COMBINED EFFECT OF LIQUID BIOFERTILIZER WITH BIOPESTICIDE ON YIELD OF TOMATO (*SOLANUM LYCOPERSICUM* L.) AND INFESTATION OF *HELICOVERPA ARMIGERA* (HUBNER).

Shashi Kant Tiwari [2] and Keshav Singh[1]

[1]Vermibiotechnology Laboratory, Department of Zoology, D. D. U. Gorakhpur University, Gorakhpur-273 009 U.P. India.
[2]Project Fellow, Department of Zoology, D. D. U. Gorakhpur University, Gorakhpur-273 009 U.P. India

(**Received on Date: 30th September 2015 Date of Acceptance: 10th December 2015**)

ABSTRACT

The aim of present study was to observed the growth, early flowering, maximum productivity as well as minimum pest infestation of tomato crop. The foliar applications of combinations of vermiwash obtained from animal dung and MSW with bio-pesticides neem (*Azadiracta indica*) oil,aquous extract of leaf, bark and vermiwash alone caused significant growth, start early flowering , enhance productivity as well as significant reduction ($P>0.05$) in pest infestation of tomato crop. The highest growth of tomato (50.09±1.29 cm) and maximum significant early flowring were observed after foliar application of mixture of vermiwash with neem oil in ratio of (2:1) whereas, the maximum significant early flowering period obtained after treatment of vermiwash of buffalo dung and MSW (2:1 ratio) with neem oil. The combinations of buffalo dung and MSW with neem oil in ratio 2:1 have also maximum productivity (8.01 kg/m^2) and minimum pest infestation of *Helicoverpa armigera* of tomato crop. The foliar application of combinations of liquid biofertilizers with biopesticides is an appropriate technology for sustainable agriculture.

Key words: Biological wastes, vermicomposting, *Eisenia fetida*, liquid biofertilizer, biopesticide, *Helicoverpa armigera* and tomato yield.

No: of Tables: 05 **No: of Figures : 08** **No: of References: 74**

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), is the world's most popular and widely cultivated fruit vegetable. It is a warm season crop and grows best in rich loamy soil. Tomatoes are now eaten throughout the world (Singh *et al.,* 2005). Being widely consumed vegetable fruit it is also known as "Mediterranean diet" and is strongly related with a reduced risk of chronic degenerative diseases. (Agarwal and Rao,2000; Rao and Agarawal,1998). Tomato is a good source of antioxidants and daily intake of it provide a significant amount of these molecules. It is consumed either fresh or as processed product such as sauce, soup, canned tomato and, juice ketchup. (Lenucci *et al*., 2006). Tomato includes carotenoids such as β-carotene, a precursor of vitamin A, and mainly lycopene, which is largely responsible for the red color of the fruit, vitamins such as ascorbic acid and tocopherols, and phenolic compounds such as flavonoids and hydroxycinnamic acid derivatives. (Borguini and Torres, 2009; Clinton, 1998; Kotkov *et al.,* 2009; Kotkov *et al*., 2011; Moco *et al.,* 2006; Vallverdú-Queralt *et al*., 2011).Tomato fruit borer, *Helicoverpa armigera* (Hubner) is a cosmopolitan, highly polyphagous pest, distributed widely in Indian subcontinent (Fennimore, 1990). Apart from tomato, *H. armigera* is reported to infest cotton, maize, chickpea, pigeon-pea, sorghum, sunflower, soyabean and groundnut (Fitt, 1989). Females lay eggs on flowering and fruiting bodies of crops where voracious larval feeding leads substantial economic loss (Reed and Pawar, 1982). Larvae affect almost all the aerial parts of the tomato plant from the early growth till to the fruit maturation stage (Lal *et al.,*1996, Tripathy *et al.,*1999). Chaudhuri (2000) has reported very high loss of tomato due to borer infestation.

The cotton bollworm is a highly polyphagous species (Robinson, 2010). *Helicoverpa armigera* (Lepidoptera: Noctuidae) is geographically widespread in Europe, Asia, Africa and Oceania (Zalucki *et al.,* 1986, Guo, 1997). Its larvae have been reported in more than 60 species of cultivated and wild plants and in around 67 host families, including Asteraceae, Fabaceae, Malvaceae, Poaceae and Solanaceae (Pogue, 2004). Moreover, this herbivore can cause losses to different economically important crops, such as cotton, leguminous plants, sorghum, maize, tomato, ornamental plants and fruit trees (Garcia, 2006). *H. armigera* larvae feed on leaves and stems, although they prefer buds, inflorescences, fruits and pods causing damage in the vegetative and reproductive plant stages (Reed, 1965; Wang and Li, 1984).Tomato fruit worm, *Helicoverpa armigera* is major threat to tomato crop causing significant yield loss (Talekar *et al*., 2006). Worldwide annual crop loss due to *H. armigera* alone is approximately 5 billion US dollar (Sharma, 2001). In Pakistan, 32- 35% fruit infestation by *H. armigera* was observed in tomato (Latif *et al.,* 1997), where as 53% fruit loss was reported in Peshawar, Khyber Pakhtunkhwa Province (Inayatullah, 2007). Nath and Singh (2011) reported that the vermicomposts singly and in combination

with different biopesticides were used in agricultural field to check the infestation of nematode (*Pratylenchus sp*.) and measured the growth and yield of tomato *(Lycopersicon esculentum*) crop. Significant reduction of nematode population was observed in the soil after mixing of combination of vermicompost with neem oil (95%) and custard apple leaves (83%). The combination of garlic extract with different vermicompost caused 100% control of nematode population. Vermicompost obtained from animal dung and gram bran with neem oil was also very effective against the nematode (*Pratylenchus* sp.). Applications of vermicompost with biopesticide increased the productivity of tomato crop up to four times with respect to control. The results clearly demonstrated that the use of vermicompost with plant product is more beneficial in organic farming. It is helpful to compensate the deficiency of nutrients in the soil as well as control of the harmful nematodes.

