"RESPONSE OF ORGANIC MANURES AND CHEMICAL FERTILIZERS ON GROWTH, FLOWERING AND VASE LIFE OF GOLDEN ROD (*Solidago canadensis* L.) cv. 'LOCAL' UNDER MIDDLE GUJARAT AGROCLIMATIC CONDITIONS "

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Reg. No. : 04-1019-2009

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A
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OF

Master of Science
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IN

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"Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agroclimatic conditions"

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ABSTRACT

The present investigation entitled "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agroclimatic conditions" was conducted at Horticultural Research Farm, Department of Horticulture, B.A.College of Agriculture, Anand Agricultural University, Anand during summer season of the year 2009-10. The treatments comprised of different levels of organic manures (FYM 20 t/ha, vermicompost 4 t/ha and castor cake 5 t/ha), nitrogen (50,100 and 150 kg/ha) and phosphorus (0 and 25 kg/ha). The experiment was laid out in a Randomized Block Design (Factorial) with eighteen treatment combinations and replicated thrice.

The results revealed that vermicompost 4 t/ha significantly recorded the highest plant height (84.7cm), fresh weight of plant (32.2 g) and dry weight of plant (10.3 g) as compared to rest of the organic manures treatments

at 60 DAP. Similarly at 90 days also vermicompost 4 t/ha produced significantly the highest plant height (92.0 cm), fresh weight of plant (98.5 g) and dry weight of plant (31.7 g). Vermicompost 4 t/ha significantly recorded the highest panicle length (67.6 cm) and no. of panicles per hectare (561878). The highest net realization, (Rs.236025/ha) CBR (1:5.60) was recorded with vermicompost 4 t/ha.

Castor cake 5 t/ha significantly recorded the highest number of panicles per plant (8.1). At peak flowering stage, FYM 20 t/ha significantly recorded the highest fresh (87.1 g) and dry weight of panicle (22.4 g).

At 60 and 90 DAP, significantly maximum plant height (85.0 and 94.3 cm), number of leaves per plant (222.1 and 408.8), leaf area index (LAI) (0.167 and 0.308), fresh weight of plant (35.0 and 101.0 g) and dry weight of plant (11.4 and 33.0 g) were obtained with nitrogen 150 kg/ha.

The maximum leaf area (416.7 cm^2), panicle length (71.2 cm), panicle stalk diameter (1.85 cm), number of panicles per plant (8.3), number of inflorescence branches per panicle (44.3), fresh and dry weight of panicle (91.0 and 24.1 g), number of inflorescences (601939) and net realization per hectare at (Rs.266406/ha) with CBR value of 1 : 7.8 were also obtained with nitrogen 150 kg/ha.

On the other hand, significantly minimum days taken for first flower and 50 % flowering was observed with nitrogen 50 kg/ha (83.6 and 106.3). Similarly maximum shelf life and vase life of inflorescence was also noted with nitrogen 50 kg/ha (16.5 and 7.5days).

At 60 and 90 DAP, significantly maximum plant height (83.0 and 91.1 cm), leaf area index (0.168 and 0.307), fresh weight of plant (33.7 and 100.8 g),

dry weight of plant (10.9 and 32.7 g) were observed with phosphorus 25 kg/ha. Significantly minimum days taken for first and 50 % flowering (83.4 and 105.0) was observed with phosphorus 25 kg/ha. At peak flowering stage, significantly maximum panicle length (67.4 cm), panicle stalk diameter (1.81 cm) number of panicles per plant (8.1), number of inflorescence branches per panicle (43.6), fresh and dry weight of panicle (87.2 and 22.9 g) were observed with same level i.e. phosphorus 25 kg/ha. Significantly maximum yield per hectare (555567) was also observed with phosphorus 25 kg/ha.

During peak period stage, significantly maximum shelf life and vase life of inflorescence (16.3 and 7.4 days) was observed with phosphorus 25 kg/ha. An application of phosphorus 25 kg/ha recorded maximum net realization of (Rs.244498/ha) with higher CBR value of 1 : 7.5 .

At 60 and 90 DAP maximum plant height (89.4 and 101.1 cm), fresh weight of plant (37.7 and 103.6 g), dry weight of plant (12.5 and 34.6 g) were noted with treatment combination N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5). At peak flowering stage, significantly maximum panicle length (72.8 cm), fresh weight of panicle (99.8 g), dry weight of panicle (26.9 g) and yield per hectare (615111 nos.) were also noted with N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5). From the foregoing discussion it can be concluded that in golden rod higher panicle with more profit and better quality of panicles can be obtained by adding vermicompost 4 t/ha. Moreover golden rod crop fertilizing with nitrogen 100 kg/ha with phosphorus 25 kg/ha gave higher number of inflorescences and profit under middle Gujarat agro climatic conditions.

DECLARATION

Dated: /12/2011

This is to certify that whole of the research work reported in the thesis in partial fulfillment of the requirement for the award of the degree of **Master of Science** (Agriculture) in the subject of **Horticulture** is the result of investigation done by undersigned, under the direct guidance and supervision of **Dr. H. C. Patel, Professor and Head, Department of Horticulture, B. A. College of Agriculture, AAU, Anand-388110** and no part of the research work has been submitted for any other degree so far.

Place: Anand

Date: /12/2011 **(Rahul Pandey)**

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CERTIFICATE

This is to certify that the thesis entitled **"Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agroclimatic conditions"** submitted by **Rahul Pandey** (**Reg. No. 04-1019-2009)** in partial fulfillment of the requirements for the award of the degree of **Master of Science** (Agriculture) in **Horticulture** of the Anand Agricultural University is a record of bonafide research work carried out by him under my personal guidance and supervision and the thesis has not previously formed the basis for award of any degree, diploma or other similar title.

Place: Anand
Date : /12/2011

(H. C. Patel)
Major Advisor

Acknowledgement

Emotions can't be adequately expressed in words hence my acknowledgement is much more than what I am expressing here.

I take this precious opportunity to express my gratitude humble indebtedness and sincere regards to ***Dr. H. C. Patel****, Professor and Head, Department of Horticulture, B A College of Agriculture and chairman of my Advisory Committee for his valuable guidance, fruitful and candid suggestions, constant inspiration and encouragement keen interest and constructive criticism right from the selection of the topic for my research work to the final shaping of the thesis in the present form as well as for his keen interest in the preparation of this manuscript. I would remain indebted forever.*

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Above all, I bow my head before the almighty whose blessing gave me the strength to make this a successful venture. All might have not been mentioned but none is forgotten.

Place : Anand

Date: - 12 - 2011 *(Rahul Pandey)*

CONTENTS

LIST OF ABBREVIATIONS

AAU	Anand Agricultural University
Anon.	Anonymous
@	At the rate of
^{0}C	degree Celsius
CBR	Cost-benefit ratio
CC	Caster cake
cm	Centimeter
C.V.	Coefficient of variation
cv.	Cultivar
DAP	Days after planting
dS	Deci Symonds
E	East
EC	Electrical conductivity
et al.	et allii : and others
etc.	Etcetera
Fig.	Figure
FYM	Farm Yard Manure
g	Gram
ha	Hectare
hrs.	Hour
i.e.	That is
K_2O	Potassium oxide
Kg	Kilogram
m	Meter

mm	Millimeter
Max.	Maximum
Min.	Minimum
N	North
N	Nitrogen
No.	Number
NS	Non-significant
%	Per cent
pH	Potential of hydrogen ions
P_2O_5	Phosphorus pentoxide
ppm	parts per million
q	Quintal
Rs.	Rupees
S.Em. $\pm$	Standard error of mean
Sr.	Serial
S.S.P	Single Super Phosphate
t	tonne
VC	Vermicompost
viz.,	Namely
Wt.	Weight
/	Per

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I. INTRODUCTION

Flowers have been an integral part of Indian culture, being used in social and religious functions, requirement of daily life or just a passion. These are also symbolize beauty, love and tranquility. Growing of flowers have been practiced in our country for many centuries as evidenced by the references found in ancient literature but commercial cultivation of flowers and development of floriculture as an industry are of recent origin (Singh and Sangama, 2000).

Our country is endowed with diverse agro-climatic conditions, which provides opportunities for production of all major flowers through out the year. Yet earliar floriculture in our country was restricted to the growing of traditional flowers like marigold, jasmine, gaillardia, spiderlily, chrysanthemum and rose. They are used as loose flowers. But today, realizing the importance of cut flowers at national and international levels, cultivation of high value cut flower crops such as Dutch rose, carnation, gladiolus, golden rod, gypsophila, gerbera, lilium etc. have been under taken.

The world trade in flowers is estimated to about $ 50 billion. Developed country contribution is higher in total world trade in floricultural products. Cut flowers contribute 45 percent share of the total

world trade in floricultural products (Singh and Sangama, 2000).In the global market, Netherlands, Germany, Japan, Europe, U.A.E and Hongkong are the main markets for Indian flowers. International trade of flowers has greatly expanded.

In India area under flower crops is about 167,000 hectare with production of about 987,000 MT of loose flowers (Anon.2009). Major flower growing states are Karnataka, Tamil Nadu , Andhra Pradesh, West Bengal, Maharashtra, Rajasthan, Uttar Pradesh, Delhi and Haryana. The total area under flower cultivation in Gujarat is about 12534 hectares with production of 95185 MT of loose flowers (Anon.2010).

Solidago, commonly known as golden rod, belongs to the family Asteraceae botanically known as *Solidago canadensis* L. The genus comprises about 130 species, mostly native of North America. Few species like *Solidago canadensis*, *S. virgaurea*, *S. memoralis* are grown in beds, borders or rock garden. Besides, they are also used as cut flowers for indoor decoration and bouquets. It produces large panicles of yellow flowers for several months a year, which are very attractive cut flowers. These hardy perennial herbs grown in almost all types of climates and soils but prefer a sunny location. Glycosides and essential oils are extracted from solidago. *S. virgaurea* occurs wild in India and two exotics have been introduced into the Indian gardens.

Golden rod plant is medium in height (about 20-30 cm tall) and have light green leaves. Plant is spreading by producing (multiplying) new suckers. Golden rod requires about 100 to 130 days for coming in the flowering stage after planting. It bears panicles of about 50-75 cm of length having 30-50 numbers of inflorescence branches per panicle. The inflorescence of golden rod is very complex in nature. Basically each small head is about 1.0 to 1.2 cm in length and 0.5 to 0.7 cm in diameter and consists of about 8 to 10 disc florets and some ray florets. Heads are axillary, solitary on main axis as well as branches and on small branch lets forming a whole compound panicle with golden yellow inflorescence.

Several hybrids have been evolved from *S. canadensis* and *S. viragaurea* which are free flowering and have showy flowers than the species. Some of the cultivars are Ballardi, Golden Gates, Golden Wings, Peter Par, etc.

Golden rod is propagated by division of stools, from suckers or seeds. The plants are easy to grow. Though they are gross feeders, soil rich in nutrient promotes vegetative growth. Addition of organic manures like FYM, vermicompost and castor cake in the soil is helpful to improve soil properties, water holding capacity and aeration which helps in the availability of nutrients and improves plant growth and production in dry season. When plants become root-bound, growth and flowering are reduced. The stools are lifted and divided for planting.

In moderate climate, planting can be done in any time but spring and rainy seasons are more favourable for growth (Sharma, 1989). The commercial cultivation of golden rod has not yet been exploited in India. Eventhough golden rod is cultivated in small scale by many farmers. The flowers (panicles) of golden rod are marketed to various places in Gujarat e.g. Surat, Ahmedabad, Vadodra, Anand etc. There is also a great demand of golden rod panicles in other large cities of India and also export for various purposes like bouquets and table decoration.

Golden rod can be cultivated on all type of soils having good structure and drainage with proper management practices. Among the different management practices, nutrient management plays an important role for good growth and flower production. The deficiency of nutrient in the soil is generally expressed in the form of certain disorders on the plant. The deficiency problems are particularly severe in light sandy soil which can be corrected by the additional supply of the particular nutrient to the plant. It has been observed that N, P, K and Fe nutrients are limiting factors in successful growing of golden rod.

Thus, the response of golden rod to the applied nutrients is quite encouraging in term of flower (panicles) production. Considering this, the present investigation was planned to find out the influence of organic manures and chemical fertilizers on growth and flower production of

golden rod (*Solidago canadensis* L.) cv. Local under middle Gujarat agroclimatic conditions with the following objectives.

1. To study the effect of different organic manures like FYM, vermicompost and castor cake on plant growth and panicle production of golden rod.
2. To find out effect of nitrogen and phosphorus on plant growth and panicle production of golden rod.
3. To find out interaction effect of organic manures, nitrogen and phosphorus on plant growth and panicle production of golden rod.
4. To find out appropriate source of nutrient supply for extending the shelf life of golden rod panicle.

II. REVIEW OF LITERATURE

The present investigation was carried out to study the "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv.'Local' under middle Gujarat agroclimatic conditions". It has been established that nutrition plays an important role in the improvement of growth and yield of golden rod crop (Ryagi *et al.,* 1996). Even though very meger work was done on nutrition aspect for this crop as well as information on alternative to inorganic fertilizers is lacking. Today, the use of inorganic fertilizers is to be reduced to encourage soil health and sustainability. Hence, an attempt has been made to find out the nutrients requirement for golden rod crop by using organic fertilizers which are also considered to be beneficial. An attempt has been made here to review the literature with special references in related floricultural crops. The review has been highlighted under different following heads:

2.1 Effect of organic manures on growth, flowering and yield

2.2 Effect of inorganic fertilizers on growth, flowering and yield

2.3 Effect of organic manures and inorganic fertilizers on shelf life and vase life

2.4 Interaction effect between organic manures and inorganic fertilizers on growth, flowering, yield and quality

2.1 Effect of organic manures on growth, flowering and yield

2.1.1 Effect of FYM

Gaur *et al.* (1992) reported that FYM contains 0.5 to 1.0 per cent N, 0.15 to 0.2 per cent P_2O_5 and 0.5 to 0.6 per cent K_2O. A brief review of literature on effect of FYM on golden rod as well as related flower crops is given below.

2.1.1.1 Effect of FYM on growth and flowering

Kulkarni *et al.* (1996) reported that an application of recommended dose of FYM 15 t ha^{-1} increased plant height (47.00 cm),number of leaves per plant (57.03),leaf area (17.28 cm^2/plant), Leaf Area Index (1.92) and number of flowers per plant (23.00) in China aster at Dharwad (Karnatka). Similarly, Yadav *et al.* (2000) also reported that the soil application of 2 % FYM gave maximum flower size (7.2 cm), fresh flower weight (11.0 g), pedicel length (7.2 cm) and no. of flowers per plant (21.1) in African marigold in pot culture experiment at Hisar (Haryana).

Saud and Chandra (2004) concluded that the application of FYM 15 t/ha gave the maximum plant height (66.83 cm), number of primary branches per plant (23.67), number of secondary branches per plant (77.75), maximum flower size (4.49 cm), fresh flower weight (3.38 g), dry weight of flower (0.42 g) and number of flowers per plant (302.35) in marigold.

Patel (2005) reported that the application of FYM 20 t/ha gave higher plant height (26.9 cm), number of leaves per plant (54.1), leaf area (70.7 cm^2), dry weight of plant (30.5 g), minimum number of days taken for flowering (82.7), panicle length (56.5 cm), number of inflorescence branches (38.7), diameter of panicle stalk (1.4 cm), fresh (102.6 g) and dry panicle weight (25.4 g) in golden rod at Navsari (Gujarat).

2.1.1.2 Effect of FYM on yield and quality

Kulkarni *et al.* (1996) reported that application of recomended dose of FYM (15 t ha^{-1}) increased flower yield (5.90 t/ha) in China aster at Dharwad (Karnatka).

Yadav *et al.* (2000) reported that soil application of 2% of FYM gave maximum flower yield per plant (228.9 g) in African marigold at Hisar (Haryana).

Saud and Chandra (2004) concluded that the application of FYM 15 t/ha gave maximum flower yield per plant (483.25 g) in marigold. Similarly, Patel (2005) also reported that the application of FYM 20 t/ha gave higher number of panicles per plant (7.0), number of panicles per hectare (521536.30) in golden rod at Navsari (Gujarat).

2.1.2 Effect of Vermicompost

Vermicomposting is an ecofriendly, low cost effective and an effective way to recycle agricultural wastes. The application of vermicomposting not

only adds plant nutrients (macro and micro) and growth regulators but also improves the physical and chemical properties of soil, besides enhancing the microbial population and carbon content of the soil.

2.1.2.1 Effect of vermicompost on growth and flowering

Kulkarni *et al.* (1996) reported that application of recomended dose of vermicompost (2.5 t ha^{-1}) increased plant height (46.81 cm),number of leaves per plant (56.00), leaf area (16.80 cm^2/plant), LAI (1.87) and number of flowers per plant (20.46) in China aster at Dharwad (Karnatka).

Nethra *et al.* (1999) conducted field experiment and reported that application of vermicompost 15 t ha^{-1} gave higher plant height (26.58 cm), number of leaves per plant (24.41) and maximum number of flowers per plant (17.16) in China aster.

Chauhan (2005) concluded that the application of vermicompost 1 kg/m^2 gave maximum plant height (22.03 cm), maximum flower stalk length (7.33 cm), number of flowers per plant (21.13), individual flower weight (5.05 g) in marigold cv. 'Pusa Narangi Gainda'. Similarly, Tyagi and Kumar (2006) also reported that various growth parameters like plant height (20.75 cm) , number of branches per plant (14.60), number of flowers per plant (13.33), stalk length (2.10 cm) and fresh flower weight (6.03 g) increased with application of vermicompost 8 t/ha in marigold.

2.1.2.2 Effect of vermicompost on yield and quality

Kulkarni *et al.* (1996) reported that application of 2.5 t per hectare vermicompost increased flower yield (5.31 t/ha) in China aster at Dharwad (Karnatka). Similarly, Nethra *et al.* (1999) reported that application of vermicompost 15 t/ha gave higher flower yield (2.85 t/ha) in China aster.

Chauhan *et al*. (2005) concluded that the application of vermicompost 1 kg/m^2 gave maximum flower yield/m^2 (1.75 kg) in marigold cv. 'Pusa Narangi Gainda'.

Tyagi and Kumar (2006) reported that flower yield (67.09 q/ha) increased with the application of vermicompost 8 t/ha in marigold at meerut (U.P.).

2.1.3 Effect of Castor Cake

2.1.3.1 Effect of castor cake on growth and flowering

Patil and Dhaduk (2009) reported that application of 100 % castor cake gave maximum plant height (159.0 cm), plant spread (88.3 cm), number of branches per plant (38.8), days to first flowering per plant (51.2 days), number of flowers per plant (35.9), flower diameter (6.0) in African marigold cv. 'Pusa Narangi Gainda' . They further observed in cv. 'Pusa Basanti Gainda' that application of 100 % castor cake gave maximum plant height (80.83 cm), plant spread (40.21 cm), number of branches per

plant (13.20), days to first flower per plant (48.41 days), number of flowers per plant (61.45), flower diameter (4.10 cm) at Navsari (Gujarat).

2.1.3.2 Effect of castor cake on yield and quality

Patil and Dhaduk (2009) reported that application of 100 % castor cake gave higher flower yield per plant (145.6 g) and per hectare (111.4 q) in cv. 'Pusa Narangi Gainda'.They further observed in cv. 'Pusa Basanti Gainda', application of 100 % castor cake also gave higher flower yield per plant (405.5 g) and per hectare (144.6 q) in African marigold at Navsari (Gujarat).

2.2 Effect of inorganic fertilizers on growth, flowering, yield and quality

An optimum dose of nitrogen, phosphorus and potassium is essential for proper vegetative growth, good quality and higher flower yield. Nitrogen plays vital role in chlorophyll synthesis and amino acids formation which contribute to the building units of protein and thereby growth of the plant. Phosphorus and potassium also occupied an important place amongst the non-renewable input of modern agriculture which is a constituent of many plant metabolites. Optimum supply of these elements ensures better growth and improves the flower yield and quality.

2.2.1 Effect of nitrogen on growth

Patel (1998) observed that plant height (33.06 cm), number of branches (6.98) and plant spread per plant (23.41 cm) were significantly higher at 300 kg N/ha in chrysanthemum at S.K. Nagar (Gujarat).On same line, Barman and Pal (1999) observed that 300 kg/ha nitrogen appreciably increased the plant height, number of branches per plant, plant spread in chrysanthemum. Similarly, Sehrawat *et al.* (2003) obtained optimum plant height (82.10 cm) with 300 N kg ha^{-1} as compared to control (200 kg ha^{-1}) in marigold cv. 'Giant Double Orange' under Hissar (Haryana) conditions.

Pandey and Mishra (2005) reported that the application of nitrogen 200 kg/ha gave maximum plant height (66.76 cm) in marigold. Similarly Patel (2005) also reported the application of nitrogen @ 200 kg/ha giving maximum plant height (30.9 cm), number of leaves/plant (56.2), leaf area (74.9 cm^2) and dry plant weight (32.4 g) in golden rod at Navsari (Gujarat).

Karuppaiah and Krishna (2005) concluded that an application of 450 kg N ha^{-1} recorded the maximum growth characters viz., plant height (63.91 cm) and number of primary branches per plant (25.09) in French marigold at Annamalainagar (Tamil Nadu) conditions.On the other hand, Rajbeer *et al.* (2009) revealed that an application of 100 kg/ha nitrogen increased the plant height (67.76 cm) and plant spread (49.88 cm) but

maximum number of primary branches/ plant (18.15) was observed at 150 kg/ha nitrogen in African marigold at Meerut (U.P.).

Ghosh and Pal (2010) observed that an application of nitrogen 300 kg/ha gave maximum plant height (67.87 cm), number of primary branches per plant (5.53) and number of secondry branches per plant (21.97) in African marigold at Mohanpur (West Bengal).

Parekh *et al.* (2010) revealed that the maximum plant height (56.87 cm) was recorded with nitrogen 100 kg/ha. On the other hand, maximum plant spread (972 sq.cm) was obtained with nitrogen 200 kg/ha in chrysanthemum cv. 'IIHR-6'at Anand (Gujarat).

2.2.2 Effect of nitrogen on flowering and yield

Patel (1998) noticed that single flower weight (2.92 g) and flower diameter (7.09 cm) were significantly higher at 200 kg N/ha in chrysanthemum at S.K. Nagar (Gujarat).

Hameed and Sekar (1999) reported that maximum flower diameter (6.35 cm), single flower weight (6.26 g) and flower yield per plant (211.30 g) were observed in African marigold cv. 'Dindigul' treated with 150 kg N/ha. The same treatment produced 50 % flowering earliest (42.66 days).

Hugar and Nalawadi (1999) reported that the highest flower yield was obtained with the application of 75 kg N ha^{-1} (19.6 and 18.0 t/ha in *rabi* and summer seasons, respectively) in gaillardia.

Singh and Sangama (2000) recorded that the application of nitrogen 300 kg/ha gave maximum flower diameter (5.46 cm), flower stalk length (27.27 cm) and number of flowers per plant (35.22) in China aster at Bangalore (Karnataka).

Yadav *et al*. (2000) observed maximum average flower weight (11.8 g), number of flowers per plant (25.6) and flower yield per plant (301.2 g) were recorded at 180 kg N level in African marigold at Hisar (Haryana).

Jadhav *et al*. (2002) revealed that number of flowers per plant (66.75), flower yield (330.0 g/plant), number of pickings (6.51), flower yield per hectare (122.93 q) were the highest under 100 kg N/ha in marigold at.

Muhammad-shafi *et. al*. (2002) found maximum number of flowers per plant (209.7) and the longest flowering period (185.3 days) with nitrogen 200 kg/ha in gaillardia.

Sehrawat *et al*. (2003) reported maximum number of flowers per plant (31.86) with 300 N kg ha^{-1} as compared to control (200 kg ha^{-1}) in marigold cv. 'Giant Double Orange' under Hisar conditions.

Acharya and Dashora (2004) revealed that the application of 150 kg N/ha produced maximum number of flowers (76.86) and flower yield per plant (417.62 g) whereas higher single flower weight (5.45 g) was obtained with 200 kg N/ha in marigold under Udaipur conditions.

Beniwal *et al.* (2005) revealed that the application of 200 kg N/ha significantly improved the flowering (days to first flowering and size of flower) and yield parameters (numbers of flowers per plant, fresh flower weight and flower yield) in chrysanthemum cv. 'Flirt' under Hissar conditions.

Karuppaiah and Krishna (2005) concluded that an application of 450 kg/ha nitrogen recorded the maximum values of flower characters viz., number of flowers per plant (53.26), single flower weight (1.57 g) and flower diameter (3.14 cm) in French marigold at Annamalainagar (Tamil Nadu) conditions.

