EFFECT OF FOLIAR APPLICATION OF PANCHAGAVYA AND LEAF EXTRACT'S ON NUTRITIONAL QUALITY OF SPINACH

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DISSERTATION

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CERTIFICATE-I

This is to certify that **Mr. SHINDE SHASHIKANT EKNATHRAO** has satisfactorily prosecuted his course credits and research for a period of not less than two years and the dissertation entitled **"EFFECT OF FOLIAR APPLICATION OF PANCHAGAVYA AND LEAF EXTRACT'S ON NUTRITIONAL QUALITY OF SPINACH"** submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination for the award of the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**.

I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any University.

Place: PARBHANI
Date: 31/05 /2018

Dr. A. L. Dhamak
Research Guide

CERTIFICATE-II

This is to certify that the dissertation entitled **"EFFECT OF FOLIAR APPLICATION OF PANCHAGAVYA AND LEAF EXTRACT'S ON NUTRITIONAL QUALITY OF SPINACH."** submitted by **Mr. SHINDE SHASHIKANT EKNATHRAO** to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY** has been approved by the student's advisory committee after oral examination in collaboration with the external examiner.

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I hereby declare that the entire work embodied in this dissertation or any part thereof has not been Previously submitted by me for a degree of any University or Institute

Place: PARBHANI
Date: 31/05//2018

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"Don't take rest after ur first Victory
because if u fail in second,
more lips are waiting to say,
that ur first Victory was just luck."

- Dr. A. P. J. Abdul kalam.

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Place: PARBHANI **SHINDE S. E.**

Date: 31 /05 /2018 **Reg.No: 2016A/115M**

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ABBREVIATIONS

%	per cent
/	per
C.D.	Critical difference
cc	Cubic centimeter
cm	centimeter
Cu	Copper
Cv	Coefficient of variation
DAS	Days after sowing
dSm^{-1}	desi Simen per meter
EC	Electrical conductivity
et al.	and others
etc.	etceteras
Fe	Iron
Fig.	Figure
g	Gram(s)
ha	Hectare(s)
i.e.	that is
K	Potassium
kg ha^{-1}	kilogram per hectare
kg	kilogram
m	meter
mg kg^{-1}	milligram per kilogram
mm	millimeter
Mn	Manganese
N	Nitrogen
No.	number
^{o}C	Degree centigrade
P	Phosphorus
RBD	Randomised Block Design.
SEm±	Standard Error
viz.,	namely
Zn	Zinc

Thesis Abstract

ABSTRACT

"EFFECT OF FOLIAR APPLICATION OF PANCHAGAVYA AND LEAF EXTRACT'S ON NUTRITIONAL QUALITY OF SPINACH

By
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Research Guide	:	Dr. A. L.DHAMAK
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Field experiment was conducted during *Rabi* season of 2017-18 at Research farm, Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani. The experimental soil was slightly alkaline in reacation (7.54), normal in salt content (0.17 dSm^{-1}), low in organic carbon content (3.10 g kg^{-1}) calcareous nature (5.10 g kg^{-1}), low in available nitrogen (173.00 kg ha^{-1}), and phosphorous (10.69 kg ha^{-1}) and very high in available potassium (640.02 kg ha -1), deficient in zinc (0.42 g kg^{-1}) and iron (3.84g kg^{-1}), sufficient in manganesse (3.29 g kg-1) and copper (1.82 g kg^{-1}). The experiment was carried out in randomized block design with three replication and eight treatments comprised of control, panchagavya, panchagavya + neem leaf extract, panchagavya + karanj leaf extract, panchagavya + glyricidia leaf extract, panchagavya + custard apple leaf extract, micronutrient grade II and 100 % N through FYM. The spinach was sow

with the spacing 15 * 5 cm. The recommended dose of NPK (80:40:40 kg^{-1})was given to spinach at the time of sowing. Foliar application of 3% panchagavya + leaf extract and 0.5% micronutrient grade II was given at 15 and 30 DAS. The growth and yield attributes viz , plant height, number of leaves, leaf area, green fresh yield and dry matter yield improved significantly with foliar application panchagavya + neem leaf extract followed by foliar application of panchagavya + glyricidia leaf extract. The pH. EC, organic carbon and calcium carbonate content is soil after harvest of spinach were statistically non-significant due to application of panchagavya and leaf extract. The available NPK and micronutrients (Fe, Zn, Mn, and Cu) were maximum with T_3

(panchagavya + neem leaf extract) treatments. The foliar application of panchagavya and neem leaf extract showed highest content and uptake of NPK and micronutrient in spinach plant at harvest . The quality parameter viz, ascorbic acid and chlorophyll content of spinach are significantly improved due to foliar application of panchagavya and neem leaf extract.

(Shinde S. E.)	(Dr. A. L.Dhamak)	(Dr. Syed Ismail)
Student	**Research Guide**	**Head, SSAC**

Introduction

CHAPTER I

INTRODUCTION

The importance of vegetable in human nutrition is well known. Vegetables are rich and comparatively cheaper source of vitamin and minerals. Consumption of vegetables in sufficient amount provides vitamins, minerals, protein, carbohydrate and fibre in the diet besides having medicinal value and provide nutritional security. Most of the leafy vegetables are short duration crop and accumulates the higher amount of biomass within small life periods.

In India, vegetables are grown in an area of 9.575 million hectares with the productivity of 17.7 mt ha^{-1} which contributes 14 % of the total world production of vegetables. Among various states in India, West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra, Orisa, Gujrat and Karnataka are the major vegetable growing states (Anonymons, 2017). In Maharashtra, area under vegetable production is 580.54 thousand hectare with the productivity of 0.80 mt ha^{-1} sharing 7 % of the country production.

Spinach (*Beta vulgaris* L.) is one of the major leafy vegetable grown and consume in India. In India, spinach commonly known as palak and it is popular due to its high nutritive value. In India, it is grown on large scale and is extensively grown in Uttar Pradesh, West Bengal, Punjab, Haryana, Delhi, Madhya Pradesh, Gujarat and Maharashtra. It is rich and cheap source of Vitamin 'A' as compared to carrot. It contains high quality of ascorbic acid (70 mg) and iron (16.2mg) per 100 gm. It is good source of folacian. Spinach leaves are valued for their medicinal properties and are used in inflammation, paralysis, headache and remedy for diseases of spleen and liver. It also act as mild lacerative besides other medicinal value, it supply most of the nutrients in which other foods are deficient.

The first reports on foliar application of mineral nutrients in plant production date back to the second half of the 18th century (Weinbaum, 1988). Particularly many studies on the uptake of mineral nutrients and their translocation within a plant were carried out after the second world war. According to Doring and Gericke (1986) and Tukey and Marczyński (1984), a combined soil and foliar fertilization should be recommended in plant production to increase both plant

productivity and yield quality. Knowledge of nutrient absorption mechanisms by above ground plant parts is crucial to optimize foliar fertilization. Since, leaves have a large surface area in relation to other above ground plant parts, mineral nutrient uptake processes in relation to structure and leaf physiology.

Among all improved agricultural production techniques recent is one of the use of different organic sources with chemical fertilizer Viz., FYM, vermicompost and different organic formulations like panchagavya, Jeevamruth, Beejamruth etc. Among many organic sources, judicious use of organic sources with chemical fertilizer plays an important role in soil health management and productivity of crops.

Organic formulations can be cheap and alternative tools to resolve many issues of fertilizers and soil fertility. In organic production systems, there is always a challenge of how to improve soil fertility, crop productivity and management of pests by organic techniques. Use of organic liquid preparations has been an age old practice in India. On farm produced *Kunapajala,* prepared by fermenting animal flesh along with herbal products used to be an established technique in ancient India. As an alternative, number of organic farmers devised organic boosters based on local experiences and gave specific names such as *Amritpani, Panchagavya, Beejamrita, Jivamrita* etc. Similarly, in other organic farming systems, few effective preparations such as BD-500, BD-501, Cow Pat Pit, Biodynamic liquid manures and in Homa Organic Farming: Agnihotra ash enriched water and Biosol are effective tools being used by number of organizations. It is interesting to note that in all these preparations, the basic ingredients are cow based products.

The panchagavya, jeevamruth and Beejamruth are cheaper ecofriendly organic preparations made by cow products namely dung, urine, milk, curd and ghee. The panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate soil and to protect the plants from disease and also increase the nutritional quality of fruits and vegetables. It is used as a foliar spray, as soil application along with irrigation water, seed or seedling treatment etc. (Choudhary *et al,* 2017).

Panchagavya, an organic product has potential to play the role in promoting growth and providing immunity in plant system. The use of organic liquid such as panchagavya results in higher growth, yield and quality of crops. Different species of insect pests were reported to be associated with spinach in different areas of the country. Usually, the management of the pests is insecticide oriented but the problems associated with synthetic chemicals Viz., development of pest resistance objectionable pesticide residue and higher cost etc, has necessitated development of new control methods. Several plants and its products are known to be potential resources. In present study leaf extracts of different plants were associated with panchagavya (Choudhary *et al,* 2014).

The intensive use of chemical inputs had not only polluted the soil, water and environment by emitting heavy metals but also affects the human life. Spinach is the ability to take up the heavy metals and thereby, become unift for human consumptions. The escalding cost of chemical fertilizers has compelled the farmers to shift towards alternatives to chemical farming.

Thus, experiment was planned to the foliar application of panchagavya and leaf extracts on nutritional quality of spinach with following objectives.

1. **To study the effect of panchagavya and leaf extract on growth and yield of spinach.**
2. **To find out changes in uptake of nutrient by spinach under different treatment.**
3. **To study the soil nutrient availability at critical growth stages of spinach under different treatment.**
4. **To study the effect of panchagavya and leaf extract on quality of spinach.**

Review of Literature

CHAPTER-II

REVIEW OF LITERATURE

This chapter deals with the research work carried out by various scientists on the effect of foliar application of organic preparation and leaf extract's on various aspects of present investigation is reviewed under the following heads :

2.1 Effect of organic preparation and leaf extract on growth and yield of various crops.

2.2 Effect of organic preparation and leaf extract on chemical properties of soil.

2.3 Effect of organic preparation and leaf extract on content and uptake of nutrients.

2.4 Effect of organic preparation and leaf extract on quality of crops.

2.1 Effect of organic preparation and leaf extract on growth and yield of various crops

Beaulah *et al.,* (2001) evaluated the efficacy of organic manures *viz.*, FYM, poultry manure, neem cake, biofertilizers *viz.*, *Azospirillum*, VAM and an organic product panchagavya on the growth and yield of moringa. The yield attributes *viz.*, number of pods per tree (225.57), pod weight (95.37 g), pod yield (35.67 kg/tree) were highest in the treatment given poultry manure + neem cake + panchagavya.

Muthuvel (2002) conducted an experiment to study the effect of panchagavya and Moringa leaf extract on the growth and yield of bhendi. Four sprays of panchagavya @ 3% and Moringa leaf extract spray @ 25 ml/ plant resulted in higher plant height, number of branches par plant, number of fruits par plant and fruit yield than control (water spray).

Selvaraj (2003) reported the effect of panchagavya on the germination and growth of New Zealand spinach (*Tetragonia tetragonoides*) showed that foliar spray of panchagavya 3% on 10^{th}, 20^{th}, 30^{th}, 40^{th} and 50^{th} day after planting (DAP) alone gave 18 per cent higher yield over the conventional method. A French bean variety Ooty-2 registered 36 per cent higher pod yield than conventional method in the given treatment of panchagavya + vermicompost.

Sridhar (2003) observed that spray of panchagavya at 4 per cent recorded higher plant growth, number of leaves, leaf area, leaf and stem dry weight, single plant yield and yield per hectare in blank night shade (*Solanum nigrum*).

Sivasubramanian and Ganeshkumar (2004) reported the impact of different organic sprays on the growth and yield of African marigold and found that the vermiwash spraying on marigold produced significantly higher plant height, number of laterals per plant, number of leaves per plant, number of flowers per plant as well as weight of flowers as compared to cow dung extract, vermicast extract, cow urine and absolute control.

Louduraj *et al.* (2005) studied the panchagavya @ 3 per cent as foliar spray 4 times along with the application of poultry manure for bhendi augmented the yield level (10.27 t/ha) which was comparable to plots given inorganic supplementation (10.39 t/ha) along with pesticide spray.

Velmurugan (2005) observed that the effect of organic farming practices on growth, yield and quality of radish cv. *Pusa chetki* and observed that seed treatment + foliar application of Panchavya-3% produced the tallest plant height (26.75 cm), higher number of leaves (14.0) and leaf area index(0.942) as compared to control.

Ramanathan *et al.,*(2006) studied the panchagavya applied @ 3 per cent as foliar spray at 0, 30 and 50 days after sowing in rice recorded significantly higher grain yield (5430 kg/ha) as compared to control without panchagavya spray (4990 kg/ha) along with the application of different organic manorial treatments.

Saraswathi *et al*. (2006) investigated the comparative performance of panchagavya and growth regulators on growth and yield of tomato and reported highest plant height, number of branches per plant and number of fruits per plant in the treatment with combined spraying of panchagavya (3%), salicylic acid (100 ppm) and nitrobenzene (150 ppm) followed by RDF as compared to individual spray and other combinations. While, treatment receiving RDF gave significantly highest yield of tomato followed by treatment receiving combined spraying of panchagavya (3%), salicylic acid (100 ppm) and nitrobenzene (150 ppm).

Yadav and Christopher (2006) studied the effect of application of organic manures and foliar spray of Panchagavya @ 3% which resulted in a significant increase in the yield attributes, grain yield and economics (B:C ratio).

Sangeetha and Singaram (2007) showed that combined application of recommended dose of inorganic fertilizer (60:30:30 kg NPK ha^{-1}) and humic acid at 20 kg ha^{-1} significantly increased plant height, number of leaves /plant and root length of onion.

Ansari (2008) observed that the yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas, average weight of onion bulbs was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water).

Arumugam and Anburani (2008) reported the effect of certain organics and pressmud on yield characters of tomato and the results of the present study indicated that the combined application of farmyard manure 12.5 t/ ha plus vermicompost 2.5 t ha^{-1} + panchagavya 3 per cent as foliar spray resulted in improving the yield characters like number of flower clusters per plant, number of flowers per cluster, number of fruits per plant, single fruit weight and fruit yield per plant in tomato followed by the application of pressmud 6.25 t ha^{-1} + vermicompost 2.5 t ha^{-1} + panchagavya 3 %.

Chandrakala (2008) conducted studies at the MARS, UAS, Dharwad and reported that liquid manure treatment Beejamruth + Jeevamruth + panchagavya and panchagavya alone recorded significantly highest dry chili yield (8.52 and 8.01 q/ha, respectively) over control (6.40 q/ha) in addition to significantly higher plant growth and other yield components. Among liquid manures Beejamruth+ Jeevamruth + Panchagavya and panchagavya alone recorded higher ascorbic acid, oleoresin and colour values (8.02:6.74, 7.89:7.00 and 8.25:7.17 per cent respectively) over control (121.89 mg/100 g, 203.01 ASTA units and 301.71 ASTA units respectively).

Karuppaiah and Balsankari (2008) studied the effect of organic manures of FYM (25t ha^{-1}), inorganic fertilizers of NPK (60:50:40) in combination with Vermiwash (1:5) dilution, *panchagavya* (3%) and humic acid (0.2%). The results revealed that the treatment 25 t ha^{-1} of FYM with recommended dose of inorganic

fertilizers (60:50:40) by foliar application of vermiwash (1:5) was found best with a total yield of 19.21 t ha^{-1}.

Gorakhnath and Singh (2009) evaluated the impact of vermiwash prepared from different sources on the growth, flowering and productivity of okra, lobia, and radish. Treatment receiving vermiwash significantly increased the growth, productivity and early starting of flowering. Significantly highest growth in okra and radish was observed in vermiwash prepared from buffalo dung with rice bran, whereas, highest growth in lobia was observed in vermiwash prepared from buffalo dung with gram bran.

Kondappa *et al.* (2009) noticed the application of 50 per cent RDF + 50 per cent N through FYM + biofertilier + Panchagavya 3 % foliar spray recorded significantly highest yield of chilli (10.34 q/ha) as compared to 7.58 q/ha in 100 per cent RDF applied plot.

Kumawat *et al*., (2009) conducted field experiment at Jaisalmer (Rajasthan) to study the effect of foliar applied neem (*Azadirachta indica*), datura (*Datura metel*) and tumba (*Citrullus colocynthis*) leaf extracts in 1:1 combination with 'panchagavya' on growth and yield of cumin (*Cuminum cyminum*). The results revealed that synthesis of chlorophyll and activity of nitrate reductase in fresh leaves increased significantly with application of neem + panchagavya compared to control at 55 and 80 days after sowing. Dry matter accumulation, branches $plant^{-1}$, umbels $plant^{-1}$, seeds $umbel^{-1}$ and 100-seed weight also recorded significant increase with application of neem + 'panchagavya'. compared to control, neem + 'panchagavya' increased grain, straw and biological yield by 58%, 72% and 65%, respectively.

Malarvizhi *et al*. (2009) studied the application of panchagavya at 2 per cent recorded the highest plant height of (68.0 cm) in paprika cv. Kt-PI-19 and increase in the number of primary branches per plant.

Pagar *et al.* (2009) reported that the treatment of vermicompost with panchagavya enhanced the various growth parameters like length of plant, number of branches, number of fruits and size of fruits of chilli as compared to the plants which were grown on vermicompost alone.

