1000 ppm (2.67 t/ha)

and CCC, 500 ppm (2.66 t/ha) as against lowest (2.51 t/ha) with TIBA, 50 ppm in growth regulator applications.

Significantly lowest (2.35 t/ha) yield was registered in control treatment as compared other growth regulator treatments.

#### 4.2.7.8 Harvest index (%)

The data indicated that the all growth regulators increased the harvest index of Coleus. The harvest index was on the range of 38.3 – 47.3 per cent in plants treated with growth regulators as against (32.7%) in control. The highest (47.3%) harvest index was recorded in CCC, 1000 ppm as against lowest (38.3%) harvest index with TIBA, 50 ppm.

The control treatment recorded significantly lowest (32.7%) harvest index as compared to other growth regulator treatments.

## V. DISCUSSION

Many of the physiological processes are directly or indirectly influenced by environment surrounding the crops. In order to suit the requirement for a crop, the environment can be manipulated to a certain extent by manipulating organic manures schedule and application of growth regulators. The results of the present investigation of such practices on productivity have been discussed under the headings as below.

### 5.1 ORGANIC MANURES APPLICATION

Crop production on profitable basis is entirely based on balanced nutrition under congenial agro-ecological conditions. The importance of balanced nutrition and nutrient requirements for better growth, development and yield of *Coleus* heavily dependent on balanced nutrients. The fertilizers with increased cost and adverse effects on non-target biota and environment has become very necessary to cut down the fertilizer input, cost of production and to reduce environment pollution. An alternate solution is necessary to sustain the production. In the present investigation the effect of different organic manures and their combinations on growth and yield of *Coleus forskohlii* Briq. are discussed as under.

#### 5.1.1 Growth parameters

In the present study plant height was significantly influenced by organic manure treatments. It was observed that plant height was highest in the plants treated with vermicompost, 6 t/ha as compared to lowest height with FYM, 30 t/ha in sole application of organic manures. This increase in height might be due to increase in major nutrients apart from increased protein synthesis with increased P uptake by incorporation of vermicompost (Tomati *et al.*, 1990). This result was in agreement with Paturde *et al.* (2002) who noticed that application of vermicompost, 5 t/ha recorded significantly higher plant height in safed musli. Similarly, Vadiraj *et al.* (1992) also observed significant increase in plant height of cardamom plants with the application of vermicompost as a potting mixture.

Plant height was markedly influenced by application of different organic manures used in combination. The treatment poultry manure + vermicompost, 1:3.37 recorded highest plant height as compared to lowest in pressmud + FYM, 1:10.9. This increase in height might be due to increase in major nutrients apart from increased protein synthesis with increased P uptake by incorporation of vermicompost (Tomati *et al.*, 1990). The highest micronutrients uptake by soybean was recorded in treatment receiving 100 per cent recommended N through poultry manure followed by vermicompost. This might be attributed to increased availability of micronutrients in soil through higher microbial and enzymes activity in poultry manure and vermicompost (Math, 2001) which resulted in increased plant height in soybean. Chensheng *et al.* (2000) observed increased plant height with the application of poultry manure in *Pteridium aquilinum* L. Similarly Paturde *et al.* (2002) noticed that application of vermicompost, 5 t/ha recorded higher plant height in safed musli.

In the present study, the plant height, number of leaves per plant, number of branches per plant, plant spread, leaf area, harvest index and all yield attributes were significantly influenced by control check, RDF than the control. The influence of control check, RDF was more at initial stages of crop growth rather than at later stages which might be due to higher availability of nutrients at initial stages.

The numbers of leaves per plant and leaf area were highly influenced by different organic manures applied singly as well as in combination treatments. The treatment vermicompost, 6 t/ha produced maximum number of leaves per plant. This might be due to direct addition and slow release of nutrients through vermicompost (Bharadwaj and Omanwar, 1994) thus enriching available nutrient pool of the soil which resulted in more number of leaves per plant. In the present study higher number of leaves might be also due to increased plant height and number of branches per plant. These results corroborate with Vadiraj *et al.* (1992) who reported significant increase in number of leaves per plant in Cardamom plants with the application of vermicompost as a potting mixture.

Among the different organic manures applied in combination, the poultry manure + vermicompost, 1:3.37 ratio recorded the highest number of leaves per plant. Application of vermicompost recorded higher available nitrogen content in soil. This might be attributed to the increased population of beneficial micro-organisms like N-fixers, P-solubilizers and also higher nitrogenase and urease enzyme activity in soil (Math, 2001). This results in increased number of leaves per plant. Vadiraj *et al.* (1992) confirmed that vermicompost was responsible for increase in leaf number in Cardamom plants. Gopal Reddy (1997) observed that incorporation of poultry manure resulted in higher availability of nitrogen. This increased available nitrogen was responsible for higher number of leaves per plant. Similarly, Chezhiyan *et al.* (2003) observed higher number of leaves per plant in Bhumyalaki with the application of poultry manure + Azospirillum + phosphobacteria. By combining vermicompost and poultry manure the number of leaves per plant was increased due to aggrandized action.

The number of branches per plant in Coleus were significantly influenced by application of different organic manures singly as well as applied in different combinations. The vermicompost, 6 t/ha recorded highest number of branches per plant. Since the vermicompost supply significant quantities of nutrients, large beneficial microbial population and also biologically active metabolites, particularly, gibberellins, cytokinins and auxins was responsible for more number of branches in diverse crops (Bano *et al.*, 1987 and Bhawalkar, 1991). Venkatesh *et al.* (1995) noticed increase in number of branches per plant in grapes with the application of vermicompost.

The maximum number of branches per plant were developed in plants applied with vermicompost + poultry manure 1:3.37. This increase in number of branches might be due to balanced nutrition throughout the crop growth and large quantities of microbial population along with biologically active metabolites (Bano *et al.*, 1987 and Bhawalkar, 1991). Poultry manure attributed to increased availability of micronutrients and N with higher microbial activity in soybean crop followed by vermicompost (Math, 2001). This resulted in increased number of branches per plant. By combining vermicompost + poultry manure the number of branches per plant were boosted rediculously than sole application. Venkatesh *et al.* (1995) recorded higher number of branches per plant with the application of vermicompost in grape vines. Chezhiyan *et al.* (2003) observed higher number of branches per plant with the application of poultry manure + Azospirillum + phosphobacteria.

In the present study, plant spread in North-South and East-West direction were significantly influenced by different organic manures. It was observed that plant spread in North-South direction was highest in the treatment vermicompost, 6 t/ha in plants applied with organic manures singly. The increased plant spread might be due to increase in major nutrients apart from increased protein synthesis with increased P uptake by incorporation of vermicompost (Tomati *et al.*, 1990).

Similarly, poultry manure + vermicompost, 1:3.37 recorded highest plant spread in North-South direction in plots treated with organic manures in combination. The increase in plant spread might be due to increase in major nutrients apart from increased protein synthesis with increased P uptake by incorporation of vermicompost (Tomati *et al.*, 1990). Along with vermicompost the poultry manure also provided major nutrients, biologically active metabolites and microbial population surround to the crop which resulted in increased plant spread.

### 5.1.2 Yield parameters

Economic yield is expressed as a function of the factors that contribute to the yield. The variation in yield due to treatments could be attributed by variation in yield attributing parameters. The main yield attributes in Coleus are number of tubers per plant, length of tubers, volume of tubers, diameter of tubers, fresh weight of tubers, dry weight of tubers and yield of tubers.

