Results and discussion

4.0 RESULTS AND DISCUSSION

Chilli is one of the most spices garnishing dishes. When eaten it gives burning sensation. Chilli powder has many beneficial properties, making it an important part in ayurvedic medicines and used as a tonic to ward off many diseases. It is used for destroying harmful toxins and stimulates gastric juices that help in digesting food. It also helps in clearing nasal congestion, relieves throat infection and acts as a pain killer in muscle spasm (http://www.chilly.in/index.htm).

They are excellent source of vitamin A, B, C and E with minerals like molybdenum, manganese, folate, potassium, thiamine and copper. Chilli contains seven times more vitamin C than orange. They are good for slimming down as it burns the calorie easily. Chillies stimulate the appetite, help to clear the lungs and stimulate the digestive system (http://www.chilly.in/Indian_chilli_varieties.htm).

"A comparative study of the effect of biofertilizer, vermicompost and chemical fertilizer on the growth and yield of green chilli (Gundu variety)" was carried out as pot culture with four replications for each treatment. The experiment was laid out in completely randomized block design. Each pot was filled with 8 kg of soil. Farmyard manure was added to each pot at the rate of 10 tonnes ha^{-1} to enrich the soil nutrition. The plantlets were transferred to the various pots and were treated with different combinations of triple -17, *Azophos* and vermicompost.

The treatments were as follows:

T_1- Uninoculated control

T_2 - Triple - 17 complex

T_3- *Azophos*

T_4- Vermicompost

T_5- Triple - 17 complex + Vermicompost

T_6- Triple - 17 complex + *Azophos*

T_7- *Azophos* + Vermicompost

T_8-Triple-17 complex + *Azophos* + Vermicompost

At the end of the 50th and 90th day of growth, chilli plants were uprooted carefully and were subjected to biometric and biochemical analysis.

The results of the study were discussed under the following headings

4.1 Biometric observations

4.1.1. Root length and Shoot length

4.1.2. Fresh weight and Dry weight

4.1.3. Number of leaves and Moisture content

4.2 Biochemical analysis

4.2.1. Chlorophyll and Carotenoids

4.2.2. Protein, Total Phenol and Total Carbohydrates

4.2.3. Nitrogen, Phosphorus and Potassium

4.3 Vermicompost analysis

4.4. Soil analysis at the initial and at the post harvesting stage

4.1 Biometric observations

The growth attributes of chilli such as root length, shoot length, fresh weight, dry weight, number of leaves and moisture content were recorded on the 50th and 90th day of growth.

4.1.1. Root length and Shoot length

Table II illustrates the root and shoot length of chilli plants on the 50th and 90th day of growth.

Root length

The root length of the treatment T_3 (*Azophos*) was found to be maximum on the 50th day of growth, which was followed by T_1 (control) and T_7 (*Azophos* + vermicompost), whereas on the 90th day of growth T_7 registered the maximum root length. This was followed by T_2 (Triple - 17 complex) and T_3 on the 90th day of growth. Thus the inoculation of *Azophos* and the coinoculation of *Azophos* with vermicompost have shown the maximum root length at the later stages of growth.

Table II
The root and shoot length of chilli plants

Treatments	Root length (cm)		Shoot length (cm)	
	Days after sowing		Days after sowing	
	50	90	50	90
T_1	6.45	8.43	9.40	18.25
T_2	5.50	13.63	7.20	43.50
T_3	7.58	10.88	9.80	37.75
T_4	4.53	7.63	8.63	25.75
T_5	5.35	10.50	9.63	25.00
T_6	3.48	6.63	9.20	26.75
T_7	6.25	13.75	11.95	35.25
T_8	4.55	7.88	10.33	32.75
CD(0.05)	1.154		4.059	

Raja and Kumari (2008), suggested that the inoculation of *Azospirillum* along with *Azotobacter* and PSB had increased the root and shoot length of Jatropha plants. The beneficial effects caused by the inocuation with *Azospirillum* are not only due to FBN in the rhizosphere, but mainly for the best efficiency in absorption of water and nutrients, which happens due to a more developed root system, increasing the soil area explored by the roots. This better development of plant root system, inoculated with *Azospirillum*, is caused by the capacity that a lot of strains are present in producing growth promoting substances of plants (Reis *et al.*, 2000).

Meena *et al.*, (2007) reported the use of vermicompost also resulted in introduction of earthworms in the field and these could have filled the soil and made it more porous and loose. Thus, increased aeration of roots resulted in better root ramification. Ramalakshmi and Raj (2008) reported that there was a significant increase in the root length of cotton plants inoculated with the *Phosphobacteria.*

Vijayananthan *et al.*, (2007) reported that the application of vermicompost (1:1:1) recorded the highest root length. Nutrients present in vermicompost are readily available

to the plant and application of vermicompost might have lead to easy transfer of nutrients to the plants.

Shoot length

From Table -II it was evident that the shoot length increased with the growth period for each treatment and the increase was found to be significant ($P < 0.05$) for all the treatments. Among the treatments T_7 (*Azophos* + vermicompost) recorded the maximum shoot length in the 50th day after sowing. This was followed by T_8 (Triple-17 complex + *Azophos* + vermicompost) and T_3 (*Azophos*). The treatment T_2 (Triple - 17 complex) was found to be superior registering maximum shoot length on the 90th day after sowing, followed by T_3. Thus it has been suggested that the inoculation of chemical fertilizers had increased the shoot length of chilli plants when compared to other combinations.

The findings are in harmony with Chattoo *et al.*, (2007) who had shown that the growth attributes of the garlic were significantly enhanced by chemical fertilizers. Singegol *et al.*, (2007) suggested that the application of 150 kg N ha^{-1} was significantly improved the growth characters of green chilli as well as the yield attributing characters like number of fruits per plant and average fruit weight.

Bhalla *et al.*, (2007) had shown that the maximum plant height was observed in the treatment involving the combination of biofertilizers (*Azospirillum* + PSB) plus Vermicompost (1:1:1) plus inorganic water soluble fertilizers in *Dianthus carpohyllus* than the other combinations.