Venkataramana *et al.* (2009) observed that foliar spray of Vermiwash @ 200 ppm twice on V-1 mulberry at 25 and 35 days after pruning significantly increase in plant height (199.50 cm), shoot length (189 cm), number of branches per plant (13.00) and number of leaves per plant (155).

Venkatlakshmi *et al.* (2009) investigate the effect of seed treatment and foliar spray of panchagavya on growth and yield of *Amaranthus viride* at T.N.A.U and found that foliar spray of panchagavya @ 3 % recorded significantly higher plant height, number of leaves, and leaf area index. Whereas, seeds soaked in panchagavya solution also recorded significantly higher plant height, number of leaves, dry matter production and leaf area index at 15 and 25 DAS in Amaranthus.

Gopal *et al.* (2010) reported coconut leaf vermiwash at 1:10 and 1:15 dilutions significantly increased seedling vigor index of cowpea and paddy, resulting in 36 per cent increase in fresh biomass weight of cowpea. While, in Maize and Bhendi the fruit yield was increased by 5-10 per cent and 22-33 per cent in 1:5 dilutions.

Gore and Sreenivasa (2011) reported that spray of panchagavya @ 3% and Moringa leaf extract @ 25 ml/ plant in tomato resulted in higher plant height and number of braches per plant.

Anuja and Jayalaxmi (2011) observed the effect of foliar application of organic nutrients and inorganic fertilizers on NPK uptake, post harvest soil available nutrients and yield performance of palak (*Beta vulgaris*) then observed that the application of panchagavya 4% + 100% NPK was found to be the best as it recorded the highest total leaf yield of 2.39 kg $plot^{-1}$.

Khanal *et al.*(2011) carried out the field experiment on the farmer's field at Tanahun (Nepal) to test the efficacy of cattle urine from gutter alone and in combination with urea as a potential supplement to nitrogenous fertilizers in improving yield and quality of cauliflower. They found that application of 100 kg N ha^{-1} through urine significantly increased curd weight as well as curd yield of cauliflower followed by combined application of 50 kg N ha^{-1} through urea + 50 kg N ha^{-1} through urine.

Ravichandran *et al.* (2011) noticed the effect of foliar spray of panchagavya on the yield of potato. They have recorded highest total No. of the tubers (575000 ha^{-1}) and total tuber yield of 28.69 t ha^{-1} in the treatment receiving 3% spraying of panchagavya at 15 days interval as compared to 3% spraying of panchagavya at 8 days interval and control. They have also observed that soaking the produced in 3% panchagavya solution before storage reduced weight loss, delay the sprouting leading to improve storability of seed potatoes.

Tharmaraj *et al.* (2011) conducted an experiment to study the influence of vermicompost and vermiwash on growth and yield of rice at Annamalai Nagar (TN). They found higher number of leaves, leaf length, height of the plant and root length in the treatment of soil application of vermicompost and spray of vermiwash over control and its individual application.

Anuja and Archana (2012) observed the effect of organic nutrient on yield and quality of bitter gourd. They applied organic manure alone and their combination with and without liquid manure to the crop. They observed that all the organic treatments proved to be superior to the control with yield. Application of FYM @ 25 t ha^{-1} + vermicompost @ 5 t ha^{-1} + panchagavya @ 3% recorded highest fruit yield per vine i.e., 1489 g in season-I and 1616 g in season-II.

Chadha *et al*. (2012) recorded that the liquid manures (10% concentration) when applied at 30, 45 and 60 DAT gave significantly higher bulb yield/plot than control. The maximum bulb yield (184.1 q/ha) was recorded with application of vermiwash as against 167.34 q/ ha in control.

Bharad *et al.,* (2013) studied the influence of organic manures and number of cuttings on growth and yield of Indian spinach. The green leaf and growth in term of number of leaves, plant height, leaf area, leaf yield and leaf quality were significantly influenced by the application of different sources of nutrients and number of cuttings. The growth performance in respect of plant height, numbers of leaves and leaf area were found to be maximum in 50 kg N ha^{-1} through urea but which was found to be at par with sheep and goat manure. While, in respect of cutting, the plant height and leaf area showed a decreasing trend with increase in cutting frequencies at all the stages of observation. Yield parameters like number of

leaves, leaf yield q/ha were recorded highest 50 kg N ha^{-1} applied in the form of urea with three levels of cutting.

Kandil *et al*. (2013) noticed that, spraying with humic acid 0.2% on onion resulted in highest growth characters, total and marketable yields, total culls and bulb weight as well as TSS% and dry matter. Further, they recommended that spraying with humic acid and adding 214.2 kg N/ha maximize onion bulb yield under environmental conditions of Gharbeia Governorate.

Vimalendran and Wahab (2013) reported the effect of foliar spray of panchagavya on the growth and yield of babycorn. Results revealed that four sprays of 3 % Panchagavya at 15, 25, 35 and 45 days after sowing (DAS) along with 100 % recommanded dose of fertilizers (RDF) recorded the highest fresh babycorn yield (7439 and 7476 kg ha^{-1} ,respectively) followed by 3 sprays of 3 % panchagavya along with 100 % RDF.

Yadav and Tripathi (2013) showed that the foliar application of panchagavya + neem-leaf extracts (NLE) significantly increased dry-matter accumulation, physiological growth and yield attributes as well as yield of greengram compared to water-sprayed control and sole application of panchagavya. Application of panchagavya + NLE recorded higher grain (27.7 and 10.5%) and straw yield (14.4 and 10.3%) as well as net returns (36.3 and 16%) compared with the control and sole panchagavya, respectively. Application of the foliar sources at 3 times (branching, pre-flowering and pod-setting stages) recorded significantly higher dry matter, growth and yield attributes, yield and net return over single or in combination.

Choudhary *et al*.,(2014) studied the effect of folair application of panchagavya and leaf extracts on groundnut and as the results revealed that foliar application of panchagavya + leaf extract of neem recorded significantly higher number of nodules, number of pods per plant, pod weight per plant , pod yield , haulm yield and harvest index as compared to other treatments. Panchagavya + leaf extracts of neem recorded significantly higher 100 kernels weight, shelling per cent.

Gopakkali and Sharanappa (2014) reported that the application of enriched biodigested liquid manure (EBDLM) at 100 kg N eq/ha + 3 spray of

panchagavya in onion recorded the highest plant height, number of leaves/ plant, leaf diameter, leaf area index, and total dry matter/ plant.

Jadhav *et al.* (2014) studied the effect of different level of vermiwash spray on growth and yield of fenugreek, indicated that growth and yield of crop obtained with treatment vermiwash foliar thrice times spray of 2% at 15,30 and 45 DAS had showed significantly higher plant height (84.10cm), root length (18.37cm), number of branches per plant (6.80), total number of pods per plant (34.48), straw weight plot^{-1} (0.85kg), seed weight (1161.33kg) and straw weight (2833.73kg).

Phate *et al*. (2014) observed the potential of utilizing panchagavya as biofertilizer on the leafy vegetable *Spinacia oleracea* and reported an increase in biomass (301%), shoot length (88.53 %) and root length (71.03 %) in panchagavya treated plants over control. Plant growth substances present in panchagavya treated soil help to bring rapid changes in phenotypes of plants and also improves the growth and ultimately improve the productivity of *Spinacia oleracea.*

Jandaik *et al.* (2015) conducted the experiment on efficancy of cow urine as plant growth enhancer and antifugal agent showed that plant height of methi increased with increase in concentration of cow urine and duration of time. Maximum plant height of methi was 14.30 + 0.40 cm with maximum concentration that is of 5% of cow urine. The mean height of methi plants was 9.00 +_ 0.46 cm in control plants. Shoot length of methi was 7.27+- 0.25, 797 +_ 0.25, 9.17 +_ 0.31, 9.67 +_ 0.25 and 10 +_ 0.20 cm. when sprayed with 1,2,3,4 and 5% concentration of cow urine respectively.

Kumar and Neeraj (2015) evaluated the performance of different onion varieties in response to organic condition during the rabi season of the year (2014-15). The pre harvest effect of the commercial biobased product namely panchagavya were studied. It was revealed from the data, maximum vegetative growth (plant height, number of leaves). bulb growth (bulb diameter, bulb weight) was observed in case of panchagavya treatment.

Maheshwari *et al.* (2016) concluded that 10:3 % vermiwash and panchagavya treated with lablab beans showed better growth promoting effects than the other plants. Thus, the results of the present study clearly suggest that 10:3 %

vermiwash and panchagavya could be used as effective foliar spray in the near future.

2.2 Effect of organic preparation and leaf extract on chemical properties of soil

Palve *et al.,* (2011) studied that the available nitrogen status of the soil increased significantly with the integrated use of inorganic fertilizers and organic manures. Application of 75% RDF with vermicompost at the rate of 1t ha^{-1} and PSB and 75% RDF with vermicompost at the rate of 1t ha^{-1} recorded significantly higher soil available nitrogen over 100% RDF.

Narendhiran *et al.,* (2014) reported that the effect of liquid organic manures, panchagavya, fish gunabajalam vermiwash and neem oil on the growth, nutrient contentand yield of egg plant. N, P and K in plants were significantly higher with the application of panchagavya +fish gunabajalam +vermiwash + neemoil . This is because of individual application of liquid organicmanures may not provide required quantity of nutrients for plants but they support the crop growth initially due to presence of animal dung, urine and activity of microflora and fauna. The plant nutrient concentrations (N, P and K) were the highest with the application of liquid organic manures.

Sridhar *et al.,* (2014) reported that the higher levels of available nitrogen, phosphorus and potassium was observed with application of either vermicompost alone or in combination with FYM in deep vertisols. FYM treated plots showed an increase in available phosphorus than inorganic fertilizers which was due to the coating of sesquioxides by organic materials that reduced phosphorus fixing capacity of soil.

Vajantha *et al* (2014) noticed the availability of N, P, K and S in soil with the effect of panchagavya made from cow (PK -C) and buffalo (PK -B) products sprayed to plants and applied to soil with different concentrations at different intervals. The available nutrients viz ., N, P, K, and S was highest with PK -C @ 15% to soil (T10) was at par with soil application of PK -B @ 15% to soil and PK -C @ 5% - 4 sprays

Boraiah *et al.,* (2015) conducted experiment to study the soil chemical properties as influenced by application of farmyard manure, composted coir pith and

panchagavya to capsicum. Significant differences were observed in soil organic carbon content, available N, P_2O_5 and K_2O with different sources, levels of organic manures and panchagavya application.

Kanwar and Sharma (2014) revealed the effect of organic and inorganic nutrition on fertility status of soil and yield of vegetable cowpea. The application of organic manure significantly influenced the available contents of N, P, K, S, Mo, Fe and Zn in the soil at crop harvest. The nutrient contents were maximum under the treatment P5 (poultry manure @ 5 t ha^{-1}). The treatment P5 was found to be statistically at par with the treatment V5 (vermicompost @ 5 t ha^{-1}).

2.3 Effect of organic preparation and leaf extract on content and uptake of nutrients.

Patil and Padmani (2007) reported the effect of integrated nutrient management on pigeon pea crop with the treatment comparised of biofertilizer, FYM, and dose of fertilizer and their possible combinations. The N, P and K content and uptake of grain as well as stalk were significantly increased by seed inoculation over uninoculated control.

Reddy and Reddy (2008) conducted experiment to evaltuate the effect of integrated nutrient management on availability of cationic micronutrients in soil, crop response and economic feasibility of their use in tomato-onion cropping system. Application of organic manures in conjunction with inorganic fertilizers significantly improved the availability of Fe, Cu, Mn and Zn in soil. The availability of Fe, Cu, Mn and Zn increased with increase in the level of organic manures application.

Sanjutha *et al.,* (2008) studied that application of FYM @ 15 t ha^{-1}+ NPK @ 75:75:50 Kg ha^{-1} + Panchagavya @ 3 per cent foliar spray recorded the highest growth parameters, nutrient uptake, yield followed by FYM @ 15 t ha^{-1}+ panchagavya @ 3 % foliar spray.

Kumawat *et al* (2009) observed that the content and uptake of N and P in seed and straw recorded significant increase with application of neem + 'panchagavya'. Application of foliar sources both at branching and flowering stages recorded significantly higher accumulation of dry matter, yield and yield attributes, content and uptake of N and P in seed and straw compared to single application at branching or flowering.

Gore and Sreenivasa (2011) reported that the application of Beejamruth + Jeevamruth + Panchagavya was best treatment and resulted in significantly highest yield as compared to RDF alone. The N, P and K concentration of plants was significantly highest in the treatment given RDF + Beejamruth + Jeevamruth + Panchagavya.

Tharmaraj *et al.,* (2011) noticed the presence of macro (N, P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients besides total reducing sugars (glucose) were observed in Panchagavya. Chemolithotrops and autotropic nitrifiers (ammonifers and nitrifers) present in panchagavya which colonize in the leaves increase the ammonia uptake and enhance the total N supply.

Saravana *et al.* (2013) studied the effect of organic manure and chemical fertilizer on the yield and macronutrient concentration of green gram. The macronutrient content was found to be higher in the dry seed of green gram in all the treatment. The phosphorus content was maximum in T_4 (FYM+CCP, 2:1) of fresh seeds and T_7 (FYM+10%NPK) of dry seeds. T_7 (FYM+10%NPK) also recorded the highest value of iron content in both fresh and dry seeds. The highest value of calcium was found in T_4 (FYM+CCP) 2:1 and T_9 (FYM+CCP+10%NPK) in the fresh seeds and T_4 (FYM+CCP) 2:1 in dry seeds. Control plants showed the minimum mineral content.

Choudhary *et al* (2014) reported the nutrient uptake of N and P, oil content over other sources. Foliar application of panchagavya with leaf extract of plants both at branching and flowering stages was found most effective with respective to nutrient uptake of N and P kernels and haulms as compared to single application either at branching or flowering stage.

Sridhar *et al.*, (2014) observed the application of organics *viz*., FYM@ 10 t ha^{-1} resulted in higher fruit yield and uptake of nutrients like N, P, K, Ca, S and over RDF alone.

Kasbe *et al.* (2015) studied organics like jeevamruta, vermicompost and biofertilizer along with chemical fertilizers on growth and yield of aerobic rice. The available N, P_2O_5 and K_2O in soil were significantly higher with application of RDF+ jeevamruta (based on crop N requirement)+ vermicompost compared to all other treatments. Application of RDF+ vermicompost was the next best treatment which registered significantly higher soil N and P_2O_5 than other treatments. It was

being at par with application of jeevamruta recorded significantly higher available K_2O than other treatments. Anandan *et al.* (2016) reported that the maximum number of florets and number of flowers per plant might be due to presence of growth promoting substances like essential plant nutrients, vitamins, enzymes and antibiotics in Farmyard manure coupled with wide spread mycelia network of VAM which penetrates deeply in soil, thus widening the root zone for improving the availability of P and enhancing the uptake of certain minerals (Zn and S) including P and water.

Choudhary *et al.* (2017) noticed the effect of panchagavya on yield, quality, nutrient content and nutrient uptake of organic black gram. Maximum N, P, K, S, Zn and Fe content and their uptake in seed and straw and protein content in seed of black gram was noticed with use of panchagavya spray 4% as compared to control 2%, 6%, 8% and 10% panchagavya and indigenous panchagavya 2%. Results further reveal that maximum N, P, K, S, Zn and Fe content and uptake in seed and straw and protein content in seed of black gram was observed with the application of panchagavya at both branching + flowering stages as compared application of panchagavya at either stage of branching or flowering stage alone.

2.4 Effect of organic preparation and leaf extract on quality of crops.

Hannah *et al.* (2005) observed that the panchagavya spray produced tastier banana fruits at the Agricultural College Research Institute, Tamil Nadu. The Panchagavya solution sprayed @ 3 per cent resulted in improvement in quality of fruits *viz.*, total soluble sugars, and total sugars while, it reduced the negative quality characters like acidity and ascorbic acid content.

Mohan (2008) reported the effect of three organic growth promoters on quality of two vegetable crops, brinjal (*Solanum melongena*) and tomato (*Lycopersicon esculentum*) and study resulted that the glycoalkaloid levels were lower under organic growth parameter treatments when compared to the control. Treatments with Bokashi showed the lowest glycoalkaloid contents.

Theunissen *et al*. (2010) reported that the high percentage of humic acids in vermicompost contributes to plant health, as it promotes the synthesis of phenolic compounds such as anthocyanins and flavonoids which may improve the plant quality.

Dange *et al.* (2011) reported the effect of organic and inorganic fertilizers on quality parameter of Spinach and study resulted that significantly highest moisture content noticed in control. The lower moisture content in treatment receiving combination of inorganic fertilizers and organic manure might be due to higher dry matter accumulation as result increased photosynthetic activity.

Bharad *et al.,* (2013) studied the quality parameters of spinach i.e. leaf chlorophyll content, leaf moisture and leaf ascorbic acid content and recorded highest in one cutting an 50 kg N ha^{-1} applied through urea.

Jagtap *et al.* (2013) noticed that foliar application of vermiwash 20% and gibberlic acid 50 ppm on fenugreek significantly increase amount of total carbohydrates, soluble protein and activities of soluble enzymes like amylase, catalase and protease thus improves phyto-chemical values.

Caliskan *et al*. (2014) reported that, the values of vitamin C content of lettuce grown in the organic production systems were higher than those of the conventional production system.