The sole application of organic manures greatly influenced the yield of tubers. The maximum yield was recorded in the plots treated with vermicompost, 6 t/ha followed by pressmud, 1.57 t/ha and poultry manure, 2.281 t/ha. The maximum yield observed in the plants may possibly due to increased number of tubers, length of tubers, volume of tubers, diameter of tubers, fresh weight of tubers and dry weight of tubers per plant. These results



**Plate-3. Growth of Coleus plants under control treatment**



**Plate-4. Coleus plants grown with vermicompost application**



**Plate-5. Growth of Coleus plants with poultry manure + vermicompost application**

Plate-3. Growth of Coleus plants under control treatment

Plate-4. Coleus plants grown with vermicompost application

Plate-5. Growth of Coleus plants with poultry manure + vermicompost application



**Plate-6. Yield of Coleus tubers under control treatment**



**Plate-7. Influence of vermicompost on tuber yield of Coleus**



**Plate-8. Influence of poultry manure + vermicompost and tuber yield of Coleus**

Plate-6. Yield of Coleus tubers under control treatment.

Plate-7. Influence of vermicompost on tuber yield of Coleus

Plate-8 Influence of poultry manure + vermicompost on tuber yield of coleus

are in conformation with Kalembasa *et al.* (1998) who observed increased yield of radish with the application of vermicompost. The significant increase in tuber yield with the application of vermicompost, 6 t/ha may be attributed to the increased growth and vigour of the plant evidenced by increased growth attributes like plant height, number of leaves per plant, number of branches per plant, plant spread and leaf area. This inturn might have increased the yield and yield attributing characters. Similar observations recorded with the application of vermicompost was reported by Bhanu Shalini, 2000, Nijhawan and Kanwar, 1952 and Krishnamoorthy and Varnanabhaia, 1996 in wheat and Kale and Bano (1986) in paddy.

The plots treated with vermicompost + poultry manures 1:3.37 ratio recorded highest yield of tubers in Coleus. The significant increase in tuber yield with the application of vermicompost, 6 t/ha may be attributed to the increased growth and vigour of the plant evidenced by increased growth attributes like plant height, number of leaves per plant, number of branches per plant, plant spread and leaf area. This inturn might have increased the yield and yield attributing characters. Similar observations with the application of vermicompost were reported by Bhanu Shalini, 2000, Nijhawan and Kanwar, 1952 and Krishnamoorthy and Varnabhaia, 1996 in wheat and Kale and Bano (1986) in paddy. Similarly Kalembasa *et al.* (1998) found higher yield of radish with vermicompost. In mulberry increase in yield was reported with application of poultry manure which might be attributed to better supply of nutrients (43.20% organic carbon, 3.08% total nitrogen and 0.62% phosphorus). By combining both vermicompost and poultry manures influence was aggrandized and it leads increase in yield.

Yield is the manifestation of yield attributing characters (Matsushima, 1976). Higher tuber yield of Coleus was influenced mainly by yield attributing components like length of tuber, number of tubers per plant, volume of tubers, diameter of tubers, fresh weight of tubers and dry weight of tubers. Significant increase in yield of Coleus due to organic manures application could be attributed to increased yield attributes.

The harvest index was markedly influenced by application of organic manures singly. The treatment vermicompost, 6 t/ha recorded highest harvest index as against lowest with FYM, 30 t/ha. These results are in agreement with Maheswarappa *et al.* (2000) who observed increased harvest index with vermicompost application in Galangal. The higher harvest index might be due to increased growth as well as yield attributes. The total dry matter production of crop during the growth period is important for the determination of the economic yield (Donald, 1962). The higher yield and growth attributes leads to increased harvest index.

The harvest index was gradually influenced by different organic manures applied in combination. The treatment poultry manure + vermicompost, 1:3.37 recorded highest harvest index. These results corroborate with Maheswarappa *et al.* (2000) who observed increased harvest index with vermicompost application in galangal. Similarly, vermicompost increased the harvest index of the Coleus when applied along with poultry manure.

## 5.2 GROWTH REGULATOR

Plant growth and development are controlled by a endogenous growth hormones produced by the plant. These phytohormones are organic compounds produced by plants in minute quantity which act at low concentrations. Treatments with growth regulators during about certain changes in both the morphology and physiology of plants.

The growth rate of a Coleus plant is greatly influenced by the environment, but its growth habit is determined largely by the interaction of internal factors, including endogenous growth substances that control the activity of numerous meristems. Substances now available that modify plant organs differentially and influence final plant form. Such substances are therefore potentially useful in agriculture, because suitable concentrations applied at appropriate time might increase the yield either by altering the dry matter distribution in the plant or by regulating growth (Watson, 1958).

Considering the biomass produced by the Coleus plant and its distribution into tubers, it was felt that there is need to find out the avenues for effective redistribution into tubers. Similarly, there is also necessity to increase the yield of tubers. In this direction the role of plant growth regulators particularly, retardants are emphasized. With this background, the

present investigation was designed with one genotype of Coleus (K-8) to evaluate the influence of various growth retardants on growth, yield and yield components. The results obtained on these aspects are discussed here under in light of the work done by other researchers.

### 5.2.1 Growth parameters

Growth retardants have been defined as the chemicals that reduce cell division and cell elongation in the shoot apex and regulate the plant height physiologically without formative effects (Cathey, 1964). Basically plant height is genetically controlled character, but several studies have indicated that plant height can be either increased or decreased by application of synthetic plant growth regulators (Govindakrishnan and Sahota, 1984; Arora *et al.*, 1998; Alam and Islam, 1989; Madalgeri and Ganiger, 1993 and Gasti, 1994).

It was observed in the present study that upto 60 DAT, there were no significant differences due to treatments since at this stage no treatments were imposed. It was further observed that at later stages the plant height reduced and the extent of reduction was more with CCC, 1000 ppm and mepiquate chloride, 1000 ppm as against lowest reduction with TIBA, 25 ppm. This indicates that growth retardants at higher concentrations are more effective in controlling plant height.

The mechanism of reduction in plant height appears to be due to reduction in cell division and cell elongation because of inhibitory action of growth retardants in the biosynthetic pathway of gibberellins (Moore, 1980). He further reported that CCC and mepiquat chloride are anti-gibberellin dwarfing agents leading to a deficiency of gibberellic acid in plants and reduced growth, that is blocking the conversion of geranyl geranyl pyrophosphate to copalyl pyrophosphate which is the first step of gibberellin synthesis. Similarly, Pandita and Hooda (1979) observed reduced plant height in potato could be due to reduction in the growth of important sinks (all axillary buds), which in turn might change the distribution pattern of assimilates.

All the growth retardants increased the number of leaves and leaf area and they show higher values than control in present study. The growth retardant CCC, 1000 ppm recorded highest number of leaves per plant compared to other treatments. The increase in number of leaves per plant might be due to more number of branches per plant spurred by reduced plant height. It was supported by earlier workers Sarkar and Singh (1984) and Mannikeri (1996) also opined that higher number of leaves per plant with CCC application in potato and turmeric crops, respectively.

The application of growth retardants significantly increased the number of branches per plant with all growth retardants particularly CCC and mepiquat chloride. The increase in number of branches could be due to suppression of apical dominance as a result of increase in the auxin activity due to application of growth retardants thereby diverting the polar transport of auxin towards the basal buds leads to increased branching. Similarly, Madalgeri and Ganiger (1993) and Gasti (1994) reported that application of cycocel, 750 ppm and mepiquat chloride, 150 ppm increased the number of tillers per plant in potato.

There was increase in plant spread in both direction due to application of growth retardants. The increase in plant spread with an increase in concentration of all growth retardants. The increase in number of branches per plant (Primary, Secondary and tertiary) were responsible for increase in plant spread in both direction due to application of growth retardants, which could mainly attributed not only to decrease in plant height but also decrease in cell division and cell elongation and increased number of leaves per plant. It is clear that the increase in the number of branches has compensated for increase in plant spread.



