Effect of Plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.)

BY

PRAVEEN KUMAR
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Dedicated To
My
Beloved Parents

CERTIFICATE - I

This is to certify that this dissertation entitled "**Effect of Plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.)**" submitted for the degree of **Ph.D.** in the subject of **Vegetable Crops** of the CCS Haryana Agricultural University, Hisar, is a bonafide research work carried out by **Praveen Kumar** under my supervision and that no part of this dissertation has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

[Dr. Sewa Lal]

MAJOR ADVISOR

CERTIFICATE - II

This is to certify that this dissertation entitled "**Effect of Plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.)**" submitted by **Praveen Kumar** to the CCS Haryana Agricultural University, Hisar in partial fulfilment of the requirements for the degree of **Ph.D.** in the subject of **Vegetable Crops,** has been approved by the Student's Advisory Committee after an oral examination on the same, in collaboration with an External Examiner.

MAJOR ADVISOR

EXTERNAL EXAMINER

HEAD OF THE DEPARTMENT

DEAN, POST-GRADUATE STUDIES

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ABBREVIATIONS

Anon	:	Anonymous
t	:	Tonne
q	:	Quintal
Kg	:	Kilogram
cm	:	Centimeter
m	:	Meter
DAT	:	Days after transplanting
N	:	Nitrogen
P	:	Phosphorus
K	:	Potassium
et al.	:	And others
ppm	:	Parts per million
RP	:	Rock phosphate
Na	:	Sodium
Ca	:	Calcium
Mg	:	Magnesium
FW	:	Fresh weight
DW	:	Dry weight
IAA	:	Indole acetic acid
DAP	:	Diammonium phosphate

CHAPTER – I

Introduction

Tomato (*Lycopersicon esculentum Mill.*) is one of the most important and popular vegetable used in every kitchen in many ways as salad, cooked, soup, juice, ketchup, paste and powder form. It is a rich source of vitamins particularly vitamin A, C and minerals. The soluble solids in tomatoes are predominantly sugars, which contribute to flavour. The free sugars, representing more than 60% of the solids in tomatoes, are mainly D-glucose and D-fructose. Glutamic acid, aspartic acid, γ-aminobutyric acid and glutamine comprise about 80% of the free amino acids and contribute to the taste of tomato fruit (Mcglasson, 1993 and Salunkhe *et al.*, 1974). Tomato is the important source of potassium in human diet. Citric acid and malic acid are the organic acids that contribute to the typical taste of tomato fruit. It also contain tomatine, a glycosidic steroidal alkaloid. Tomato is rich in medicinal properties. Hot water extract of dried fruits has been used in the treatment of ulcers, wounds, hemorrhoids and burns (Caceres *et al.*, 1987 and Ramirez *et al.*, 1988). Tomato poultice has been used in the

treatment of edema during pregnancy. The fresh fruits are reported to be effective as digestive aids and in the treatment of Kidney and liver problems (Liebstein, 1927).

Tomato is grown all over the world in an area of 35,42,000 ha., with an estimated annual production of around 95,127,000 metric tonnes. In India tomato is grown on 4,56,500 ha land with an annual production of 74,26,800 metric tonnes and productivity of 16.3 tonnes/ha. In Haryana tomato is grown in about 9000 ha with production of 1,99,500 tonnes and productivity of 22.2 tonnes/ha (Anon., 2001). In the world it occupies the largest area after potato and sweet-potato, but tops the list of nutritious and processed vegetables (Chaudhary, 1967).

Tomato is a major feeder of nutrients and their average uptake of N, P, K were 3.82, 1.01 and 3.65 kg, respectively, per tonne fruit production (Cholakov, 1987). Therefore, supply and monitoring of nutrients are essential for high productivity. For high achievements, excess of chemical fertilizers and other chemicals are being applied in vegetable crops, which may be health hazardous for human beings. Kaushik and Kaushik (2001) reported that excessive use of nitrogenous fertilizers can enrich the surface water and even ground water with nitrates and can results in methaemoglobinemia and stomach cancer in humans. Anand Prakash *et al.* (2001)

also reported that in the developed world, mineral fertilizer application has gone so high that it has shown its ill effects on the environment, like ground water pollution and eutrophication of surface water.

Excessive use of chemicals and artificial fertilizers also cause soil degradation and make the soil polluted. Kathpal and Arora (1988) recorded maximum vegetable contamination with BHC followed by DDT and endosulphan. Thus, organic farming has an important role to play in ensuring stability and sustainability of food production. Efforts are being made to increase and provide vegetables free from harmful effects of chemicals to consumers and the use of organic manures is a major step towards this effort. Organic materials such as FYM, green manure, poultry manure, crop residue etc. offer sustainable and ecologically sound alternative for meeting the nutrient requirement, particularly nitrogen. Fayad and Sweelam (1989) found that application of triple phosphate with cattle manure reduced nematode population and thus increased nutrient uptake and improve the tomato growth. Rumpel (1998) reported that after many years treatment, soil porosity and water retention increased significantly with FYM. Also, the organic carbon and humus content was over 2 times higher with FYM. The combination of FYM with mineral fertilizers did not increase total N content after crop harvest

compared to FYM alone. Lucarini *et al.* (1999) reported that organic tomatoes had a lower dietary fibre content and higher sugar and malic acid contents. There was no difference in total polyphenols between the organic and non-organic fruits, but single phenolic acids were lower in organic tomatoes. Different studies indicated considerable increase in vegetable production and quality improvement by using organic materials without any harmful effect on soil. The herbal (Acorin, Emodin, Serpentine etc.) extract containing some active components which may affect the nutrient mineralization in the soil and metobolism in plants. Consequently, growth and yield of plants are affected. Annupan supplied by M/s. Indian organic foods co, one such extract containing free sugar which affect the microbial activities in soil. Therefore, keeping in view the residual effect of synthetic fertilizers and pesticides, it has been planned to study the effect of plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentun* Mill) with the following objectives:

1. To evaluate the plant vitalizers for growth, yield and quality of tomato.
2. To compare the plant vitalizers and organic manure in relation to tomato production.
3. To study the plant protection capability of plant vitalizers against insects and diseases.

CHAPTER – II

Review of Literature

At global level considerable progress has been made in the field of agricultural production. The success of green revolution in India was engineered by breeding high yielding varieties together with the use of fertilizers and pesticides in the best agroclimatic conditions. However, this narrow emphasis was so crucial to the success in productivity terms. It has largely ignored its effects on the soil health, environmental and socio-economic diversity. Practically no work has been done under present day research methodology in comparison with VIRAKSHAYURVEDA. According to ayurveda every living thing is composed of five basic elements (PANCH MAHABUTAS) i.e. earth, water, air, fire and ether. In various combination of these elements affect three GUNAS i.e. SATVA, TAMA and RAJA and three DOSHA i.e. VATTA, PITTA and KAPHA are called vitia because they uphold or pollute the body. This being the natural

rejuvenation of plant need details studies and first time an attempt has been made in this direction, hence forth, could not be supported with relevant documents. So, in future the agricultural scientists and farmers are going to face a big challenge of maintaining the productivity of lands at a sustainable level. Chaudhary and Sharma (1992) reported that out of 329 million ha total geographical area about 29 million ha has become subject to degradation due to explotive type of agriculture.

Sharma (1993) reported that use of chemical fertilizers in high amounts; parts of canal irrigated lands are facing the problems of development of sick soils containing high amount of salts. It has been estimated that 10.5% of the cultivated area is infested with this problem in Haryana.

Soil health and conditions

The various studies conducted on the effect of applied herbicides on the microflora and fauna in soil indicate that application of herbicides stimulates bacterial and algal population but reduces the population of fungi and actinomycetes (Malkomes, 1976). Sarwad (1985) reported that Thimet (phorate), Bavistin (carbendazine) and diuron at 10-100

ppm inhibited nitrification but soil dehydrogenase activity was stimulated by all pesticides. Drinkwater *et al.* (1995) reported that nitrogen mineralization potential, microbial and parasitoid abundance and diversity were higher in organic farms as compared to conventional farms and suggested that biological processes compensated for reductions in the use of synthetic fertilizers and pesticides.

The concept of soil, as a living system, is the centre of farming system as opposed to chemical farming. Soil must be "fed", in a way, that the activities of beneficial soil organisms, necessary for recycling the nutrients and producing humus, are not restricted (Bhawalkar, 1992). Studies conducted for several years at Hisar reveal that application of nitrogenous fertilizers alongwith continuous use of FYM improved the efficiency of fertilizers and other nutrients applied (Singh *et al.*, 1994). It has also been reported that low grade economically cheap rock phosphate composted for about three months in a pit in the ratio of 1:4 (RP : Farm waste) could work as good as any phosphatic fertilizers (Singh *et al.*, 1983 and Ruhal *et al.*, 1991). Chaudhary *et al.* (1991) suggested that organic carbon content in unfertilized soil has gone down to about half of the initial

level. Similarly, added N through fertilizers also did not have beneficial effect on organic carbon but when FYM was used in every crop season, the organic carbon content increased to about double the initial level. Yadav *et al.* (2001) also reported that the nutrient content was more in organic manure treated soils than that of inorganic fertilizers treated soils. It was also observed that improvement in physical properties of soil was more in plots treated with organic manure alone or in combination with inorganic fertilizers than that of treated with inorganic fertilizers only. Nehra and Grewal (2001) noted that application of organic manures (FYM @ 15t/ha) increased the organic carbon content and available NPK in soil significantly whereas, soil pH and electrical conductivity did not change under the influence of organic manures as well as fertilizer levels.

Ramteke *et al.* (2001) reported that physico-chemical properties of soil such as bulk density and water holding capacity were significantly improved by FYM applied @ 5 t/ha and paddy straw @ 5 t/ha compared to PM @ 5 t/ha and control. Availability of nitrogen was significantly improved due to FYM and poultry manure. Kaushik and Kaushik (2001) reported that

indiscriminate use of agro-chemicals affected the non-target soil organisms which are helpful in maintaining soil fertility. Fertilizers replenish the inorganic materials but not the organic matter and humus. Regular use of inorganic fertilizers resulted imbalances in soil eco-system. Pesticdies used for crop protection disturb the natural predator- prey relationships. Organic farming, is ecologically safe and sustainable method of farming. Organic matter produces humus, gets decomposed by soil microbes and releases NPK etc. necessary for plant growth. It also helps in maintaining the soils physical, chemical, and biological properties on long-term basis. Angadi and Meli (2001) suggested that organic farming with FYM @ 10 t/ha or vermicompost @ 2.5t/ha in the long run can sustain productivity. Integrated use of vermicompost with organic and inorganic fertilizers further elevated the productivity with enhanced returns.

Geissler and Schmidt (1978) recommended peat, FYM and slurry to improve soil structure. Nazaryuk (1989) also reported that combined mineral and organic inputs are considered essential methods of significantly improving the nitrogen status of low fertility soils. Ranganna *et al.* (1991)

reported that BGSS (manure used for biogass generation) has a higher percentage composition of total N, P_2O_5, K_2O and organic carbon than FYM and has positive effect on soil health. Ahmed (1993) observed that composted coir pith (5-20 t/ha), incorporated into the soil one day before transplanting the tomato, generally improved soil condition (including strength (kg/cm^3) and bulk density) and moisture retention capacity compared with 10t FYM/ha. Rumpel (1998) also reported that soil density decreased while porosity and water retention increased significantly with FYM @ 40t/ha. Also the organic carbon content and humus content was over two times higher with FYM. The treatment combination of FYM and NPK (150:100:200 kg/ha) did not increase total N content after crop harvest compared to FYM alone.

Plant growth

An application of FYM @ 20t/ha, proper plant growth and development contribute a lot to crop productivity. FYM + NP at 60:60 kg/ha or NP at 120:60kg/ha resulted in good root growth of tomato (Ovchinnikova, 1972). Jose *et al.* (1988) noted the combinations of 50kg N as organic form showed increased dry matter content and higher uptake of N, P, K, Ca and Mg than

the other treatments. Organic manure increased the available nitrogen in the soil (Spasov *et al.*, 1977) and this ultimately leads to increased N uptake by the plant. Besides, the organic manure might have improved the development of root system for increased adsorption and uptake of N. The higher plant height (75.15cm) were recorded by the plants receiving 50 kg N as urea and 50 kg N as poultry manure. The improved growth of plants supplied with poultry manure and urea may be attributed to the increased N uptake and utilization. Poultry manure contained growth promoting substances which induced better plant growth. Enhanced plant growth with the application of poultry manure and inorganic fertilizers have been reported by Abusaleha (1981) in bhendi and Dhandpani (1982) in cauliflower. The efficacy of inorganic fertilizers is much pronounced when they are combined with organic manure (Fritz and Wonneberger, 1973). Application of triple phosphate as a source of phosphorus together with cattle manure increased the nutrient uptake and tomato growth reported by Fayad and Sweelam (1989). Application of inorganic fertilizers in the absence of FYM retarded formation of vegetative organs and subsequently reproductive organs (Cerna, 1980). FYM favourably

affected vegetative mass, dry weight, plant height and photosynthetic potential (Meena *et al.*, 1990). Oikeh and Asiegbu (1993) reported that very high manure application (30t/ha) depressed growth, irrespective of the manure source. The potential fertilizer values of the organic manures were not fully reflected by early growth parameters as they were with NPK treatment, apparently due to slow release of the elements that were still bound in organic forms in the manures. The ultimate yield advantages associated with the organic manures compared with NPK fertilizer were ascribed to their probable effects on the supply of macro and micronutrient elements not present is NPK fertilizer. Gagnon and Berrouard (1994) reported that application of organic waste from the agri-food industry mixed with peat compost growing medium prior to transplanting of tomato, produced best growth, significantly by increasing shoot dry weight 57-83% compared with non-fertilized plants. Zeenat and Sharma (1994) found that application of fresh algae improved the vegetative growth (Plant height, leaf no., root biomass and shoot biomass) of tomato seedlings in pots when compared with DAP treatments.

In tomato crop, growth parameters were improved with recommended dose of NPK + FYM (Mallangouda *et al.*, 1995). Treatments with 100% organic manure alone or in combination with ammonium nitrate resulted in taller plants than inorganic fertilizers alone (Youssef *et al.*, 2001). Wang *et al.* (1996) reported that application of organic granular fertilizer composed of powdered poultry manure, NP & K fertilizers and micronutrients. (A formulation containing 88% powdered poultry manure, 4% urea, 4% KCl, 4% boron sulphate) was best for vegetative growth of tomato. Similar observations were reported by Kumaran *et al.* (1998) when applied organic and inorganic fertilizer in combination. Shelke *et al.* (1999) reported that the plant height, number of branches, leaves per plant and leaf area of brinjal were significantly increased due to the application of N through organic and inorganic combination. It was further observed that the highest available NPK content and their uptake by the brinjal plant were due to the application of 40% N through urea and 60% N through poultry manure (Nanthakumar and Veeraragavathatham, 1999).

Flowering and fruiting behaviour

Early flowering and fruiting in tomato plants occurred whose seedlings had been pricked out into a 2:1 mixture of garden soil and FYM with added NPK and perlite. Compared to the control (2:1 mixture of garden soil and FYM) organic matter formation was accelerated in transplants pricked out into a 1:1 mixture of soil and FYM or into a 2:1 mixture with higher NPK and lower perlite contents (Petrov and Andreev, 1972). Watering the seedlings of tomato 12 hours before transplanting with 0.005% humus solution (from well rotted FYM) at 250 ml/pot under conditions of high mineral and low organic nutrition increased earliness in early cultivar by 9-13%, in medium cultivars by 12-15% and in late varieties by 23-30% (Stanchev, 1972).

Application of organic and biofertilizers along with inorganic NPK in brinjal resulted into early vigorous growth of root would have helped to synthesize more cytokinin by these plants. Better stem girth attained would have helped the translocation of these synthesized cytokinin when compared with the treatments which received the inorganic fertilizers alone. The increased nutrient availability from FYM, the organic

phosphorus through phosphobacteria and IAA from azospirillum might have increased the various endogenous hormonal levels in the plant tissue, which were responsible for enhanced pollen germination and tube growth which ultimately increased the fruit set (Rajagopal and Rao, 1974).

The higher number of fruits per plant (13.0) were recorded by the plants receiving 50kg N as urea and 50kg N as poultry manure than the plants which received 100kg N through inorganic source (Jose *et al.*, 1988). Early flowering has been noticed in the plants supplied with inorganic fertilizers as stated by Abusaleha (1981) in bhendi and Dhandpani (1982) in cauliflower. Gianquinto and Borin (1990) reported that tomato ripening was delayed when grown with N 200kg, P_2O_5 100kg and K_2O 280 kg/ha as compared to FYM 20 t/ha with N 100kg, P_2O_5 50kg and K_2O 140 kg/ha. The recommended dose of fertilizer + farmyard manure recorded more number of fruits per plant (25.47) and the lowest in control (11.60). This was due to favourable influence of fertilizers on Chilli crop. (Mallanagouda *et al.*, 1995).

Number of fruits of tomato per m^2 was significantly increased by poultry manure when applied @ 1.5 t/ha (Argerich

et al., 1998). NanthaKumar and Veeraragavathatham (1999) reported that number of flowers per plant in brinjal crop, which is one of the most vital attributes, was considerably increased due to the combined application of organic and biofertilziers along with inorganic NPK than the treatments which received the inorganic fertilizers alone. Jose (1984) noted an increase in both long and medium styled flowers (productive flowers) in the treatment with half of the dose as organic source and other half as inorganic source of fertilizers. The fruit set was also significantly improved in the same treatment. The higher fruit set may also be due to the higher percentage of productive flower in these elite treatments (Uma, 1984). The greater fruit weight was recorded in the crop fertilized with both organic and inorganic fertilizes, which might have been due to accelerated mobility of photosynthates from source to sink as influenced by growth hormone, released or synthesized due to the organic source of fertilizers (Susan, 1995).