Raghavendra *et al*. (2014) observed that the panchagavya contains several nutrients i.e. macronutrients like N, P, K and micronutrients which are required for various amino acids, vitamins, growth regulators like Auxins and gibberellins.

Shailaja *et al.* (2014) studied that the impact of Panchagavya on the leaf quality of *spinacia oleracea* and study showed that the leaf conents like vitamin ,minersals and protein are more in quantity with Panchagavya treatment.

Jandaik *et al.* (2015) noticed that the application of 5% cow urine significantly increase protein, carbohydrates and chlorophyll content in okra and methi.

Islam *et al.* (2017) studied yield and quality of tomato fruits using different types of organic and inorganic fertilizers. No significant difference was observed in the quality (total soluble solids) of tomato fruits in both varieties response to the treatments.

Shariff *et al.* (2017) conducted the experiment to see the effect of soil amendments and organic foliar sprays on crop growth, seed yield and quality of green gram. Organic foliar spray of 3 % panchagavya recorded significantly highest 100 seed weight, germination percentage, root length, shoot length, seedling vigour index

and protein content. The interactions of soil amendments and organic foliar spray were found to be significant with respect to seed quality parameters such as germination per cent, shoot length, root length and seedling vigour index.

Gunasekar *et al.* (2018) conducted field trial to study the effect of leaf extracts and panchagavya foliar spray on plant characters, yield and resultant seed quality of blackgram and reported that panchagavya 3% foliar spray recorded higher values for plant characters and yield such as plant height, days to 1st flowering, days to 50% flowering, number of leaves per plant, number of branches per plant, number of pods per plant, pod length, number of seeds per pod, seed yield per plant, seed yield per plot, 100 seed weight and the resultant seed quality from the same treatment registered best.

Material And Methods

CHAPTER-III

MATERIAL AND METHODS

The present investigation pertaining to "Effect of foliar application of panchagavya and leaf extract's on nutritional quality of spinach" was carried out during the year 2017-18 at Department of Horticulture, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The details regarding the materials used and methods followed during the course of investigation are presented in this chapter. The analytical work was done in the laboratory of Department of Soil Science and Agricultural Chemistry. College of Agriculture, Parbhani.

The material used and methods adopted for planning and conduct of field experiment are presented in this chapter under following subheads:

3.1 Physiography and climate
3.2 Soils and their minerology
3.3 Preparatory tillage operations
3.4 Field experiment
3.5 Observations recorded
3.6 Soil analysis
3.7 Plant analysis
3.8 Quality parameters
3.9 Uptake of nutrients
3.10 Statistical analysis

3.1 Physiography and climate

Parbhani district covers 61,038 sq km. geographical area which is centrally situated in Marathwada region of Maharashtra State. The main rivers flowing in the district are Godavari, Purna and Dudhna and wholly belong to Godavari peninsular basin situated in the northern side of district. Geographically, Parbhani district was lies between $76^0$46' East latitude and $19^0$16' North longitude, having elevation of 408.46 m above the sea level in Marathwada division of Maharashtra state. The Parbhani district falls under semi-arid climate. The Parbhani area receives rainfall mainly from South West monsoon commencing from second week of June. The average rainfall of the district is 830 mm, mostly concentrated during monsoon particularly from June to October. Maximum rainfall occurs in the month of July and August. The mean maximum temperature varies from 28.5^0 C in

winter to 43.6^0 C in summer and the mean minimum temperature varies from 7.5 ^{0}C to 27.7^0 C. The mean minimum and maximum relative humidity varied from 25 to 63 and 85 to 96 percent in May and December, respectively. The soils of the region are medium to deep black (Inceptisol/Vertisol).

Weather data and climatic condition

The meteorological data on rainfall, maximum and minimum temperature and relative humidity recorded during the experimental period at Meteorological Observatory, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani are given in Table 1

Table 1 Weekly weather data recorded at Agro meteorological Observatory, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the year 2017- 18

Week	Period	Rainfall (mm)	R. D.	Temperature ^{o}C		Humidity (%)	
				Max.	Min.	AM	PM
51	18-24 Dec.	0.0	0.0	29.4	8.3	75	28
52	25-31 Dec.	0.0	0.0	29.2	8.3	77	23
1	01-07 Jan.	0.0	0.0	29.6	9.2	76	32
2	08-14 Jan.	0.0	0.0	29.8	11.5	76	30
3	15-21 Jan.	0.0	0.0	31.3	11.8	74	26
4	22-28 Jan.	0.0	0.0	29.7	8.7	76	25
5	29-04 Feb.	0.0	0.0	31.7	8.9	74	14
6	05-11 Feb.	0.0	0.0	31.1	12.5	77	26

Data on weekly weather parameters from 22th December 2017 to 4th February, 2018 are given on rainfall pattern, temperature and humidity variation during the period of experimentation (2017-2018) are tabulated in Table 1, 2.

The data indicated that during crop growth no rainfall was received. The maximum temperature was in the 5th meterological week i.e. 31.7^{0}C. whereas, minimum temperature was in the 51 to 52 meterological week. The data on relative humidity was maximum during AM and during PM was 77 percent and 32 percent and minimum was 74 percent and 14 percent and , respectively during 2017-18.

3.2 Soils and their mineralogy

The soils of Parbhani district are derived from "Deccan trap" rock (basalt) which is rich in iron, lime and magnesium (Gajbe *et al*, 1976) . On the basis of morphology, soil depth and texture, these soils were classified as Vertisols, Inceptisols and Entisols. The soils used for experiment is identical to that of Parbhani series (Typic haplustert) as classified by Malewar (1976). The primary mineral studies carried out by Maniyar *et al*. (1981) revealed that Parbhani soils constituted bulk of iron ores along with augite, epidote, chlorite, hornblend, tourmaline, pyrite, pyroxenes, feldspar, quartz and muscovite: x-ray differaction studies indicated that these soils were dominated in montmorillonite clay (Malewar and Randhawa, 1978 and Maniyar *et al* 1981).

3.3 Preparatory tillage operations

Ploughing was done with the help of tractor drawn plough up to 30 cm deep. Then harrowing was carried out with the help of tractor drawn disc harrow. Land leveling operation was under taken with the help of long wooden planker. In this way all preparatory tillage operations were carried out in the month of November, 2017.

3.4 Field experiment

3.4.1 Experimental site

The experiment was conduct on deep black soil (Typic haplustort) at Research farm of Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during 2017-18. The field was fairly leveled and plain. The surface soil samples from 0-15 cm were collected randomly from selected plots all over the experimental field before super imposing the treatment. The composite sample was prepared and analyzed for its various Physico- chemical properties. The results obtained are presented in Table 2.

Table 2 Initial soil properties of experimental soils

Sr. No.	Soil Properties	Unit	Value
1.	Soil reaction (pH)	-	7.54
2.	Electrical conductivity (EC)	dSm^{-1}	0.17
3.	Organic carbon (O.C.)	$g\ kg^{-1}$	3.10
4.	Calcium carbonate	$g\ kg^{-1}$	5.10
5.	Available nitrogen	$kg\ ha^{-1}$	173.09
6.	Available phosphorus	$kg\ ha^{-1}$	10.69
7.	Available potassium	$kg\ ha^{-1}$	640.02
8.	Available Zn (DTPA)	$mg\ kg^{-1}$	0.42
9.	Available Fe	$mg\ kg^{-1}$	3.84
10.	Available Mn	$mg\ kg^{-1}$	3.29
11.	Available Cu	$mg\ kg^{-1}$	1.82

3.4.2 Experimental layout

The experiment was laid out in randomized block design (RBD) with Eight (8) treatments and three replications. The layout of experiment is presented in Fig.4

3.4.3 Experimental details

1. Year of experiment : 2017-18
2. Season : *Rabi*
3. Design of Experiment : RBD (Randomized Block Design)
4. Number of treatments : 08
5. Replication : 03
6. Total number of pots : 24
7. Plot size : 1.2 m x 1.5 m^2
8. Row to row spacing : 15 cm
9. Plant to spacing : 5 cm
10. Crop : Spinach
11. Variety : All Green
12. Method of sowing : Line Sowing

Fig. 1 Overview of experimental plot

13. RDF : 80:40:40

14. Source of fertilizer : Urea , Single super phosphate, Murate of potash

15. Date of Sowing : 22 Dec. 2017

16 Date of harvesting : 4 Feb. 2018

3.4.4 Treatment details

Treatment	Treatment details
T_1	Control (Only water spray)
T_2	Panchagavya
T_3	Panchagavya + neem leaf extract
T_4	Panchagavya + karanj leaf extract
T_5	Panchagavya + glyricidia leaf extract
T_6	Panchagavya + custard apple leaf extract
T_7	Micronutrient Grade II
T_8	100% N through FYM

3.4.5 Preparation of panchagavya and leaf extract

In present investigation panchagavya and leaf extracts were used .These formulations are prepared as per the standard procedure mentioned in the ancient literature. Panchagavya solution was prepared by through mixing of cow dung (5 kg) ,cow ghee (butter oil, 0.5 kg), fresh cow urine (3L), cow milk (2L), cow curd (2L), jaggery (500 gram) and coconut water (2L). The leaf extracts of neem, karanj , glyricidia and custard apple were prepared by mixing fresh leaves with cow urine in 1:1 ratio followed by fermentation .The filtrates of leaf extracts were mixed with the filtered panchagavya solution in 1:1 ratio for respective leaf extracts.

3.4.6 Application of panchagavya and leaf extract

Initially prepared and filtered solution of panchagavya and leaf extract were diluted with water and applied on the crop foliage @ 3% spray at 15 and 30 days as per treatments. Recommended dose of N, P and K was applied uniformly in all the treatments before sowing of crop. Micronutrient grade II was applied @ 0.5% spray at 15 and 30 DAS.

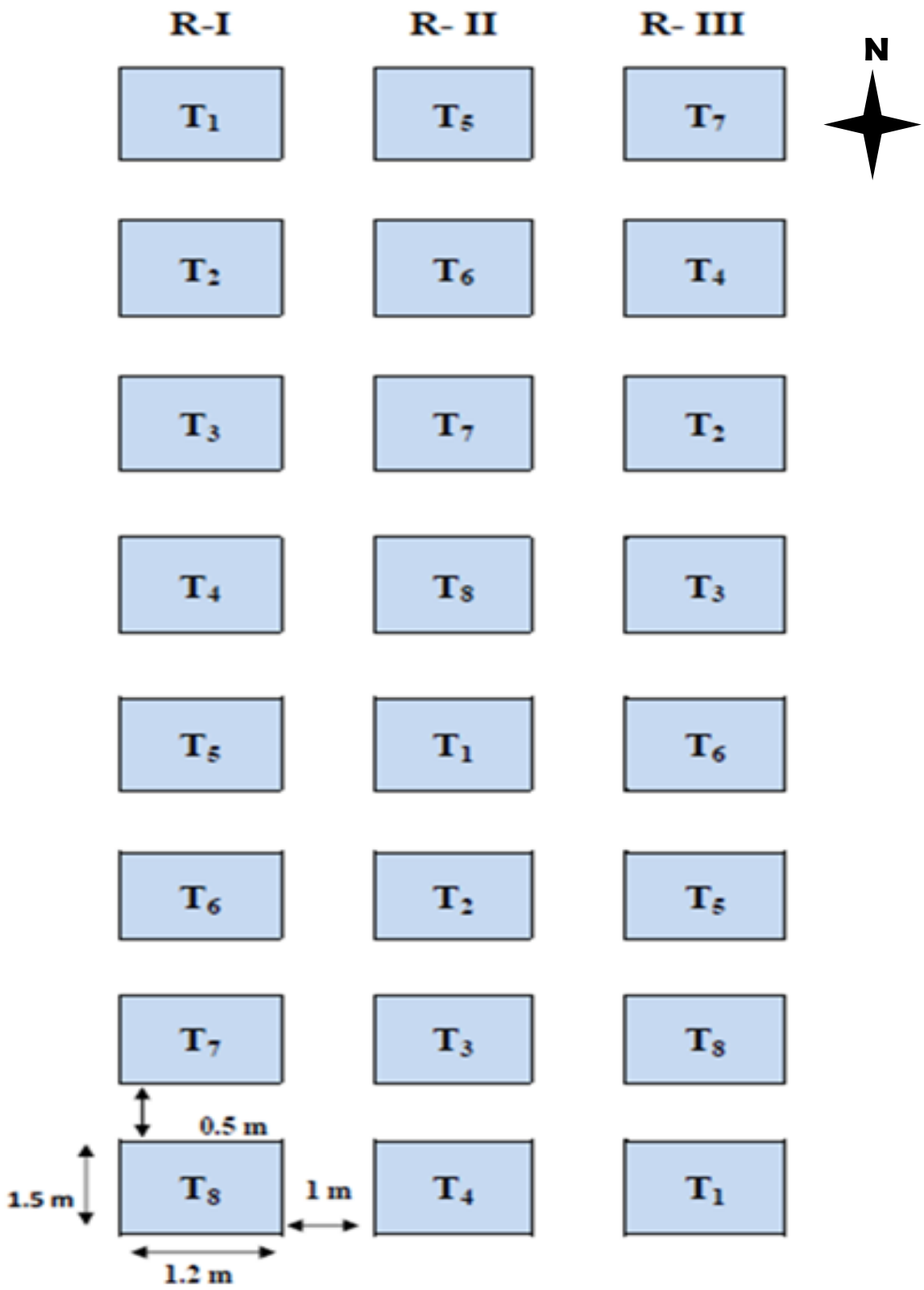


Fig. 1 Plan of Layout

3.4.7 Seed and Sowing

The seeds were sown at a spacing of 15 cm between rows and 5 cm within the row. The field was irrigated immediately after sowing and thinning was done at 15 days after sowing of the crop.

3.4.8 Irrigation

The crop was irrigated immediately after sowing. Subsequently, the irrigations were given at 7 days interval to maintain uniform soil moisture throughout the crop growth period.

3.4.9 Interculture operation

The experiment plot was kept free of weeds throughout the crop growth period. . One weeding was carried out during the crop growth period of spinach.

3.4.10 Harvesting

The crop was harvested at 45 days after sowing after the full growth of leaves.

3.5. Observations recorded

Five plants in each treatment and replications were randomly selected and tagged of each replication in each treatment for recording the observations.

3.5.1 Sampling techniques

Five plants were randomly selected from each plot, tagged and all biometric observation were recorded

3.5.2 Plant height (cm)

The plant height was measured from base of the plant to the tip of fully opened leaf on the main shoot and the mean plant height was expressed in centimeters.

3.5.3 Number of leaves plant^{-1}

Number of leaves per plant was at 45 days after sowing from five plants per replication per treatment and their mean was worked out.

3.5.4 Yield ha^{-1}

The leaf yields were recorded by taking fresh weight. The total yields were computed by adding the weights recorded at all cuttings and were expressed as t ha^{-1} by taking standard population count in the plot on per plant basis.

3.6 Soil analysis

Soil samples were collected before sowing and after the harvest stage of crop at 0-15 cm depth from each treated plot. Soil was air dried, ground with wooden mortar and pestle and sieved through 2 mm sieve. The sieved samples were stored in polythene bags with proper labeling for further analysis. These soil samples were subjected to various chemical estimations as per the methods given below.

3.6.1 Soil Reaction (pH)

pH was determined in (1:2.5) soil water suspension using digital pH meter described by Jackson (1973).

3.6.2 Electrical conductivity

Electrical conductivity was determined in (1:2.5) soil water suspension by using conductivity bridge meter described by Jackson (1973).

3.6.3 Organic carbon

Organic carbon was determined by Walkley and Black method (1934).

3.6.4 Calcium Carbonate

Calcium Carbonate was determined by rapid titration method as suggested by Jackson (1973).

3.6.5 Available Nitrogen

Available N was determined by alkaline potassium permanganate method as described by Subbiah and Asija (1956).

3.6.6 Available Phosphorus

Available Phosphorus was extracted from the soil with 0.5 M sodium bicarbonate (pH 8.5) as an extractant and measured calorimetrically by using 420 nm wave length as described by Olsen *et al*. (1954).

3.6.7 Available Potassium

Available Potassium was determined by using neutral normal ammonium acetate as an extractant and was measured on Flame photometer (Piper, 1966).

3.6.8 Micronutrients (Zn, Fe, Mn and Cu)

Zn, Fe, Mn and Cu were determined by using DTPA extract as described by Lindsay and Norvell (1978).

3.7 Plant analysis

3.7.1 Preparation of plant samples

For the determination of nutrient content in plants, the plant samples were collected at different growth stages of the crop. First of all the fresh plant was washed with tap water and roots were discarded. Preparation of plant samples are carried out first by drying in shade and then oven drying. The oven dried samples were grinded in electrically operated grinder with stainless steel blade to maximum fineness. All the precaution was taken to avoid the contamination from other plant materials. The grind plant materials were stored in the paper bags with proper labelling and used for nutrient analysis.

3.7.2 Digestion of plant samples

Fine powdered plant sample (0.5 g) was taken in 100 ml conical flask. 5 ml of concentrated nitric acid was added to it and kept for overnight. On next day, 10 ml of diacid mixture (HNO_3 and $HClO_4$ in 9:4) was added and digested on hot plate as described by Piper (1966). After digestion, known volume was prepared with glass distilled water. The same extract was used for the estimation of P, K, Fe, Zn, Cu and Mn.