**Plate-9. Growth of Coleus plants under control treatment**



**Plate-10. Coleus plants with enhanced growth in response to CCC, 1000 ppm**



**Plate-11. Growth of Coleus plants with Mepiquat chloride, 1000 ppm**

Plate-9. Growth of Coleus plants under control treatment

Plate-10. Coleus plants with enhanced growth in response to CCC, 1000 ppm

Plate- 11. Growth of Coleus plants with Mepiquat chloride, 1000 ppm



**Plate-12. Yield of Coleus tubers under control treatment**



**Plate-13. Influence of CCC, 1000 ppm on tuber yield of Coleus**



**Plate-14. Influence of Mepiquat chloride, 1000 ppm on tuber yield of Coleus**

Plate-12. Yield of coleus tubers under control treatment

Plate-13. Influence of CCC, 1000 ppm on tuber yield of Coleus

Plate-14. Influence of Mepiquat chloride, 1000 ppm on tuber yield of Coleus

## 5.2.2 Yield parameters

Improvement in yield according to Humphries (1979) could happen in two ways *i.e.* by adopting the existing variety to grow better in their environment or by altering the relative proportion of different plant parts so as to increase the yield of economically important parts. The growth retardants are capable of redistribution of dry matter in the plant parts thereby bringing about improvement in yield (Reddy and Patil, 1981; Chetti, 1991 and Chandrababu *et al.*, 1995). Crop yield depends not only on the accumulation of photosynthates during the crop growth and development, but also on the partitioning of photosynthates between the desired plant organs. These in turn are influenced by the efficiency of metabolic processes within the plant.

It was observed in the present investigation that the application of growth retardants increased the number of tubers per plant, length of tubers, volume of tubers, diameter of tubers, fresh weight of tubers, dry weight of tubers and yield of tubers which are the important yield determining components in *Coleus*. Among the various growth retardants tried, higher yield was recorded with CCC, 1000 ppm followed by mepiquat chloride, 1000 ppm as compared to lowest in TIBA, 25 ppm. It was further observed that with an increase in the concentration of growth retardants, there was enhancement in the per cent increase in yield indicating that higher concentrations of the growth retardants used are more beneficial. However, increase in yield was least with control treatment.

The increase in yield due to growth retardant could be attributed to increase in distribution of number of tubers per plant, length of tubers, volume of tubers, diameter of tubers, fresh weight, dry weight and yield of tubers. The significant increase in yield and yield components with CCC, 1000 ppm followed by mepiquat chloride, 1000 ppm as against lowest with TIBA, 25 ppm. It was also observed that there was an increase in the chlorophyll content and nitrate reductase activity due to growth retardants which also might have contributed for increase in yield and yield components. These results are corroborated with several workers and they observed increase in yield and yield components in potato due to growth retardant treatments (Pandita and Hooda, 1979; Banerjee and Das, 1984; Madalgeri and Ganiger, 1993; Gasti, 1994 and Madalgeri, 1996).

In the present study, harvest index was markedly influenced by growth retardants. It was observed that highest harvest index was noticed in the treatment CCC, 1000 ppm as compared to lowest in TIBA, 25 ppm. This result was in accordance with Mannikeri (1996) reported that higher harvest index of ginger by CCC application than other growth regulator treatments. Satheesan and Ramadhasam (1988) observed significant increase of harvest index with the application of 400 ppm of CCC in turmeric as compared to other treatments.

## FUTURE LINE OF WORK

There is no full stop to gain into scientific knowledge. Any amount of work does not satisfy the hunger of scientists as problems circumvent and new ideas will continue to flow and this work is not an exception. The present investigation has opened up new areas and given rise to new ideas on utilization of organic manures and growth regulators in *Coleus* production. Hence, the following future lines of work are being suggested.

1. There is need to undertake integrated nutrient management to improve the growth, yield and quality parameters.
2. There is need to undertake study on effect of organic manures on quality parameters and forskolin yield.
3. Detailed studies on influence of different organic manures on root knot nematode.
4. There is a need to undertake an experiment on influence of growth regulators on growth and yield of *Coleus*.
5. Detailed investigation on influence of growth retardants on *Coleus* yield and quality of *Coleus* during *rabi* season.

## VI. SUMMARY

Investigations were carried out in Medicinal and Aromatic plants Unit at Saidapur Farm, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad for a span of one year during 2004-05 to study the effect of different organic manures and growth regulators on growth and yield of Coleus. Dharwad is situated in the Transitional Zone of North Karnataka, which has equable climate.

Totally two experiments were conducted such as organic manures and growth regulators to study the effect on growth and yield of Coleus. Salient findings of these studies are summarized as under.

### STUDIES ON ORGANIC MANURES

In case of sole application of organic manures, the Vermicompost 6 t/ha recorded highest yield over FYM, 30 t/ha. Among the combination treatments, the highest yield was recorded with Vermicompost + poultry manures, 1:3.37 and was on par with Vermicompost + Sheep manures, 1:1 as against lowest in Pressmud + FYM, 1:10.9.

Harvest index also showed similar result with Poultry manure + vermicompost, 1:3.37 which registered as a canny treatment in organic manures applied in different combinations and Vermicompost 6 t/ha recorded higher harvest index in sole application of organic manures.

The number of leaves per plant and leaf area were higher in vermicompost, 6 t/ha followed by pressmud, 1.57 t/ha as compared to FYM, 30 t/ha in plots applied with organic manures singly. Poultry manure + vermicompost, 1:3.37 occupied the thorne in combination treatments. Control check, RDF recorded maximum at initial stages than harvest.

Plant height and plant spread in both directions recorded the same results. The vermicompost, 6 t/ha and poultry manure + vermicompost, 1:3.37 produced highest values in both sole application of organic manures as well as in combination of organic manures. Control check, RDF recorded the higher plant height at initial stages as compared to harvest stage.

Number of branches per plant showed highest values for vermicompost, 6 t/ha and poultry manure + vermicompost, 1:3.37 in sole application and in combination of organic manures, respectively. Control check, RDF recorded higher number of branches per plant at initial stages than at harvest.

### STUDIES ON GROWTH REGULATORS

In the experiment with growth regulators, the data showed that all growth regulators favoured higher yield as compared to untreated control plot. Among growth regulators CCC, 1000 ppm and mepiquat chloride, 1000 ppm gave higher yield as compared to control. Harvest index also recorded the same result.

The growth regulators CCC, 1000 ppm and mepiquat chloride, 1000 ppm promoted higher number of leaves per plant and leaf area.

With regard to plant height, CCC, 1000 ppm reduced the plant height as compared to control and it was on par with mepiquat chloride.

Plant spread in both directions, the growth regulators CCC, 1000 ppm and mepiquat chloride, 1000 ppm recorded higher values as compared to control.

Peer observation on number of branches per plant was recorded higher with higher concentrations of CCC and mepiquat chloride as compared to control.

## CONCLUSION

Out come of these studies, the better production of Coleus with the application of different organic manures and growth regulators under Dharwad conditions would be concluded as follows.

1. Vermicompost, 6 t/ha occupied the thorne in sole application of organic manures
2. Poultry manure + vermicompost, 1:3.37 seated on crown in organic manures applied in combination
3. Arriving out of the growth regulators study indicates that higher concentrations of CCC and mepiquat chloride were best for better growth and yield.