Yield

Khvatov *et al.* (1973) also reported the best results in tomato from plots receiving combined mineral (full rate) and organic (half rate) fertilizers. Spasov *et al.* (1977) reported that

tomato growing third and fourth year after the last organic fertilizer application resulted in higher yields than the control. In tomato crop, total commercial yield was highest (68.6t/ha) from plots receiving poultry manure @ 500g/planting hole + NPK at 60:240:240 kg/ha (Almeida *et al.*, 1981). Tomato yield was highest under organic soil treatment as compared to mineral soil treatments (Eggert and Kahrmann, 1984). Linardakis and Tsikalas (1984) reported that tomato plants in the plots receiving FYM gave the highest total and marketable yields, with NK fertilization having a lesser effect. Jose *et al.* (1988) reported that the highest yield (51.03t/ha) of brinjal was obtained from plants receiving 50 kg N/ha as poultry manure + 50 kg N/ha as urea. The control gave 20.9 t/ha, which is 143.23% less than the above said. Bagal *et al.* (1989) reported that application of FYM @ 20t/ha with NPK at 200:100:100 kg/ha produce the highest yield (309 q/ha) of tomato. Hilman and Suwandi (1989) found that the highest yield of tomato 2.16 kg/plant was obtained with sheep manure @ 36 t/ha. Prezotti *et al.* (1989) reported that application of poultry manure @ 10 t/ha appreciably increased the yield of tomato and augmented fruit size. Phosphorus was beneficial only in the absence of organic

matter in the soil. Liming had no appreciable effect on yield. Silva and Vizzotto (1989) reported that the highest yield of tomato fruits (53 t/ha) was obtained with 103.5 kg N + 285.8 kg P_2O_5 + 103.5 kg K_2O + 20 t poultry manure/ha. Without poultry manure the yield declined to 46.2 t/ha. Application of inorganic fertilizer alone decreased fruit yield was due to retarded formation of vegetative organs and subsequently reproductive organs (Cerna, 1980). Annanurova *et al.* (1992) found that application of NPK alone increase yield per plant by 43.4% compared with untreated control and when supplemented with FYM @ 30 t/ha by 161.8%. Ahmed (1993) recorded highest tomato yield (19.01 t/ha) with FYM @ 10 t/ha followed by 20t coirpith/ha (16.97 t/ha) and were lowest in controls (11.23 t/ha) with no treatment. Oikeh and Asiegbu (1993) reported that very high manure application (30 t/ha) depressed the yield, irrespective of the manure source. The potential fertilizer values of the organic manures were not fully reflected by early growth parameters as they were with NPK treatment, apparently due to slow release of the elements that were still bound in organic forms in the manures. The ultimate yield advantage associated with the organic manures compared with NPK fertilizer were in

plant, ascribed to their probable effects on the soil physical characteristics. The highest fruit yield (20.9 q/ha FW and 5.7 q/ha DW). In tomato the percentage of yield affected by blossom end rot was lowest with the composted manure treatment given at the start of cultivation. Dried manure given at the start of the experiment gave significantly greater fresh weights than composted manure (Salmmen, 1997). Alexiev *et al.* (1997) reported that application of 200t FYM/ha increased tomato yields by 14.6% compared with application of only 50t FYM/ha. Kalembasa *et al.* (1998) reported that vermicompost and FYM increased the yield of lettuce and tomatoes in comparison to the unamended control. Except at the lowest rate, ammonium nitrate decreased the yield of lettuce and tomatoes. The form of N used had a significant effect only on tomato K, Mg and Ca contents. Kumaran *et al.* (1998) reported that results of an experiment showed that a combination of organic and inorganic fertilizers gave the best results in terms of yield. Rumpel (1998) found that tomato and onion yields was significantly higher with combined fertilizer treatment (FYM @ 40 t/ha + NPK 150:100:200 kg/ha) compared to FYM alone. Duraisamy *et al.* (1999) reported that fruit yield of tomato was higher when

supplied with organic fertilizer composted coir-pith (CCP) 12.5 t/ha or FYM 12.5 t/ha than those supplied with inorganic N. Among the organic fertilizers CCP resulted in the highest fruit yield (14.68 t/ha). NanthaKumar and Veeraragavathatham (1999) reported that a combined nutrition of organic manure through 12.5 t/ha of FYM, 2 kg each of azospirillum and phosphobacteria and 75 per cent of the recommended dose of inorganic (NPK 75:37.5:30 kg/ha) increased the yield parameters and yield in brinjal. The increased yield obtained in plants inoculated with azosprilliuum could be attributed to the effect of growth hormones like IAA, cytokinin produced by azospirillum (Fallick *et al.*, 1989), Vitamin B12 (Sankaran, 1960), auxin (Naumova *et al.*, 1962). Fugro (2000) reported that the treatment comprising organic manure in combination with NPK superimposed with alternate sprays of organic and chemical pesticides produced the maximum yield of green chilli (166 q/ha).

Fruit quality

Michalik *et al.* (1975) reported that FYM or mineral fertilizers had no appreciable effect on the juice, dry matter content and vitamin C content of tomatoes and capsicums.

Matev and Stanchev (1979) found strongest antagonism between K^+ and Ca^{2+} which inhibited sugar, organic acid and vitamin C synthesis and reduced TSS percentage in the glasshouse tomatoes. Humus extracts from FYM reduced antagonism between Ca^{2+} and K^+ and improved growth and fruit development. Blanc *et al.* (1983) reported that FYM reduced the tomato fruit number, nitrate and K contents of fruit calyces. Eggert and Kahrmann (1984) found that the concentration of reduced ascorbic acid was higher in tomatoes grown under the organic treatments. Patil and Bojappa (1984) reported that the highest level of nitrogen (150 kg/ha) recorded the highest percentage of total sugar (3.127) and reducing sugar (2.867). Verma *et al.* (1970) and Maher (1972) also observed an increase in reducing and total sugars with increase in nitrogen levels. As regards phosphorus, the increase in the level of applied phosphorus had no significant influence on the sugars content.

Piven *et al.* (1987) found that increasing nitrogen from 120 to 240 kg/ha reduce dry matter and sugar content in tomato. Bagal *et al.* (1989) reported that application of increasing rates of NPK fertilizes significantly increased the juice content and TSS The percentage moisture and nitrite contents

were not affected by fertilizer treatment. Acidity increased with increasing fertilizer application, upto rates of NPK 200 kg, 100kg and 100 kg/ha after which there were no further increase. Increasing rates of K resulted in an increase in lycopene content whereas, P had the opposite effect. Hasegawa (1989) found that sugar level of tomato fruits was highest with organic fertilizers and vitamin C content was highest with fossil shell fertilizer. Meier *et al.* (1989) reported that composted FYM gave the superior results of desirable nutrients (Vit. C and sugars) and undesirable constituents (nitrates) of tomato and improvement in organoleptic properties also occurred with the biogenic waste compost. Montagu and Goh (1990) reported that fruit colour in tomato increased significantly on application of blood and bone compost, Ammonium Sulphate and Potassium nitrate, where as compost showed no effect. Vitamin C content in fruits decreased when any one of the N fertilizes was applied. In an experiment, application of poultry manure and mineral fertilizer combination (equivalent to 140kg N + 140 kg P_2O_5 + 100 kg K_2O/ha) compared with non-fertilized control, showed improved fruit colour of processing tomatoes but reduced the acidity, acid content and soluble solids ratio. In processing tomatoes, the

best score of suitability for paste transformation were obtained with mixed fertilizer (33.3% poultry manure and 66.7% mineral fertilizer) and the plots receiving only mineral fertilizers produced fruits with less favourable values of pH and electrical conductivity compared with the poultry manure ones. Trpevski *et al.* (1992) found that application of 120 kg N with 40t FYM/ha showed non-significant effect on fruit N, dry matter, organic acid and vitamin C content. Lacatus *et al.* (1994) reported that the best quality tomatoes for processing was obtained with NPK @ 300, 150 and 75 kg/ha, respectively plus 20t FYM/ha. Kumaran *et al.* (1998) reported that quality parameters such as TSS, ascorbic acid and lycopene contents were comparatively higher in organically grown tomato plants. Duraisamy *et al.* (1999) found that TSS and acidity were not significantly affected by organic or inorganic fertilized treatment. Lucarini *et al.* (1999) noted that organic tomatoes had a lower dietary fiber content and higher sugar and malic acid contents. There was no difference in total polyphenols between the organic and non-organic fruits but single phenolic acids were lower in organic tomatoes. NanthaKumar and Veeraragavathatham (1999) observed that combined application of 12.5t FYM/ha,

azospirillum and phosphobacteria (2kg each) + inorganic fertilizers at 75% of the recommended rate of N (75 kg/ha) P (37.5 kg/ha) and 100% of K (30kg/ha) increased the keeping quality, lowered the commulative physiological loss in weight, improved the general appearance and overall acceptance of the harvested fruits compared to the ones treated with inorganic fertilizers. Xu *et al.* (2000) reported that application of an organic fertilizer (bokashi) and poultry manure increased the photosynthesis. Concentrations of sugars and organic acids were higher in fruits of plants given bokashi, vitamin C content was higher in fruits from poultry manure and bokashi plots than in those from chemical fertilizer plots. Youssef *et al.* (2001) reported that tomato fruit dimensions were highest with organic manure alone. Organic manure (25%) + mineral fertilizers (75%) was the best treatment for TSS of fruits. Pimpini *et al.* (1992) reported that in processing tomatoes, the best scores of suitability for paste formation were obtained with mixed fertilizers (33.3% poultry manure and 66.7% mineral fertilizers.)

Insect and disease Incidence

Salmmen (1997) reported that percentage of yield affected by blossom-end rot was lowest with the composted

manure treatment given at the start of cultivation. Fugro (2000) reported that the incidence of die-back in chilli was significantly higher in treatment comprising organic manure superimposed with organic pesticides than in those combined with inorganic fertilizers and chemical pesticides. In contrast, the incidence of leaf curl virus was comparatively higher in treatment comprising organic/inorganic fertilizers superimposed with chemical and organic pesticides than in the organic manure/pesticides treatments. The appropriate combination of both organic and inorganic fertilizers and pesticides is needed to manage the diseases to a satisfactory level.

Omori *et al.* (1972) reported that the incidence of blossom-end rot was increased in tomatoes by the use of heavy application of fresh cattle manure @ 10t/ha. Cucumbers and tomatoes were injured by the use of fresh chicken manure applied @ >5t/acre but 5-10 t/acre could be used for pimento, egg plant and Chinese cabbage without deleterious effect. Prezotti *et al.*, (1989) found that liming @ 1 t/ha or poultry manure @ 10t/ha markedly reduced the incidence of blossomend rot. Fayad and Sweelam (1989) reported that the addition of organic matter significantly reduced the nematode population,

owing to nematicidal effect of some compounds produced from the amendments. P fertilization significantly reduced the nematode population except basic slag when compared with the control, because basic slag had no effect on soil pH. These results are in agreement with those of Dowe and Decker (1975) and Badra *et al.* (1979). Maoreg (1984) reported that organic amendments reduced the population of *Meloidogyne javanica* due to the biological and chemical changes in the soil caused by the chemical decomposition of the added organic matter. It was concluded that if tomato is planted on soil infested with *M. javanica* application of triple phosphate as a source of P along with organic matter (cattle manure) may reduce the nematode population, thereby increasing the nutrient uptake and tomato growth. Wahundeniva (1991) reported that application of high rates of poultry manure (10t/ha) reduced the root-knot nematode population considerably in infested soil.

CHAPTER – III

Materials And Methods

Experimental site

The present investigation entitled "Effect of plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill)" was carried out at vegetable Research Farm of Department of vegetable crops, Chaudhary Charan Singh Haryana Agricultural University, Hisar during the spring-summer season of 2001 and 2002.

The details of the materials used and methods applied in the experiment are mentioned below:

Soil conditions

Random soil samples from the experimental field were drawn from ten places with the help of soil auger to the depth of 22cm before layout of the experiment, before second year of crop planting and after harvest. Each time all the samples taken from ten places were mixed thoroughly and a uniform sample was analysed for assessing the status of the soil. The physical and chemical compositions of soil samples are presented in Table 1.

Climatic conditions

Hisar is situated at latitude 29°.10' North and longitude 75°.46' East at an altitude of 215.2 meters. It is a semi-arid climate with hot and dry desiccating winds accompanied by frequent dust storm in summer, severe cold during winter and humid-warm monsoon months. The mean maximum and minimum temperatures, therefore, show a wide range of fluctuation during summer and winter months. A maximum temperature around 48°C during summer and temperature upto freezing point accompnined by occurrence of frost in winter is common in this region. The average rainfall is around 400mm. most of which is received from south-west monsoon during July to September. A few showers of cyclonic rains also occur during December, January or late spring.

Since the growth, development, yield and quality of the crop is considerably influenced by the weather conditions, the record of the total weekly rainfall, maximum and minimum temperature and relative humidity (morning and evening) recorded during the period of experimentation at the agrometerological observatory of the meteorology Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar, are presented in Annexure – I and figure 1.

Table 1: Physico-chemical characteristics of the soil.

Sr. No.	Particular	Values observed
A.	**Before layout of the experiment**	
1.	Soil texture	Sandy Loam
2.	PH	8.4
3.	Organic carbon	0.39
4.	Available nitrogen (kg/ha)	100.00
5.	Available phosphorus (kg/ha)	25.00
6.	Available potassium (kg/ha)	384.00
7.	EC (dS/m)	0.70
B.	**Before transplating the second crop**	
1.	Soil texture	Sandy loam
2.	PH	8.3
3.	Organic carbon	0.44
4.	Available nitrogen (kg/ha)	98.00
5.	Available phosphorus (kg/ha)	23.00
6.	Available potassium (kg/ha)	225.00
7.	EC (dS/m)	0.70
	After harvest of second crop	
1.	Soil texture	Sandy loam
2.	PH	8.2
3.	Organic carbon	0.54
4.	Available nitrogen (kg/ha)	97.00
5.	Available phosphorus (kg/ha)	22.00
6.	Available potassium (kg/ha)	192.00
7.	EC (dS/m)	0.65

A persual of weekly meteorological data indicate that maximum and minimum temperature during crop growth seasons fluctuated between 15.1°C to 43.6°C and 1.0°C to 25.2°C in 2001, 46.6°C to 18.8°C and 1.32°C to 28.4°C in 2002, respectively. The total rainfall received during the crop season was 306.2mm and 20.2mm in 2001 and 2002, respectively.

EXPERIMENTAL TECHNIQUE:

Experiment I: "Effect of plant vitalizers (Anupaam + Anupaan R) on tomato Cv. Hisar Arun".

Treatments and layout plan

The experiment consisted of four doses of Anupaan + Anupaan R and four methods of application and one control was laidout in Randomized Block Design. There were seventeen treatment combinations and each treatment combination was replicated three times and allotted randomly. The plot size for each treatment was 3.0m x 3.0m. The details of the treatments layout is depicted in Fig. 2.