3.7.3 Nitrogen content

The nitrogen content in dry matter was determined by Micro Kjeldhals method (AOAC, 1975)

3.7.4 Phosphorus content

The phosphorus in dry matter was estimated spectrophotometrically by vanadomolybdate phosphoric acid yellow colour method (Jackson, 1973)

3.7.5 Potassium content

Potassium content in plants was determined from the di-acid extract on Flame photometer (Jackson, 1973).

3.7.6 Total Zn, Fe, Cu and Mn

The Fe, Mn, Zn, Cu in plants was estimated with the help of Atomic Absorption Spectrophotometer. (Lindsay and Norvell, 1978).

3.8 Quality parameters

3.8.1 Moisture percentage

Moisture percentage of spinach was estimated by taking 100 gm sample of spinach leaves collected from each treatment by recording fresh weight and oven dry weight at 80^0C for 48 hours at harvest. It was calculated by following formula.

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

3.8.2 Dry Matter percentage

After harvest of leaves, the fresh weight of five observation plant was recorded and dried in an oven. The average dry weight was worked out.

3.8.3 Vitamin - C (mg $100g^{-1}$)

One gram of sample was blended with 3 per cent Meta phosphoric acid and then made up to 100 ml and filtered. From the filterate, 10 ml sample was pipetted into conical flask and titrated with the standard dye to a pink end point (Ranganna, 1986).

3.8.4 Chlorophyll (mg $100g^{-1}$ fresh weight)

One gram of fresh leaf material of spinach was taken and kept in 50 ml of Dimethyl Sulphoxide (DMSO) in a beaker. The leaf material with DMSO was incubated in the hot air oven at 80^oC for 2 hours. On incubation, the entire chlorophyll from leaf moves into DMSO. After incubation the leaf material was removed from the beaker. The DMSO with chlorophyll was measured by spectrophotometer at 625 nm. The sole DMSO was used as blank

3.9 Uptake of nutrients

Nutrient uptake i.e. uptake of N, P, K, Fe, Zn Cu, Mn was calculated by considering fresh yield at harvest in particular treatment plot in relation to concentration of the particular nutrient in respective treatment plot using the formula.

$$\text{Uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient concentration (\%) X Dry matter yield (kg ha}^{-1}\text{)}}{100}$$

3.10 Statistical Analysis

The data obtained from growth parameters, yield attributing characters, quality parameters, soil analysis and plant analysis was compiled and statiscally analyzed as per the method given in “Statistical Methods for Agricultural Workers” by Panse and Sukhatme (1985) using computer programmed. Appropriate standard error (S.E.) and critical difference (C.D.) at 5 % levels were worked out for interpretation of results.

Results And Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The increasing prices of chemical fertilizer have compelled the farmer to shift towards the other alternative nutrient sources. The organic source of nutrient is supposed to be good source for growing the leafy vegetable. Therefore, the present experiment was carried to find out the "Effect of foliar application of panchagavya and leaf extracts on nutritional quality of spinach". The data collected are presented, interpreted and discussed in this chapter.

4.1 Effect of foliar application of panchagavya and leaf extracts on growth parameters and yield of spinach.

4.1.1 Plant height

4.1.2 Number of leaves per plant

4.1.3 Leaf area

4.1.4 Green fresh yield

4.1.5 Dry matter yield

4.2 Effect of foliar application of panchagavya and leaf extracts on physico-chemical properties of soil under spinach.

4.2.1 Soil pH

4.2.2 Electrical conductivity

4.2.3 Organic carbon content

4.2.4 Calcium carbonate content

4.3 Effect of foliar application of panchagavya and leaf extracts on nutrient availability in soil under spinach.

4.3.1 Available nitrogen

4.3.2 Available phosphorus

4.3.3 Available potassium

4.3.4 DTPA extractable iron

4.3.5 DTPA extractable manganese

4.3.6 DTPA extractable zinc

4.3.7 DTPA extractable copper

4.4 **Effect of foliar application of panchagavya and leaf extracts on nutrient content and uptake by spinach plant**

4.4.1 Nitrogen content and uptake

4.4.2 Phosphorus content and uptake

4.4.4 Iron content and uptake

4.4.5 Manganese content and uptake

4.4.6 Zinc content and uptake

4.4.7 Copper content and uptake

4.5 **Effect of foliar application of panchagavya and leaf extracts of quality parameter of spinach**

4.5.1 Moisture percentage

4.5.2 Dry matter percentage

4.5.3 Ascorbic acid content

4.5.4 Chlorophyll content

4.1 Effect of foliar application of panchagavya and leaf extracts on growth parameter and yield of spinach.

4.1.1 Plant height

The data on plant height of spinach at harvest influenced by foliar application of panchagavya and leaf extracts are presented in Table 3 and depicted in Fig. 2. The

plant height varied in the range of 16.26 to 28.03 cm at harvest of spinach. The treatment T_3 (Panchagavya +neem leaf extract) showed significantly more plant height of spinach but at par with T_5 and T_4 treatments followed by the treatment T_6, T_7 , T_2 , T_8 and T_1, respectively.

Table No.3 Effect of foliar application of panchagavya and leaf extracts on plant height at harvest of spinach.

Tr. No.	Treatments details	Plant height (cm)
T_1	Control (only water spray)	16.26
T_2	Panchagavya	17.83
T_3	Panchagavya + neem leaf extract	28.03
T_4	Panchagavya + karanj leaf extract	25.34
T_5	Panchagavya + glyricidia leaf extract	26.03
T_6	Panchagavya + custard apple leaf extract	24.06
T_7	Micronutrient Grade II	22.52
T_8	100% N through FYM	20.19
	Grand Mean	22.53
	SEm (±)	1.23
	CD at 5%	3.73

It was noticed that the application of panchagavya + leaf extracts recorded significantly higher plant height over alone application of FYM, panchagavya and control. This shows the balance application of nutrient through panchagavya and it also contains growth promoting substances, enzyme, auxins, vitamins, etc. These results are in compliance with the findings of Velmurugan (2005), Saraswathi *et al.,* (2006), Venkatalakshmi *et al.,* (2009) and Kumawat *et al.,* (2009).

4.1.2 Number of leaves per plant

The number of leaves per plant is one of the growth parameter related to physiological development of the crop. The leaves count was taken at harvest of spinach and the data are presented in Table 4 and Fig 3.

Table No. 4 Effect of panchagavya and leaf extracts on number of leaves per plant at harvest of spinach

Tr. No.	Treatments details	No. of leaves per plant
T_1	Control (only water spray)	6.23
T_2	Panchagavya	8.10
T_3	Panchagavya + neem leaf extract	16.03
T_4	Panchagavya + karanj leaf extract	13.13
T_5	Panchagavya + glyricidia leaf extract	13.93
T_6	Panchagavya + custard apple leaf extract	12.86
T_7	Micronutrient Grade II	10.96
T_8	100% N through FYM	9.60
	Grand Mean	11.35
	SEm (±)	0.51
	CD at 5%	1.56

It was found that the number of leaves ranged from 6.23 to 16.03 during harvest of spinach. Maximum number of leaves per plant with T_3 treatment received foliar spray of panchagavya and neem extract. Minimum number of leaves per plant was noticed in treatment T_1 i.e. control. The application of panchagavya +neem extract proved significantly to increase number of leaves per plant over only panchagavya application and control. Yadav and Tripathi (2013) showed that the foliar application of panchagavya + neem leaf extract significantly increased physiological growth and yield attributes, dry matter accumulation and yield of green gram as compaired to water sprayed control and sole application of panchagavya. These results are in line with the findings of Sridhar (2003) and Velmurgan (2005).

4.1.3 Leaf area

The result on leaf area as influenced by application of foliar sprays of panchagavya and leaf extract at harvest of spinach are presented in Table 5 and graphically depicted in Fig 4. Leaf area varied in the range of 260.00 to 378.00 cm^2 at harvest of spinach. The highest leaf area was recorded with T_3 (Panchagavya +neem leaf extract) treatment followed by T_5 (Panchagavya +glyricidia leaf extract)

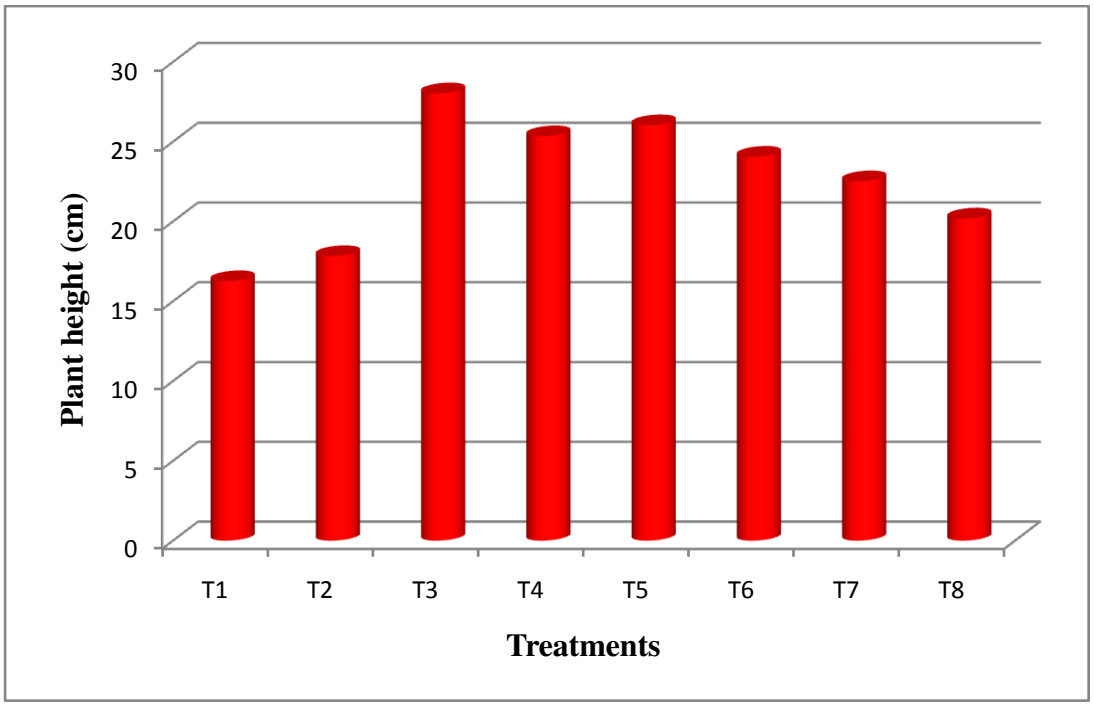


Fig. 2 Effect of foliar application of panchagavya and leaf extracts on plant height of spinach

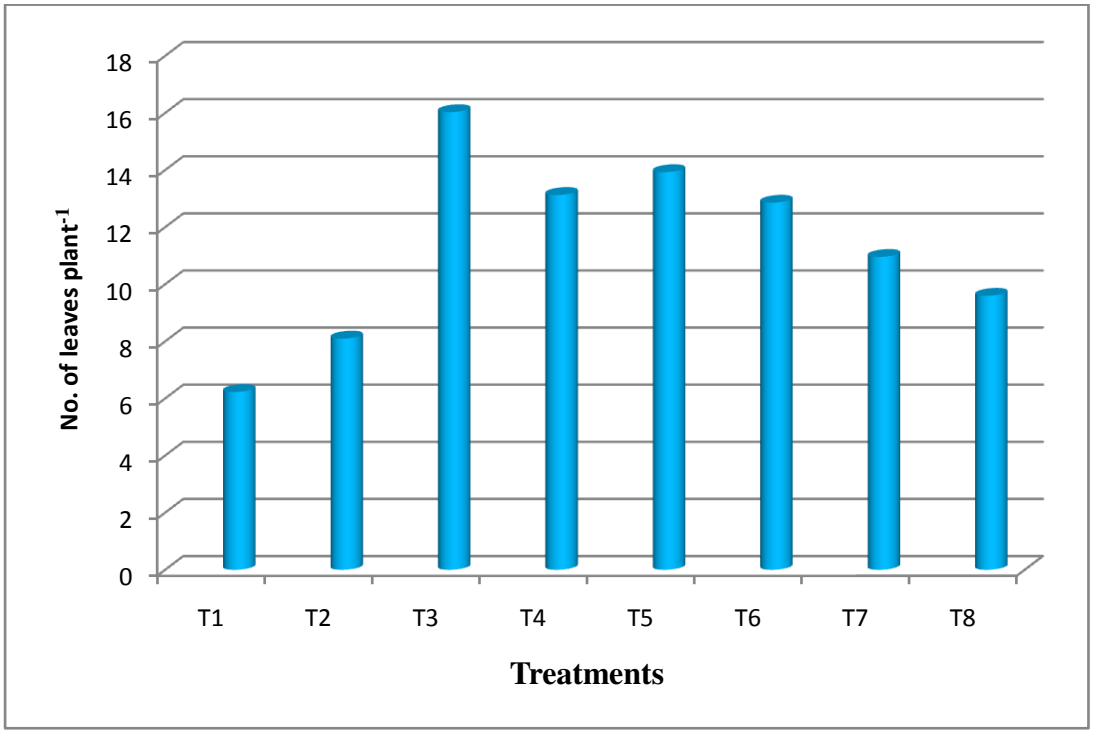


Fig. 3 Effect of foliar application of panchagavya and leaf extracts on No. of leaves per plant at harvest of spinach

treatment. The lowest leaf area was observed in T_1 (control) treatment. Arumugam and Anburani (2008) observed that combine application of FYM and vermicompost with 3% foliar spray improved the leaf area of tomato. These findings are also accordance with the findings reported by Velmurugan (2005).

Table No. 5 Effect of panchagavya and leaf extracts on Leaf area (cm^2) at harvest of spinach

Tr. No.	Treatments details	Leaf area (cm^2)
T_1	Control (only water spray)	260.00
T_2	Panchagavya	282.00
T_3	Panchagavya + neem leaf extract	378.00
T_4	Panchagavya + karanj leaf extract	330.00
T_5	Panchagavya + glyricidia leaf extract	363.00
T_6	Panchagavya + custard apple leaf extract	331.00
T_7	Micronutrient Grade II	319.00
T_8	100% N through FYM	307.00
	Grand Mean	321.25
	SEm (±)	16.10
	CD at 5%	47.60

4.1.4 Green fresh yield

The green fresh yield of spinach was calculated and tabulated in Table 6 and graphically presented in Fig 5. The green fresh yield per hectare of spinach was significantly influenced by various treatments. The highest green fresh yield of spinach (232.90 q ha^{-1}) was registered under T_3 treatment (Panchagavya +neem leaf extract) which was statistically at par with T_5, T_4 and T_3 treatments. The treatment T_1 (only water spray) recorded lowest green fresh yield (159.60 q ha^{-1}). The influenced of different treatments on green fresh yield followed the order $T_3 > T_5 > T_4 > T_6 > T_7 > T_8 > T_2 > T_1$. Smaller quantity of IAA and GA present in panchagavya when foliar sprayed could have created stimuli in the plant system wrist in turn increased the production of growth regulator in cell system and the action of growth regulators in plant system stimulated the necessary growth and development, leading to better

yield. Yadav and Christopher (2006) reported increased yield of crop plants with panchagavya application due to enhancement in the biologically efficiency of crop plants. The maximum improvement in yield with all the foliar sources might be associated with increased yield attributes due to concomitant increased with dry matter accumulation, chlorophyll content, nitrate reductase activity and supply of all the plant nutrients (Kumawat *et al.,* 2009).

4.1.5 Dry matter yield

The dry matter yield of spinach at harvest are presented in Table 6 and depicted in Fig 5. The dry matter yield varied from 18.51 to 32.74 q ha^{-1}. The dry matter yield was highest (32.74 q ha^{-1}) with the treatment T_3 (Panchagavya +neem leaf extract). The lowest dry matter yield (18.51 qha^{-1}) was recorded in treatment T_1 (Only water sprays i.e. control). Similar results were also reported by Yadav and Christopher (2006), Kumawat *et al* (2009) and Gore and Srinivasa (2011).