## VII. REFERENCES

- ABOU HUSSEIN, S. D., ELSHORBAGY, T., ABOU HADID, A. F., EL-BEHARIY, U., ABOU HADID, A. F., 2003, Effect of cattle and chicken manure with or without mineral fertilizers on vegetative growth, chemical composition and yield of potato crops. *Acta Horticulturae*, **608** : 73-79.
- ABRAHAM, Z., 1981, *Glimpses of Indian Ethnobotany* (Eds. Jain, S. K.) Oxford and IBH Publishing Company, Bombay, pp. 315-316.
- ALAM, S. M. M. AND ISLAM, T. M., 1989, Effect of some growth regulators on growth, yield and chemical composition of potato. *Indian Journal of Agricultural Research*, **23** (1) : 52-58.
- AMMON, H. P. T. AND MULLER, A. B., 1985, Forskolol : From an ayurvedic Remedy to a modern agent. *Planta Medica*, **46** : 473-477.
- ANONYMOUS, 1950, *Coleus forskohlii* Briq. *Wealth of Indian-Raw Materials* Vol. II, Central Scientific and Industrial Research, New Delhi, p. 308.
- ANONYMOUS, 1962, Fertilizer trials on paddy, pepper, ginger and tapioca in Kerala state. *Fertilizer News*, **7**(6) : 12-24.
- ANONYMOUS, 2003, Effect of FYM on yield, NPK uptake of safed musli. *Annual Report NRCMAP*, Anand (Gujarat), pp. 19-20.
- ARORA, S. K., JITENDER KUMAR, M. AND PANDITA, M. L., 1988, Effect of plant growth substances on growth and yield of potato cv. Kufri Chandramukhi. *Journal of Indian Potato Association*, **15** (1-2) : 80-82.
- BAIJAL, B. D., KUMAR, P. AND SIDDIQUI, M. A., 1983, Interaction of growth regulators and photoperiods on growth, flowering, stolon development and tuber initiation and yield in potato. *Indian Journal of Plant Physiology*, **26** : 61-67.
- BALAJI, S. K., 1994, Effect of vermicompost on growth and flower yield of China aster (*Callistephus chinensis*). *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.
- BALASHANMUGAM, P. V., VANANGAMUDI, K. S. AND CHAMY, A., 1989, Studies on the influence of farmyard manure on the rhizome yield of turmeric. *Indian Cocoa, Arecanut and Spices Journal*, **12** : 126.
- BANERJEE, N. C. AND DAS, T. K., 1984, Effect of plant growth regulators on growth and tuber yield of potato. *South Indian Horticulture*, **32**(2) : 75-77.
- BANERJEE, N. C. AND SINGHAMAHAPATRA, D. K., 1986, Effect of different organic manures and biofertilizers on growth and yield of potato. *Indian Agriculturist*, **30** (2) : 117-123.
- BANO, B., KALE, R. D. AND GAJANAN, G. N., 1987, Culturing of earthworm *Eudrilus eugeniae* for cast production and assessment of worm cast as biofertilizer. *Journal of Soil Biology and Ecology*, **7** : 98-104.
- BAPHANA, P. D., 1992, Organic farming in sapota. *Proceedings of National Seminar on Organic Farming and Technology. Keynote Paper and Extended Abstracts*, IIT, Bombay, **4** : 10-15.
- BHANU SHALINI, S., 2000, Integrated nitrogen management in knol khol. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.
- BHARADWAJ, V. AND OMNWAR, P. K., 1994, Long term effect of continuous rational cropping and fertilization on crop yields and soil properties II. Effect on Ec, pH, organic matter and available nutrients of soil. *Journal of Indian Society of Soil Science*, **42** : 387-392.

- BHASKAR, S., VASANTH KUMAR, J. AND SRIVASTAVA, H. C., 1997, Effect of growth regulators on production of herbage and oil in Patchouli (*Pogostemon patchouli*). *Indian Perfumer*, **41**(3) : 98-101.
- BHAT, P. B., FAROOQI, A. A. AND SUBBAIAH, T. K., 1989, Influence of growth regulators on growth, herbage and essential oil yield of Davana (*Artemisia pallens* Wall.). *Proceedings of XI International Congress of Essential Oils, Fragrances and Flavour*, **3** : 81-84.
- BHAT, S. V., BAJWO, B. S., DORNAUER, H., DE SOUZA, N. J. AND FEHLILHABER, H. W., 1977, Structure and stereo chemistry of new labdane diterpenoid from *Coleus forskohilii* Briq. *Tetrahedron Letters*, **19** : 1669-1672.
- BHAWALKAR, U. S., 1991, Vermiculture biotechnology for LEISA. *Seminar on Low External Input Sustainable Agriculture*, Amsterdam, Netherlands, pp. 1-6.
- BRAVE, J. V., 1992, Vermiculture in grape cultivation. Congress on traditional science and technology. *Keynote Paper and Extended Abstracts*, IIT, Bombay, **4** : 10-15.
- CANOR, P. AND PARDO, M. R., 1983, Effect of mepiquat chloride on the cotton *Gossypium hirsutum* L. plant. *Agricultura Technican*, Mexico, **9**(1) : 35-44.
- CATHEY, H. M., 1964, Physiology of growth retarding chemicals. *Annual Review of Plant Physiology*, **15** : 271-301.
- CHANDRABABU, R., MANIAN, K., NAGARAJAN, M. AND RAMACHANDRAN, T. K., 1995, Effect of Mepiquat chloride on growth and yield of groundnut. *Madras Agricultural Journal*, **82** (3) : 229-230.
- CHETTI, M. B., 1991, Evaluation of chamatkar on groundnut. *Pestology*, **15** (8) : 43-50.
- CHEZHIAN, N., SARASWATHY, S. AND VASUMATHI, R., 2003, Studies on organic manures, biofertilizers and plant density on growth, yield and alkaloid content of Bhumyamalaki (*Phyllanthus amarus* Schum. and Tonn.). *South Indian Horticulture*, **51** : 16.
- CHOUDHARY, R. S., ROYCHOUDHARI, P. K. AND VEERARAGHAVATHATHAM, P. A., 1976, Response of potato crop to treatment with ascorbic acid and cycocel. *Indian Journal of Plant Physiology*, **19** : 15-18.
- CHOUHAN, G. G. AND ARUNABH JOSHI, 2002, Response of safed musli (*Chlorophytum borivillianum*). *Extended Summaries 2<sup>nd</sup> International Agronomy Congress*, Vol. 1, November 26-30, new Delhi, pp. 505-506.
- DANG, Y. P. AND VERMA, K. S., 1996, Direct and residual effect of pressmud cakes in rice – wheat cropping system. *Journal of Indian Society of Soil Science*, **44** : 448-450.
- DAS, P. K., SARANGI, D., JENA, M. K. AND MOHANTY, S., 2002, Response of green gram (*Vigna radiate*) to integrated application of vermicompost and chemical fertilizers in acid lateritic soils. *Indian Agriculturist*, **46** (1-2) : 79-87.
- DASTUR, R. H. AND PRAKASH, V., 1957, The response of the cotton plants to some growth regulating substances. *Indian Cotton Growers Review*, **8** : 173-188.
- DE SOUZA, N. J. AND SHAH, V., 1988, Forskololn – An adenylate cyclase activating drug from Indian Herb. In : *Economic and Medicinal Plant Research*, Vol. 2, Academic Press, New Delhi.
- DESAI, 1992, Vermiculture application in Horticulture. In : Congress and Traditional Science and Technology, Keynote Papers and Extended Abstracts, IIT, Bombay, **5** pp. 10-14.
- DONG CHENSHING, CHEN ZHOIXIN, NUEJUNYI, ZHANG JINWEN, XIYUQIN, DONG, C. S., CHENOZXNUI, J. Y., ZHANG, J. W. AND XIYO, 2000, Influence of plant