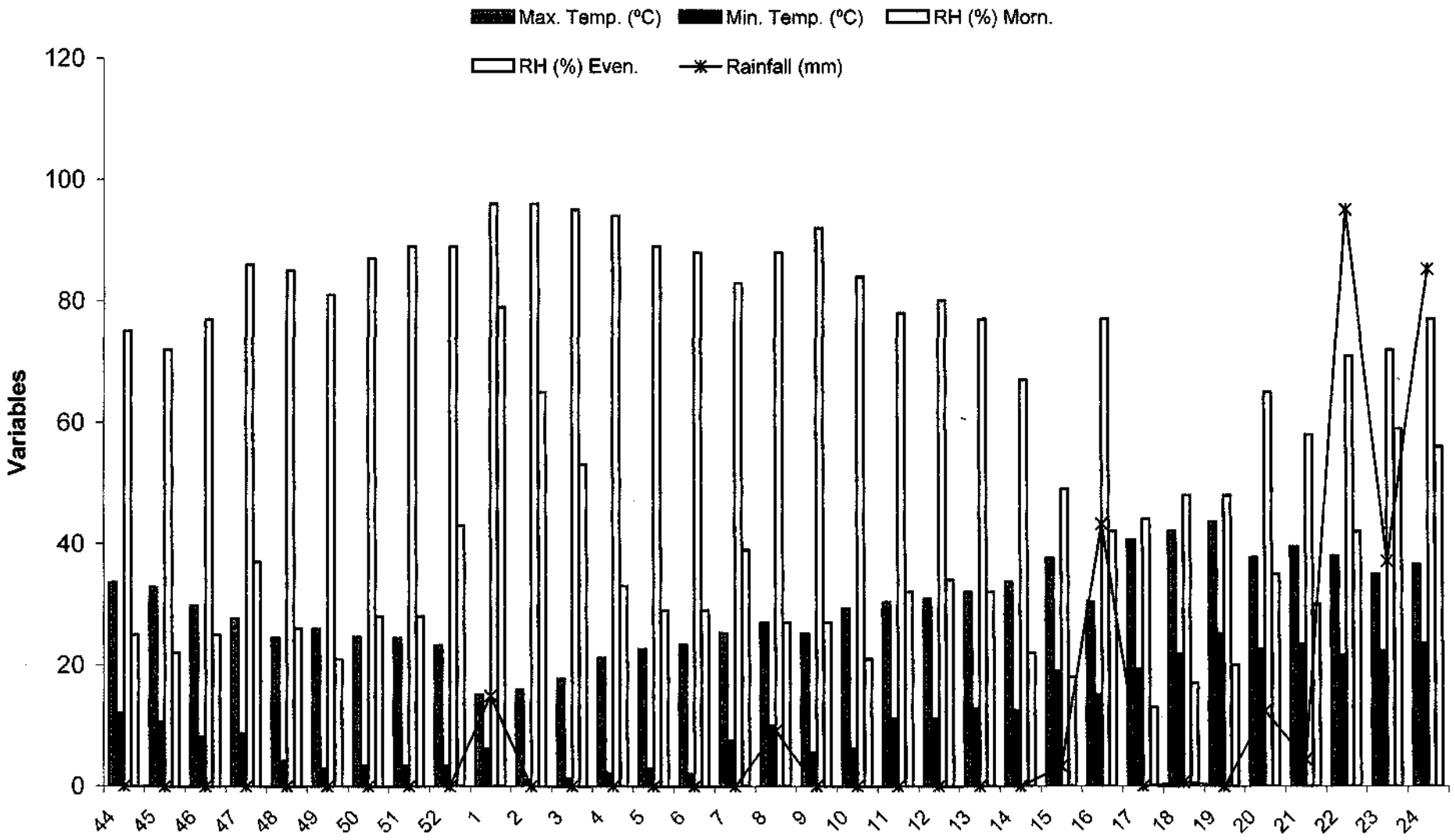

Fig. 1: Meterological data 2000-01

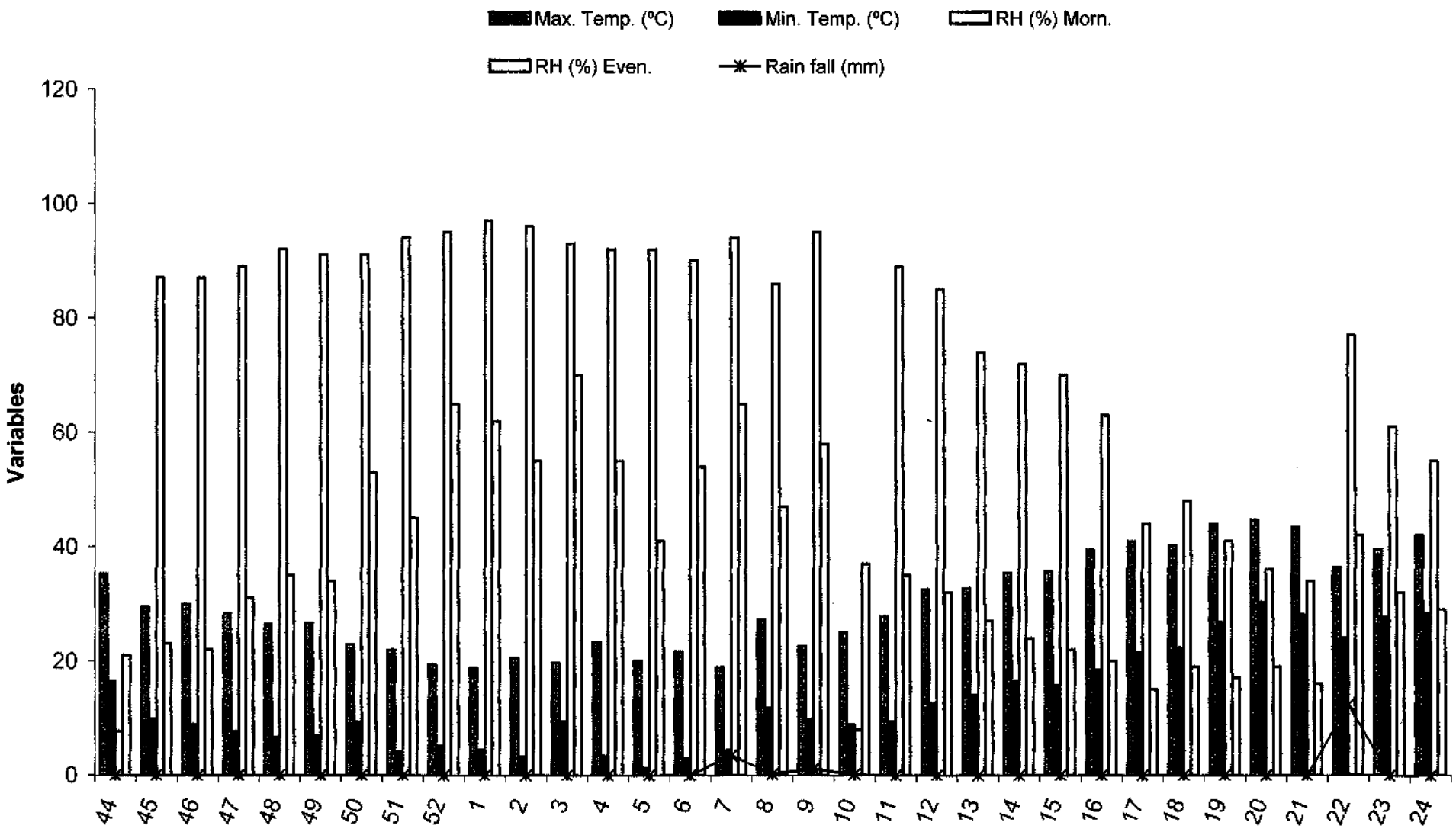

Fig. 1: Meterological data 2001-02

LAYOUT PLAN (EXPT. NO. 1)

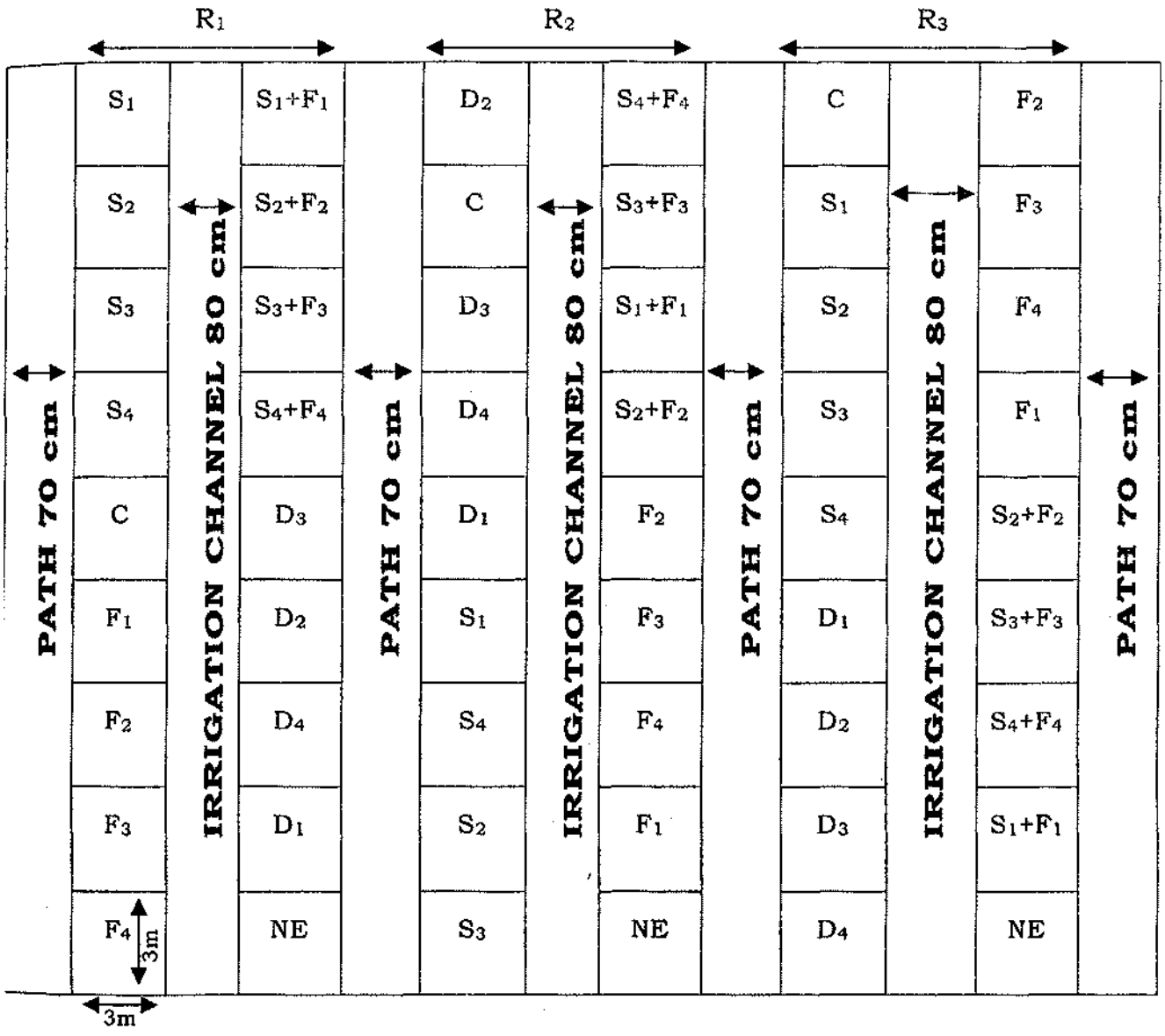

FIG. 2

TREATMENTS

Plant vitalizer

Anupaan + Anupaan R (A + AR)

:(i) Suggested dose (225ml+225ml/acre)

:(ii) 25% less than suggested dose (168.75ml + 168.75ml)

:(iii) 25% more than suggested dose (281.25ml + 281.25ml)

:(iv) 50% more than suggested dose (337.50ml + 337.50ml)

Treatment combination-17 given below:

C	Control
S_1	Soil application of A + AR at suggested does
S_2	Soil application of A + AR at 25% less than suggested dose
S_3	Soil application of A + AR at 25% more than suggested dose
S_4	Soil application of A + AR at 50% more than suggested dose
F_1	Foliar application of A + AR at suggested does
F_2	Foliar application of A + AR at 25% less than suggested dose
F_3	Foliar application of A + AR at 25% more than suggested dose
F_4	Foliar application of A + AR at 50% more than suggested dose
S_1+F_1	Soil + Foliar application of A + AR at suggested dose
S_2+F_2	Soil + Foliar application of A + AR at 25% less than suggested dose
S_3+F_3	Soil + Foliar application of A + AR at 25% more than suggested dose
S_4+F_4	Soil + Foliar application of A + AR at 50% more than suggested dose
D_1	Root dipping in suggested dose of A + AR
D_2	Root dipping in 25% less than suggested dose of A + AR
D_3	Root dipping in 25% more than suggested dose of A + AR
D_4	Root dipping in 50% more than suggested dose of A + AR

Foliar spray	:	20, 30, 40 and 50 DAT
Method of application	:	Four (soil, foliar, root dipping and soil + foliar)
Design of Experiment	:	RBD
Replication	:	Three
Variety	:	Hisar Arun
Plot size	:	3 x 3 = 9 sq. m.
Total plots	:	17 x 3 = 51

EXPERIMENT - II

"Comparative studies of plant vitalizers and organic manures on tomato Cv. Hisar Arun".

Treatments and layout plan

The experiment consisting of four doses of plant vitalizers (Anupaan + Anupaan R), two organic manures (FYM and poultry manure) and one control was laid out in Randomized Block Design. There were 12 treatment combinations and each treatment combination was replicated three times and allotted randomly. The plot size for each treatment was 3.0m x 3.0m. The layout of the experiment presented in Fig. 3.

LAYOUT PLAN (EXPT. NO. 2)

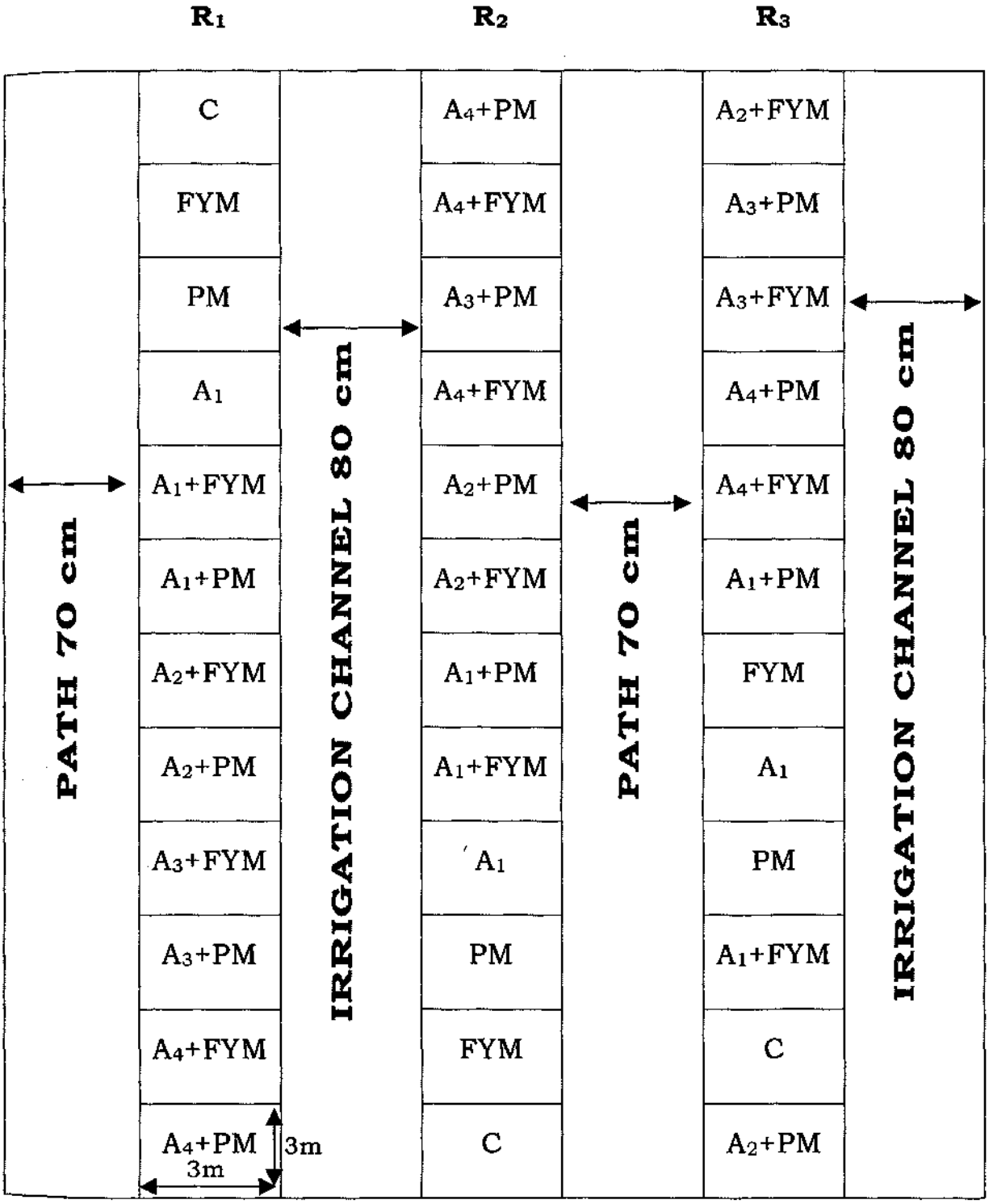

FIG. 3

TREATMENTS

Organic manures

FYM : Farm Yard Manure, Suggested dose (14 T/acre)

PM : Poultry Manure, Suggested does (23.5 q/acre)

Doses of plant vitalizes : Anupaan + Anupaan R (A + AR)

A_1 : suggested dose (225ml+225ml/acre)

A_2 : 25% less than suggested dose (168.75ml+168.75ml/acre)

A_3 : 25% more than suggested dose (281.25ml+281.25ml/acre)

A_4 : 50% more than suggested dose (337.50ml+337.50ml/acre)

Method of Application : One-soil

Treatment combinations : 12 given below:

C	Control
FYM	Farm yard manure
PM	Poultry manure
A_1	A + AR at suggested dose
A_1+FYM	A + AR at suggested dose + FYM
A_1+PM	A + AR at suggested dose + PM
A_2+FYM	A + AR at 25% less than suggested dose + FYM
A_2+PM	A + AR at 25% less than suggested dose + PM
A_3+FYM	A + AR at 25% more than suggested dose + FYM
A_3+PM	A + AR at 25% more than suggested dose + PM
A_4+FYM	A + AR at 50% more than suggested dose + FYM
A_4+PM	A + AR at 50% more than suggested dose + PM

Design of Experiment	:	RBD
Replications	:	Three
Variety	:	Hisar Arun
Plot Size	:	3.0 x 3.0 = 9 sq. m.
Total plots	:	12 x 3 = 36

Land preparation

The experimental field was prepared by three ploughings followed by planking to achieve good tilth so that suitable seed beds can be prepared. The field was divided into different plots measuring 3.0m x 3.0m having 80cm irrigation channel and 70cm path in between.

Nursery raising

The seeds of tomato variety Hisar Arun were sown in the well prepared nursery beds on December 3, 2000 for the first year crop and November 3, 2001 for the second year crop. After seed sowing nursery beds were irrigated daily with the help of watering cane till the seed germination. After that subsequent irrigations were done as and when required. Proper care was taken to protect the seedlings from frost and infestation of

insects and diseases till seedlings become ready for transplanting.

Application of organic manures and plant vitalizers (Anupaan + Anupaan R)

The suggested quantity of each organic manure i.e. FYM and poultry manure was added in the allocated plots and mixed well before preparing the ridges. The suggested quantity of Anupaan + Anupaan R with respect to treatment was mixed in small quantity of soil and then mixed in the respective plots before ridges preparation. For root dipping treatments, required quantity of Anupaan + Anupaan R was mixed in 1 litre of water and tomato seedlings were dipped for ten minutes at the time of transplanting. For foliar application, required quantity of Anupaan + Anupaan R were mixed in 1 liter of water and then sprayed with baby spray pump in respective treatment at 20, 30, 40 and 50 DAT.

Transplanting

The transplanting of seedlings was done on February 6, 2001 for the first year and January 4, 2002 for the second year crop. Seedlings ready for transplanting were taken from the nursery beds carefully without causing injury to their root and

foliage system. Uniformly selected healthy seedlings were transplanted at 45 cm apart on the ridges, made 60 cm distance. Experimental field was irrigated immediately after transplanting.

Irrigation and other cultural practices

The first irrigation was applied just after transplanting followed by second irrigation which was given five days after the first irrigation followed by gap filling. Subsequent irrigations were applied as and when required. Other cultural practices like hoeing, weeding, earthing up were carried out as and when required.

Harvesting

The harvesting was done in four pickings when fruits were ready for harvest i.e. red ripe fruits. The first picking was done on May 11, 2001 for first year crop and on April 23, 2002 for the second year crop. After that subsequent pickings were done as and when fruits ready for harvest.

Characters studied

The vegetative growth, flowering and fruiting behaviour of plant and yield and quality of tomato fruits were studied during the course of experimentation. Observations made on various parameters are as follows:

A. GROWTH PARAMETERS

For recording data on vegetative growth characters, five plants were selected at random from each treatment and tagged. The average value was calculated from the total of the data recorded from five plants as sample to represent the population.

Plant height

The height of plants was measured in centimeters from the base of the plant to apex of main shoot at 30, 60 and 90 days after transplanting.

Leaves per plant

Number of leaves per plant was counted at 90 days after transplanting.

Branches per plant

The number of primary and secondary branches per plant were counted at 90 days after transplanting.

Thickness of main stem

Randomly selected two plants were taken from each plot and their main stem thickness was measured with the help of vernier calliper.

Weight of leaves

After cutting all the leave of two selected plants were weighed and their average weight was recorded.

B. FLOWERING AND FRUITING BEHAVIOUR

Days to 50% flowering

The number of days required from the date of transplanting to the flowering in 50 per cent plants under each treatment were recorded.

Days to ripening from flower anthesis

The number of days required from the date of opening of first flower to ripening of first fruit under each treatment were recorded.

