

**EFFECT OF BANANA PSEUDOSTEM SAP AND VERMIWASH
SPRAY ON YIELD AND QUALITY OF ORGANICALLY GROWN
ONION**

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ONION**

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A B S T R A C T

A field experiment was conducted at Organic Farm, NAU, Navsari during *rabi* season of 2010-11. The objectives of the experiment were (i) To study the effect of banana pseudostem sap and vermiwash spray on yield and yield attributes of onion, (ii) To study the effect of banana pseudostem sap and vermiwash spray on quality and nutrient uptake and (iii) Work out the economics of different treatments. Total 7 treatments *viz.*, T₁: Control, T₂: Banana pseudostem sap @ 2% spray, T₃: Enriched banana pseudostem sap @ 2% spray, T₄: Vermiwash @ 2% spray, T₅: T₂ and T₃ in 2:1 ratio, T₆: T₂ and T₃ in 1:2 ratio and T₇: T₂ and T₃ in 1:1 ratio were tested using RBD with three replications. Common dose of BC, CC and VC on N equivalent basis (33.3% N from each source) was applied to supply RDN of the onion.

The plant height and number of leaves were recorded at 30, 60 and 90 DATP; among this plant height recorded at 30 DATP and number of leaves recorded at 90 DATP were affected significantly due to different treatments. The significantly higher plant height (36.2 cm) and number of leaves (9.7) were recorded in the treatment T₃. But it was remains at par with treatment T₂ (31.7

cm), T₆ (34.0 cm), and T₇ (31.9 cm) in case of plant height and treatment T₁ (9.3) and T₇ (9.0) in case of number leaves.

The effect of different treatments on equatorial and polar diameter of bulb was significant. Significantly higher equatorial (6.64 cm) and polar (4.96 cm) diameter of bulb were observed in the treatment T₃ (Enriched banana pseudostem sap @ 2% spray) as compared to control. Minimum equatorial diameter of 5.29 cm and polar diameter of 3.90 cm were recorded in treatment T₁. Similarly, treatment T₃ recorded significantly higher average bulb weight (68.1g) followed by treatment T₇ (62.4g). Among the growth and yield parameters (plant height, number of leaves, size and weight of bulbs), periodical plant height and weight of bulb had positive and significant correlation with yield.

Treatment effect on dry matter yield of bulb and leaves was found non significant but significant on bulb yield. Significantly higher bulb yield of 43.7 t/ha was recorded in the treatment T₃. However, it was remain at par with treatment T₇.

The quality parameters like bulb neck thickness and bolting percentage, TSS and pyruvic acid content in bulb were not affected significantly due to different treatments.

Major (N, P and K), secondary (S) and micronutrients (Fe, Mn, Zn and Cu) content in leaves and bulbs of onion were determined after harvest of crop. Among these, only Zn content in leaves and Mn content in bulbs were affected significantly due to different treatments and treatment T₃ recorded significantly higher Zn and Mn content in leaves and bulbs, respectively as compared to control.

Among the major (N, P and K) and secondary (S) nutrient uptake by leaves, bulbs and its total, only N uptake by leaves was affected significantly. The treatment T₃ recorded significantly higher N uptake by leaves *i.e.* 40.5 kg/ha but was remains at par with all the treatment except treatment T₅. But in case of micro nutrients (Fe, Mn, Zn and Cu) treatment T₃ recorded significantly higher uptake of these micro nutrients by leaves, bulbs and its total as compared to remaining treatments. However, Cu uptake by leaves and bulbs, Fe uptake by bulbs and Zn uptake by bulbs were not affected significantly due to different treatments.

None of the soil fertility (Available N, P₂O₅, K₂O, S, Fe, Mn, Zn and Cu) and physical (IR and WSA) parameters were affected significantly due to different treatments.

From the economic point of view, maximum bulb yield of 43.7 t/ha and net profit of Rs. 168470/ha with BCR of 4.4 was recorded with the treatment T₃ involving application of enriched sap @ 2% followed by treatment T₇ which recorded bulb yield of 40.0 t/ha and net income of Rs.150825/ha with BCR of 4.1.

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CERTIFICATE

This is to certify that the thesis entitled **“EFFECT OF BANANA PSEUDOSTEM SAP AND VERMIWASH SPRAY ON YIELD AND QUALITY OF ORGANICALLY GROWN ONION.”** submitted by **BOKARE SACHIN PANDURANG** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE** in the subject of **SOIL SCIENCE AND AGRICULTURAL CHEMISTRY** of the Navsari Agricultural University, is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place: Navsari

Date: 29th June, 2013

Major Advisor

(K.G. PATEL)

DECLARATION

This is to declare that the whole of the research work reported here in this thesis for partial fulfillments of the requirement for the degree of **MASTER OF SCIENCE in SOIL SCIENCE AND AGRICULTURAL CHEMISTRY** by the undersigned is the result of investigation done by me under the direct guidance and supervision of **Dr. K. G. PATEL**, Associate Professor Department of Soil Science and Agricultural Chemistry, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and no part of the work has been submitted for any other degree so far.

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Place : Navsari

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(Sachin P. Bokare)

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LIST OF ABBREVIATIONS

| | |
|--------------|---|
| M.A.U. | = Maharashtra Agricultural University |
| N.A.U. | = Navsari Agricultural University |
| T.N.A.U. | = Tamil-Nadu Agricultural University |
| R.B.D. | = Randomized Bloch Design |
| H.P. | = Himachal Pradesh |
| VC | = Vermi compost |
| FYM | = Farm Yard Manure |
| L.A.I. | = Leaf Are Index |
| FCRD | = Completely Randomized design with factorial concept |
| A.N.G.R.A.U. | = N.G. Ranga Agricultural University |
| RDF | = Recommended dose of fertilizer |
| DAS | = Days after sowing |
| CC | = Castor Cake |
| DTPA | = Diethylene Triamine Penta Acetic Acid |
| BF | = Biofertilizer |
| U.P. | = Uttar Pradesh |
| GM | = Green Manure |
| A.P. | = Andhra Pradesh |
| U.A.S. | = University of Agricultural Science |
| R.R.S. | = Regional Research Station |
| C.I.M.A.P. | = Central Institute of Medicinal and Aromatic Plant |
| PSB | = Phosphate Solublising Bacteria |
| PM | = Poultry Manure |
| Sap | = Banana pseudostem sap |

I INTRODUCTION

Onion is grown throughout the world for its pungency and nutritive value. This crop is grown in India from the ancient time. The crop is grown as green vegetable as well as mature bulbs. It is annual for bulb production and biennial for seed production. It is a popular salad crop, used as a cooked vegetable in soups and also used as flavouring agent in many dishes. Because of its importance in cookery, onion is called as “Queen of the Kitchen”. India ranks second in area (5.12 mha) and production (74.4 lakh MT). India’s export of onion is about 12% of total production. In India, Maharashtra, Gujarat, Karnataka, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and Bihar are the major onion growing states. Maharashtra is leading state among them with 23.4% and 27.5% of total area and production, respectively (Anon., 2011a). Gujarat ranks second in onion production next to Maharashtra in India. In Gujarat, an area of 0.42 million ha was engaged under onion cultivation and producing 9.02 lakh MT of onion with productivity of 21.23 t/ha (Anon., 2009). Major onion growing districts of Gujarat are Bhavnagar, Amreli, Junagadh, Rajkot, Mehsana, Surat, Valsad and Kheda.

Imbalanced and unscientific use of agricultural chemicals *viz.*, fertilizer and synthetic pesticides resulted in unhealthy soil; ultimately which affects the quality of farm produce. Farm produces with unwarranted chemicals are considered to be harmful to consumer’s health. Increasing awareness about devastating impact of agricultural chemicals on environment, stringent rules and regulations of food safety and deadly effect on human well being

compelled to raise the crops devoid of these dangerous chemicals. Under such circumstances when demand of higher quality food is increasing day by day, crops which are raised with eco-friendly techniques are one of the potential options. This can be achieved by adopting organic farming practices. The demand of quality and health friendly organic product has also been increasing and now it become more popular and also sold at a premium prices in domestic and foreign market.

The growth of organic agriculture in India as well as in Gujarat state is increasing day by day. The area under certified organic farming in India during 2003-04 was 42,000 ha and it increased almost 26 folds during the last 5 years. By March 2010, India has brought more than 4.48 million ha area under organic certification process (Fig. 1).

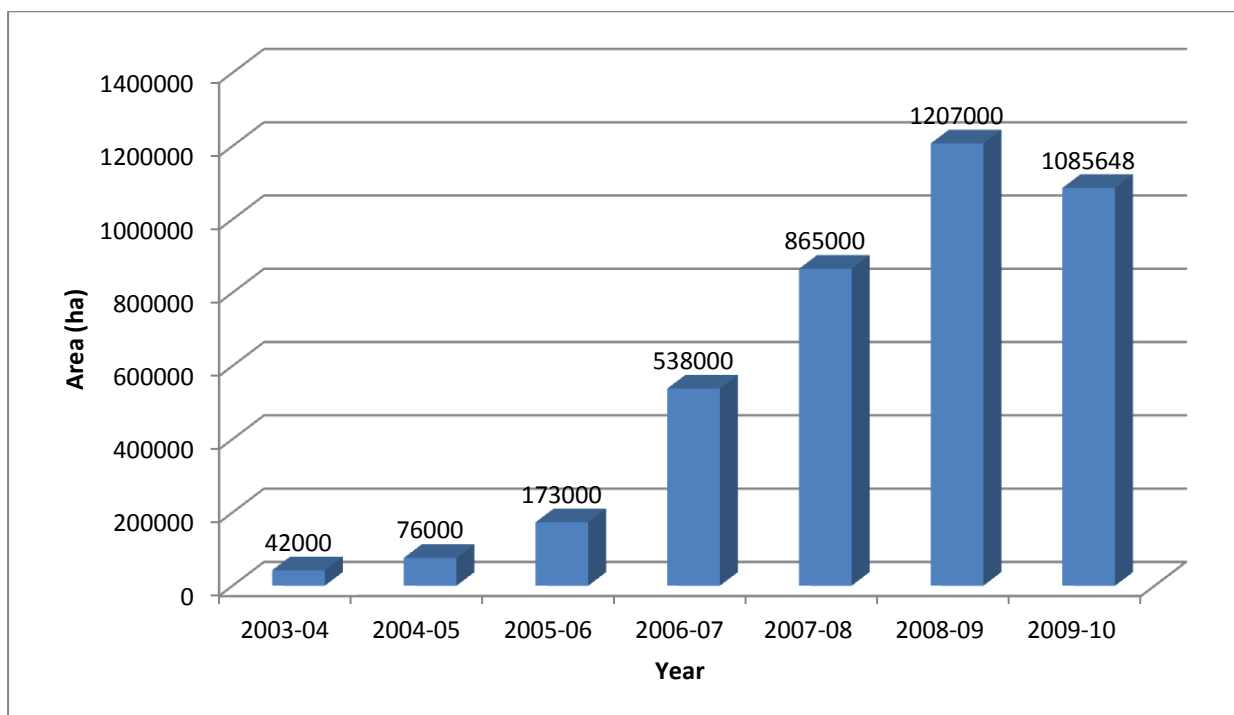


Fig. 1: Trend organic farming in India (Anon., 2011a)

In Gujarat, total 29,566 farmers adopted organic farming covering the area of 70,539 ha (Anon, 2011a).

For successful organic farming in any crops depends upon the availability of nutrients at right time and in right amount, particularly in short duration crops. If nutrient supply is not matching with the requirements then crop production is adversely affected. The availability of nutrients from organic manures is depending upon the C:N ratio of the manures. Wider the C:N ratio, slower the nutrient release and sometime immobilization is occurred. Therefore, integration of different organic manures to narrow the C:N ratio can increase the rate of decomposition and speedup the nutrient release. As South Gujarat is known as “Bowl of Sugar” therefore, number of sugar factories are working in this area and produce biocompost as byproduct. Vermicompost and FYM are widely used organic manures. When these manures mix with concentrate *viz.*, castor or neem cake having higher content of N, releases the available nutrient particularly N at faster rate. Number of experiments were conducted on this line and the results of these experiments indicated that through integration of these manures achieved the yield equivalent to chemical fertilizers (Anon., 2011b). Organic manures are slow release natural fertilizers and also improve the nutrient use efficiency and quality of the crops. Apart from these, it improves the soil physical conditions which are more desirable for tuber crops like onion and more so under high clay containing soils.

It is well known that banana is the heavy feeder crop of nutrients. After harvest of banana, remaining plant parts treated as waste. This contain high amount of essential plant nutrients, which is being lost. By utilising such waste plant material, many useful by-products like fibre, paper, fabrics, organic manure *etc.* can be prepared. While separating fibres from the banana pseudostem, the

liquid available is known as sap which contains good amount of essential macro and micronutrients as well as growth boosters. Salunkhe, (2010) analysed the samples of banana pseudostem for its elemental composition and found that banana pseudostem contained macro elements in the range of 1.00 to 1.12 % N, 0.50 to 0.71 % P, 2.39 to 20.2 % K and micro nutrients in the range of 259 to 323.2 mg/kg Fe, 47.3 to 241.3 mg/kg Mn, 10.1 to 107.4 mg/kg Zn and 13.4 to 83.6 mg/kg Cu. Similarly, vermiwash also contains sugar, proteins, free amino acids, growth hormones like auxin and cytokinin as well as macro and micro nutrients (Gopal *et al.*, 2010 and Tharmaraj *et. al.*, 2011). When it applied to the crops it removes the imbalances in terms of physical, chemical and physiological aspects and harmonizes the basic element which revitalizes the growth process (Natarajan, 2008). However, very limited work on use of banana pseudostem sap and vermiwash has been done. Therefore, present experiment was planned to study the “Effect of Banana Pseudostem Sap and Vermiwash Spray on Yield and Quality of Organically Grown Onion” with the following objectives.

1. To study the effect of banana pseudostem sap and vermiwash spray on yield and yield attributes of onion.
2. To study the effect of banana pseudostem sap and vermiwash spray on quality and nutrient uptake.
3. To workout the economics of different treatments.

II. REVIEW OF LITERATURE

Organic farming is the best option for the enhancement of soil health quality and it also improve the nutritional status of crops. Some of the liquid organic manures like banana pseudostem sap, panchagavya, cow urine *etc.* also known to improve the yield and quality of crops. Review of literature related to effect of liquid organic manures on yield, quality and nutrient uptake by onion and other crops as well as on soil properties are presented in this chapter under following heads.

2.1 Effect on yield and yield attribute:

2.2 Effect on nutrient content and uptake:

2.3 Effect on quality:

2.4 Effect on soil properties:

2.1 Effect on yield and yield attribute:

The liquid organic manures contains small amount of nutrients and growth boosters. When it applied to the crops it removes the imbalances in terms of physical, chemical and physiological aspects and harmonizes the basic element which revitalizes the growth process (Natarajan, 2008). Numbers of experiments were conducted at different places of India to study the effect of liquid organic manures on growth and quality of crops. However, different liquid organic manures are very in their nutrient and biochemical content therefore, variable response of crop to different liquid organic manures will anticipated. The content of liquid organic manures used in different experiments are reviewed and presented in table 1.

Table 1: Content of liquid organic manures

| Particulars | Content (mg/l) | | | | | |
|-----------------|----------------|--------------|------------|---|------------------|-------------------|
| | Sap | Enriched sap | Vermi wash | Cow urine | Cow dung extract | Pancha gavya |
| N | 257.4 | 7900-10700 | 28.0 | 62.12 | 58.20 | 6650 |
| P | 17.6 | 270-274 | 8.0 | 17.30 | 18.20 | 4310 |
| K | 1540 | 1600-1900 | 1088.0 | 42.00 | 46.10 | 5200 |
| S | -- | 130-170 | -- | -- | -- | 0.56 |
| Fe | 6.43 | 44.85 | 0.310 | -- | -- | 142.5 |
| Mn | 5.74 | 13.45 | 1.4775 | -- | -- | 14.8 |
| Zn | 1.64 | 4.44 | 0.479 | -- | -- | 82 |
| Cu | 0.49 | 0.83 | 0.1785 | -- | -- | 58 |
| Cytokinin | -- | 137.8-244.3 | -- | -- | -- | -- |
| GA ₃ | 34 | 180 | -- | -- | -- | -- |
| Total phenol | 21.3 | 48.5 | -- | -- | -- | -- |
| Reference | Anon., (2010) | | | Sivasubramanian and Ganeshkumar, (2004) | | Natarajan, (2008) |

Thanunathan *et al.* (1997) conducted an experiment on effect of different sources and levels of organic manures on growth and yield attributing characters of onion at Annamalai Nagar (TN). Application of soil + mine spoil + coir pith vermicompost (1:1:1) + RDF significantly enhanced plant height (27.2 cm), number of leaves (33.3), and yield per plant (38.5g), as compared to mine spoil alone + RDF.