Aziz (2007) reported that the foliar application of benzyladenine, NPK fertilizer or their combinations influenced the vegetative growth of croton plants, especially when plants were sprayed with BA (20 ppm/l) combined with NPK (4g pot $^{-1}$).

Kagne *et al.*, (2008) reported that among the chemical fertilizers level 120:60:60 NPK in kg/ha recorded the significantly highest shoot length (284.2 cm) than the other combinations in sweet sorghum.

4.1.2. Fresh weight and Dry weight

The fresh and dry weights of chilli for various stages of growth were depicted in Table III.

Table – III
Effect of biofertilizer, vermicompost and chemical fertilizer on the fresh and dry weights of chilli

Treatments	Fresh weight (g/plant)		Dry weight(g/plant)	
	Days after sowing		Days after sowing	
	50	90	50	90
T_1	0.36	6.24	0.04	1.05
T_2	0.56	25.81	0.07	5.63
T_3	0.66	17.15	0.08	4.16
T_4	0.17	17.91	0.03	4.97
T_5	0.62	14.31	0.10	4.26
T_6	0.57	19.36	0.07	5.38
T_7	0.82	28.26	0.08	6.37
T_8	0.94	26.62	0.10	5.80
CD(0.05)	1.837		0.315	

Fresh weight

It was clear from the Table - III that the treatment, T_8 (Triple-17 complex + *Azophos* + vermicompost) had tremendously increased the fresh weight, which was followed by T_7 (*Azophos* + vermicompost) and T_3 (*Azophos*), on the 50th day of growth, whereas the fresh weight was found to be significantly ($P < 0.05$) higher in T_7 on the 90th day of growth. This was followed by T_8 and T_2 (Triple - 17 complex) respectively.

Thus it was understood that the triple inoculation of vermicompost, *Azophos* and triple -17 complex had enhanced the fresh weight in earlier stages, whereas combined application of *Azophos* and vermicompost increased the fresh weight of the chilli plants

at the later stages of growth. The enhanced biomass might be due to the improvement in soil physical conditions and the increased availability of nutrients. The findings are in harmony with Raja and Kumari (2008) who had shown that the fresh weight of shoot, root and leaves of Jatropha plants treated with bioinoculants were significantly higher than the control plants.

Vijayananthan *et al.*, (2007) had shown that the inoculation of vermicompost : sand : red soil in the ratio of 1:1:1 had induced the significant improvement in shoot fresh and dry weights compared to the control as well as the other vermiproduct application. Vermicompost is rich in humus, which contains enough plant nutrients, micronutrients and is rich in vitamins, beneficial microorganisms, antibiotics, enzymes etc., which is available for long time nutritional needs of plant growth (Dominguez *et al.*, 1997).

Dry weight

The dry weights of the treatments T_5 (triple - 17 complex + vermicompost) and T_8 (triple-17 complex + *Azophos* + vermicompost) were found to be higher on the 50^{th} day after transplantation, which was followed by T_7 (*Azophos* + vermicompost) and T_3 (*Azophos*). Among the treatments, T_7 recorded a significantly higher dry weight on the 90^{th} day of growth. Thus it was clear that the combined application of *Azophos* and vermicompost had increased the dry weight of the plants.

A study by Ramalakshmi and Raj (2008) reported that there was a significant increase in the dry weight of cotton due to biofertilizers inoculation. The highest dry weight was observed with *Azophos* and mycorrhiza combination at 90 and 120 DAG.

A study by Chamani (2008) showed that the media with 20% and 40% vermicompost incorporated increased significantly the fresh and dry weights of Petunia shoots compared to both control and peat amended media.

Atiyeh *et al.*, (2001) reported that substituting Metro – mix 360 with 5, 10, 25 and 50% pig manure vermicompost progressively increased leaf numbers, shoot lengths and

shoot dry weights at 14 and 21 days after germination of tomato seedlings with no fertilizer treatment compared with the Metro-mix control.

Karmegam *et al.*, (1999) and Karmegam and Daniel (2000) reported that the fresh and dry matter yields of cowpea were higher when the soil was amended with vermicompost than with biodigested slurry.

4.1.3. Number of leaves and Moisture content

The number of leaves and moisture content of chilli plants on the 50th and 90th days of growth are presented in table -IV

Table –IV
The number of leaves and moisture content in chilli plants

Treatments	Number of leaves		Moisture content (g)	
	Days after sowing		Days after sowing	
	50	90	50	90
T_1	9.53	12.25	0.32	5.18
T_2	8.25	21.25	0.50	20.18
T_3	10.60	17.50	0.59	12.99
T_4	9.50	21.75	0.14	12.94
T_5	10.45	17.50	0.52	10.05
T_6	11.25	13.50	0.50	13.98
T_7	12.45	14.75	0.74	22.15
T_8	11.65	17.75	0.84	20.81
CD(0.05)	1.698		0.919	

Number of leaves

The maximum number of leaves was registered in T_7 (*Azophos* + vermicompost), which was followed by T_8 (triple-17 complex + *Azophos* + vermicompost) on the 50th day after sowing. Whereas T_4 (vermicompost) was found to be superior on the 90th day which was followed by T_8 and T_5 (triple - 17 complex + vermicompost) respectively.

Thus at the initial stages of growth, combined inoculation of *Azophos* with vermicompost and at the later stage the sole application of vermicompost had influenced the leaf formation.

Singh *et al.*, (1998) reported that the plants treated with vermicompost, compost and mulch combinations exhibited better growth than the *Rizobium* and VAM culture in *Dalbergia sissoo*.

Warade *et al.*, (2007) reported that the combined treatment of vermicompost and PSB was found to be significantly higher with respect to the height of the plant (cm) and number of leaves plant $^{-1}$ in Dahlia.

Vasugi *et al.*, (2008) reported that the maximum leaf area index (LAI) was observed with the application of FYM, poultry manure and vermicompost and foliar spraying of panchagavya, vermiwash and humic acid. This might be possible due to higher uptake of nutrients owing to the improved physical conditions of soil by the application of FYM, poultry manure and vermicompost.