Patel (2005) reported that the application of nitrogen @ 200 kg/ha took minimum number of days for flowering (78.4) and maximum length of panicle (60.0 cm), number of inflorescence branches per panicle (45.4), diameter of panicle stalk (2.0 cm), fresh weight of panicle (120.0 g),dry weight of panicle (31.5 g), number of panicles per plant (8.7) and number of panicles per hectare (627160.5) in golden rod at Navsari (Gujarat).

Karetha *et al.* (2008) conducted a field experiment at Junagadh (Gujarat) and observed that application of 200 kg N ha^{-1} increased flower yield in gaillardia cv. 'Local Double'.

Rajbeer *et al.* (2009) revealed that application of nitrogen 150 kg/ha gave maximum number of flowers per plant (17.33), flower yield per plant (170.73 g) and per hectare (14.32 t) in African marigold.

Chavan *et al.* (2010) recorded maximum number of days to open first flower (68.40 days) with application of 300 kg N/ha. They further observed highest number of flowers per plant (24.02) and flower yield (127.42 q ha^{-1}) with application of 200 kg N/ha in China aster at Junagadh (Gujarat).

Ghosh and Pal (2010) observed that an application of nitrogen 300 kg/ha gave maximum flower diameter (5.68 cm) and individual flower weight (5.44 g) in African marigold at Mohanpur (West Bengal).

2.2.3 Effect of phosphorus on growth

Patel (1998) observed that plant height (31.47 cm), number of branches (6.80) and plant spread (22.50 cm) were significantly higher at 100 kg P/ha in chrysanthemum cv. IIHR-6 at S.K. Nagar (Gujarat). In same line, Karuppaiah and Krishna (2005) concluded that an application of 100 kg P_2O_5 ha^{-1} recorded maximum growth characters viz., plant height (36.26 cm) and number of branches per plant (12.84) in French marigold at Annamalainagar (Tamil Nadu) conditions.

Pandey and Mishra (2005) reported that the application of phosphorus 200 kg/ha gave higher plant height (62.69 cm) in marigold.

Similarly, Sehrawat *et al*. (2003) found out optimum plant height (82.10 cm) with 200 P kg ha^{-1} in marigold cv. 'Giant Double Orange' under Hissar conditions.

Patel (2005) reported that application of phosphorus 50 kg/ha gave maximum plant height (29.7 cm), number of leaves per plant (56.5), leaf area (71.6 cm^2) and dry plant weight (33.3 g) in golden rod cv. 'Local yellow' at Navsari (Gujarat).

Rathi *et al.* (2005) noticed that an application of full dose of P_2O_5 (50 kg ha^{-1}) gave maximum number of branches/plant (17.47) and plant spread (37.47 N-S and 31.47 E-W) under Navsari (Gujarat) conditions in African marigold cv. 'Local'. Similarly, Nandre (2005) concluded in field experiment at Akola (Maharashtra) that an application of 50 kg ha^{-1} P_2O_5 increased plant height (58.72 cm) and number of branches per plant (26.45) in China aster.

Syamal *et al.* (2006) reported that application of 75 kg/ha phosphorus gave optimum plant height (61.77 cm) in marigold cv. 'Rusty Red'.

2.2.4 Effect of phosphorus on flowering and yield

Khader *et al*. (1990) noted that an application of 200 kg P_2O_5/ha had resulted maximum flower yield in chrysanthemum cvs. 'Co-1', 'Co-2' and 'MDU-1'.

De and Dhiman (1998) observed that the application of phosphorus 300 kg/ha gave optimum flower diameter (9.50 cm), stalk length (21.0 cm) and early flower opening (102 days) in chrysanthemum cv. Chandrama.

Patel (1998) noticed that minimum days were taken to first flowering (122.17 days) and maximum duration of flowering (47.26 days) were obtained with application of phosphorus at 50 kg/ha. He further noticed that maximum no. of flowers per plant (34.40) and higher flower yield/plant (98.74 g) were obtained with the application of phosphorus at 100 kg/ha in chrysanthemum cv. IIHR-6 at S.K. Nagar (Gujarat).

Hameed and Sekar (1999) reported that maximum flower diameter (6.35 cm), single flower weight (6.26 g) and flower yield per plant (211.30 g) were observed in African marigold cv. 'Dindigul' treated with 120 kg P_2O_5/ha. The same treatment produced 50% flowering earliest (42.66 days).

Pandey and Mishra (2005) reported that the application of phosphorus 200 kg/ha gave maximum no. of flowers per plant (66.80), flower size (5.11 cm) and flower yield per plant (563.59 g) in marigold at Hissar (Haryana).

Rajadurai *et al.* (2000) concluded that higher flower production as well as the longest flower stalks were produced with 45 kg P_2O_5/ha in African marigold at Annamalainagar (Tamil Nadu).

Sehrawat *et al*. (2003) reported maximum number of flowers per plant (31.86) with 200 kg P_2O_5/ha in marigold cv. 'Giant Double Orange' under Hisar conditions.

Acharya and Dashora (2004) revealed that the application of 200 kg P_2O_5 ha^{-1} produced maximum number of flowers per plant (68.40) and flower yield per plant (323.07 g) whereas higher single flower weight (5.08 g) was obtained with 100 kg P_2O_5 ha^{1} in marigold under Udaipur conditions.

Beniwal *et al.* (2005) revealed that the application of 200 kg/ha phosphorus significantly improved the flowering (days to first flowering and size of flower) and yield parameters like numbers of flowers per plant, fresh flower weight and flower yield in chrysanthemum cv. 'Flirt' under Hisar conditions.

Karuppaiah and Krishna (2005) concluded that an application of 100 kg P_2O_5 ha^{-1} recorded maximum value for flower characters viz., number of flowers per plant (28.93), single flower weight (0.74 g) and flower diameter (1.45 cm) in French marigold at Annamalainagar (Tamil Nadu) conditions.

Patel (2005) reported that the application of phosphorus 50 kg/ha took less number of days for flowering (79.7), maximum length of panicle (56.5 cm), number of inflorescence branches per panicle (42.0), diameter of panicle stalk (1.8 cm), fresh (122.4 g) and dry panicle weight (32.2 g), number of panicles per plant (8.5), number of panicles per hectare (627160.5) in golden rod at Navsari (Gujarat). Similarly, Nandre *et al.* (2005) reported that an application of 50 kg ha^{-1} P_2O_5 resulted maximum number of flowers per plant (39.60) and flower yield (107.20 g/plant and 11.62 t ha^{-1}) in China aster under Akola (Maharashtra) conditions.

Karetha *et al.* (2008) conducted a field experiment at Junagadh (Gujarat) and observed that application of 75 kg P_2O_5 ha^{-1} significantly increased flower yield in gaillardia cv. 'Local Double'.

Panchal (2009) reported that an application of 100 kg P_2O_5 gave highest flower diameter (7.37 cm), number of flowers per plant (161.28) and flower yield (22.56 t ha^{-1}) in annual white chrysanthemum at Anand (Gujarat) conditions.

2.3 Effect of organic manures and inorganic fertilizers on shelf life and vase life

Khimani and Patil (1995) reported that an increasing nitrogen levels (100, 150 and 200 kg/ha) resulted in a corresponding decrease in the shelf life of gaillardia flowers.

Singatkar *et al*. (1995) revealed that keeping quality of gaillardia flowers was similar at 100 kg N/ha and no nitrogen application, but further increase in nitrogen 200 kg/ha decreased the keeping quality.

Patel (1998) noticed that keeping life of loose flower (5.61 days), with pedicillate flowers (7.32 days) and vase life of cut flowers (10.68 days) were significantly higher at 100 kg P/ha. He further noticed that keeping life of loose flower without pedicle (7.22 days), with pedicel (8.64 days) and vase life of cut flowers (12.79 days) were significantly higher at lower dose of nitrogen i.e 100 kg/ha in chrysanthemum at S.K. Nagar (Gujarat).

Nethra *et al.* (1999) reported that application of vermicompost 15 t/ha gave higher vase life (9.50 days) in China aster.

Patel (2005) reported that application of FYM 20 t/ha gave higher shelf life of inflorescence (16.6 days) and vase life of inflorescence (7.1 days). He further reported that the application of nitrogen @ 200 kg/ha took maximum shelf life of inflorescence (19.5 days) and vase life of inflorescence (5.8 days) in golden rod at Navsari (Gujarat).

Panchal (2009) reported that an application of 100 kg P_2O_5 gave the highest shelf life (4.33 days) in annual white chrysanthemum at Anand (Gujarat) conditions.

2.4 Interaction effect of organic manures and inorganic fertilizers on growth, flowering, yield and quality

Patel (1998) observed significantly higher number of flowers per plant (37.72) under 200 kg N x 100 kg P_2O_5 /ha in chrysanthemum cv. IIHR-6 at S.K. Nagar (Gujarat).

De and Dhiman (1998) noticed that application of N 200 + P 400 kg/ha gave optimum plant height (75 cm), number of flowers/plant (57) a five flower average weight (37 g) in chrysanthemum cv. Chandrama.

Pandey and Mishra (2000) reported that application of 200 kg/ha N + 200 kg/ha P_2O_5 gave maximum plant height (69.71 cm), no. of flowers per plant (74.29) and flower yield per plant (717.44 g) in marigold. They further observed that 200 kg/ha N + 200 kg/ha P_2O_5 +100 kg/ha K_2O gave maximum plant height (71.01 cm), no. of flowers per plant (75.84) and flower yield per plant (754.00 g) in marigold at Hisar (Haryana).

Saud and Chandra (2004) concluded that application of higher doses of fertilizers (150 : 150 :150 kg NPK ha^{-1}) resulted maximum plant height (72.89 cm), number of primary branches per plant (30.96), number of secondary branches per plant (105.22) and flower yield (768.00 g) in marigold.

Sunitha *et al.* (2007) reported that application of 112.5: 30: 30 kg NPK/ha + vermicompost 2.5 t/h gave maximum plant height (100.3 cm) and number of flowers per plant (66.2) in marigold.

Patel (2005) reported that application of nitrogen 200 kg/ha with phosphorus 50 kg/ha gave maximum plant height (35.1 cm), fresh weight of plant (111.9 g), dry weight of plant (36.1 g), panicle stalk diameter (2.2 cm), fresh (127.6 g) and dry panicle weight (36.4 g), number of panicles per plant (9.7) and per hectare (720987.6), shelf life of inflorescence (16.8 days) and vase life of inflorescence (5.0 days) in golden rod cv. 'Local Yellow' at Navsari (Gujarat).

Chawala *et al.* (2006) reported that application of 300 +150 kg N and P per hectare gave maximum plant height (46.70 cm), duration of flowering (40.67 days), number of flowers per plant (49.00) and flower yield (12.98 t/ha) in chrysanthemum.

III. MATERIALS AND METHODS

The details of the materials used and experimental methods adopted during the course of this investigation on "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agroclimatic conditions" is presented in this chapter.

3.1 GENERAL

3.1.1 Experimental Site

The experiment was conducted at the Horticulture Research Farm, Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand during summer season of the year 2009-10.

3.1.2 Plant Materials

Golden rod suckers were obtained from College Nursery, Horticulture Department, B. A. College of Agriculture, Anand for planting in experimental plot.

3.1.3 Treatment Materials

Organic manures like FYM, vermicompost and castor cake and for application of nitrogen and phosphorus, fertilizers like urea and single superphosphate were obtained from Horticulture Research Farm, Department of Horticulture, B.A. College of Agriculture, A.A.U., Anand.

3.2 PHYSIOGRAPHICAL SITUATION

3.2.1 Location

Horticulture Research Farm of the Department of Horticulture, B.A. College of Agriculture, Anand Agricultural University, Anand is situated on 22^0 35′ North latitude and 72^0 56′ East longitudes at an elevation of 45.1 meters above the mean sea level.

3.2.2 Climate and Weather Conditions

The climate of Anand region is semi-arid and sub-tropical, winter is fairly cool and dry, while summer is quite hot and dry. Temperature during hot weather commences by about mid February and ends by about middle of June. The mean minimum temperature ranged from 19.1 ^oC to 26.3 ^oC and mean maximum temperature ranged from 31.41 ^oC to 41.34 ^oC during the crop season of the year 2010. An average annual rainfall of this region is about 836 mm. Monsoon of this region is often erratic and uncertain, both in respect of total rainfall and its distribution.

The mean weekly meteorological data on sunshine hours/day, rainfall, maximum and minimum temperatures and relative humidity recorded at the Meteorological Observatory of Anand during the year 2010 (during cropping period of the experimental crop of golden rod) are given in Appendix-I and graphically depicted in Fig. 3.1.

3.2.3 Soil Characteristics

The experimental soil is classified as sandy loam locally known as '*Goradu*'. *Goradu* soil is alluvial by its origin and very deep, well drained and fairly retentive of moisture. It responds well to irrigation and manuring and is suitable for golden rod cultivation. The physical and chemical properties of the experimental field are presented in Table 3.1and 3.2.

Table 3.1: Physical properties of the experimental plot

Sr. No.	Particulars	Value in per cent (0-15 cm depth)	Method of analysis
1.	Coarse sand (%)	0.43	International pipette method (Piper, 1950)
2.	Fine sand (%)	83.57	- do -
3.	Silt (%)	10.82	- do -
4.	Clay (%)	5.18	- do -
5.	Texture	Sandy loam	

Table 3.2: Chemical properties of the experimental plot

Sr. No.	Soil characteristics	Value (0-15 cm depth)	Method of analysis
1.	Organic carbon (%)	0.29	Walkley and Black's method (Jackson, 1973)
2.	Total nitrogen (%)	0.043	Kjeldahl's method (Jackson, 1973)
3.	Available phosphorus (kg/ha)	45.7	Olsen's method (Jackson, 1973)
4.	Available potash (kg/ha)	336.9	Flame photometric method (Jackson, 1973)
5.	Soil pH (1:2.5, soil : water ratio)	7.22	Backman's pH meter (Jackson, 1973)
6.	EC (dsm^{-1})	0.21	Solubridge method (Jackson, 1973)

3.3 EXPERIMENTAL DETAILS

With a view to study the "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agro climatic conditions" was conducted during summer season of 2009-10. The details of experiment are given below.

3.3.1 Experimental Design: Randomized Block Design (Factorial)

3.3.2 Number of Replications : Three (3)

3.3.3 Plot Area **:** Gross plot: 3.60 x 2.10 m

Net plot : 2.70 x 1.50 m

3.3.4 Spacing **:** 45 x 30 cm

3.3.5 Plant Population : Total number of plots in replication = 18

Total number of rows within plot = 06

Total number of plants per row = 08

Total number of plants per plot = 48

3.3.6 Treatment Details:

(A) Organic manures (M)

M_1 : FYM 20 t/ha

M_2 : Vermicompost 4 t/ha

M_3 : Castor cake 5 t/ha

(B) Nitrogen levels (N)

N_1 : 50 kg/ha

N_2 : 100 kg/ha

N_3 : 150 kg/ha

(C) Phospshorus levels (P)

P_1 : 0 kg/ha

P_2 : 25 kg/ha

In this experiment 18 (eighteen) treatment combinations were tried which are presented in Table 3.3.

Table 3.3: Treatment details with its concentrations

Sr. No.	Treatment No.	Treatment Symbol	Details of Treatment combination		
			Level		
			Organic manures (t/ha)	N (kg/ha)	P (kg/ha)
1	T_1	$M_1N_1P_1$	20 FYM	50	0
2	T_2	$M_1N_1P_2$	20	50	25
3	T_3	$M_1N_2P_1$	20	100	0
4	T_4	$M_1N_2P_2$	20	100	25
5	T_5	$M_1N_3P_1$	20	150	0
6	T_6	$M_1N_3P_2$	20	150	25
7	T_7	$M_2N_1P_1$	4 VC	50	0
8	T_8	$M_2N_1P_2$	4	50	25
9	T_9	$M_2N_2P_1$	4	100	0
10	T_{10}	$M_2N_2P_2$	4	100	25
11	T_{11}	$M_2N_3P_1$	4	150	0
12	T_{12}	$M_2N_3P_2$	4	150	25
13	T_{13}	$M_3N_1P_1$	5 CC	50	0
14	T_{14}	$M_3N_1P_2$	5	50	25
15	T_{15}	$M_3N_2P_1$	5	100	0
16	T_{16}	$M_3N_2P_2$	5	100	25
17	T_{17}	$M_3N_3P_1$	5	150	0
18	T_{18}	$M_3N_3P_2$	5	150	25

3.4 CULTURAL OPERATIONS

Various cultural operations right from the beginning till the end of experimentation were performed quite successfully which are described here under in sequence and also shown in Appendix-II.

3.4.1 Layout Of Experiment

Layout of the experiment was done according to the experimental design (Fig. 3.2). The marking of lines was done with the help of marker in dry condition of soil. Later on plots were prepared with the help of labours.

3.4.2 Application Of Manures

Well decomposed farmyard manure, vermi compost and castor cake were applied uniformly to all the experimental plot @ 20, 4 and 5 t/ha, respectively as a basal dose before the planting in all the treatments.

3.4.3 Application Of Fertilizers

According to treatments half dose of nitrogen and full dose of phosphorus was applied as basal dose while second dose of remaining nitrogen was applied one month after planting. Potash 25 kg/ha was applied in form of muriate of potash as common dose before the planting of suckers in all treatments.

3.4.4 Planting of golden rod suckers

Golden rod suckers were obtained from College Nursery, Horticulture Department, B. A. College of Agriculture, Anand. The planting was done at plot no. HC-3, Horticulture Research Farm, Department of Horticulture, B.A. College of Agriculture, A.A.U., Anand on 24th February, 2010. Small pits were prepared at 45 X 30 cm distance in the plots and suckers were planted.

3.4.5 After Cares

3.4.5.1 Irrigation

A light irrigation was given immediately after planting of suckers in the field for proper establishment of suckers. Irrigations were given regularly at 7 to 8 days interval depending upon soil moisture status and requirement of the crop (Appendix-II).

3.4.5.2 Weeding and hoeing

For the control of weeds, hand weeding was carried out at 12-15 days interval at the initial stage of growth and 25-30 days interval at later stage of experimentation. Three hoeings were carried out at initial growth stage (Appendix-II).

3.4.5.3 Plant protection

No major pest and diseases were observed in experimental plot. But termite problem was observed. Plant protection measures were adopted to protect the crop against termite attack. The crop protection measures were used in the present experiment are presented in Appendix-III.

3.4.5.4 Stage of harvesting

Harvesting was done early in the morning at the stage of few opened flowers on the top of the panicle at three or four days interval with secateurs. The yield of net plot was recorded in form of number of panicles.

3.5 COLLECTION OF EXPERIMENTAL DATA BY SAMPLING TECHNIQUE

Five plants were selected at random from each net plot of each treatment and tagged for recording the observations.

3.6 OBSERVATIONS RECORDED

3.6.1 Observations On Growth Parameters

3.6.1.1 Plant height (cm)

Golden rod is a rosette type of plant with a spreading habit so plants remain dwarf to medium in height. The observations on plant height were recorded from five tagged plants. The plant height of five tagged plants in

each net plot was measured by metric scale from the base to the tip of the main shoot of the plant at 60 and 90 days interval after transplanting.

3.6.1.2 Number of leaves per plant

Numbers of leaves of five tagged plants in each net plot were recorded at 60 and 90 days interval after transplanting and average was worked out.

3.6.1.3 Leaf area (cm^2) during peak flowering period stage

In order to measure the leaf area, leaves of different size viz., big, medium and small were randomly selected from the lower, middle and upper portion of five plants. Their leaf area was measured with portable leaf area meter (model (I) 203 area meter (ii) Inc. made in USA) and their average values were worked out in square centimetre.

3.6.1.4 Leaf area index (LAI) at 60 and 90 days interval after transplanting

Leaf area of five previously selected plants was calculated by leaf area meter. Then average leaf area index was worked out with following formula.

$$LAI = \frac{\text{Leaf Area } (cm^2)}{\text{Spacing } (cm^2)}$$

3.6.1.5 Fresh weight of plant (g) at 60 and 90 days interval after transplanting

At 60 and 90 days after planting five plants were taken out from each plot (except net plot) with roots and were immediately weighed out and average was worked out.

3.6.1.6 Dry weight of plant (g) at 60 and 90 days interval after transplanting

After recording fresh weight of five plants these were air dried under shade in laboratory and then oven-dried at 60 °C till constant weight and average was worked out.

3.6.1.7 Moisture (%) at 60 and 90 days interval after transplanting

On the basis of fresh and dry weight of plants, moisture % was calculated with the help of following formula.

$$\text{Moisture \%} = \frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$$

3.6.2 Observations On Flowering and Yield Parameters

3.6.2.1 Days taken for first flowering

The time interval between planting of plants and the appearance of first inflorescence in each plot was counted as days required for first flowering.

3.6.2.2 Days taken for 50% flowering

The time interval between planting of plants and the 50% appearance of inflorescences in each plot was counted as days required for 50% flowering.

3.6.2.3 Length of panicle (cm) at peak flowering stage

The length of an individual panicle of five tagged plants of each net plot was recorded after harvesting.

3.6.2.4 Diameter of panicle stalk (cm) at peak flowering stage

At the peak flowering stage five tagged plants from each net plot the panicle diameter was measured in centimetres with the help of Vernier callipers and average was worked out.

3.6.2.5 Number of panicles per plant

From five tagged plants from each net plot, numbers of panicles were counted and average was worked out.

3.6.2.6 Number of inflorescence branches per panicle at peak flowering stage

From five tagged plants from each net plot, numbers of inflorescence per panicles were counted and average was worked out.

3.6.2.7 Fresh weight of panicle (g) at peak flowering stage

At peak flowering stage from five plants, panicles were taken out from each experimental plot. These were immediately weighed out and average was worked out.

3.2.6.8 Dry weight of panicle (g) at peak flowering stage

After recording fresh weight of panicles of five plants, these were air dried under shade in laboratory and then oven dried at 60 ^{O}C till constant weight and average was worked out.

3.2.6.9 Yield per net plot and per hectare (nos.)

The total number of harvested panicles from each net plot during total flowering period was counted and total no. of panicles per net plot was converted on hectare basis to reflect the yield per hectare in numbers with multiple factor.

Multiple Factor (MF) = 10,000 sq. m. / area of each net plot in sq. m.

Yield per hectare (nos.) **=** MF X Yield of each net plot

3.6.3 Observations on Quality Parameters

3.6.3.1 Shelf life of inflorescence (days)

Fully opened inflorescence was plucked from each treatment and shelf life of inflorescence of individual panicle was recorded in days by keeping them under *in situ* condition. Shelf life of inflorescence was considered as number of days from harvest till the withering of inflorescence started.

3.6.3.2 Vase life of inflorescence (days)

Fully opened inflorescence was plucked from each treatment and their cut ends were immediately immersed in distilled water. In the laboratory, inflorescence stalks were cut so as to maintain their uniform stem length and then the cut ends were kept in a beaker containing distilled water. Distilled water was added whenever necessary to maintain the original level and the stem end was cut about one centimetre continuously every alternate day. The vase life was expressed as the numbers of days from harvest of the inflorescence to no longer remained fit as a cut flower.

3.7 STATISTICAL ANALYSIS

The data pertaining to all characters studied were subjected to the statistical analysis using variance techniques as described by Panse and Sukhatme (1967). The method of analysis of variance for Randomized Block Design (Factorial) was used. The treatment differences were tested by 'F' test of significance on the basis of null hypothesis.

The critical difference was calculated when differences between the treatments were found significant by 'F' test. In remaining cases only standard error means were worked out. The co-efficient of variance (CV %) was also worked out to see the extent of variation within the blocks.

3.8 ECONOMICS:

In order to evaluate the effectiveness of different treatments and to ascertain the most remunerative treatments, the expenses incurred on all cultural operations right from preparation of land to harvesting of the crop including as cost of inputs, viz., organic manures and inorganic fertilizers, irrigation and pesticides applied to each treatments were computed and added.

The gross realization was worked out on the basis of mean no. of flower yield per hectare of each treatment and the prevailing market price of golden rod cut flowers.

The net realization per hectare was calculated by deducting the cost of cultivation from the gross realization for each treatment and recorded accordingly.

The Cost Benefit Ratio (CBR) was calculated on the basis of the formula given below:

$$CBR = \frac{\text{Gross realization (Rs/ha)}}{\text{Total cost of cultivation (Rs/ha)}}$$

IV. EXPERIMENTAL RESULTS

The results of an experiment entitled "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agroclimatic conditions are presented in this chapter. The data are given in tables accordingly and illustrated in figures wherever needed.