Fruit per cluster

The number of fruits from five randomly selected cluster of five selected plants from each treatment were counted and average number of fruit per cluster was calculated.

Fruit per plant

The total number of fruits from five selected plants on each picking were summed up and fruits per plant were calculated by dividing the total number of fruits by total number of plants.

Fruit size

Randomly ten fruits were taken from five selected plants in each treatment and weighed. By dividing the total fruits weight by ten, average fruit weight was calculated.

Fruit yield per plant

The weight of fruits from five selected plants in each treatment on each picking was recorded. Fruits yield per plant was calculated by dividing the total weight by five.

Fruit yield per hectare

Fruit weight recorded from all the pickings was added to calculate that yield in kg per plot from which the yield q/ha was calculated.

C. FRUIT QUALITY

Pulp and juice content

One hundred gram of fruit from each treatment was crushed and juice extracted by squeezing through muslin cloth. The juice, pulp and seed content were separated. The juice was measured with the help of a measuring glass cylinder and was recorded in per cent of total fruit weight. Pulp content was also recorded in per cent of total fruit weight.

Seed content

Seed content was calculated per 100g of fruit weight basis.

Total soluble solids (TSS)

Total soluble solids were determined with the help of Erma Hand Refractometer and expressed as per cent TSS

Acidity

Acid content of extracted juice was determined by titrating the fruit juice against N/10 NaOH using phenolphthalein as an indicator (A.O.A.C., 1975).

Ascorbic acid

Ascorbic acid content in tomato fruits was determined by 2, 6-dichlorophenol indophenol titration method (A.O.A.C. 1975) and expressed in mg per 100g of fruit weight.

Sugar content

Sugar was determined by the method expressed by Hulme and Narain (1931).

D. PHYSIOLOGICAL STUDIES

Chlorophyll (a & b) content of leaves

Photosynthetic pigment Chl 'a' and Chl 'b' were estimated according to the method of Hiscox and Irraelstom (1979) using Dimethyl sulfoxide (DMSO).

Dry matter accumulation in plant

To determine dry matter production per plant, plants were cut close to the ground at harvest. The plant samples were first dried in sun light and then oven dried at 60°C till constant weight was obtained.

Mineral composition of plant

Plant samples were dried in over at 60°C and than ground in grinder. Nitrogen, phosphorus, and potassium contents were estimated by following methods.

a) Nitrogen : Nessler's reagent method (Lindner, 1944)

b) Phosphorus : Yellow colour method (Koenig and Johnson, 1942).

c) Potassium : Flame photometer method (Jackson, 1967).

E. INCIDENCE OF PEST AND DISEASES

Tomato leaf curl virus (TLCV)

Plants infected with TLCV were counted per plot and converted into percentage.

Tomato fruit borer

Fruits infected with tomato fruit borer were counted per plot and converted into percentage.

Statistical analysis

The data recorded on various characteristics were analysed statistically by the method of variance in order to find out the significance and the result of each treatment as described by Panse and Sukhatme's (1967) method.

Analysis of variance

Source	d.f.	S.S.	M.S.	F. cal
Replication	r-1	SS_r	MS_r	$\frac{MS_r}{MS_e}$
Treatment	t-1	SS_t	MS_t	$\frac{MS_t}{MS_e}$
Error	(r-1)(t-1)	SS_e	MS_e	
Total	rt-1			

S.E. is the standard error of the difference of the treatment means which was calculated as follows:

$$S.Ed. = \sqrt{\frac{2EMs}{r}}$$

In order to compare the means of different treatments, the critical difference (C.D.) was calculated by using the below mentioned formula.

C.D. = S.E. x t

Where,

EMs = Error mean sum of squares

n = Number of replication

t = Tabulated value of 't' at 5% level of significance for error degree of freedom

Chapter – IV

Experimental Results

The results of the experiment have been explained with help of data recorded on various growth, yield attributing characters, yield and quality of fruits presented in various tables in this chapter.

EFFECT OF PLANT VITALIZERS (ANUPAAN + ANUPAAN R) ON TOMATO CV. HISAR ARUN

A. Growth studies

1. Plant height

The observations recorded on plant height at different stages of plant growth (30, 60 and 90 DAT) under the influence of different treatments presented in Table 2, did not show any significant response to different concentrations and methods of application of Anupaan + Anupaan R at various stages of plant growth during both the years. However, on the basis of mean value, the treatment S_4+F_4 gave better results as compared to

Table 2: Effect of Anupaan + Anupaan R on plant height (cm) at different stages of plant growth.

Sr. #	Treatments	30 DAT			60 DAT			90 DAT		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	17.1	16.5	**16.8**	25.5	26.7	**26.1**	36.3	32.9	**34.6**
2	S_1	22.0	19.9	**21.0**	29.2	33.7	**31.3**	48.0	43.1	**45.6**
3	S_2	21.4	17.7	**19.5**	29.1	26.7	**27.9**	38.3	39.0	**38.6**
4	S_3	23.2	20.5	**21.9**	33.5	29.9	**31.7**	49.1	47.9	**48.5**
5	S_4	24.5	20.7	**22.6**	36.4	32.7	**34.6**	49.9	48.1	**49.0**
6	F_1	19.5	20.1	**19.8**	36.5	36.0	**36.3**	46.0	43.6	**44.8**
7	F_2	19.9	19.3	**19.6**	35.1	35.0	**35.0**	41.8	34.6	**38.2**
8	F_3	20.5	20.8	**20.7**	36.1	35.0	**35.6**	44.9	44.7	**44.8**
9	F_4	22.3	20.9	**21.6**	41.0	36.9	**39.0**	48.9	52.4	**50.7**
10	$S_1 + F_1$	23.1	20.5	**21.8**	39.4	37.6	**38.6**	48.1	47.2	**47.7**
11	$S_2 + F_2$	20.3	19.1	**19.7**	32.7	35.3	**34.0**	45.0	43.9	**44.4**
12	$S_3 + F_3$	26.1	23.2	**24.6**	42.1	38.7	**40.4**	46.7	48.7	**47.7**
13	$S_4 + F_4$	28.8	24.0	**26.4**	42.2	42.5	**42.4**	56.2	53.5	**55.1**
14	D_1	20.1	19.7	**19.9**	32.6	34.6	**33.6**	45.9	47.5	**46.7**
15	D_2	19.6	19.3	**19.4**	30.1	32.7	**31.4**	38.9	44.4	**41.6**
16	D_3	21.4	20.7	**21.0**	35.7	35.1	**35.4**	48.1	50.5	**49.3**
17	D_4	22.2	21.7	**22.0**	36.7	37.7	**37.2**	49.1	51.6	**50.3**
SE (m)±		**3.1**	**1.5**		**4.9**	**2.1**		**6.6**	**3.0**	
C.D. at 5%		**NS**	**NS**		**NS**	**NS**		**NS**	**NS**	

other treatments and maximum plant height 26.4cm, 42.4cm and 55.1cm were noted at 30, 60 and 90 DAT, respectively under this treatment.

2. Leaves per plant (No.)

The leaves per plant were influenced significantly by different treatments of Anupaan+ Anupaan R in both the years (Table 3). The treatments S_3 +F_3 and S_4 +F_4 during both the years, F_4 in first year and S_1 +F_1 in second year were found significantly superior over control in increasing the number of leaves per plant but statistically at par with each other. The average value showed that the maximum number of leaves (71.7) were produced under treatment S_4 +F_4. The application of Anupaan + Anupaan R at 50% more than the suggested dose either applied in soil, foliar, root dipping or soil + foliar application was found beneficial as compared to other treatments in both the years.

3. Fresh weight of leaves per plant

The data pertaining to fresh weight of leaves per plant showed significant response to different treatments in both the years (Table 3). The treatments F_3, F_4 and S_3 +F_3 during first year and treatments S_4 and S_4 +F_4 during both the years,

Table 3: Effect of Anupaan + Anupaan R on number of leaves and fresh weight of leaves per plant at 90 DAT.

Sr. #	Treatments	Leaves/plant (#)			Fresh Wt. of leaves/plant (g)		
		2001	2002	Mean	2001	2002	Mean
1	Control	40.7	38.0	**39.3**	42.0	48.0	**45.0**
2	S_1	41.8	45.3	**43.6**	58.7	67.7	**63.2**
3	S_2	41.3	44.0	**42.7**	48.3	64.7	**56.5**
4	S_3	42.3	48.7	**45.5**	63.0	75.7	**69.3**
5	S_4	47.7	51.3	**49.5**	66.7	80.0	**73.3**
6	F_1	44.9	42.7	**43.8**	57.5	61.7	**59.6**
7	F_2	42.3	39.3	**40.8**	46.7	56.0	**51.3**
8	F_3	51.0	43.3	**47.2**	67.5	63.3	**65.4**
9	F_4	53.7	46.3	**50.0**	71.7	69.0	**70.3**
10	$S_1 + F_1$	50.3	53.3	**51.8**	60.0	65.0	**62.5**
11	$S_2 + F_2$	48.3	47.3	**47.8**	55.0	53.3	**54.2**
12	$S_3 + F_3$	55.7	64.3	**60.0**	66.7	73.3	**70.0**
13	$S_4 + F_4$	69.0	74.3	**71.7**	76.7	91.7	**84.2**
14	D_1	41.0	36.7	**38.8**	53.7	45.0	**49.3**
15	D_2	40.8	33.0	**36.9**	46.7	39.0	**42.8**
16	D_3	45.7	41.7	**43.7**	56.0	51.7	**53.8**
17	D_4	47.0	42.3	**44.7**	60.0	56.3	**58.2**
SE (m)±		**7.8**	**4.9**		**7.8**	**8.2**	
C.D. at 5%		**12.4**	**14.4**		**22.6**	**29.6**	

improved significantly the fresh weight of leaves per plant over control but all these treatments were statistically at par amongst each other. Perusal of mean reveal that S_4 +F_4 treatment produced maximum fresh weight of leaves per plant (84.2g).

4. Branches per plant

The data regarding number of branches per plant presented in Table 4, indicate that all the treatments gave non-significant results with respect to number of branches per plant during both the years. However, on the basis of observed value highest number of branches per plant (7.8) was recorded in S_4 +F_4 treatment.

5. Thickness of main stem

The effect of different treatments of Anupaan +Anupaan R on diameter of main stem are summarized in Table 4. The treatments S_3 +F_3, S_4 +F_4 during both the years and treatments S_4, F_3 , F_4 and D_4 only during the second year showed significant higher diameter over control. The treatment S_3 +F_3 and S_3 +F_4 were statistically at par with each other during both the years but significantly superior to other treatments during second year. ON the basis of mean value, maximum diameter of

Table 4: Effect of Anupaan + Anupaan R on branches/plant and thickness of main stem at 90 DAT.

Sr. #	Treatments	Branches/ Plant (#)			Diameter of main stem (cm)		
		2001	2002	Mean	2001	2002	Mean
1	Control	5.4	5.3	**5.4**	0.9	0.8	**0.8**
2	S_1	6.8	5.8	**6.3**	1.2	1.1	**1.2**
3	S_2	6.2	5.4	**5.8**	1.2	1.1	**1.1**
4	S_3	7.0	5.7	**6.4**	1.3	1.1	**1.2**
5	S_4	8.0	5.9	**7.0**	1.3	1.2	**1.2**
6	F_1	7.0	6.1	**6.5**	1.1	1.1	**1.1**
7	F_2	6.7	6.0	**6.3**	1.0	1.0	**1.0**
8	F_3	7.2	6.2	**6.7**	1.3	1.3	**1.3**
9	F_4	8.7	6.3	**7.5**	1.3	1.3	**1.3**
10	$S_1 + F_1$	7.7	6.0	**6.9**	1.3	1.0	**1.1**
11	$S_2 + F_2$	5.7	5.7	**5.7**	1.2	0.9	**1.1**
12	$S_3 + F_3$	9.0	6.2	**7.6**	1.8	1.8	**1.8**
13	$S_4 + F_4$	9.3	6.3	**7.8**	2.0	1.8	**1.9**
14	D_1	6.8	6.1	**6.5**	1.3	1.1	**1.2**
15	D_2	6.5	5.6	**6.1**	1.0	1.0	**1.0**
16	D_3	8.8	6.2	**7.5**	1.2	1.1	**1.2**
17	D_4	9.1	6.2	**7.7**	1.3	1.3	**1.3**
SE (m)±		**1.6**	**0.5**		**0.2**	**0.1**	
C.D. at 5%		**NS**	**NS**		**0.5**	**0.3**	

main stem (1.9cm) was recorded in S_4 +F_4 treatment followed by S_3 +F_3 treatment (1.8cm).

B. Physiological studies

1. Chlorophyll 'a' and 'b' content of leaves

The analysis for chlorophyll 'a' and 'b' (Table 5) indicate that chlorophyll 'a' and 'b' contents of leaves were not affected significantly by different treatments of Anupaan + Anupaan R during both the years.

2. Dry matter accumulation of plant

The dry matter accumulation of plant reveal that all the treatments of Anupaan + Anupaan R showed significant response in improving the dry matter accumulation of plant over control during both the years. Whereas, these treatments were statistically at par during both the years. On the basis of data gathered in Table 5, highest production of dry matter (118.9g) per plant was noted in treatment S_4 +F_4.

3. Mineral Composition of plant

Nitrogen content of plant in the second year and phosphorus and potassium contents of plant during both the years were influenced significantly by different treatments of Anupaan + Anupaan R (Table 6). The treatments S_4, S_3 +F_3, S_4

Table 5: Effect of Anupaan + Anupaan R on chlorophyll 'a' and 'b' content of leaves at 65 DAT and dry matter content of plant at harvest.

Sr. #	Treatments	Chlorophyll 'a' (mg/g)			Chlorophyll 'b' (mg/g)			Dry matter/ Plant (g)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	2.6	2.5	**2.5**	1.4	1.4	**1.4**	47.7	44.9	**46.3**
2	S_1	2.7	2.7	**2.7**	1.4	1.4	**1.4**	100.4	96.8	**98.6**
3	S_2	2.7	2.7	**2.7**	1.4	1.4	**1.4**	92.2	91.8	**92.0**
4	S_3	2.8	2.8	**2.8**	1.5	1.5	**1.5**	105.1	100.3	**102.7**
5	S_4	2.8	2.8	**2.8**	1.5	1.5	**1.5**	112.9	107.8	**110.4**
6	F_1	2.9	3.0	**2.9**	1.4	1.5	**1.5**	112.6	110.5	**111.6**
7	F_2	2.9	2.9	**2.9**	1.4	1.4	**1.4**	103.1	103.0	**103.0**
8	F_3	3.0	3.0	**3.0**	1.5	1.5	**1.5**	114.2	112.8	**113.5**
9	F_4	3.0	3.0	**3.0**	1.5	1.5	**1.5**	116.8	114.5	**115.6**
10	$S_1 + F_1$	3.0	3.0	**3.0**	1.4	1.5	**1.4**	107.7	103.2	**105.4**
11	$S_2 + F_2$	2.9	2.9	**2.9**	1.4	1.5	**1.5**	106.1	101.1	**103.6**
12	$S_3 + F_3$	3.0	3.0	**3.0**	1.5	1.5	**1.5**	120.2	112.3	**116.3**
13	$S_4 + F_4$	3.0	3.0	**3.0**	1.5	1.5	**1.5**	122.5	115.8	**118.9**
14	D_1	2.9	2.9	**2.9**	1.4	1.4	**1.4**	109.0	104.0	**106.5**
15	D_2	2.9	2.9	**2.9**	1.4	1.4	**1.4**	107.1	102.8	**105.0**
16	D_3	3.0	2.9	**3.0**	1.4	1.4	**1.5**	112.3	110.9	**111.6**
17	D_4	3.0	3.0	**3.0**	1.5	1.5	**1.5**	114.7	113.2	**113.9**
SE (m)±		**0.4**	**0.5**		**0.2**	**0.2**		**11.7**	**8.9**	
C.D. at 5%		**NS**	**NS**		**NS**	**NS**		**33.9**	**26.5**	

Table 6: Effect of Anupaan + Anupaan R on mineral composition of tomato plant.

Sr. #	Treatments	N Content (%)			P Content (%)			K Content (%)		
		2001	**2002**	**Mean**	**2001**	**2002**	**Mean**	**2001**	**2002**	**Mean**
1	Control	0.705	0.703	**0.704**	0.104	0.103	**0.103**	0.309	0.306	**0.307**
2	S_1	0.708	0.705	**0.706**	0.106	0.104	**0.105**	0.316	0.312	**0.314**
3	S_2	0.705	0.700	**0.702**	0.105	0.103	**0.104**	0.313	0.310	**0.311**
4	S_3	0.711	0.708	**0.709**	0.108	0.106	**0.107**	0.317	0.314	**0.315**
5	S_4	0.715	0.711	**0.713**	0.112	0.110	**0.111**	0.319	0.317	**0.318**
6	F_1	0.706	0.703	**0.704**	0.107	0.105	**0.106**	0.314	0.315	**0.314**
7	F_2	0.707	0.704	**0.705**	0.104	0.102	**0.103**	0.311	0.311	**0.311**
8	F_3	0.711	0.708	**0.709**	0.114	0.112	**0.113**	0.319	0.315	**0.317**
9	F_4	0.715	0.708	**0.711**	0.114	0.118	**0.116**	0.318	0.317	**0.317**
10	$S_1 + F_1$	0.707	0.705	**0.706**	0.114	0.112	**0.113**	0.318	0.318	**0.318**
11	$S_2 + F_2$	0.706	0.705	**0.705**	0.109	0.107	**0.108**	0.316	0.314	**0.315**
12	$S_3 + F_3$	0.712	0.710	**0.711**	0.118	0.116	**0.117**	0.320	0.320	**0.320**
13	$S_4 + F_4$	0.715	0.711	**0.713**	0.117	0.123	**0.120**	0.317	0.324	**0.320**
14	D_1	0.708	0.705	**0.706**	0.114	0.112	**0.113**	0.315	0.314	**0.314**
15	D_2	0.707	0.704	**0.705**	0.112	0.110	**0.111**	0.315	0.315	**0.315**
16	D_3	0.712	0.709	**0.710**	0.119	0.116	**0.117**	0.319	0.318	**0.318**
17	D_4	0.714	0.710	**0.712**	0.118	0.116	**0.117**	0.320	0.319	**0.319**
SE (m)±		**0.002**	**0.002**		**0.003**	**0.002**		**0.002**	**0.002**	
C.D. at 5%		**NS**	**0.005**		**0.008**	**0.005**		**0.006**	**0.006**	

+F_4, D_3 and D_4 were found significant over control with respect to nitrogen content of plant but statistically at par during the second year. The maximum nitrogen content (0.713%) was noted in S_4 and S_4 +F_4 treatments.