Jayathilake *et al.* (2002) at Hyderabad studied the effect of integrated nutrient management on growth yield and yield attributing characters of onion. They observed that application of 50% N through vermicompost + 50% N and 100% PK (chemical fertilizer) with the combinations of *Azospirillum* significantly increases bulb yield of onion while combinations of these treatments

with *Azotobactor* significantly increases plant height (60.90 cm), number of leaves per plant (16.19) and leaf area per plant (781.55 cm²) as compared to application of organic manures alone (FYM @ 20 t/ha, VC @ 5 t/ha and FYM @ 10 t/ha).

Abraham and Lal (2003) conducted an experiment on sandy loam soils of Allahabad during *kharif* seasons of 1998 and 1999 to study the effect of INM on yield and yield attributes of green gram. They found higher pods per plant, seed yield and biological yield in the treatment application of farm compost @ 5t/ha + poultry manure @ 1t/ha as compared to control and application of farm compost @ 5t/ha + VC @ 1t/ha. They also found that spraying of biofertilizer + cow urine increase pods/plant, test weight and seed yield as compared to control and spraying of biofertilizer only.

Response of greengram to varied concentration of panchagavya was studied by Somasundaram *et al.* (2003) at Coimbatore. The result indicated that application of panchagavya @ 3% significantly increased grain yield (17.7 q/ha), number of seed per pod (12.1) and 100 grain weight (4.0g) as compared to application of recommended dose of fertilizer.

Sivasubramanian and Ganeshkumar (2004) at Tamil Nadu Agricultural University, Coimbatore conducted a pot trial to study the effect of vermiwash (vermiwash, vermibed extract and vermicast extract) on growth and yield of marigold. The higher plant height, number of leaves, leaf area, flowers per plant and weight of flower was observed in the treatment of vermiwash spray as compared to cow dung extract, cow urine and vermicast extract.

Paramasivam *et al.* (2006) studied the effect of organic manures (poultry manure, pressmud, VC, FYM with and without panchagavya) when applied on N equivalent base on yield and seed quality parameters of groundnut at Coimbatore. They observed higher dry matter production, vigour index and field emergence percentage in the treatment of composted pressmud in both the seasons (*rabi* 2003 and *kharif* 2004) as compared to other organic manures and RDF.

A field experiment was planned at TNAU, Coimbatore by Yadav and Christopher (2006) to study the effect of organic manures and panchagavya spray (made from cow's dung, urine, milk, curd, clarified butter ghee in addition of sugarcane juice, coconut water and riped banana) on yield and yield attributes of rice and economics. The result revealed that the yield components *viz.*, productive tillers/hill, panicle length, filled grain panicle, seed test weight, grain yield and straw yield were found significantly higher in the treatment of panchgavya spray @ 3% as compared to control (without panchagavya).

George *et al.* (2007) studied the effect of vermiwash on chilli at Dharwad. They used three different dilution of vermiwash *viz.* 1:1, 1:2 and 1:4 either with vermicompost @ 2.5 t/ha or neem cake @ 5 t/ha. They found that application of vermicompost @ 2.5 t/ha along with vermiwash 1:1 spray registered significantly maximum dry chilli yield of 2.99 t/ha and plant height of 78.1 cm.

Somasundaram *et al.* (2007) studied the biochemical changes, N flux and yield of crops due to organic sources of nutrients in Maize-Sunflower-Green gram cropping system in sandy clay loam soil of Coimbatore. The soil application of bio-gas slurry

from 3 milch animals with 3% foliar spray of panchagavya recorded significantly higher grain yield of maize, sunflower, green gram as compared to RDF.

Bindumathi Mohan (2008) studied the effect of different organic growth promoters *viz.*, panchagavya (3% and 5%), amrit pani (3% and 5 %), bokashi (750 kg or 1250 kg/ha) on vegetable crops. She observed maximum number of fruits per plant and yield per plant of brinjal in the treatment of bokashi @ 750 kg/ha while in tomato the number of fruits per plant and yield per plant was observed maximum in the treatment of Bokashi @ 1250 kg/ha. However, panchagavya was found the most cost effective as it recorded higher CBR followed by amrit pani and bokashi.

Sanjutha *et al.* (2008) at Coimbatore (Tamil Nadu) carried out an experiment on integrated nutrient management in Kalmegh (*Andrographis paniculata*). They use different organic sources *i.e.* FYM @ 15t/ha, coir compost @ 7 t/ha and vermicompost @ 5 t/ha alone or in combination with panchagavya. They noted that foliar spray of panchagavya @ 3 % in combination with any organic source increases growth and yield of Kalmegh (*Andrographis paniculata*) as compared to application of organic sources alone. However, the highest yield was observed in the treatment of FYM+NPK+Panchagavya.

Kumar *et al.* (2008) studied the effect of organic (vermiwash, goat extract and panchagavya) and inorganic (urea, DAP and KCl) foliar nutrients application on the performance of black gram during summer (2002) at Coimbatore. The result revealed that the higher values of growth and yield parameter *viz.* plant height, leaf area index, dry matter production, number of

flower per plant, number of pods per plant, number of filled grain per pod and grain yield were recorded in the treatment of 1% urea or 2% DAP spray followed by vermiwash spray at floral initiation and 15 days after flowering.

Patil *et al.* (2008) at Rahuri (Maharashtra) conducted field experiment to study the effect of use of manures and fertilizers on yield and quality of soyabean grains. They observed that application of 33t FYM + 8t neem cake/ha significantly increases the grain yield (20.5 q/ha) and straw yield (24.5 q/ha) of soyabean. Whereas, the highest crude protein (19.3%) observed in the treatment received the nutrients based on STCR target 25 q/ha (50:145:43 NPK kg/ha).

Kagne *et al.* (2008) at Akola (Maharashtra) conducted field experiment to study the response of fertilizers and organic manures on growth, yield and quality of sweet sorghum. They found that application of vermicompost @ 2.5 t/ha along with seed treatment of *Azospirillum* and PSB enhanced the growth and quality of sorghum and produced highest seed yield (21.7 q/ha).

Naidu *et al.* (2009) studied the effect of INM on growth, yield and economics of chilli grown in Vertisol of Dharwad. The result revealed that application of 50% RDN + 50% N through FYM + VAM and PSB @ 12.5 kg/ha + panchagavya @ 3% spray recorded significantly higher number of branches/plant, number of fruits/plant, fruit length and fruit yield as compared to RDF. This treatment also registered highest B:C ratio.

Venkatalakshmi *et al.* (2009) studied the effect of foliar application of panchakavya (0, 3 and 6%) on growth, yield attributes and yield of *Amaranthus viride* at Coimbatore. They

observed that foliar application of panchagavya @ 3 % significantly increased number of leaves, LAI, green leaf yield and dry matter yield over control. They also found that increasing level of panchakavya beyond 3 per cent level caused scorching which decreases the photosynthetic area resulted in poor yield.

Venkatalakshmi *et al.* (2009) conducted a field experiment to study the influence of seed treatment (control and seed soaked in panchagavya solution for 6 hours) and foliar spray of panchkavya (3 and 6%) on growth, yield and yield attributes of amaranthus. The result indicated that when panchagavya applied @ 3% and 6% with seed soaking treatment recorded 11 and 9 t/ha green leaf yield, respectively which was significantly higher than other combinations.

Zalate and Padmani (2009) conducted the field exeperiment to study the effect of organic manures (VC 1 and 2 t/ha, FYM 3 and 6 t/ha, CC 0.5 and 1.0 t/ha) and biofertilizers (*Rhizobium* and PSM) on growth and yield attributing characters and yield of groundnut at Rajkot. They found that application of FYM @ 6 t/ha + *Rhizobium* + PSM significantly increased plant height (32.9 cm), pod weight per plant (11.9), seed index (55.3 g) and yield (1278 kg/ha) as compared to RDF.

A field trial to study the effect of banana pseudostem sap and vermiwash on fruit setting in mango was conducted at NAU, Navsari during 2009 to 2011. There were seven treatments comprising of 1% foliar spray of banana pseudostem sap, enriched banana pseudostem sap, vermiwash and its combinations along with control, apply 4 spray *i.e.* at the time of flowering and 25, 50 and 100% flower opening. They observed maximum fruit retention with

the treatment of sap and vermiwash in 1:1 ratio as compared to control. However it was at par with the treatment of enriched sap alone and sap and vermiwash in 2:1 ratio. (Anon, 2011b).

Vennila and Jayanthi (2010) studied the effect of organic foliar spray (2% of microorganism, panchagavya and vermiwash spray) on growth and yield of okra, at TNAU, Tamil Nadu. They found that application of 100% RDF + panchagavya spray @ 2% significantly increased the plant height (131.7 cm), fruit length (21.8 cm), fruit girth (4.66cm), fruit weight (13.9 g /fruit), fruit yield (12.7 q/ha), dry matter production (5.9 g per plant) and number of branches (3.2 per plant) as compared to 100% RDF.

Venkataramana *et al.* (2010) studied the efficacy of foliar sprays of vermiwash and cow dung wash each of at 100, 150 and 200 mg/l concentration on yield of mulberry (*Morus alba* L.). The experiment was conducted on clay loam soil of Vikarabad (AP). The results revealed that application of 200 mg/l vermiwash spray recorded 24.3, 23.5, 85.7 and 29.2 per cent higher value of plant height, length of shoot, number of branches/plant and number of leaves/plant, respectively over control.

Salunkhe (2010) conducted the field experiment, to study the feasibility of using banana pseudostem sap as a liquid fertilizer in onion under drip irrigation at NAU, Navsari. The result revealed that the application of banana pseudostem sap @ 2000 l/ha through micro irrigation system increase the plant height, leaf area per plant, bulb weight, average bulb weight and dry matter yield of onion as compared to control.

Bais *et al.* (2010) at Akola carried out the study on effect of foliar application of cow urine, buffalo urine and panchagavya

each at 2, 4 and 6% on auxin content and IAA oxidase enzyme activity in deshi cotton. They observed that foliar application of 6 % cow urine followed by panchagavya 6 % was found to be superior in increasing the auxin content and reducing activity of IAA oxidase enzyme in shoot tip of cotton. According to them this information becomes useful to increasing the number of branches and productivity of deshi cotton.

Impact of bioregulators (1 to 5% panchagavya, leaf extracts of mukia, moringa, prosopis and root extract of withania at 1 to 5%) on medicinal plant black night shade (*Solanum nigrum*) was studied by Sritharan *et al.* (2010) at Coimbatore. They observed that application of panchagavya 4% foliar spray registered higher dry matter production of 73.1 g/plant followed by moringa 5% foliar spray recording yield of 70.0 g/plant.

Ravichandran *et al.* (2011) studied the effect of panchagavya foliar spray on the yield of potato during summer season of 2004 and 2005 at Muthorai (TN). They observed that highest number of tubers (575000/ha) and tuber yield (28.7 t/ha) in the treatment of 3% spraying of panchagavya at 15 days interval as compared to 3% spraying of panchagavya at 8 days interval and control.

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.

An experiment on evaluation of banana pseudostem sap as liquid fertilizer through drip irrigation in Banana was conducted at Soil and Water Management Research Unit at NAU, Navsari. The result revealed that the higher fruit yield was recorded in the treatment, application of three litre pseudostem sap per plant + 80 % of RDF. It was at par with the treatment, application of 4 litre pseudostem sap + 80 % RDF and 4 litre pseudostem sap + 100 % RDF. Treatment, 4 litre pseudostem sap + 100% RDF recorded significantly more number of fingers per bunch than the remaining treatments. Similar experiment was also conducted on sugarcane and recorded the yield level during first and second year ranging from 140 to 200 t/ha. Through the treatment effect was not significant yet, numerically the cane yield was tended to increase with increase in level of sap application from 5000 l/ha to 15000 l/ha (Anon., 2011b).

Virdia *et al.* (2011) studied the effect of organics (FYM 10 t/ha, sugarcane trash 20 t/ha and biocompost 20t/ha) on paddy – castor cropping system at Vyara (Gujrat). The organics were applied one week before transplanting of paddy. Castor was grown without organic manure to study residual effect. They found that application of biocompost @ 20 t/ha to paddy recorded significantly higher yield attributes and yield of paddy and castor followed by green manuring of dhaincha.

2.2 Effect on nutrient content and uptake:

Somasundaram *et al.* (2007) conducted the field experiment at Coimbatore to study the effect of organic sources of nutrients on N uptake by maize, sunflower and green gram grown in

sequence. The soil of experimental field was moderately deep, well drained sandy clay loam soil with a pH 8.3. The soil was low, medium and high in available N, P, and K, respectively. The result indicated that soil application of bio-gas slurry from 3 milch animals along with 3 % foliar spray of panchagavya recorded significantly higher N uptake by maize, sunflower and green gram as compared to RDF. However, both the treatments remains at par in case of N uptake by green gram.

Sanjutha *et al.* (2008) at Coimbatore (Tamil Nadu) carried out an experiment on integrated nutrient management in Kalmegh (*Andrographis paniculata*). They use different organic sources *i.e.* FYM (15 t/ha), coir compost (7 t/ha) and vermicompost (5 t/ha) alone or in combination with panchagavya. They noted that foliar spray of panchagavya @ 3 % in combination with any organic source increase content and uptake of N, P and K by Kalmegh as compared to application of organic sources alone. However, the highest content and uptake of these nutrients were found in the treatment, FYM + NPK (75-75-50 kg/ha) + Panchagavya.

Naidu *et al.* (2009) at Dharwad (Karnataka) conducted an experiment on chili to study the effect of integrated nutrient management on nutrient uptake and residual fertility. They applied N @ 25, 50 and 100 % of RDN and remaining through FYM and VC with and without BF and panchagavya. They found highest uptake of major and micronutrients by chili in the treatment 50% RDN+50% N through FYM + BF + Panchagavya @ 3% foliar spray.

Venkataramana *et al.* (2010) studied the efficacy of foliar sprays of vermi wash and cow dung wash each of at 100, 150 and 200 mg/l concentration on nutrient content in of mulberry leaves.

The experiment was conducted on clay loam soil of Vikarabad (AP). The soil was deep, moderately drained, low in available N, medium in available P and high in available K and having pH 7.9 and EC 0.11 dS/m. The result revealed that foliar spray of vermiwash @ 200 mg/l significantly increases N, P and K content in mulberry leaves as compared to rest of the treatments.

Sathish and Paramaguru (2010) at Coimbatore conducted trial to study the response of bioregulators on nutrient uptake pattern of turmeric cultivar BSR. They use different bioregulators like panchagavya, vermiwash, humic acid, effective microorganism and recommended dose of fertilizer and found higher content and uptake of N (0.84 % 277.82 kg/ha), P (0.22 % 64.27 kg/ha) and K (0.88 % 270.52 kg/ha) in the treatment of foliar application of humic acid @ 0.05% as compared to foliar application of panchagavya (3 and 4 %), vermiwash (10 and 20 %), EM (1 and 2 %) and control.

2.3 Effect on Quality:

Paramasivam *et al.* (2006) studied the effect of organic sources of nutrients on seed quality characteristics of groundnut at TNAU, Tamil Nadu. There was no significant improvement in oil and protein content in groundnut seed was observed when applied composted poultry manure, composted pressmud or vermicompost on N equivalent base alone or in combination with panchagavya spray @ 3 %.

At Coimbatore, Somasundaram *et al.* (2007) found that application of biogas slurry of 3 milch animal + spray of panchgavya @ 3 % increase soluble protein content of 15.20,

15.93, 16.94 mg/g in maize, sunflower, green gram respectively in both the years (2006 and 2007) as compared to RDF only.

Sanjutha *et al.* (2008) studied an integrated nutrient management in Kalmegh (*Andrographis paniculata*) at Coimbatore. They observed significantly the highest andrographolide content (1.31 %) and yield (8.11 kg/ha) in the treatment of FYM @ 15 t/ha + RDF + panchgavya foliar application @ 3 %. However, the higher content and yield of andrographolide among organic treatments was recorded in the treatment of FYM @ 5 t/ha + panchagavya foliar application @ 3 % as compared to application of only FYM @ 5 t/ha or digested coircompost @ 7 t/ha or vermicompost @ 5 t/ha.

Surekha *et al.* (2009) studied the status of organic farming and research experience in rice. They reported that organic treatment improves the cooking quality in terms of elongation ratio and nutritional quality in terms of P and K content in brown and white rice grown in *kharif* as compared to inorganic treatment. Both the treatments were on par with respect to hulling (%), head rice recovery (%), length/breadth of seed, amylase (%) and protein (%).

Sritharan *et al.* (2010) conducted the experiment on sandy clay loam soil at Coimbatore to study the effect of bioregulators on quality parameters of *Solanum nigrum* and they found that application of panchagavya 4 % enhanced the quality parameters like solasodine, ascorbic acid (34 mg/100g), TSS (9.2) and Total Fenolics (0.697 mg/g) content in fruit as compared to other bioregulators *i.e.* leaf extract of mukia, moringa, prosopis and root extract of withania.

Efficacy of foliar spray of vermiwash and cowdung each at 100, 150 and 200 mg/l on biochemical content of mulberry was

studied by Venkatarmana *et al.* (2010) at Vikarabad (AP). They found improvement in quality of mulberry fruit in terms of chlorophyll a and b, protein and carbohydrate content when applied 200 mg/l vermiwash as compared to control.