MATERIALS AND METHODS

Collection of MSW and experiment set up for vermicomposting:

Municipal solid wastes (sewage sludge) and buffalo dung were collected from the local municipality and farm house of Gorakhpur city. Vermibeds were prepared from municipal solid wastes and animal dung in different ratio. For pretreatment, exposed to the sunlight for 5 to 10 days to remove the various harmful organisms and noxious gases. After pretreatment, adult earthworms *Eisenia fetida* were inoculated in each vermibed for vermicomposting. The vermibed covered with jute packet and moistened daily up to 40-50 days for maintaining the moisture (50% to 60% RH). After one week interval vermibed were turned manually. The tea like granules, brown color have been appeared on the upper surface of each vermibed after 60 days(Nath *et al.,* 2009).

Extraction of vermiwash:

Vermiwash were extracted from prepared vermicompost by the help of vermiwash collecting device. The apparatus is made from plastic drum having capacity of five liter and a tap at the bottom. The drum is filled with broken bricks, about 3 cm thickened which is followed by sand layer of 2-3 cm thickness lastly filled by prepared vermicompost with earthworms, simultaneously one liter fresh water was added in to the drum and after 24 hours a container kept below the tap for the collection of vermiwash (Nath *et al*., 2009).

Extraction of neem (Azadirachta indica A. Juss.):

Neem leaves, bark and fruit were collected from local area of Gorakhpur U.P. India. Neem leaves and bark were crushed in water. After preparation of aqueous extract of leaf, bark, and oil were mixed with vermiwash in ratio of 1:20. The mixtures of vermiwash with bio- pesticide were diluted with ten times water for treatment (w/v). Prepared vermiwash with biopesticides sprayed on tomato crop at interval of 10 days after plantation.

Measurement of the growth, productivity of Tomato and infestation of *Leucinodes orbonalis*:

The 40 days old seedlings of Tomato (*Solanum lycopersicum* L.) -- AZAD T - 2, were planted in agricultural field. Randomly selected six spots, each square meter area were used for sowing the crops. The growth (cm.) of plant was measured by Auxanometer at the interval of 10 days of plantation. The productivity was measured as kg/m^2 of tomato crop. The different combinations of vermiwash with neem biopesticides was sprayed over the crops after each 10 days interval for the measurement of growth whereas, at the time of starting of flowering after each 10 days interval the different combinations of vermiwash with biopesticides was sprayed over the crops and control have no treatment.

Statistical Analysis:

All experiments were replicated six times. Significant variance ($p<0.05$) determined by three way analysis of variance (ANOVA) was applied in between different treatment and different parameters (Sokal and Rohlf, 1973).

RESULTS

The combination of vermiwash obtained from animal dung and MSW with bio-pesticides neem (*Azadiracta indica*) oil, aquous extract of leaf, bark and vermiwash alone caused significant growth, start early flowering , enhance productivity as well as significant reduction ($P>0.05$) in pest infestation of tomato crop.(Table 1-4 Fig.1-8). The highest growth of tomato (50.09±1.29 cm) was observed in foliar application of mixture of vermiwash with neem oil in ratio of (2:1). The significant early flowering was observed in all the treatments of vermiwash with aqueous extract of neem plant parts. The maximum significant early flowering period of tomato was (90.90±1.03) days in treatment of vermiwash of buffalo dung and MSW (2:1 ratio) with neem oil. The significant increase in productivity of tomato was observed in all the combinations of vermiwash of buffalo dung and municipal solid wastes singly and in binary combination with neem- oil, aqueous leaf and bark extract. The combinations of buffalo dung and MSW with neem oil have maximum productivity of tomato (8.01 kg/m^2) in comparison to all the treatments. .(Table 1-4 Fig.1-8). The significant reduction in infestation of *H. armigera* was observed in foliar application of all the combinations of vermiwash with neem plant parts. The minimum pest infestation of *H. armigera* was obtained in vermiwash obtained from combination of buffalo dung and MSW (2:1 ratio) with neem oil .(Table 1-4 Fig.1-8).

DISCUSSION

It is evident from result section that the use of the combination of vermiwash obtained from animal dung and MSW with biopesticides-neem (Azadiracta indica) oil, aquous extract of leaf, bark and vermiwash alone caused significant growth, start early flowering, enhance productivity as well as significant reduction in pest infestation of tomato crop. Vermiwash of different animal dung and municipal solid wastes have significant amount of nitrogen, phosphorus, Ca++, K+ vitamins, enzyme, plant hormones etc. which promotes the plant growth (Suthar, 2008; Garg *et al.*,2003; Pathak and Ram, 2004). Krishnamoorthy and Vajranabhiah

(1986) reported the microbial activity in vermicomposts could result in production of significant quantity of plant growth

Table 1: Effect of different combination of vermiwash of combination of different animal dung with MSW on the growth, ,flowering and productivity as well as per cent pest infestation of tomato (*Solanum melogenum*).