Moisture content

From Table - IV, it was clear that the treatment, T_8 (triple-17 complex + *Azophos* + vermicompost) has recorded the highest moisture content, followed by T_7 (*Azophos* + vermicompost) on the 50th day of growth. Whereas the trend was reversed was on the 90th day with T_7 recording the maximum moisture content which was followed by T_8.

Thus the combined application of *Azophos* and vermicompost has influenced the moisture content at the earlier stages of growth whereas the triple inoculation of *Azophos,* vermicompost and triple- 17 was found to best at the later stages of growth.

Upadhyay *et al.*, (2007) reported that the combination of vermicompost at 10 tonnes ha^{-1} plus *Azospirillum* recorded the maximum moisture content in cabbage when compared to the other treatments.

4.2 Biochemical analysis

4.2.1. Chlorophyll and Carotenoids

The levels of chlorophyll and carotenoids of chilli as influenced by the application of biofertilizers, vermicompost and chemical fertilizers were depicted in Table – V, Figure 1 and 2 respectively.

TABLE –V
Levels of chlorophyll and carotenoid contents of chilli as influenced by the biofertilizer, vermicompost and chemical fertilizer

Treatments	Chlorophyll (mg/g)		Carotenoids(mg/g)	
	Days after sowing		Days after sowing	
	50	90	50	90
T_1	1.10	1.76	0.19	0.27
T_2	2.18	2.83	0.27	0.47
T_3	1.39	2.24	0.20	0.34
T_4	1.68	1.98	0.22	0.31
T_5	2.23	2.57	0.25	0.47
T_6	2.20	3.41	0.29	0.47
T_7	1.39	2.70	0.23	0.26
T_8	2.56	3.38	0.30	0.58
CD(0.05)	0.063		0.008	

Chlorophyll

Among the treatments T_8 (triple-17 complex + *Azophos* + vermicompost) exhibited the highest chlorophyll content on the 50th day of growth and T_6 (triple - 17 complex + *Azophos*) and T_8 recorded the maximum as well as comparable values on the 90th day of growth. Thus the application of triple -17 complex along with *Azophos* and vermicompost had increased the chlorophyll content of chilli plants.

Chandrasekar *et el.*, (2005) reported that the treatments of *Azospirillum* and *Azotobacter* plus 100% urea resulted in significant increase in total chlorophyll as compared to the control. The beneficial effects of bacterial inoculation on increased

chlorophyll content might have been due to the supply of higher amounts of nitrogen to the growing tissue and organs by the nitrogen fixing *Azospirillum* and *Azotobacter*.

Balachandran *et al.*, (2006) observed that the half RDF (10 kg N and 20 kg P_2O_5 ha^{-1}) plus 5 tonnes pressmud and PSB significantly increased the leaf chlorophyll content over RDF and other treatments in green gram.

Velmurugan *et al.*, (2008) reported that the total chlorophyll content was maximum by the application of *Azospirillum* and Phosphobacteria as seedling dip plus foliar spraying of panchakavya to cauliflower. This is because the biofertilizers stimulate the production of growth regulators like auxins and gibberellins which in turn triggered the growth and biochemical activity.

Carotenoids

The application of *Azophos* in combination with vermicompost and triple – 17 complex (T_8) was found to be superior throughout the growth period recording a high carotenoid content over the other treatments. The treatment, T6 (Triple - 17 complex + *Azophos*) had recorded a value on par with T_8 on the 50^{th} day of growth which was followed by T_2 (Triple - 17 complex) and T_5 (Triple - 17 complex + vermicompost). The other treatments recorded similar values of carotenoid content. Whereas on the 90^{th} day of growth, the treatment T_8 recorded the maximum carotenoid content and the treatments, T_2, T_5 and T_6 were recorded a comparable value.

Thus the triple inoculation with *Azophos,* vermicompost and triple -17 complex had significantly increased the carotenoid content over the other treatments.

Upadhyay *et al.*, (2007) reported that in a study involving the effect of biofertilizers in combination of organic amendments or inorganic fertilizers on the growth, yield and quality attributes of cabbage (*Brassica oleracea* L.var. *capitata)*, the maximum total carotenoid content was recorded in the combination involving FYM (20 t ha^{-1}), *Azospirillum* and PSM.

Figure 1
Chlorophyll content in *Capsicum annuum* L.