The phosphorus content of plant was improved significantly over control by the treatments F_3, F_4, S_1 +F_1, S_3 + F_3, S_4+F_4, D_1, D_3 and D_4 during both the years whereas, S_4 and D_2 treatments showed significant results only during second year. In first year all the treatments were statistically at par but during second year the treatment F_4, S_3 +F_3, S_4 +F_4, D_3 and D_4 were significantly superior than other treatments. The average of two years showed phosphorus content (0.120%) under the treatment S_4 +F_4.

The Treatments S_3, S_4, F_3, F_4, S_1 +F_1, S_2+F_2, S_3+F_3, S_4 +F_4, D_3 and D_4 showed significant results over control with respect to potassium content of plant during both the years. The treatment S_1 during first year and F_1, D_1 and D_2 treatment during the second year also improved significantly for potassium content in plant over control. All these treatments were statistically at par during both the year except S_4 +F_4 treatment

during second year only. Perusal of data showed maximum potassium content (0.320%) in S_3 +F_3 and S_4 +F_4 treatments.

C. Flowering and fruiting behaviour

1. Days to 50% flowering

Days to 50% flowering was not significantly affected due to different treatments of Anupaan + Anupaan R during both the years. However, on the basis of mean value, treatment S_4 + F_4 gave better results as compared to other treatments under which flowering took 41.3 days whereas, it was 47.3 days in control plot (Table 7).

2. Days to fruit ripening from flower anthesis

The number of days to fruit ripening from flower anthesis was not affected significantly by the variation in treatments of Anupaan + Anupaan R during both the years. However, on the basis of mean, lowest duration (46.2) were taken by S_4 + F_4 treatment whereas, in case of control it ripened in 51.2 days (Table 7).

3. Fruit per cluster

The observations regarding number of fruits per cluster summarized in Table 8, reveal that all the treatments showed non-significant results with respect to fruits per cluster

Table 7: Effect of Anupaan + Anupaan R on days to 50% flowering and days to fruit ripening from flower anthesis.

Sr. #	Treatments	Days to 50% flowering			Days to fruit ripening from flower anthesis		
		2001	2002	Mean	2001	2002	Mean
1	Control	46.0	48.7	**47.3**	50.0	52.3	**51.2**
2	S_1	42.7	42.0	**42.3**	48.7	47.1	**47.9**
3	S_2	42.7	43.3	**43.0**	47.3	47.7	**47.5**
4	S_3	41.3	43.7	**42.5**	47.7	47.0	**47.3**
5	S_4	42.3	42.0	**42.2**	48.0	47.7	**47.8**
6	F_1	43.0	41.7	**42.3**	49.3	48.2	**48.7**
7	F_2	42.7	42.7	**42.7**	48.1	47.3	**47.7**
8	F_3	43.3	43.3	**43.3**	49.7	48.2	**49.0**
9	F_4	43.7	42.0	**42.8**	49.7	49.3	**49.5**
10	$S_1 + F_1$	43.3	43.3	**43.3**	48.7	48.0	**48.3**
11	$S_2 + F_2$	42.3	42.7	**43.5**	48.1	49.7	**48.9**
12	$S_3 + F_3$	42.7	42.0	**42.3**	47.3	47.7	**47.5**
13	$S_4 + F_4$	41.7	41.0	**41.3**	46.4	46.1	**46.2**
14	D_1	44.7	41.3	**43.0**	50.7	43.0	**49.8**
15	D_2	43.7	43.3	**43.5**	47.0	48.7	**47.8**
16	D_3	44.3	41.7	**43.0**	49.3	50.0	**49.7**
17	D_4	43.0	43.7	**43.3**	49.7	48.3	**49.0**
SE (m)±		**1.4**	**1.0**		**1.5**	**1.0**	
C.D. at 5%		**NS**	**NS**		**NS**	**NS**	

Table 8: Effect of Anupaan + Anupaan R on number of fruits/cluster, number of fruits/plant and fruit size.

Sr. #	Treatments	Fruit/Cluster (#)			Fruit/Plant (#)			Fruit size (g)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	2.0	2.3	**2.2**	12.9	14.9	**13.4**	13.7	16.7	**15.2**
2	S_1	2.3	3.0	**2.7**	22.8	20.8	**21.8**	15.7	17.6	**16.7**
3	S_2	2.3	2.3	**2.3**	21.5	19.9	**20.7**	15.9	16.1	**16.0**
4	S_3	3.0	3.0	**3.0**	25.3	23.6	**24.4**	14.9	16.6	**15.8**
5	S_4	3.3	3.3	**3.3**	26.9	25.2	**26.1**	14.6	16.0	**15.3**
6	F_1	3.0	3.0	**3.0**	21.3	20.1	**20.7**	17.0	17.0	**17.0**
7	F_2	2.3	2.7	**2.5**	20.6	19.4	**20.0**	13.0	17.0	**17.0**
8	F_3	3.0	3.0	**3.0**	27.4	26.4	**26.9**	14.3	14.1	**14.2**
9	F_4	3.3	3.3	**3.3**	28.8	26.8	**27.8**	14.9	15.3	**15.1**
10	$S_1 + F_1$	3.0	3.0	**3.0**	29.4	27.1	**28.2**	14.5	15.0	**14.8**
11	$S_2 + F_2$	2.0	2.7	**2.3**	27.5	25.6	**26.5**	15.1	15.5	**15.3**
12	$S_3 + F_3$	3.0	3.3	**3.2**	33.6	28.7	**31.2**	13.5	16.0	**14.8**
13	$S_4 + F_4$	3.3	3.7	**3.5**	35.8	34.2	**35.0**	16.6	17.4	**17.0**
14	D_1	2.3	3.0	**2.7**	28.0	26.2	**27.1**	12.7	12.9	**12.8**
15	D_2	2.3	3.0	**2.7**	22.6	21.1	**21.8**	15.0	15.0	**15.0**
16	D_3	2.7	3.3	**3.0**	29.5	28.0	**28.7**	12.9	12.9	**12.9**
17	D_4	3.0	3.7	**3.3**	34.4	31.3	**32.9**	11.6	12.2	**11.9**
SE (m)±		**0.5**	**0.4**		**3.4**	**3.3**		**7.3**	**3.6**	
C.D. at 5%		**NS**	**NS**		**9.8**	**6.9**		**NS**	**NS**	

during both the years. However, with in the mean observations, maximum number of fruits per cluster (3.5) was recorded in S_4 + F_4 treatment.

4. Fruits per plant

The data pertaining to number of fruits per plant presented in Table 8, indicate that all the treatments increased significantly the number of fruits per plant over control except S_2, F_1, F_2 and D_2 during both the years and S_1 during second year. The highest number of fruits per plant (35.8) was recorded in S_4 + F_4 treatment during first year which was significantly superior to S_1 and S_3 treatment and statistically at par with above mentioned other treatments. During second year maximum number of fruits per plant (34.2) was also recorded in S_4 + F_4 treatment which was significantly superior to all the above said treatments except S_3 + F_3, D_3 and D_4 treatments where these were statistically at par. On the basis of observed values, maximum number of fruits per plant (35.0) was counted under the treatment S_4 + F_4.

5. Fruit size

The fruit size was not affected significantly by different treatments of Anupaan + Anupaan R during both the

years. However, information in Table 8 indicate that largest fruit size (17.0g) were produced by $S_4 + F_4$, F_1 and F_2 treatments.

6. Fruit yield per plant

The perusal of data in Table 9 on fruit yield per plant indicate that different treatments of Anupaan + Anupaan R affected significantly the fruit yield per plant. The treatments F_4, $S_1 + F_1$, $S_3 + F_3$ and $S_4 + F_4$ during both the years and the treatments S_3, S_4, F_3, $S_2 + F_2$, D_3 and D_4 during first year showed significant results over control. The maximum fruit yield per plant (0.49kg) was recorded with $S_4 + F_4$ treatment during both the years. This treatment was significantly superior to all other treatments but at par with $S_3 + F_3$ treatment.

7. Fruit yield per hectare

The data on fruit yield per hectare presented in Table 9, reveal that all the treatments of Anupaan + Anupaan R significantly increased the fruit yield per hectare over control during both the years except S_2, F_1, F_2 and D_2 treatments during both the years and D_1 treatment during the first year. Maximum fruit yield per hectare i.e. 17.0 t/ha and 16.4 t/ha was recorded with $S_4 + F_4$ treatment during first and second year, respectively. The treatment $S_4 + F_4$ was found significantly superior to all

Table 9: Effect of Anupaan + Anupaan R on fruit yield per plant and fruit yield per hectare.

Sr. #	Treatments	Fruit yield (kg/plant)			Fruit yield (t/ha)		
		2001	2002	Mean	2001	2002	Mean
1	Control	0.31	0.32	**0.31**	10.2	10.5	**10.3**
2	S_1	0.36	0.37	**0.36**	12.8	12.2	**12.5**
3	S_2	0.34	0.32	**0.33**	11.4	10.7	**11.0**
4	S_3	0.38	0.39	**0.38**	13.7	13.1	**13.3**
5	S_4	0.39	0.40	**0.40**	14.2	13.4	**13.7**
6	F_1	0.36	0.34	**0.35**	12.0	11.4	**11.7**
7	F_2	0.35	0.33	**0.34**	11.7	11.0	**11.3**
8	F_3	0.39	0.37	**0.38**	13.0	12.4	**12.7**
9	F_4	0.43	0.41	**0.42**	14.3	13.7	**13.9**
10	$S_1 + F_1$	0.43	0.41	**0.42**	14.2	13.5	**13.8**
11	$S_2 + F_2$	0.42	0.40	**0.41**	13.8	13.2	**13.5**
12	$S_3 + F_3$	0.45	0.46	**0.46**	15.9	15.3	**15.6**
13	$S_4 + F_4$	0.49	0.49	**0.49**	17.0	16.4	**16.7**
14	D_1	0.36	0.34	**0.35**	11.9	12.0	**11.9**
15	D_2	0.34	0.32	**0.33**	11.2	11.2	**11.2**
16	D_3	0.38	0.36	**0.37**	12.7	12.7	**12.6**
17	D_4	0.40	0.38	**0.39**	13.3	13.2	**13.2**
SE (m)±		**0.02**	**0.02**		**0.7**	**0.5**	
C.D. at 5%		**0.06**	**0.08**		**2.0**	**1.2**	

other treatments but statistically at par with S_3 + F_3 treatment during both the years.

D. Fruit quality

1. Pulp, juice and seed content

The observed values presented in Table 10 show that the pulp, juice and seed contents of tomato fruit were not influenced significantly by various treatments of Anupaan + Anupaan R during both the years.

2. Total soluble solids and sugar content

The total soluble solids (TSS) and sugar content of tomato fruit were not affected significantly by different treatments of Anupaan + Anupaan R during both the years (Table 11). However, on the basis of mean value, maximum TSS and sugar content (6.2% and 4.1%), respectively, of tomato fruit was recorded in S_4 + F_4 treatment.

3. Acidity

The influence of different treatments of Anupaan + Anupaan R on acidity was significant. Data summarized in Table 12 indicate that only S_4 + F_4 treatment significantly increased the acid content of tomato fruit over control during both the years. Higher acidity (0.9%) was recorded in S_4 + F_4 treatment,

Table 10: Effect of Anupaan + Anupaan R on pulp, juice and seed contents.

Sr. #	Treatments	Pulp Content (%)			Juice Content (%)			Seed Content (g/100g)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	49.4	50.2	**49.8**	50.0	49.2	**49.6**	0.3	0.2	**0.2**
2	S_1	49.2	46.3	**47.7**	49.8	53.0	**51.4**	0.4	0.2	**0.3**
3	S_2	48.8	46.8	**47.8**	50.1	52.6	**51.1**	0.3	0.3	**0.3**
4	S_3	48.8	47.2	**48.0**	50.5	52.2	**51.3**	0.3	0.3	**0.3**
5	S_4	50.8	51.9	**51.4**	48.0	47.0	**47.5**	0.4	0.3	**0.3**
6	F_1	49.2	47.5	**48.3**	49.6	51.4	**50.5**	0.3	0.3	**0.3**
7	F_2	48.2	49.2	**48.7**	50.9	49.8	**50.4**	0.3	0.2	**0.3**
8	F_3	46.8	49.1	**48.0**	52.2	49.8	**51.0**	0.3	0.3	**0.3**
9	F_4	47.7	48.7	**48.2**	51.5	50.5	**51.0**	0.3	0.3	**0.3**
10	$S_1 + F_1$	50.0	49.0	**49.5**	49.0	50.0	**49.5**	0.3	0.3	**0.3**
11	$S_2 + F_2$	47.1	46.1	**46.6**	51.7	52.7	**52.2**	0.3	0.3	**0.3**
12	$S_3 + F_3$	51.5	47.5	**49.5**	47.7	51.6	**49.7**	0.3	0.3	**0.3**
13	$S_4 + F_4$	54.0	49.0	**51.5**	45.2	50.2	**47.7**	0.4	0.3	**0.3**
14	D_1	46.5	48.1	**47.3**	52.5	50.8	**51.6**	0.3	0.2	**0.2**
15	D_2	48.6	49.3	**49.0**	51.2	49.7	**50.5**	0.2	0.2	**0.2**
16	D_3	49.8	48.2	**49.0**	49.3	51.0	**50.2**	0.2	0.2	**0.3**
17	D_4	48.7	50.0	**49.3**	50.6	49.2	**49.9**	0.3	0.3	**0.3**
SE (m)±		**7.4**	**3.6**		**8.7**	**3.6**		**0.1**	**0.1**	
C.D. at 5%		**NS**	**NS**		**NS**	**NS**		**NS**	**NS**	

Table 11: Effect of Anupaan + Anupaan R on TSS and Sugar content of tomato fruit.

Sr. #	Treatments	T.S.S (%)			Sugar content (%)		
		2001	2002	Mean	2001	2002	Mean
1	Control	4.0	4.3	**4.2**	2.6	2.5	**2.6**
2	S_1	4.4	4.9	**4.6**	3.1	3.1	**3.1**
3	S_2	3.7	4.5	**4.1**	3.0	3.0	**3.0**
4	S_3	3.9	5.2	**4.6**	3.2	3.2	**3.2**
5	S_4	4.0	6.0	**5.0**	3.3	3.2	**3.2**
6	F_1	4.5	4.9	**4.7**	3.3	3.2	**3.2**
7	F_2	4.5	4.6	**4.6**	3.2	3.1	**3.2**
8	F_3	4.5	5.1	**4.8**	3.3	3.3	**3.3**
9	F_4	4.6	5.8	**5.2**	3.5	3.4	**3.4**
10	$S_1 + F_1$	4.1	4.5	**4.3**	3.4	3.3	**3.3**
11	$S_2 + F_2$	4.0	4.3	**4.2**	3.3	3.2	**3.3**
12	$S_3 + F_3$	5.6	5.9	**5.7**	3.4	3.4	**3.4**
13	$S_4 + F_4$	6.0	6.3	**6.2**	5.1	3.1	**4.1**
14	D_1	4.3	4.5	**4.4**	3.1	3.1	**3.1**
15	D_2	4.3	4.4	**4.3**	3.1	3.0	**3.1**
16	D_3	4.6	5.2	**4.9**	3.1	3.1	**3.1**
17	D_4	4.9	5.5	**5.2**	3.2	3.2	**3.2**
SE (m)±		**0.4**	**0.3**		**0.3**	**0.2**	
C.D. at 5%		**NS**	**NS**		**N.S.**	**N.S.**	

Table 12: Effect of Anupaan + Anupaan R on quality of tomato fruit.

Sr. #	Treatments	Acidity (%)			Ascorbic acid (mg/100g fruit)		
		2001	2002	Mean	2001	2002	Mean
1	Control	0.5	0.5	**0.5**	19.8	27.1	**23.4**
2	S_1	0.5	0.6	**0.5**	23.4	26.7	**25.0**
3	S_2	0.5	0.5	**0.5**	23.7	25.9	**24.8**
4	S_3	0.6	0.6	**0.6**	22.5	26.2	**24.4**
5	S_4	0.6	0.6	**0.6**	22.9	26.9	**24.9**
6	F_1	0.6	0.5	**0.5**	24.5	25.8	**25.2**
7	F_2	0.5	0.5	**0.5**	25.2	27.5	**26.4**
8	F_3	0.6	0.5	**0.6**	24.6	28.2	**26.4**
9	F_4	0.6	0.5	**0.6**	20.2	25.9	**23.0**
10	$S_1 + F_1$	0.5	0.5	**0.5**	24.1	28.7	**26.4**
11	$S_2 + F_2$	0.5	0.5	**0.5**	26.5	25.6	**26.1**
12	$S_3 + F_3$	0.7	0.6	**0.6**	23.6	26.5	**25.0**
13	$S_4 + F_4$	0.9	0.9	**0.9**	24.4	27.3	**25.9**
14	D_1	0.5	0.5	**0.5**	30.0	27.6	**28.8**
15	D_2	0.5	0.5	**0.5**	23.0	25.7	**24.4**
16	D_3	0.5	0.5	**0.5**	24.9	24.1	**24.5**
17	D_4	0.6	0.6	**0.6**	25.2	28.4	**26.8**
SE (m)±		**0.1**	**0.1**		**6.4**	**1.9**	
C.D. at 5%		**0.3**	**0.3**		**NS**	**NS**	

which was significantly superior to all other treatments during both the years but statistically at par with S_3 + F_3 treatment during first year.

4. Ascorbic Acid

The data regarding ascorbic acid of tomato fruit presented in Table 12 indicate that the ascorbic acid content of tomato fruit during both the years was not affected statistically by the application of Anupaan + Anupaan R. However, on the basis of observed value, treatment S_4 + F_4 maintained its superiority (28.8 mg/100 g fruit).

E. Incidence of pest and diseases

1. Tomato leaf curl virus (TLCV)

The observations on tomato leaf curl virus affected plants per plot recorded in Table 13 indicate that all the treatments had non-significant effect on incidence of TLCV during both the years. However, the data indicate minimum infestation (1.7%) by TLCV under the treatment S_4 + F_4 as compared to other treatments.