2.4 Effect on Soil properties:

(1) Effect on Physical properties:

The field experiment was conducted for five years (2004-05 to 2009-10) covering 10 crop season on deep black clayey Vertisols at Directorate of Rice Research Farm, Hyderabad (AP) to compare organic and conventional system with fine quality rice varieties. After five years they found improvement in physical properties of soil under organic treatment. The values of soil BD under inorganic and organic treatments were 1.48 and 1.30 g/cc, respectively. Whereas, the values of penetration resistance under respective treatments were 11.8 and 7.7 kg/cm². (Surekha *et al.* 2009)

Tharmaraj *et al.* (2011) conducted the experiment to study the influence of vermicompost and vermiwash on physico chemical properties of rice cultivated soil at Annamalainagar (Tamil Nadu). The result revealed that soil application of vermicompost and spray of vermiwash improved physical (water holding capacity, porosity and moisture content), chemical properties (pH and EC) as well as soil fertility (N, P, K, Ca and Mg) over control and its individual application.

(2) Effect on Chemical properties:

Naidu *et al.* (2009) conducted an experiment at Dharwad on chilli to study the effect of integrated nutrient management on

soil fertility. The soil of experimental field was clayey in texture having pH 7.4, EC 0.38 dS/m and OC 0.57%. The treatments consist of different proportion of RDN, FYM, BF with and without panchagavya. They found highest status of major and micronutrients in soil in the treatment, 50% RDN+50% N through FYM + BF + Panchagavya @ 3% foliar spray.

Ansari and Kumar (2010) studied on effect of vermiwash (100 ml/plant), vermicompost (100 g/plant) and cow dung (100 g/plant) on yield of okra and soil parameters. They found the significantly higher content of organic C in the treatment of vermiwash + vermicompost followed by only vermicompost and only cowdung (100 g/plant). However, higher content of N, P, K, Ca, Mg, Fe, Mn, Zn and Cu were observed in the chemical fertilizer treatment followed by treatments of vermiwash + vermicompost.

Ramesh *et al.* (2010) surveyed the certified organic farm of Maharashtra, Karnataka, Tamil Nadu, Kerala, Uttarakhand to ascertain the real benefits and feasibility of organic farming in terms of the production potential, economics and soil health in comparison to the conventional farms. The survey result revealed that there was an all over improvement in soil quality in terms of physical, chemical, fertility and biological properties of soil.

III. MATERIAL AND METHODS

The details of material used and techniques adopted during the course of the present investigation are elaborated in this chapter.

3.1 Materials:

The details of material used in the experiment are given here under.

3.1.1 Experimental site

In order to achieve the objectives of the present investigation, the field experiment was conducted during the *rabi* season of year 2010-11 at the Organic Farm (F Block), Navsari Agricultural University, Navsari. In 2005, the farm was converted to organic since then organic management practices were adopted for raising the crops.

3.1.2 Climate and Weather

This place is situated at 20° 57' N latitude, 72° 54' E longitude and has an altitude of about 10 m above the mean sea level. As per the Agro Climatic Zone of Gujarat, Navsari is placed in South Gujarat Heavy Rainfall Zone, AES-III. The climate of this zone is typically tropical, warm and humid. Monsoon commences by the second fortnight of June and recedes by September end with an average annual rainfall of 1500 mm received entirely from South-West monsoon currents. July and August are the months of heavy precipitation. The winter season commences from November and ceases by the middle of February, whereas the hottest months are March to May.

Table 2: Meteorological data

| Month | Std. Week | Temp. (°C) | | R.H (%) | | Sunshine (hrs) | Wind velocity (km/hr) | Evapo. (mm) |
|----------|-----------|------------|------|---------|------|----------------|-----------------------|-------------|
| | | Max. | Min. | Morn. | Eve. | | | |
| December | 49 | 30.6 | 18.4 | 81.3 | 51.3 | 7.7 | 2.1 | 3.6 |
| | 50 | 27.1 | 10.9 | 81.1 | 32.6 | 8.7 | 3.3 | 2.7 |
| | 51 | 29.8 | 11.3 | 73.0 | 27.6 | 9.4 | 2.7 | 2.8 |
| | 52 | 28.8 | 13.8 | 87.5 | 37.9 | 6.6 | 3.2 | 3.1 |
| January | 1 | 28.0 | 13.5 | 56.7 | 29.0 | 8.5 | 2.6 | 2.7 |
| | 2 | 30.2 | 10.6 | 69.7 | 19.7 | 9.6 | 1.3 | 3.8 |
| | 3 | 29.9 | 10.6 | 82.3 | 24.9 | 9.5 | 1.5 | 3.6 |
| | 4 | 32.2 | 13.1 | 79.7 | 53.1 | 9.3 | 2.2 | 4.1 |
| February | 5 | 32.0 | 14.0 | 73.1 | 33.4 | 9.2 | 2.2 | 4.3 |
| | 6 | 32.5 | 13.8 | 82.1 | 29.4 | 9.3 | 2.3 | 4.3 |
| | 7 | 31.2 | 15.1 | 85.7 | 34.0 | 9.4 | 3.4 | 4.4 |
| | 8 | 31.4 | 13.7 | 74.6 | 42.9 | 9.6 | 4.4 | 4.1 |
| March | 9 | 30.0 | 14.0 | 60.4 | 27.9 | 7.9 | 3.8 | 4.1 |
| | 10 | 34.4 | 15.6 | 75.9 | 23.9 | 8.8 | 3.7 | 5.0 |
| | 11 | 37.6 | 15.9 | 57.3 | 15.3 | 9.6 | 4.3 | 5.3 |
| | 12 | 34.0 | 19.8 | 88.0 | 37.3 | 9.7 | 3.4 | 5.6 |
| | 13 | 36.7 | 19.0 | 76.3 | 39.6 | 9.5 | 1.5 | 6.1 |
| April | 14 | 34.1 | 20.1 | 82.9 | 50.3 | 9.3 | 2.0 | 6.4 |

The average weather data of weekly maximum and minimum temperature, relative humidity, bright sunshine hours and pan evaporation recorded during the experimental period of *rabi* season 2010-11 at the Organic Farm (F Block), Navsari Agricultural University, Navsari are presented in table 2. The range of maximum temperature, minimum temperature, morning and evening relative humidity were 27.1⁰C to 37.6⁰C, 10.6⁰C to 20.1⁰C, 56.7% to 88.0% and 19.7% to 51.3%, respectively. Maximum sunshine hours (9.7), wind velocity (4.3 km/h) and evaporation (6.4 mm) were observed

in months of March-April and minimum sunshine hours (6.6), wind velocity (1.3 km/h) and evaporation (2.7 mm) were observed in months of December-January.

3.1.3 Physico-chemical characteristics of soil

According to the seventh approximation, the soils of the experimental field is classified under the order *Inceptisols* comprising members of fine, montmorillonitic, isohyperthermic family of *Vertic Ustrochrepts* and Jalalpur soil series. The soil develops deep cracks and become extremely hard when dry, while plastic and sticky when wet. The average thickness of solum ranged from 2.5 to 3.0 m. The colour of dry soil is dark brown and texture is clayey. The experimental field had an even topography with gentle slope towards South-West with moderate drainage. The soil of the experimental plot was non-saline and slightly alkaline in reaction, medium in available N and P₂O₅ and high in available K₂O and there was no deficiency of micronutrients. Physico-chemical properties of experimental plot are presented in table 3.

Table 3: Physico-chemical properties of experimental soil (0-15cm)

| Parameters | Value |
|---|--------------|
| (A) Mechanical | |
| Sand (%) | 14.3 |
| Silt (%) | 21.2 |
| Clay (%) | 64.5 |
| (B) Physical | |
| Bulk Density (g/cc) | 1.37 |
| Infiltration rate (mm) | 10.2 |
| Water Stable Aggregates (>1.0 mm) | 50.3 |
| Water Stable Aggregates (0.5-1.0 mm) | 19.6 |
| (C) Chemical | |
| pH _{2.5} | 7.4 |
| EC _{2.5} (dS/m at 25°C) | 0.42 |
| Organic C (%) | 0.74 |
| (D) Nutrients | |
| Available N (kg/ha) | 270.3 |
| Available P ₂ O ₅ (kg/ha) | 43.27 |
| Available K ₂ O (kg/ha) | 326.8 |
| CaCl ₂ S (mg/kg) | 11.4 |
| DTPA Fe (mg/kg) | 14.3 |
| DTPA Mn (mg/kg) | 20.8 |
| DTPA Zn (mg/kg) | 0.63 |
| DTPA Cu (mg/kg) | 2.9 |

3.1.4 Variety

The seed of onion var. pilipati was procured from Research Scientist (Onion and Garlic), Junagadh Agricultural University, Junagadh.

3.1.5 Irrigation water

The crop was irrigated with tube well water. The chemical analysis of irrigation water is presented in table 4. The analysis indicated that it was fairly safe for the purpose of irrigation.

Table 4: Quality of irrigation water used in the experiment

| Sr. No. | Constituents | Value |
|---------|--|-------|
| 1. | Ph | 7.64 |
| 2. | EC (dS/m at 25°C) | 0.95 |
| 3. | Ca + Mg (me/l) | 5.56 |
| 4. | Na (me/l) | 3.39 |
| 5. | Sodium Adsorption Ratio (SAR) | 2.87 |
| 6. | CO ₃ ²⁻ (me/l) | Nil |
| 7. | HCO ₃ ⁻ (me/l) | 4.98 |
| 8. | Chloride (me/l) | 3.84 |
| 9. | Residual Sodium Carbonate (RSC) (me/l) | Nil |

3.1.6 Solid organic manure

For supplying RDN (125 kg/ha), bio-compost, vermicompost and castor cake were used. Chemical composition of these manures are given in table 5.

Table 5: Chemical composition of solid organic manures

| Manures | N | P | K | Fe | Mn | Zn | Cu |
|---------------|------|------|------|---------|-----|----|----|
| | (%) | | | (mg/kg) | | | |
| Bio compost | 1.74 | 1.03 | 1.41 | 2460 | 144 | 56 | 17 |
| Vermi compost | 1.32 | 0.72 | 1.13 | 1240 | 84 | 36 | 14 |
| Castor Cake | 4.63 | 1.90 | 1.42 | 876 | 46 | 52 | 29 |

3.1.7 Liquid organic manure

Chemical composition of liquid organic manure *i.e.*

experiment banana pseudostem sap, enrich banana pseudostem sap and vermiwash used in the experiment are given in table 6.

Table 6: Chemical composition of liquid organic manures

| Manures | Content of nutrients (mg/l) | | | | | | |
|------------------------------|-----------------------------|-------|--------|-------|------|------|------|
| | N | P | K | Fe | Mn | Zn | Cu |
| Banana pseudostem sap | 70.0 | 26.1 | 1700 | 7.44 | 2.66 | 0.40 | 0.26 |
| Enrich banana pseudostem sap | 1140 | 280.3 | 1166 | 86.09 | 6.73 | 4.61 | 0.97 |
| Vermiwash | 57.4 | 5.3 | 1088.1 | 3.51 | 1.48 | 0.48 | 0.19 |

3.2 Methods

The details of the experimental techniques employed for the present investigation are described here.

3.2.1 Preparation of planting layout

After achieving of good tilth through harrowing and planking, raised beds each of 1.2 m width were prepared. The plot size was 3.6 x 3.0 m therefore, three raised bed each of 1.2 m width and 3 m length were included in one plot and there were total 21 plots in the experiment (Fig 2 and Plate 1).



Plate 1: General view of experimental plot

3.2.2 Experimental details

(a) Treatment details

Seven treatment combinations involving foliar application of banana pseudostem sap, enriched banana pseudostem sap, vermiwash and combinations of sap along with control treatment *i.e.* water spray were used in this treatment. The treatment details are given as under:

T₁: Control

T₂: Banana pseudostem sap @ 2% spray

T₃: Enriched banana pseudostem sap @ 2% spray

T₄: Vermiwash @ 2% spray

T₅: T₂ and T₃ in 2 :1 ratio

T₆: T₂ and T₃ in 1 :2 ratio

T₇: T₂ and T₃ in 1 :1 ratio

- (b) Experimental design** : RBD
- (c) Replications** : Three
- (d) Plot size** : **Gross** : 3.6 m X 3.0 m
Net : 1.2 m X 2.2 m
- (e) Number of plots** : 21
- (f) Spacing** : 15 cm X 10 cm
- (g) Crop/Variety** : Onion cv. Local Pili Patti

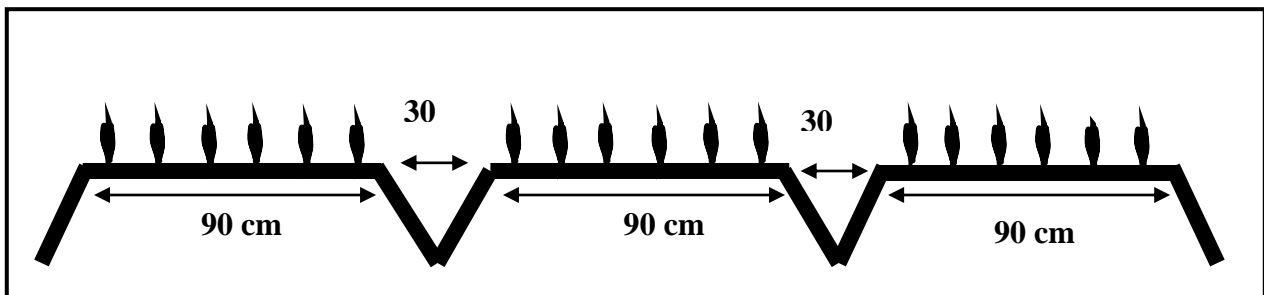


Fig 3: Schematic diagram of raised bed

3.2.3 Sowing of seed

Raised bed of 1.0 m width and 10 m length was prepared and sowing was done through broadcasting methods (Plate 2).



Plate 2: Onion nursery

3.2.4 Transplanting

The wet transplanting of 35 days old healthy onion seedling was done on 3/12/2010 at the spacing of 15 X 10 cm on raised beds.

3.2.5 Application of solid organic manure

Common dose of RDN (125 kg/ha) was applied through BC, CC and VC in equal proportion. Twenty one kilogram of N was applied from each source at the time of transplanting and same dose was repeated at one month after transplanting.

3.2.6 Application of liquid manure

As per the treatments 2% banana pseudostem sap, enriched banana pseudostem sap and vermiwash were prepared by mixing 2 ml of liquid organic manure in 100 ml of water and combinations of sap were prepared as follows.

| Ratio | Sap (ml) | Enriched sap (ml) | Water (ml) |
|-----------------------|-----------------|--------------------------|-------------------|
| 2:1 (T ₅) | 1.3 | 0.7 | 100 |
| 1:2 (T ₆) | 0.7 | 1.3 | 100 |
| 1:1 (T ₇) | 1.0 | 1.0 | 100 |

The liquid manures were applied at 15 days interval starting from 15 days after transplanting *i.e.* 15, 30 and 45 days after transplanting.

3.2.7 Irrigations

At the time of transplanting and one week after transplanting, total 2 irrigations were given through surface method of irrigation. Subsequent irrigations were given through drip method. In this method one lateral was placed in middle of each bed having dripper of 8l/h discharge rate and placed at 50 cm space. The system was operated at alternate day for 3.5 to 4 hours (plate 3).

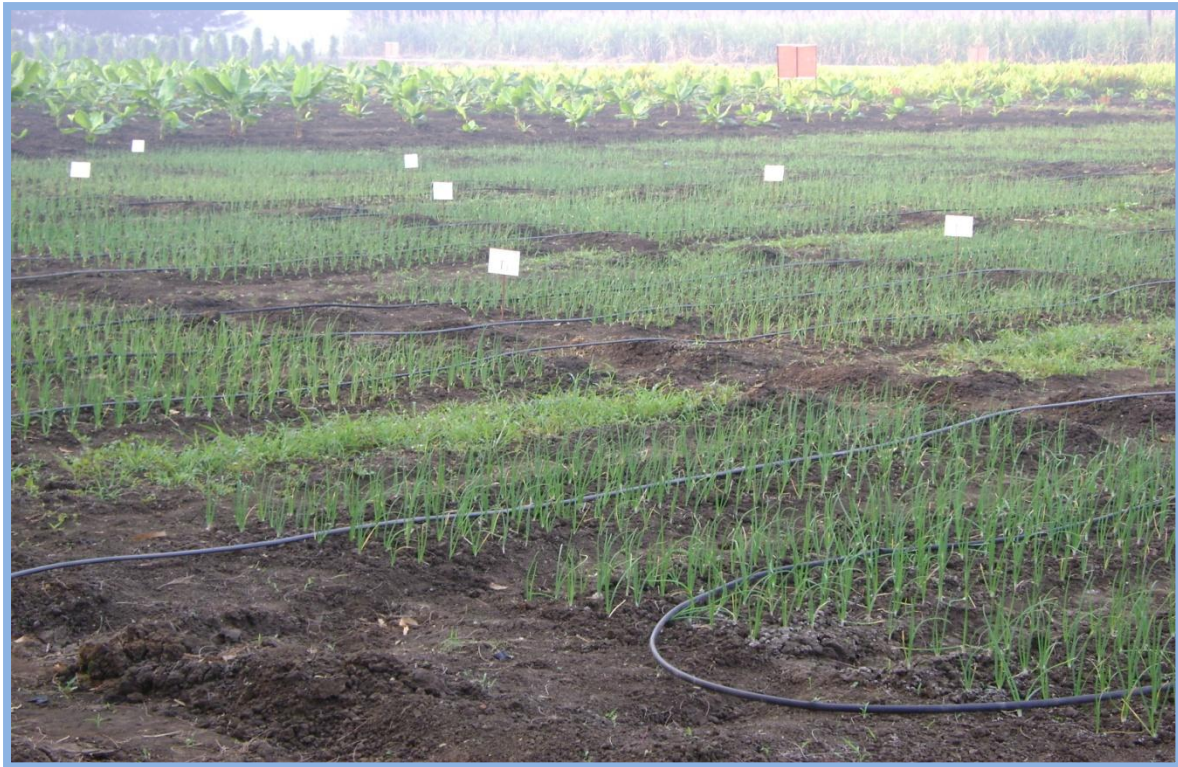


Plate 3: Drip irrigation in onion

3.2.8 Weeding

Attempts were made to keep the experimental field free from weeds throughout the crop season. Therefore, manual weeding was carried out as and when required.