Combination	Ratio	Growth(cm)			Flowering(days)	% Pest infestation			Productivity (kg/m^2)
		50days	70days	90days		110 days	120 days	130 days	
Control	----	12.75±0.48	19.22±1.16	29.22±1.16	106.77±0.74	55.84±1.54	68.33±0.86	80.29±0.72	1.12±0.40
MSW	----	14.77±0.59	23.29±1.50	33.09±1.50	105.57±0.73	45.28±0.87	54.29±0.81	66.27±1.03	1.41±0.43
Cow dung +MSW	----	17.03±6.95	24.05±3.81	34.05±3.81	103.47±2.80	34.52±3.60	29.13±2.11	25.01±1.09	3.05±1.40
	1:1	19.05±0.85	26.01±1.04	36.01±1.04	100.47±0.66	28.83±0.81	23.19±0.84	19.05±1.19	3.67±0.56
	1:2	21.01±0.57	28.03±0.84	38.03±0.84	101.57±0.78	30.67±1.07	25.17±0.88	21.04±0.82	4.11±0.76
	2:1	23.02±0.58	30.02±0.79	40.02±0.79	102.78±0.76	32.55±0.83	27.14±0.77	23.04±1.16	4.75±0.65
Buffalo dung+MSW	---	20.55±0.62	25.05±0.90	35.05±0.90	100.11±1.37	31.05±0.79	24.05±0.76	19.05±1.19	3.16±0.64
	1:1	22.37±0.60	28.01±0.84	38.01±0.84	99.05±0.80	27.25±0.94	21.02±0.78	16.07±0.97	3.92±0.66
	1:2	24.03±0.98	30.12±0.83	40.12±0.83	101.01±1.00	29.01±1.07	23.01±0.79	17.06±1.19	4.77±0.73
	2:1	26.01±0.91	34.45±1.16	44.45±1.16	98.02±0.81	26.82±0.85	20.11±0.76	15.02±1.32	5.01±0.67
Goat dung+MSW	---	17.33±0.61	21.52±0.81	31.52±0.81	104.85±0.96	35.81±1.05	30.52±0.83	25.09±1.01	2.75±0.69
	1:1	19.47±0.66	23.57±0.78	33.57±0.78	102.81±0.73	33.33±0.97	28.78±0.78	23.11±0.96	3.55±0.80
	1:2	20.52±0.67	25.61±0.69	35.61±0.69	103.78±0.77	31.59±0.78	26.71±0.81	21.29±0.86	4.03±0.78
	2:1	22.19±1.07	27.13±0.82	37.13±0.82	101.87±0.79	36.49±0.87	31.82±0.87	26.31±0.82	4.19±0.77
Horse dung+MSW	----	19.02±0.87	23.05±0.88	33.05±0.88	102.57±0.86	33.21±0.98	28.57±0.68	24.39±0.94	3.09±0.89
	1:1	20.07±1.04	25.01±0.70	35.01±0.70	100.29±0.70	31.11±0.87	26.59±0.80	22.12±0.65	3.68±0.90
	1:2	22.01±0.94	27.03±0.67	37.03±0.67	99.19±0.64	29.17±0.57	24.29±0.88	20.18±1.16	4.09±0.92
	2:1	23.09±1.49	29.52±0.89	39.52±0.89	101.43±0.62	27.65±0.71	22.77±0.69	18.85±0.64	4.39±0.65

Each value is the mean ± SE of six replicates
Three way ANOVA: Significant (P<0.05) within column and row.

Table 2: Effect of different combination of vermiwash of different animal dung with MSW and neem bark on the growth, ,flowering and productivity as well as per cent pest infestation of tomato (*Solanum melogenum*).

Combination	Ratio	Growth(cm)			Flowering(days)	% Pest infestation			Productivity (kg/m^2)
		50days	70days	90days		110 days	120 days	130 days	
Control	----	12.75±0.48	19.22±1.16	29.22±1.16	106.77±0.74	55.84±1.54	68.33±0.86	80.29±0.72	1.12±0.40
MSW	----	15.79±1.02	24.31±1.44	34.01±1.44	105.07±0.71	41.23±0.87	50.28±0.83	62.25±1.01	1.49±0.45
Cow dung +MSW	----	18.05±0.55	25.07±1.03	35.07±1.03	101.83±2.81	30.51±3.52	25.11±2.12	21.09±1.05	3.29±1.41
	1:1	20.08±0.67	27.01±1.04	37.01±1.04	98.63±1.16	24.83±2.19	19.17±0.85	15.05±1.51	3.97±0.59
	1:2	22.03±0.69	29.59±1.07	39.59±1.07	99.01±0.74	26.66±1.19	21.16±0.81	17.07±1.03	4.48±0.67
	2:1	24.04±0.81	31.29±1.17	41.29±1.17	100.27±0.75	28.51±1.11	23.15±0.71	19.05±1.06	4.93±0.69
Buffalo dung+MSW	---	21.32±0.72	26.62±0.69	36.62±0.69	98.11±1.31	27.05±0.99	20.06±0.67	15.04±1.09	3.69±0.92
	1:1	23.37±0.75	29.61±2.21	39.61±2.21	97.19±0.83	23.24±0.95	17.03±0.87	12.03±0.98	4.37±0.67
	1:2	25.51±0.58	32.35±0.84	42.35±0.84	99.23±1.03	25.01±1.17	19.02±0.97	13.04±1.11	4.98±0.74
	2:1	27.83±3.35	36.96±0.82	46.96±0.82	96.05±0.80	22.81±1.25	16.12±0.65	11.01±1.23	5.92±0.68
Goat dung+MSW	---	18.01±1.03	22.52±1.16	32.52±1.16	102.85±0.95	31.79±1.35	26.52±0.73	21.09±1.13	3.01±0.65
	1:1	20.03±1.10	24.57±0.81	34.57±0.81	102.85±0.95	29.31±0.98	24.78±0.72	19.12±0.97	3.59±0.81
	1:2	21.05±1.23	26.61±0.78	36.61±0.78	100.32±0.71	27.58±0.79	22.69±0.79	17.28±0.87	4.20±0.79
	2:1	23.02±2.05	28.15±0.69	38.15±0.69	101.68±0.82	32.47±0.89	27.79±0.78	22.31±0.83	4.61±0.75
Horse dung+MSW	----	19.77±1.59	24.27±0.88	34.27±0.88	100.37±0.91	29.22±0.99	24.51±0.62	20.32±0.95	3.37±0.88
	1:1	21.93±2.99	26.11±0.71	36.11±0.71	98.19±0.93	27.13±0.88	22.52±0.82	18.13±0.66	3.98±0.91
	1:2	23.47±1.96	28.17±0.66	38.17±0.66	97.85±0.97	25.18±0.56	20.23±0.91	16.47±1.17	4.37±0.93
	2:1	24.81±1.81	30.12±0.89	40.12±0.89	99.31±0.92	23.62±0.72	18.71±0.60	15.11±0.99	4.59±0.67