2. Tomato fruit borer

The data pertaining to tomato fruit borer indicate that all the treatments of Anupaan + Anupaan R significantly lowered

Table 13: Effect of Anupaan + Anupaan R on tomato leaf curl virus plants/plot, and tomato fruit borer.

Sr. #	Treatments	TLCV plants /plot (%)			Tomato Fruit Borer (%)		
		2001	2002	Mean	2001	2002	Mean
1	Control	6.7	6.7	**6.7**	39.2	39.9	**39.6**
2	S_1	3.3	6.7	**5.0**	35.0	35.0	**35.0**
3	S_2	6.7	3.3	**5.0**	38.3	36.8	**37.5**
4	S_3	6.7	1.7	**4.2**	29.9	30.1	**30.0**
5	S_4	3.3	1.7	**2.5**	20.6	25.1	**22.8**
6	F_1	3.3	3.3	**3.3**	27.9	26.2	**27.1**
7	F_2	6.7	1.7	**4.0**	31.2	29.3	**30.2**
8	F_3	3.3	1.7	**2.5**	20.1	23.0	**21.6**
9	F_4	3.3	1.7	**2.5**	17.0	17.8	**17.4**
10	$S_1 + F_1$	3.3	1.7	**2.5**	18.6	17.1	**17.8**
11	$S_2 + F_2$	3.3	3.3	**3.3**	19.1	22.1	**20.6**
12	$S_3 + F_3$	3.3	1.7	**2.5**	18.6	17.0	**17.8**
13	$S_4 + F_4$	1.7	1.7	**1.7**	13.2	13.0	**13.1**
14	D_1	3.3	3.3	**3.3**	32.9	32.4	**32.6**
15	D_2	6.7	3.3	**5.0**	34.7	34.1	**34.4**
16	D_3	3.3	3.3	**3.3**	26.5	17.6	**22.0**
17	D_4	3.3	1.7	**2.5**	24.7	12.2	**18.4**
SE (m)±		**0.6**	**0.5**		**2.8**	**3.1**	
C.D. at 5%		**NS**	**NS**		**7.2**	**8.3**	

the tomato fruit borer attack as compared to control except, S_1, S_2, D_1 and D_2 treatments during both the years. The lowest number of affected fruits (13.2%) by tomato fruit borer was recorded under $S_4 + F_4$ treatment during first year which was significantly superior to all the treatments except F_3, F_4, $S_1 + F_1$, $S_2 + F_2$ and $S_3 + F_3$ treatments which were statistically at par. Whereas, in second year, minimum infection (12.2%) by tomato fruit borer was recorded in D_4 treatment which was statistically at par with F_4, $S_1 + F_1$, $S_3 + F_3$, $S_4 + F_4$ and D_3 treatments and significantly superior to rest of the treatments (Table 13).

COMPARATIVE STUDIES OF PLANT VITALIZERS AND ORGANIC MANURES ON TOMATO CV. HISAR ARUN

A. Growth studies

1. Plant height

The plant height was not affected significantly by different treatments of organic manures and Anupaan + Anupaan R at various stages of plant growth (30, 60 and 90 DAT) during both the years. However, on average basis, the treatment A_4 + PM produced taller plants at all the stages of plant growth as compared to other treatments (Table 14).

Table 14: Effect of Anupaan + Anupaan R and organic manures on plant height (cm) at different stages of plant growth.

Sr. #	Treatments	30 DAT			60 DAT			90 DAT		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	18.2	17.7	**18.0**	26.3	24.6	**25.5**	36.3	33.3	**34.8**
2	FYM	20.1	22.3	**21.2**	38.1	38.7	**38.4**	44.5	44.1	**44.3**
3	PM	21.9	24.3	**23.1**	38.5	40.8	**39.7**	48.3	49.2	**47.8**
4	A_1	19.1	18.9	**19.0**	32.5	36.8	**34.6**	42.7	44.0	**43.3**
5	A_1+FYM	21.1	25.7	**23.4**	39.6	42.5	**41.1**	45.2	49.6	**47.4**
6	A_1+PM	23.5	27.5	**25.5**	43.3	43.6	**43.5**	48.3	54.8	**51.6**
7	A_2+FYM	20.3	24.6	**22.5**	39.3	39.5	**39.4**	41.3	46.0	**43.6**
8	A_2+PM	22.4	24.1	**23.3**	41.1	43.0	**42.0**	43.7	48.3	**46.0**
9	A_3+FYM	24.9	27.3	**26.1**	43.1	46.7	**44.9**	48.0	56.5	**52.3**
10	A_3+PM	25.0	29.1	**27.0**	44.7	49.3	**47.0**	52.6	54.0	**53.3**
11	A_4+FYM	27.3	29.1	**28.2**	45.6	49.7	**47.7**	54.3	60.9	**57.6**
12	A_4+PM	30.1	33.2	**31.7**	48.9	50.8	**49.8**	61.4	68.7	**65.1**
SE (m)±		**4.0**	**1.3**		**5.9**	**2.7**		**5.2**	**5.2**	
C.D. at 5%		**N.S.**	**N.S.**		**N.S.**	**N.S.**		**N.S.**	**N.S.**	

2. Leaves per plant

The data presented in Table 15 reveal that leaves per plant was significantly increased by all the treatments of organic manure and Anupaan + Anupaan R except PM, A_1 + FYM and A_2 + FYM during first year and FYM and A_1 treatments during both the years. The maximum number of leaves per plant (75.3) was recorded under the treatment A_4 + PM during first year which was significantly superior to FYM, PM A_1 and A_2 + FYM treatments and statistically at par with rest of the treatments. During second year the maximum number of leaves (84.0) per plant was recorded under A_4 + PM treatment which was significantly superior to all the treatments but statistically at par with A_3 + PM and A_4 + FYM treatments.

3. Fresh weight of leaves per plant

The observations related to fresh weight of leaves per plant gathered in Table 15 indicate that all the treatments of organic manures and Anupaan + Anupaan R significantly increased the fresh weight of leaves per plant over control except FYM, A_1 and A_2 + FYM during both the years. The highest fresh weight of leaves per plant i.e. 136.7g and 151.7g were recorded with A_3 + PM and A_4 + PM treatments during first year and

Table 15: Effect of Anupaan + Anupaan R and organic manures on number of leaves and fresh weight of leaves per plant at 90 DAT.

Sr. #	Treatments	Leaves/ Plant (#)			Fresh Wt. of leaves/plant (g)		
		2001	2002	Mean	2001	2002	Mean
1	Control	46.3	45.7	**46.0**	76.7	68.3	**72.5**
2	FYM	54.0	55.7	**54.8**	96.7	98.3	**97.5**
3	PM	58.3	59.7	**59.0**	113.3	121.3	**117.3**
4	A_1	51.7	49.0	**50.3**	88.7	83.3	**86.0**
5	A_1+FYM	59.7	60.2	**59.9**	115.3	118.7	**117.0**
6	A_1+PM	68.3	71.1	**69.7**	128.3	135.0	**131.7**
7	A_2+FYM	55.7	57.3	**56.5**	105.0	108.3	**106.7**
8	A_2+PM	63.0	65.7	**64.3**	120.0	126.7	**123.3**
9	A_3+FYM	64.3	67.3	**65.8**	124.7	131.7	**128.2**
10	A_3+PM	71.7	77.3	**74.5**	136.7	142.3	**139.5**
11	A_4+FYM	68.7	78.0	**73.3**	129.7	143.0	**136.3**
12	A_4+PM	75.3	84.0	**79.7**	132.3	151.7	**142.0**
SE (m)±		**5.3**	**3.6**		**11.2**	**15.9**	
C.D. at 5%		**15.7**	**10.6**		**33.1**	**47.0**	

second year, respectively. These treatments were significantly superior to FYM and A_1 treatments and statistically at par with rest of the other treatments.

4. Branches per plant

Number of branches per plant did not show any significant response to different treatments of organic manures and Anupaan + Anupaan R during both the years. However, A_3 + PM and A_4 + PM treatment gave better results (1.7) as compared to other treatments (Table 16).

5. Thickness of main stem

The diameter of main stem was significantly influenced by different treatments of organic manures and Anupaan + Anupaan R (Table 16). It was significantly increased under all the treatments over control during both the years except A_1 treatment during first year. The maximum diameter of main stem (2.0 and 1.7 cm) was recorded in A_4 + PM treatment during first year and second year, respectively. A_4 + PM treatment was statistically at par with A_3 + PM and A_4 + FYM treatments during first year and A_4 + FYM treatment during second year and significantly superior to rest of the treatments during the respective years (Table 16).

Table 16: Effect of Anupaan + Anupaan R and organic manures on branches/plant and thickness of main stem.

Sr. #	Treatments	Branches/ Plant (#)			Diameter of main stem (cm)		
		2001	2002	Mean	2001	2002	Mean
1	Control	7.1	6.7	**6.9**	0.9	0.9	**0.9**
2	FYM	8.1	8.4	**8.3**	1.3	1.3	**1.3**
3	PM	8.8	8.7	**8.8**	1.4	1.3	**1.4**
4	A_1	7.9	7.7	**7.8**	1.2	1.2	**1.2**
5	A_1+FYM	9.5	9.1	**9.3**	1.3	1.4	**1.4**
6	A_1+PM	10.4	10.1	**10.3**	1.5	1.4	**1.4**
7	A_2+FYM	8.2	8.6	**8.4**	1.3	1.3	**1.3**
8	A_2+PM	9.3	9.4	**9.4**	1.4	1.4	**1.4**
9	A_3+FYM	10.5	10.7	**10.6**	1.7	1.5	**1.6**
10	A_3+PM	12.1	11.5	**11.8**	1.9	1.5	**1.7**
11	A_4+FYM	11.3	11.6	**11.4**	1.9	1.6	**1.7**
12	A_4+PM	13.5	13.2	**13.4**	2.0	1.7	**1.9**
SE (m)±		**1.8**	**0.6**		**0.2**	**0.1**	
C.D. at 5%		**N.S.**	**N.S.**		**0.3**	**0.2**	

B. Physiological Studies

1. Chlorophyll 'a' and 'b' contents of leaves

The observations recorded on chlorophyll 'a' and 'b' indicate that chlorophyll ('a' and 'b') contents of leaves were not affected significantly by different treatments of organic manures and Anupaan + Anupaan R during both the years. However, on the basis of mean value, treatment A_3 + PM and A_4 + PM exhibit better colour ton as compared to other treatments (Table 17).

2. Dry matter accumulation of plant

The values of dry matter accumulation of plant (Table 17) indicate that all the treatments of organic manures and Anupaan + Anupaan R improved significantly the dry matter content of plant over control except FYM, A_1 and A_2 + FYM treatments during first year and A_1 treatment during second year. The maximum biomass per plant (142.1g) was recorded in A_4 + PM treatment during first year which was significantly superior to FYM, A_1 and A_2 + FYM treatments and statistically at par with rest of the treatments. During second year maximum dry matter production per plant (140.8g) was recorded in A_4 + PM treatment which is statistically at par with the treatments

Table 17: Effect of Anupaan + Anupaan R and organic manures on chlorophyll 'a' and 'b' contents of leaves at 65 DAT and dry matter of plant at harvest.

Sr. #	Treatments	Chlorophyll 'a' (mg/g)			Chlorophyll 'b' (mg/g)			Dry matter /Plant (g)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	2.5	2.5	**2.5**	1.4	1.4	**1.4**	86.8	95.6	**91.2**
2	FYM	2.6	2.7	**2.7**	1.4	1.4	**1.4**	109.1	119.8	**114.5**
3	PM	2.7	2.7	**2.7**	1.4	1.4	**1.4**	118.6	126.5	**122.6**
4	A_1	2.6	2.6	**2.6**	1.4	1.4	**1.4**	101.4	114.9	**108.2**
5	A_1+FYM	2.7	2.7	**2.7**	1.4	1.4	**1.4**	120.2	119.5	**119.8**
6	A_1+PM	2.7	2.8	**2.7**	1.4	1.4	**1.4**	128.2	119.4	**123.8**
7	A_2+FYM	2.7	2.7	**2.7**	1.4	1.4	**1.4**	112.3	119.4	**115.9**
8	A_2+PM	2.7	2.7	**2.7**	1.4	1.4	**1.4**	121.0	131.3	**126.1**
9	A_3+FYM	2.7	2.7	**2.7**	1.4	1.4	**1.4**	128.6	123.7	**126.1**
10	A_3+PM	2.8	2.8	**2.8**	1.5	1.5	**1.5**	135.1	127.6	**131.4**
11	A_4+FYM	2.8	2.8	**2.8**	1.5	1.5	**1.5**	131.8	134.8	**133.3**
12	A_4+PM	2.9	3.0	**3.0**	1.5	1.5	**1.5**	142.1	140.8	**141.4**
SE (m)±		**0.4**	**0.3**		**0.2**	**0.3**		**9.1**	**6.7**	
C.D. at 5%		**N.S.**	**N.S.**		**N.S.**	**N.S.**		**26.9**	**19.9**	

PM, A_2 + PM, A_3 + FYM, A_3 + PM and A_4 + FYM and significantly superior to rest of the treatments.

3. Mineral composition of plant

The data regarding mineral composition of tomato plant tabulated in Table 18 reveal that nitrogen content of tomato plant did not show any significant response to different treatments of organic manures and Anupaan + Anupaan R during both the year. However, on the basis of mean value, maximum nitrogen content (0.729%) was recorded in A_4 + PM treatment.

Phosphorus content in tomato plant showed significant response to various treatments of organic manures and Anupaan + Anupaan R during both the years. All the treatments significantly contributed the phosphorus content of tomato plant over control except FYM, A_1 and F_2 + FYM during both the years and A_1 + FYM during the second year. Maximum phosphorus (0.136% and 0.137%) accumulated in A_4 + PM treatment during first and second year, respectively. The treatment A_4 + PM was statistically at par with A_1 + PM, A_2 + PM, A_3 + P.M and A_4 + FYM during both the years but during second year A_4 + PM also statistically at par with PM treatment and

Table 18: Effect of Anupaan + Anupaan R and organic manures on mineral composition of tomato plant.

Sr. #	Treatments	N Content (%)			P Content (%)			K Content (%)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	0.707	0.701	**0.704**	0.112	0.116	**0.114**	0.315	0.305	**0.310**
2	FYM	0.716	0.713	**0.714**	0.120	0.124	**0.122**	0.325	0.327	**0.326**
3	PM	0.719	0.715	**0.717**	0.127	0.129	**0.128**	0.330	0.334	**0.332**
4	A_1	0.708	0.706	**0.707**	0.114	0.118	**0.116**	0.319	0.316	**0.317**
5	A_1+FYM	0.718	0.715	**0.716**	0.122	0.125	**0.123**	0.326	0.328	**0.327**
6	A_1+PM	0.721	0.717	**0.719**	0.132	0.133	**0.132**	0.331	0.333	**0.332**
7	A_2+FYM	0.713	0.715	**0.714**	0.119	0.121	**0.120**	0.324	0.326	**0.325**
8	A_2+PM	0.718	0.715	**0.716**	0.128	0.130	**0.129**	0.328	0.329	**0.328**
9	A_3+FYM	0.723	0.716	**0.719**	0.123	0.127	**0.125**	0.329	0.331	**0.330**
10	A_3+PM	0.732	0.717	**0.724**	0.134	0.135	**0.134**	0.333	0.336	**0.334**
11	A_4+FYM	0.730	0.717	**0.723**	0.125	0.129	**0.127**	0.332	0.334	**0.333**
12	A_4+PM	0.742	0.718	**0.729**	0.136	0.137	**0.136**	0.337	0.339	**0.338**
SE (m)±		**0.009**	**0.004**		**0.003**	**0.003**		**0.007**	**0.005**	
C.D. at 5%		**N.S.**	**N.S.**		**0.008**	**0.009**		**N.S.**	**0.014**	

significantly superior to rest of the treatments in respective years.

The potassium content of tomato plant was influenced significantly only during second year .All the treatments of organic manures and Anupaan + Anupaan R improved potassium content of tomato plant over control except A_1 treatment. Maximum potassium content (0.339%) was recorded in A_4 + PM treatment which was significantly superior to A_1 treatment and statistically at par with rest of the treatments (Table 18).

C. Flowering and fruiting behaviour

1. Days to 50% flowering

The observations on days to 50% flowering presented in Table 19 reveal that days to 50% flowering was not affected significantly by different treatments of organic manures and Anupaan + Anupaan R during both the years. However, on the basis of mean value, 50% plants flowered in 41.5 days after transplanting when treatments A_4 + PM was applied whereas plants under control took 45.5 days to reach up to this stage of flowering.

Table 19: Effect of Anupaan + Anupaan R and organic manures on days to 50% flowering and days to fruit ripening from flower anthesis.

Sr. #	Treatments	Days to 50% flowering			Days to fruit ripening from flower anthesis		
		2001	2002	Mean	2001	2002	Mean
1	Control	45.0	46.0	**45.5**	51.2	52.7	**52.0**
2	FYM	43.7	41.7	**42.7**	44.3	50.7	**50.0**
3	PM	42.7	42.3	**42.5**	48.7	49.3	**49.0**
4	A_1	43.7	43.0	**43.3**	49.3	50.7	**50.0**
5	A_1+FYM	42.7	42.3	**42.5**	48.7	49.7	**49.2**
6	A_1+PM	41.7	42.0	**41.8**	47.7	47.7	**47.7**
7	A_2+FYM	43.0	43.0	**43.0**	49.0	49.3	**49.2**
8	A_2+PM	42.7	42.3	**42.5**	48.7	49.3	**49.0**
9	A_3+FYM	42.7	43.0	**42.8**	48.7	47.3	**48.0**
10	A_3+PM	43.0	43.3	**43.2**	47.3	46.7	**47.0**
11	A_4+FYM	42.7	41.3	**42.0**	48.7	47.3	**48.0**
12	A_4+PM	41.3	41.7	**41.5**	47.3	45.7	**46.5**
	SE (m)±	**0.8**	**1.0**		**1.2**	**1.0**	
	C.D. at 5%	**N.S.**	**N.S.**		**N.S.**	**N.S.**	

2. Days to fruit ripening from flower anthesis

The days to fruit ripening from flower anthesis did not show any significant response to different treatments of organic manures and Anupaan + Anupaan R during both the years (Table 19). However, on the basis of average values, minimum days (46.5) were taken by A_4 + PM treatment for fruit ripening from flower anthesis where as in case of control it was longest duration (52.0 days).