3.2.9 Plant protection

Serious problem of pest and disease was not observed. To minimize the problem of sucking pest, trap crop maize was grown on border of the experiment.

3.2.10 Harvesting

Onion bulbs were harvested manually on 4-4-2011 at maturity. The bulbs and leaves were separated by using sickle and plot wise weight of bulbs and leaves of net area were recorded separately.

3.3 Observations

For biometric observations, 5 plants were randomly selected and tagged in net plot area.

3.3.1 Growth and yield attributes

(a) Average bulb weight

Bulb weight (g) of tagged plants from each plot was recorded using digital balance at the time of harvesting and average weight was computed.

(b) Bulb equatorial and polar diameter

Equatorial and polar diameter (cm) of 10 bulbs from each plot was measured using vernier calliper after harvest of crop (Plate 4).



Plate 4: Measurement of equatorial and polar diameter

(c) Dry matter yield

Leaves of selected plants were dried in sunlight for suitable period whereas bulb was dried in oven at 65⁰ C and weight was measured in gram with the help of digital weighing balance. Based on this, the ratio of fresh and dry weight of bulbs and leaves was worked out. This ratio was used to convert fresh weight into dry weight and the dry weight is reported in kg/ha.

(d) Number of leaves

Treatment wise numbers of leaves/plant of tagged plants were measured at 30, 60 and 90 days after transplanting.

(e) Plant height (cm)

Plant height (cm) of tagged onion plants was measured at 30, 60 and 90 days after transplanting using scale.

3.3.2 Quality parameter

(a) Total soluble solids

Total soluble solid (TSS) was determined from fresh onion bulb samples with the help of hand refractometer.

(b) Bolting percentage

The treatment wise bolted plants per net plot were recorded and reported in percentage.

(c) Pyruvic acid

(d) Bulb neck thickness

Bulb neck thickness of selected plants was measured by vernier calliper in mm.

3.3.3 Plant analysis

(a) Preparation of samples:

The leaves and bulbs of tagged plants from each plot were taken and dried at $60 \pm 2^{\circ}\text{C}$ temperature in oven. After drying, the powder was prepared in mixer and preserved in polythene bag for subsequent chemical analysis.

b) Chemical analysis:

For plant chemical analysis, 0.5g of plant sample was digested in diacid mixture of HNO₃ and HClO₄ in ratio of 10:4 till it become colourless. The digest was then transferred in 100 ml volumetric flask and made volume up to the mark. Except N, the nutrients under study were analyses from this extract. The chemical analysis was carried out by using methods as mentioned in table 7.

Table: 7 Methods used for plant analysis

| Nutrient | Method employed | Reference |
|--------------------|---|---------------------------|
| N | Micro Kjeldahl (H ₂ SO ₄ :H ₂ O ₂) | Warnke and Barber (1974) |
| P | Spectro photometer | Jackson (1973) |
| K | Flame photometer | Jackson (1973) |
| S | Turbidimetric method | Chesnin and Yien (1950) |
| Fe, Mn, Zn and Cu, | Atomic absorption spectrophotometer (AAS) | Elwell and Gridley (1967) |
| TSS | Hand refractometer | Chopra and Kanwar (1980) |

3.3.4 Soil analysis

(a) Sampling and sample preparation

Representative soil samples were collected at the depth of 0-15 cm from each plot after harvest of crop and dried in shed. After drying, the samples were grind in wooden mortar and pestle and sieved through 0.5 to 2 mm sieve according to the requirement of analysis. The soil analysis was carried out by using standard procedure (Table 8).

Table: 8 Methods used for soil analysis

| Nutrient | Method employed | Reference |
|-------------------------|--|---------------------------|
| Organic C | Walkley and Black rapid titration method | Jackson(1973) |
| Available N | Alkaline KMnO ₄ | Subbiah and Asija (1956) |
| Available P | Olsen | Jackson (1973) |
| Available K | 1N NH ₄ OAc | Jackson (1973) |
| CaCl ₂ -S | CaCl ₂ extractable | Chesnin and Yien (1950) |
| DTPA Fe, Mn, Zn and Cu, | DTPA extractable | Elwell and Gridley (1967) |
| BD | Core method | Black (1965) |

3.3.5 Nutrient Uptake

The uptake of different nutrients by onion leaves and bulbs were computed on dry weight basis by using the following formula.

$$\text{Uptake of NPK (kg/ha)} = \frac{\text{Content (\%)} \times \text{Yield (kg/ha)}}{100}$$

$$\text{Uptake of micronutrient (g/ha)} = \frac{\text{Content (mg/kg)} \times \text{Yield (kg/ha)}}{1000}$$

3.4 Statistical method used

The data pertaining to biometric observations, quality parameters, nutrient content and uptake by plant and available nutrient status of soil were subjected to statistical analysis. The statistical analysis was carried out as per the methods described by Panse and Sukhatme (1967).

3.5 Economics

The gross income in terms of rupees per hectare was worked out by taking into consideration the bulb yield from each treatment and their prevailing market prices. Similarly, the cost of cultivation of the crop for the respective treatment was also worked out by considering the expenses on labour, cultivations, seed, irrigations, solid and liquid organic manures *etc* (Table 9). The profit was worked out by subtracting gross income from cost of cultivation and ratio of gross income and cost of cultivation was worked out to calculate benefit cost ratio (BCR).

Table 9: Input price

| Sr.No. | Particulars | Cost Rs. |
|---|---|-----------------|
| (A) Common cost: | | |
| 1 | Land preparation (1 ploughing and 1 harrowing) | 3000 |
| 2 | Onion seeds (6 kg/ha) | 1200 |
| 3 | Irrigation | 13500 |
| 4 | Sowing of seeds (15 labour/ha) | 1000 |
| 5 | Bio-compost (2.5t) | 1150 |
| 6 | Vermicompost (3.3t) | 9900 |
| 7 | Castorcake (0.9t) | 5760 |
| 8 | Transplanting (20 labour) | 2400 |
| 9 | Hand weeding (25 labour/ha) | 3000 |
| 10 | Interculturing (10 labour) | 1200 |
| 11 | Harvesting and cleaning (45 labours/ha) | 5400 |
| | Total fixed cost..... | 47510 |
| (B) Treatment cost: | | |
| 1 | T ₂ : Banana pseudostem sap @ 2% spray 18 litre | 810 |
| 2 | T ₃ : Enriched banana pseudostem sap @ 2% spray 18 litre | 2520 |
| 3 | T ₄ : Vermiwash @ 2% spray 18 litre | 1260 |
| 4 | T ₅ : T ₂ and T ₃ in 2 :1 ratio 18 litre | 1950 |
| 5 | T ₆ : T ₂ and T ₃ in 1 :2 ratio 18 litre | 1380 |
| 6 | T ₇ : T ₂ and T ₃ in 1 :1 ratio 18 litre | 1665 |
| (C) Rates used for cultivation and inputs: | | |
| 1 | Tractor Ploughing (Rs./ha) | 2400 |
| 2 | Tractor Harrowing and planking (Rs/ha) | 600 |
| 3 | Labour charges (Rs./day) | 120 |
| 4 | Irrigation/hr | 30 |
| 5 | Biocompost (Rs./t) | 460 |
| 6 | Vermicompost (Rs./t) | 3000 |
| 7 | Castor cake (Rs./t) | 6400 |
| 8 | Vermiwash 660 ml used (Rs./l) | 30 |
| 9 | Banana pseudostem sap (Rs./l) | 5 |
| 10 | Enrich banana pseudostem sap (Rs./l) | 100 |
| 11 | Onion seed (Rs./kg) | 200 |
| (D) Selling price of produce: (bulb Rs/kg) | | 5.0 |

IV. EXPERIMENTAL RESULTS

In order to accomplish the objectives of present investigation, a field experiment entitled “**Effect of Banana Pseudostem Sap and Vermiwash Spray on Organically Grown Onion**” was conducted at Organic Farm (F Block), NAU, Navsari during *rabi* season of 2010-11. Total seven treatments comprising of T₁: Control, T₂: Banana pseudostem sap @ 2 % spray, T₃: Enriched banana pseudostem sap @ 2 % spray, T₄: Vermiwash @ 2 % spray, T₅: T₂ and T₃ in 2:1 ratio, T₆: T₂ and T₃ in 1:2 ratio and T₇: T₂ and T₃ in 1:1 ratio were tested using RBD with three replications. In all treatments, 33.3 % of RDN (125 kg/ha), each from BC, CC and VC was applied in two equal splits *i.e.* at TP and one month after TP. Three sprays of liquid manures were given at 15 days interval after transplanting. The data pertaining to yield and yield attributes, quality, nutrient uptake and the economics of different treatments recorded during the course of investigation were statistically analysed for the test of significance and are presented in this chapter. Broadly, this chapter is divided into following subheads.

4.1 Growth parameters

4.2 Yield parameters

4.3 Quality parameters

4.4 Nutrient content

4.5 Nutrient uptake

4.6 Available nutrients in soil

4.7 Soil physical properties

4.1 Growth parameters

Growth parameters such as plant height and number of leaves were recorded at 30, 60 and 90 days after transplanting. The results of these parameters are presented in tables 10 and 11.

4.1.1 Plant height

The results pertaining to the effect of different treatment on periodical plant height are presented in table 10. The plant height recorded at 30 DATP was found significantly higher in the treatment T₃ but it was remains at par with treatment T₂, T₆, and T₇. While minimum plant height was observed in the treatment T₁. Plant height recorded at 60 and 90 DATP was not affected significantly due to the application of liquid organic manures. However, in both the period maximum plant height was observed in the treatment T₃.

4.1.2 Number of leaves/plant

The results data presented in table 11 showed that the effect of different treatments on the number of leaves/plant. None of the treatment showed significant effect on number of leaves recorded on 30 and 60 DATP. At 90 DATP, the experimental plot receiving treatment T₃ recorded the significantly higher number of leaves (9.7) but it was at par with the treatment T₁ (9.3) and T₇ (9.0).

Table 10: Effect of different treatments on plant height (cm) of onion

| Treatments | 30 DATP | 60 DATP | 90 DATP |
|----------------------|----------------|----------------|----------------|
| T₁ | 28.1 | 52.7 | 60.7 |
| T₂ | 31.7 | 48.0 | 62.3 |
| T₃ | 36.2 | 58.3 | 62.7 |
| T₄ | 29.8 | 52.0 | 60.3 |
| T₅ | 30.7 | 48.7 | 60.0 |
| T₆ | 34.0 | 50.3 | 63.3 |
| T₇ | 31.9 | 47.7 | 57.3 |
| S.Em. ± | 1.5 | 3.3 | 2.8 |
| C.D. at 5 % | 4.6 | NS | NS |
| C.V. % | 8.2 | 11.0 | 7.9 |

Table 11: Effect of different treatments on number of leaves per plant of onion

| Treatments | 30 DATP | 60 DATP | 90 DATP |
|----------------------|----------------|----------------|----------------|
| T₁ | 4.7 | 6.0 | 9.3 |
| T₂ | 4.7 | 7.3 | 8.3 |
| T₃ | 5.3 | 7.7 | 9.7 |
| T₄ | 5.3 | 6.7 | 8.0 |
| T₅ | 4.7 | 7.0 | 8.3 |
| T₆ | 5.0 | 6.7 | 7.3 |
| T₇ | 5.3 | 6.7 | 9.0 |
| S.Em. ± | 0.6 | 0.4 | 0.4 |
| C.D. at 5 % | NS | NS | 1.3 |
| C.V. % | 20 | 11 | 8 |

4.2 Yield parameters

Yield contributing parameters such as equatorial and polar diameter of bulb were measured at harvest of the crops and results are presented in table 12.

4.2.1 Equatorial and polar diameter of bulb

The results pertaining to the effect of different treatments on equatorial and polar diameter of bulb were presented in table 12. The result revealed that significantly higher equatorial (6.64 cm) and polar (4.96 cm) diameter of bulb were observed in the treatment T₃ (Enriched banana pseudostem sap @ 2% spray) which was significantly higher than control (T₁) only. The minimum equatorial (5.29 cm) and polar (3.90) diameter of bulb was recorded with treatment T₁ (Control).

4.2.2 Average bulb weight

Plot wise average bulb weight from 10 bulbs was calculated and analysed statistically. The result is presented in table 12. Average bulb weight was affected significantly due to different treatments and significantly higher bulb weight was recorded in treatment T₃ (68.1 g). This treatment remains at par with treatment T₇ recorded average bulb weight of 62.4 g.

4.2.3 Yield

The dry matter yield of bulb and leaves (Table 13) was not affected significantly due to different treatments but comparatively higher dry matter yield of bulb (5383kg/ha) and leaves (4950 kg/ha) were recorded in the treatment T₃ (Enriched banana pseudostem sap @ 2% spray). As far as bulb yield is concerned, the treatment effect was found significant and significantly higher bulb yield of 43.7 t/ha was recorded in the treatment T₃. However, it was remain at par with treatment T₇ and recorded bulb yield of 40t/ha. The minimum bulb yield of 35.9 t/ha was recorded in treatment T₁.

Table 12: Effect of different treatments on yield attributes of onion

| Treatments | Bulb equatorial (cm) | Bulb polar (cm) | Average bulb weight (g) |
|----------------------|-----------------------------|------------------------|--------------------------------|
| T₁ | 5.29 | 3.90 | 55.9 |
| T₂ | 6.53 | 4.82 | 60.1 |
| T₃ | 6.64 | 4.96 | 68.1 |
| T₄ | 5.91 | 4.36 | 56.9 |
| T₅ | 6.43 | 4.74 | 57.9 |
| T₆ | 6.19 | 4.56 | 57.1 |
| T₇ | 6.63 | 4.89 | 62.4 |
| S.Em. ± | 0.3 | 0.2 | 2.0 |
| C.D. at 5 % | 0.8 | 0.6 | 6.2 |
| C.V. (%) | 7 | 8 | 6 |

Table 13: Effect of different treatments on dry and fresh yield of onion

| Treatments | Dry yield of bulb (kg/ha) | Dry yield of leaves (kg/ha) | Bulb yield (t/ha) |
|----------------------|----------------------------------|------------------------------------|--------------------------|
| T₁ | 4232 | 4146 | 35.9 |
| T₂ | 4308 | 4337 | 38.5 |
| T₃ | 5383 | 4950 | 43.7 |
| T₄ | 4310 | 4318 | 36.5 |
| T₅ | 4373 | 3929 | 37.1 |
| T₆ | 4406 | 4394 | 36.6 |
| T₇ | 4709 | 4551 | 40.0 |
| S.Em. ± | 258 | 215 | 1.5 |
| C.D. at 5 % | NS | NS | 4.6 |
| C.V. (%) | 10 | 9 | 7 |

4.3 Quality parameters

To study the effect of different treatments on crop quality treatment wise, some of the quality related parameters were

determined and then statistically analysed. The results are presented in table 14.

Table 14: Effect of different treatments on quality parameters of onion

| Treatments | Bulb neck thickness (cm) | Bolting (%) | TSS (%) | Pyruvate (μ moles/g) |
|----------------|--------------------------|-------------|---------|---------------------------|
| T ₁ | 1.2 | 2.2 | 11.4 | 4.7 |
| T ₂ | 1.4 | 3.1 | 12.2 | 5.5 |
| T ₃ | 1.5 | 3.0 | 13.4 | 5.9 |
| T ₄ | 1.2 | 2.3 | 11.8 | 4.7 |
| T ₅ | 1.4 | 1.9 | 12.5 | 4.7 |
| T ₆ | 1.4 | 2.4 | 11.8 | 5.7 |
| T ₇ | 1.5 | 2.7 | 12.8 | 6.3 |
| S.Em. \pm | 0.1 | 0.4 | 0.5 | 0.6 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 10.5 | 29.3 | 7.3 | 19.5 |

The quality parameters like bulb neck thickness and bolting percentage were recorded in field, while TSS and pyruvic acid content in bulb were determined in laboratory and the results are presented in table 14. The treatments were failed to change the value of quality parameter significantly. However, the narrower bulb neck thickness was recorded in treatment T₁ and T₄ (1.2 cm) and lower bolting percentage was recorded in treatment T₅ (1.9%). The higher TSS content was recorded in treatment T₃ (13.4%) whereas, higher pyruvic acid content was recorded in treatment T₇ (6.3 μ moles/g).