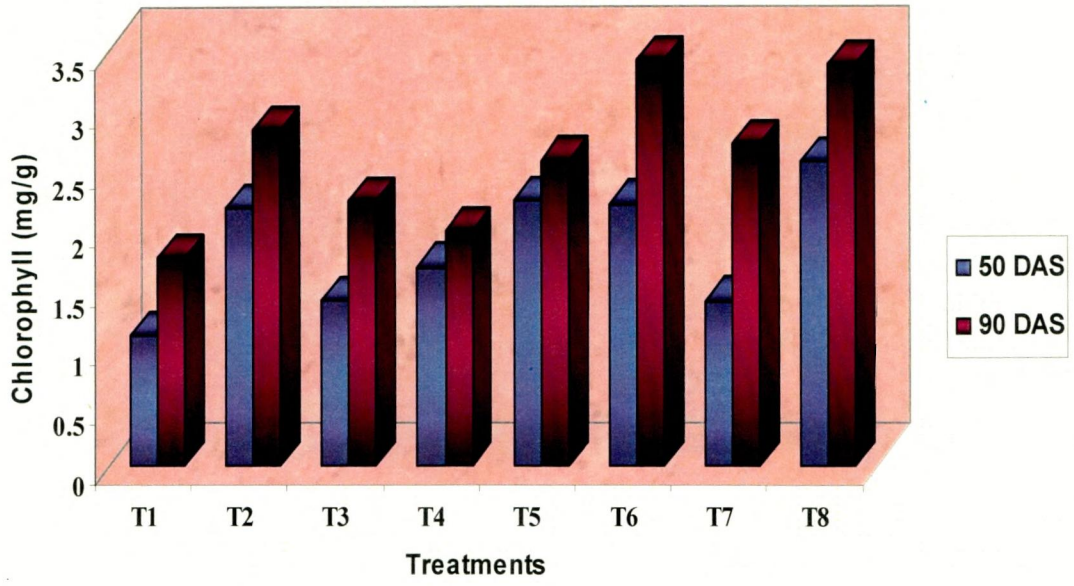
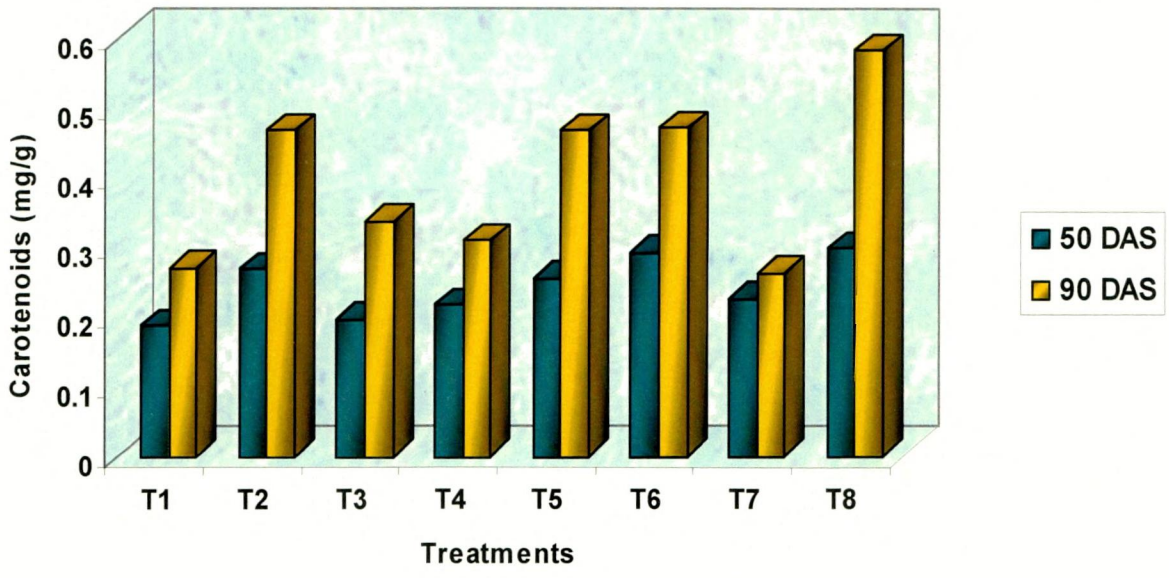


Figure 2
Carotenoid content in *Capsicum annuum* L.



4.2.2. Protein, Total Phenol and Total Carbohydrate

Table – VI, Figure 3, 4 and 5 represents the protein, phenol and carbohydrate contents of chilli leaves on the 50th and 90th day of growth.

TABLE –VI
Protein, Total phenol and Total carbohydrate contents in chilli

Treatments	Protein (mg/g)		Total phenol (mg/g)		Total carbohydrate(mg/g)	
	Days after sowing		Days after sowing		Days after sowing	
	50	90	50	90	50	90
T_1	2.84	34.77	2.56	6.60	26.88	29.76
T_2	2.67	36.79	2.88	8.11	38.40	67.68
T_3	3.24	26.00	3.54	7.23	37.44	51.12
T_4	3.42	36.23	4.88	6.35	39.60	56.15
T_5	2.67	38.16	5.50	6.97	62.64	79.20
T_6	3.69	34.39	5.62	7.79	40.32	62.16
T_7	3.14	29.18	3.88	6.99	83.52	83.52
T_8	3.53	42.51	6.10	9.56	39.60	88.56
CD (0.05)	0.781		0.340		1.776	

Protein

The treatment involving T_6 (triple - 17 complex + *Azophos)* resulted an enhanced protein content over the rest of the treatments on the 50th day of growth. This was followed by T_8 (triple-17 complex + *Azophos* + vermicompost) and T_4 (vermicompost). Whereas on the 90th day of growth, the maximum protein content was recorded in T_8, which was followed by T_5 (triple - 17 complex + vermicompost), T_2 (*Azophos*) and T_4 respectively. Also for the other treatments, the protein contents improved very much with number of days of growth except T_7. Even though initially the combination of triple -17 complex and *Azophos* enhanced the protein content, at the later stage of growth it was influenced by the triple inoculation of *Azophos,* vermicompost and triple -17 complex.

A study by Yasari *et al.*, (2007) on the canola (*Brassica napus* L.) the maximum protein content of the seed was seen in the combination involving the biofertilizers (*Azophos* and *Azospirillum*) and nitrogen. Singh *et al.*, (2007) reported that in kharif

cowpea application of *Rhizobium* along with nitrogen and phosphorus enhanced the protein content. This might be due to the fixation of atmospheric nitrogen, which in turn enhanced the total nitrogen content in seed as well as in other parts of the pant. Meena *et al.*, (2007) reported that the application of 120kg N ha^{-1} resulted in significantly higher protein content in rabi maize.

Total phenol

The phenolic content of leaves in the treatment T_8 (triple-17 + *Azophos*+ vermicompost) was found to be greater on the 50^{th} and 90^{th} day of growth which was followed by T6 (triple - 17 complex + *Azophos*) and T5 (triple - 17 complex + vermicompost) on the 50^{th} and T_3 (*Azophos*) on the 90^{th} day of growth. Thus the triple inoculation of *Azophos,* vermicompost and triple – 17 had increased the phenolic content of chilli.

Vijayakumari and Janardhanan (2003) reported that the maximum content of phenol was seen in silk cotton by the application of VAM, phosphobacteria and *Azospirillum.*

Figure -3
Protein content in *Capsicum annuum* L.