- density and fertilizer types on growth and development of *Ptessidium aquilinum* L. (Kouhn). *Scientia-Silvae Science*, **36** (4) : 129-132.
- DUBEY, S. K., 1992, Effect of organic materials and *Bradyrhizobium* inoculation on soybean. *Bharthiya Krrishi Anusandhan Patrika*, **7** : 155-162.
- DYSON, P. W. AND HUMPSHRIES, E. C., 1966, Modification of growth habit of Majestic potato by growth regulators applied at different times. *Annual Applied Biology*, **58** : 171-182.
- DYSON, P. W., 1965, Effect of Gibberlic acid and CCC on potato growth and development. *Journal of the Science of Food and Agriculture*, **16** : 542-549.
- EL-EBED, S. O., EL-BELTAGY, M. S., ABOU-HUSSEIN, M. R., EL-BEGAGY, A. S. AND MAKSOUUD, M. A., 1980, Effect of some growth regulators on growth and development of potato plants. *Egyptian Journal of Horticulture*, **7** (2) : 169-190.
- EL-MARHRABY. S. C., 1997, Impact of natural conditioners and saline irrigation water frequency of calcarious soil productivity. *Egyption Journal of Soil Science*, **37** (2) : 267-281.
- EZIZONDO, M. T. AND MARTINEZ, J., 1973, Economic value of application of CCC to potatoes. *Neuro Leon*, **7** : 13-14.
- FAROOQI, A. A. AND KHAN, M. M., 1993, *Cultivation Practices for Medicinal Plants*. University of Agricultural Sciences, Bangalore.
- FERNANDES, A., DE, P. M., LIRA, M. DE, A., FRANCA, M. P. AND SANTOS, V. F., 1986, Effect of organic sources on production of maize, sorghum and elephant grasses. *Psequisa Agropruria Brasileria*, **21** (10) : 1015-1022.
- FISHER, A. M., 1974, Effect of CCC on yield and culinary qualities of potato. *Nauchyitraudy*, **17** (1) : 46-49.
- GANIGER, V. M., 1992, Use of growth retardants in potato (*Solanum tuberosum* L.) production. *M. Sc. (Agri.) Thesis*, submitted to the University of Agricultural Sciences, Dharwad.
- GASTI, V. D., 1994, Response of commercial vegetables to growth retardants. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.
- GHOSH, S. P., 2000, Medicinal and Aromatic plants : Present Status and Future prospective. *Indian Journal of Arecanut, Spices and Medicinal Plant*, **2** (4) : 10-11.
- GOPAL REDDY, B., 1997, Soil health under integrated nutrient management in maize-soybean cropping system. *Ph. D. Thesis*, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad.
- GOVINDAKRISHNAN, P. M. AND SAHOTA, T. S., 1984, Effect of Cycocel and nitrogen combinations on haulm growth and tuber yield of potato in the hills of shillong and shimla. *Journal of Indian Potato Association*, **11** : 26-31.
- GREWAL, J. S. AND TREHAN, S. P., 1984, Results of continuous use of phosphatic and potassic fertilizers and farmyard manure on potato yield and nutrients status of an acidic brown hill soil. *Journal of Potassium Research*, **4** (1) : 24-30.
- GUPTA, R., 1988, Procedure for *invitro* multiplication and *invitro* conservation of threatened/endangered medicinal plants. *JPI. Gen. Resou.*, **1** : 98-102.
- HASSAN, M. A. M., FARRAG M. M. A. AND FARRAG, I. A., 1989, Response of potato Cv. Diamant to various rates of mepiquat chloride applied at 3 stages of plant growth. *Australian Journal of Agricultural Sciences*, **20** (5) : 143-157.
- HAUMADI, F. M., 1987, Effect of plant spacing, CCC on growth and yield of potato, *ZnCo*, **5** : 33-39.

- HILLMAN, Y. AND SUWANDI, 1999, Effect of different kinds of rates of FYM on tomato (*Lycopersicon esculentum*) cultivar Goldol. *Bulletin of Penelitian Hortikultra*, **18** (2) : 33-43.
- HOPP, H. AND SLATES, G. S., 1949, The effect of earth worms on the productivity of agricultural soil. *Journal of Agricultural Research*, **78** : 325-339.
- HUMPSHRIES, E. C., 1979, Response of crop plants to growth regulators. *Monograph 31*. Rothamsted Experimental Station, England.
- IKPE, F. N., POWELL, J. M., ISIRIMAH, N. O., WAHUA, I. A. T. AND NGODIGHA, 1999, Effect of primary tillage and soil amendment practices on pearl millet yield and nutrient uptake in the sahel of West Africa. *Experimental Agriculture*, **35** (4) : 437-448.
- JECIK, M. AND IVANOVSKI, P. R., 1999, The sheep manure in direct and prolonged effect on Macedonian high mountain pastures. *Macedonian Agricultural Review*, **46** (1-2) : 33-35.
- KADWE, B., HATMODE, C. N., DEOTALE, R. D., ARCHANA THORAT AND CHORE, C. N., 2004, Response of different levels of fertilizers and pressmud on biochemical and yield contributing parameters of groundnut. *Journal of Soils and Crops*, **14** (1) : 58-61.
- KALE, R. D. AND BANO, K., 1986, Field trials with vermicompost (Vee comp. E 83 UAS) an organic fertilizer proceedings of National Seminar on Organic Waste Utilization. Eds. Pash, M. C., Senapathi, B. K. and Mishra, P. C., pp. 151-160.
- KALE, R. D. BANO, K., SREENIVASA, M. M. AND BAGYARAJ, D. J., 1987, Influence of worm cast on the growth and mycorrhizal colonization of two Ornamental plants. *South Indian Horticulture*, **35** : 433-437.
- KALE, R. N., BANO, K. AND SATYAVATI, G. P., 1991, Influence of vermicompost application on growth and yield of cereals and ornamental plants. *Final Report of KSCST Project N67-04/Vermi/34B (3478)*.
- KALEMBASA, S., DESKA, J. AND FIEDOROW, Z., 1998, Possibility of utilizing vermicomposts in the cultivation of radish and praprika. *Roczniki Akademii Rolniczej-w-poznaniu cogrodnictwo alo*, **27** : 136-137.
- KATIYAR, R. S. AND SINGH, B., 2003, Organic cultivation of *Nigella sativa* on semi-reclaimed sodic wasteland, *2<sup>nd</sup> World Congress on Biotechnological Developments of Herbal Medicine*, NBRI, Lucknow, India, **135** : 2003.
- KHAN, K. W., 1966, Earthworms of West Pakistan and their activity in soil improvement. *Agriculture Pakistan*, **17** : 415-434.
- KRISHNAMOORTHY AND VARANANABHAI, S. N., 1986, Biological activity of earthworm casts : An Assessment of plant growth promoter levels in the cast. *Proceedings of Indian Academy of Science*, **95** (3) : 342-351.
- KRISHNAMOORTHY, V. AND MADALGERI, M. B., 2000, Influence of plant growth regulators on growth, seed yield and oil content in ajwan (*Trachiospermum ammi* L.). *Indian Perfumer*, **44**(4) : 255-259.
- KULKARNI, S. S., CHETTI, M. B. AND AMAREGOUD, A., 1995, Influence of growth retardants on morphological characters in sunflower (*Helianthus annuus* L.) genotypes. *Karnataka Journal of Agricultural Sciences*, **8** : 40-50.
- LOKANATH, M. AND DASH, N. K., 1964, Determination of optimum spacing, fertilization and method of planting in ginger (*Zingiber officinale* Rosc.). *Indian Journal of Agronomy*, **9** : 281-285.
- MADALGERI, B. B. AND GANIGER, V. M., 1993, Mepiquat chloride increases potato yield. *Journal of Indian Potato Association*, **20** (3-4) : 45.