Table 6 Effect of foliar application of panchagavya and leaf extract on fresh and dry yield of spinach

Tr. No.	Treatments details	Fresh yield (q ha^{-1})	Dry matter yield(q ha^{-1})
T_1	Control (only water spray)	159.60	18.51
T_2	Panchagavya	163.40	19.64
T_3	Panchagavya + neem leaf extract	232.90	32.74
T_4	Panchagavya + karanj leaf extract	216.70	29.94
T_5	Panchagavya + glyricidia leaf extract	222.60	31.11
T_6	Panchagavya + custard apple leaf extract	210.20	29.00
T_7	Micronutrient Grade II	203.30	26.59
T_8	100% N through FYM	170.01	21.77
	Grand Mean	197.30	26.16
	SEm (±)	11.20	1.00
	CD at 5%	34.00	3.03

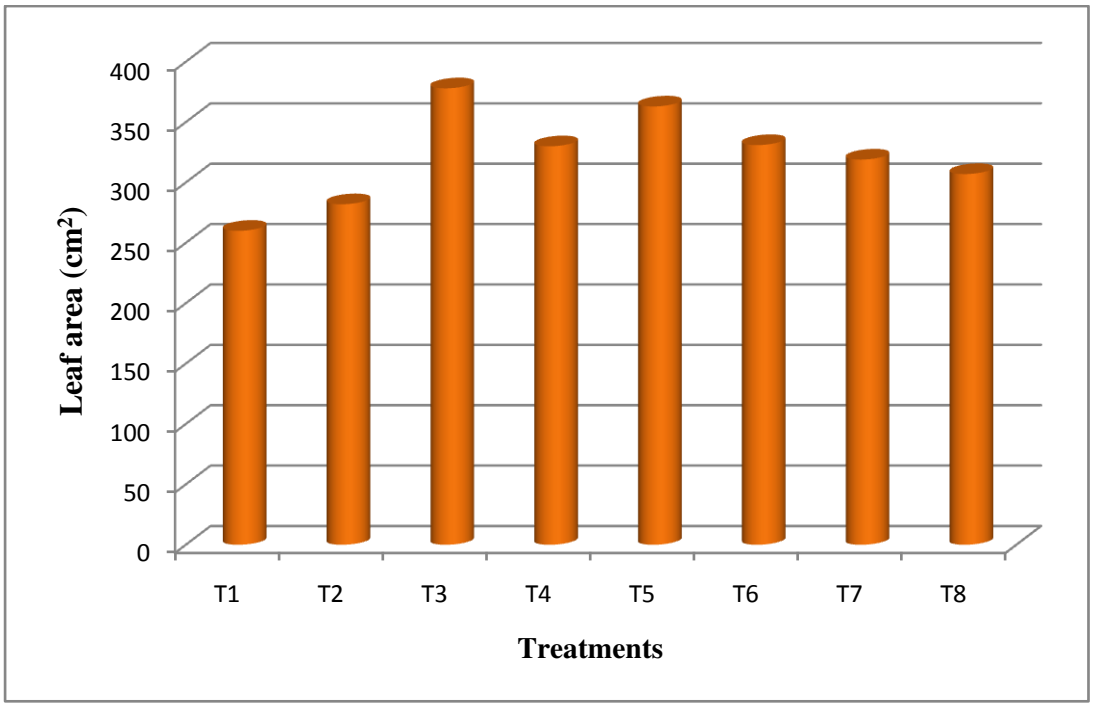


Fig. 4 Effect of foliar application of panchagavya and leaf extracts on leaf area of spinach

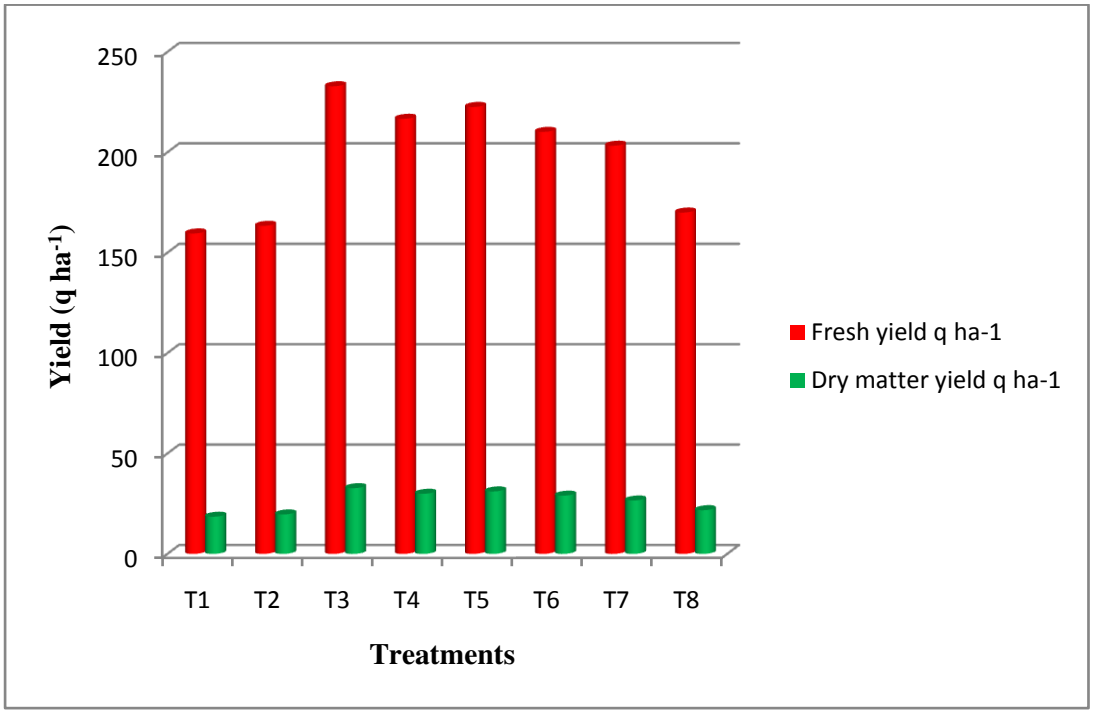


Fig. 5 Effect of foliar application of panchagavya and leaf extracts on yield of spinach

4.2 Effect of foliar application of panchagavya and leaf extract on physico-chemical properties of soil after harvest of spinach

4.2.1 Soil pH

The data pertaining to soil pH as influenced by different treatments after harvest of spinach are presented in Table 7. The initial soil pH was 7.54. The soil pH increased due to application of fertilizers over initial value. The soil pH was in the range of 7.58 to 7.68 at harvest of spinach. However, results on soil pH is statistically non significant.

Table 7 Effect of foliar application of panchagavya and leaf extract on physico-chemical properties of soil after harvest of spinach.

Tr. No.	Treatments details	pH	EC (dSm^{-1})	Organic carbon ($g\ kg^{-1}$)	$CaCO_3$ ($g\ kg^{-1}$)
T_1	Control (only water spray)	7.59	0.21	3.30	51.30
T_2	Panchagavya	7.61	0.24	3.60	52.70
T_3	Panchagavya + neem leaf extract	7.62	0.25	3.70	53.10
T_4	Panchagavya + karanj leaf extract	7.65	0.26	3.50	53.80
T_5	Panchagavya + glyricidia leaf extract	7.65	0.24	3.90	54.00
T_6	Panchagavya + custard apple leaf extract	7.66	0.25	4.00	52.70
T_7	Micronutrient Grade II	7.68	0.26	3.90	51.60
T_8	100% N through FYM	7.58	0.27	4.10	52.70
	Grand Mean	7.63	0.25	3.70	52.70
	SEm (±)	0.07	0.03	0.30	0.80
	CD at 5%	NS	NS	NS	NS

4.2.2 Electrical conductivity

The results on electrical conductivity as influenced by different treatment after harvest of spinach are reported in Table 7. The initial value of electrical conductivity was 0.17 dSm^{-1}. From the results, it is clear that the effect of different treatment on electrical conductivity was statistically non significant. However, EC value

numerically increased over initial value. The electrical conductivity value varied from 0.21 to 0.27 dSm^{-1} at harvest stage of spinach.

4.2.3 Organic carbon content

The data on organic carbon content in soil after harvest of spinach as influenced by different treatments is narrated in Table 7.The initial organic carbon content in soil was 3.10 g kg^{-1}. The organic carbon content in soil was in the range of 3.30 to 4.10 g kg^{-1} at harvest stage of spinach. However, non significant variation was recorded among the different treatment super imposed to the spinach crop.

4.2.4 Calcium carbonate content

The data on effect of panchagavya and leaf extract on calcium carbonate content in soil after harvest of spinach are shown in Table 7. The initial calcium carbonate content in soil was 51.00 g kg^{-1}. The calcium carbonate was slightly increased after harvest of spinach. The calcium carbonate content in soil varied from 51.30 to 54.00 g kg^{-1} at harvest stage of spinach. The influence of different treatments on calcium carbonate content in soil was statistically non significant.

4.3 Effect of foliar application of panchagavya and leaf extracts on nutrient availability in soil after harvest of spinach

4.3.1 Available nitrogen

The results on effect of foliar application of panchagavya and leaf extracts on available nitrogen content in soil at harvest of spinach are tabulated in Table 8 and depicted in Fig 6. The initial available nitrogen in soil was 173.09 kg ha^{-1}. It was found that the availability of nitrogen varied from 178.08 to 208.85 kg ha^{-1} at harvest of spinach. The maximum nitrogen availability was recorded with T_3 treatment receiving foliar application of panchagavya along with neem leaf extracts at harvest of spinach. In general, among the different treatments, T_3 has shown significantly higher nitrogen availability in soil followed by T_5, T_4, T_6, T_7, T_8, T_2, and T_1 treatments. Further, it was noticed that available N content was increased in the treatment receiving panchagavya + leaf extract along with RDF. This might be due to synergetic

effect between panchagavya and chemical fertilizer. Similar findings were reported by Palve *et al* (2011), Vajantha *et al* (2014) and Kanwar and Sharma (2014).

4.3.2 Available phosphorous

The data pertaining to effect of foliar application of panchagavya and leaf extract on phosphorous availability in soil after harvest of spinach are tabulated in Table 8 and depicted in Fig 6. The initial available phosphorous was 10.69 kg ha^{-1}. The phosphorous availability in soil varied from 10.65 to 18.00 kg ha^{-1} at harvest stage of spinach. The treatment i.e. application of panchagavya + neem leaf extract (T_3) showed significantly higher soil phosphorus availability as compare to rest of the treatments and lower phosphorus availability was noticed in T_1 (water spray) treatment. It is clearly shown that phosphorous availability to spinach was maximized by applying panchagavya + neem leaf extract along with RDF. These results are in agreement with the findings of Shridhar *et al* (2014), Vajantha *et al* (2014) and Kanwar and Sharma (2015).

Table 8 Effect of foliar application of panchagavya and leaf extracts on nutrient availability in soil after harvest of spinach.

Tr. No.	Treatments details	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
T_1	Control (only water spray)	178.08	10.65	670.07
T_2	Panchagavya	183.52	11.50	686.59
T_3	Panchagavya + neem leaf extract	208.85	18.00	744.94
T_4	Panchagavya + karanj leaf extract	197.28	16.63	716.15
T_5	Panchagavya + glyricidia leaf extract	202.50	17.02	732.59
T_6	Panchagavya + custard apple leaf extract	194.49	16.03	702.06
T_7	Micronutrient Grade II	191.45	15.54	708.32
T_8	100% N through FYM	189.99	13.32	697.98
	Grand Mean	193.27	14.84	707.40
	SEm (±)	7.91	1.02	17.23
	CD at 5%	16.89	2.19	35.74

4.3.3 Available potassium

The results on available potassium in soil as influenced by foliar application of panchagavya and leaf extracts at harvest stage of spinach are narrated in Table 8 and graphically presented in Fig. 6. The initial soil available potassium was 640.02 kg ha^{-1}. The data presented in Table 8 revealed that the treatments T_3 recorded significantly higher potassium in soil over rest of the treatment at harvest stage of spinach. The potassium availability varied from 670.04 to 744.94 kg ha^{-1} at harvest stage of spinach. The lowest available potassium was observed in treatment T_1 (only water spray).The availability was increased with foliar application of panchagavya and neem leaf extract along with RDF. Palve *et al* (2011) also observed higher available potassium with the application of organics along with RDF. The similar results were also quoted by Vajantha *et al* (2014) and Kanwar and Sharma (2014).

4.3.4 DTPA extractable Iron

The data on DTPA extractable iron in soil recorded at harvest stage of spinach are compiled in Table 9 and depicted in Fig. 7. Available iron varied from 3.87 to 4.40 mg kg^{-1} at harvest stage of spinach. The treatment T_3 (panchagavya + neem leaf extract) showed maximum Fe availability followed by T_5 (panchagavya + glyricidia leaf extract). The minimum Fe availability was registered in Table T_1 (control/only water spray) treatment. Kanwar and Sharma (2014) also observed higher DTPA extractable Fe was recorded with organic formulations were applied with RDF.

4.3.5 DTPA extractable Mn

The data on DTPA extractable manganese in soil recorded at harvest of spinach are compiled in Table 9 and Fig.7. The Mn content ranged between 2.84 to 4.71 mg kg^{-1} at harvest stage of spinach. The maximum Mn content was obtained by the application of panchagavya + neem leaf extract followed by panchagavya + glyricidia leaf extract and panchagavya + karanj leaf extract . The sufficient status of Mn content in soil may be attributed to the fact that lower oxidation status at neutral pH ranges of soil. The similar result findings were also reported by Kanwar and Sharma (2014).

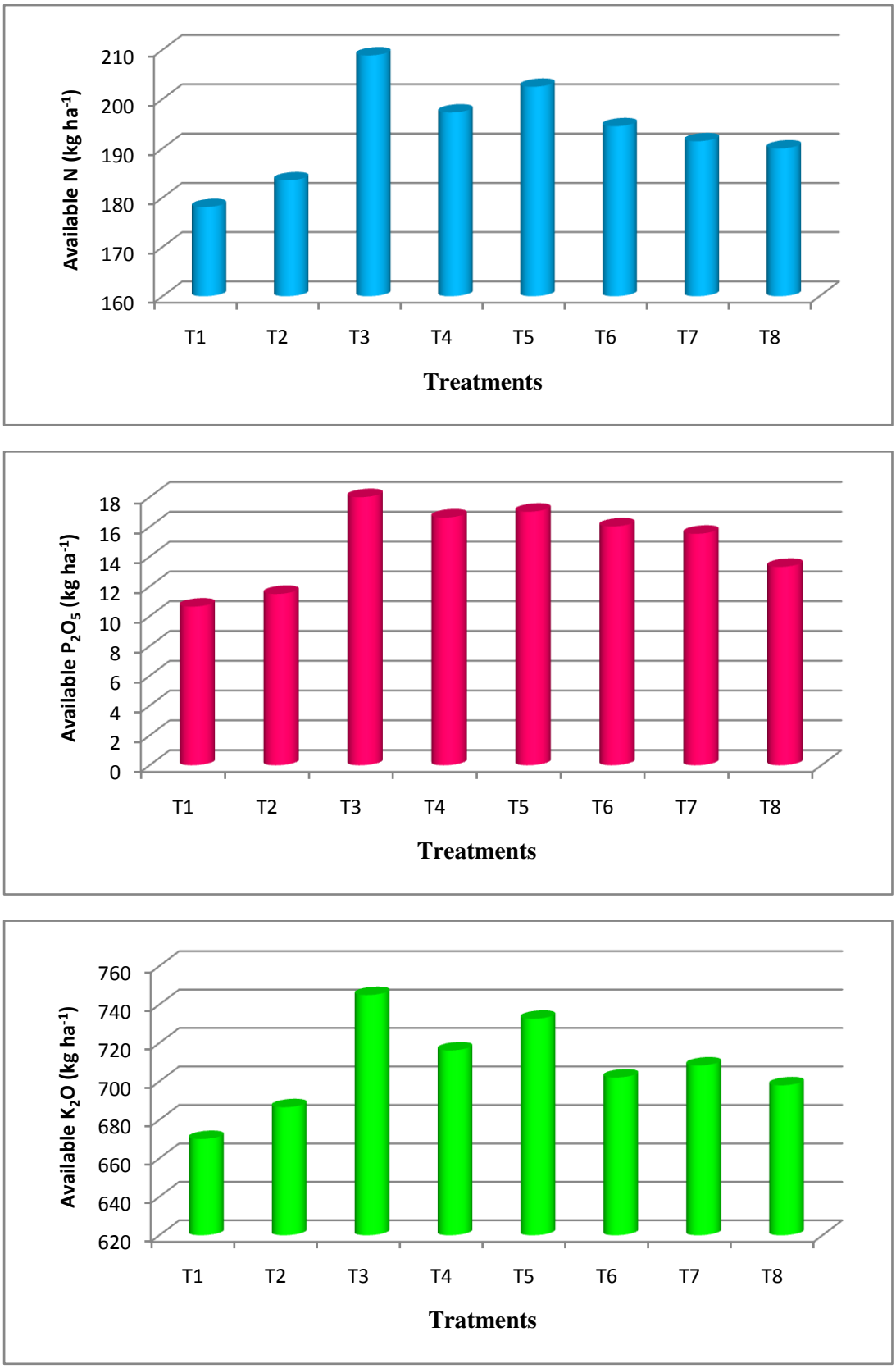


Fig. 6 Effect of foliar application of panchagavya and leaf extracts on Available N, P and K in soil after harvest of spinach