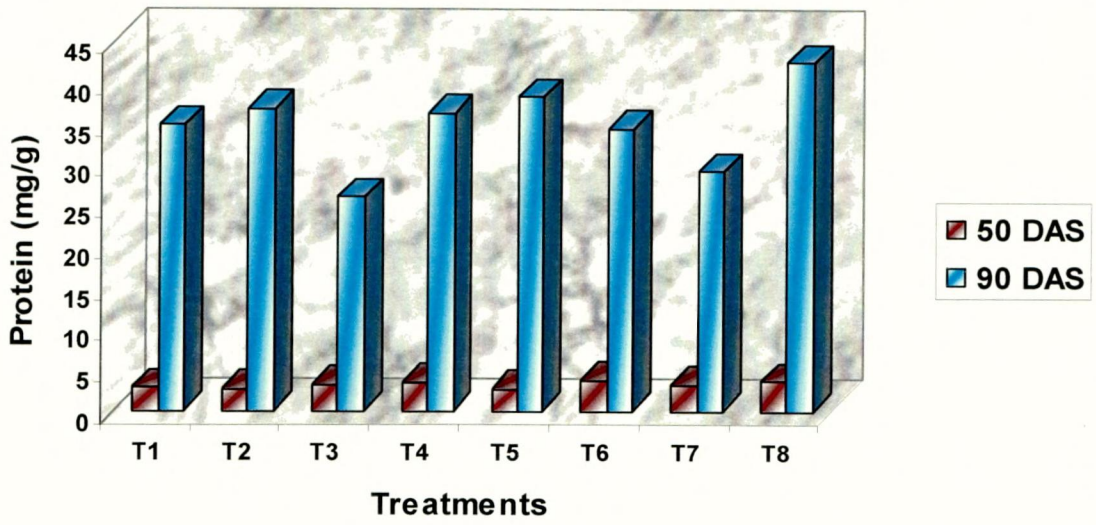


Figure -4
Total Phenol content in *Capsicum annuum* L.

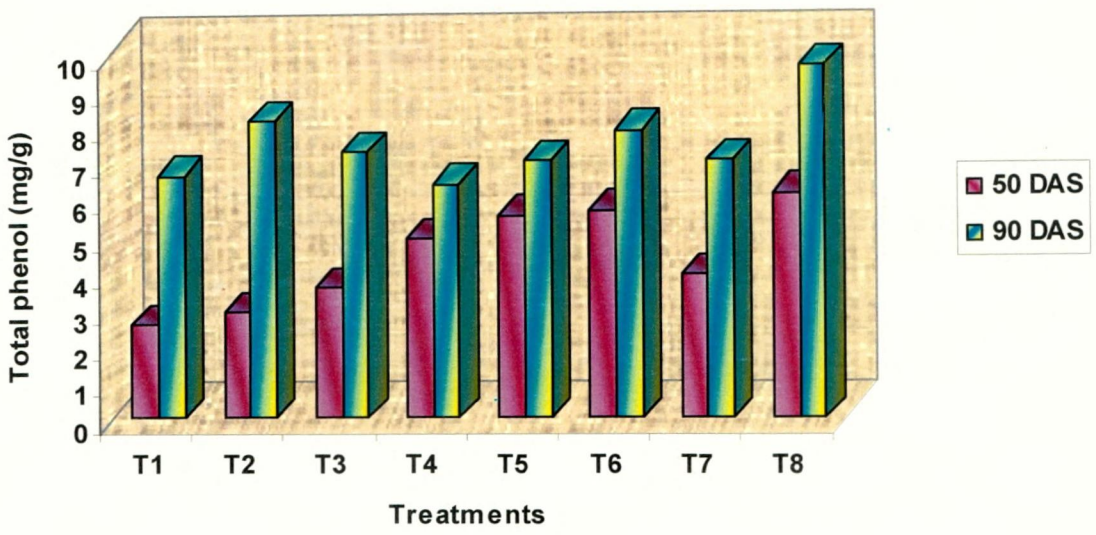
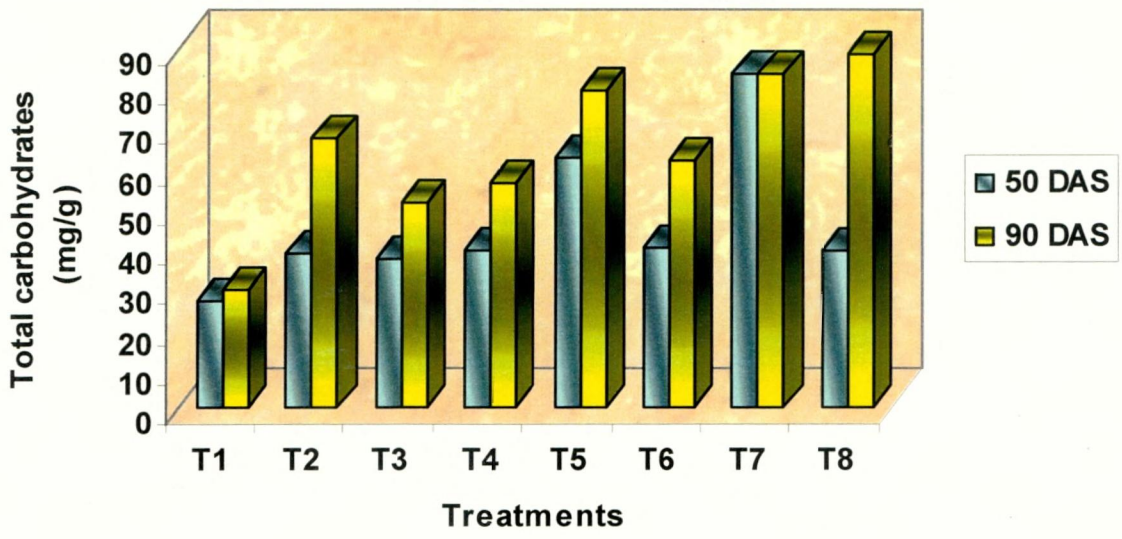


Figure - 5
Total Carbohydrate content in *Capsicum annuum* L.