4.4 Nutrient content

Major, Secondary and Micronutrients *i.e.* N, P, K, S, Fe, Mn, Zn and Cu from dry leaves and bulbs of onion were determined after harvest of crop to know the effect of different treatment on

content of these nutrients. The results are presented in tables 15 to 18.

4.4.1 Major nutrient content in leaves

The results presented in table 15 regarding N, P, K and S content in leaves, indicated non-significant effect of different treatments on these nutrient content. Eventhough, higher N of 0.82% was recorded in treatment T₂, higher P content of 0.28% and K content of 1.28% were recorded in treatment T₆, whereas higher S of 0.18% was recorded in treatment T₁ and T₅.

Table 15: Effect of different treatments on major nutrient content (%) in leaves of onion

| Treatments | N | P | K | S |
|----------------|------|-------|------|------|
| T ₁ | 0.80 | 0.27 | 1.24 | 0.18 |
| T ₂ | 0.77 | 0.26 | 1.20 | 0.15 |
| T ₃ | 0.82 | 0.26 | 1.13 | 0.14 |
| T ₄ | 0.76 | 0.22 | 1.07 | 0.15 |
| T ₅ | 0.64 | 0.25 | 1.14 | 0.18 |
| T ₆ | 0.77 | 0.28 | 1.28 | 0.16 |
| T ₇ | 0.77 | 0.21 | 1.14 | 0.14 |
| S.Em. ± | 0.04 | 0.02 | 0.07 | 0.01 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 9.29 | 12.60 | 9.86 | 14.1 |

4.4.2. Micronutrient content in leaves

Effect of different treatments on Fe, Mn and Cu content in leaves of onion was not significant but its effect on Zn content was significant (Table 16). Treatment T₃ (Enriched banana pseudostem sap @ 2% spray) recorded significantly higher content of Zn (21.5 mg/kg) which was at par with the treatments T₅ (20.7 mg/kg), T₆ (19.8 mg/kg) and T₇ (19.6 mg/kg). Minimum Zn content

in leaves recorded in treatment T₁ *i.e.* 16.5 mg/kg. The treatment effect on other micronutrients was not significant however, maximum Fe content (325 mg/kg) was recorded in the treatment T₃ whereas, Mn and Cu recorded in the treatment T₅ (65.3 and 11.5 mg/kg).

Table 16: Effect of different treatments on micro nutrient content (mg/kg) in leaves

| Treatments | Fe | Mn | Cu | Zn |
|----------------------|-----------|-----------|-----------|-----------|
| T₁ | 272 | 55.9 | 10.2 | 16.5 |
| T₂ | 308 | 63.6 | 11.6 | 21.0 |
| T₃ | 325 | 65.1 | 11.0 | 21.5 |
| T₄ | 293 | 60.7 | 10.4 | 19.1 |
| T₅ | 310 | 65.3 | 11.5 | 20.7 |
| T₆ | 305 | 61.8 | 10.8 | 19.8 |
| T₇ | 296 | 65.2 | 10.9 | 19.6 |
| S.Em. ± | 11 | 2.9 | 0.5 | 0.7 |
| C.D. at 5 % | NS | NS | NS | 2.1 |
| C.V. % | 6.5 | 8.0 | 7.9 | 5.9 |

4.4.3 Major nutrient content in bulb

The results pertaining to the major and secondary nutrients like N, P, K and S contents in bulb revealed that there was no significant effect of different treatments on content of these nutrients in bulb. Comparatively, treatment T₁ recorded the higher N (1.08%), P (0.33%), K (1.13%) and S (0.18%) content (Table 17).

Table 17: Effect of different treatments on major nutrient content (%) in bulb

| Treatments | N | P | K | S |
|----------------------|----------|----------|----------|----------|
| T₁ | 1.08 | 0.33 | 1.13 | 0.18 |
| T₂ | 0.92 | 0.31 | 1.05 | 0.17 |
| T₃ | 0.98 | 0.31 | 0.87 | 0.16 |
| T₄ | 0.92 | 0.26 | 0.93 | 0.16 |
| T₅ | 1.03 | 0.30 | 1.00 | 0.18 |
| T₆ | 0.93 | 0.33 | 1.13 | 0.17 |
| T₇ | 0.91 | 0.26 | 1.00 | 0.15 |
| S.Em. ± | 0.07 | 0.02 | 0.07 | 0.01 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 12.52 | 14.09 | 12.51 | 12.47 |

4.4.4 Micronutrient content in bulb

The result regarding the micronutrient content in bulbs like Fe, Mn, Zn and Cu revealed that only Mn content in bulbs was significantly affected by the different treatments (Table 18). The highest Mn content in the bulbs was observed in the treatment T₃ (42.2 mg/kg) which was at par with the treatment T₂ (40.6 mg/kg), T₄ (38.2 mg/kg), T₅ (41.2 mg/kg), T₆ (39.3 mg/kg) and T₇ (42.0 mg/kg). None of the treatments showed significant effect on Fe, Zn and Cu content. However, the maximum Zn (22.7mg/kg) and Cu (16.1mg/kg) content was recorded in the treatment T₅ while treatment T₃ recorded the maximum Fe content (208 mg/kg).

Table 18: Effect of different treatments on micro nutrient content (mg/kg) in bulb

| Treatments | Fe | Mn | Zn | Cu |
|----------------------|-----------|-----------|-----------|-----------|
| T₁ | 175 | 34.3 | 18.4 | 14.4 |
| T₂ | 197 | 40.6 | 22.0 | 15.3 |
| T₃ | 208 | 42.2 | 22.2 | 15.4 |
| T₄ | 188 | 38.2 | 21.1 | 14.5 |
| T₅ | 199 | 41.2 | 22.7 | 16.1 |
| T₆ | 195 | 39.3 | 21.7 | 15.1 |
| T₇ | 189 | 42.0 | 21.3 | 14.9 |
| S.Em. ± | 7.2 | 1.5 | 0.8 | 0.6 |
| C.D. at 5 % | NS | 4.5 | NS | NS |
| C.V. % | 6.5 | 6.4 | 6.8 | 7.3 |

4.5 Nutrient uptake

Major (N, P and K), Secondary (S) and Micronutrients (Fe, Mn, Zn and Cu) content in leaves and bulbs were multiply with respective dry matter yield to calculate the uptake of different nutrients by leaves and bulbs. Then calculate the total uptake by summing the uptake of leaves and bulbs. The results regarding uptake of different nutrients by leaves, bulbs and their total are presented in tables 19 to 23.

4.5.1 Major and secondary nutrients uptake by leaves

The results presented in table 19 are of N, P, K and S uptake by leaves. Among these, only N uptake by leaves was affected significantly. The treatment T₃ recorded significantly higher N uptake *i.e.* 40.5 kg/ha but was remains at par with all the treatment except treatment T₅. There were no any significant differences in all the treatments regarding P, K and S uptake by leaves. However, treatment T₃, T₆ and T₁ recorded higher P, K and S uptake, respectively.

Table 19: Effect of different treatments on uptake of major and secondary nutrient (kg/ha) by leaves.

| Treatments | N | P | K | S |
|----------------------|----------|----------|----------|----------|
| T₁ | 33.3 | 10.8 | 51.4 | 7.2 |
| T₂ | 33.4 | 11.4 | 52.2 | 6.7 |
| T₃ | 40.5 | 13.1 | 55.5 | 7.0 |
| T₄ | 33.0 | 9.4 | 46.1 | 6.7 |
| T₅ | 25.0 | 10.0 | 44.5 | 6.9 |
| T₆ | 33.7 | 12.3 | 56.4 | 7.1 |
| T₇ | 35.2 | 9.4 | 52.2 | 6.6 |
| S.Em. ± | 2.5 | 0.9 | 4.1 | 0.6 |
| C.D. at 5 % | 7.8 | NS | NS | NS |
| C.V. % | 13.1 | 14.9 | 14.0 | 15.6 |

Table 20: Effect of different treatments on micro nutrient uptake (g/ha) by leaves.

| Treatments | Fe | Mn | Zn | Cu |
|----------------------|-----------|-----------|-----------|-----------|
| T₁ | 1129 | 231 | 68.1 | 42.1 |
| T₂ | 1336 | 276 | 90.8 | 50.3 |
| T₃ | 1611 | 321 | 106.4 | 54.5 |
| T₄ | 1265 | 262 | 82.6 | 44.9 |
| T₅ | 1219 | 257 | 81.5 | 45.3 |
| T₆ | 1337 | 271 | 86.6 | 47.4 |
| T₇ | 1346 | 297 | 88.9 | 49.5 |
| S.Em. ± | 85.8 | 15.3 | 3.4 | 2.8 |
| C.D. at 5 % | 264 | 47 | 10.4 | NS |
| C.V. % | 11.3 | 9.7 | 6.8 | 10.2 |

4.5.2 Micronutrient uptake by leaves

The results pertaining to the effect of different treatments on uptake of Fe, Mn and Zn revealed that except uptake of Cu, uptake of all the micronutrients by leaves were influenced

significantly due to different treatments (Table 20). The significantly higher uptake of Fe (1611 g/ha), Mn (321 g/ha) and Zn (106.4 g/ha) by leaves was recorded in treatment T₃. However, in case of Mn uptake by leaves, this treatment remains at par with treatment T₂ (276 g/ha) and T₇ (297 g/ha).

4.5.3 Major and secondary nutrients uptake by bulb

The effect of different treatments related to foliar application of liquid organic manures on N, P, K and S uptake by bulb was studied. The results related to these are presented in table 21. The results indicated that none of the major and secondary nutrients were affected significantly due to different treatments. In majority of the cases, higher uptake of these nutrients was recorded in treatment T₃.

4.5.4 Micronutrient uptake by bulbs

The treatment effect on micronutrient uptake by bulb was more or less similar to that observed in major nutrient uptake by bulbs. But, Mn uptake was affected significantly due to different treatments (Table 22). Significantly higher Mn uptake was observed in the treatment T₃ (226 g/ha) which was remains at par with the treatment T₇. Though the treatment effect on Fe, Zn and Cu uptake by bulbs was non-significant but this treatment (T₃) recorded the comparative higher value of uptake of these micronutrients by bulbs.

Table 21: Effect of different treatments on major and secondary nutrient uptake (kg/ha) by bulb

| Treatments | N | P | K | S |
|----------------------|----------|----------|----------|----------|
| T₁ | 45.4 | 13.7 | 47.8 | 7.6 |
| T₂ | 40.0 | 13.6 | 45.4 | 7.3 |
| T₃ | 52.8 | 16.9 | 47.2 | 8.3 |

| | | | | |
|----------------------|------|------|------|------|
| T₄ | 39.8 | 11.1 | 40.5 | 7.0 |
| T₅ | 45.0 | 13.1 | 43.5 | 7.9 |
| T₆ | 40.6 | 14.5 | 49.6 | 7.6 |
| T₇ | 42.6 | 12.4 | 47.0 | 7.1 |
| S.Em. ± | 3.7 | 1.7 | 4.6 | 0.8 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 14.8 | 21.3 | 17.5 | 17.7 |

Table 22: Effect of different treatments on micronutrient uptake (g/ha) by bulb

| Treatments | Fe | Mn | Zn | Cu |
|----------------------|-----------|-----------|-----------|-----------|
| T₁ | 740 | 145 | 78.0 | 60.7 |
| T₂ | 858 | 176 | 95.7 | 66.5 |
| T₃ | 1121 | 226 | 119.4 | 82.8 |
| T₄ | 809 | 164 | 90.9 | 62.7 |
| T₅ | 869 | 181 | 99.7 | 70.7 |
| T₆ | 859 | 173 | 95.6 | 66.6 |
| T₇ | 892 | 198 | 100.4 | 70.2 |
| S.Em. ± | 70.4 | 11.4 | 8.1 | 5.2 |
| C.D. at 5 % | NS | 35 | NS | NS |
| C.V. % | 13.9 | 11.0 | 14.4 | 13.2 |

4.5.5 Total uptake of major and secondary nutrients

The results regarding uptake of major and secondary nutrients by individual components *i.e.* leaves and bulbs were non-significant in almost all cases. This was reflected in results of total uptake (Table 23). Here, the total uptake of N, P, K and S were not affected significantly. However, treatment T₃ (Enriched banana pseudostem sap @ 2% spray) recorded higher total N, P and S uptake *i.e.* 93.3, 30.0 and 15.3 kg/ha, respectively. But treatment T₆ recorded the higher total K uptake *i.e.* 106 kg/ha.

Table 23: Effect of different treatments on total uptake of major and secondary nutrient (kg/ha) by onion

| Treatments | N | P | K | S |
|----------------------|----------|----------|----------|----------|
| T₁ | 78.7 | 24.5 | 99.2 | 14.8 |
| T₂ | 73.4 | 25.1 | 97.5 | 14.0 |
| T₃ | 93.3 | 30.0 | 102.7 | 15.3 |
| T₄ | 72.8 | 20.5 | 86.6 | 13.7 |
| T₅ | 70.0 | 23.1 | 88.0 | 14.8 |
| T₆ | 74.4 | 26.8 | 106.0 | 14.7 |
| T₇ | 77.8 | 21.8 | 99.3 | 13.6 |
| S.Em. ± | 4.9 | 2.4 | 8.1 | 1.3 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 10.9 | 17.1 | 14.5 | 15.5 |

4.5.6 Total uptake of micronutrients

The results obtained in the study regarding total uptake of micronutrients (Table 24) revealed that the total uptake of Fe, Mn, Zn and Cu were affected significantly due to different treatments. The onion receiving treatment T₃ removes higher amount of Fe (2731 g/ha), Mn (547 g/ha), Zn (226 g/ha) and Cu (137 g/ha). However, this treatment remains at par with treatment T₇ in case of total uptake of Mn and Cu by onion.

Table 24: Effect of different treatments on total uptake of micronutrient (g/ha) by onion

| Treatments | Fe | Mn | Zn | Cu |
|----------------------|-----------|-----------|-----------|-----------|
| T₁ | 1869 | 376 | 146 | 103 |
| T₂ | 2194 | 452 | 187 | 117 |
| T₃ | 2731 | 547 | 226 | 137 |
| T₄ | 2073 | 426 | 174 | 108 |
| T₅ | 2088 | 438 | 181 | 116 |
| T₆ | 2196 | 444 | 182 | 114 |
| T₇ | 2238 | 495 | 189 | 120 |

| | | | | |
|--------------------|-------|------|-----|-----|
| S.Em. ± | 142.5 | 24.1 | 9.2 | 6.1 |
| C.D. at 5 % | 439 | 74 | 28 | 19 |
| C.V. % | 11.2 | 9.2 | 8.6 | 9.1 |

4.6 Available nutrient content in soil

After harvest of the crop, plot wise representative soil samples from 0-15 cm depth were collected and analysed for organic C and available major, secondary and micronutrient to monitor the changes that occur due to different treatments. The results are presented in tables 25 and 26.

4.6.1 Major available nutrient content in soil

Different treatments were failed to change the content of organic C, as well as the content of available major and secondary nutrients (N, P₂O₅, K₂O and S) in the soil significantly (Table 25).

4.6.2 Micronutrient content in soil

The data regarding the DTPA extractable Fe, Mn, Zn and Cu content in soil at harvest of onion are presented in table 26. Similar to the content of major nutrient in soil, treatment effect on content of micronutrient in soil was non-significant.

Table 25: Effect of different treatments on organic carbon and major available nutrient content in soil at harvest

| Treatment | O.C. (%) | Available N (kg/ha) | Available P₂O₅ (kg/ha) | Available K₂O (kg/ha) | CaCl₂ S (mg/kg) |
|----------------------|-----------------|----------------------------|---|---|-----------------------------------|
| T₁ | 0.83 | 278 | 51.2 | 330 | 12.8 |
| T₂ | 0.88 | 268 | 48.1 | 336 | 13.1 |
| T₃ | 0.86 | 307 | 53.8 | 365 | 13.2 |
| T₄ | 0.81 | 293 | 45.5 | 347 | 13.2 |
| T₅ | 0.85 | 287 | 47.0 | 323 | 13.1 |
| T₆ | 0.75 | 297 | 45.9 | 303 | 13.1 |
| T₇ | 0.87 | 305 | 55.0 | 349 | 12.5 |
| S.Em. ± | 0.031 | 14.9 | 4.1 | 13.8 | 0.7 |

| | | | | | |
|--------------------|-----|-----|-----|-----|-----|
| C.D. at 5 % | NS | NS | NS | NS | NS |
| C.V. % | 6.4 | 8.9 | 9.3 | 7.1 | 9.9 |

Table 26: Effect of different treatments on micro nutrient content (mg/kg) in soil at harvest

| Treatments | Fe | Mn | Zn | Cu |
|----------------------|-----------|-----------|-----------|-----------|
| T₁ | 14.2 | 21.7 | 0.52 | 3.5 |
| T₂ | 13.3 | 22.1 | 0.62 | 3.8 |
| T₃ | 15.6 | 22.7 | 0.57 | 3.4 |
| T₄ | 14.6 | 21.2 | 0.58 | 3.2 |
| T₅ | 15.3 | 21.0 | 0.56 | 3.0 |
| T₆ | 14.2 | 22.2 | 0.58 | 3.0 |
| T₇ | 11.8 | 18.4 | 0.62 | 3.4 |
| S.Em. ± | 1.5 | 2.1 | 0.06 | 0.3 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 18.1 | 17.0 | 19.0 | 17.3 |

4.7 Physical properties of soil

The result regarding physical properties *i.e.* BD, IR and WSA are presented in table 27.