- MADALGERI, M. B., 1996, Investigations on the True Potato Seed (TPS) transplants for potato production in rainfed vertisols. *Ph. D. Thesis*, University of Agricultural Sciences, Dharwad.
- MAHESWARAPPA, H. P., NANJAPPA, H. V. AND HEGDE, M. R., 2000, Dry matter production and accumulation in different parts of galangal (*Kaempferia galangal*) as influenced by organic practices when grown as an inter crop in coconut garden. *Indian Journal of Agronomy*, **45** (4) : 698-706.
- MANDAL, S., CHAKRABORTHY, T. AND DATTA, J. K., 1997, Influence of growth retardants and rock phosphate on growth and development of greengram (*Vigna radiata* L. Wilczek). *Indian Journal of Plant Physiology*, **2** : 32-35.
- MANNIKERI, I. M., 1996, Studies on response of turmeric (*Curcuma longa* L.) cv. Amalapuram to vermicompost and growth regulators. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.
- MATH, K. K., 2001, Effect of nitrogen substitution through organics on soil health and crop yields in wheat-soybean cropping system. *Ph. D. Thesis*, University of Agricultural Sciences, Dharwad.
- MATSUSHIMA, S., 1976, High yielding rice cultivation, University of Tokyo press, p. 2.
- MOHAN DAS, S. AND SAMPATH, V., 1985, Studies on the regulation of growth and yield in geranium with hormonal sprays. *South Indian Horticulture*, **33** : 344-346.
- MOHAN KUMAR, C. R. AND MURALIDHARAN NAIR, G., 1979, Note on the effect of planting material and levels of FYM on the yield of *Dioscorea alata*. *Journal of Root Crops*, **5**(1) : 67-68.
- MOHMED RAFI, NARWADKAR, P. R., PRABHU, T. AND SANINDRANATH, A. K., 2002, Effect of organic and inorganic fertilizers on growth and yield of tomato (*Lycopersicon esculentum* Mill.). *South Indian Horticulture*: 522-526
- MOORE, T. C., 1980, Biochemistry and Physiology of Plant Hormones. *Naroja Publishing House*, New Delhi, pp. 107-131.
- MORE, S. D., 1994, Effect of farm wastes and organic manures on soil properties, nutrient availability and yield of rice-wheat grown on sodic vertisol. *Journal of Indian Society of Soil Science*, **42** (2) : 253-256.
- MULDER, L., 1981, Mepiquat chloride slightly reduce the plant height of potato at different stages. *Agricultura Technican, Mexico*, **9** : 30-62.
- MUNSHI, L., RAY, CHAUDHURY, A. AND PAL, S. K., 1985, Effect of fertilizer levels on alkaloid content in vinca rosea (*Catharanthus roseus* Don). *Indian Agriculture*, **29** (3) : 209-212.
- MUTHUKRISHNAN, C. R., THAMBURAJ, S., SHANMUGAM, A. AND SHANMUGAVELU, K. G., 1947, Effect of certain growth regulators on tapioca and sweet potato. *Journal of Root Crops*, **2** : 52-56.
- NAGARAJU, M. S., SHANKARAIHAH, C. AND USHA RAVINDRA, 2000, Effect of integrated use of fertilizer nitrogen with sulphitation pressmud and *Azotobacter* on growth, yield and quality of sugarcane. *Mysore Journal of Agricultural Sciences*, **34** : 311-316.
- NAIR, P. G. AND MOHAN KUMAR, B., 1984, Response of sweet potato (*Ipomea batatas* L.) to NPK and lime in acid lateritic soil. *Journal of Root Crops*, **10**(2) : 17-21.
- NARAYANA, M. R., DIMRI, B. P, AND KHAN, M. N. A., 1977, *Catharanthus roseus* and its cultivation in India. *Farm Bulletin No. 8*, CIMPO India.

- NARWAL, R. P., GUPTA, A. P. AND ANTIL, L. K., 1990, Efficiency of triple super phosphate and mussorie rock phosphate mixture incubated with poultry manure. *Journal of the Indian Society of Soil Science*, **38** : 51-55.
- NERSON, H., EDELETEIN, M. AND MEIRCHICK, M., 1978, The values of farmyard manure in wheat cultivation in Northern Negev. *Hossadeh*, **58** : 732-736.
- NIJHAWAN, S. G. AND KANWAR, J. S., 1952, Physico-chemical properties of earthworm casting and their effect on productivity of soil. *Indian Journal of Agricultural Sciences*, **22** : 357-375.
- OBI, M. E. AND EBO, P. O., 1995, The effect of organic and inorganic amendments on soil physical properties and maize production in several severely degraded sandy soil in South Nigeria. *Bioresource Technology*, **51** : 117-123.
- PANDITA, M. L. AND HOODA, R. S., 1979, Effect of cycocel on growth, yield and quality of potato (*Solanum tuberosum* L.) cultivar Kufri Candramukhi. *Haryana Journal of Horticultural Sciences*, **8**(3-4) : 139-142.
- PATIL, M. S., 1995, Integrated nutrient management of commercial vegetables. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.
- PATRUDE, J. T., WANLHADE, S. G., KHODE, P. P., CHATOL, P. U., DEO, D. D. AND BHUYA, S. A., 2002, Effect of organic manures and plant population on yield of safed musli (*Chlorophytum borivillanum*). *Agricultural Science Digest*, **22** (1) : 51-52.
- PHOGAT, K. P. S. AND SINGH, O. P., 1987, Effect of cycocel and ethrel on growth and yield of ginger. *Progressive Horticulture*, **19**(3-4) : 223-226.
- PIRMOWICZ, F. AND SANGIN, M. L., 1978, Increase of total tuber yield either by foliar application or tuber treatment with cycocel. *Annals of Applied Biology*, **58** : 178-190.
- PRABHU, T., NARWADKAR, P. R., SANINDRANATH, A. K. AND MOHMED RAFI, 2002, Effect of integrated nutrient management on growth and yield of okra (*Abelmoschus esculantus* L.) cv. Parbhani Kranti. *South Indian Horticulture*, **50** : 550-553.
- PRASAD, M. AND RAO, M. V. L., 1986, Effect of nitrogen, phosphorus and potassium on sweet potato yield. *Journal of Root Crops*, **12**(2) : 111-112.
- PRAVEEN PRAKASH, CHETTI, M. B., PATIL, S. S. AND PRAKASH, P., 2001, Effect of plant growth regulators on growth parameters and yield in potato. *Karnataka Journal of Agricultural Sciences*, **14**(4) : 938-942.
- RAMESHWAR AND SINGH, C. M., 1998, Effect of FYM and fertilizers on growth and development of maize (*Zea mays* L.) and wheat (*Triticum aestivum* L.) in sequence. *Indian Journal of Agricultural Research*, **32**(1) : 65-70.
- RAO, D. V. R., SREEHARI, D., THIMMAREDDY, N. AND REDDY, K. S., 1989, Influence of certain plant growth regulators on growth, tuberization and rhizome yield of turmeric. *Progressive Horticulture*, **21**(3-4) : 194-197.
- REDDY, S. C. AND PATIL, S. V., 1981, Effect of growth retardants on yield and yield attributes of groundnut. *Mysore Journal of Agricultural Sciences*, **15** : 238-243.
- RODRIGEUS, E. T. AND SUMIOKA, A. T., 2003, Yam production as a function of manure. *Cienciae Agrotologia*, **27**(4) : 822-828.
- ROY, B., MISHRA, S. AND MISHRA, S. S., 1975, Effect of N, P and K on growth attributes, yield and quality of misrikand (*Pachyrrhizus angulatus* Rich.) in the sandy loam soil of North Bihar. *Journal of Root Crops*, **2**(2) : 29-35.