Each value is the mean ± SE of six replicates
Three way ANOVA: Significant (P<0.05) within column and row.

Table 3: Effect of different combination of vermiwash of different animal dung with MSW and aqueous nextract of neem leaf on the growth, flowering and productivity as well as per cent pest infestation of tomato (*Solanum melogenum*).

Combination	Ratio	Growth(cm)			Flowering(days)	% Pest infestation			Productivity (kg/m^2)
		50days	70days	90days		110 days	120 days	130 days	
Control	----	12.75±0.48	19.22±1.16	29.22±1.16	106.77±0.74	55.84±1.54	68.33±0.86	80.29±0.72	1.12±0.40
MSW	----	16.75±0.55	25.29±1.11	35.02±1.11	103.69±0.73	36.23±3.61	45.28±2.11	56.25±1.10	1.78±1.81
Cow dung +MSW	----	19.07±0.95	26.05±1.04	36.09±1.04	99.83±1.81	25.51±0.82	20.11±0.83	16.09±1.16	3.72±0.96
	1:1	21.09±0.85	28.01±1.14	38.01±1.14	96.88±0.66	19.83±1.07	14.17±1.05	11.05±0.84	4.81±0.92
	1:2	23.11±0.57	30.07±0.79	40.07±0.79	97.89±0.76	21.66±0.83	16.17±0.82	13.06±1.17	5.32±0.98
	2:1	25.08±0.59	32.39±0.91	37.39±0.91	98.91±0.77	23.51±0.81	18.15±0.77	17.37±1.21	5.91±0.68
Buffalo dung+MSW	---	22.91±0.62	27.71±0.85	37.71±0.85	96.19±1.31	22.05±0.95	16.09±0.82	11.01±1.20	4.03±0.72
	1:1	22.49±0.61	30.18±0.83	40.18±0.83	95.12±0.82	18.24±1.09	13.25±0.59	8.02±1.23	5.09±0.97
	1:2	26.23±0.92	33.07±1.03	43.07±1.03	97.11±0.89	20.14±0.88	12.13±1.01	9.05±0.97	6.17±0.59
	2:1	29.89±0.93	38.39±1.11	48.39±1.11	94.01±0.65	17.19±1.06	10.01±0.81	6.02±1.13	7.01±0.77
Goat dung+MSW	---	19.09±0.74	23.03±0.80	43.03±0.80	100.44±1.02	26.79±0.99	20.52±0.89	17.09±1.31	3.34±0.92
	1:1	21.09±0.72	25.11±0.87	35.11±0.87	98.41±0.88	24.32±0.96	22.78±0.83	15.11±1.04	3.93±0.54
	1:2	22.25±1.21	27.09±0.79	37.09±0.79	99.48±0.69	22.55±0.97	18.61±0.86	13.21±0.99	4.68±0.59
	2:1	24.09±1.29	28.08±0.86	38.08±0.86	97.52±0.75	28.47±0.88	24.71±0.87	19.13±0.87	5.03±0.53
Horse dung+MSW	----	20.49±1.81	25.16±0.88	35.16±0.88	98.37±0.74	25.45±0.85	20.45±1.19	16.21±0.96	3.67±0.57
	1:1	22.37±1.91	27.17±0.71	37.17±0.71	96.78±0.78	23.47±0.74	18.47±0.49	14.11±1.15	4.33±0.53
	1:2	24.06±1.86	29.08±0.77	39.08±0.77	95.86±0.83	21.24±0.75	17.21±0.64	12.09±0.63	4.57±0.58
	2:1	26.73±1.59	31.01±0.91	41.01±0.91	97.33±0.99	19.62±0.76	15.62±0.66	10.11±0.67	4.88±0.57

Each value is the mean ± SE of six replicates

Three way ANOVA: Significant (P<0.05) within column and row.

Table 4: Effect of different combination of vermiwash of different animal dung with MSW and neem oil on the growth, ,flowering and productivity as well as per cent pest infestation of tomato (*Solanum melogenum*).