4.1 EFFECT OF ORGANIC MANURES AND CHEMICAL FERTILIZERS ON GROWTH PARAMETERS

The mean data on the growth parameters as influenced by different organic manures and chemical fertilizers recorded during the experimentation are presented as under.

4.1.1 Effect on plant height (cm)

The mean data on plant height as influenced by various organic manures and chemical fertilizers at varied levels were recorded at 60 and 90 DAP are presented in Table 4.1 and also graphically depicted in Fig. 4.1.

4.1.1.1 Effect of organic manures

At 60 DAP, the increase in the plant height was noted with different organic manures. Vermicompost 4 t/ha significantly recorded the highest plant height (84.7cm) as compared to rest of the organic manures. Similarly, at 90 days also vermicompost 4 t/ha produced

significantly the highest plant height (92.0 cm) as compared to castor cake 5 t/ha but was found at par with FYM 20 t/ha (88.4 cm).

4.1.1.2 Effect of nitrogen

At 60 and 90 DAP, different levels of nitrogen significantly affected plant height (Table 4.1). It was observed that with increase in levels of nitrogen, plant height increased. Significantly, maximum plant height (85.0 and 94.3 cm) was obtained with N_3 level (150 kg/ha) while minimum plant height was observed with N_1 level (50 kg/ha) (78.7 and 86.9 cm).

4.1.1.3 Effect of phosphorus

From Table 4.1, it is observed that at 60 and 90 DAP, significantly maximum plant height was observed with phosphorus level 25 kg/ha (83.0 and91.9 cm) as compared to no application of phosphorus.

4.1.1.4 Interaction effect

At 60 DAP, N × P interaction (Table 4.2) was found significant. Significantly maximum plant height (89.4 and 101.0 cm) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) as compared to the rest of the combinations. Similarly, 90 DAP, N × P interaction was also found significant (Table 4.3). Significantly, maximum plant height (101.1 cm) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) as compared to rest of the combinations.

Table 4.1 : Influence of organic manures and chemical fertilizers on plant height at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Plant height (cm)			
	60 DAP		90 DAP	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	79.8		88.4	
M_2 = Vermicompost 4 t/ha	84.7		92.0	
M_3 = Castor cake 5 t/ha	78.6		87.3	
S.Em. ±	1.20		1.35	
C.D. at 5 %	3.46		3.88	
CHEMICAL FERTILIZERS				
Nitrogen levels (Kg/ha)				
N_1 = 50 kg/ha	78.7		86.9	
N_2 = 100 kg/ha	79.4		86.5	
N_3 = 150 kg/ha	85.0		94.3	
S.Em. ±	1.20		1.35	
C.D. at 5 %	3.46		3.88	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	79.1		86.5	
P_2 = 25 kg/ha	83.0		91.9	
S.Em. ±	0.98		1.10	
C.D. at 5 %	2.83		3.17	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5%**
M × N	2.08	NS	2.33	NS
M × P	1.70	NS	1.91	NS
N × P	1.70	4.90	1.91	5.49
M × N × P	2.95	NS	3.30	NS
C.V. %	6.30		6.40	

Table 4.2 : Interaction effect between nitrogen and phosphorus levels on plant height at 60 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}
N_{50}	76.8	80.7
N_{100}	79.9	78.9
N_{150}	80.7	89.4

Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	1.70	4.90	6.30

Table 4.3 : Interaction effect between nitrogen and phosphorus levels on plant height at 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0		P_{25}
N_{50}	84.8		89.0
N_{100}	87.2		85.8
N_{150}	87.5		101.1
Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	1.91	5.49	6.40

4.1.2 Effect on number of leaves per plant

The mean data regarding number of leaves per plant as affected by various organic manures and chemical fertilizers at varied levels recorded at 60 and 90 DAP, are presented in Table 4.4 and also graphically illustrated in Fig. 4.2.

4.1.2.1 Effect of organic manures

At 60 and 90 DAP, the data presented in Table-4.4 indicated that different organic manures did not show any significant impact on number of leaves per plant.

4.1.2.2 Effect of nitrogen

Table 4.4 indicated that at 60 and 90 DAP, the result pertaining to number of leaves per plant showed significant differences with different levels of nitrogen. Significantly maximum number of leaves per plant was obtained with N_3 level i.e. 150 kg/ha (222.1 and 408.8) as compared to N_1 level (50 kg/ha) i.e. however, N_2 level (100 kg/ha) was found at par with N_3 level (150 kg/ha).

4.1.2.3 Effect of phosphorus

At 60 and 90 DAP, significantly maximum number of leaves (222.8 and 407.7) was observed with P_2 level i.e. 25 kg/ha(222.8 and 407.7) as compared to zero phosphorus level (209.4and388.1).

4.1.2.4 Interaction effect

All the interactions were found non-significant with respect to number of leaves per plant at 60 and 90 DAP.

Table 4.4 : Influence of organic manures and chemical fertilizers on number of leaves per plant at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Number of leaves per plant			
	60 DAP		90 DAP	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	214.6		385.8	
M_2 = Vermicompost 4 t/ha	224.7		409.1	
M_3 = Castor cake 5 t/ha	209.1		398.9	
S.Em. ±	4.52		7.73	
C.D. at 5 %	NS		NS	
CHEMICAL FERTILIZERS				
Nitrogen levels (Kg/ha)				
N_1 = 50 kg/ha	205.9		381.9	
N_2 = 100 kg/ha	220.3		403.1	
N_3 = 150 kg/ha	222.1		408.8	
S.Em. ±	4.52		7.73	
C.D. at 5 %	13.01		22.2	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	209.4		388.1	
P_2 = 25 kg/ha	222.8		407.7	
S.Em. ±	3.69		6.31	
C.D. at 5 %	10.62		18.14	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	7.83	NS	13.39	NS
M × P	6.40	NS	10.93	NS
N × P	6.40	NS	10.93	NS
M × N × P	11.08	NS	18.93	NS
C.V. %	8.9		8.2	

4.1.3. Effect on leaf area during peak flowering stage (cm^2)

The mean data on leaf area as influenced by various organic manures and chemical fertilizers at varied levels were recorded during peak flowering stage are presented in Table 4.5 and also graphically illustrated in Fig. 4.3.

4.1.2.1 Effect of organic manures

The data presented in Table-4.5, indicated that there was no significant differences observed in the leaf area with different organic manures during peak flowering stage.

4.1.2.2 Effect of nitrogen

From Table 4.5, it is observed that during peak flowering stage, the data revealed that the leaf area was significantly influenced with different levels of nitrogen. The maximum leaf area was obtained with N_3 level i.e. 150 kg/ha (416.7 cm^2) which was at par with N_2 level 100 kg/ha (410.8 cm^2) while the minimum leaf area (389.2 cm^2) was recorded with N_1 level (50 kg/ha) (389.2).

4.1.2.3 Effect of phosphorus

During peak flowering stage, significantly maximum leaf area (415.6) was observed with P_2 level (25 kg/ha) as compared to no phosphorus application,(Table 4.5).

4.1.2.4 Interaction effect

All the interaction effects were found non-significant with regards to leaf area at peak flowering stage (Table 4.5).

Table 4.5 : Influence of organic manures and chemical fertilizers on leaf area (cm^2)during peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Leaf area (cm^2)	
ORGANIC MANURES		
M_1 = FYM 20 t/ha	393.2	
M_2 = Vermicompost 4 t/ha	416.9	
M_3 = Castor cake 5 t/ha	406.5	
S.Em. ±	7.87	
C.D. at 5 %	NS	
CHEMICAL FERTILIZERS		
Nitrogen levels (Kg/ha)		
N_1 = 50 kg/ha	389.2	
N_2 = 100 kg/ha	410.8	
N_3 = 150 kg/ha	416.7	
S.Em. ±	7.87	
C.D. at 5 %	22.6	
Phosphorus levels (kg/ha)		
P_1 = 0 kg/ha	395.5	
P_2 = 25 kg/ha	415.6	
S.Em. ±	6.43	
C.D. at 5 %	18.48	
Interaction	**S.Em. ±**	**C.D. at 5 %**
M × N	13.64	NS
M × P	11.14	NS
N × P	11.14	NS
M × N × P	19.30	NS
C.V. %	8.24	

4.1.3. Effect on leaf area index (LAI)

The mean data on leaf area index (LAI) as influenced by various organic manures and chemical fertilizers at varied levels were recorded at 60 and 90 DAP are presented in Table 4.6 and also graphically depicted in Fig. 4.4.

4.1.2.1 Effect of organic manures

A perusal of data in Table-4.6 shows that different levels of organic manures did not exert any significant influence on leaf area index (LAI) of golden rod flower at 60 and 90 DAP.

4.1.2.2 Effect of nitrogen

From data of Table 4.6 at 60 and 90 DAP, it was observed that the leaf area index (LAI) was significantly influenced with different levels of nitrogen. The maximum leaf area index (LAI) was obtained (0.167 and 0.308) with N_3 level (150 kg/ha) which was at par (0.165 and 0.304) with N_2 level (100 kg/ha) while the minimum leaf area index (LAI) was recorded (0.156 and 0.288) with N_1 level (50 kg/ha).

4.1.2.3 Effect of phosphorus

At 60 and 90 DAP, significantly maximum leaf area index (0.168 and 0.307) was observed with P_2 level (25 kg/ha) as compared to no application of phosphorus.(Table 4.6)

4.1.2.4 Interaction effect

From Table 4.6, it is seen that all the interactions were found non-significant with respect to leaf area index (LAI).

Table 4.6 : Influence of organic manures and chemical fertilizers on leaf area index (LAI) at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Leaf area index (LAI)			
	60 DAP		90 DAP	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	0.161		0.291	
M_2 = Vermicompost 4 t/ha	0.168		0.308	
M_3 = Castor cake 5 t/ha	0.158		0.301	
S.Em. ±	0.003		0.005	
C.D. at 5 %	NS		NS	
CHEMICAL FERTILIZERS				
Nitrogen levels (Kg/ha)				
N_1 = 50 kg/ha	0.156		0.288	
N_2 = 100 kg/ha	0.165		0.304	
N_3 = 150 kg/ha	0.167		0.308	
S.Em. ±	0.003		0.005	
C.D. at 5 %	0.009		0.016	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	0.157		0.293	
P_2 = 25 kg/ha	0.168		0.307	
S.Em. ±	0.002		0.004	
C.D. at 5 %	0.008		0.013	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	0.005	NS	0.010	NS
M × P	0.004	NS	0.008	NS
N × P	0.004	NS	0.008	NS
M × N × P	0.008	NS	0.014	NS
C.V. %	8.88		8.24	

4.1.3. Effect on fresh weight of plant (g)

The mean data on fresh weight of plant as influenced by various organic manures and chemical fertilizers at different levels recorded at 60 and 90 DAP are presented in Table 4.7 and also illustrated in Fig. 4.5.

4.1.1.1 Effect of organic manures

At 60 DAP, vermicompost 4 t/ha significantly recorded the highest fresh weight of plant (32.2 g) as compared to FYM 20 t/ha (28.9 g). However, it was at par with castor cake 5 t/ha (31.0 g). Similarly at 90 days also vermicompost 4 t/ha significantly recorded the highest fresh weight of plant (98.5 g) as compared to FYM 20 t/ha (92.6 g), while the minimum fresh weight of plant was recorded with castor cake 5 t/ha (90.9 g).

4.1.1.2 Effect of nitrogen

At 60 and 90 DAP, different levels of nitrogen significantly affected fresh weight of plant. It was observed that with increase in levels of nitrogen, significant increase in fresh weight of plant was noted. Significantly, maximum fresh weight of plant (35.0 and 101.0 g) was obtained with N_3 level (150 kg/ha) as compared to rest of the levels at 60 days while N_1 & N_2 levels were found at par with each others. Significantly minimum fresh weight of plant (26.2 and 88.8 g) was observed with N_1 level (50 kg/ha) at 60 and 90 DAP, respectively.

4.1.1.3 Effect of phosphorus

At 60 and 90 DAP, significantly maximum fresh weight of plant (33.7 and 100.8 g, respectively) was observed with P_2 level (25 kg/ha) as compared to 0 level of phosphorus (27.7 and 82.2 g, respectively).

4.1.1.4 Interaction effect

At 60 DAP, N × P interaction (Table 4.8) was found significant. Significantly, maximum fresh weight of plant (37.7 g) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) which was at par with N_2P_2 (100 kg/ha N x 25 kg/ha P_2O_5) (35.3 g). Similarly, 90 DAP, same interaction was also found significant (Table 4.9). Significantly maximum fresh weight of plant (103.6 g) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) which was at par (103.3 g) with N_2P_2 (100 kg/ha N x 25 kg/ha P_2O_5), N_3P_1 (150 kg/ha N x 0 kg/ha P_2O_5) (98.4 g) and N_1P_2 (50 kg/ha N x 25 kg/ha P_2O_5) i.e. 95.5 g as compared to rest of the combinations.

Table 4.7: Influence of organic manures and chemical fertilizers on fresh weight of plant (g) at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Fresh weight of plant (g)			
	60 DAP		90 DAP	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	28.9		92.6	
M_2 = Vermicompost 4 t/ha	32.2		98.5	
M_3 = Castor cake 5 t/ha	31.0		90.9	
S.Em. ±	0.68		2.12	
C.D. at 5 %	1.98		6.09	
CHEMICAL FERTILIZERS				
Nitrogen levels (Kg/ha)				
N_1 = 50 kg/ha	26.2		88.8	
N_2 = 100 kg/ha	30.8		92.2	
N_3 = 150 kg/ha	35.0		101.0	
S.Em. ±	0.68		2.12	
C.D. at 5 %	1.98		6.09	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	27.7		87.2	
P_2 = 25 kg/ha	33.7		100.8	
S.Em. ±	0.56		1.73	
C.D. at 5 %	1.61		4.97	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	1.19	NS	3.67	NS
M × P	0.97	NS	2.99	NS
N × P	0.97	2.80	2.99	8.62
M × N × P	1.68	NS	5.19	NS
C.V. %	9.52		9.57	

Table 4.8 : Interaction effect between nitrogen and phosphorus levels on fresh weight of plant (g) at 60 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}	
N_{50}	24.3	28.1	
N_{100}	26.4	35.3	
N_{150}	32.3	37.7	
Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	0.97	2.80	9.52

Table 4.9 : Interaction effect between nitrogen and phosphorus levels on fresh weight of plant (g) at 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}	
N_{50}	81.9	95.5	
N_{100}	81.1	103.3	
N_{150}	98.4	103.6	
Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	2.99	8.62	9.57

4.1.3. Effect on dry weight of plant (g)

The mean data on dry weight of plant as influenced by various organic manures and chemical fertilizers at varied levels recorded at 60 and 90 DAP are presented in Table 4.10 and also graphically depicted in Fig. 4.6.

4.1.1.1 Effect of organic manures

At 60 and 90 DAP, vermicompost 4 t/ha significantly recorded the highest dry weight of plant (10.3 and 31.7 g) as compared to FYM 20 t/ha (8.8 and 28.6 g, respectively). However, it was at par with castor cake 5 t/ha (10.1and 29.4 g, respectively).

4.1.1.2 Effect of nitrogen

At 60 and 90 DAP, different levels of nitrogen significantly affected dry weight of plant. It was observed that with increase in levels of nitrogen, significant increase in dry weight of plant was noted. Significantly, maximum dry weight of plant (11.4 and 33.0 g) was

obtained with N_3 level (150 kg/ha) as compared to rest of the levels. The minimum dry weight of plant was observed with N_1 level (50 kg/ha) i.e. 8.1 and 27.5 g at 60 & 90 DAP, respectively.

4.1.1.3 Effect of phosphorus

At 60 and 90 DAP, significantly maximum dry weight of plant (10.9 and 32.7 g, respectively) was observed with P_2 level (25 kg/ha) as compared to no application of phosphorus (8.6 and 27.1 g, respectively).

4.1.1.4 Interaction effect

At 60 DAP, only N × P interaction (Table 4.11) was found significant. Significantly, maximum dry weight of plant (12.5 g) was noted in N_3P_2 combination (150 kg/ha N x 25 kg/ha P_2O_5) as compared to rest of the levels except N_2P_2 (11.4 g) while the minimum dry weight of plant (7.4 g) was observed with N_1P_1 (50 kg/ha N x 0 kg/ha P_2O_5). Similarly 90 DAP, same interaction was also found significant (Table 4.12). Significantly, maximum dry weight of plant (34.6 g) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) which was at par with N_2P_2 (100 kg/ha N x 25 kg/ha P_2O_5) (33.4 g). However, minimum dry weight of plant (24.9 g) was observed with N_1P_1 (50 kg/ha N x 0 kg/ha P_2O_5) .

Table 4.10: Influence of organic manures and chemical fertilizers on dry weight of plant (g) at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Dry weight of plant (g)			
	60 DAP		90 DAP	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	8.8		28.6	
M_2 = Vermicompost 4 t/ha	10.3		31.7	
M_3 = Castor cake 5 t/ha	10.1		29.4	
S.Em. ±	0.21		0.66	
C.D. at 5 %	0.62		1.91	
CHEMICAL FERTILIZERS				
Nitrogen levels (kg/ha)				
N_1 = 50 kg/ha	8.1		27.5	
N_2 = 100 kg/ha	9.8		29.2	
N_3 = 150 kg/ha	11.4		33.0	
S.Em. ±	0.21		0.66	
C.D. at 5 %	0.62		1.19	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	8.6		27.1	
P_2 = 25 kg/ha	10.9		32.7	
S.Em. ±	0.17		0.54	
C.D. at 5 %	0.51		1.56	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	0.37	NS	1.15	NS
M × P	0.30	NS	0.94	NS
N × P	0.30	0.88	0.94	2.71
M × N × P	0.53	NS	1.63	NS
C.V. %	9.47		9.45	

Table 4.11 : Interaction effect between nitrogen and phosphorus levels on dry weight of plant (g) at 60 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

P levels (kg/ha) / N levels (kg/ha)	P_0	P_{25}
N_{50}	7.4	8.8
N_{100}	8.1	11.4
N_{150}	10.3	12.5

Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	0.30	0.88	9.47

Table 4.12 : Interaction effect between nitrogen and phosphorus levels on dry weight of plant (g) at 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

P levels (kg/ha) / N levels (kg/ha)	P_0	P_{25}
N_{50}	24.9	30.2
N_{100}	25.0	33.4
N_{150}	31.4	34.6

Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	0.94	2.71	9.45

4.1.3. Effect on moisture percentage (%) of plant at 60 and 90 DAP

The mean data on moisture percentage of plant as influenced by various organic manures and chemical fertilizers at varied levels recorded at 60 and 90 DAP are presented in Table 4.13 and also graphically depicted in Fig. 4.7.

4.1.1.1 Effect of organic manures

At 60 and 90 DAP, the data presented in Table-4.13 indicated that moisture percentage of plant remained unaffected due to different organic manures. The effect of different organic manures was found non significant.

4.1.1.2 Effect of nitrogen

At 60 and 90 DAP, the data (Table-4.13) further revealed that different nitrogen levels also did not manifest any difference in the moisture percentage of golden rod plant.

4.1.1.3 Effect of phosphorus

A perusal of data from Table-4.13 revealed that phosphorus fertilization did not show any significant influence on moisture percentage of plant at 60 and 90 days after planting.

4.1.1.4 Interaction effect

All interactions between organic manures, nitrogen and phosphorus did not show any statistical difference for moisture percentage of plant.

Table 4.13: Influence of organic manures and chemical fertilizers on moisture percentage of plant at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Moisture percentage of plant (%)			
	60 DAP		90 DAP	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	69.5		69.1	
M_2 = Vermicompost 4 t/ha	67.9		67.8	
M_3 = Castor cake 5 t/ha	67.4		67.7	
S.Em. ±	1.28		1.29	
C.D. at 5 %	NS		NS	
CHEMICAL FERTILIZERS				
Nitrogen levels (kg/ha)				
N_1 = 50 kg/ha	69.0		69.0	
N_2 = 100 kg/ha	68.3		68.3	
N_3 = 150 kg/ha	67.4		67.3	
S.Em. ±	1.28		1.29	
C.D. at 5 %	NS		NS	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	68.8		68.9	
P_2 = 25 kg/ha	67.6		67.5	
S.Em. ±	1.04		1.05	
C.D. at 5 %	NS		NS	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	2.21	NS	2.23	NS
M × P	1.81	NS	1.82	NS
N × P	1.81	NS	1.82	NS
M × N × P	3.13	NS	3.16	NS
C.V. %	7.96		8.02	

4.2 EFFECT OF ORGANIC MANURES AND CHEMICAL FERTILIZERS ON FLOWERING AND YIELD PARAMETERS

4.2.1 Effect on days taken for first and 50 % flowering

The mean data of days taken for first flower and 50 % flowering as influenced by various organic manures and chemical fertilizers at varied levels were recorded and presented in Table 4.14 and also graphically illustrated in Fig. 4.8.

4.2.1.1 Effect of organic manures

The data presented in Table-4.14 indicated that there was no significant differences on days taken for first flower and 50 % flowering of golden rod with different organic manures.

4.2.1.2 Effect of nitrogen

Different nitrogen levels significantly affected days taken for first flower and 50 % flowering. It was observed from Table-4.14 that with increase in levels of nitrogen, days taken for first flower and 50 % flowering was also increased. Significantly, minimum days were taken for first flower and 50 % flowering was observed with N_1 level i.e. 50 kg/ha (83.6 and 106.3).

4.2.1.3 Effect of phosphorus

Significantly minimum days taken for first and 50 % flowering (83.4 and 105.0) were observed with P_2 (25 kg/ha) as compared to no phosphorus application (89.2 and 117.7 days).

4.2.1.4 Interaction effect

All the interaction effects were found non-significant with respect to no. of days taken for first flower and 50 % flowering.

Table 4.14 : Influence of organic manures and chemical fertilizers on days taken for first flower and 50 % flowering in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Days taken for flowering			
	First flowering		50 % flowering	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	85.2		110.7	
M_2 = Vermicompost 4 t/ha	86.2		110.0	
M_3 = Caster cake 5 t/ha	87.6		113.3	
S.Em. ±	1.16		2.43	
C.D. at 5 %	NS		NS	
CHEMICAL FERTILIZERS				
Nitrogen levels (Kg/ha)				
N_1 = 50 kg/ha	83.6		106.3	
N_2 = 100 kg/ha	87.5		112.8	
N_3 = 150 kg/ha	87.8		114.8	
S.Em. ±	1.16		2.43	
C.D. at 5 %	3.35		7.00	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	89.2		117.7	
P_2 = 25 kg/ha	83.4		105.0	
S.Em. ±	0.95		1.98	
C.D. at 5 %	2.73		5.71	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	2.01	NS	4.21	NS
M × P	1.64	NS	3.44	NS
N × P	1.64	NS	3.44	NS
M × N × P	2.85	NS	5.96	NS
C.V. %	5.73		9.28	

4.2.2 Effect on length of panicle at peak flowering stage (cm)

The mean data on length of panicle as influenced by various organic manures and chemical fertilizers at varied levels recorded at peak flowering stage are presented in Table 4.15 and also graphically depicted in Fig.4.9.

4.2.2.1 Effect of organic manures

At peak flowering stage, the increase in the panicle length was noted with different organic manures. Vermicompost 4 t/ha significantly recorded the highest panicle length (67.6 cm), while the minimum panicle length was recorded with castor cake 5 t/ha (59.1 cm).

4.2.2.2 Effect of nitrogen

At peak flowering stage, different levels of nitrogen significantly affected the panicle length. It was observed that with increase in levels of nitrogen, increase in panicle length was noted. Significantly, maximum panicle length (71.2 cm) was obtained with N_3 level (150 kg/ha) as compared to N_2 (64.5 cm). However, minimum panicle length (51.8 cm) was noted with N_1 level (50 kg/ha).

4.2.2.3 Effect of phosphorus

At peak flowering stage, significantly maximum panicle length (67.4 cm) was observed with P_2 level (25 kg/ha) as compared to no phosphorus application (57.6 cm).

4.2.2.4 Interaction effect

At peak flowering stage, only N × P interaction (Table 4.16) was found significant. Significantly maximum panicle length (72.8 cm) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) as compared to N_1P_1 (46 cm), N_2P_1 (57.2 cm) and N_1P_2 (57.6 cm). However, it was at par with N_2P_2 (100 kg/ha N x 25 kg/ha P_2O_5) (71.8 cm) and N_3P_1 (150 kg/ha N x 0 kg/ha P_2O_5) (69.7 cm) while the minimum panicle length (46.0 cm) was observed with N_1P_1 (50 kg/ha N x 0 kg/ha P_2O_5).