Total carbohydrate

The treatment T_7 (*Azophos* + vermicompost) recorded the highest carbohydrate content on the 50^{th} day of growth, which was follower by T_5 (triple - 17 complex +

vermicompost), whereas the rest of the treatments have shown a comparable carbohydrate content. T_8 (triple-17 complex + *Azophos* + vermicompost) recorded a maximum carbohydrate content on the 90th day of growth and was followed by T_7 and T_5 respectively. Thus initially the dual application of *Azophos* and vermicompost had increased the carbohydrate content in leaves, but in later stage it was influenced by the triple inoculation of *Azophos,* vermicompost and triple 17 complexes.

Rao *et al.*, (2007) reported that the dual inoculation of VAM and BBM (Bacterial Biofertilizer – *Azotobacter chrococcum*) had influenced the biosynthesis of carbohydrates in the leaves of mulberry.

4.2.3. Nitrogen, Phosphorus and Potassium

Table – VII gives the nitrogen, phosphorus and potassium levels of chilli plant on the 50th and 90th day of growth. Figure 6, 7 and 8 depicts the same.

Table – VII
NPK contents of chilli plants as influenced by the application of biofertilizer, vermicompost and chemical fertilizer

Treatments	Nitrogen (%)		Phosphorus (mg/g)		Potassium (%)	
	Days after sowing		Days after sowing		Days after sowing	
	50	90	50	90	50	90
T_1	0.89	0.85	1.48	1.56	0.016	0.003
T_2	1.35	1.45	3.25	2.45	0.061	0.046
T_3	1.26	1.56	1.56	1.59	0.058	0.046
T_4	1.45	1.46	1.55	1.56	0.046	0.035
T_5	1.46	1.02	2.05	1.75	0.055	0.038
T_6	1.58	0.85	2.09	1.65	0.060	0.050
T_7	1.49	0.93	2.89	2.05	0.075	0.055
T_8	1.55	1.22	3.59	2.50	0.046	0.040
CD (0.05)	0.019		0.015		0.0002	

Nitrogen

The nitrogen content in chilli leaves was found to be greater in the treatment T_6 (triple - 17 complex + *Azophos*) on the 50th day which was followed by T_8 (triple-17 complex + *Azophos* + vermicompost) and T_7 (*Azophos* + vermicompost). Among the treatments T_3 (*Azophos*) recorded a higher nitrogen content on the 90th day which was followed by T_4 (vermicompost) and T_2 (triple - 17 complex) respectively.

Yasari *et al.*, (2007) reported that the capacity of the canola plant to extract nitrogen from the soil was more efficient at the presence of *Azospirilum* and *Azotobacter* showing their ability to make available nitrogen more for canola. However in the presence of other nutrient components the effectiveness of the bacteria for nutrient availability was less.

Phosphorus

The treatment T_8 has recorded the highest phosphorus content which was followed by T_2 and T_7 on the 50th as well as on the 90th day of growth. The rest of the treatments have shown comparable values throughout the growth period. Thus it was clear that the triple inoculation of *Azophos,* vermicompost and triple -17 complex have very much influenced the phosphorus content.

Shaheen *et al.*, (2007) also reported that the dual application of biofertilizers with chemical nitrogen fertilizer for okra plantation resulted in better N, P K contents in pods compared to the plants which have received chemical nitrogen fertilizer alone.

Velmurugan *et al.*, (2007) reported that the application of FYM, *Azospirillum,* phosphobacteria and VAM enhanced the greater uptake of phosphorus in turmeric. The inoculation of phosphobacteria resulted in the increased availability of phosphorus by degrading the complex forms of phosphate into more soluble form.

Potassium

Among the treatments T_7 (*Azophos* + vermicompost) registered the maximum potassium level on the 50th as well as on the 90th day of growth which was followed by T_2 (triple - 17 complex) on the 50th day and T_6 (triple - 17 complex + *Azophos*) on the 90th day of growth.

Kumar and Singh (2008) reported that in paddy the potassium content showed an increasing trend with increasing levels of nitrogen. Kolkar and Lakshman, (2008) reported that in *Terminalia bellerica* the nutrients such as N, P, K, Mg and Mo contents in shoots were enhanced by the combined inoculation of VAM, *Rhizobium* and Molybdenum.

Dange *et al.*, (2007) also reported that in wheat the highest potassium uptake was noticed in the treatment with single super phosphate, FYM and biofertilizers together. The application of organics and biofertilizers helps in improving the soil physical and biochemical properties which in turn, improved the availability of nutrients and their uptake by the plants.

Figure - 6
Nitrogen content in *Capsicum annuum* L.