3. Fruits per cluster

The observations on number of fruits per cluster summarized in Table 20 reveal that all the treatments of organic manures, Anupaan + Anupaan R and their combinations gave non-significant results with respect to fruit per cluster during both the years. The application of A4 + PM treatment produced maximum number of fruits per cluster (4.3) in the year 2002 as compared to all other treatments.

4. Fruits per plant

The values recorded on number of fruits per plant indicate that all the treatments of organic manures and Anupaan + Anupaan R improved number of fruits per plant (Table 20). Significant increase in number of fruits per plant

Table 20: Effect of Anupaan + Anupaan R and organic manures on number of fruits/cluster, number of fruits/plant and fruit size.

Sr. #	Treatments	Fruits/Cluster (#)			Fruits/Plant (#)			Fruit size (g)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	2.3	2.3	**2.3**	14.8	11.0	**13.4**	22.1	29.0	**25.5**
2	FYM	3.0	3.0	**3.0**	18.2	17.2	**17.7**	23.8	25.5	**24.6**
3	PM	3.3	3.0	**3.2**	20.4	19.4	**19.9**	22.6	24.1	**23.4**
4	A_1	3.0	2.7	**3.3**	23.8	22.6	**23.2**	14.5	17.1	**15.8**
5	A_1+FYM	3.3	3.3	**3.3**	21.1	29.4	**25.2**	23.2	16.8	**20.0**
6	A_1+PM	3.0	3.7	**3.3**	27.8	30.4	**29.1**	20.2	18.5	**19.3**
7	A_2+FYM	3.0	3.0	**3.0**	16.2	15.4	**15.8**	28.5	26.3	**27.4**
8	A_2+PM	3.0	3.0	**3.0**	21.8	15.7	**18.7**	24.6	30.5	**27.5**
9	A_3+FYM	3.3	3.3	**3.3**	20.6	19.3	**19.9**	25.4	26.9	**26.1**
10	A_3+PM	3.7	3.3	**3.5**	31.6	20.5	**26.1**	17.8	27.6	**22.7**
11	A_4+FYM	3.3	3.7	**3.5**	27.1	20.1	**23.6**	19.5	24.7	**22.1**
12	A_4+PM	3.7	4.3	**4.0**	33.5	28.1	**30.8**	27.2	29.8	**28.5**
SE (m)±		**0.5**	**0.4**		**4.6**	**3.0**		**4.2**	**2.7**	
C.D. at 5%		**N.S.**	**N.S.**		**7.2**	**9.0**		**N.S.**	**N.S.**	

over control was recorded only under the treatments A_1, A_1 + PM, A_3 + PM, A_4 + PM and A_4 + FYM during both the years and A_1 + FYM during second year 2002. Highest number of fruits per plant (33.5) was recorded in A_4 + PM treatment which was statistically at par with A_1 + PM, A_3 + PM and A_4 + FYM and significant superior to rest of the treatments during the first year 2001. Whereas, in second year, maximum number of fruits per plant (30.4) was recorded in A_1 + PM treatment which was statistically at par with A_1, A_1 + FYM and A_4 + PM and significantly superior to rest of the treatments (Table 20).

5. Fruit size

The data on fruit size presented in Table 20 indicate that fruit size was not affected significantly by various treatments of organic manures and Anupaan +Anupaan R during both the years. However, on the basis of average value of two years, heaviest fruit size (28.5g) was recoded with A_4 + PM treatment.

6. Fruit yield per plant

The observations recorded (Table 21) on fruit yield per plant reveal that all the treatments of organic manures and Anupaan + Anupaan R increased significantly the fruit yield per

Table 21: Effect of Anupaan + Anupaan R and organic manures on fruit yield per plant and fruit yield per hectare.

Sr. #	Treatments	Fruit yield (kg/plant)			Fruit yield (t/ha)		
		2001	2002	Mean	2001	2002	Mean
1	Control	0.33	0.35	**0.34**	12.1	11.5	**11.8**
2	FYM	0.43	0.44	**0.43**	14.4	14.6	**14.5**
3	PM	0.46	0.47	**0.47**	15.4	15.6	**15.5**
4	A_1	0.35	0.39	**0.37**	13.0	12.9	**13.0**
5	A_1+FYM	0.49	0.49	**0.49**	16.3	16.4	**16.4**
6	A_1+PM	0.56	0.56	**0.56**	18.5	18.5	**18.5**
7	A_2+FYM	0.46	0.47	**0.46**	15.4	15.6	**15.5**
8	A_2+PM	0.54	0.54	**0.54**	17.8	18.0	**17.9**
9	A_3+FYM	0.52	0.52	**0.52**	17.4	16.6	**16.9**
10	A_3+PM	0.56	0.57	**0.56**	18.8	18.7	**18.7**
11	A_4+FYM	0.53	0.50	**0.51**	19.3	17.3	**18.3**
12	A_4+PM	0.58	0.06	**0.57**	20.1	18.9	**19.5**
SE (m)±		**0.03**	**0.02**		**1.2**	**1.1**	
C.D. at 5%		**0.09**	**0.09**		**3.5**	**2.9**	

plant over control during both the years except A_2 treatment during first year 2001 and A_2 and FYM treatments during the year 2002. In first year, maximum fruit yield per plant (0.58 kg) was recorded in A_4 + PM treatment which was significantly superior to FYM, PM, A_1 and A_2 + FYM and statistically at par with rest of the treatments. In second year maximum fruit yield per plant (0.57kg) was recorded in A_3 + PM treatment which was significantly superior to FYM, PM, A_1 and A_2 + FYM treatments and statistically at par with rest of the treatments.

7. Fruit yield per hectare

The data regarding fruit yield per hectare presented in Table 21 reveal that all the treatments of organic manures and Anupaan + Anupaan R increased significantly the fruit yield over control except A_1 treatment during both the years and FYM, PM and A_1 treatments during first year. Maximum fruit yield per hectare (20.1t) was recorded in A_4 + PM treatment which was significantly superior to FYM, PM, A_1, A_1 + FYM and A_2 + FYM treatments and statistically at par with rest of the treatments. During second year, maximum fruit yield per hectare (18.9t) trend was maintained by A_4 + PM treatment which was

significantly superior to FYM, PM, A_1 and A_2 + FYM treatments and statistically at par with rest of the treatments.

D. Fruit quality

1. Pulp juice and seed content

The pulp, juice and seed contents of tomato fruit were not affected significantly by different treatments of organic manures and Anupaan + Anupaan R during both the years (Table 22).

2. Total soluble solids and sugar contents

The observations recorded on total soluble solids (TSS) presented in Table 23 indicate that all the treatments of organic manures and Anupaan + Anupaan R improved significantly the TSS content of tomato fruit over control only during the year 2001. In the year 2002 application of different treatments did not show any significant result in TSS content. The maximum TSS of tomato fruit (6.1%) was recorded in A_4 + PM treatment which was significantly superior to A_1 treatment and statistically at par with rest of the treatments.

Sugar content of tomato fruit was significantly increased over control by all the treatments of organic manures and Anupaan + Anupaan R during both the years (Table 23).

Table 22: Effect of Anupaan + Anupaan R and organic manures on pulp, juice and seed contents.

Sr. #	Treatments	Pulp Content (%)			Juice Content (%)			Seed Content (g/100g)		
		2001	2002	Mean	2001	2002	Mean	2001	2002	Mean
1	Control	51.4	50.5	**50.9**	47.9	48.7	**48.3**	0.3	0.2	**0.3**
2	FYM	51.6	50.2	**50.9**	47.8	48.7	**48.2**	0.3	0.3	**0.3**
3	PM	52.8	52.9	**52.9**	46.1	45.4	**45.8**	0.3	0.3	**0.3**
4	A_1	50.3	50.0	**50.1**	48.8	48.8	**48.8**	0.3	0.3	**0.3**
5	A_1+FYM	50.4	52.0	**51.2**	48.6	46.6	**47.6**	0.3	0.3	**0.3**
6	A_1+PM	52.4	50.2	**51.3**	46.7	48.8	**47.7**	0.3	0.3	**0.3**
7	A_2+FYM	50.9	51.7	**51.3**	48.3	46.9	**47.6**	0.3	0.3	**0.3**
8	A_2+PM	49.8	51.7	**50.7**	49.4	47.1	**48.2**	0.4	0.3	**0.3**
9	A_3+FYM	51.2	52.9	**52.0**	47.7	46.5	**47.1**	0.4	0.3	**0.4**
10	A_3+PM	52.9	52.5	**52.7**	46.0	46.4	**46.2**	0.4	0.4	**0.4**
11	A_4+FYM	51.8	52.3	**52.0**	47.2	46.9	**47.0**	0.4	0.4	**0.4**
12	A_4+PM	52.3	52.9	**52.6**	46.4	46.1	**46.2**	0.4	0.4	**0.4**
SE (m)±		**5.0**	**3.3**		**5.6**	**3.4**		**0.2**	**0.3**	
C.D. at 5%		**N.S.**	**N.S.**		**N.S.**	**N.S.**		**NS**	**NS**	

Table 23: Effect of Anupaan + Anupaan R and organic manures on TSS and Sugar content of tomato fruit.

Sr. #	Treatments	T.S.S (%)			Sugar content (%)		
		2001	2002	Mean	2001	2002	Mean
1	Control	3.0	4.8	**3.9**	2.5	2.5	**2.5**
2	FYM	5.4	5.2	**5.3**	4.0	4.0	**4.0**
3	PM	5.5	5.5	**5.5**	4.1	4.1	**4.1**
4	A_1	4.8	4.9	**4.8**	3.9	4.0	**3.9**
5	A_1+FYM	5.4	5.4	**5.4**	4.2	4.2	**4.2**
6	A_1+PM	5.9	5.7	**5.8**	4.3	4.3	**4.3**
7	A_2+FYM	5.1	5.2	**5.2**	4.1	4.1	**4.1**
8	A_2+PM	5.2	5.2	**5.2**	4.1	4.2	**4.1**
9	A_3+FYM	5.3	5.5	**5.4**	4.3	4.3	**4.3**
10	A_3+PM	5.8	5.4	**5.6**	4.4	4.4	**4.4**
11	A_4+FYM	5.5	5.9	**5.7**	4.3	4.4	**4.4**
12	A_4+PM	6.1	5.5	**5.8**	4.5	4.5	**4.5**
SE (m)±		**0.4**	**0.5**		**0.2**	**0.3**	
C.D. at 5%		**1.3**	**N.S.**		**0.9**	**0.9**	

Treatment A_4 + PM followed the similar trend of superiority in both the years.

3. Acidity

The data on the effect of different treatments of organic manures and Anupaan + Anupaan R on acidity presented in Table 24. It indicate that the treatments A_3 + FYM, A_3 + PM, A_4 + PM during both the years and A_4 + FYM during the years 2001 increased significantly the acidity content of tomato fruit over control. During the year 2001 maximum acidity content (1.6%) was recorded in A_4 + PM treatment which was significantly superior to all the treatments. In second year highest level of acidity content (0.8%) was recorded in A_4 + PM and A_3 + FYM treatments which were statistically at par with PM, A_1 + FYM, A_1 + PM and A_3 + PM treatments and significantly superior to rest of the treatments.

4. Ascorbic acid

The observations on ascorbic acid content of tomato fruit indicate that all the treatments were non-significant for ascorbic acid content of tomato fruit during both the years (Table 24). However, on the basis of observed value, maximum ascorbic acid content (27.6 mg/100g fruit) was recorded under A_4 + PM treatment.

Table 24: Effect of Anupaan + Anupaan R and organic manures on quality of tomato fruit.

Sr. #	Treatments	Acidity (%)			Ascorbic acid (mg/100g fruit)		
		2001	2002	Mean	2001	2002	Mean
1	Control	0.5	0.4	**0.5**	18.6	23.1	**20.8**
2	FYM	0.6	0.5	**0.6**	19.4	25.5	**22.5**
3	PM	0.8	0.6	**0.6**	20.5	26.6	**23.5**
4	A_1	0.5	0.5	**0.5**	18.9	24.2	**21.5**
5	A_1+FYM	0.6	0.6	**0.6**	20.1	25.5	**22.8**
6	A_1+PM	0.8	0.6	**0.7**	21.7	24.5	**23.1**
7	A_2+FYM	0.5	0.5	**0.5**	14.0	22.9	**18.5**
8	A_2+PM	0.8	0.5	**0.6**	15.3	24.3	**19.9**
9	A_3+FYM	0.9	0.8	**0.8**	22.2	26.3	**24.5**
10	A_3+PM	1.1	0.7	**0.9**	22.8	24.1	**23.5**
11	A_4+FYM	1.1	0.5	**0.8**	24.6	23.8	**24.2**
12	A_4+PM	1.6	0.8	**1.2**	28.7	26.4	**27.6**
SE (m)±		**0.2**	**0.1**		**3.7**	**1.5**	
C.D. at 5%		**0.3**	**0.2**		**N.S.**	**N.S.**	

E. Incidence of pest and diseases

1. Tomato leaf curl viruses (TLCV)

The observations regarding TLCV affected plants presented in Table 25 indicate that all the treatments of organic manures and Anupaan + Anupaan R showed non-significant effect on TLCV infestation during both the years. However, on the basis of mean value recorded, lowest number of plants (1.7%) affected by TLCV in A_4 + PM treatment.

2. Tomato fruit borer

The infection of tomato fruit due to borer presented in Table 25 indicate that all the treatments of organic manures and Anupaan + Anupaan R reduced the tomato fruit borer incidence. The treatments A_1, A_3 + FYM, A_3 + PM, A_4 + PM and A_4 + FYM lowered significantly the tomato fruit borer attack over control during both the years. Minimum tomato fruit borer attack (18.9%) was recorded in A_4 + PM treatment which was statistically at par with A_1, A_1 + PM, A_3 + PM, A_3 + FYM and A_4 + FYM and significantly superior to rest of the treatments during first year. In the year 2002 lowest tomato fruit borer attack (17.4%) was observed in A_4 + PM treatment which was statistically at par with A_1, A_3 + FYM, A_3 + PM, A_4 + FYM treatments and significantly superior to rest of the treatments.

Table 25: Effect of Anupaan + Anupaan R and organic manures on tomato leaf curl virus plants/plot, and tomato fruit borer.

Sr. #	Treatments	TLCV plants /plot (%)			Tomato fruit Borer (%)		
		2001	2002	Mean	2001	2002	Mean
1	Control	6.7	5.0	**5.8**	55.1	52.1	**53.6**
2	FYM	6.7	3.3	**5.0**	46.0	44.6	**45.3**
3	PM	5.0	3.3	**4.2**	39.3	37.1	**38.2**
4	A_1	3.3	1.7	**2.5**	29.8	28.7	**29.3**
5	A_1+FYM	5.0	3.3	**4.2**	40.6	38.4	**39.5**
6	A_1+PM	3.3	1.7	**2.5**	36.9	36.8	**36.9**
7	A_2+FYM	5.0	3.3	**4.2**	44.8	42.7	**43.8**
8	A_2+PM	5.0	1.7	**3.3**	38.8	37.1	**37.9**
9	A_3+FYM	3.3	1.7	**2.5**	28.2	29.6	**28.9**
10	A_3+PM	5.0	3.3	**4.2**	24.3	22.7	**23.5**
11	A_4+FYM	3.3	1.7	**2.5**	23.9	21.9	**22.9**
12	A_4+PM	1.7	1.7	**1.7**	18.9	17.4	**18.1**
SE (m)±		**0.2**	**0.1**		**6.1**	**5.2**	
C.D. at 5%		**NS**	**NS**		**18.2**	**15.3**	

CHAPTER – V

Discussion

The present investigations were carried out to evaluate the effect of plant vitalizers (Anupaan + Anupaan R) and different organic manures on growth, flowering, yield and quality of tomato cv. Hisar Arun. The studies yielded some useful, interesting and encouraging results. The salient features of these findings are discussed in the following pages:

EFFECT OF PLANT VITALIZERS (ANUPAAN + ANUPAAN R) ON TOMATO CV. HISAR ARUN.

A. Growth studies

The growth parameters such as number and fresh weight of leaves per plant and diameter of main stem were influenced significantly by the application of plant vitalizers (Anupaan + Anupaan R) whereas, the plant height and branches per plant did not respond significantly. It is clear from the findings that the application of Anupaan + Anupaan R @ 50 per cent more than suggested dose applied as soil + foliar feeding

gave better results as compared to other treatments with respect to all the growth parameters. This might be due to growth promoting effects of Anupaan + Anupaan R which might have encouraged all physiological activities going on in the plants. The growth is a vital phenomenon. The protoplasm assimilates the products of digestion and cell enlarge and divides and the plant grows as a whole (Dutta, 1976). Similar results were obtained by Zeenat and Sharma (1994) on growth and biomass of tomato crop.

Chlorophyll 'a' and 'b' contents of leaves were improved by Anupaan + Anupaan R application but results were not significant. Dry matter accumulation of plant was increased significantly with different concentrations and methods of application of Anupaan + Anupaan R. The bio-fertilizers such as phosphate solubilizers increased the growth (Vishwanath, 2002), the Anupaan + Anupaan R was also acting in the same way and promoting growth parameters. Plants mineral composition (NPK) were also improved by these plant vitalizers. This indicate that the uptake of these nutrients by plant improved by application of plant vitalizers, there by showing

improved plant growth (Tables 2-5) and ultimately productivity (Tables 8-9) of tomato crop increased.

B. Flowering and fruiting behaviour

It is evident from the results that flowering and fruiting behaviour of the plant was influenced by the Anupaan + Anupaan R. There was early flowering and fruit ripening in plants receiving the higher doses of Anupaan + Anupaan R when applied in soil + foliar combination. These plant vitalizers also increased number of fruits per plant. The early flowering, heavy fruiting and early ripening of fruits in plants receiving plant vitalizers might be due to commencement of early reproductive phase in plants under the influential effects of Anupaan + Anupaan R. As number and fresh weights of leaves increased more photosynthates were assimilated and consequently, transferred to the storage organ i.e. ovary and as a result fruit developed early. These finding were supported by Petrov and Andreev (1972)and Stanchev (1972).