Table 4.15 : Influence of organic manures and chemical fertilizers on panicle length at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Length of panicle (cm)	
ORGANIC MANURES		
M_1 = FYM 20 t/ha	60.8	
M_2 = Vermicompost 4 t/ha	67.6	
M_3 = Castor cake 5 t/ha	59.1	
S.Em. ±	1.51	
C.D. at 5 %	4.35	
CHEMICAL FERTILIZERS		
Nitrogen levels (kg/ha)		
N_1 = 50 kg/ha	51.8	
N_2 = 100 kg/ha	64.5	
N_3 = 150 kg/ha	71.2	
S.Em. ±	1.51	
C.D. at 5 %	4.35	
Phosphorus levels (kg/ha)		
P_1 = 0 kg/ha	57.6	
P_2 = 25 kg/ha	67.4	
S.Em. ±	1.23	
C.D. at 5 %	3.55	
Interaction	**S.Em. ±**	**C.D. at 5 %**
M × N	2.62	NS
M × P	2.14	NS
N × P	2.14	6.15
M × N × P	3.70	NS
C.V. %	10.27	

Table 4.16 : Interaction effect between nitrogen and phosphorus levels on panicle length at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}
N_{50}	46.0	57.6
N_{100}	57.2	71.8
N_{150}	69.7	72.8

Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	2.14	6.15	10.27

4.2.3 Effect on panicle stalk diameter (cm) at peak flowering stage

The mean data on panicle stalk diameter (cm) at peak flowering stage as influenced by various organic manures and chemical fertilizers at varied levels recorded are presented in Table 4.17 and graphically illustrated in Fig.4.10.

4.2.3.1 Effect of organic manures

The data presented in Table 4.4 indicated that different organic manures did not show any statistical differences for panicle stalk diameter at peak flowering stage.

4.2.3.2 Effect of nitrogen

The data revealed that the panicle stalk diameter at peak flowering stage was significantly influenced with different nitrogen levels. Significantly maximum panicle stalk diameter (1.85 cm) was obtained with N_3 level (150 kg/ha) as compared to N_1 level i.e. 1.66 cm (50 kg/ha), however, it was at par with N_2 level(1.80 cm).

4.2.3.3 Effect of phosphorus

At peak flowering stage, significantly maximum panicle stalk diameter (1.81 cm) was observed with P_2 level (25 kg/ha) as compared to zero phosphorus level (1.73 cm).

4.2.3.4 Interaction effect

All the interaction effect were found non-significant with respect to panicle stalk diameter.

Table 4.17 : Influence of organic manures and chemical fertilizers on panicle stalk diameter at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Panicle stalk diameter (cm)	
ORGANIC MANURES		
M_1 = FYM 20 t/ha	1.73	
M_2 = Vermicompost 4 t/ha	1.78	
M_3 = Castor cake 5 t/ha	1.80	
S.Em. ±	0.02	
C.D. at 5 %	NS	
CHEMICAL FERTILIZERS		
Nitrogen levels (kg/ha)		
N_1 = 50 kg/ha	1.66	
N_2 = 100 kg/ha	1.80	
N_3 = 150 kg/ha	1.85	
S.Em. ±	0.02	
C.D. at 5 %	0.07	
Phosphorus levels (kg/ha)		
P_1 = 0 kg/ha	1.73	
P_2 = 25 kg/ha	1.81	
S.Em. ±	0.02	
C.D. at 5 %	0.06	
Interaction	**S.Em. ±**	**C.D. at 5 %**
M × N	0.04	NS
M × P	0.03	NS
N × P	0.03	NS
M × N × P	0.06	NS
C.V. %	6.18	

4.2.4 Effect on no. of panicles per plant

The mean data on no. of panicle per plant as influenced by various organic manures and chemical fertilizers at varied levels recorded are presented in Table 4.18 as well as graphically depicted in Fig.4.11.

4.2.4.1 Effect of organic manures

The maximum number of panicles per plant was noted with different organic manures. Castor cake 5 t/ha significantly recorded the highest no. of panicles per plant (8.1) as compared to FYM 20 t/ha (7.2). However, it was at par with vermicompost 4 t/ha (7.7).

4.2.4.2 Effect of nitrogen

The data revealed that the number of panicles per plant was significantly influenced with different nitrogen levels. Significantly maximum number of panicles per plant (8.3) was obtained with N_3 level (150 kg/ha) as compared to N_1 (50 kg/ha) (6.9). However, N_3 level was at par with N_2 level (100 kg/ha) (7.8).

4.2.4.3 Effect of phosphorus

Significantly, maximum no. of panicles per plant (8.1) was observed with P_2 level (25 kg/ha) as compared to no phosphorus application (7.3).

4.2.4.4 Interaction effect

All the interactions with regards to number of panicles per plant were found non-significant.

Table 4.18 : Influence of organic manures and chemical fertilizers on number of panicles per plant in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Number of panicles per plant	
ORGANIC MANURES		
M_1 = FYM 20 t/ha	7.2	
M_2 = Vermicompost 4 t/ha	7.7	
M_3 = Castor cake 5 t/ha	8.1	
S.Em. ±	0.24	
C.D. at 5 %	0.69	
CHEMICAL FERTILIZERS		
Nitrogen levels (kg/ha)		
N_1 = 50 kg/ha	6.9	
N_2 = 100 kg/ha	7.8	
N_3 = 150 kg/ha	8.3	
S.Em. ±	0.24	
C.D. at 5 %	0.69	
Phosphorus levels (kg/ha)		
P_1 = 0 kg/ha	7.3	
P_2 = 25 kg/ha	8.1	
S.Em. ±	0.19	
C.D. at 5 %	0.56	
Interaction	**S.Em. ±**	**C.D. at 5 %**
M × N	0.42	NS
M × P	0.34	NS
N × P	0.34	NS
M × N × P	0.59	NS
C.V. %	13.33	

4.2.5 Effect on no. of inflorescence branches per panicle at peak flowering stage

The mean data on no. of inflorescence branches per panicle at peak flowering stage as influenced by various organic manures and chemical fertilizers at varied levels recorded are presented in Table 4.19 and graphically depicted in Fig.4.12.

4.2.5.1 Effect of organic manures

The data presented in Table-4.19 indicated that no. of inflorescence branches per panicle at peak flowering stage remained un-affected with different organic manures.

4.2.5.2 Effect of nitrogen

At peak flowering stage, the data revealed that the no. of inflorescence branches per panicle was significantly influenced with different nitrogen levels. The maximum no. of inflorescence branches per panicle (44.3) was obtained with N_3 level (150 kg/ha) as compared to 50 kg N/ha (38.3). However, it was at par (42.2) with N_2 level (100 kg/ha).

4.2.5.3 Effect of phosphorus

From the Table-4.19, it is further observed that at peak flowering stage, significantly maximum no. of inflorescence branches per panicle (43.6) was obtained with P_2 level (25 kg/ha) as compared to zero level of phosphorus (39.6).

4.2.5.4 Interaction effect

All the interaction effects were found non-significant with respect to no. of inflorescence branches per panicle.

Table 4.19 : Influence of organic manures and chemical fertilizers on no. of inflorescence branches per panicle at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	**No. of inflorescence branches per panicle**	
ORGANIC MANURES		
M_1 = FYM 20 t/ha	40.4	
M_2 = Vermicompost 4 t/ha	42.7	
M_3 = Castor cake 5 t/ha	41.7	
S.Em. ±	1.63	
C.D. at 5 %	NS	
CHEMICAL FERTILIZERS		
Nitrogen levels (kg/ha)		
N_1 = 50 kg/ha	38.3	
N_2 = 100 kg/ha	42.2	
N_3 = 150 kg/ha	44.3	
S.Em. ±	1.63	
C.D. at 5 %	4.69	
Phosphorus levels (kg/ha)		
P_1 = 0 kg/ha	39.6	
P_2 = 25 kg/ha	43.6	
S.Em. ±	1.33	
C.D. at 5 %	3.83	
Interaction	**S.Em. ±**	**C.D. at 5 %**
M × N	2.82	NS
M × P	2.31	NS
N × P	2.31	NS
M × N × P	4.00	NS
C.V. %	16.6	

4.2.6 Effect on fresh and dry weight of panicle at peak flowering stage (g)

The mean data on fresh and dry weight of panicle as influenced by various organic manures and chemical fertilizers at varied levels recorded at peak flowering stage are presented in Table 4.20 and also graphically illustrated in Fig.4. 13.

4.2.6.1 Effect of organic manures

At peak flowering stage, the increase in the fresh and dry weight of panicle was noted significant with different organic manures. FYM 20 t/ha significantly recorded the highest fresh and dry weight of panicle (87.1 and 22.4 g) as compared to castor cake 5 t/ha (76.9 and 19.8 g). However, treatment M_1 was found at par with vermicompost 4 t/ha (86.6 and 22.3 g).

4.2.6.2 Effect of nitrogen

At peak flowering stage, different nitrogen levels significantly affected fresh and dry weight of panicle. Significantly, maximum fresh and dry weight of panicle (91.0 and 24.1 g) was obtained with N_3 level (150 kg/ha) as compared to N_2 100 kg/ha (76.7 and 19.8 g) and N_1 level (50 kg/ha i.e. 82.8 and 20.8 g).

4.2.6.3 Effect of phosphorus

At peak flowering stage, significantly maximum fresh and dry weight of panicle (87.2 and 22.9 g) respectively, was observed with P_2 level (25 kg/ha) as compared to no application of phosphorus (79.8 and 20.2 g)

4.2.6.4 Interaction effect

At peak flowering stage, only N × P interaction (Table 4.21) was found significant with respect to fresh and dry weight of panicle. Significantly maximum fresh weight of panicle (99.8 g) was recorded in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) as compared to rest of the combinations, while minimum fresh weight of panicle (75.1 g) was observed with N_2P_2 (100 kg/ha N x 25 kg/ha P_2O_5). Similarly, (Table 4.22) significantly, maximum dry weight of panicle (26.9 g) was noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) as compared to rest of the N × P combinations. However, minimum dry weight of panicle (19.5 g) was observed with N_1P_1 (50 kg/ha N x 0 kg/ha P_2O_5).

Table 4.20: Influence of organic manures and chemical fertilizers on fresh and dry weight of panicle (g) at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Weight of panicle (g)			
	Fresh weight		Dry weight	
ORGANIC MANURES				
M_1 = FYM 20 t/ha	87.1		22.4	
M_2 = Vermicompost 4 t/ha	86.6		22.3	
M_3 = Castor cake 5 t/ha	76.9		19.8	
S.Em. ±	2.48		0.63	
C.D. at 5 %	7.13		1.82	
CHEMICAL FERTILIZERS				
Nitrogen levels (kg/ha)				
N_1 = 50 kg/ha	82.8		20.8	
N_2 = 100 kg/ha	76.7		19.8	
N_3 = 150 kg/ha	91.0		24.1	
S.Em. ±	2.48		0.63	
C.D. at 5 %	7.13		1.82	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	79.8		20.2	
P_2 = 25 kg/ha	87.2		22.9	
S.Em. ±	2.05		0.51	
C.D. at 5 %	5.82		1.49	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	4.29	NS	1.10	NS
M × P	3.50	NS	0.89	NS
N × P	3.50	10.08	0.89	2.58
M × N × P	6.07	NS	1.55	NS
C.V. %	12.61		12.49	

Table 4.21 : Interaction effect between nitrogen and phosphorus levels on fresh weight of panicle (g) at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}
N_{50}	78.8	86.8
N_{100}	78.3	75.1
N_{150}	82.1	99.8

Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	3.50	10.08	12.61

Table 4.22 : Interaction effect between nitrogen and phosphorus levels on dry weight of panicle (g) at peak flowering stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}	
N_{50}	19.5	22.1	
N_{100}	19.8	19.7	
N_{150}	21.3	26.9	
Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	0.89	2.58	12.49

4.2.7 Effect on panicle yield (nos./ha)

The mean data on panicle yield as influenced by various organic manures and chemical fertilizers at varied levels recorded are presented in Table 4.23 and also graphically depicted in Fig. 4.13.

4.2.7.1 Effect of organic manures

From Table 4.23, it is seen that all the organic manures significantly differed with each other with respect to nos. of panicles per hectare. Significantly, the highest no. of panicles per hectare (561878) was produced with vermicompost 4 t/ha as compared to FYM 20 t/ha (500989) as well as castor cake 5 t/ha (498622).

4.2.7.2 Effect of nitrogen

Different nitrogen levels also significantly affected the panicle yield. It was observed that with increase in levels of nitrogen, significant increase in yield was noted. Significantly, maximum panicle yield per hectare (601939) was obtained with N_3 level (150 kg/ha) while

significantly minimum yield per hectare was observed with N_1 level (50 kg/ha) i.e. 419539 (nos.)

4.2.7.3 Effect of phosphorus

Significantly maximum yield per hectare (555567) was observed with P_2 level (25 kg/ha) as compared to no application of phosphorus.

4.2.7.4 Interaction effect

Only N × P interaction (Table 4.24) was found significant. Significantly, maximum panicle yield per hectare (615111 nos.) was noted with N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5) which was at par with N_2P_2 (100kg/ha N x 25 kg/ha P_2O_5) (604044 nos.) and N_3P_1 (150 kg/ha N x 0 kg/ha P_2O_5) (588767 nos.), while significantly minimum panicle yield per hectare (391533 nos.) was observed with N_1P_1 (50 kg/ha N x 0 kg/ha P_2O_5) as compared to rest of the combinations.

Table 4.23: Influence of organic manures and chemical fertilizers on panicle yield (nos./ha) in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Yield (nos./ha)	
ORGANIC MANURES		
M_1 = FYM 20 t/ha	500989	
M_2 = Vermicompost 4 t/ha	561878	
M_3 = Castor cake 5 t/ha	498622	
S.Em. ±	11398.7	
C.D. at 5 %	32760.1	
CHEMICAL FERTILIZERS		
Nitrogen levels (kg/ha)		
N_1 = 50 kg/ha	419539	
N_2 = 100 kg/ha	540011	
N_3 = 150 kg/ha	601939	
S.Em. ±	11398.7	
C.D. at 5 %	32760.1	
Phosphorus levels (kg/ha)		
P_1 = 0 kg/ha	485426	
P_2 = 25 kg/ha	555567	
S.Em. ±	9306.9	
C.D. at 5 %	26748.5	
Interaction	**S.Em. ±**	**C.D. at 5 %**
M × N	19743.1	NS
M × P	16120.2	NS
N × P	16120.2	46329.8
M × N × P	27921.0	NS
C.V. %	9.29	

Table 4.24 : Interaction effect between nitrogen and phosphorus levels on panicle yield (nos./ha) in golden rod (*Solidago canadensis* L.) cv. 'Local'

P Levels (kg/ha) / N Levels (kg/ha)	P_0	P_{25}	
N_{50}	391533	447544	
N_{100}	475978	604044	
N_{150}	588767	615111	
Interaction	S.Em.±	C.D. at 5%	C.V. %
N×P	16120.2	46329.8	9.29

4.3 EFFECT OF ORGANIC MANURES AND CHEMICAL FERTILIZERS ON INFLORESCENCE QUALITY PARAMETERS

4.3.1 Effect on shelf life and vase life of inflorescence during peak period stage (days)

The mean data on shelf life and vase life of inflorescence as influenced by various organic manures and chemical fertilizers at varied levels recorded during peak period stage are presented in Table 4.26 and graphically depicted in Fig.4.14.

4.3.1.1 Effect of organic manures

During peak period stage, the data presented in Table-4.26 indicated that shelf and vase life remained unaffected due to different organic manures.

4.3.1.2 Effect of nitrogen

During peak period stage, different levels of nitrogen significantly affected shelf and vase life of inflorescence. It was observed that with increase in levels of nitrogen, shelf and vase life of inflorescence were decreased. Significantly, maximum shelf life of inflorescence was noted with N_1 level (50 kg/ha) i.e.16.5 days which was at par with N_2 level (100 kg/ha) i.e. 15.7 days and minimum shelf life of inflorescence was observed with N_3 level 150 kg/ha i.e.15.3 days. Similarly, maximum vase life of inflorescence was obtained with N_1 level (50 kg/ha) (7.5 days) which was at par with N_2 level (100 kg/ha) (7.0 days), while minimum vase life of inflorescence was noted with N_3 level (150 kg/ha) (6.9 days)

4.3.1.3 Effect of phosphorus

During peak flowering period, significantly maximum shelf life of inflorescence (16.3 days) was observed with P_2 – (25 kg/ha). Similarly, maximum vase life of inflorescence (7.4 days) was also observed with P_2 – 25 kg/ha.

4.3.1.4 Interaction effect

All the interaction effects were found non-significant with respect to shelf life and vase life of inflorescence.

Table 4.25 : Influence of organic manures and chemical fertilizers on shelf and vase life of inflorescence during peak period stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

FACTORS	Shelf life (days)		Vase life (days)	
ORGANIC MANURES				
M_1=FYM 20 t/ha	15.6		7.0	
M_2=Vermicompost 4 t/ha	16.3		7.4	
M_3=Castor cake 5 t/ha	15.5		7.0	
S.Em. ±	0.33		0.15	
C.D. at 5 %	NS		NS	
CHEMICAL FERTILIZERSs				
Nitrogen levels (Kg/ha)				
N_1 = 50 kg/ha	16.5		7.5	
N_2 = 100 kg/ha	15.7		7.0	
N_3 = 150 kg/ha	15.3		6.9	
S.Em. ±	0.33		0.15	
C.D. at 5 %	0.94		0.44	
Phosphorus levels (kg/ha)				
P_1 = 0 kg/ha	15.3		6.9	
P_2 = 25 kg/ha	16.3		7.4	
S.Em. ±	0.26		0.12	
C.D. at 5 %	0.77		0.36	
Interaction	**S.Em. ±**	**C.D. at 5 %**	**S.Em. ±**	**C.D. at 5 %**
M × N	0.57	NS	0.26	NS
M × P	0.46	NS	0.21	NS
N × P	0.46	NS	0.21	NS
M × N × P	0.80	NS	0.37	NS
C.V. %	8.84		9.09	

4.4 ECONOMICS

4.4.1 Economics of different treatments

The details of income expenditure and net realization along with CBR values gained under different levels of organic manures and chemical fertilizers are given in Table-4.26.

4.4.1.1 Effect of organic manures

Data revealed that application of vermicompost (M_2) increased net realization as compared to FYM (M_1) and castor cake (M_3).The higher net realization at Rs.236025/ha with CBR value of 1:5.6 was recorded under treatment M_2 (4 t/ha) as compared to M_1 (20 t/ha) which earned Rs. 211881/ha with CBR value of 1:5.84 followed by M_3 (5 t/ha) which earned Rs. 184497/ha with CBR value of 1:3.4.

4.4.1.2 Interaction effect between nitrogen and phosphorus

Perusal of the data presented in Table 4.26 revealed that the highest net realization of Rs. 272220 with CBR value of 1:7.84 was obtained with treatment N_3P_2 (N_3 150 Kg/ha + P_2 25 Kg/ha). But the best treatment of nitrogen and phosphorus interaction was N_2P_2 (N_2 100 Kg/ha + P_2 25 Kg/ha) with net realization of Rs. 267236 and CBR value of 1:7.82.This may be due to higher doses of nitrogen which decreases soil health.

Table 4.26: Economics of different levels of organic manures and chemical fertilizers in golden rod (*Solidago Canadensis* L.) cv. 'Local'

Treatments	No. of panicle /ha	Gross realization (Rs./ha)	Net realization (Rs./ha)	Average cost of production (Rs./ha)	CBR
ORGANIC MANURES					
M_1-FYM 20 t/ha	500989	250495	211881	42862	1:5.80
M_2 - Vermicompost 4t/ha	561878	280939	236025	49855	1:5.60
M_3 -Castor cake 5t/ha	498622	249311	184497	71944	1:3.50
INTERACTION EFFECT OF INORGANIC FERTILIZERS					
N_1P_1	391533	195767	161903	37589.0	1:5.21
N_1P_2	447544	223772	189536	38001.8	1:5.89
N_2P_1	475978	237989	203575	38199.5	1:6.23
N_2P_2	604044	302022	267236	38612.3	1:7.82
N_3P_1	588767	294384	259420	38810.0	1:7.59
N_3P_2	615111	307556	272220	39222.8	1:7.84

Selling price of golden rod panicle = 0.5 Rs./panicle

4.4.1.4 Interaction effect

Perusal of the data presented in Table 4.27 revealed that the highest number of panicles (631533 ha^{-1}) and net realization (268431 Rs. ha^{-1}) were obtained with treatment T_{12} (vermicompost 4 t/ha + N_3 150 Kg/ha + P_2 25 Kg/ha) followed by treatment T_6 (263864 Rs. ha^{-1}) and T_{10} (259031 Rs. ha^{-1}). The treatment T_4 ranked first with the highest CBR (1:6.77) which was followed by other treatments. The lowest net realization (110169 Rs. ha^{-1}) and CBR value (1:2.29) were recorded with treatment T_{13} (castor cake 5 t/ha + N_1 50 Kg/ha + P_1 0 Kg/ha).

Table 4.27: Economics of golden rod (*Solidago Canadensis* L.) cv. 'Local' as influenced by various treatments

Treatments	No of panicle /ha	Gross realization (Rs.ha^{-1})	Total cost of cultivation (Rs.ha^{-1})	Net realization Rs. ha^{-1}	CBR
T_1	355100	177550	43694.04	138186	1:4.06
T_2	426600	213300	44106.82	173564	1:4.84
T_3	420400	210200	44304.54	170286	1:4.74
T_4	605766	302883	44717.32	262597	1:6.77
T_5	588666	294333	44915.04	253869	1:6.55
T_6	609400	304700	45327.82	263864	1:6.72
T_7	456633	228317	50909.04	182453	1:4.48
T_8	521933	260967	51321.82	214731	1:5.08
T_9	548133	274067	51519.54	227653	1:5.32
T_{10}	611633	305817	51932.32	259031	1:5.89
T_{11}	601400	300700	52130.04	253736	1:5.77
T_{12}	631533	315767	52542.82	268431	1:6.01
T_{13}	362866	181433	79103.04	110169	1:2.29
T_{14}	394100	197050	79515.82	125414	1:2.48
T_{15}	459400	229700	79713.54	157886	1:2.88
T_{16}	594733	297367	80126.32	225181	1:3.71
T_{17}	576233	288117	80324.04	215753	1:3.59
T_{18}	604400	302200	80736.82	229464	1:3.74

Selling price of golden rod panicle = 0.5 Rs./panicle

V. DISCUSSION

To achieve maximum yield of better quality using optimum condition for a crop is the aim of developing any agro-technique. Many complicated physiological and biochemical processes taking place in plant are influenced by soil and climatic conditions and agronomical manipulations. Maximum yield may be obtained when most optimum conditions are provided. For these, different factors may be selected and adopted in such a manner that each may supplement each other for obtaining higher yield. By analysis of the growth pattern and factors contributing to yield under different agronomic practices and climatic conditions, it is possible to manipulate factors responsible for maximum production. Keeping these factors in view, a field experiment was carried out to study the "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agro climatic conditions" and the results obtained are being discussed in this chapter.

5.1 EFFECT OF ORGANIC MANURES

5.2 EFFECT OF NITROGEN

5.3 EFFECT OF PHOSPHORUS

5.4 INTERACTION EFFECT

5.1 EFFECT OF ORGANIC MANURES

It is well documented that addition of organic manures has great influence on physical, chemical and biological properties of the soil. Decomposition of organics also release micronutrients and increase the carrying capacity of the soil.

5.1.1 Effect of organic manures on growth

Different growth attributes of golden rod viz., plant height, fresh and dry weight of plant were significantly influenced by organic manure (Table 4.1, 4.9 and 4.10). At 60 and 90 DAP, vermicompost 4 t/ha significantly recorded the highest plant height (84.7 and 92.0 cm), highest fresh weight of plant (32.2 and 98.5 g) and highest dry weight of plant (10.3 and 31.7 g), respectively as compared to rest of the organic manures. An increase in plant height, fresh weight and dry weight of plant might be due to more availability of organic carbon for multiplication of micro-organism and this helped in improving the N and P availability in soil. These nutrients flow into the plants and thereby favouring the plant growth and stimulation of auxillary buds resulting in more plant height. These results confirm well with those reported by Gupta (1997), Chauhan *et al.* (2005), Tyagi and Kumar (2006) in marigold, Sunitha *et al.* (2007) and Gaur *et al.* (2008) in marigold, Kulkarni *et al.* (1996), Nethra *et al.* (1999) and Nandre *et al.* (2005) in China aster. Organic manures did not shows any

significant impact on growth characters like no. of leaves, leaf area and leaf area index.