Combination	Ratio	Growth(cm)			Flowering(days)	% Pest infestation			Productivity (kg/m^2)
		50days	70days	90days		110 days	120 days	130 days	
Control	----	12.75±0.48	19.22±1.16	29.22±1.16	106.77±0.74	55.84±1.54	68.33±0.86	80.29±0.72	1.12±0.40
MSW	----	17.87±0.59	26.41±1.13	36.01±1.13	102.69±0.72	41.23±0.87	50.28±0.83	62.25±1.01	1.87±0.46
Cow dung +MSW	----	20.07±1.91	27.05±1.16	37.05±1.16	97.81±1.82	30.51±3.52	25.11±2.12	21.09±1.05	3.72±1.42
	1:1	22.09±0.86	29.01±1.17	39.01±1.17	93.93±1.19	24.83±2.19	19.17±0.85	15.05±1.51	4.81±0.61
	1:2	24.13±0.57	31.02±1.44	41.02±1.44	95.89±1.17	26.66±1.19	21.16±0.81	17.07±1.03	5.32±0.68
	2:1	26.08±0.97	33.01±1.16	43.01±1.16	96.87±1.25	28.51±1.11	23.15±0.71	19.05±1.06	5.91±0.71
Buffalo dung+MSW	---	23.71±1.11	28.23±1.22	38.23±1.22	94.72±1.33	27.05±0.99	20.06±0.67	15.04±1.09	4.83±0.76
	1:1	25.61±1.35	31.22±1.26	41.22±1.26	93.50±1.31	23.24±0.95	17.03±0.87	12.03±0.98	5.89±0.68
	1:2	27.63±1.23	35.23±1.27	45.23±1.27	92.02±0.84	25.01±1.17	19.02±0.97	13.04±1.11	6.77±0.75
	2:1	31.39±1.07	40.09±1.29	50.09±1.29	90.90±1.03	22.81±1.25	16.12±0.65	11.01±1.23	8.01±0.69
Goat dung+MSW	---	20.11±1.19	24.03±1.31	34.03±1.31	98.88±0.81	31.79±1.35	26.52±0.73	21.09±1.13	3.61±0.65
	1:1	22.11±0.65	26.12±1.33	36.12±1.33	96.96±0.96	29.31±0.98	24.78±0.72	19.12±0.97	4.43±0.81
	1:2	24.25±0.78	28.08±1.31	38.08±1.31	97.97±0.99	27.58±0.79	22.69±0.79	17.28±0.87	4.89±0.79
	2:1	26.09±0.75	30.08±1.15	40.01±1.15	95.85±0.97	32.47±0.89	27.79±0.78	22.31±0.83	5.42±0.75
Horse dung+MSW	----	21.41±1.91	26.19±1.06	36.19±1.06	96.62±0.98	29.22±0.99	24.51±0.62	20.32±0.95	4.02±0.88
	1:1	23.23±1.09	28.17±0.88	38.17±0.88	93.85±0.92	27.13±0.88	22.52±0.82	18.13±0.66	4.85±0.91
	1:2	25.08±1.10	30.05±0.89	40.09±0.89	92.39±0.87	25.18±0.56	20.23±0.91	16.47±1.17	5.23±0.93
	2:1	27.73±1.18	33.02±0.93	43.02±0.93	94.77±0.89	23.62±0.72	18.71±0.60	15.11±0.99	5.62±0.69

Each value is the mean ± SE of six replicates

Three way ANOVA: Significant (P<0.05) within column and row.

Table 5. Summary of computation of analysis of variance (ANOVA) of the data of table 1,2,3,4.

Source of variation	Flowering (Days)					Productivity (kg/m^2)					% Pest infestation				
Components	D.F.	S.S.	Variance(σ^2)	F-value	P	D.F.	S.S.	Variance(σ^2)	F-value	P	D.F.	S.S.	Variance (σ^2)	F-value	P
Between 6 treatment	5	78611.9	15722.4	8.28	0.05	5	336.45	67.29	7.92	0.05	5	2200.85	4400.77	12.7	0.05
Between 4 animal	3	79427.4	26475.8	13.9	0.05	3	119.44	39.41	4.68	0.05	3	17647	5882.33	17.0	0.05
Between 4 pesticides	3	289.40	96.49	3.05	0.05	3	162.65	54.21	6.38	0.05	3	1945.52	648.50	1.9	0.05
Residual variation	84	159482.1	1898.59			84	713.43	8.49			84	29078.75	346.17		
Total	95	1732.20				95	1331.98				95	70674.91			