- SANKAR, V., THAMBURAJ, S., KANAN, N., SHANMUGAM, M., VEERARAGHAVATHATHAM, D., 1999, Effect of sequential cropping of vegetable cowpea (*Vigna unguiculata* L. Walp.) and different levels of FYM on growth and yield Cassava (*Manihot esculenta* Crantz). *South Indian Horticulture*, **47**(1-6) : 89-94.
- SARKAR, G. K. AND SINGH, I. J., 1984, Effect of nitrogen on growth, yield and quality of potato cv. Kufri Chandramukhi. *Progressive Horticulture*, **16**(1-2) : 73-77.
- SATHEESAN, K. V. AND RAMADHASAM, A., 1988, Effect of growth retardant CCC on growth and productivity of tuber under monoculture and in association with coconut. *Journal of Plantation Crops*, **16** : 140-143.
- SEAMON, K. B., 1984, Forskolin and adenylate cyclase : new opportunities in drug design. In : *Annual Report on Medicinal Chemistry*, 19 (Bailey D.M.ED.), Academic Press, New York, pp. 293-302.
- SHADEQUE, A. AND PANDITA, M. L., 1982, Effect of CCC as foliar spray on growth, yield and quality of potato. *Journal of research*, **3** (1) : 34-39.
- SHAHA, A. K., 1988, Note on response of turmeric to manures and source of nitrogen and phosphorus under terrace conditions of mid altitude Mizorium. *Indian Journal of Horticulture*, **45** : 139-140.
- SHARFUDDIN, A. P. M. AND ISLAM, M. A., 1977, Effect of CCC on vegetative growth, tuberization and yield of potato. *Bangladesh Horticulture*, **5** (1) : 1-4.
- SHARMA, B. L., KULDEEP PRASAD, D. K., SINGH, SUBASH SHARMA AND SINGH, S. B., 1999, Sulphitation pressmud cake in sugarcane : An integrated approach with inorganic nitrogen. *Indian Journal of Agricultural Chemistry*, **32** (1 and 2) : 1-5.
- SHARMA, S. AND KUMAR, A., 2003, Improving growth and productivity of *Plumbago zeylanica*. *National Symposium on Emerging Trends in Indian Medicinal Plants*, Lucknow, **21**(3-13) : 10-12.
- SHIVASUPIRAMANIAN, A. K. AND MALIK, P. A., 1999, Effect of sheep manure on growth and yield of potato. *Journal of American Society for Hort Science*, **113** : 124-129.
- SHIVAKUMAR, PATEL, A. L., TOMER, R. P. S. AND DAHIYA, B. S., 1994, Influence of nitrogen and 2, 3, 5-tri-iodobenzoic acid (TIBA) on hybrid seed yield and its components in sunflower. *Crop Research*, **8** : 457-490.
- SINGH, A. K. AND NEOPANEY, B., 1993, Effect of NPK nutrition and spacing on yield attributes in ginger. *Haryana Journal of Horticultural Sciences*, **22**(2) : 143-148.
- SINGH, A. P., PANKAJ, S. L. AND SINGH, G. N., 1983, Effect of growth regulators on growth, yield and quality of onion. *Punjab Horticulture Journal*, **23** : 100-104.
- SINGH, D. N., TRIPATHI, P., SAHU, A. AND NANDI, A. I., 1980, Effect of spacing and planting material on growth and yield of *Dioscorea alata*. *Journal of Root Crops*, **20** (2) : 87-89.
- SINGH, K. K., PELVI, S. K. AND SINGH, H., 1980, Medicinal properties of *Coleus forskohlii* Briq. *Bulletin of Medico – Ethano Botanical Research*, **1** : 4.
- SINGH, R. P., PRASAD, R. N., SINHA, H. AND SINGH, K. D. N., 1979, Effect of organic amendments on zinc availability to maize and soybean in calcareous soil. *Journal of the Indian Society of Soil Science*, **27** (3) : 321-324.
- SINGH, Y., GANGWAR, M. S., SINGAMAHAPATRA, B. S, SRIVASTAVA, P. C. AND KULSHRESHTHA, A., 1995, Utilization of distillery effluents for crop production and improving soil fertility. *Proceedings of National Symposium on Sustainable Agriculture in Aub-humid Zone*, pp. 97-99.

- STEFANESCU, M. AND DASCO, I., 1998, The effect of application of tare of organic and chemical fertilizers on wheat and maize. *Probleme de Agro fit technic Teoreticas : Applicate*, **10** (1) : 12-24.
- STOLYERENKO, V. S., KOVELENKO, V. E., SAMOSKAIN, A. A., BONDAR, P. S., PASHOVA, V. T. AND SKRITINK, L. N., 1992, Growth, development and microelements content in maize plantlets manured with organic waste bioconservation products. *Fiziogiya Biokhimiya Kol Tunmykh Rastenil*, **24** : 276-282.
- SURESH, N. S., 1980, Studies on the effects of nutrients and growth regulators on growth and yield of *Catherathus roseus*. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore.
- SYCHORA, Z. F., BALAGUROVA, I. I. AND VASYOKOVA, V. A., 1975, Effect of CCC on respiration and frost resistance of potato plant. *Fiziologiy Rastenii Kayelskogo Filio Alandanu Nauk Ptrozardos*, USSR.
- TALASHILKAR, S. C. DOSANI, A. A. K., MEHTA, V. B. AND PAWAR, A. G., 1997, Integrated use of fertilizers and poultry manure to groundnut crop. *Journal of Maharashtra Agricultural Universities*, **22** (2) : 205-207.
- THAKUR, S. S., PANDEY, I. B. AND MISHRA, S. S., 1999, Effect of organic manures, fertilizer levels and seed rate on yield and quality of late sown wheat (*Triticum aestivum* L.). *Indian Journal of Agronomy*, **44** (4) : 754-759.
- THIMMEGOWDA, S., MUNIYAPPA, A. V., RAMACHANDRA PRASAD, T. V. AND SHIVANANJE GOWDA, B. N., 1979, Potatoes responds to foliar nutrients and hormones. *Current Research*, **4** (7) : 140-150.
- TOMATI, U., GALLI, E., GTAPELLI, A. AND DILKENA, G., 1990, Effect of earth warm casts on protein synthesis in radish (*Raphanus sativus*) and lettuce seedlings. *Biology of Fertile Soils*, **9** : 12.
- TOMPE, S. V. AND MORE, S. D., 1996, Influence of pressmud cake on soil characteristics of a Vertisol. *Journal of Maharashtra Agricultural Universities*, **21** (1) : 6-8.
- VADIRAJ, B. A., KRISHNA KUMAR, M., JAYAKUMARAN AND NAIDU, R., 1992, Studies on vermicompost and the effect on cardamom nursery seedlings. *In Proceedings of IV National Symposium on Soil Biology and Ecology*, pp. 53-57.
- VADIRAJ, B. A., SIDDAGANGAIA, H. AND NARAYAN POTI, 1998, Effect of vermicompost on growth and yield of turmeric. *South Indian Horticulture*, **46** : 176-179.
- VALDES, L. J., MISLANKAR, S. G. AND PAUL, A. G., 1987, *Coleus barbatus* (Lamiaceae) and the potential new drug forskolin (Colenol). *Economic Botany*, **41** : 474-483.
- VASANTHI, D. AND KUMARASWAMY, K., 2000, Effect of manures and fertilizer schedules on the yield and uptake of nutrients by cereals, fodder crops and soil fertility. *Journal of the Indian Society of Soil Science*, **48**(3) : 510-515.
- VASANTHI, D., KUMARASWAMY, K. AND SUBBIA, K. K., 1998, Yield and nutritive values of cereal forage crops as influenced by manures-fertilizer schedules. *Forage Research*, **24** (3) : 163-167.
- VEERARAGHAVATHATHAM, V., VENKATACHALAM, R. AND SUNDARARAJAN, S., 1988, Effect of various levels of N, P and K on the tuber yield of *Coleus forskohlii*. *South Indian Horticulture*, **36**(5) : 252-257.
- VENKATESH, 1995, Effect of vermiculture on soil composition on growth, yield and quality of Thompson seedless grapes (*Vitis vinifera*). *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.