5.1.2 Effect of organic manures on flowering and yield

At peak flowering stage, the increase in flowering and yield parameters was noted with different organic manures. Vermicompost 4 t/ha significantly recorded the highest length of panicle (67.6 cm) of golden rod (Table 4.15).

The increase in the inflorescence yield per hectare was noted with different organic manures. Vermicompost 4 t/ha significantly recorded the highest yield per hectare (561878 nos.). This might be probably due to better nourishment provided from application of vermicompost. Almost similar results were also reported by Soltanzad *et al.* (1982) in chrysanthemum. It might be due to the fact that phyto-hormones produced by the vermicompost enhance the microbial enzymatic activity in soil, which stimulated root growth and induced changes in root morphology, which in turn affected the assimilation of the nutrients. Such boosting effect also might be due to higher accumulation of carbohydrates which increased inflorescence weight and yield. Similar results were recorded by Rathi *et al* (2005) and Kumar *et al* (2006) in marigold, Rathod *et al*. (2002) and Parmar (2006) in gaillardia, and Kaloti (1998), Panchal (2006),

Kulkarni *et al.* (1996) and Nethra *et al.* (1999) in China aster, where as Chauhan *et al*. (2005) and Tyagi and Kumar (2006) in marigold.

Castor cake 5 t/ha significantly recorded the highest number of panicles per plant (8.1). Similar results were recorded by Patil and Dhaduk (2009) in African marigold.

FYM 20 t/ha significantly recorded the highest fresh and dry weight of panicle (87.1 and 22.4 g). The increase in fresh and dry weight of panicle might be due to the fact that when FYM was applied it increased the availability of essential plant nutrients which enhanced root and shoot development and thereby the growth. Thereafter, it might have influenced the reproductive phase and induced flowering which resulted in increased fresh and dry weight of panicle. These findings are in accordance with the result of Gupta (1997), Saud and chauhan (2004), Syamal *et al.* (2006), Gaur *et al.* (2008) and Patel *et al.* (2008) in marigold, Kaloti (1998), Kulkarni *et al.* (1998), Nethra *et al.* (1999), Nandre *et al.* (2005) and Panchal (2006) in China aster, Parmar (2006) in gaillardia and Panchal (2009) in chrysanthemum, Yadav *et al.* (2000) and Patel (2005) in golden rod.

5.1.4 Effect of organic manures on economics

The economics of crop production worked out for each treatment (Table 4.26) separately showed that the highest net realization was found with vermicompost 4 t/ha (236025 Rs. ha^{-1}) due to higher yield which led to higher income. However, the highest CBR value was recorded with FYM 20 t/ha (1:5.84) because of the lowest cost as compared to rest of the treatments. The lowest net realization and CBR value was recorded with castor cake 5 t/ha (184497 and 1:3.47) due to the lowest yield and higher price as compared to rest of the treatments.

5.2 EFFECT OF NITROGEN

5.2.1 Effect of nitrogen on growth attributes

The result revealed that highest level of nitrogen 150 g/plant recorded significantly maximum plant height, number of leaves per plant, leaf area, leaf area index, fresh and dry weight of plant at 60 and 90 days interval after transplanting. Significantly maximum plant height (85.0 and 94.3 cm) was obtained with nitrogen 150 kg/ha. The maximum number of leaves per plant was obtained with N_3 level (150 kg/ha) i.e. 222.1 and 408.8. The maximum leaf area was also obtained with nitrogen 150 kg/ha (416.7 cm^2). The maximum leaf area index (LAI) was obtained with N_3 level (150 kg/ha) (0.167 and 0.308).

Significantly maximum fresh weight of plant (35.0 and 101.0 g) was obtained with N_3 level (150 kg/ha). Significantly maximum dry weight of plant (11.4 and 33.0 g) was obtained with N_3 level (150 kg/ha).

This might be due to increased synthesis of protein and protoplasm, better availability of nitrogen leading to the quick and better vegetative growth of plant. As the meristamatic tissues have active protein metabolism, photosynthates were transported to the site of growth. These findings are in accordance with those of Mukhopadhyay and Banker (1986) in tuberose, Koladiya (1995) in spider lily, Ryagi *et al.* (1996) and Sodha and Dhaduk (2002), Patel (1998) in chrysanthemum, Belgaonkar *et al.* (1996), Karuppaiah and Krishna (2005) in French marigold, Pandey and Mishra (2000), Ghosh and Pal (2010) in African marigold, Patel (2005) in golden rod, and Parekh *et al.* (2010) in chrysanthemum.

5.2.2 Effect of nitrogen on flowering and yield attributes

An application of nitrogen significantly influenced the days to first flowering, days taken for 50% flowering, length of panicle (cm) at peak flowering stage, diameter of panicle stalk (cm) at peak flowering stage, number of panicle per plant, number of inflorescence branches per panicle at peak flowering stage, fresh weight of panicle (g) at peak flowering stage, dry weight of panicle (g) at

peak flowering stage and yield per hectare (nos.). Different levels of nitrogen had significantly affected the days taken for first and 50 % flowering. It was observed that with increase in levels of nitrogen, days taken for first and 50 % flowering was also increased. Significantly, minimum days taken for first and 50 % flowering were observed with N_1 level (50 kg/ha) i.e. 83.6 and 106.4 days.This might be due to the fact that higher supply of nitrogen keeps plant in vegetative stage for longer period which resulted in delayed first and 50 % flowering. Similar results were confirmed by Muhammad-Shafi *et al.* (2002) in gaillardia, Beniwal *et al.* (2005) in chrysanthemum, Patel (1998) in chrysanthemum and Patel (2005) in golden rod.

The highest level of nitrogen (150 kg/ha) also resulted in maximum length of panicle (71.2 cm), maximum diameter of panicle stalk (1.85 cm), maximum number of panicle per plant (8.3) and maximum number of inflorescence branches per plant (44.3). This might be due to better growth and development of panicle with increase in nitrogen level, reflection in maximum length, diameter of panicle stalk, maximum number of panicle per plant and number of inflorescence branches per plant. Similar results have also been reported by Rao *et al.* (1992) and Prajapati (1996) in marigold, Vaghasia (1997) in chrysanthemum, Ryagi *et al.* (1996), Sodha and Dhaduk (2002) and Patel (2005) in golden rod.

At peak flowering stage, different levels of nitrogen significantly affected the fresh and dry weight of panicle (Table 4.20). It was observed that with increase in levels of nitrogen, increased the fresh and dry weight of panicle. Significantly maximum fresh and dry weight of panicle (91.0 and 24.1 g) were obtained with N_3 level (150 kg/ha). This might be due to better growth and development of panicle with increased nitrogen level reflection in maximum weight of panicle. Similar results have also been reported by Rao *et al.* (1992), Prajapati (1996) in marigold, Vaghasia (1997) in chrysanthemum, Ryagi *et al.* (1996), Patel (1998) in chrysanthemum, Hameed and Sekar (1999), Acharya and Dashora (2004) in African marigold and Karuppiah and Krishna (2005) in French marigold, Sodha and Dhaduk (2002) in golden rod and Patel (2005) in golden rod.

Different levels of nitrogen significantly affected the yield per hectare (Table 4.23). It was observed that with increase in levels of nitrogen, increased the yield per hectare. Significantly maximum no. of inflorescences per hectare (601939) was obtained with N_3 level (150 kg/ha). This might be due to the reason that nitrogen is an important constituent of nucleotides, phosphatides, enzymes, hormones etc., which have great importance in plant metabolism, augmented crucial role in enhancement of plant growth and resulted in higher flower yield.

These results are in agreement with the findings of Singh and Sangama (2000), Chavan *et al.* (2010) in China aster, Yadav *et al*. (2000), Jadhav *et al*. (2002), Acharya and Dashora (2004), Ghosh and Pal (2010) in African marigold, Beniwal *et al.* (2005) in chrysanthemum, Patel (2005) in golden rod, Hugar and Nalawadi (1999), Karetha *et al.* (2008) in gaillardia.

5.2.3 Effect of nitrogen on quality attributes

During peak flowering period, different levels of nitrogen had significantly affected the shelf and vase life of inflorescence (Table 4.25). It was observed that with increase in levels of nitrogen, shelf and vase life of inflorescence was also decreased. Significantly maximum shelf and vase life of inflorescence were noted with N_1 level (50 kg/ha) i.e 16.5 and 7.5 days, respectively. However, minimum shelf and vase life of inflorescence was noted with nitrogen 150 kg/ha (15.3 days and 6.9 days, respectively).This indicates that there is a negative effect of nitrogen on shelf and vase life of inflorescence. Higher doses of nitrogen resulted in to poor shelf and vase life of inflorescence of golden rod which might be due to higher dose of nitrogen that keeps the plant as well as inflorescence soft and succulents in texture. This type of texture of inflorescence results in higher and faster respiration and dehydration. Similar results have also been reported by Anuradha e*t al.* (1990) in marigold, Ryagi *et al.* (1996), and Sodha and

Dhaduk (2002) in golden rod. Because of higher level of nitrogen which resulted in depletion of carbohydrate causing a digestion of proteins which might have reduced supply which is one of the factors determined the keeping quality of flowers. Similar trends were also-observed by Avari (1990), Anuradha *et al.* (1990) and Lodhi *et al.* (1991) and Patel (1998) in chrysanthemum, Khimani and Patil (1995) and Singatkar (1995) in gaillardia and Patel (2005) in golden rod.

5.3 EFFECT OF PHOSPHORUS

5.3.1 Effect of phosphorus on growth attributes

The phosphorus is a part of the molecular structure of several vitally important compounds, deoxyribonucleic acid (DNA), the two forms of ribonucleic add (m- RNA and t-RNA), the enzyme system necessary for the energy transformation in photosynthesis and respiration and adenosine diphosphate (ADP) and adenosine triphosphate (ATP). The energy release from high energy bonds of ATP is used by all living things to maintain the living condition and to perform work. Since, the energy bonds are made available by crop plants, the vital importance of phosphorus to nutrition of crop plants is obvious.

In the present investigation, it was observed that an application of phosphorus at 25 kg P_2O_5/ha recorded better vegetative growth. The result

revealed that phosphorus 25 kg P_2O_5/ha recorded significantly maximum plant height (83.0 and 91.1 cm), number of leaves per plant (222.8 and 407.7), leaf area (415.6 cm^2), leaf area index (0.168 and 0.307), fresh weight of plant (33.7 and 100.8 g) and dry weight of plant (10.9 and 32.7 g) at 60 as well as 90 days interval after transplanting (Table 4.1,4.4,4.5,4.6,4.7 and 4.10).

At 60 and 90 DAP, significantly maximum plant height (83.0 and 91.1 cm), maximum number of leaves per plant (222.8 and 407.7) and maximum leaf area (415.6 cm^2), was observed with phosphorus 25 kg/ha (Table 4.1,4.4 and 4.5).

This might be as phosphorus is an essential element for photosynthesis, respiration, cell division and sugar starch translocation in plants. Its deficiency cause slowing down of growth of plants. These results are in agreement with the findings of Patel (1998) in chrysanthemum, Pandey and Mishra (2000), Sherawat *et al.*(2003) and Syamal *et al.* (2006) in marigold, Karuppaiah and Krishna (2005) in French marigold, Rathi *et al.* (2005) in China aster and Patel (2005) in golden rod.

At 60 and 90 DAP, significantly maximum leaf area index (LAI) (0.168 and 0.307) was observed with P_2 level (25 kg/ha). This might be as phosphorus is one of the important nutrients necessary for proper growth of the plant. Its deficiency caused slowing down of plant growth.

At 60 and 90 DAP, significantly maximum fresh (33.7 and 100.8 g) and dry weight of plant (10.9 and 32.7 g), were observed with phosphorus 25 kg/ha. This may be as phosphorus is one of the essential elements in the plant which is needed mainly at initial stage of growth and during flowering and yield. These results are in agreement with the findings of Patel (1998) in chrysanthemum, Pandey and Mishra (2000), Sherawat *et al.* (2003), Syamal *et al.* (2006) in marigold, Patel (2005) in golden rod

5.3.2 Effect of phosphorus on flowering and yield attributes

Significantly minimum days taken for first and 50 % flowering (83.4 and 105.0) were observed with phosphorus 25 kg/ha (Table 4.14). This is as phosphorus is one of the essential elements in the plant which is needed at initial stage of growth and during flowering and yield. These results are in agreement with the findings of De and Dhiman (1998) in chrysanthemum, Patel (1998) in chrysanthemum, Beniwal *et al.* (2005) in chrysanthemum, Patel (2005) in golden rod.

At peak flowering stage, significantly maximum length of panicle (67.4 cm), maximum diameter of panicle stalk (1.81 cm), maximum number of panicles per plant (8.1) and maximum number of inflorescence branches per plant (43.6), respectively were observed with phosphorus 25 kg/ha. This is as phosphorus is

one of the essential elements in the plants, which is needed mainly at initial stage of growth and during flowering and yield. These results are in accordance with the results obtained by De and Dhiman (1998), Patel (1998) and Beniwal *et al.* (2005) in chrysanthemum , Rajadurai *et al.* (2000) in African marigold and Patel (2005) in golden rod.

At peak flowering stage, significantly maximum fresh and dry weight of panicle (87.2 and 22.9 g respectively), were observed with phosphorus 25 kg/ha (Table 4.20). This is as phosphorus is one of the essential elements in the plant which is needed mainly at initial stage of growth and during flowering and yield. These results are in accordance with the results obtained by Singh *et al.* (1996) in tuberose, Belgaonkar *et al.* (1996) in pansy, Rupinder and Ramesh (1998), Patel (1998) and Beniwal *et al.* (2005) in chrysenthemum, Acharya and Dashora (2004) in marigold, Karuppaiah and Krishna (2005) in French marigold, Sodha and Dhaduk (2002) and Patel (2005) in golden rod.

Significantly maximum yield per hectare (555567) was observed with phosphorus 25 kg/ha. Increase in panicle yield might be due to phosphorus application, which enhanced the root growth extensively. Moreover, it is the essential constituent of co-enzymes, which are important for photosynthesis and protein synthesis. This might have increased number of branches per plant and

number of panicles per plant, which ultimately increased panicle yield per hectare. These results are in agreement with the findings of Khader *et al*. (1990), Patel (1998), Beniwal *et al.* (2005) and Panchal (2009) in chrysanthemum, Acharya and Dashora (2004), Pandey and Mishra (2000) in marigold, Nandre *et al.* (2005) in China aster, Karetha *et al.* (2008) in gaillardia , Patel (2005) in golden rod.

5.3.3 Effect of phosphorus on quality attributes

During peak period stage, significantly maximum shelf and vase life of inflorescence (16.3 and 7.3 days, respectively) was observed with phosphorus 25 kg/ha. This may be as phosphorus is one of an essential elements in the plant which slows down the rate of respiration and dehydration and increases inflorescence quality. This result is in conformity with the result of Khimani and Patil (1995) and Singatkar *et. al*. (1995) in gaillardia, Patel (1998) in chrysanthemum, Patel (2005) in golden rod and Panchal (2009) in China aster.

5.4 INTERACTION EFFECT OF ORGANIC MANURES, NITROGEN AND PHOSPHORUS

Among different growth parameters of golden rod, the interaction effect between nitrogen x phosphorus was found to be significant for plant height (Table 4.2 and 4.3), fresh and dry weight of plant (Table 4.8,4.9,4.11 and 4.12), length of panicle at peak flowering stage (Table 4.16), fresh and dry weight of

panicle (Table 4.21 and 4.22), yield of panicle per hectare (Table 4.24), due to improved availability of nitrogen and phosphorus and more balance growth and elaboration of carbohydrates, proteins and fats for which these elements are known. Adequate supply of nitrogen and phosphorus to the plant resulted in the proper development due to higher dry matter production in the plant and development of reproductive system. Similar observations were also noted by Nanjan *et al.* (1980), Parthiban and Khader (1991) and Dahiya *et al.* (1998) in tuberose, Anuradha *et al.* (1988), Pandey and Mishra (2000) in marigold, De and Dhiman (1998), Patel (1998) and Chawala *et al.* (2006) in chrysanthemum, Patel (2005) in golden rod.

These may be due to nitrogen and phosphorus interacted with each other for inflorescence weight of golden rod. Nitrogen enhanced the inflorescence weight of golden rod. Nitrogen and phosphorus are also an essential elements in the plant which are needed for plant growth, flowering and yield. All other treatment combinations were found to be non-significant with respect to interaction of organic manures, nitrogen and phosphorus.

5.4.1 Interaction effect of nitrogen and phosphorus on economics

Perusal of the data presented in Table 4.26 revealed that the highest net realization of Rs. 272220 with CBR value of 1:7.84 was obtained with treatment N_3P_2 (N_3 150 Kg/ha + P_2 25 Kg/ha).But the best treatment of nitrogen and phosphorus interaction was N_2P_2 (N_2 100 Kg/ha + P_2 25 Kg/ha) with net realization of Rs. 267236 with CBR value of 1:7.82.This may be due to application of higher doses of nitrogen which increases the yield but simultaneously decreases soil health due to salt damage.

VI. SUMMARY AND CONCLUSION

SUMMARY

The present investigation entitled "Response of organic manures and chemical fertilizers on growth, flowering and vase life of golden rod (*Solidago canadensis* L.) cv. 'Local' under middle Gujarat agroclimatic conditions" was conducted at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during summer season of the year 2009-10. The treatments comprised of different levels of organic manures (FYM 20 t/ha, Vermicompost 4 t/ha and Castor cake 5 t/ha), nitrogen (50,100 and 150 kg/ha) and phosphorus (0 and 25 kg/ha). The experiment was laid out in a Randomized Block Design (Factorial) with eighteen treatments and replicated thrice.

The salient features of the experimental findings obtained at harvesting are being summarized as under :

6.1 EFFECT OF ORGANIC MANURES

At 60 and 90 DAP, vermicompost 4 t/ha significantly recorded the highest plant height (84.7 and 92.0 cm), fresh weight of plant (32.2 and 98.5 g), dry weight of plant (10.3 and 31.7 g) as compared to rest of the organic manures. Vermicompost 4 t/ha significantly recorded the highest panicle length (67.6 cm) at peak flowering stage.

Castor cake 5 t/ha significantly recorded the highest number of panicles per plant (8.1) at peak flowering stage. At peak flowering stage, there was significant increase in the fresh (87.19) and dry weight of panicle (22.4 g) with FYM 20 t/ha.

Significantly the highest no. of panicles per hectare (561878), net realization at Rs.236025/ha with CBR value of 1:5.6 were associated with vermicompost 4 t/ha.

6.2 EFFECT OF NITROGEN

At 60 and 90 DAP, significantly maximum plant height (85.0 and 94.3 cm), number of leaves per plant (222.1 and 408.8), leaf area (416.7 cm^2), leaf area index (LAI) (0.167 and 0.308), fresh weight of plant (35.0 and 101.0 g), dry weight of plant (11.4 and 33.0 g), fresh and dry weight of panicle (91.0 and 24.1 g), were obtained with N_3 level (150 kg/ha). Significantly maximum panicle length (71.2 cm), panicle stalk diameter (1.85 cm), number of panicles per plant (8.3), number of inflorescence branches per panicle (44.3), number of inflorescences per hectare (601939) were obtained with N_3 level (150 kg/ha).

Significantly minimum days taken for first flower, 50 % flowering, maximum shelf and vase life of inflorescence was observed with nitrogen 50 kg/ha (83.6, 106.3 days, 16.5 and 7.5 days respectively).

6.3 EFFECT OF PHOSPHORUS

At 60 and 90 DAP, significantly maximum plant height (83.0 and 91.1 cm, respectively), no. of leaves (222.8 and 407.7, respectively), leaf area index (0.168 and 0.307, respectively), fresh weight of plant (33.7 and 100.8 g, respectively), dry weight of plant (10.9 and 32.7 g, respectively), maximum fresh and dry weight of panicle (87.2 and 22.9 g) were observed with phosphorus 25 kg/ha. Significantly maximum leaf area (415.6), panicle length (67.4 cm), panicle stalk diameter (1.81 cm), number of panicles per plant (8.1), number of inflorescence branches per panicle (43.6), number of inflorescences per hectare (555567), shelf and vase life of inflorescence (16.3 and 7.4 days, respectively) were observed with phosphorus 25 kg/ha.

Significantly minimum days taken for first and 50 % flowering (83.4 and 105.0, respectively) were observed with phosphorus 25 kg/ha.

6.4 INTERACTION EFFECT

At 60 and 90 DAP, significantly maximum plant height (89.4 and 101.1 cm, respectively), fresh weight of plant (37.7 and 103.6 g, respectively), dry weight of plant (12.5 and 34.6 g, respectively), fresh weight of panicle (99.8 and 26.9 g, respectively), were noted in N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5). Significantly maximum panicle length (72.8 cm) and

number of inflorescences per hectare (615111 nos.) were noted with N_3P_2 (150 kg/ha N x 25 kg/ha P_2O_5). The best treatment of nitrogen and phosphorus interaction was N_2P_2 (N_2 100 Kg/ha + P_2 25 Kg/ha) with net realization of Rs. 267236 with CBR value of 1:7.82.

CONCLUSION

From the foregoing discussion it can be concluded that in golden rod, better quality of panicles with higher panicle with more profit and can be obtained by adding vermicompost 4 t/ha. Moreover golden rod crop fertilizing with nitrogen 100 kg/ha with phosphorus 25 kg/ha gave higher number of inflorescences and profit under middle Gujarat agro climatic conditions.