The results pertaining to the effect of different treatments on physical properties of soil such as BD, IR and WSA are given in table 27. The results revealed that these parameters were not affected significantly due to different treatments. The value of BD under different treatments was in the range of 1.22 to 1.42 g/cc whereas, IR was in the range of 9.6 to 10.7 mm/hr. The range of WSA of >1.0 and 0.5-1.0 mm size was 50.0 to 53.6% and 20.4 to 22.3%, respectively.

Table 27: Effect of different treatments on physical properties of soil at harvest

| Treatments | BD (g/cc) | IR (mm/hr) | WSA (%) | |
|----------------------|----------------------|-----------------------|------------------------|-----------------------|
| | | | > 1.0 mm | 0.5-1.0 mm |
| T₁ | 1.29 | 9.8 | 51.3 | 20.8 |
| T₂ | 1.36 | 10.5 | 50.0 | 20.4 |
| T₃ | 1.22 | 10.7 | 51.7 | 22.3 |
| T₄ | 1.39 | 10.4 | 51.1 | 22.1 |
| T₅ | 1.42 | 10.4 | 52.3 | 21.1 |
| T₆ | 1.42 | 9.6 | 53.6 | 20.8 |
| T₇ | 1.33 | 10.2 | 52.9 | 21.6 |
| S.Em. ± | 0.06 | 1.0 | 3.9 | 1.8 |
| C.D. at 5 % | NS | NS | NS | NS |
| C.V. % | 7.66 | 16.7 | 13.1 | 14.4 |

V. DISCUSSION

In order to accomplish the objectives (i) To study the effect of banana pseudostem sap and vermiwash spray on yield and yield attributes of onion, (ii) To study the effect of banana pseudostem sap and vermiwash spray on quality and nutrient uptake and (iii) Work out the economics of different treatments, a field experiment “Effect of Banana Pseudostem Sap and Vermiwash Spray on Yield and Quality of Organically Grown Onion” was conducted using RBD with 3 replications at Organic Farm, NAU, Navsari during *rabi* season of 2010-11. There were seven treatments comprising of T₁: Control, T₂: Banana pseudostem sap @ 2% spray, T₃: Enriched banana pseudostem sap @ 2% spray, T₄: Vermiwash @ 2% spray, T₅: T₂ and T₃ in 2:1 ratio, T₆: T₂ and T₃ in 1:2 ratio and T₇: T₂ and T₃ in 1:1 ratio. The results regarding treatment effect on growth and yield, nutrient content and uptake and soil properties are presented in earlier chapter and in this chapter an attempts is made to justify the results with suitable reasoning and supported by earlier work. For convenience, this chapter is divided under following subheads.

5.1 Growth and Yield

5.2 Quality parameters

5.3 Nutrient content

5.4 Nutrient uptake

5.5 Soil fertility

5.6 Soil physical properties

5.7 Economics

5.1 Growth and yield parameter

The results pertaining to the effect of different treatment on plant height and number of leaves recorded at 30, 60 and 90 DATP are presented in table 10 and 11. Among these, plant height at 30 DATP and number of leaves at 90 DATP were affected significantly (Figs. 4 and 5) and higher values of both the parameters were observed in treatment T₃. Similarly, yield parameters like bulb equatorial and polar diameters and average bulb weight were affected significantly due to different treatments and same treatment gave bigger and heavier bulb (Table 12 and Fig. 6 to 8). The liquid organic manures contains small amount of essential nutrients (Table 1 and 6) and growth boosters and these constituents are known to have positive effect on growth and yield attributes of the crops. This was the possible reason for increasing the growth and yield of onion under liquid manure treatments. It is evident from table 16 and 18 that application of liquid organic manures increases the content of micronutrients in leaves and bulb of onion. However, significant increase due to the treatments was only observed in case of Zn content in leaves and Mn content in bulb (Tables 16 and 18). To study the feasibility of foliar applied organic liquid manures on crops, numbers of experiments were conducted such as Venkataramana *et al.* (2010) use vermi wash and cow dung wash on mulberry at Vikarabad (AP) and Venkatalakshmi *et al.* (2009) use panchgavya on amaranthus at Coimbatore (TN).

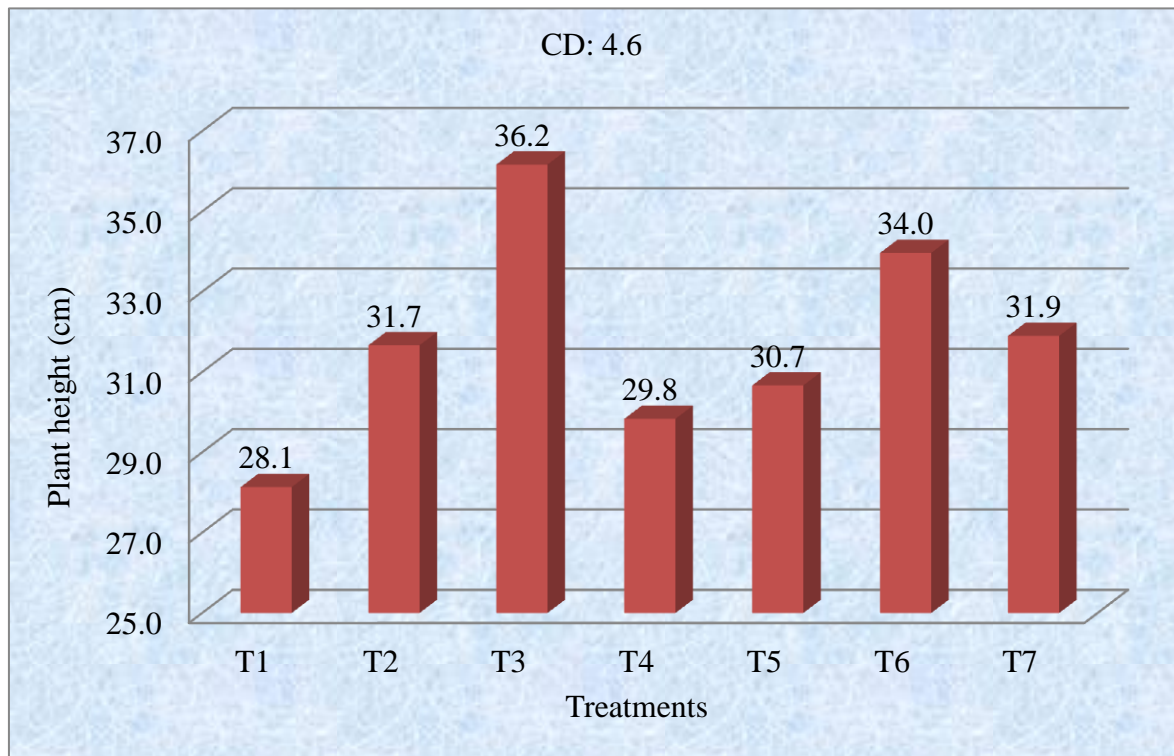


Fig. 4 Effect of different treatments on plant height at 30 days after transplanting

The results of these experiments indicated that application of liquid organic manures improves the growth and yield attributes. Natarajan, (2008) also suggested that the liquid organic manures contains small amount of nutrients and growth boosters. When it applied to the crops it removes the imbalances in terms of physical, chemical and physiological aspects and harmonizes the basic element which revitalizes the growth process.

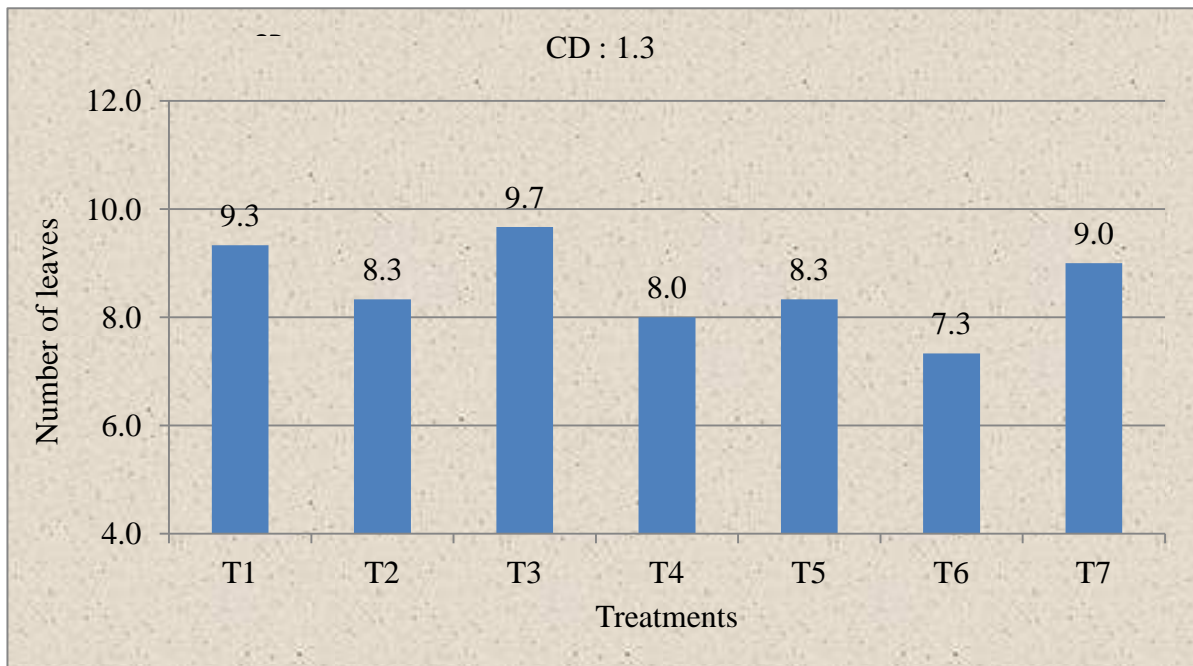


Fig. 5 Effect of different treatments on number of leaves at 90 days after transplanting

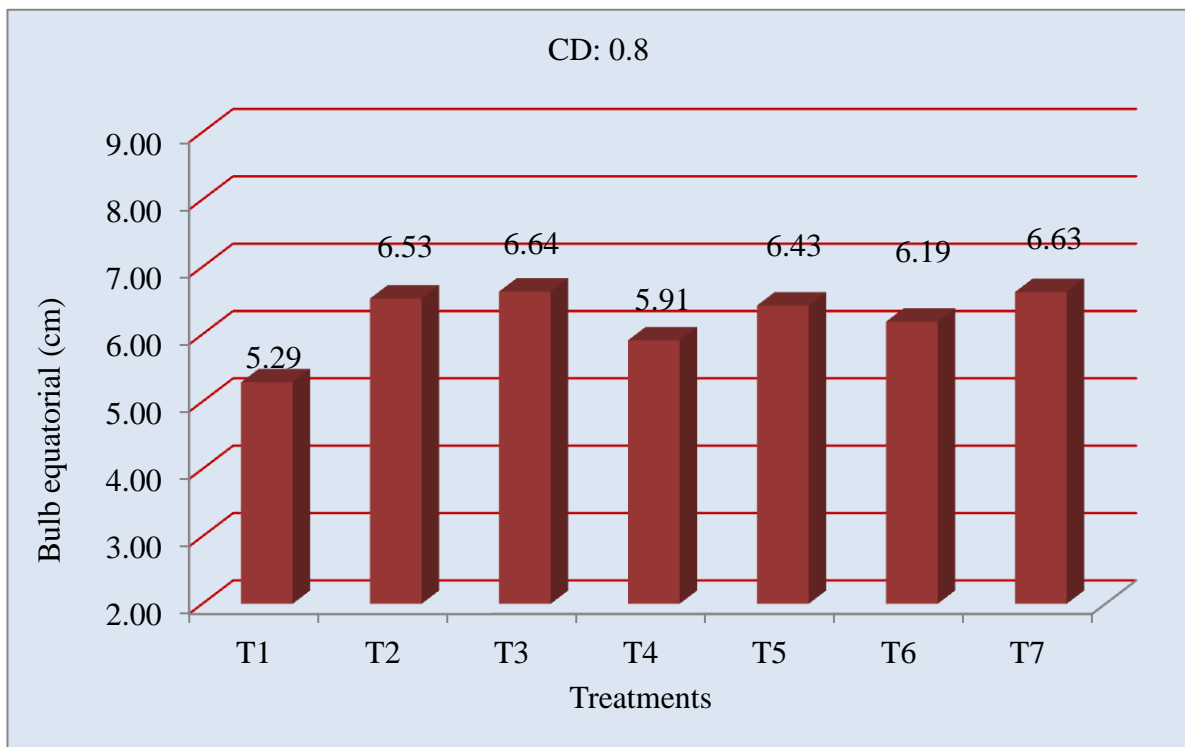


Fig. 6 Effect of different treatments on bulb equatorial (cm)

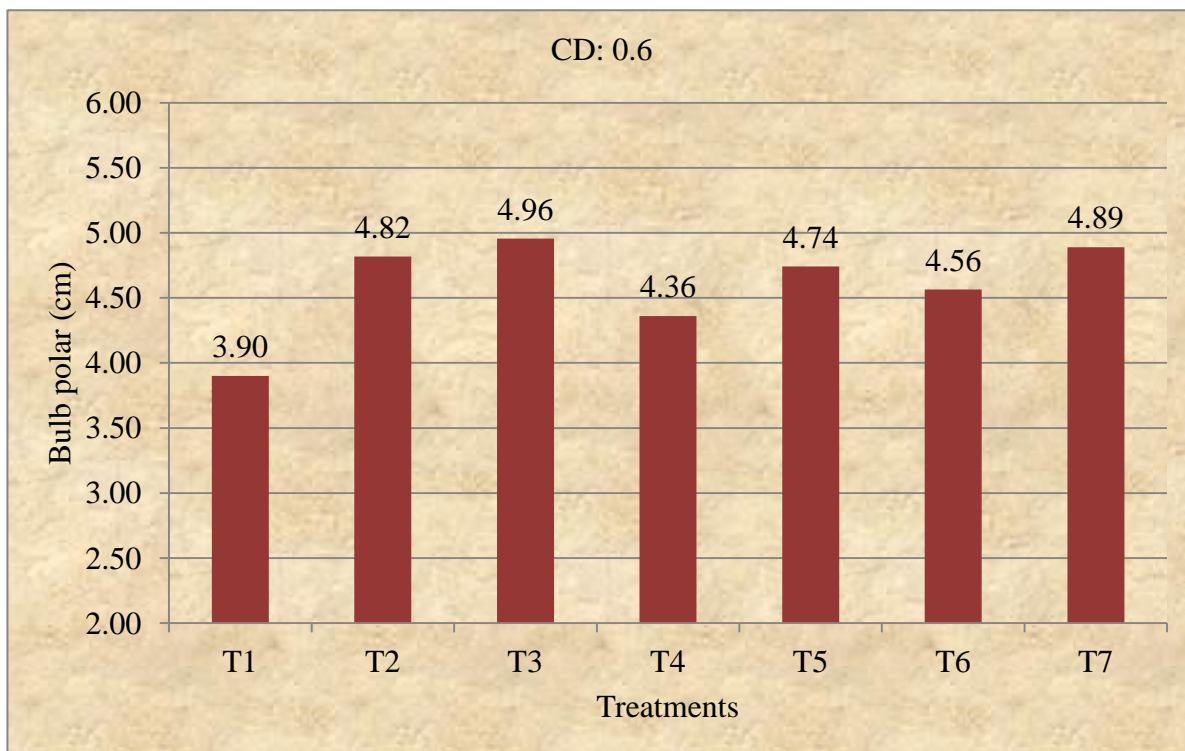


Fig. 7 Effect of different treatments on bulb polar (cm)