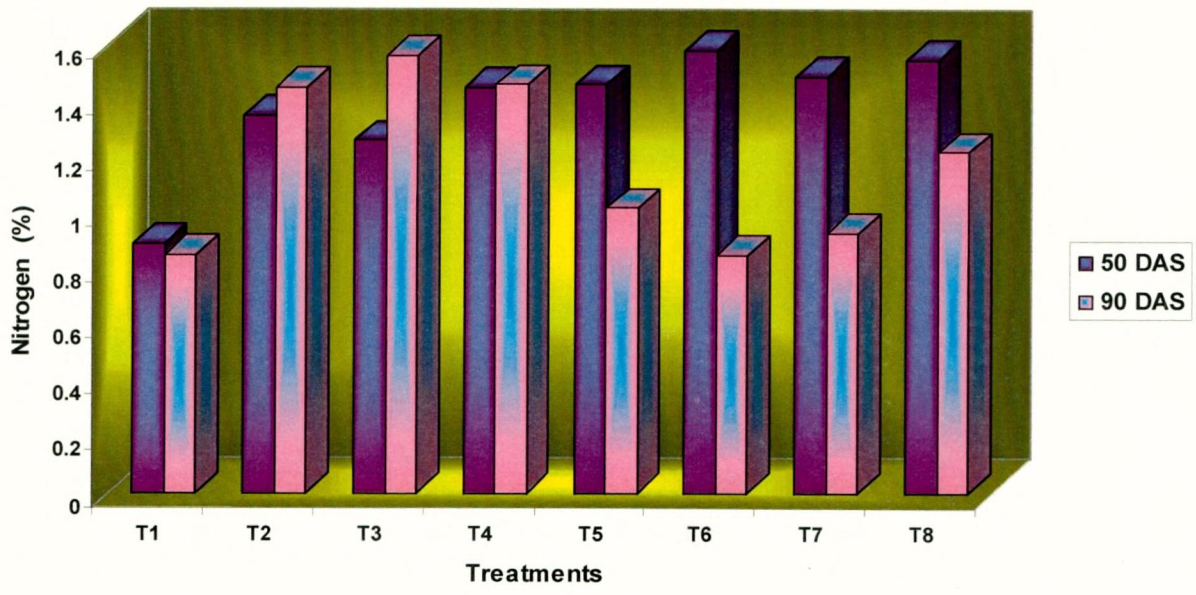


Figure - 7
Phosphorus content in *Capsicum annuum* L.

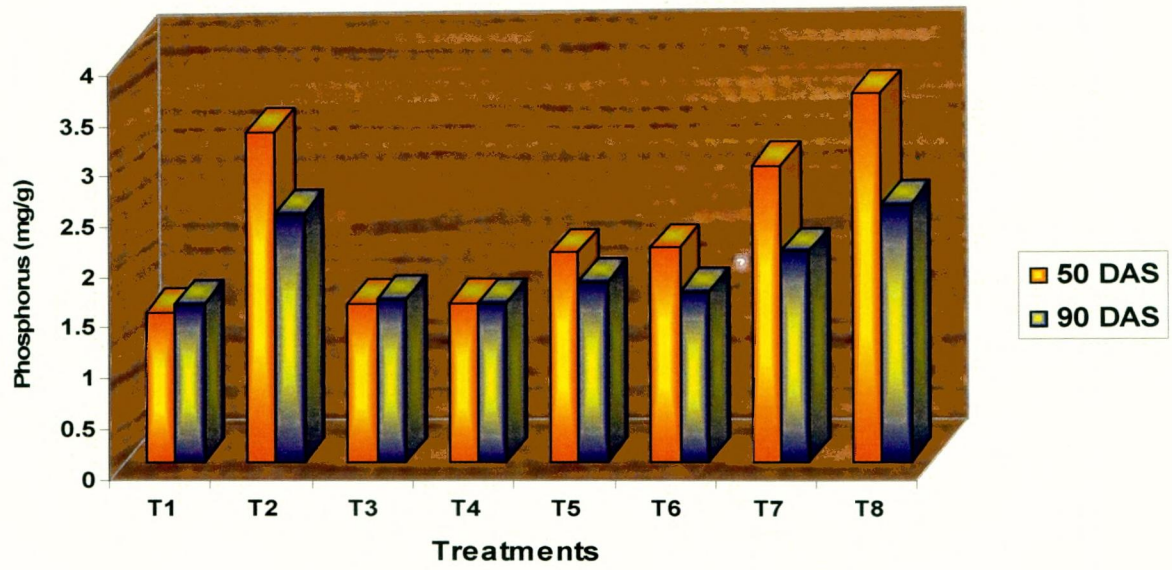
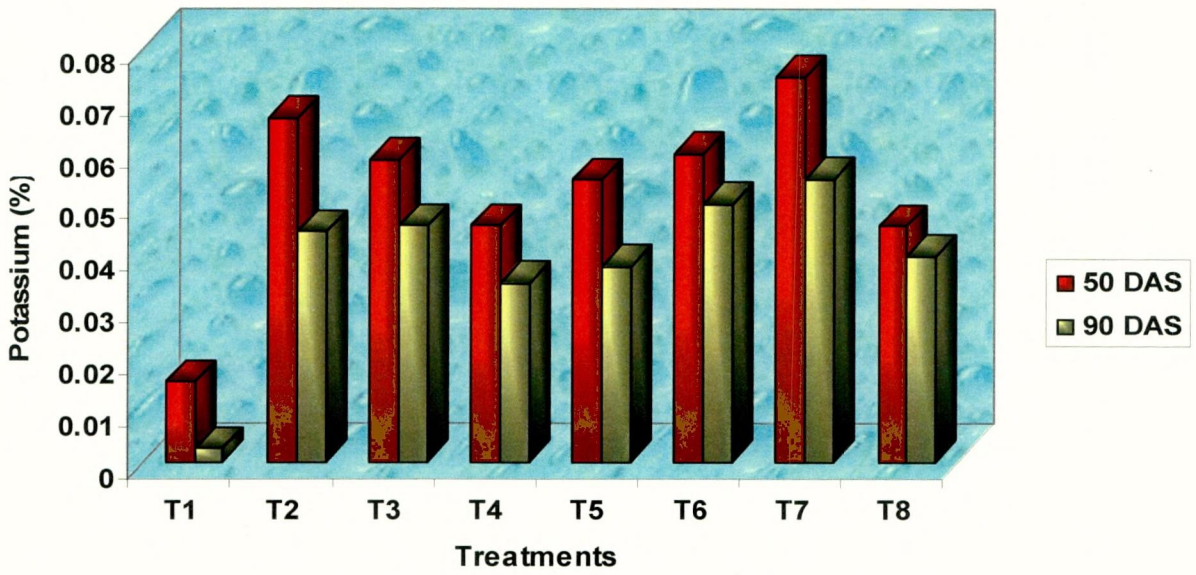


Figure - 8
Potassium content in *Capsicum annuum* L.



4.3 Vermicompost analysis

The vermicompost used for the study was analyzed for the N, P, K, organic carbon, Ca and Mg. The values are given in Table – VIII.

Table – VIII
Biochemical constituents of vermicompost

Nutrients	Vermicompost (%)
Nitrogen	1.68
Phosphorus	0.50
Potassium	0.72
Organic carbon	10.41
Calcium	160.00
Magnesium	96.00

Being rich in micro and macro nutrients, the soil health could be maintained by applying vermicompost (Thanunathan *et al.*, 2002). The vermicompost has been found ideal organic manure enhancing biomass production of a number of crops (Hidalgo, 1999).