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* Original not seen

APPENDICES

APPENDIX- I METEOROLOGICAL WEATHER DATA OF YEAR 2010

Standard weeks	Rain fall	Max. Temp.	Min. Temp.	Mean Temp.	Max. RH	Min. RH	Mean RH
5	0.0	29.9	13.3	21.6	82.7	37.3	60.0
6	0.0	31.0	16.2	23.6	80.0	37.6	58.8
7	0.0	30.2	12.5	21.3	70.6	29.1	49.9
8	0.0	32.5	14.8	23.6	67.7	27.1	47.4
9	0.0	34.9	16.6	25.8	74.1	24.9	49.5
10	0.0	34.4	18.8	26.6	62.4	26.7	44.6
11	0.0	38.1	17.3	27.7	70.7	16.6	43.6
12	0.0	39.8	19.3	29.6	73.4	18.3	45.9
13	0.0	37.2	20.8	29.0	78.6	25.1	51.9
14	0.0	38.6	21.6	30.1	68.6	18.0	43.3
15	0.0	39.5	22.9	31.2	80.6	29.1	54.9
16	0.0	40.8	24.6	32.7	83.0	27.9	55.4
17	0.0	41.1	23.1	32.1	58.6	21.1	39.9
18	0.0	40.9	25.5	33.2	64.4	25.3	44.9
19	0.0	42.0	26.4	34.2	66.9	23.4	45.1
20	0.0	42.2	27.3	34.8	70.4	22.6	46.5
21	0.0	44.2	27.9	36.1	64.6	25.0	44.8
22	0.0	40.2	27.8	34.0	72.6	38.4	55.5
23	59.2	37.0	27.2	32.1	78.6	57.3	67.9
24	11.2	39.0	28.2	33.6	77.7	44.7	61.2
25	0.0	38.7	29.1	33.9	76.0	48.4	62.2
26	0.0	38.0	28.3	33.2	79.4	44.1	61.8
27	43.7	34.4	26.2	30.3	89.4	76.3	82.9
28	60.7	33.7	26.3	30.0	88.6	75.1	81.9
29	19.1	33.6	27.2	30.4	89.3	71.9	80.6
30	93.8	31.1	26.1	28.6	91.1	74.6	82.9
31	171.5	31.4	25.3	28.3	93.4	80.6	87.0
32	86.6	30.5	25.1	27.8	95.3	78.6	86.9
33	21.8	32.3	25.9	29.1	94.9	71.0	82.9
34	18.0	32.1	25.5	28.8	94.3	66.3	80.3

Standard weeks	Rain fall	Max. Temp.	Min. Temp.	Mean Temp.	Max. RH	Min RH	Mean RH
35	74.7	32.9	25.1	29.0	96.9	77.3	87.1
36	76.9	29.9	25.3	27.6	97.9	83.7	90.8
37	175.1	29.3	24.7	27.0	97.3	86.1	91.7
38	10.0	32.8	24.6	28.7	96.0	61.6	78.8
39	0.0	35.8	24.0	29.9	85.7	50.9	68.3
40	0.0	37.9	22.8	30.4	83.0	33.7	58.4
41	0.0	34.9	23.5	29.2	87.7	51.1	69.4
42	0.0	41.7	27.9	30.7	94.3	54.1	63.9
43	0.0	35.4	21.9	28.7	90.4	36.4	63.4

Appendix- IV: Cost of cultivation of golden rod and economic details

(A) Details of operational cost

Sr.No.	Particulars	Cost (Rs ha^{-1})
A.	**Land Preparation**	
1.	Tractor cultivation (3 hrs @ Rs. 200.00 hr^{-1})	600.00
2.	Harrowing and planking (2PB, 2M)	600.00
B.	**Sowing**	
1.	a. Cost of seedling (Rs. 2 for 1 plant) b. Cost of sowing (10 W)	14814.00 1000.00
C.	Irrigation (15 irrigation x Rs 150 ha^{-1})	2250.00
1.	(1 M x 15 irrigation x 100 Rs day^{-1})	1500.00
D.	Hand weeding nine time (8 W x 9)	7200.00
E.	Thinning and Gap filling (3 W)	300.00
1.	Plant protection a. Chlorpyriphos 20 EC @ (3 lit^{-1}) (Rs.200 lit^{-1}) b. Drenching charges (100 x 3 M)	 600.00 300.00
F.	**Picking (6 W- per picking) – 6 picking**	3600.00
G.	**Land revenue**	150.00
	Total Cost	32914.00

PB : Pair of bullock @ Rs. 200 day^{-1}

M : Man (labour) @ Rs. 100.00 day^{-1}

W : Woman (labour) @ Rs. 100.00 day^{-1}

Note : The total cost has been carried over to Appendix IV (B)

APPENDIX: IV (B): Details of cost of treatments

Treatments	Cost (Rs ha^{-1})	Application charges (Rs.ha^{-1})	Total cost of treatments (Rs.ha^{-1})
T_1	6250.00	200	6450.00
T_2	6621.87	200	6821.87
T_3	6800.00	200	7000.00
T_4	7171.87	200	7371.87
T_5	7350.00	200	7550.00
T_6	7721.87	200	7921.87
T_7	12750.00	200	12950.00
T_8	13121.87	200	13321.87
T_9	13300.00	200	13500.00
T_{10}	13671.87	200	13871.87
T_{11}	13850.00	200	14050.00
T_{12}	14221.87	200	14421.87
T_{13}	38150.00	200	38350.00
T_{14}	38521.87	200	38721.87
T_{15}	38700.00	200	38900.00
T_{16}	39071.87	200	39271.87
T_{17}	39250.00	200	39450.00
T_{18}	39621.87	200	39821.87

APPENDIX: IV (C): Total cost incurred for different treatments

Sr. No.	Treatment	Treatment cost ($Rs.ha^{-1}$)	Cost of cultivation ($Rs.ha^{-1}$)	Interest on column 3+4 @ (12 % per annum) for 6 months ($Rs.ha^{-1}$)	Supervision charge (column 3+4) @ (10 % per annum) for 6 months ($Rs.ha^{-1}$)	Total cost of cultivation (3+4+5+6) ($Rs.ha^{-1}$)
1	**2**	**3**	**4**	**5**	**6**	**7**
1	T_1	6450.00	32914	2362	1968	43694.04
2	T_2	6821.87	32914	2384	1987	44106.82
3	T_3	7000.00	32914	2395	1996	44304.54
4	T_4	7371.87	32914	2417	2014	44717.32
5	T_5	7550.00	32914	2428	2023	44915.04
6	T_6	7921.87	32914	2450	2042	45327.82
7	T_7	12950.00	32914	2752	2293	50909.04
8	T_8	13321.87	32914	2774	2312	51321.82
9	T_9	13500.00	32914	2785	2321	51519.54
10	T_{10}	13871.87	32914	2807	2339	51932.32
11	T_{11}	14050.00	32914	2818	2348	52130.04
12	T_{12}	14421.87	32914	2840	2367	52542.82
13	T_{13}	38350.00	32914	4276	3563	79103.04
14	T_{14}	38721.87	32914	4298	3582	79515.82
15	T_{15}	38900.00	32914	4309	3591	79713.54
16	T_{16}	39271.87	32914	4331	3609	80126.32
17	T_{17}	39450.00	32914	4342	3618	80324.04
18	T_{18}	39821.87	32914	4364	3637	80736.82

Vermicompost: Rs. 2.5 kg^{-1} FYM: Rs. 250 $tonnes^{-1}$

Urea: Rs. 5.06 kg^{-1} SSP: Rs. 3.98 kg^{-1}

MOP: Rs. 4.62 kg^{-1} Castor cake: Rs. 6.38 kg^{-1}

Appendix-II : Schedule of cultural operations followed in experimental field during the course of investigation

Sr. No.	Cultural operations	Date of operation
[A]	**Pre-transplanting operations**	
1.	Ploughing and harrowing by tractor	20/02/2010
2.	Planking and leveling by tractor	22/02/2010
3.	Preparation of layout of experiment	22/02/2010
4.	Manure application	22/02/2010
5.	Fertilizer application	
	50 % dose of N + full dose of P_2O_5 and K_2O as basal dose	23/02/2010
6.	Planting	24/02/2010
[B]	**Post-transplanting operations**	
1.	Gap filling: First	13/03/2010
	: Second	27/03/2010
2.	Weeding : First	16/03/2010
	: Second	08/04/2010
	: Third	28/04/2010
	: Fourth	20/05/2010
	: Fifth	14/06/2010
	: Sixth	06/07/2010
	: Seventh	29/07/2010
	: Eighth	20/08/2010
	: Ninth	24/09/2010
3.	Irrigation : First	12/03/2010
	: Second	26/03/2010
	: Third	01/04/2010
	: Fourth	09/04/2010
	: Fifth	16/04/2010
	: Sixth	23/04/2010
	: Seventh	30/04/2010
	: Eighth	10/05/2010

	: Ninth : Tenth : Eleventh : Twelfth : Thirteenth : Fourteenth : Fifteenth	18/05/2010 25/05/2010 02/06/2010 10/06/2010 17/06/2010 25/06/2010 05/07/2010
4.	**Application of Fertilizer (split dose)**	23/03/2010
[C]	**Harvesting of panicles** : First : Second : Third : Fourth : Fifth : Sixth	 10/06/2010 18/06/2010 23/08/2010 01/09/2010 09/09/2010 13/09/2010
[D]	**Final harvesting**	05/10/2010

APPENDIX - III Crop protection measure

Sr. No.	Particulars	Control measures	Date of application
I	**Insect pests** i) Termites	Chlorpyriphos (Dermate) drenching 20 EC @ (2 ml lit^{-1})	15/03/10

Plate 1: **General view** of an experimental field of golden rod cv. 'Local'

(Effect of T_{10} (Vermicompost 4 t/ha + 100 kg N/ha + 25 Kg P_2O_5/ha)

(Effect of T_8 (Vermicompost 4 t/ha + 50 kg N/ha + 25 Kg P_2O_5/ha)

Plate 2: Effect of T_{10} and T_8 on panicle yield (nos.) of golden rod cv. 'Local'

View of vase life of infloresences of golden rod cv. 'Local'

Effect of T_8 (Vermicompost 4 t/ha + 50 kg N/ha + 25 kg P_2O_5 ha) Vs T_{12} (Vermicompost 4 t/ha + 150 kg N/ha + 25 kg P_2O_5 ha) on shelf life of golden rod cv. 'Local'

Plate 3: View of vase life of infloresences and effect of T_8 Vs T_{12} on shelf life of golden rod cv. 'Local'

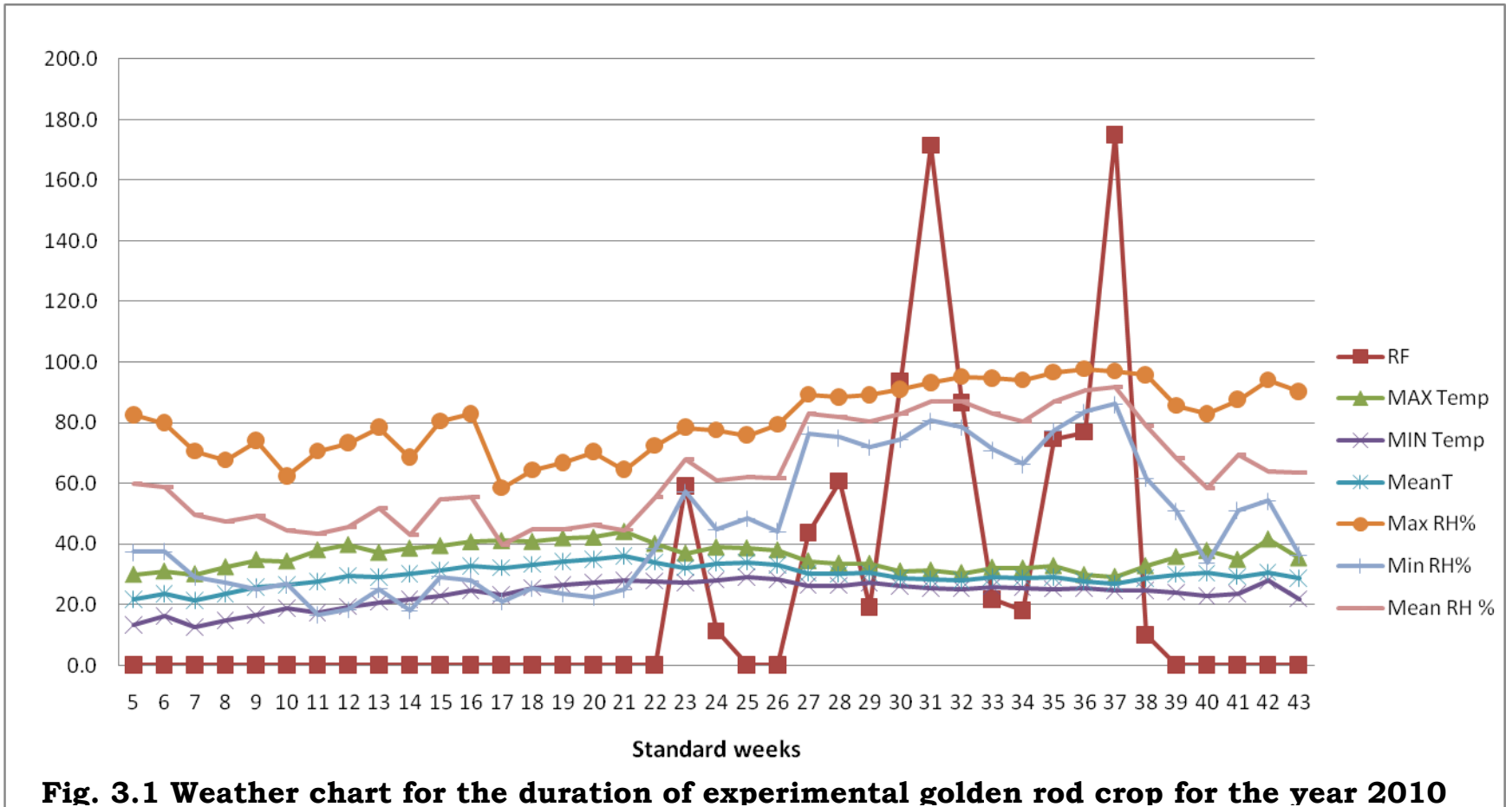

Fig. 3.1 Weather chart for the duration of experimental golden rod crop for the year 2010

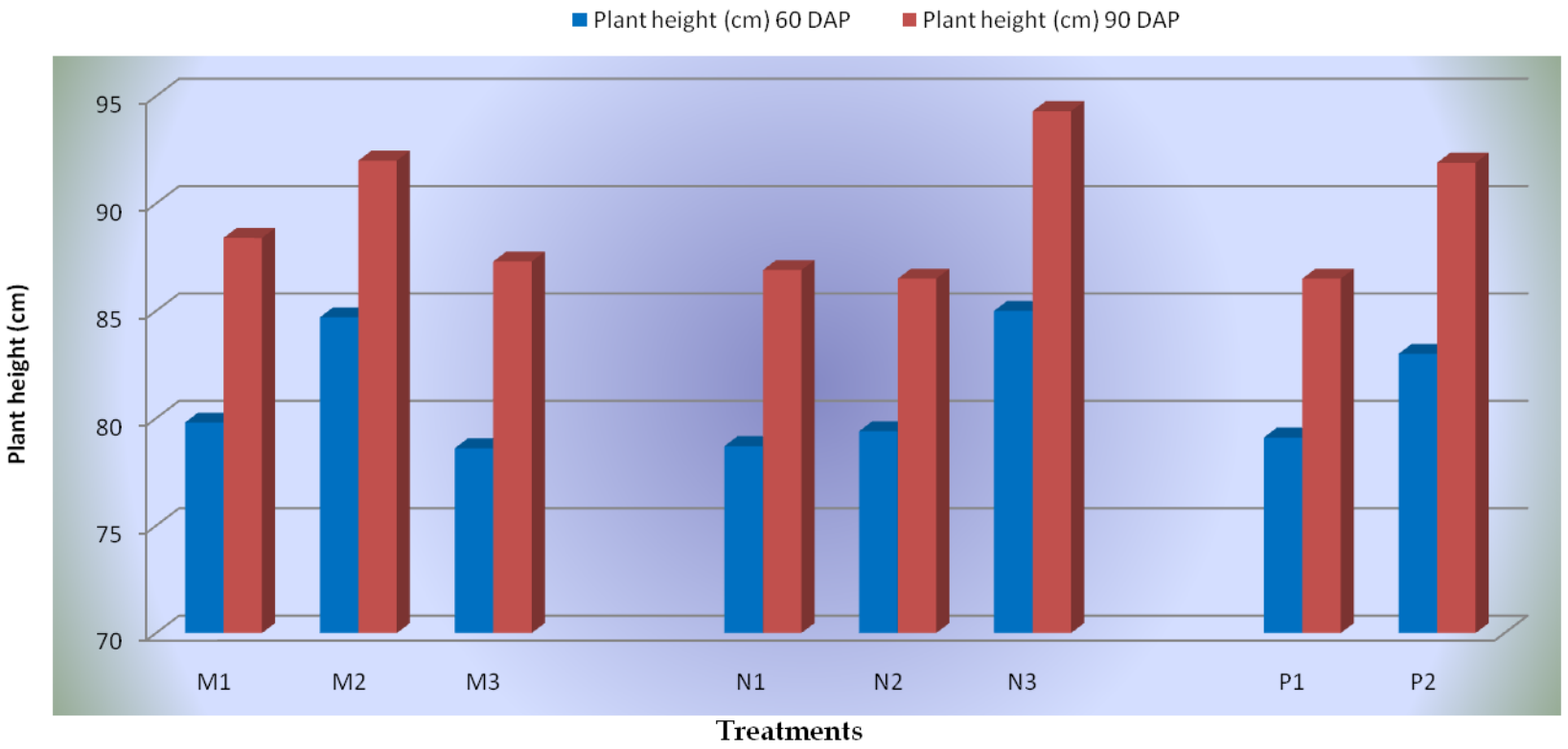

Fig. 4.1 : Influence of organic manures and chemical fertilizers on plant height at 60 and 90 DAP in golden rod (Solidago Canadensis L.) cv. 'Local'

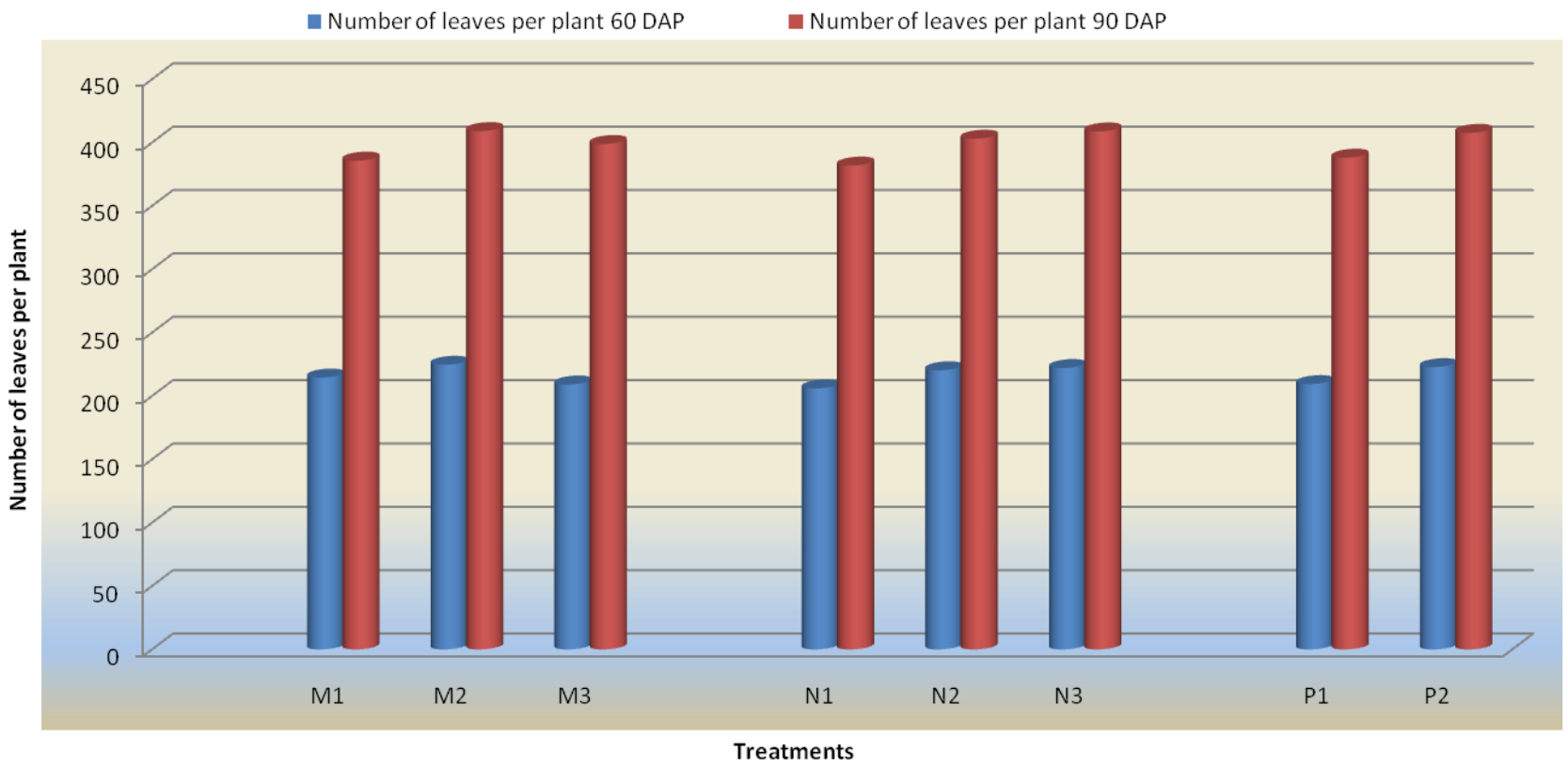

Fig. 4.2: Influence of organic manures and chemical fertilizers on number of leaves per plant at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv.'Local'

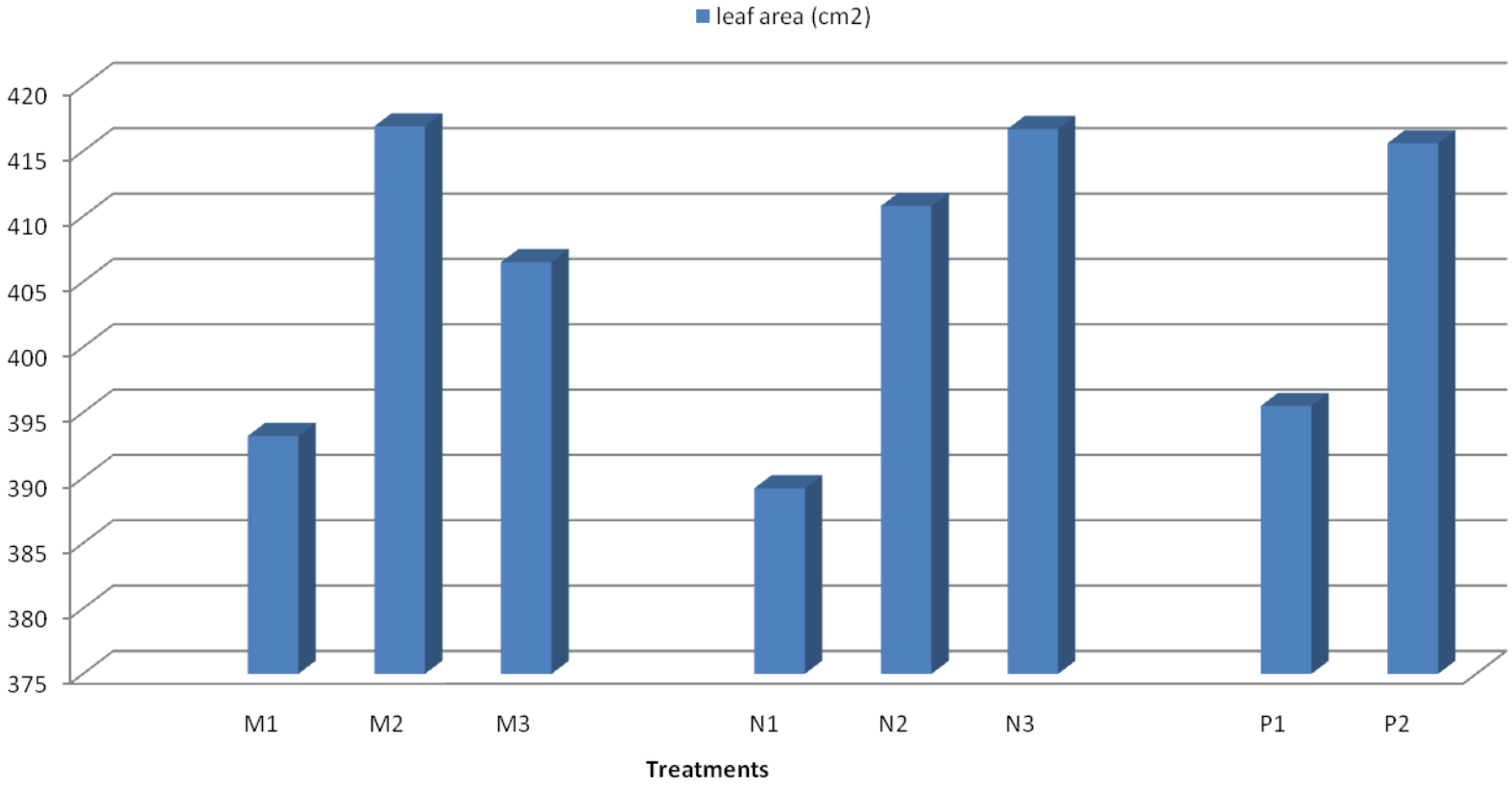

Fig. 4.3: Influence of organic manures and chemical fertilizers on leaf area (cm^2)during peak flowering stage in golden rod (*Solidago canadensis* L.) cv.'Local'