C. Yield

Fruit yield per plant and per hectare were significantly increased by higher doses of these plant vitalizers when applied as soil + foliar. This is due to the promoting effects of plant

vitalizers (Anupaan + Anupaan R) on growth, flowering and fruiting behaviour of tomato plants and ultimately on fruit yield. It is interesting to note that the application of Anupaan + Anupaan R at 50% more than suggested dose either applied in soil, foliar, root dipping or soil + foliar was found beneficial as compared to other treatments. This might be due to accelerated, mobility of photosynthates from source to sink as influenced by harmones, released or synthesized due to organic sources. Similar findings were corroborated by Rajagopal and Rao (1974), Uma (1984) and Susan (1995).

D. Fruit quality

Anupaan + Anupaan R has no significant effect on total soluble solids and ascorbic acid contents but acidity was increased significantly only in the treatment S_4 + A_4 (50% more than suggested dose, soil + foliar application). Sugar content was also not improved significantly by Anupaan + Anupaan R. This indicate that the plant vitalizers applications have not affected much the fruit quality of tomato. Similarly Matev and Stanchev (1979) found the antagonism between K+ and Ca++ which inhibited in sugar, organic acid and vitamin C synthesis and reduced TSS in tomato crop.

E. Incidence of pest and diseases

Tomato fruit borer attack was significantly lowered by different treatments of Anupaan + Anupaan R. Higher doses of these plant vitalizers showed minimum incidence of tomato fruit borer. As it has been suggested by the manufacturer of these plant vitalizers that Anupaan R is an insect repellant and less attack of tomato fruit borer in plants receiving plant vitalizers is due to specific role of Anupaan R. Weerakkody *et al.* (2002) also reported good insect control when neem seed and garlic extracts were applied as insect repellant two and six weeks after planting of tomato crop, respectively.

Tomato leaf curl virus were not controlled significantly by these plant vitalizers. This indicate that Anupaan R did not keep away the viruses transmitting insects. Vishwanath (2002) reported that some of the biopesticides such as need seed kernel extract, tobacco extract, garlic extract etc. which do not harm the environment but effectively reduced the pest population.

It was interesting to note that the higher concentration of plant vitalizers (Anupaan + Anupaan R) i.e. 50% more than suggested dose gave appreciable results applied either as soil, foliar, root dipping or soil + foliar. The soil + foliar

application improved almost all the growth, yield attributing parameters and yield of tomato because Anupaan + Anupaan R may be more effective at higher concentration than suggested dose. Work done by Omori *et al.*, (1972) recorded similar information.

COMPARATIVE STUDIES OF PLANT VITALIZERS AND ORGANIC MANURES ON TOMATO CV. HISAR ARUN

A. Growth studies:

The results clearly show that the growth parameter such as number and fresh weight of leaves per plant and diameter of main stem were improved with the addition of organic manures along with plant vitalizers application (Tables 15-16). Whereas the plant height and branches per plant were not affected significantly.

Better performance of the organic manures along with Anupaan + Anupaan R in comparison to their alone applications with respect to growth parameters may be because of the fact that addition of organic manures enhances the supply of macro and micronutrients to the plants, increase organic matter content of soil which in turn improves physical properties of soil. Among organic manures, an application of FYM @ 20t/ha,

proper plant growth and development contribute a lot to crop productivity. FYM + NP @ 60:60kg/ha resulted in good root growth of tomato (Ovchinnikova, 1972). Application of inorganic fertilizer in the absence of FYM retarded formation of vegetative organs and subsequently reproductive organs (Cerna, 1980). The poultry manure along with plant vitalizers showed more encouraging results as compared to FYM because it might be rich in nutrient contents than FYM. Spasov *et al.* (1977) reported that the improved growth of plants employed with poultry manure and urea may be attributed to the increased nitrogen uptake and utilization. Poultry manure contained growth promoting substances which induced better plant growth. Enhanced plant growth with the application of poultry manure and inorganic fertilizer have also been reported by Abusaleha (1981) in bhendi and Dhandpani (1982) in cauliflower.

Chlorphyll 'a' and 'b' contents of leaves were improved by organic manures along with Anupaan + Anupaan R but results were non-significant (Table 17). All the organic manures along with Anupaan + Anupaan R increased the dry matter accumulation of plant. The reason for higher dry matter accumulation in plant may be due to organic manures along

with Anupaan + Anupaan R enhanced the supply of macro and micro-nutrients for the plants, which directly associated with physiological processes like photosynthesis which in turn responsible for more dry matter accumulation in plants. FYM favourabely affected vegetative mass, dry weight and photosynthetic potential (Meena *et al.*, 1990). Jose *et al.* (1988) also reported that combinations of 50kg N as organic form showed increased dry matter content. Maximum nitrogen, phosphorus and potassium contents in tomato plant were recorded in poultry manures treatments applied along with Anupann + Anupaan R as compared to FYM treatments. This is because of the fact that poultry manure has higher NPK content than FYM. Spasov *et al.* (1977) reported that organic manure increased the available nitrogen in the soil and this ultimately leads to increased nitrogen uptake by the plant. Besides this, organic manure might have improved the root ramification causing increased absorption and uptake of nitrogen. Gagnon and Berrouard (1994) reported that application of organic waste from the agri-food industry mixed with peat compost growing medium prior to transplanting of tomato, produced best growth; significantly increasing shoot dry weight (57-83%) as compared

with non-fertilized plant. Similar observations were reported by Kumaran *et al.* (1998) when applied organic and inorganic fertilizer in combination. It was further observed that the highest available N, P, K contents and their uptake by brinjal plant were due to the application of 40% N through urea and 60% N through poultry manure (Nanthakumar and Veeraragavathatham, 1999).

B. Flowering and fruiting behaviour:

Early flowering and fruit ripening were noticed in the organic manures and Anupann + Anupaan R treatments in comparison with control. Similar findings by Gianquinto and Borin (1990) reported that tomato ripening was delayed when grown with N 200 kg, P_2O_5 100kg and K_2O 280 kg/ha as compared to FYM 20t/ha with N 100kg P_2O_5 50kg and K_2O 140kg/ha.

Stanchev (1972) reported that watering the seedlings of tomato 12 hours before transplanting with 0.005% humus solution (from well rotted FYM) @ 250ml/pot under conditions of high mineral and low organic nutrition, increased earliness in early cultivars by 9-13%, in medium cultivars by 12-15% and in late varieties by 23-30%. Early flowering has been noticed in the

plants supplied with inorganic fertilizer as stated by Abusaleha (1981) in bhendi and Dhandpani (1982) in cauliflower.

Maximum fruit per cluster, per plant and fruit size were recorded under poultry manure along with Anupaan + Anupaan R treatments in comparison to control. Because the organic manures increased the availability of nutrients to the plants, for a long time and there was no loss in nutrients. Nanthakumar and Veeraragavathatam (1999) reported that number of flowers per plant in brinjal crop was considerably increased due to the combined application of organic and biofertilizers along with inorganic NPK than the treatment which received the inorganic fertilizers alone. Gianquinto and Borin (1990) reported that FYM @ 20t/ha with N 100kg, P_2O_5 50kg and K_2O 100kg/ha produced more number of fruits per plant (25.4) and the lowest in control (11.60).

Rajagopal and Rao (1974) reported that application of organic and biofertilizers along with inorganic NPK in brinjal resulted into early vigorous growth of root which would have helped to synthesize more cytokinin by these plants. Better stem girth attained would have helped the translocation of these synthesized cytokinin when compared with the treatments which

received the inorganic fertilizers alone. The increased nutrients availability from FYM might have increased the various endogenous harmonal levels in the plant tissue, which enhanced pollen germination and tube growth, ultimately increasing the fruit set.

C. Yield:

Fruit yield per plant and per hectare was significantly increased by the organic manures viz. FYM and poultry manure along with Anupaan + Anupaan R. These findings are supported by Prezotti *et al.* (1989) and reported that application of poultry manure @ 10t/ha appreciably increased the yield of tomato and augmented fruit size. Annanurova *et al.* (1992) found that application of NPK alone increased yield per plant by 43.4% compared with untreated control and when supplemented with FYM @ 30t/ha by 161.8% Khvatov *et al.* (1973) also reported the best results in tomato from plots receiving combined mineral (full rate) and organic (half rate) fertilizers. Tomato yield was highest under organic soil treatment as compared to mineral soil treatment (Eggert and Kahrmann, 1984).

Silva and Vizzotto (1989) reported that the highest yield of tomato fruits (53t/ha) was obtained with recommended

dose of NPK +20t poultry manure/ha. Without poultry manure the yield declined to 46.2t/ha. Cerna (1980) reported that application of inorganic fertilizer alone decreased fruit yields, was due to retarded formation of vegetative organ and subsequently reproductive organs.

D. Fruit quality:

The sugar, total soluble solids and acidity of tomato fruit was increased by organic manures viz. FYM and poultry manure along with Anupaan + Anuapann R (Tables 23-24). Kumaran *et al.* (1998) also reported that quality parameters such as TSS, ascorbic acid and lycopene contents were comparatively higher in organically grown tomato plants. Meier *et al.* (1989) stated that composted FYM gave superior results of desirable nutrients (Vit C and Sugars). Montagu and Goh (1990) observed the best scores of suitability of tomato for paste formation were obtained with mixed fertilizer (33.3%), poultry manure and 66.7% mineral fertilizer). The plots receiving only mineral fertilizers produced fruits with less favourable values of pH and electrical conductivity compared with poultry manure ones. Eggert and Kahrmann (1984) found that the concentration of ascorbic acid was higher in tomatoes grown under the organic treatments. Meier *et al.* (1989) reported that composted FYM

gave improved improvement in organoleptic properties (Vit C and sugars levels) and undesirable constituents (nitrate) of tomato.

E. Incidence of insect and diseases:

Tomato leaf curl virus and tomato fruit borer attack was lowered by the organic manures along with Anupaan + Anupaan R as compared to control. The plant vitalizer Anupaan R has showed its capability to reduce the attack of insect and disease similar to the previous experiment. The results were also reported by Fugro (2000) that the incidence of leaf curl virus in chilli was comparatively lower in organic manures/pesticides treatments than in treatments comprising organic/inorganic fertilizers superimposed with chemical and organic pesticides.

A perusal of findings of both experiments reveal that Anupaan + Anupaan R at higher concentration i.e. more than 50% of suggested dose as well as the same dose along with organic manures gave highly appreciable results with respect to growth and development of tomato crop ultimately leading to high productivity i.e. yield. It might be due to the higher concentration of Anupaan + Anupaan R along with the organic manure which effectively improved the all vital activities of plant. Wahundeniva (1991) worked on post management recorded the similar information.

CHAPTER – VI

Summary And Conclusion

The present investigation entitled "**Effect of plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill)**" was carried out on farm of Department of Vegetable Crops, CCS Haryana Agricultural University, Hisar to study the effect of plant vitalizers (Anupaan + Anupaan R) alone and in combination with organic manures (FYM and Poultry manure) on tomato cv. Hisar Arun. In the first experiment four doses of Anupaan + Anupaan R (168.75, 225.00, 281.25 and 337.50 ml/acre) were applied through soil, foliar, root dipping and soil + foliar methods. While in second experiment above said four doses of Anupaan + Anupaan R were applied through soil in combination with FYM and poultry manure, keeping control for comparison. The results of the investigation are summarized and concluded in the following pages:

EFFECT OF PLANT VITALIZERS (ANUPAAN + ANUPAAN R) ON TOMATO CV. HISAR ARUN.

1. The growth parameters such as number and fresh weight of leaves per plant and thickness of main stem in $S_4 + F_4$ treatment were increased significantly over control during both the years. Plant height and branches per plant did not show significant impact.
2. Chlorophyll 'a' and 'b' contents of leaves were not increased significantly. The dry matter accumulation of plant was increased significantly by all the treatments during both the years and in the treatment $S_4 + F_4$ dry matter accumulation increased by 61.1% over control. NPK content of tomato plant was significantly improved with the application of $S_4 + F_4$ treatment during both the years.
3. Days to 50% flowering, fruit ripening from flower anthesis, fruits per cluster and its size were not influenced significantly due to various treatment in both the years.
4. Maximum number of fruits per plant and fruit yield per plant was recorded in $S_4 + F_4$ treatment during both the years. The significant fruit yield per hectare was 38.3%

higher than control under the influence of this treatment.

5. Pulp, juice, seed content, total soluble solids, sugar and ascorbic acid were not affected significantly by the application of different treatments. Whereas, Acidity of tomato fruit was increased significantly by S_4 + F_4 treatment during both the years.
6. Tomato leaf curl virus was not controlled significantly but lowest fruit borer attack (1.7%) was recorded in S_4 + F_4 treatment.

COMPARATIVE STUDIES OF PLANT VITALIZERS AND ORGANIC MANURES ON TOMATO CV. HISAR ARUN

1. The growth parameters such as number and fresh weight of leaves per plant and thickness of main stem were influenced significantly over control by A_4 + PM treatment during both the years. Plant height and branches per plant did not show significant improvement due to the exogenous application.
2. Chlorophyll 'a' and 'b' contents of leaves were found non-significant due to different treatments. Significant higher dry matter accumulation of plant was recorded in A_4 + PM treatment during both the years which was

35.5% more than control. As regard to mineral contents of plant, nitrogen content of plant did not vary but significantly more phosphorus was recorded in A_4 + PM treatment during both the years. The potassium content during the second year followed the same trend that of phosphorus.

3. Days to 50% flowering, fruit ripening from flower anthesis, fruits per cluster and its size were not improved significantly.
4. Statistically highest number of fruit per plant (30.8), fruit yield per plant (0.57kg) and per hectare (19.5t) were recorded with the application of A_4 + PM treatment during both the years. Fruit yield per hectare was increased by 39.5% in comparison to control.
5. Pulp, juice, seed content and ascorbic acid content were found non-significant during both the years. Maximum total soluble solids and sugar content of tomato fruit was recorded in A_4 + PM treatment.
6. The lowest tomato leaf curl virus (1.7) was observed with A_4 + PM application. Similar trend for fruit borer attack (18.1%) was recorded in this treatment.

CONCLUSION

Application of Anupaan + Anupaan R @ 50% more than the suggested had improved the growth and yield of tomato crops in both the years. The combination of organic source for nutrients supply system proved better as compared to alone application of either sources. Pest infection was significantly reduced due to the application of Anupaan + Anupaan R and Anupaan + Poultry manure in both the years.

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ANNEXURE – I

Weekly weather data for Hisar during crop period – 2000-01*

Std. Week	Max. Temp. (°C)	Min. Temp. (°C)	RH (%) Morn.	RH (%) Even.	Rainfall (mm)
44	33.6	12	75	25	0.0
45	32.8	10.6	72	22	0.0
46	29.8	8.1	77	25	0.0
47	27.6	8.7	86	37	0.0
48	24.5	4.1	85	26	0.0
49	25.9	2.9	81	21	0.0
50	24.6	3.4	87	28	0.0
51	24.4	3.3	89	28	0.0
52	23.2	3.4	89	43	0.0
1	15.1	6.1	96	79	15.0
2	15.9	1.0	96	65	0.0
3	17.7	1.2	95	53	0.0
4	21.1	2.1	94	33	0.0
5	22.6	2.8	89	29	0.0
6	23.4	2.0	88	29	0.0
7	25.3	7.5	83	39	0.0
8	27.0	10.0	88	27	9.2
9	25.2	5.5	92	27	0.0
10	29.3	6.1	84	21	0.0
11	30.3	11.1	78	32	0.0
12	30.9	11.1	80	34	0.0
13	32.0	12.7	77	32	0.0
14	33.7	12.5	67	22	0.0
15	37.6	19.0	49	18	3.3
16	30.4	15.1	77	42	43.3
17	40.6	19.3	44	13	0.0
18	42.1	21.8	48	17	0.8
19	43.6	25.2	48	20	0.0
20	37.7	22.6	65	35	12.5
21	39.5	23.4	58	30	4.5
22	38.0	21.6	71	42	95.1
23	35.0	22.3	72	59	37.2
24	36.6	23.6	77	56	85.3

* **Source:** Department of Agriculture Meteorology, CCS HAU, Hisar

ABSTRACT

Title of Thesis	:	Effect of plant vitalizers and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.)
Name of the Degree Holder	:	**Praveen Kumar**
Admission No.	:	99A73D
Title of Degree	:	Doctor of Philosophy
Name and Address of Major-Advisor	:	**Dr. S. Lal (Professor)** Department of Vegetable Crops CCS Haryana Agricultural University, Hisar – 125 004 (India)
Degree awarding university	:	CCS Haryana Agricultural University, Hisar-125004 (INDIA)
Year of award of degree	:	2002
Major Subject	:	Vegetable Crops
Total no. of page in thesis	:	113 + xvi
Total no. of words in Abstract	:	300 Approximately

(An abstract of the dissertation submitted to the CCS Haryana agricultural University, Hisar for partial fulfilment of the requirement for the degree of Doctor of Philosophy in Vegetables Crops).

Field experiments were conducted on the research farm of the Department of Vegetable Crops, CCS Haryana Agricultural University, Hisar to study the effect of plant vitalizers (Anupaan + Anupaan R) and organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill) Cv. Hisar Arun. In the first experiment, four doses of Anupaan + Anupaan R (168.75, 225.00, 281.25 and 337.50

Anupaan + Anupaan R (168.75, 225.00, 281.25 and 337.50 ml/acre) were added through four method of application viz. Soil, foliar, root dipping and soil + foliar, while in the second experiment, all the above said doses of Anupaan + Anupaan R in combination with organic manures viz. FYM and poultry manure were applied through soil application, keeping control for comparison.

All the growth parameters (number of leaves per plant, fresh weight of leaves per plant and diameter of main stem, dry matter per plant), yield parameters (number of fruit per plant, fruit yield per plant), quality parameters (sugar and Acidity), NPK content of tomato plant increased significantly whereas, plant height at 20, 60 and 90 DAT, branches per plant, chlorophyll 'a' and 'b' content of leaves, days to 50% flowering, days to fruit ripening from flower anthesis, fruit per cluster, fruit size, pulp, juice, seed content, TSS, Ascorbic acid, were not affected significantly.

The application of Anupaan + Anupaan R did not influence the infestation of tomato leaf curl virus but tomato fruit borer was significantly checked by different treatment of Anupaan + Anupaan R.

Fruit yield per hectare was improved significantly by different treatments of Anupaan + Anupaan R when blended with organic manure. The combination of A_4 + PM treatment gave best results regarding the fruit yield of tomato.