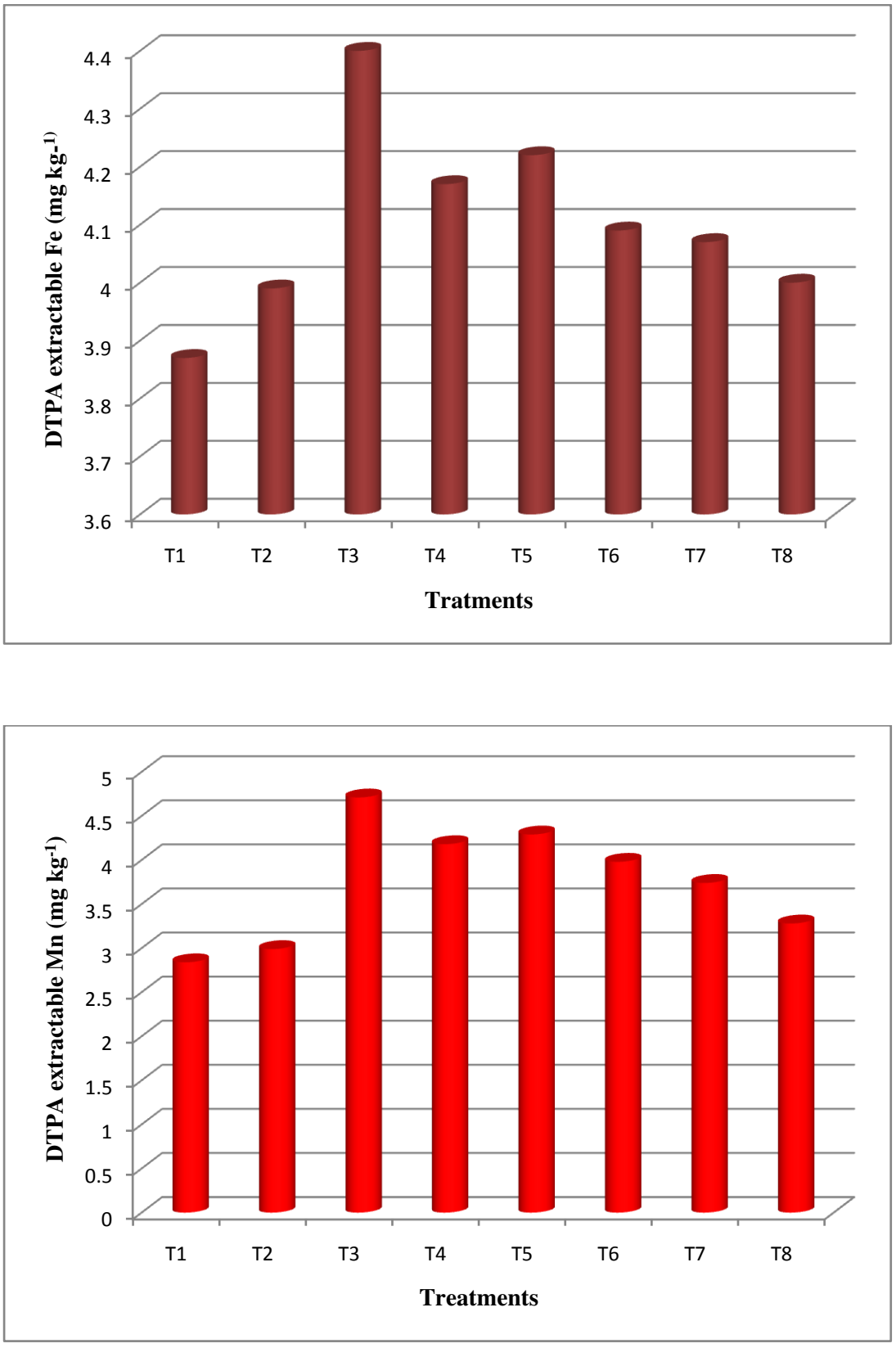


Fig. 7 Effect of foliar application of panchagavya and leaf extracts on DTPA extractable Fe and Mn in soil after harvest of spinach

Table 9 Effect of foliar application of panchagavya and leaf extracts on DTPA micronutrient in soil after harvest of spinach

Tr. No	Treatments details	DTPA extractable (mg kg^{-1})			
		Fe	Mn	Zn	Cu
T_1	Control (only water spray)	3.87	2.84	0.41	1.85
T_2	Panchagavya	3.99	2.99	0.47	1.94
T_3	Panchagavya + neem leaf extract	4.40	4.71	0.78	2.83
T_4	Panchagavya + karanj leaf extract	4.17	4.18	0.68	2.22
T_5	Panchagavya + glyricidia leaf extract	4.22	4.29	0.70	2.38
T_6	Panchagavya + custard apple leaf extract	4.09	3.98	0.66	2.18
T_7	Micronutrient Grade II	4.07	3.74	0.58	2.05
T_8	100% N through FYM	4.00	3.28	0.54	2.00
	Grand Mean	4.10	3.75	0.60	2.18
	SEm (±)	0.22	0.27	0.04	0.11
	CD at 5%	0.68	0.82	0.12	0.35

4.3.6 DTPA extractable zinc

The available zinc in soil as influenced by different treatments at harvest of spinach was recorded and data are presented in Table 9 and depicted in Fig.8. The initial soil available Zn was 0.42 mg kg^{-1}. The results indicated that DTPA extractable zinc in soil varied from 0.41 to 0.78 mg kg^{-1} at harvest stage of spinach. The treatment T_3 (panchagavya + neem leaf extract) showed maximum Zn availability followed by T_5 (panchagavya + glyricidia leaf extract) at harvest stage of spinach. The soils are low in available zinc and respond to the application of organic and inorganic fertilizer. Zinc is found to be deficient in black soil because of presence of calcium carbonate decreases the availability of zinc. These results were in line with the findings of Kanwar and Sharma (2014).

4.3.7 DTPA extractable copper

The data on effect of foliar application of panchagavya and leaf extracts on DTPA extractable copper in soil after harvest of spinach are presented in Table 9 and

Fig.8 The soil available Cu ranged from 1.85 to 2.83 mg kg^{-1} at harvest stage of spinach. The treatment T_3 (panchagavya + neem leaf extract) showed maximum Cu availability followed T_5 (panchagavya + glyricidia leaf extract) and T_4 (panchagavya + karanj leaf extract). The high Cu content in soil might be due to presence of copper minerals like Cuprite and Chalcosite in parent material similar findings were also reported by Kanwar and Sharma (2014).

4.4 Effect of foliar application of panchagavya and leaf extracts on content and uptake of nutrients

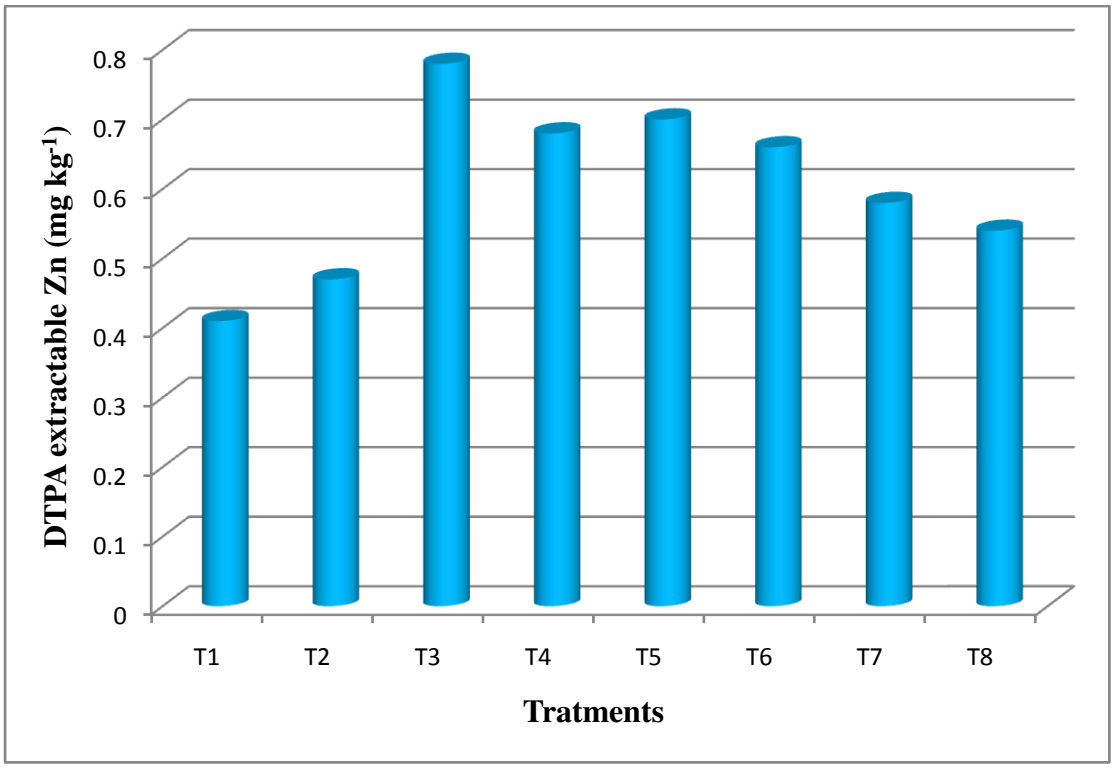
4.4.1 Nitrogen content and uptake

As regards to content and uptake in spinach at harvest as influenced by different treatments are presented in Table 10 and Fig 9.

Table 10 Effect of foliar application of panchagavya and leaf extract on nitrogen content and uptake in spinach

Tr. No.	Treatments details	N content (%)	N uptake (kg ha^{-1})
T_1	Control (only water spray)	1.98	36.68
T_2	Panchagavya	2.06	40.42
T_3	Panchagavya + neem leaf extract	2.39	78.28
T_4	Panchagavya + karanj leaf extract	2.22	71.05
T_5	Panchagavya + glyricidia leaf extract	2.27	73.20
T_6	Panchagavya + custard apple leaf extract	2.19	63.58
T_7	Micronutrient Grade II	2.13	56.74
T_8	100% N through FYM	2.10	45.65
	Grand Mean	2.16	58.20
	SEm (±)	0.07	4.86
	CD at 5%	0.23	14.70

The plant N content and uptake of N ranged from 1.98 to 2.39 % and 36.68 to 78.28 kg ha^{-1}, respectively. The treatment T_3 (panchagavya +neem leaf extract) gave significantly higher N content (2.39 %) and uptake (78.28 kg ha^{-1}) as compared to



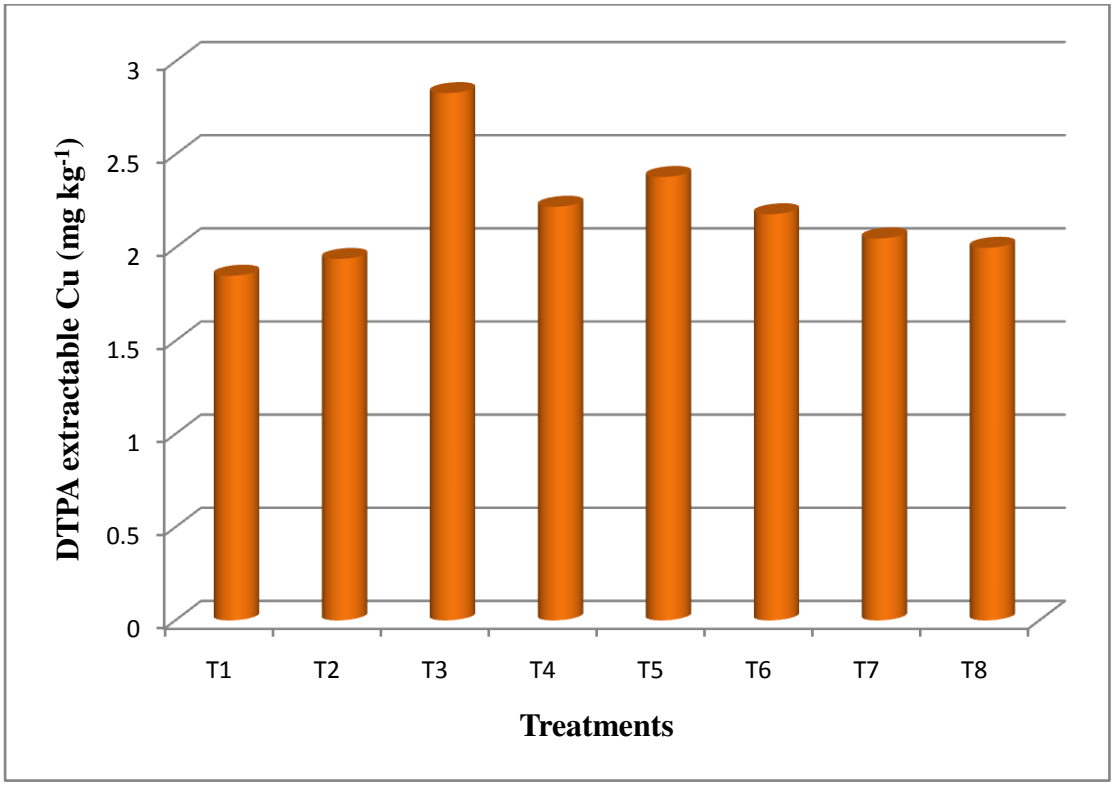


Fig. 8 Effect of foliar application of panchagavya and leaf extracts on DTPA extractable Zn and Cu in soil after harvest of spinach

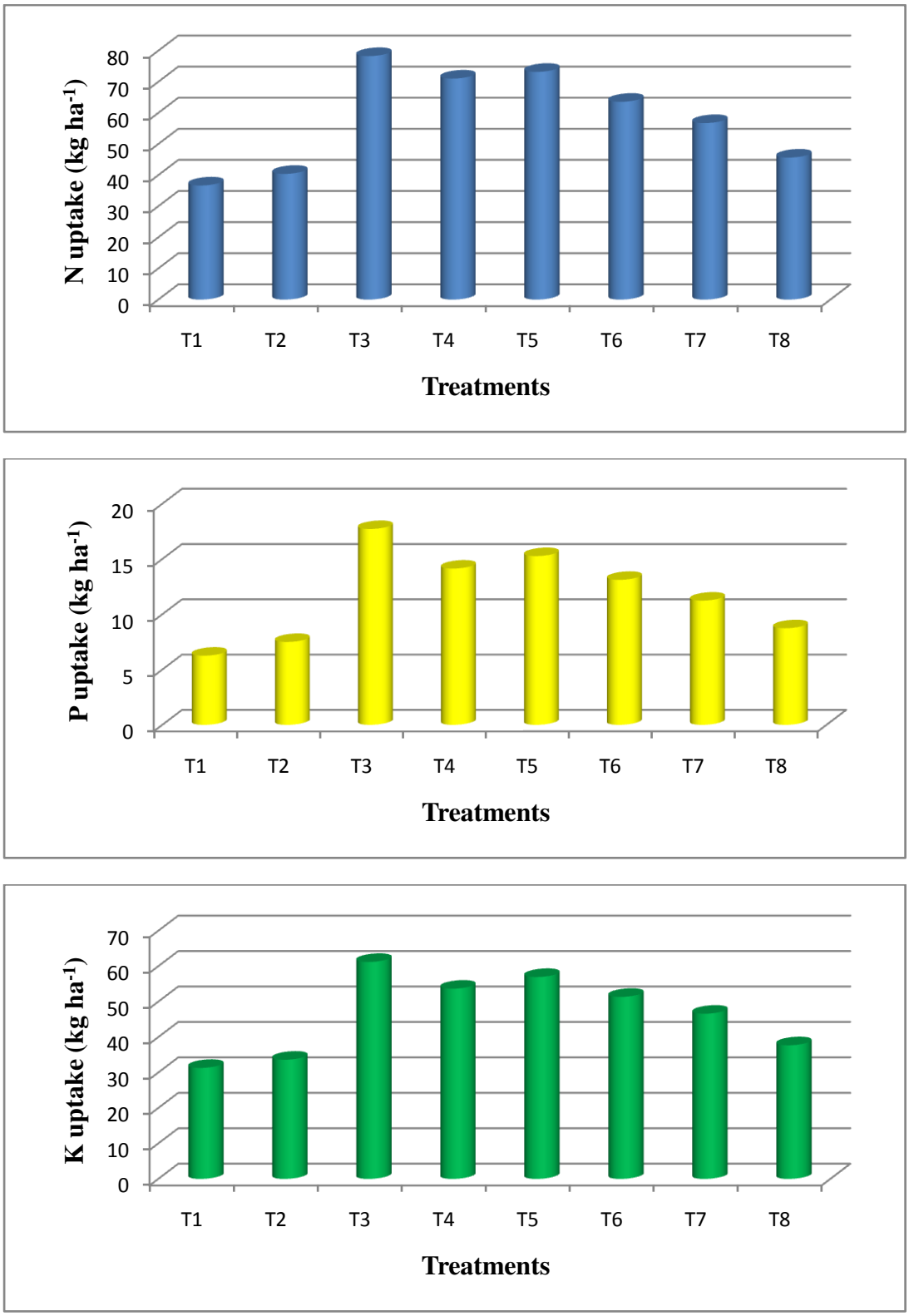


Fig. 9 Effect of foliar application of panchagavya and leaf extracts on uptake of N, P and K in spinach

control (1.98 % N content and 36.68 kg ha^{-1} N uptake). The treatment T_4 (panchagavya +karanj leaf extract) and T_5 (panchagavya + glyricidia leaf extract) was found to be statistically at par with treatment T_3 (panchagavya +neem leaf extract) and superior over the remaining treatments. The cow urine rich in uric acid, a source of nitrogen was readily soluble and liquid form,one of the important compounds in panchagavya and was readily available to the plants directly influencing the nitrogen content of leaves. Panchagavya eliminates the imbalance in physical, chemical and biological processes due to the cosmic energy produce by stirring of the stock solution. Similar findings were also reported by Sanjutha *et al., (*2008) and Gore and Sreenivasa (2011).