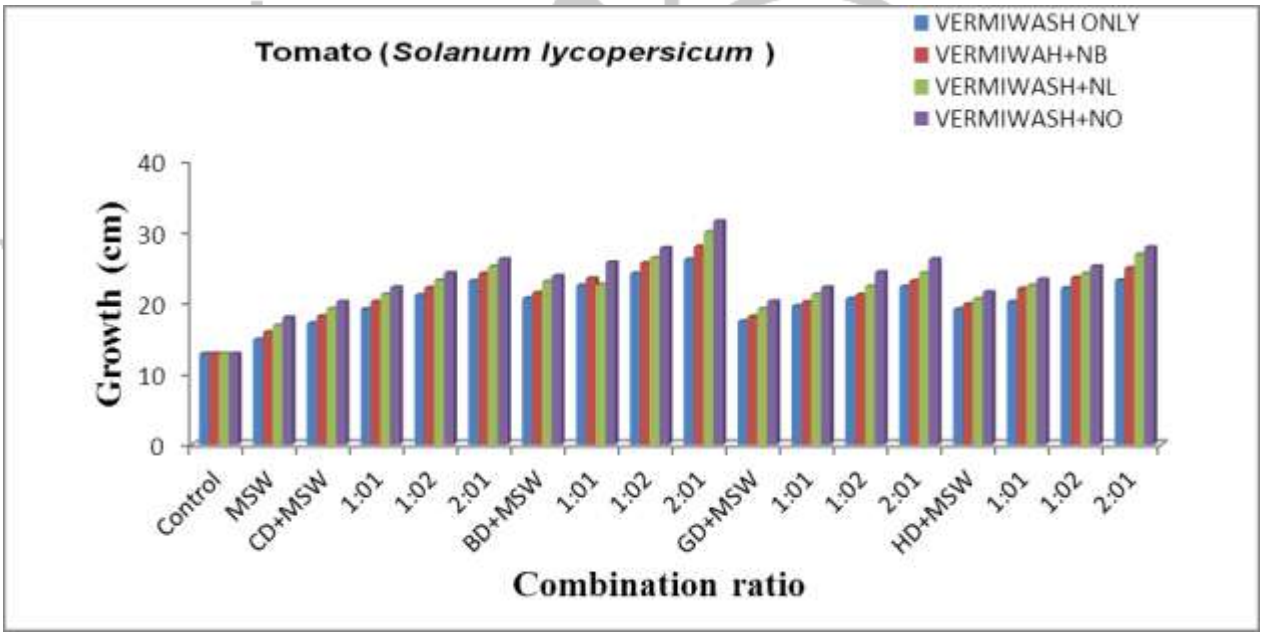

Fig 1: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on growth of tomato plant at 30 days NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung.

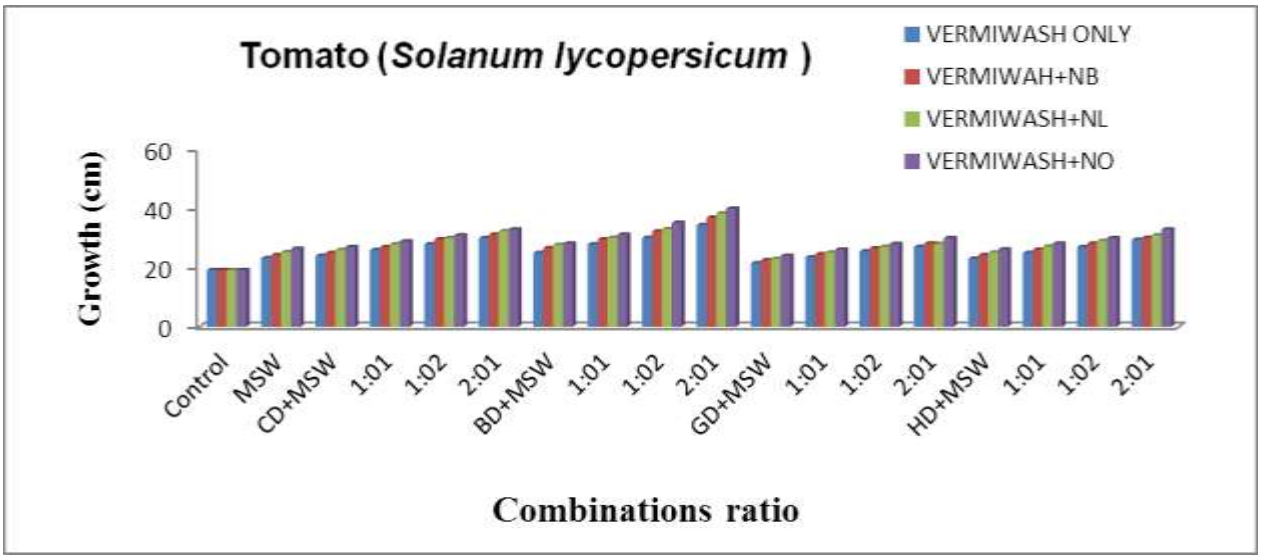

Fig 2: - Effect of vermiwash of combinations of animal dung and MSW with biopesticides on growth of tomato plant at 40 days. NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung.