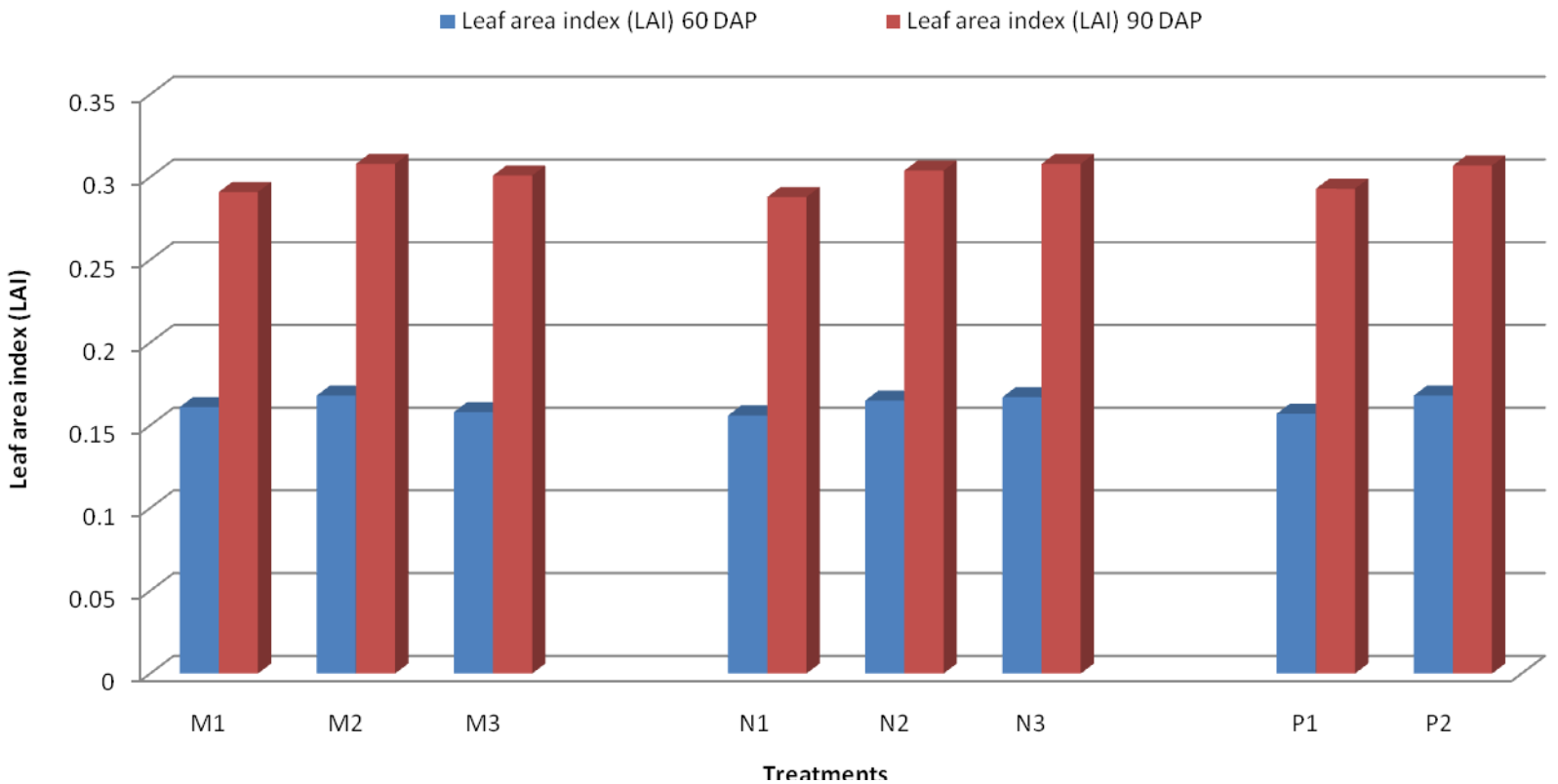

Fig. 4.4: Influence of organic manures and chemical fertilizers on leaf area index (LAI) at 60 and 90 DAP in golden rod *(Solidago canadensis* L.) cv.'Local'

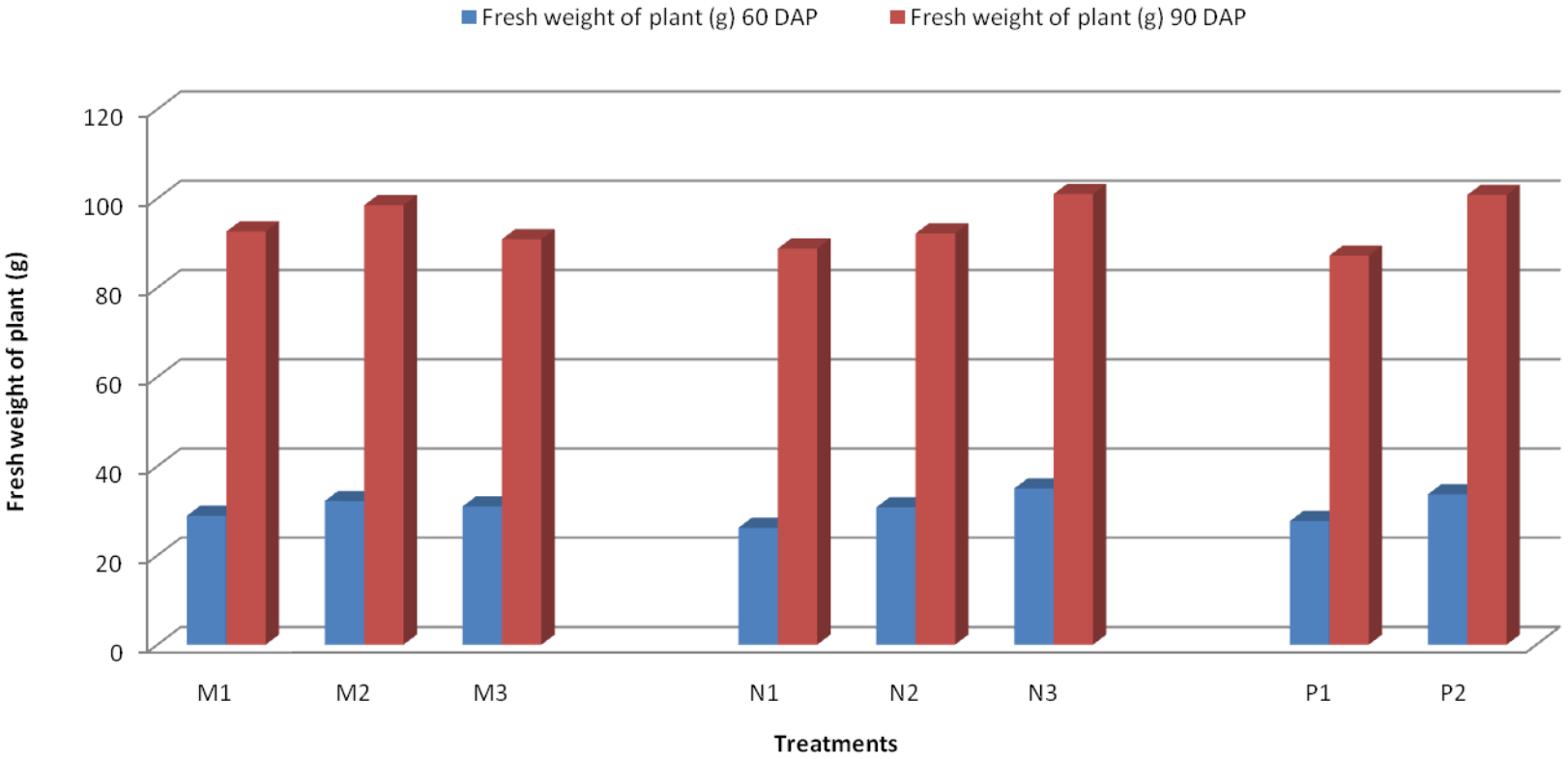

Fig. 4.5 : Influence of organic manures and chemical fertilizers on fresh weight of plant (g) at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv.'Local'

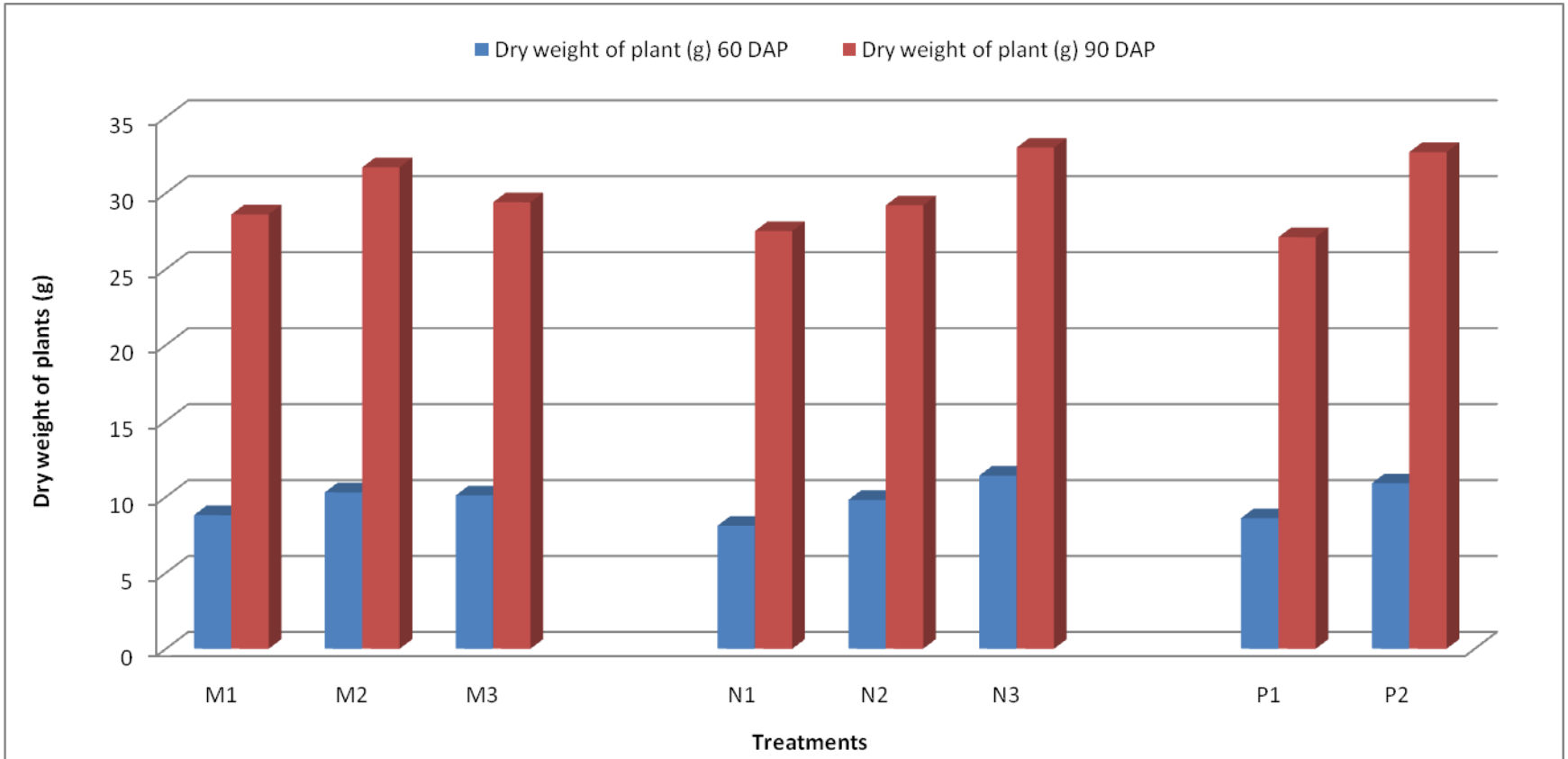

Fig. 4.6 : Influence of organic manures and chemical fertilizers on dry weight of plant (g) at 60 and 90 DAP in golden rod (*Solidago canadensis* L.) cv.'Local'

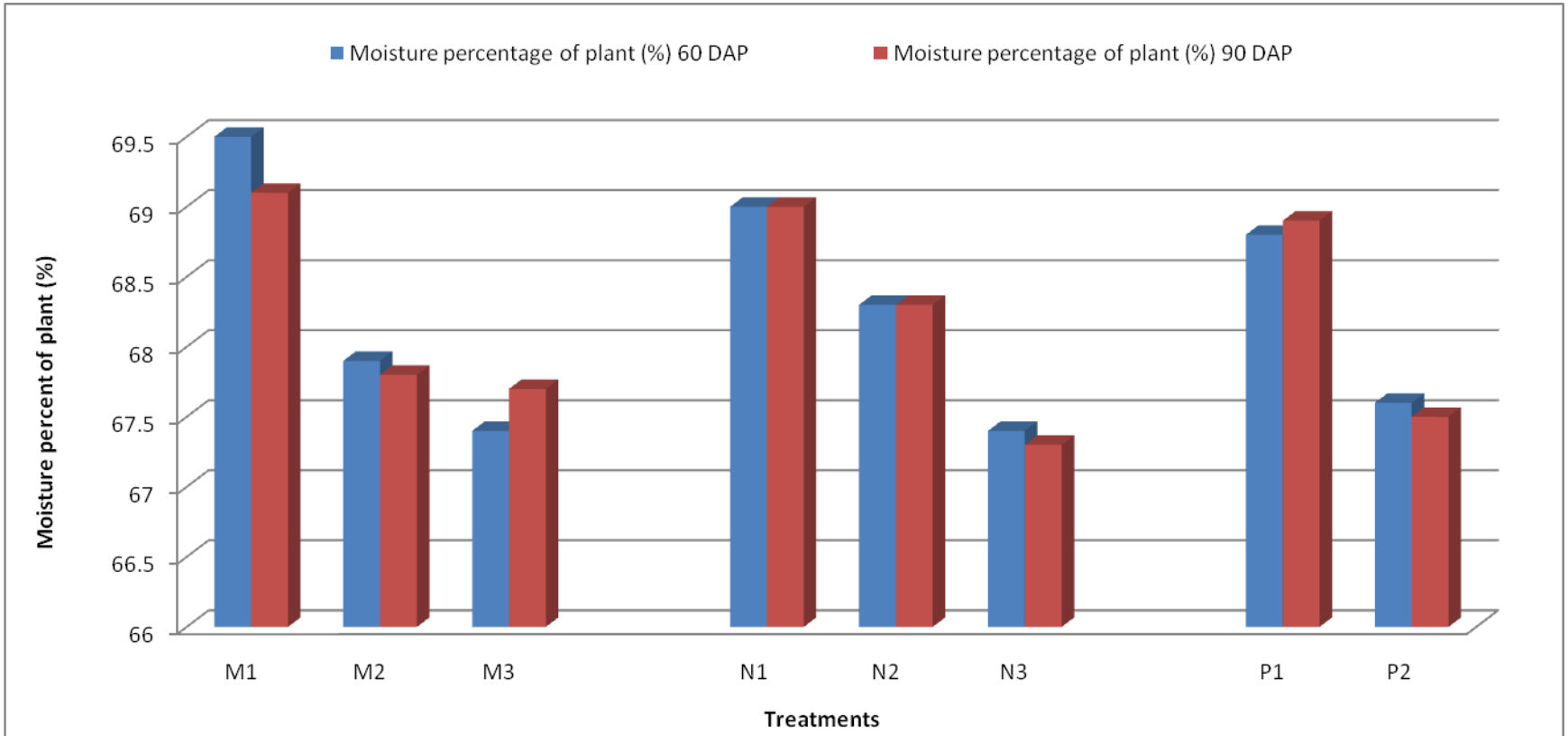

Fig. 4.7 : Influence of organic manures and chemical fertilizers on moisture percentage of plant at 60 and 90 DAP in golden rod *(Solidago canadensis* L.) cv.'Local'

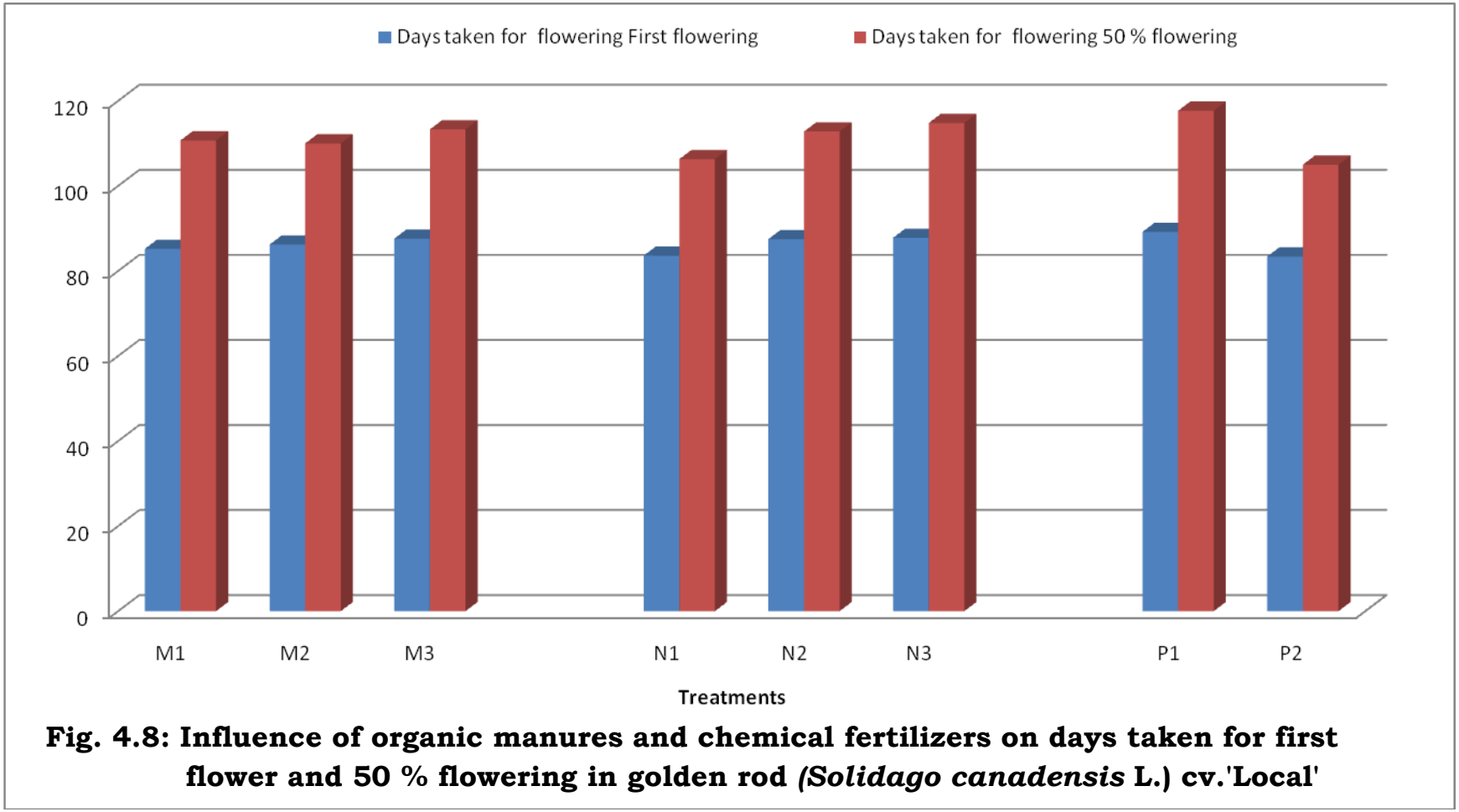

Fig. 4.8: Influence of organic manures and chemical fertilizers on days taken for first flower and 50 % flowering in golden rod *(Solidago canadensis* L.) cv.'Local'

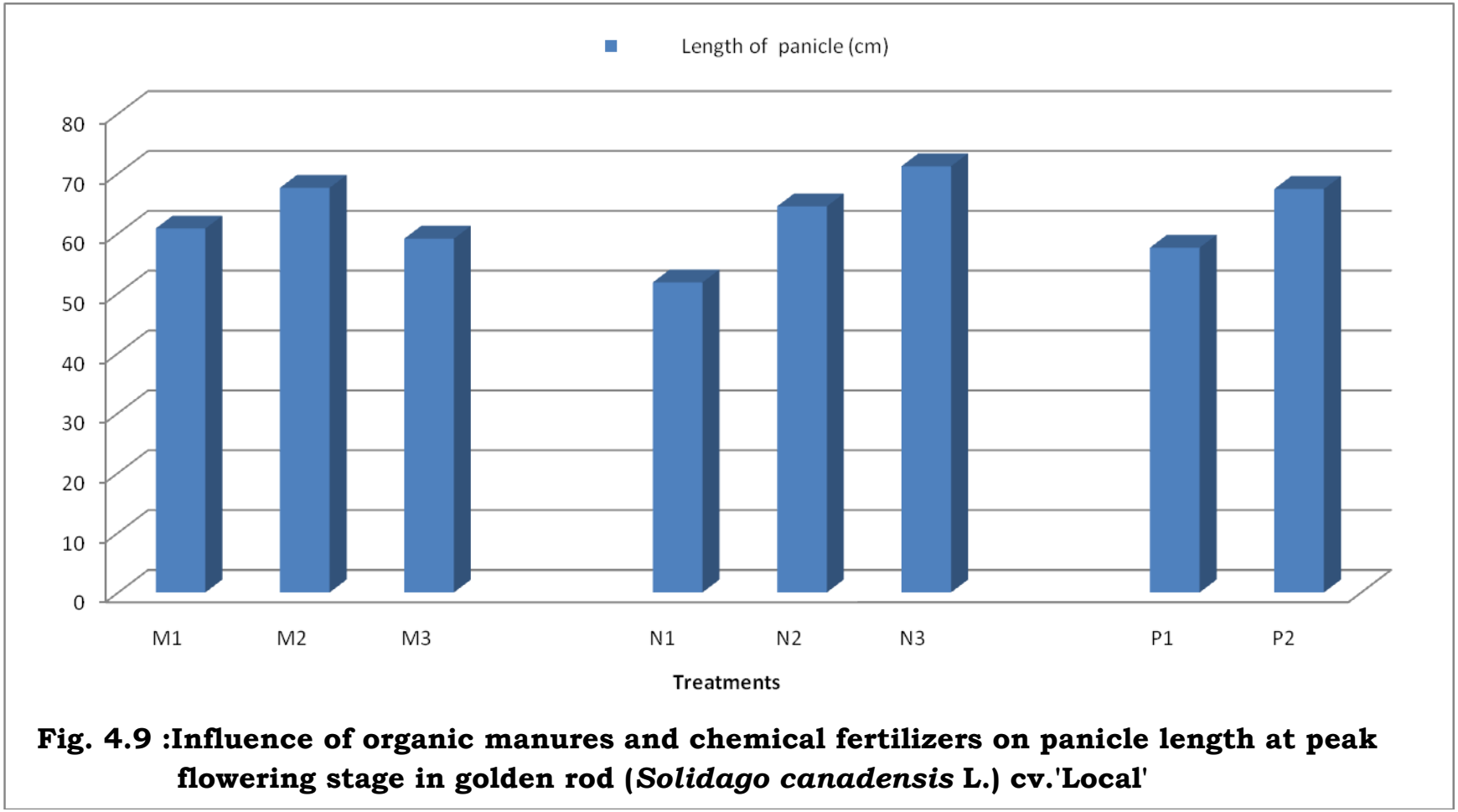

Fig. 4.9 :Influence of organic manures and chemical fertilizers on panicle length at peak flowering stage in golden rod (*Solidago canadensis* L.) cv.'Local'

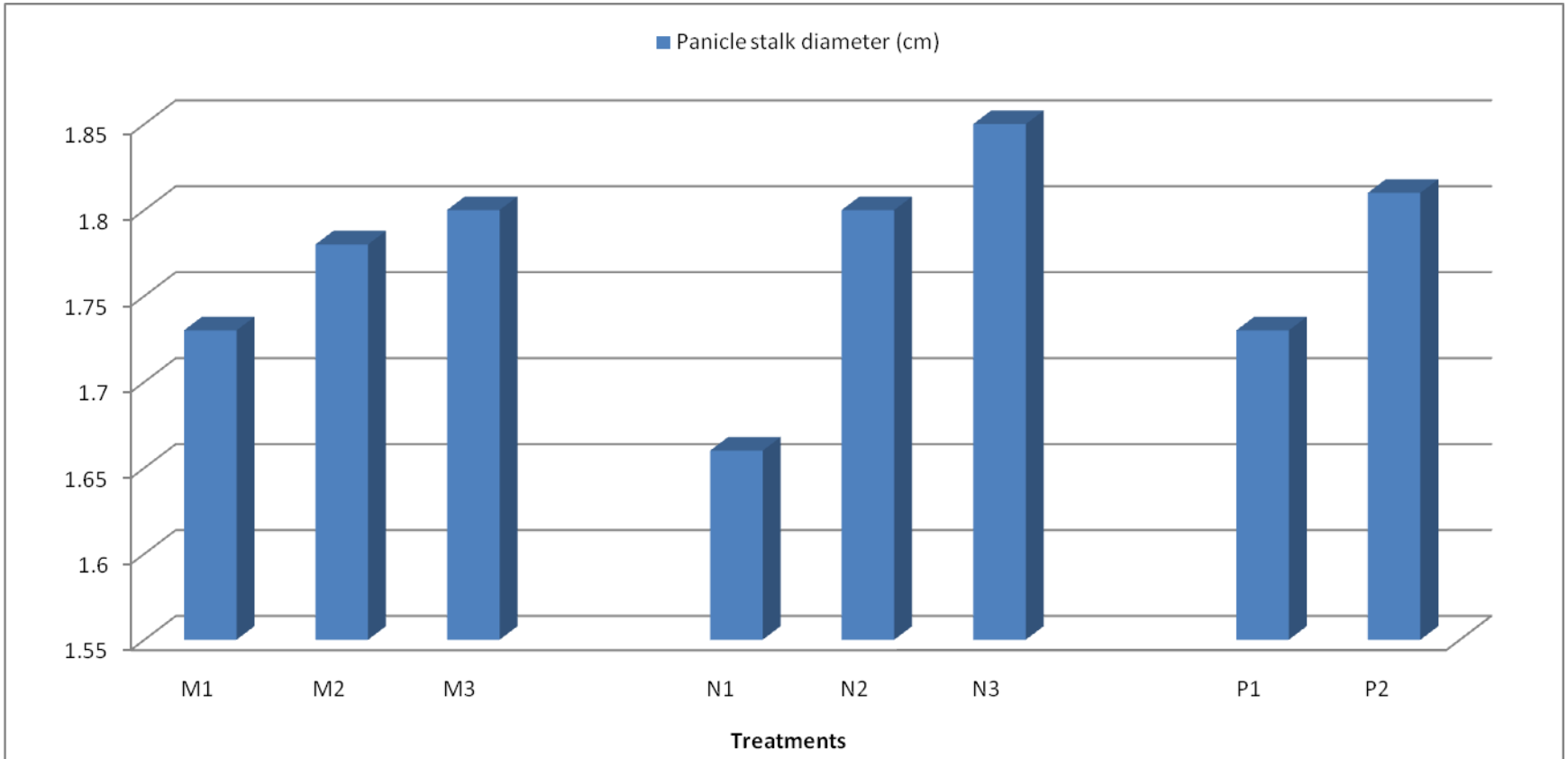

Fig. 4.10 : Influence of organic manures and chemical fertilizers on panicle stalk diameter at peak flowering stage in golden rod (*Solidago canadensis* L.) cv.'Local'