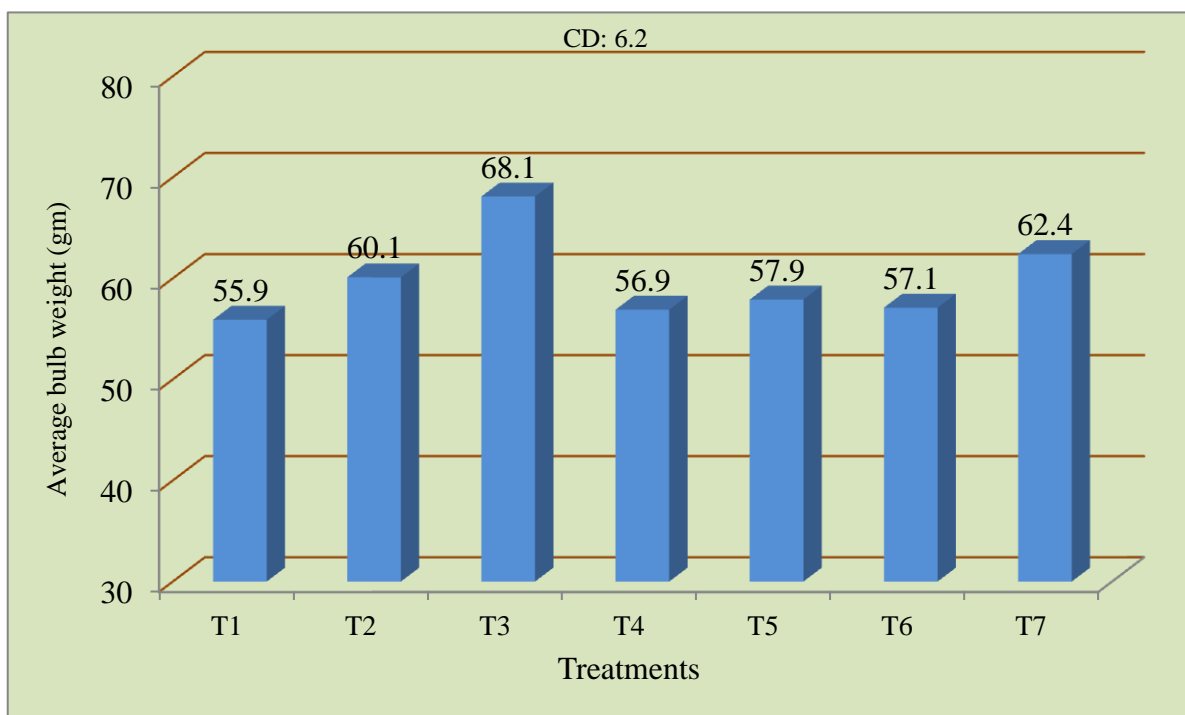


Fig. 8 Effect of different treatments average bulb weight

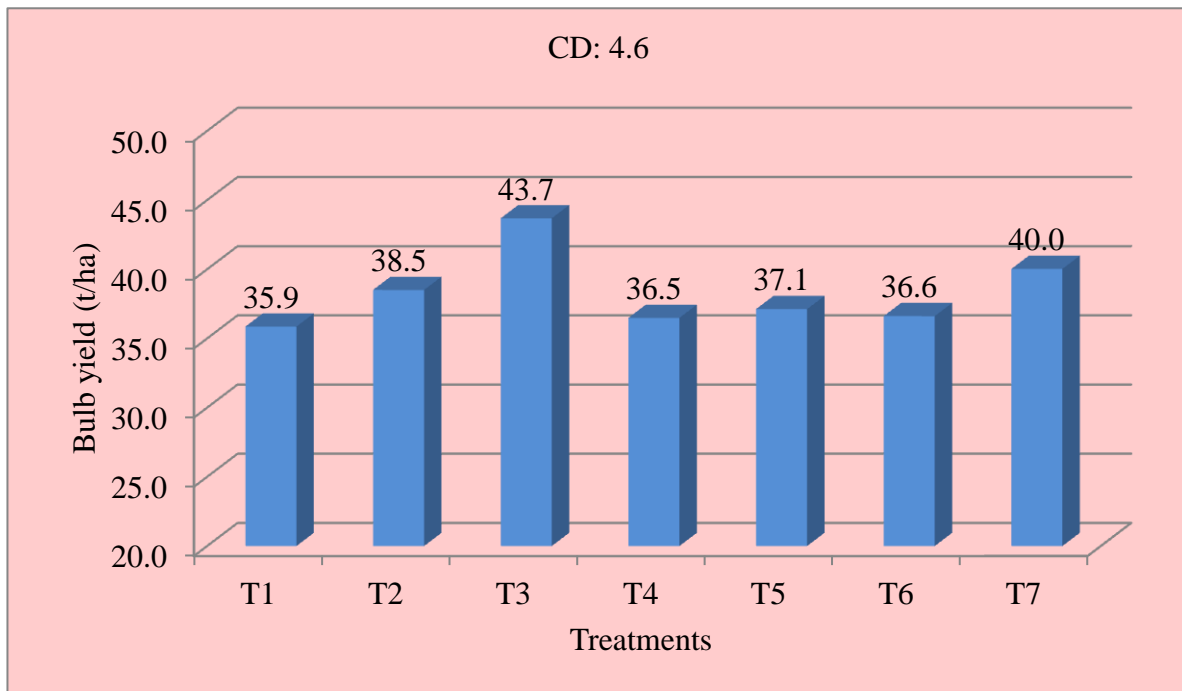


Fig. 9 Effect of different treatments on bulb yield (t/ha)

Dry matter yield of leaves and bulb and bulb yield recorded after harvest of the crop and results are presented in table 13. Among these, bulb yield was affected significantly and significantly higher bulb yield was recorded in treatment T₃ but it was remain at par with treatment T₇. In general, application of liquid organic manures improves the bulb yield as compared to control. The final yield is depending upon the growth and yield attributes of the crop. Here, the growth and yield parameters such as number of leaves, plant height and polar and equatorial diameter of bulb and average bulb weight had positive correlation with bulb yield (Table 28). This indicated that cumulative positive effect of liquid organic manures on these parameters finally results in good yield. The result of experiment conducted at SWMRU, NAU, Navsari also proved that foliar application of enriched sap @ 2% to mango increase the fruit retention and yield of mango fruit (Anon., 2010)

Table 28: Correlation coefficient between growth and yield attributing with bulb yield.

| Parameters | Correlation coefficient |
|-----------------------|--------------------------------|
| No. of leaves 30 DATP | 0.16 |
| No. of leaves 60 DATP | 0.60** |
| No. of leaves 90 DATP | 0.43* |
| Plant height 30 DATP | 0.48* |
| Plant height 60 DATP | 0.37 |
| Plant height 90 DATP | 0.09 |
| Bulb equatorial | 0.38 |
| Bulb polar | 0.39 |
| Average bulb weight | 0.49* |

5.2 Quality parameters

The quality parameters such as bulb neck thickness, bolting percentage and total sugar and pyruvic acid content in bulb were not affected significantly (Table 14). However, the value of these quality parameters were higher where the treatments receiving liquid organic manures. This could be due to the quality of crops is governed by the genetical traits and under normal condition it is not changed (Spangler *et al.* 2012).

5.3 Nutrient content

The content of plant nutrients *viz.*, N, P, K, S, Fe, Mn, Zn and Cu were determined separately from leaves and bulb of onion (Tables 15 to 18). Among these, Zn content in leaves (Fig. 10) and Mn content in bulb (Fig. 11) was affected significantly. As compared to control, the significantly higher content of these micronutrients were recorded in treatment T₃. Almost all treatments receiving liquid organic manures remain at par with each other.

Now, looking to the results regarding content of major, secondary and micronutrients, treatment had pronounce effect on micronutrients content in leaves and bulb of onion. This could be due to higher utilization rate of micronutrients than macronutrients. According to Oosterhuis (2009), the higher utilization rate of micronutrients than macronutrients are mainly due to (i) The majority of pores are small in size and are readily accessible to low molecular weight solutes but not to larger molecules such as synthetic chelates and phosphates, (ii) These pores are lined with negative charges increasing in density from the outside to the inside of the cuticle, which facilitates the movement of cations along this gradient. Absorption of cations like Fe, Mn, Zn and Cu, therefore, is faster than anions like NO_3 and SO_4 . Cristensen (2005) reported that the use of foliar spray with macronutrients like N and K_2O has shown limited benefits when compared to micronutrients because of higher requirement, therefore, many applications is required.

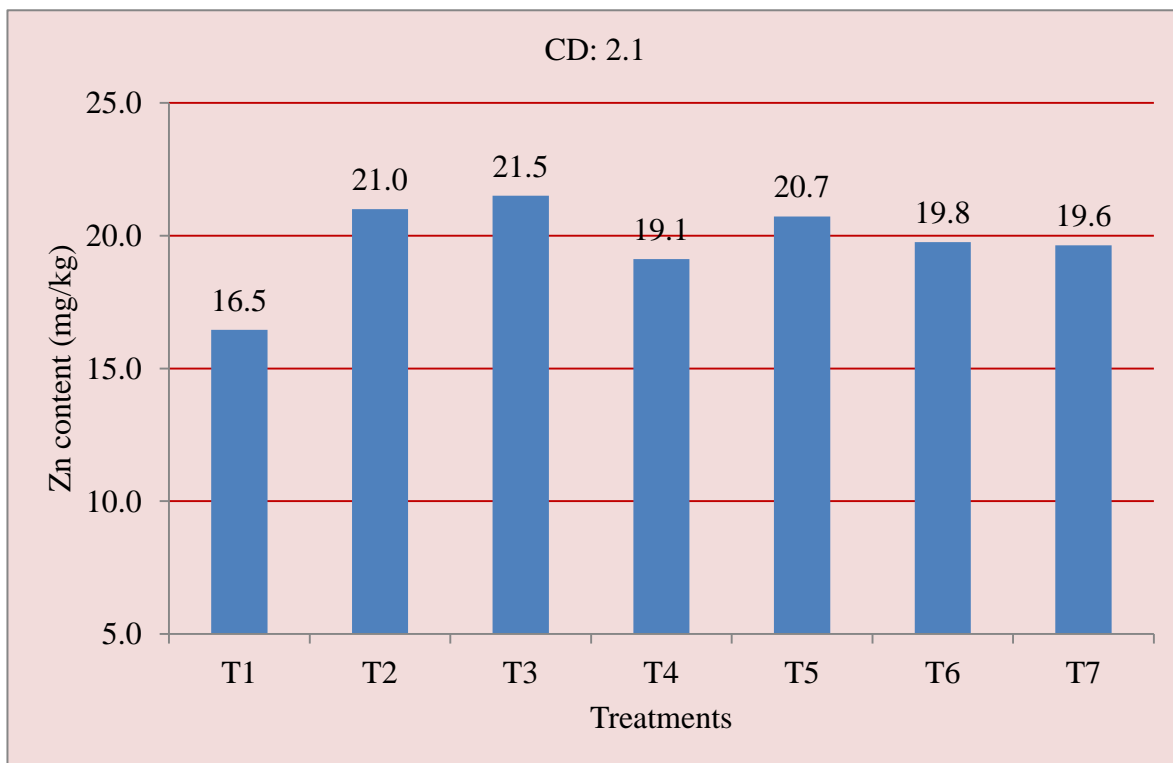


Fig. 10 Effect of different treatments on Zn content (mg/kg) in leaves

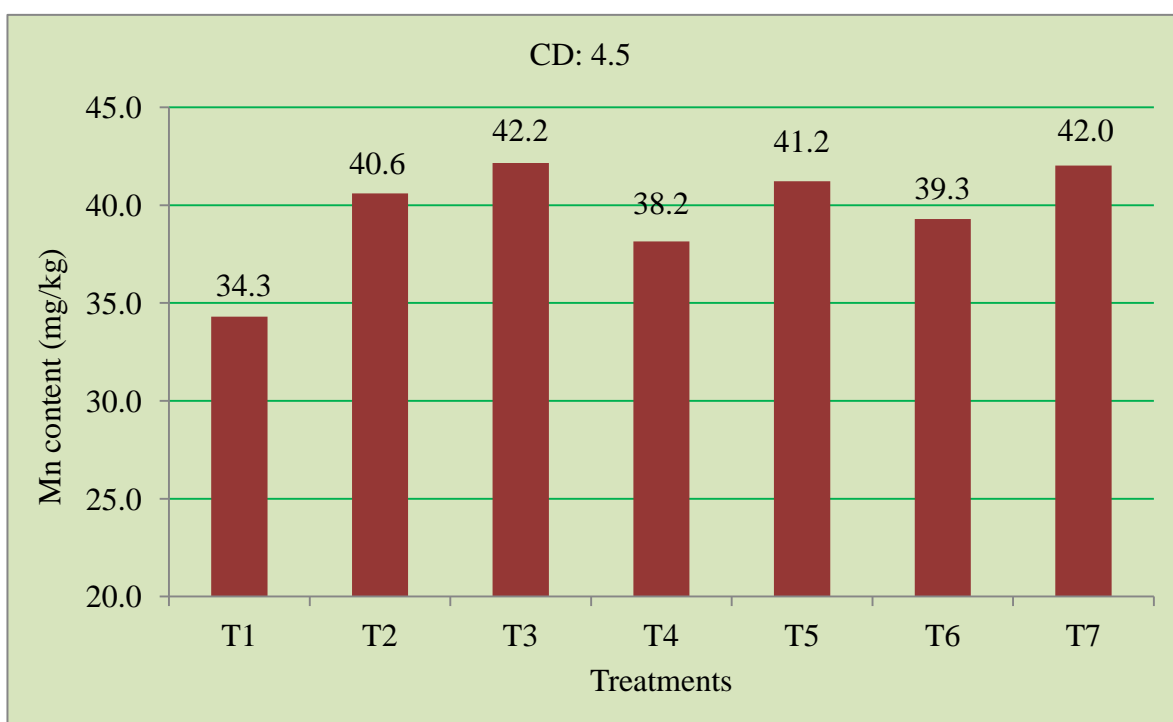


Fig. 11 Effect of different treatments on Mn content (mg/kg) in bulb

5.4 Nutrient uptake

Nutrients uptake by leaves and bulb and their total uptake were calculated from the content of nutrient and respective dry biomass yield. The nutrient requirement of crops was ultimately reflected on total uptake value therefore the effect of different treatments on total uptake by onion is discussed here. Among the total uptake of major (N, P and K) secondary (S) and micronutrients (Fe, Mn, Zn and Cu), only micronutrients uptake were affected significantly (Table 24 and Figs. 12 to 15) and treatment T₃ recorded significantly higher uptake in majority of the cases as compared to rest of the treatments. Treatment T₃ absorb 3.4 to 22.4 per cent higher major and secondary nutrients and 33.0 to 54.8 per cent higher micronutrients as compared to control (Table 29).

Table 29: Per cent increase of total uptake of nutrients over respective control

| Nutrients | Total uptake | | Per cent increase |
|---------------------------------------|--------------|---------|-------------------|
| | Enriched sap | Control | |
| N (kg/ha) | 93.3 | 78.7 | 18.6 |
| P ₂ O ₅ (kg/ha) | 30.0 | 24.5 | 22.4 |
| K ₂ O (kg/ha) | 102.7 | 99.2 | 3.5 |
| S (kg/ha) | 15.3 | 14.8 | 3.4 |
| Fe (g/ha) | 2731 | 1869 | 46.1 |
| Mn (g/ha) | 547 | 376 | 45.4 |
| Zn (g/ha) | 226 | 146 | 54.8 |
| Cu (g/ha) | 137 | 103 | 33.0 |

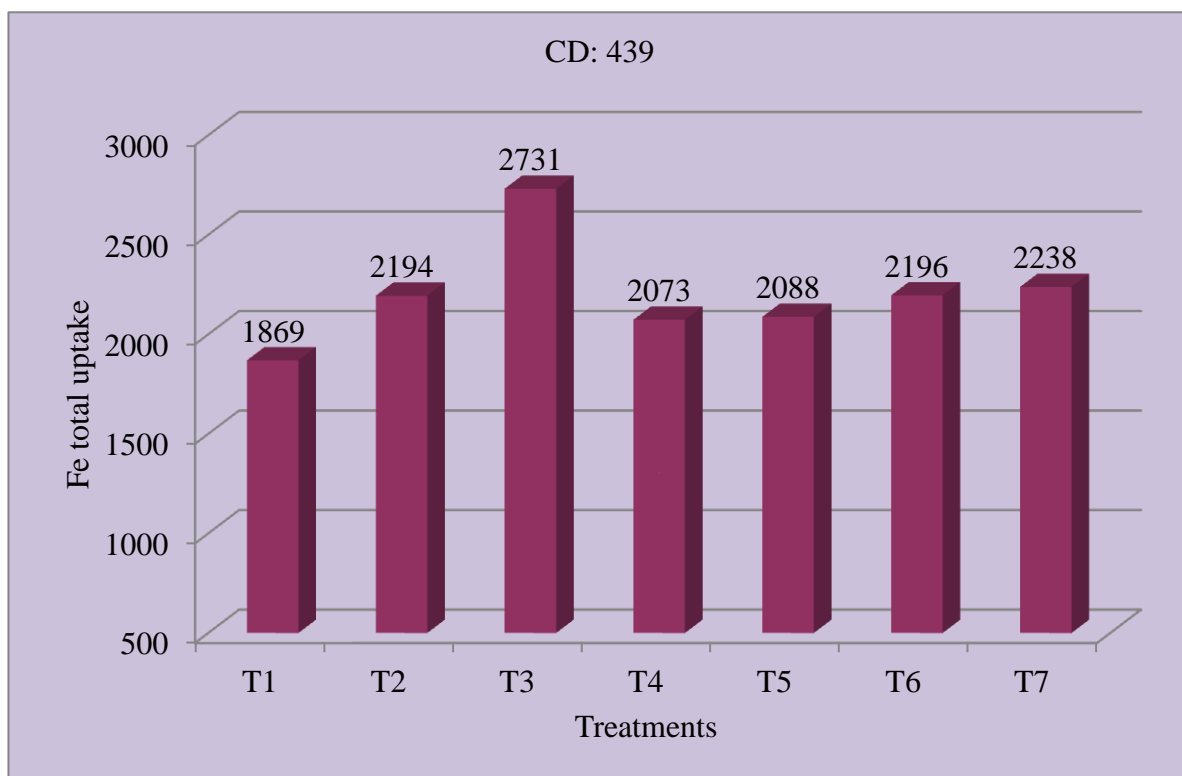


Fig. 12 Effect of different treatments on total Fe uptake (g/ha)