- VENKATESH, J., 1994, Studies on the evaluation of promising cultivars and nutritional requirements of turmeric (*Curcuma domestica* Val.). *Ph. D. Thesis*, University of Agricultural Sciences, Bangalore.
- VENKATESH, PATIL, P. B., SUDHIR KUMAR, K. AND KOTIKAL, Y. K., 1995, Influence of insitu vermiculture and vermicompost on yield and yield attributes of grapes. *Advances in Agricultural Research in India*, **8** : 53-56.
- VIRENDRA KUMAR AND MISHRA, B., 1991, Effect of two types of pressmud cake on growth of rice-maize and soil properties. *Journal of the Indian Society of Soil Science*, **39** : 109-113.
- VISHWAKARMA, R. A., TYAGI, B. R., AHMED, B. AND HUSSAIN, A., 1988, Variation in forskolin content in the roots of *Coleus forskohlii* Briq.. *Plant Medica*, **54** (5) : 471-472.
- VYAS, S. H., MODHWADIA, M. M. AND KHANPARA, V. D., 1997, Integrated nutrient management in wheat. *Journal of Research*, Gujarat Agricultural University, **23**(1) : 12-18.
- WASNIK, K. G. AND BAGGA, A. K., 1992, Effect of CCC on nitrate reductase activity and grain yield of green gram (*Vigna radiata* L. Wilczek). *Indian Journal of Plant Physiology*, **35** : 104-107.
- WEARING, P. F., 1982, The controlled development of potato plant by endogenous and exogenous growth regulators. In : *Chemical Manipulation and Crop Growth and Development*, Mc Larena (Ed.). Butter Worth, London, pp. 129-138.
- WATSON, D. J., 1958, The dependence of net assimilation rate on leaf area index. *Annals of Botany*, **22** : 37.
- WURR, D. C. E., 1976, The effect of growth regulating compounds methyl decanoate and TIBA on potato tuber size. *Journal of Agricultural Sciences*, **82** (2) : 241-255.
- YERRISWAMY, R. M., VASUKI, N. AND SATYANARAYANA, T., 1994, Alleviation of iron chlorosis of maize on calcareous vertisol. *Journal of the Indian Society of Soil Science*, **42** (1) : 156-159.
- YORK, A. C., 1983, Response of cotton to mepiquat chloride with varying N rates and plant populations. *Agronomy Journal*, **75** : 667-672.

Appendix I. Price of inputs and returns

<b>Sl. No.</b>	<b>Particulars</b>	<b>Prices (Rs.)</b>
I	Inputs	
1.	Planting material	2.00/10 cuttings
II	Manures and fertilizers	
	Urea	4.45/kg
	DAP	8.95/kg
	MOP	4.25/kg
	FYM	300/t
	Vermicompost	2000/t
	Sheep manure	450/t
	Poultry manure	2000/t
	Pressmud	1500/t
III	Plant growth regulators	
	TIBA	950/5 g
	CCC	540/250 g
	Mepiquat chloride	320/l
IV	Plant protection chemicals	
	Bavistin	420/kg
	Carbofuran	65/kg
	Vitavax	114/100g
	Knap sack sprayer	50.00/day
V	Labour charges	
	Men	50.00/day
	Women	30.00/day
	Bullock pair with men	300.00/day
	Miscellaneous	
	Land rent	5000/ha
	Tractor rent	2500/ha
VI	Returns	
	Rate of tubers	40.00/kg

Appendix II. Economic analysis of coleus as influenced by different organic manures and their combination

Treatment	Yield of tuber (t/ha)	Total cost invested (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit : Cost ratio
T <sub>1</sub> – Control	1.33	25130	53200	28070	1:2.07
T <sub>2</sub> – Control check, RDF	3.34	26819	133600	106780	1: 4.98
T <sub>3</sub> – FYM, 30 t/ha	2.41	34130	94400	62270	1: 2.76
T <sub>4</sub> – Vermicompost, 6 t/ha	2.70	37130	108000	70870	1: 2.90
T <sub>5</sub> – Sheep Manure, 6 t/ha	2.43	27830	97200	69370	1: 3.9
T <sub>6</sub> – Poultry manure, 2.281 t/ha	2.44	29692	97600	67908	1: 3.28
T <sub>7</sub> – Pressmud, 1.57 t/ha	2.68	27485	107200	79715	1: 3.90
T <sub>8</sub> – Vermicompost + FYM, 1:10	3.14	30130	125600	95470	1: 4.16
T <sub>9</sub> – Vermicompost + sheep manure, 1:1	3.29	28480	131600	103120	1: 4.62
T <sub>10</sub> – Poultry manure + FYM, 1:16.85	3.05	32185	122000	89815	1: 3.79
T <sub>11</sub> – Pressmud + FYM, 1:10.9	3.04	29900	121600	91700	1: 4.06
T <sub>12</sub> – Poultry manure + Vermicompost, 1:3.37	3.44	33870	137600	103730	1: 4.06

Appendix III . Economic analysis of coleus as influenced by different growth regulators

<b>Treatment</b>	<b>Yield of tuber (t/ha)</b>	<b>Total cost invested (Rs./ha)</b>	<b>Gross returns (Rs./ha)</b>	<b>Net returns (Rs./ha)</b>	<b>Benefit : Cost ratio</b>
T <sub>1</sub> – Control	2.35	25130	94000	68870	1:3.74
T <sub>2</sub> – TIBA, 50 ppm	2.51	26080	100400	74320	1:3.84
T <sub>3</sub> – TIBA, 100 ppm	2.54	26990	101600	7610	1:3.76
T <sub>4</sub> – CCC, 500 ppm	2.66	25670	106400	80730	1:4.14
T <sub>5</sub> – CCC, 1000 ppm	2.77	26130	110800	8670	1:4.24
T <sub>6</sub> – Mepiquat chloride, 500 ppm	2.56	25290	1022400	77110	1:4.04
T <sub>7</sub> – Mepiquat chloride, 1000 ppm	2.67	25480	106800	81380	1:4.19

# INFLUENCE OF ORGANIC MANURES AND GROWTH REGULATORS ON GROWTH AND YIELD OF COLEUS (*Coleus forskohlii* Briq.)

SUNIL KUMAR, G. S.

2005

Dr. J. C. MATHAD

Major Advisor

## ABSTRACT

Studies were conducted to find out the influence of organic manures and growth regulators on growth and yield of Coleus (*Coleus forskohlii* Briq.).

Among the organic manures applied in combination, poultry manure + vermicompost, 1:3.37 excelled in morphological characters like plant height, plant spread, number of branches per plant, number of leaves per plant and leaf area at 120 DAT. But in sole application of manures, vermicompost, 6 t/ha has recorded higher values for all morphological characters by following the same trend as seen in the different organic manures applied in combination to the crop. With respect to yield parameters, the treatment poultry manure + vermicompost, 1:3.37 had the highest number of tubers per plant (24.70), length of tubers (25.05 cm), diameter of tuber (1.85 cm), volume of tuber (242.03 cc), fresh weight of tubers (247.44 g/plant), dry weight of tuber (45.03 g/plant), yield of tubers (3.44 t/ha) and harvest index (33.2%). In sole application of organic manures, vermicompost, 6 t / ha traced the same trend as that of other combination treatments.

With regards to application of growth regulators, CCC, 1000 ppm recorded the highest reduction in plant height and produced more number of leaves per plant, number of branches per plant, plant spread and leaf area as compared to other treatments. The yield and yield parameters were also significantly influenced by application of growth regulators. The CCC, 1000 ppm recorded the highest number of tubers per plant (30.48), length of tubers (27.85 cm), diameter of tuber (1.96 cm), volume of tuber (246.96 cc), fresh weight of tubers (260.28 g/plant), dry weight of tuber (46.55 g/plant), yield of tuber (2.77 t/ha) and harvest index (47.3%).