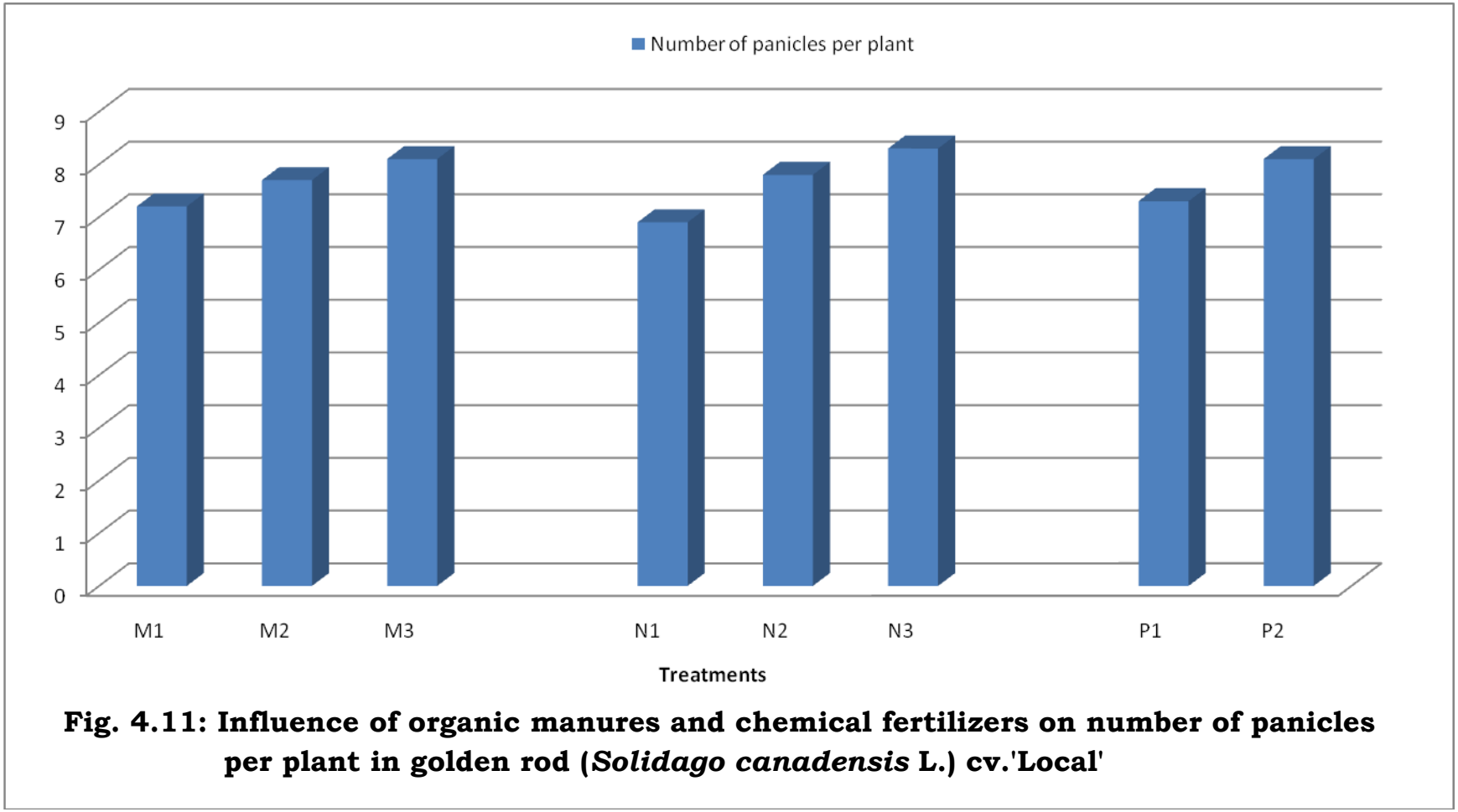

Fig. 4.11: Influence of organic manures and chemical fertilizers on number of panicles per plant in golden rod (*Solidago canadensis* L.) cv.'Local'

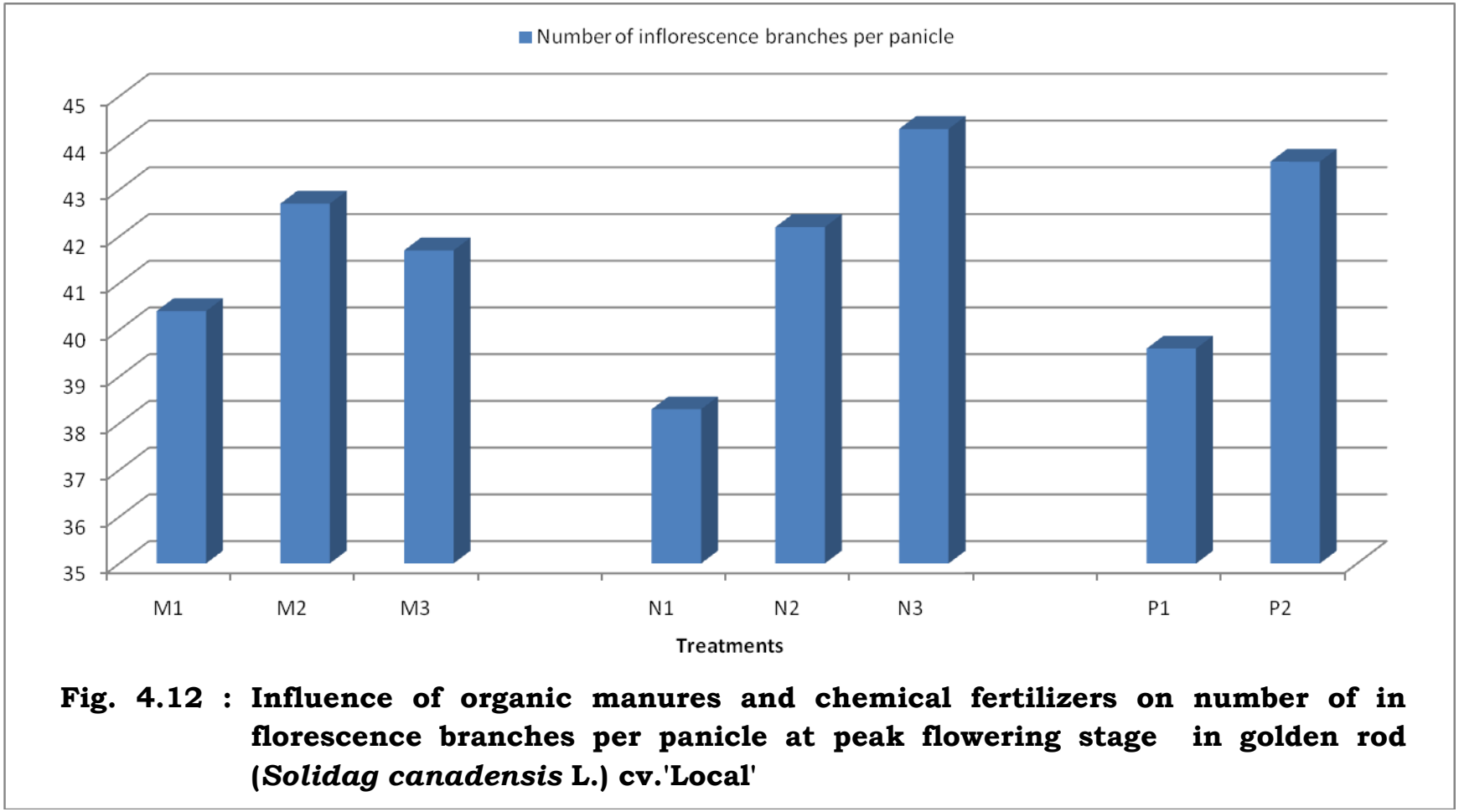

Fig. 4.12 : Influence of organic manures and chemical fertilizers on number of in florescence branches per panicle at peak flowering stage in golden rod (*Solidag canadensis* L.) cv.'Local'

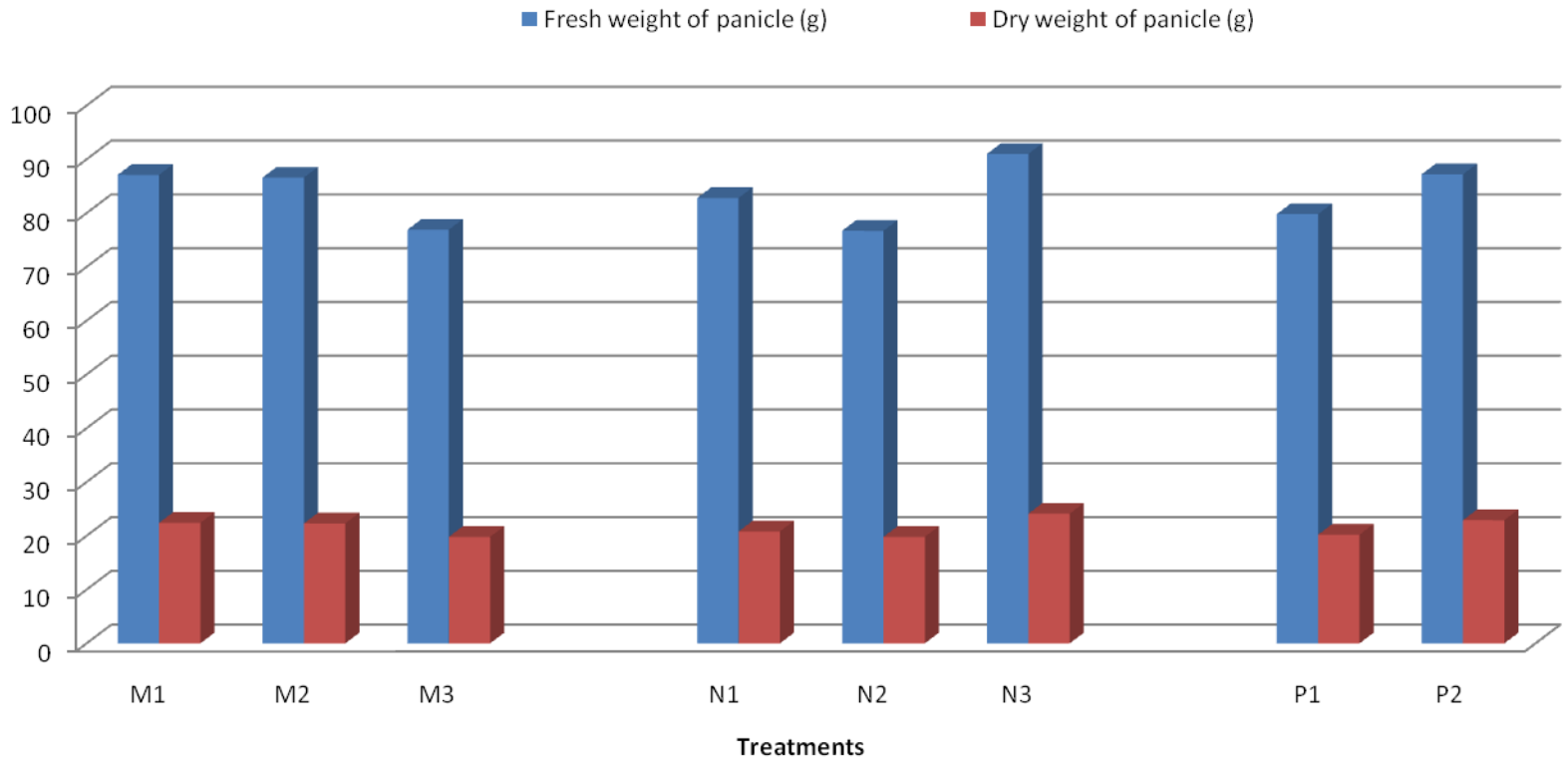

Fig. 4.13 : Influence of organic manures and chemical fertilizers on fresh and dry weight of panicle(g) at peak flowering stage in golden rod *(Solidago canadensis* L.) cv.'Local'

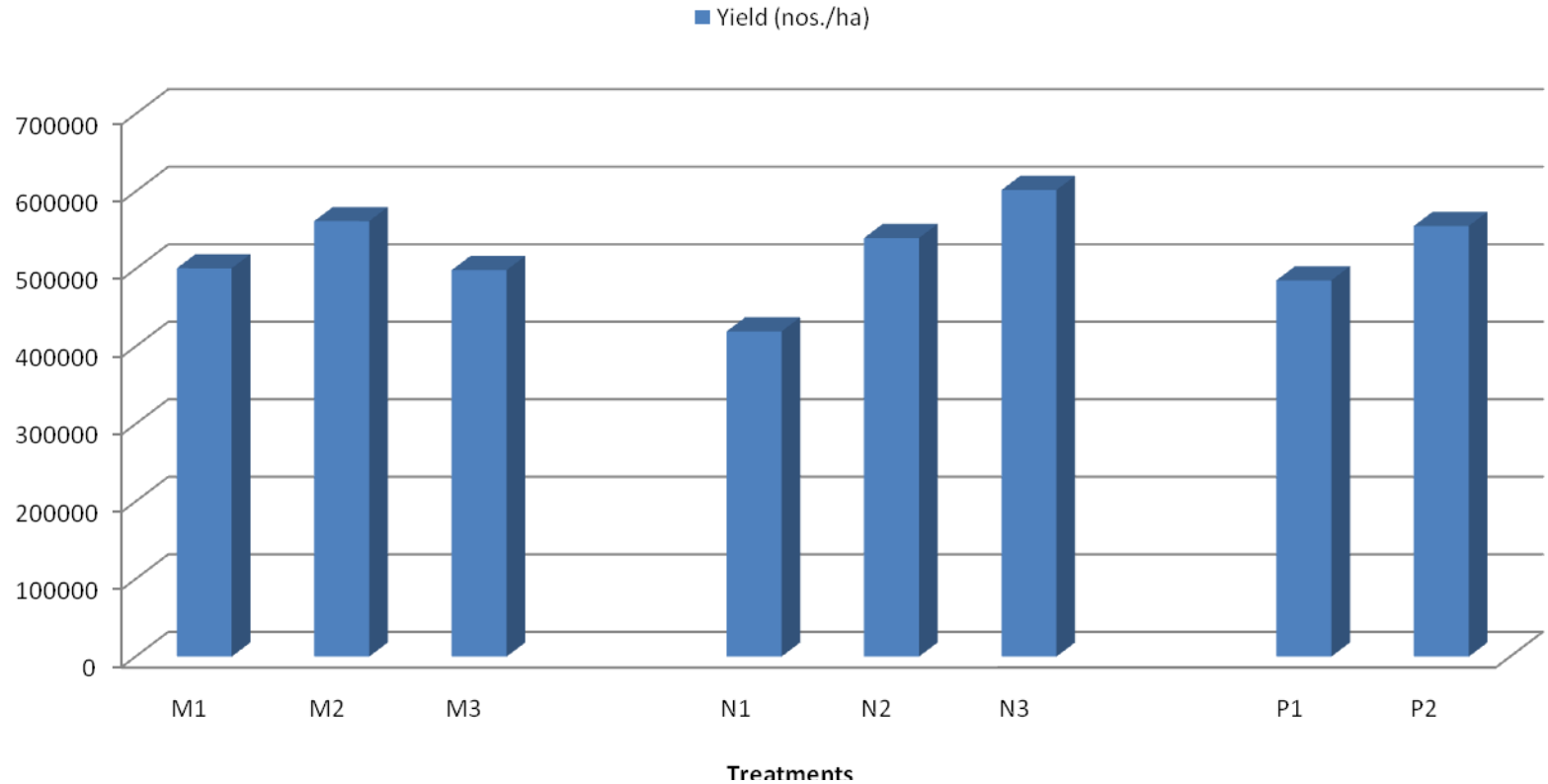

Fig. 4.14: Influence of organic manures and chemical fertilizers on yield (nos./ha) in golden rod (*Solidago canadensis* L.) cv.'Local'

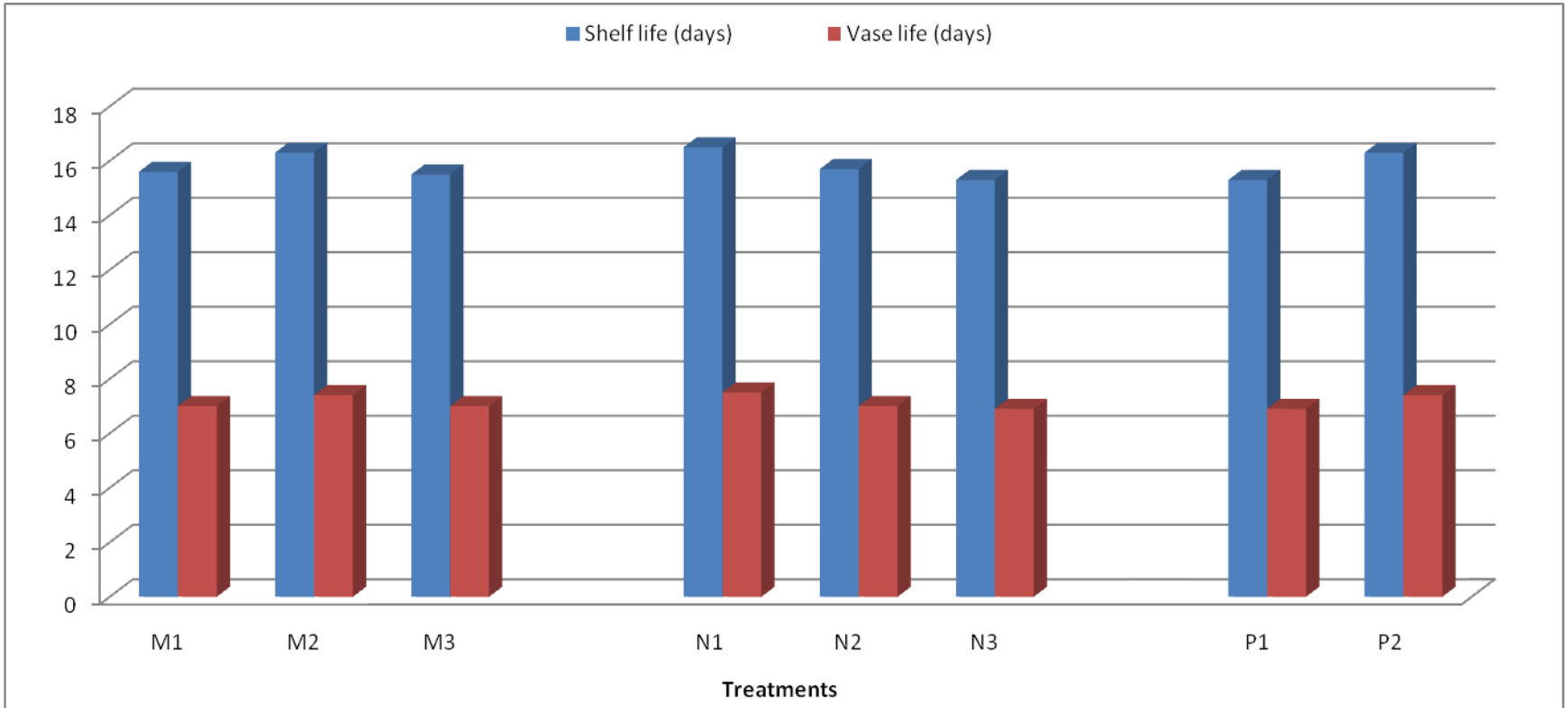

Fig. 4.15: Influence of organic manures and chemical fertilizers on shelf and vase life of inflorescence during peak period stage in golden rod (*Solidago canadensis* L.) cv. 'Local'

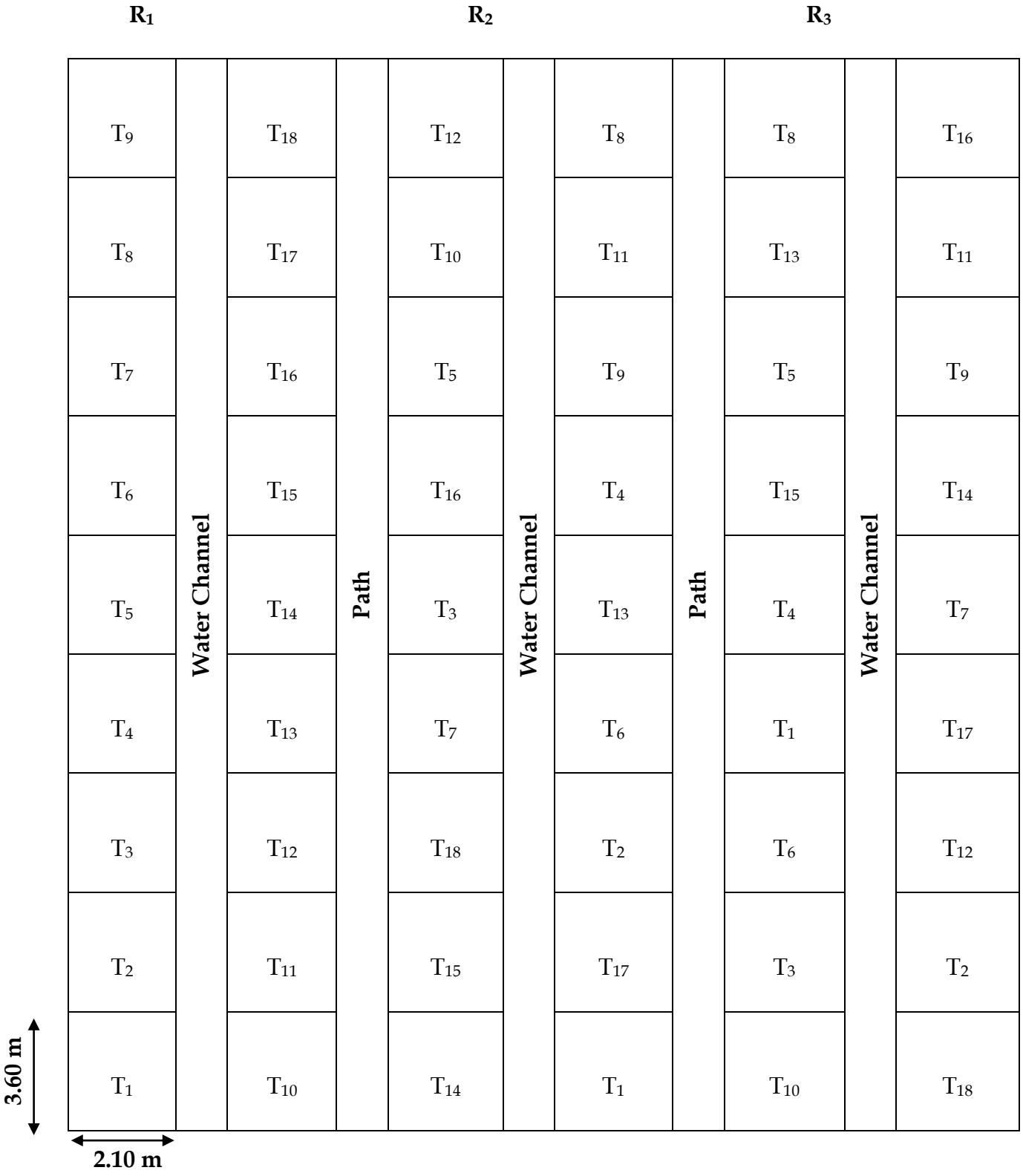

Fig. 1: General Experimental Layout of Plot