4.4.2 Phosphorus content and uptake

It was evidenced from the data presented in Table 11 and Fig 9 that P content and uptake shows significant variation under the different treatments of foliar application of panchagavya and leaf extracts in spinach plant. The content and uptake of P varied from 0.34 to 0.54 % and 6.26 to 17.72 kg ha^{-1}, respectively. Significantly highest P

Table 11 Effect of foliar application of panchagavya and leaf extract on phosphorus content and uptake in spinach

Tr. No.	Treatments details	P content (%)	P uptake (kg ha^{-1})
T_1	Control (only water spray)	0.34	6.26
T_2	Panchagavya	0.38	7.50
T_3	Panchagavya + neem leaf extract	0.54	17.72
T_4	Panchagavya + karanj leaf extract	0.47	14.14
T_5	Panchagavya + glyricidia leaf extract	0.49	15.27
T_6	Panchagavya + custard apple leaf extract	0.45	13.12
T_7	Micronutrient Grade II	0.42	11.24
T_8	100% N through FYM	0.40	8.74
	Grand Mean	0.43	11.75
	SEm (±)	0.02	0.90
	CD at 5%	0.09	2.73

content and uptake in spinach was found with foliar application of panchagavya and neem leaf extract (0.54% and 17.72 kg ha^{-1}) as compared to rest of the treatment. The lowest P content and uptake was observed in T_1 (0.34 % and 6.26 kg ha^{-1}) with control. The increased supply of plant nutrients with source of foliar application in plant available form might have increased the accumulation of dry matter concomitantly by affecting the ramification of roots favourablely. The increased dry matter in above ground parts favours translocation of more carbohydrates towards developing roots as reported by Kumawat (2009).

4.4.3 Potassium content and uptake

The data narrated in Table 12 and Fig. 9 indicates that significant differences were observed with K content and uptake in spinach plant with foliar application of panchagavya and leaf extracts. K content and uptake in spinach plant varied from 1.69 to 1.87 % and 31.31 to 61.21 kg ha^{-1}, respectively. Results revealed that the significantly highest K content and uptake (1.87 % and 61.21 kg ha^{-1}) was noted with foliar application of

Table 12 Effect of foliar application of panchagavya and leaf extract on potassium content and uptake in spinach

Tr. No.	Treatments details	K content (%)	K uptake (kg ha^{-1})
T_1	Control (only water spray)	1.69	31.31
T_2	Panchagavya	1.71	33.62
T_3	Panchagavya + neem leaf extract	1.87	61.21
T_4	Panchagavya + karanj leaf extract	1.79	53.66
T_5	Panchagavya + glyricidia leaf extract	1.83	56.96
T_6	Panchagavya + custard apple leaf extract	1.78	51.35
T_7	Micronutrient Grade II	1.75	46.60
T_8	100% N through FYM	1.73	37.70
	Grand Mean	1.76	46.55
	SEm (±)	0.02	1.59
	CD at 5%	0.09	4.82

panchagavya and neem leaf extract (T_3) treatment. Whereas, lowest K content and uptake (1.69% and 31.31 kg ha^{-1}) was obtained with control (T_1) treatment. Similar results was also reported by Saravanan *et al.,* (2013). Increase in K content and uptake was might be due to its synergetic relationship with N and P.

4.4.4 Iron content and uptake

Fe content and uptake was significantly influenced with the foliar application of panchagavya and leaf extracts, the data is presented in Table 13 and depicted in Fig10. The Fe content and uptake in spinach plant increased with foliar application of panchagavya and leaf extracts which was varied from 290.00 to 363.00 mg kg^{-1} and 537.86 to 1190.00 g ha^{-1}, respectively. Among different treatments, foliar application of panchagavya and neem leaf extract (363.00 mg kg^{-1} and 1190.00 g ha^{-1}) noticed highest iron content and uptake as compared to rest of the treatments. Whereas, lowest iron content and uptake was found in (T_1) control (290.00 mg kg^{-1} and 537.86 g ha^{-1}) The result of these experiment are also concurrent with the findings of Choudhary *et al*, (2017).

Table 13 Effect of foliar application of panchagavya and leaf extract on iron content and uptake in spinach.

Tr. No.	Treatments details	Fe content (mg kg^{-1})	Fe uptake (g ha^{-1})
T_1	Control (only water spray)	290.04	537.86
T_2	Panchagavya	309.06	606.67
T_3	Panchagavya + neem leaf extract	363.13	1190.00
T_4	Panchagavya + karanj leaf extract	341.17	1022.11
T_5	Panchagavya + glyricidia leaf extract	349.07	1086.28
T_6	Panchagavya + custard apple leaf extract	333.21	966.89
T_7	Micronutrient Grade II	329.21	877.37
T_8	100% N through FYM	313.14	683.69
	Grand Mean	328.50	871.36
	SEm (±)	8.57	40.20
	CD at 5%	25.90	121.38

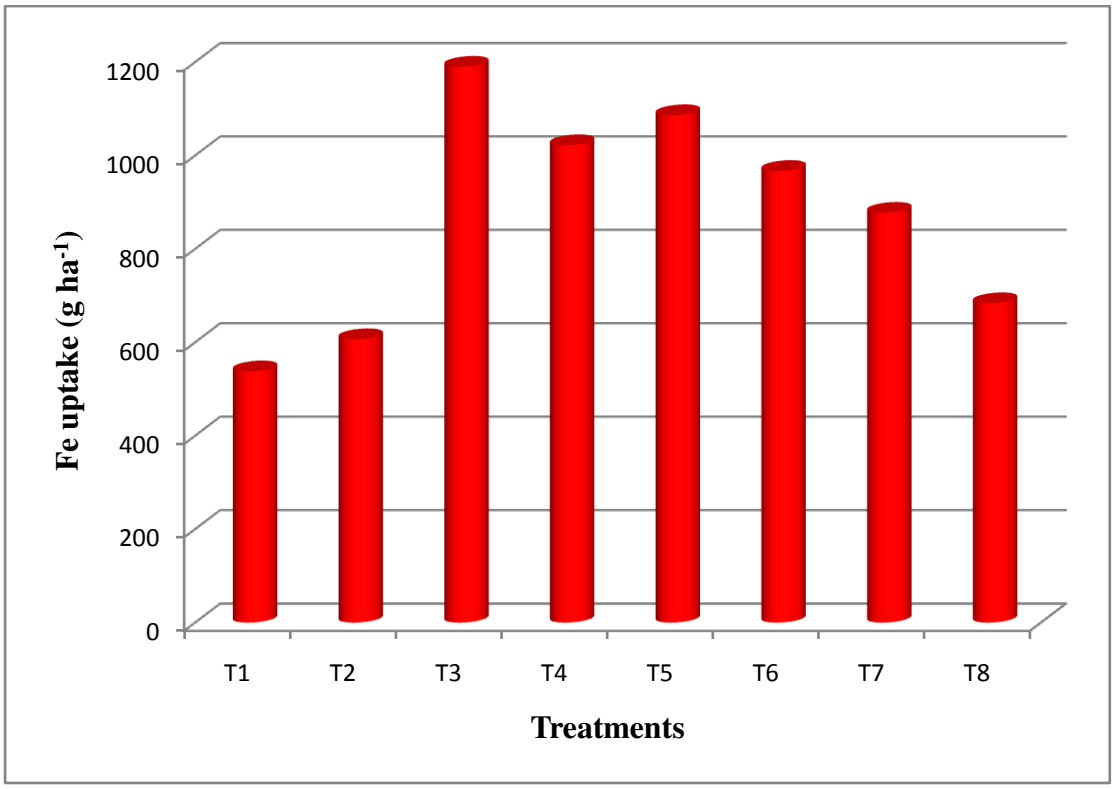
4.4.4 Manganese content and uptake

Foliar application of panchagavya and leaf extracts has significantly influenced the manganese content and uptake by spinach is presented in Table 14 and depicted in Fig 12. Fe content and uptake in spinach showed significant variation after

Table 14 Effect of foliar application of panchagavya and leaf extract on manganese content and uptake in spinach

Tr. No.	Treatments details	Mn content (mg kg^{-1})	Mn uptake (g ha^{-1})
T_1	Control (only water spray)	180.10	333.03
T_2	Panchagavya	184.04	361.78
T_3	Panchagavya + neem leaf extract	226.13	740.73
T_4	Panchagavya + karanj leaf extract	213.04	638.52
T_5	Panchagavya + glyricidia leaf extract	217.11	675.76
T_6	Panchagavya + custard apple leaf extract	209.08	606.97
T_7	Micronutrient Grade II	206.14	548.78
T_8	100% N through FYM	191.12	416.73
	Grand Mean	203.34	540.29
	SEm (±)	4.08	23.67
	CD at 5%	12.33	71.47

foliar application of panchagavya and leaf extract it was varied from 180.00 to 226.00 mg kg^{-1} and 333.03 to 740.73 g kg^{-1}, respectively. Results showed that Mn content and uptake increased significantly with foliar application of panchagavya and neem leaf extract (226.00 mg kg^{-1} and 740.73 g kg^{-1}). Plots without foliar spray of panchagavya and leaf extract produced significantly lower Mn content and uptake (180.00 mg kg^{-1} and 740.73 g kg^{-1}) as compared to applied plots. Our results are in line with findings of Sridhar *et al.* (2014) who reported the organic formulation used as source of nutrient results in higher manganese concentration than RDF.



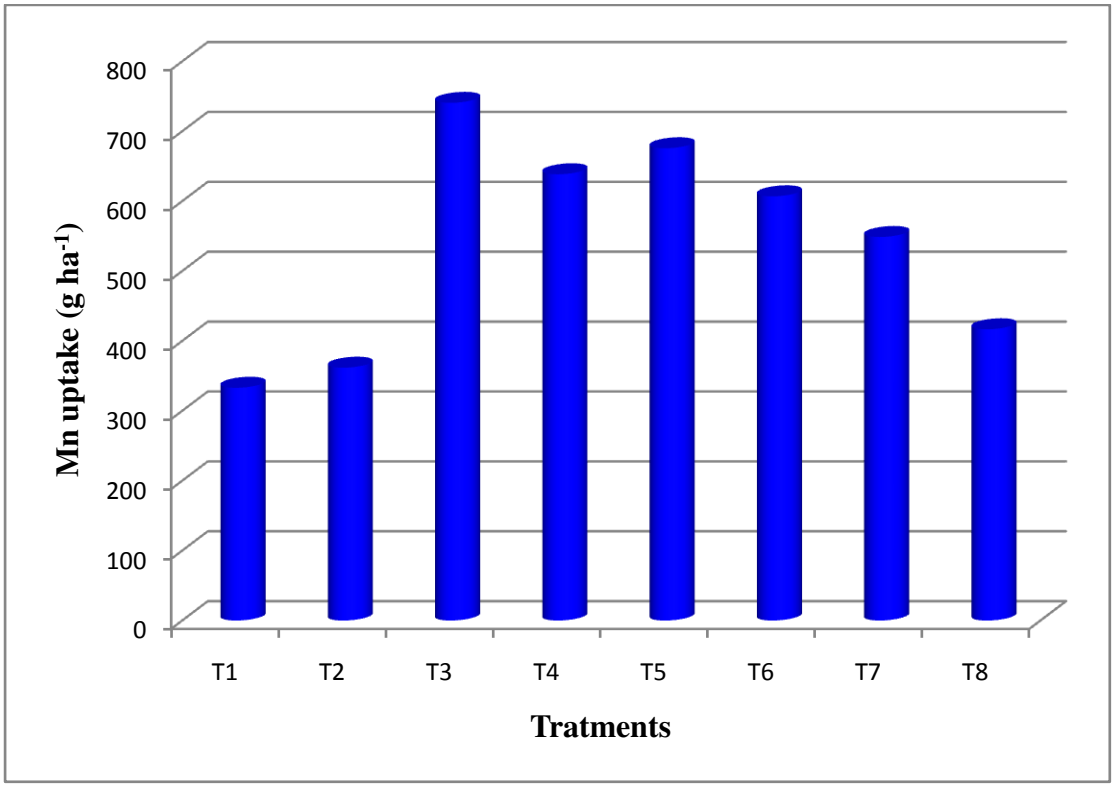


Fig. 10 Effect of foliar application of panchagavya and leaf extracts on uptake of Fe and Mn in spinach

4.4.5 Zinc content and uptake

The data clearly demonstrates a remarkable Zn content and uptake increased by the foliar application of panchagavya and leaf extracts as compared to without application of panchagavya and leaf extracts (Table 15and Fig 11). It was varied from 42.00 to 76.00 mg kg^{-1} in content and 77.76 to 249.32 g kg^{-1} in uptake.

Table 15 Effect of foliar application of panchagavya and leaf extract on zinc content and uptake in spinach.

Tr. No.	Treatments details	Zn content (mg kg^{-1})	Zn uptake (g ha^{-1})
T_1	Control (only water spray)	42.04	77.76
T_2	Panchagavya	46.02	90.45
T_3	Panchagavya + neem leaf extract	76.08	249.32
T_4	Panchagavya + karanj leaf extract	65.11	195.50
T_5	Panchagavya + glyricidia leaf extract	69.08	214.85
T_6	Panchagavya + custard apple leaf extract	57.11	165.05
T_7	Micronutrient Grade II	53.09	141.96
T_8	100% N through FYM	49.05	106.92
	Grand Mean	57.20	155.23
	SEm (±)	3.60	10.77
	CD at 5%	10.88	32.53

Significantly higher zinc content was seen with foliar application of panchagavya and neem leaf extract (76.00 mg kg^{-1}) followed by foliar application of panchagavya and glyricidia leaf extract (69.00 mg kg^{-1}), foliar application of panchagavya and karanj leaf extract (65.00 mg kg^{-1}). However, highest uptake of zinc was also found with foliar application of panchagavya and neem leaf extract (249.32 g ha^{-1}) which was significantly superior over other treatments. The zinc content and uptake from spinach plant was lower in control (42.00 mg kg^{-1} and 77.76 g ha^{-1}).

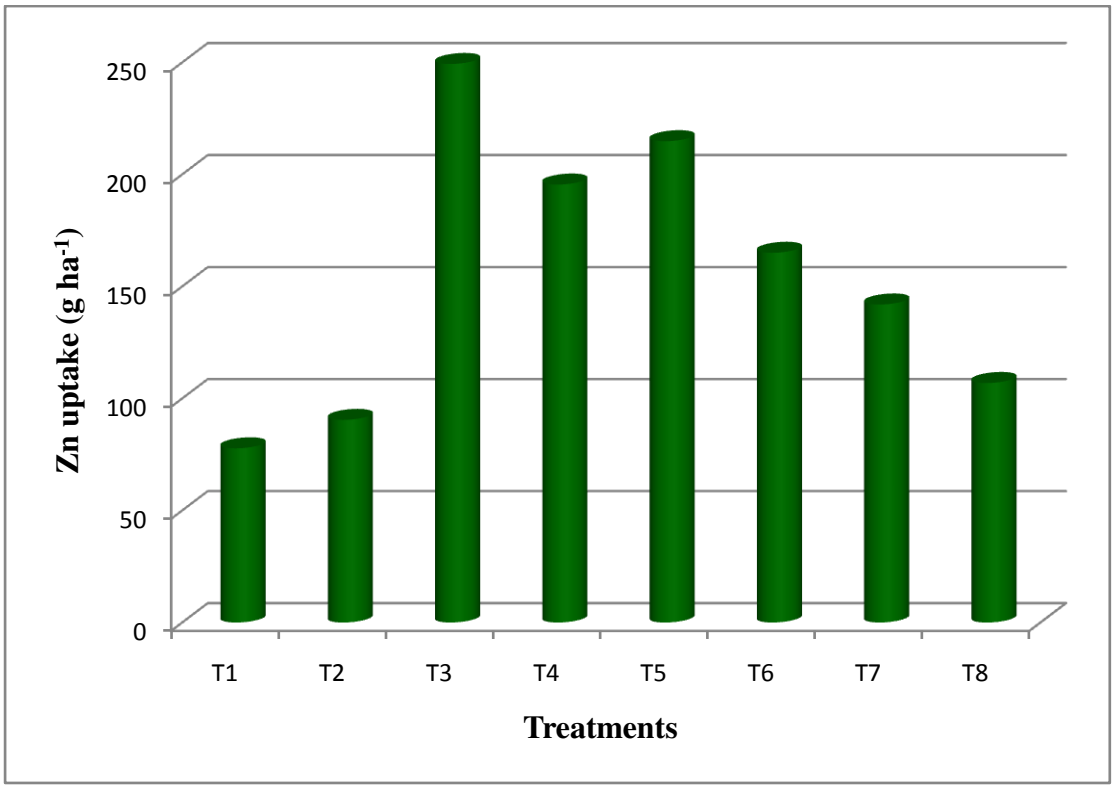
4.4.5 Copper content and uptake

As Table 16 and Fig.11 shows, Cu content and uptake in spinach plant was found much higher in panchagavya and leaf extract applied plants than the control. Copper content and uptake ranged from 16.00 to 39.00 mg kg^{-1} and 29.62 to 128.19 g ha^{-1}, respectively. Results revealed that higher content and uptake of copper was noticed in the treatment of foliar application of panchagavya and neem leaf extract (39.00 mg kg^{-1} and 128.19 g ha^{-1}) followed by foliar application of panchagavya and glyricidia leaf extract (37.00 mg kg^{-1} and 115.94 g ha^{-1}).

Table 16 Effect of foliar application of panchagavya and leaf extract on copper content and uptake in spinach

Tr. No.	Treatments details	Cu content (mg kg^{-1})	Cu uptake (g ha^{-1})
T_1	Control (only water spray)	16.04	29.62
T_2	Panchagavya	19.10	37.44
T_3	Panchagavya + neem leaf extract	39.13	128.19
T_4	Panchagavya + karanj leaf extract	31.07	93.84
T_5	Panchagavya + glyricidia leaf extract	37.14	115.94
T_6	Panchagavya + custard apple leaf extract	27.17	79.19
T_7	Micronutrient Grade II	23.12	61.61
T_8	100% N through FYM	21.20	46.27
	Grand Mean	26.74	74.01
	SEm (±)	3.23	9.99
	CD at 5%	9.76	30.18

The lowest content and uptake of copper in spinach was observed in control plots (16.00 mg kg^{-1} and 29.62 g ha^{-1}). Experimental results are in agreement with the report of Sridhar *et al* (2014) who also noted that higher content of copper was obtained with organic formulation along with RDF.