Senthilkumar *et al.*, (2004) found that the vermicompost alone or in combination with NPK fertilizers significantly enhanced the growth, yield and quality of rose. Premuzic *et al.*, (1998) reported that the tomatoes contained significantly more Ca and vitamin C when grown on organic substrates such as vermicompost.

Kumari and Ushakumari (2002) reported that the treatment with enriched vermicompost enhanced the uptake of N, P, K, Ca and Mg by cowpea. Desai *et al..*, (1999) also stated that the application of vermicompost along with nitrogen fertilizer gave higher dry matter and grain yield of wheat (*Triticum asetivum*) and higher dry matter yield of the following coriander (*Coriander sativum*) crop in sequential cropping system.

4.4. Soil analysis at the initial stage and at the post harvesting stage

The soil used for the study was analyzed for N, P, K, pH, electrical conductivity, lime and texture at the initial stage. At the end of the 90th day of growth, the soil was analyzed for the above characteristics to see the effect of biofertilizer, vermicompost and triple -17 complex applications on the soil pH, electrical conductivity, N, P and K contents.

Table – IX
Physicochemical properties of soil at the initial and at the post harvesting stages

Treatments	pH	Electrical conductivity (d Sm^{-1})	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
Initial	8.53	0.19	157	29.2	188
Post harvest stage T_1	8.54	0.32	151	62.8	455
T_2	8.65	0.19	151	40.3	948
T_3	8.34	0.33	132	73.7	793
T_4	8.43	0.42	171	36.0	707
T_5	8.13	0.71	196	29.2	944
T_6	8.46	0.31	182	71.4	370
T_7	8.27	0.26	246	42.4	736
T_8	8.56	0.53	151	38.3	526

Initially the pH of the soil was found to be 8.53. After the application of biofertilizers, vermicompost and triple -17 there was only a slight variation in the soil pH (8.56). Table – IX clearly predicts that there was a slight improvement in the soil pH

inoculated with triple -17 complex (T_2) and the pH values of other treatments were found to be lower when compared to the initial stage of analysis.

Ramalakshmi *et al.*, (2008) reported that the biofertilizers inoculation resulted in change in pH reducing the alkalinity slightly in the black cotton soils. The acidification of rhizosphere could be through liberation of organic acids by proton extrusion mechanism (Illmer and Schinner 1995).

Sanwal *et al.*, (2007) reported that the application of FYM, poultry manure, and pig manure considerably reduced the soil acidity, while it is increased with the addition of inorganic chemical fertilizers

By studying the electrical conductivity of the soil at the initial and post harvest stage, the saline content of the soil was found to be very low at both the stages. But there was a slight improvement in the saline content at the post harvest stage except for the treatment with triple – 17 complex alone(T_2).

The texture of the soil was found to be sandy clay loam and it is of non-calcareous in nature both at the initial and post harvest stage of analysis. This shows that there is no effect of biofertilizers, vermicompost and chemical fertilizer on the texture and calcareous nature of the soil.

Table – XI clearly predicts that there was only a slight improvement in the nitrogen content of the soils only in few treatments. Among the treatments T_7 (*Azophos* + vermicompost) recorded a higher nitrogen content (246 kg ha^{-1}) which was followed by T_5 (196 kg ha^{-1}) and T_6 (182 kg ha^{-1}).

A study by Kannan *et al.*, (2005) stated that the application of vermicompost with *Azospirilllum* recorded the highest available nitrogen of 254 kg ha^{-1} over 100% nitrogen as urea in tomato. This could be attributed to the lower C: N ratio of vermicompost,

which has resulted in faster decomposition and release of nutrients as compared to the FYM. Further *Azospirillum* enhanced the available nitrogen through fixation.

The phosphorus levels was found to be higher in the treatment T_3 (*Azophos*) followed by T_6 (triple - 17 complex + *Azophos)*. Thus the inoculation of *Azophos* or the coinoculation of *Azophos* with triple -17 had increased the phosphorus content of the soil.

Ramalakshmi *et al.*, (2008) reported that the co-inoculation of mycorrhiza and phosphobacteria increased the available phosphorus in black cotton soil. Sanwal *et al.*, (2007) stated that the application of organics showed higher available phosphorus and potassium rather than direct addition through inorganic sources. The organic materials form a cover on sesquioxides, thus reducing the phosphate fixing capacity of the soil and solubilisation of insoluble phosphorus fractions resulting in the release of available phosphorus.

It was clear from the Table –IX that there was a significant improvement in the potassium content of the soil at the post harvest stage when compared to the initial stage. The treatment T_2 (triple - 17 complex) recorded a higher potassium content followed by T_5 (triple - 17 complex + vermicompost) and T_3. Thus the sole application of triple -17 complex or the co-inoculation of triple -17 complex along with vermicompost had increased the potassium content of the soil.

Mamatha *et al.*, (2006) reported that the potassium content significantly increased in onion (*Allium cepa* L.) due to the application of 100 per cent RDN (Recommended dose of Nitrogen) through FYM and vermicompost.

Thus the application of triple -17 complex (T_2) alone had exhibited higher pH and potassium levels in the soil and higher shoot lengths in chilli plants. The single inoculation of *Azophos* (T_3) had increased the phosphorus levels in soils and nitrogen levels in plants. Inoculation with vermicompost (T_4) alone had increased the number of leaves in the chilli plants.

The combined application of triple - 17 complex plus *Azophos* (T_6) had increased the chlorophyll contents in chilli leaves. The root length, fresh weight, dry weight, moisture content of the plants, potassium levels in leaves and nitrogen contents in soils were enhanced by the dual inoculation of *Azophos* plus vermicompost (T_7). The use of vermicompost in conjunction with triple – 17 complex and *Azophos* (T_8) showed an enhanced effect of carotenoid, protein, phenol, carbohydrates and phosphorus contents in leaves.