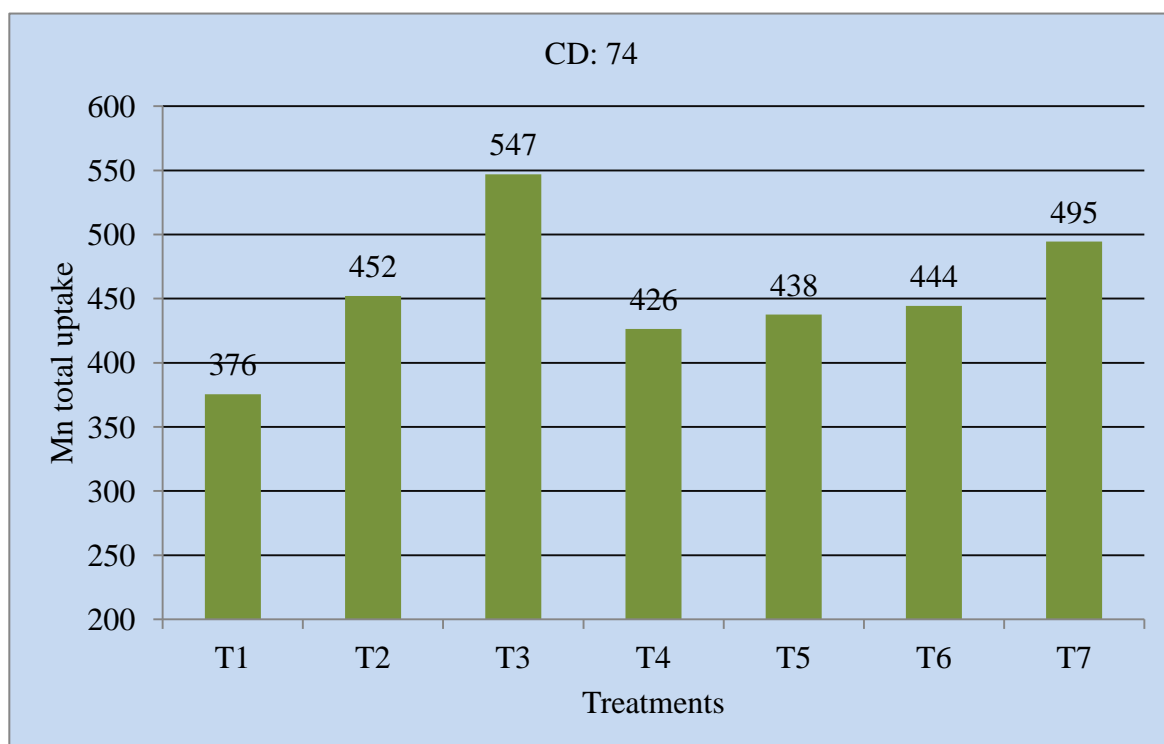


Fig. 13 Effect of different treatments on total Mn uptake (g/ha)

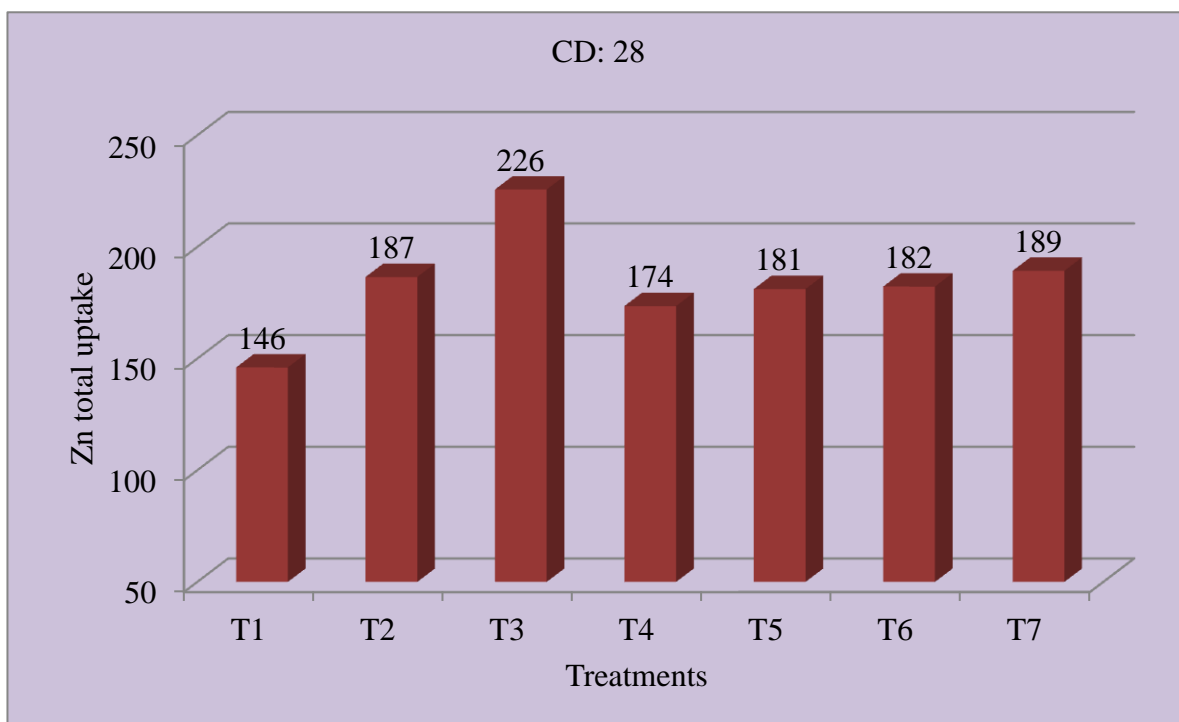


Fig. 14 Effect of different treatments on total Zn uptake (g/ha)

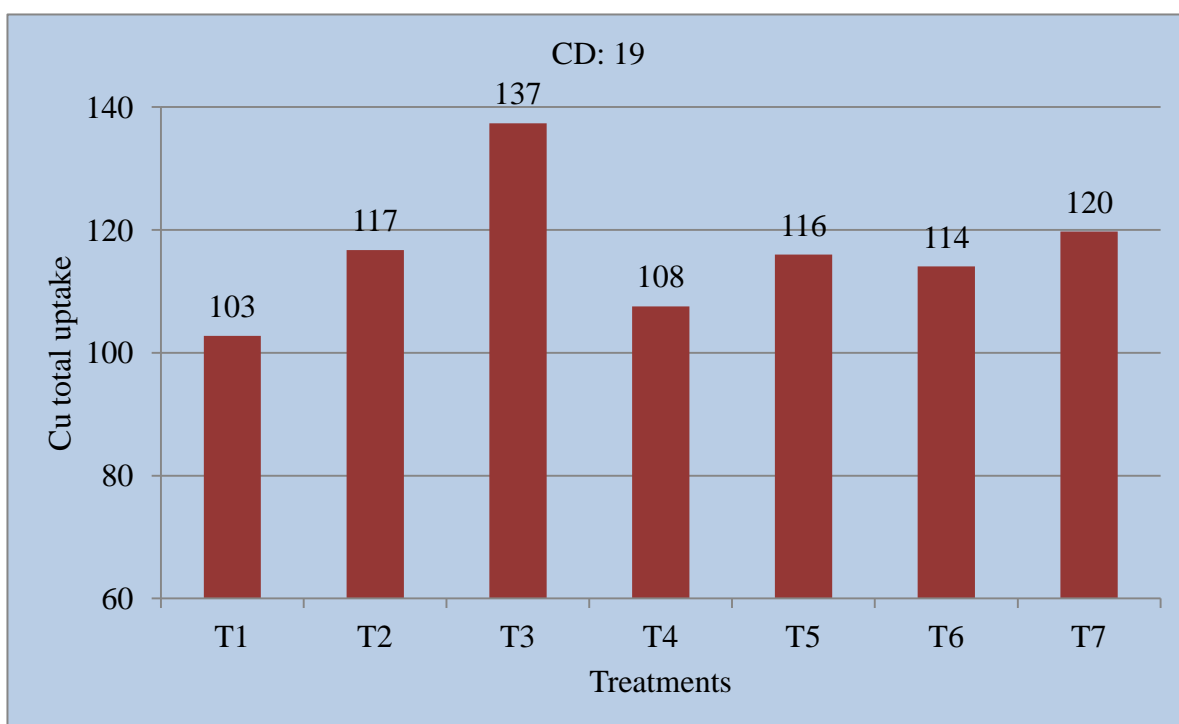


Fig. 15 Effect of different treatments on total Cu uptake (g/ha)

As discussed in nutrient content part of this chapter, utilization rate of micronutrients were higher than major and

secondary nutrients. Total uptake of nutrients is the function of nutrient content in crop and dry matter yield, therefore, the reason given for higher yield and nutrient content in leaves and bulb of onion is equally applicable here also, (Sathish and Paramaguru, 2010).

5.5 Soil properties

Foliar application of liquid organic manures was done and its effect on growth and yield, as well as nutrient content and uptake was discussed in this chapter earlier. In order to know the variation in these parameter due to treatments have any effect on soil properties, the plot wise soil samples were collected and analysed for soil fertility (Available N, P₂O₅, K₂O, S, Fe, Mn, Zn and Cu) and physical (IR and WSA) percentage and reported in tables 25 to 27. The results indicated that there is no significant effect of different liquid organic manures on soil fertility and physical parameters. To supply RDN, common application of BC, VC and CC were done and liquid organic manures applied as spray, therefore, non-significant effect of the treatments was anticipated. The variations in growth and yield as well as nutrient content and uptake due to different treatments have no effect on soil properties.

5.7 Economics

Considering cost of cultivation and selling price, economics of each treatments was calculated and presented in table 30. Maximum bulb yield of 43.7 t/ha and net profit of Rs. 168470 with BCR of 4.4 was recorded with treatment T₃ involving application of enriched sap @ 2% followed by treatment T₇ which

recorded bulb yield of 40.0 t/ha and net income of Rs.150825 with BCR of 4.1.

Table 30: Economics of different treatments

| Treatments | Bulb yield (t/ha) | Cost of cultivation (Rs./ha) | Gross income (Rs./ha) | Net profit (Rs./ha) | BCR |
|----------------------|--------------------------|-------------------------------------|------------------------------|----------------------------|------------|
| T₁ | 35.9 | 48230 | 179500 | 131270 | 3.7 |
| T₂ | 38.5 | 48320 | 192500 | 144180 | 4.0 |
| T₃ | 43.7 | 50030 | 218500 | 168470 | 4.4 |
| T₄ | 36.5 | 48770 | 182500 | 133730 | 3.7 |
| T₅ | 37.1 | 49460 | 185500 | 136040 | 3.8 |
| T₆ | 36.6 | 48890 | 183000 | 134110 | 3.7 |
| T₇ | 40.0 | 49175 | 200000 | 150825 | 4.1 |

VI. SUMMARY AND CONCLUSIONS

A field experiment entitled “Effect of Banana Pseudostem Sap and Vermiwash Spray on Organically Grown Onion” was conducted at Organic Farm (F Block), NAU, Navsari during *rabi* season of 2010-11. The objectives of the experiment were (i) To study the effect of banana pseudostem sap and vermiwash spray on yield and yield attributes of onion, (ii) To study the effect of banana pseudostem sap and vermiwash spray on quality and nutrient uptake and (iii) Work out the economics of different treatments. Total seven treatments such as T₁: Control, T₂: Banana pseudostem sap @ 2% spray, T₃: Enriched banana pseudostem sap @ 2% spray, T₄: Vermiwash @ 2% spray, T₅: T₂ and T₃ in 2:1 ratio, T₆: T₂ and T₃ in 1:2 ratio and T₇: T₂ and T₃ in 1:1 ratio were tested using RBD with three replications. Common dose of BC, CC and VC on N equivalent base (33.3% N from each source) was applied to supply RDN to the onion. The results presented and discussed in preceding chapter are summarized here

6.1 SUMMARY

6.1.1 Growth and yield parameters and yield

- The plant height was recorded at 30, 60 and 90 DATP; among this plant height recorded at 30 DATP was affected significantly due to different treatments. The significantly higher plant height (36.2 cm) was recorded in the treatment T₃ but it was at par with treatment T₂ (31.7 cm), T₆ (34.0 cm), and T₇ (31.9 cm). While lowest plant height of 28.1 cm was observed in control. Similarly, same treatment recorded significantly higher number of leaves at 90 DATP (9.7) but it was remain at par with the

treatment T₁ (9.3) and T₇ (9.0). None of the treatment showed significant effect on number of leaves recorded at 30 and 60 DATP.

- The effect of different treatments on equatorial and polar diameter of bulb was significant and as compared to control significantly higher equatorial (6.64 cm) and polar (4.96 cm) diameter of bulb were observed in the treatment T₃. Control treatment (T₁) recorded minimum equatorial (5.29 cm) and polar (3.90) diameter of bulb. Similarly, treatment T₃ recorded significantly higher average bulb weight (68.1g) but it was remain at par with treatment T₇ (62.4g).
- Among the growth and yield parameters (plant height, number of leaves, size and weight of bulbs), periodical plant height and weight of bulb had positive and significant correlation with yield.
- The dry matter yield of bulb and leaves was not affected significantly due to different treatments but comparatively higher dry matter yield of bulb (5383kg/ha) and leaves (4950 kg/ha) were recorded in the treatment T₃. As far as bulb yield is concerned, the treatment effect was significant and significantly higher bulb yield of 43.7 t/ha was recorded in the treatment T₃. However, it was remain at par with treatment T₇ (40.0 t/ha).

6.1.2 Quality parameters

- The quality parameters like bulb neck thickness and bolting percentage, TSS and pyruvic acid content in bulb were not affected significantly due to different treatments. However, the

narrower bulb neck thickness was recorded in treatment T₁ and T₄ (1.2 cm) and lower bolting percentage was recorded in treatment T₅ (1.9%). The higher TSS content was recorded in treatment T₃ (13.4%) whereas, higher pyruvic acid content was recorded in treatment T₇ (6.3 µmoles/g).

6.1.3 Nutrient content

- Major and secondary nutrients *i.e.* N, P, K and S content in leaves and bulbs of onion were not affected significantly due to different treatments.
- In case of micronutrients like Fe, Mn Zn and Cu content in leaves and bulbs of onion, only Zn content in leaves and Mn content in bulbs was affected significantly due to different treatments and treatment T₃ recorded significantly higher Zn and Mn content in leaves and bulbs, respectively as compared to control.

6.1.4 Nutrient uptake

- Among the Major (N, P and K) and secondary (S) nutrient uptake by leaves, bulbs and their total, only N uptake by leaves was affected significantly. The treatment T₃ recorded significantly higher N uptake by leaves *i.e.* 40.5 kg/ha but it remains at par with all the treatment except treatment T₅.
- But in case of micro nutrients (Fe, Mn, Zn and Cu), treatment T₃ recorded significantly higher uptake of these nutrients by leaves, bulbs and its total in majority of cases as compared to remaining treatments. However, Cu uptake by leaves and bulbs, Fe and Zn uptake by bulbs were not affected significantly due to different treatments.

6.1 5 Soil properties

Soil fertility (Available N, P₂O₅, K₂O, S, Fe, Mn, Zn and Cu) and physical (IR and WSA) parameters determined after harvest of the crops were not affected significantly due to different treatments.

5.7 Economics

From the economic point of view, maximum net profit of Rs. 168470/ha with BCR of 4.4 was recorded in treatment T₃ involving application of enriched sap @ 2% followed by treatment T₇ which recorded net income of Rs.150825/ha with BCR of 4.1.

CONCLUSION

Based on the results of present study, following conclusions are emerged:

- (1) For getting higher bulb yield and net profit from onion grown organically spraying of enriched sap @ 2% or sap + enriched sap (1:1) @ 2% at 15, 30 and 45 DATP is essential.
- (2) Apart from higher bulb yield at net profit, uptake of nutrient was also improved due to spraying of enriched sap alone or in combination with sap (1:1).

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(BOKARE S. P.)