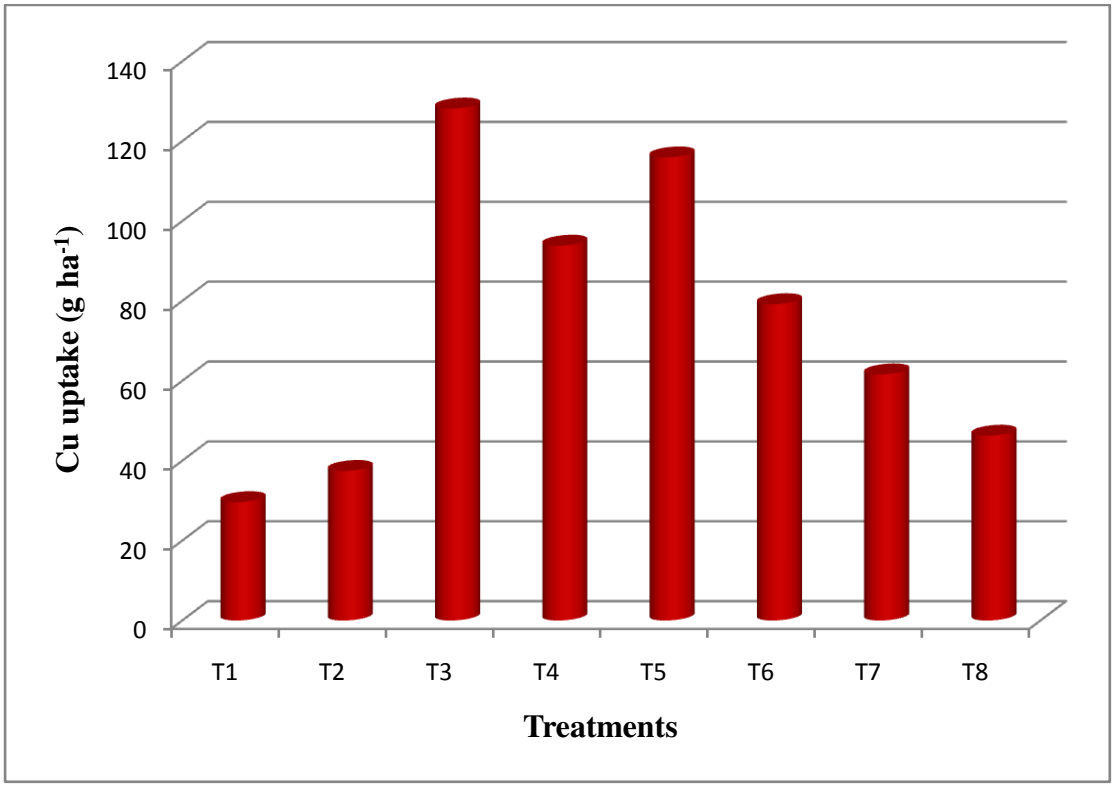


Fig. 11 Effect of foliar application of panchagavya and leaf extracts on uptake of Zn and Cu in spinach

4.5 Effect of foliar application of panchagavya and leaf extracts on quality parameters of spinach.

The data pertaining to quality parameters of spinach as influenced by foliar application of panchagavya and leaf extracts are presented in Table 10 and Fig 12.

4.5.1 Moisture percentage

The average moisture percentage as influenced by various treatments was 86.85% (Table 10). Among the various treatments, the maximum moisture percentage was noticed in the treatment T_1 (control) only water spray over rest of the treatments. The minimum moisture percentage was recorded (85.94%) in treatment panchagavya + neem leaf extract (T_3). The lowest moisture content in treatment receiving panchagavya + neem leaf extract might be due to higher dry matter accumulation as a result increased photosynthetic activity. More or less similar trend in respect of moisture percentage was also registered by Dange *et al.,* (2011).

4.5.2 Dry matter percentage

The data regarding dry matter percentage are presented in Table 10 and Fig 12. The maximum dry matter to the extent of 14.06% was observed in treatment receiving application of panchagavya + neem leaf extract which was found significantly superior over rest of the treatment. The lowest dry matter percentage was registered in treatment T_1 i.e. control (11.60%). The increase in dry matter accumulation with combination of inorganic fertilizers with organic manure was also reported by Dange *et al.,* (2011).

4.5.3 Ascorbic acid content

The data pertaining to ascorbic acid content in leaves of spinach are narrated in Table 10 and depicted in Fig 13. The highest ascorbic acid content was noticed in treatment T_3 (45.13 mg $100g^{-1}$) and lowest in treatment T_1 (31.72 mg 100 g^{-1}). The results are in accordance with the findings of Hannah *et al.,* (2005).

4.5.4 Chlorophyll content

The chlorophyll content in spinach leaves varied between 5.85 to 7.31 mg g^{-1} with an average value of 6.44 mg g^{-1}.It was observed that application of panchagavya along with leaf extract was increased the greenness of spinach. Among the various treatments tried in the present investigation, application of panchagavya

with neem leaf extract proved superior and showed highest chlorophyll content (7.31 mg g^{-1}).The control T_1 had lowest chlorophyll content in spinach leaves (5.50 mg g^{-1}). The results are in agreement with the results obtained by research workers Jandik *et al.,* (2015) a.

Table 17 Effect of foliar application of panchagavya and leaf extracts on quality parameters of spinach

Tr. No.	Treatments details	Moisture (%)	Dry matter (%)	Ascorbic acid (mg/100g)	Chlorophyll (mg/gm)
T_1	Control (only water spray)	88.40	11.60	31.72	5.5
T_2	Panchagavya	87.98	12.02	34.73	5.85
T_3	Panchagavya + neem leaf extract	85.94	14.06	45.13	7.31
T_4	Panchagavya + karanj leaf extract	86.18	13.82	39.07	6.70
T_5	Panchagavya + glyricidia leaf extract	86.02	13.98	41.73	7.07
T_6	Panchagavya + custard apple leaf extract	86.20	13.80	39.37	6.61
T_7	Micronutrient Grade II	86.92	13.08	40.20	6.33
T_8	100% N through FYM	87.20	12.8	35.83	6.13
	Grand Mean	86.85	13.14	38.47	6.44
	SEm (±)	0.08	0.06	1.39	0.36
	CD at 5%	0.23	0.19	4.22	1.11

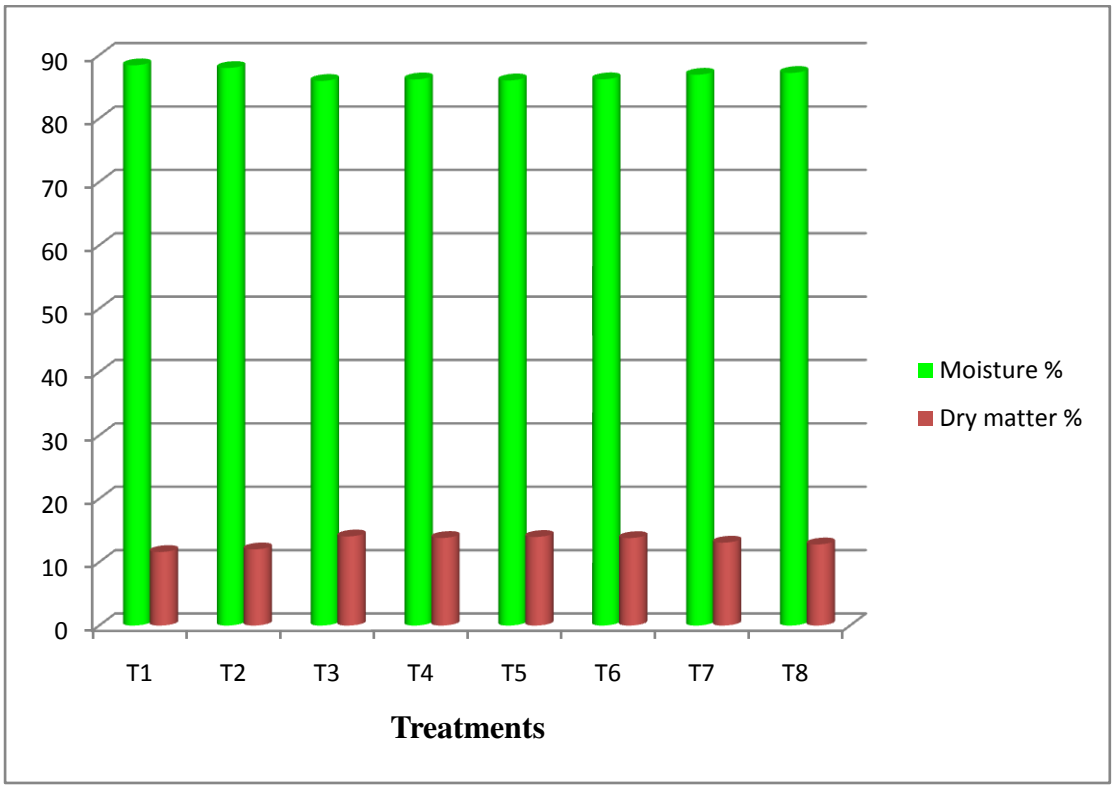


Fig. 12 Effect of foliar application of panchagavya and leaf extracts on moisture and dry matter per centage of spinach

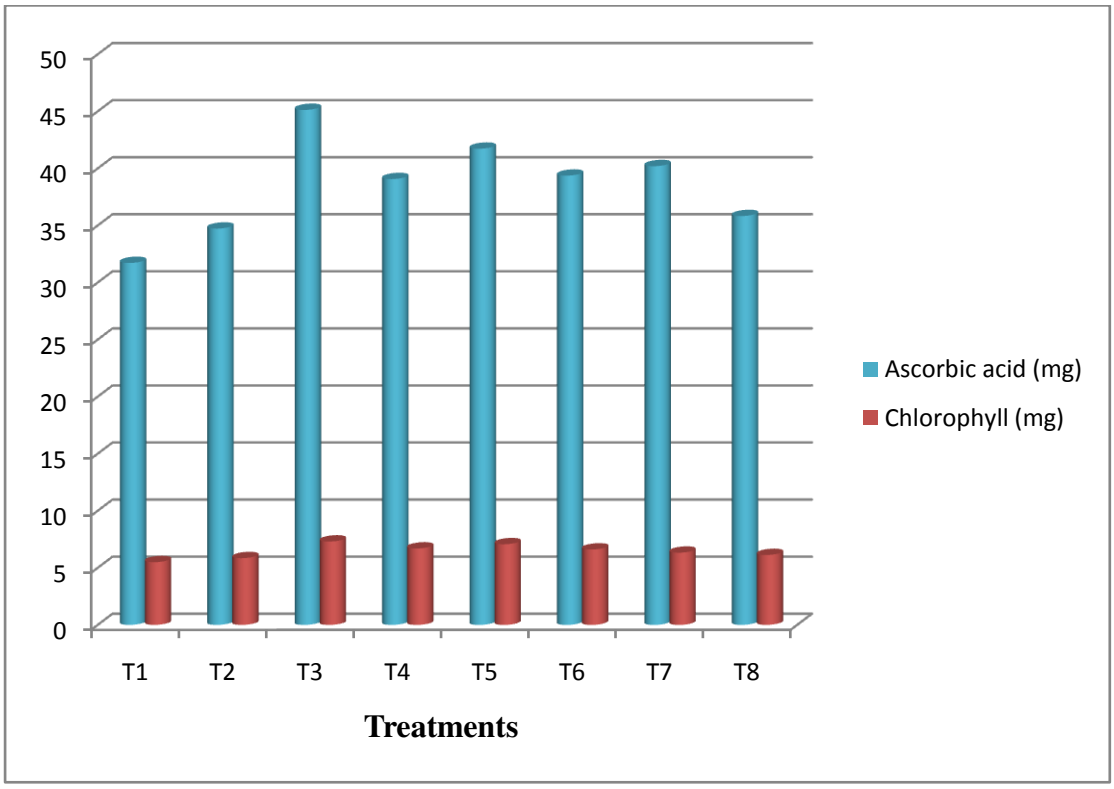


Fig. 13 Effect of foliar application of panchagavya and leaf extracts on ascorbic acid and chlorophyll content of spinach

Summary and Conclusions

Chapter V

SUMMARY AND CONCLUSION

The field experiment was conducted during Rabi 2017 at the Research farm, Department of Horticulture, VNMKV, Parbhani. The experiment was laid out in randomized block design with eight treatment and three replications. During experimentation initial and at harvest soil samples were collected from each plot and analyzed for chemical properties of soil using standard procedures. Moreover, biometric observations were recorded at harvest of spinach. The yield and quality parameters was determine during investigation. Plant samples were also collected and analysed for nutrient content and uptake by spinach.

The salient findings interpreted and discussed in previous chapter are summarized below.

1. Soil of experimental field was well drained , uniform, deep black cotton soil, clayey in texture and alkaline in nature. It was safe in salt content. The soil was low in organic carbon content and calcareous in nature.

2. The growth parameter like plant height, number of leaves and leaf area of spinach showed significantly increased with foliar application of panchagavya and neem leaf extract.

3. The highest green yield and dry matter yield of spinach was obtained by foliar application of panchagavya and neem leaf extract and lowest green and dry matter yield of spinach was recorded in control plot.

4. The effect of application of panchagavya and leaf extracts on soil pH electrical conductivity, organic carbon content and calcium carbonate content at the harvest of spinach was non –significant.

5. The N, P_2O_5, K_2O and micronutrients (Fe,Mn, Zn and Cu) in soil at harvest of spinach was increased with the foliar application of panchagavya and neem leaf extract followed by treatment panchagavya + glyricidia leaf extract.

6. The highest N, P and K content and uptake in spinach plant was recorded by foliar application of panchagavya and neem leaf extract followed by treatment panchagavya + glyricidia leaf extract. Where as, lowest content and uptake of these nutrient in spinach plant was noted in control.

7. Micronutrient i.e Fe, M, Zn and Cu content and uptake of spinach plant were found highest with the foliar application of panchagavya + neem leaf extract and lowest value of micronutrient content and uptake by spinach plant were registered in control.

8. The highest dry matter percentage, ascorbic acid and chlorophyll content in spinach was recorded by foliar application of panchagavya + neem leaf extract followed by foliar application of panchagavya + glyricidia leaf extract. The lowest dry matter percentage, ascorbic acid and chlorophyll content was observed in control treatment. However, lowest moisture percentage was noted in treatment i.e. foliar application of panchagavya + neem leaf extract.

Conclusion

From the results summarized above following conclusions are drawn.

The foliar application of panchagavya + neem leaf extract found to be effective in improving growth parameters like plant height, number of leaves, leaf area, green fresh and dry matter yield. The availability of N, P,K and micronutrients (Fe, Mn, Zn and Cu) in soil at harvest of spinach found to be improved due to application of panchaygavya and leaf extracts over control. The N, P, K and micronutrients (Fe, Mn, Zn and Cu) content and uptake by spinach was higher due to foliar application of panchagavya +neem leaf extract. The foliar application of panchagavya + neem leaf extract significantly enhanced the quality parameter of spinach.

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Appendix-I

WEEKLY WEATHER DATA RECORDED AT CENTRAL METEOROLOGY OBSERVATION PARBHANI 2017-18

MW	Duration	Thrips	Temperature (^{0}C)		Humidity (%)		Rainfall (mm)	EVP	BSS (hrs)	WV (km/h)
			Max	Min	AM	PM				
48	26-02 Dec.	2.8	29.8	10.2	77	30	0	3.86	9.17	2.86
49	03-09 Dec.	4.20	30.4	14.4	75	42	0	4.50	7.39	4.70
50	10-16 Dec.	5.13	12.5	4.7	77	31	0	4.71	8.60	2.80
51	17-23 Dec.	7.23	29.2	7.9	75	27	0	4.04	8.44	3.84
52	24-31 Dec.	8.60	25.5	6.1	66	18	0	3.36	8.26	2.74
1	01-07 Jan.	11.33	29.6	9.2	76	31	0	3.90	8.60	2.60
2	08-14 Jan.	14.33	30.3	11.2	76	29	0	4.50	8.70	2.90
3	15-21 Jan	20.93	31.0	11.8	75	25	0	5.10	9.20	3.00
4	22-28 Jan	24.73	29.9	8.7	77	24	0	4.50	9.40	3.10
5	29-04 Feb.	28.13	31.8	8.9	75	17	0	5.00	9.70	3.00
6	05-11 Feb	32.67	31.1	12.5	77	25	0	4.60	5.90	2.80
7	12-18 Feb.	36.00	39.6	14.2	47	27	0	4.70	8.20	4.60
8	19-25 Feb.	40.33	34.8	14.8	75	20	0	5.80	9.10	3.20
9	26-04 Mar.	39.86	36.5	15.9	64	17	0	7.20	9.20	3.30
10	05-11 Mar.	38.66	36.0	17.8	94	21	0	8.10	8.60	4.40
11	12-18 Mar.	37.06	33.6	19.0	70	32	0	6.40	5.80	3.60
12	19-25 Mar.	36.66	37.7	17.0	74	14	0	7.50	6.80	4.60

VITAE

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