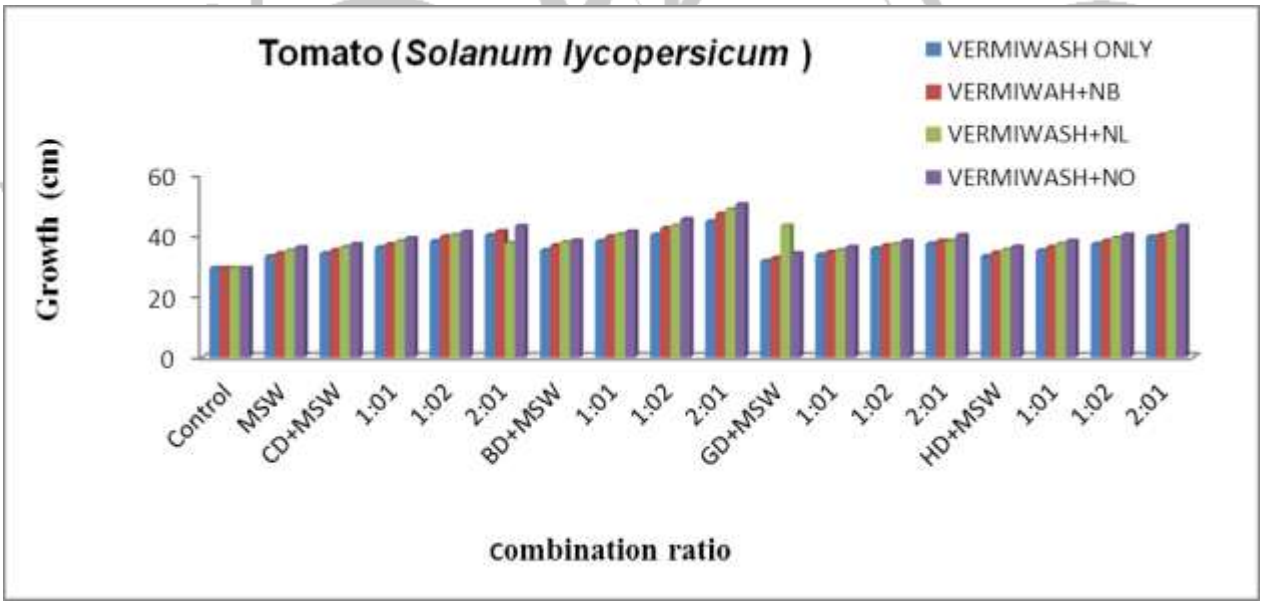

Fig 3: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on growth of tomato plant at 50 days. NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung.

.

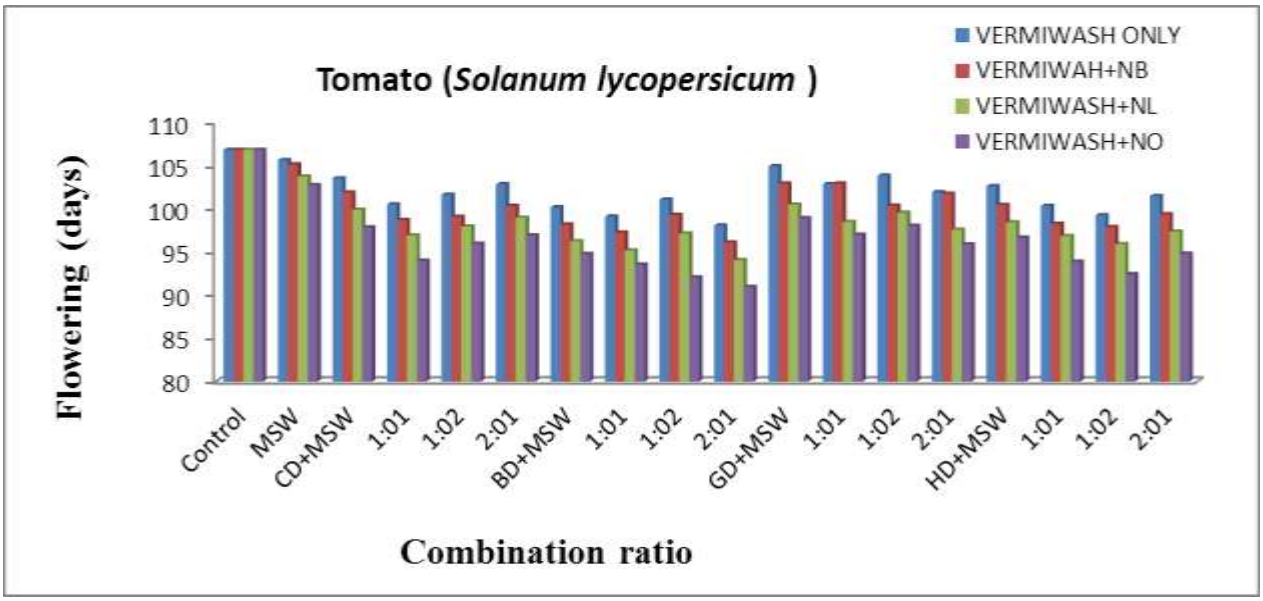

Fig 4: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on flowering of tomato plant. NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung.

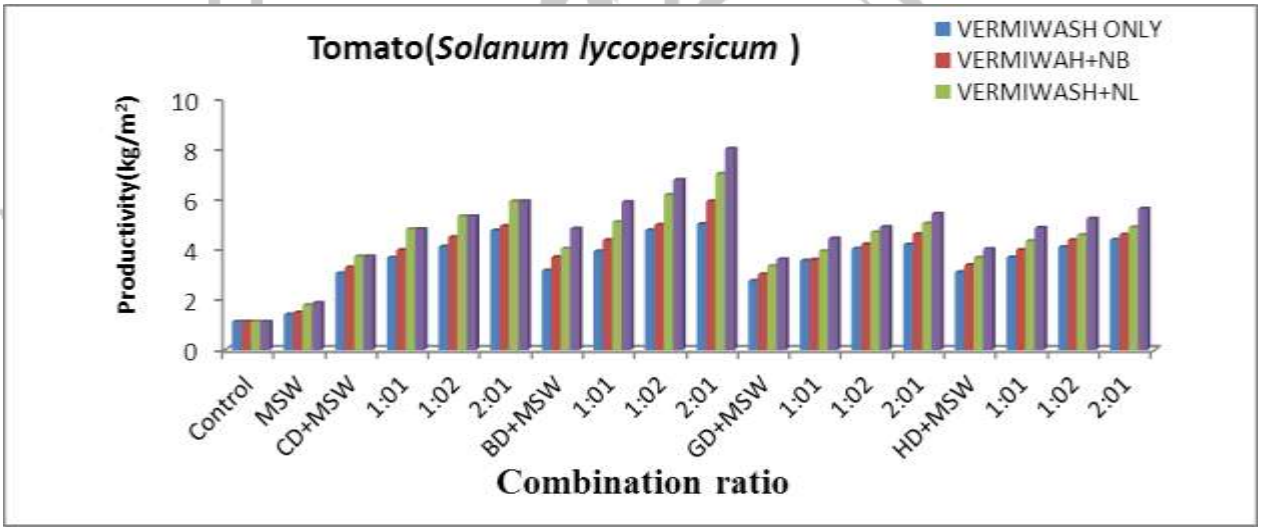

Fig 5: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on productivity of tomato plant. NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung .

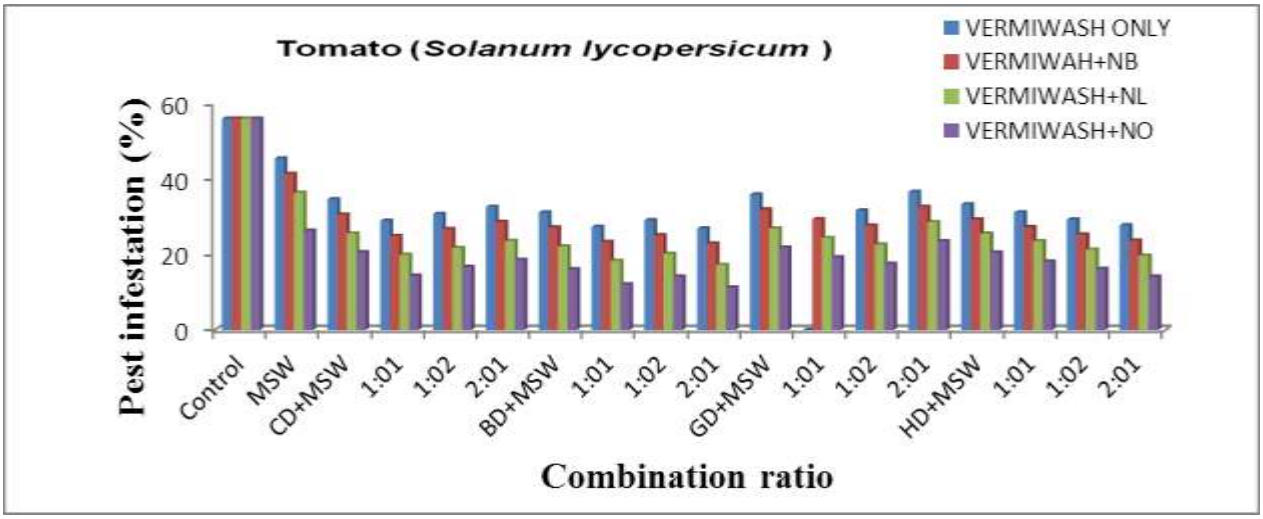

Fig 6: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on productivity of tomato plant at 110 days.NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung .

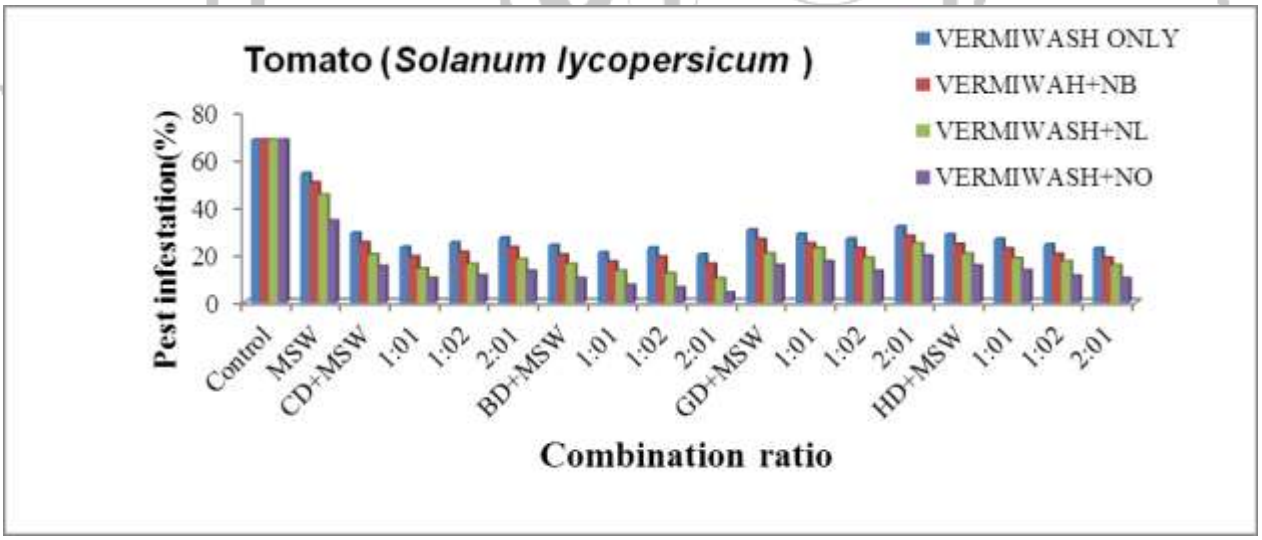

Fig 7: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on productivity of tomato plant at 120 days. NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung.

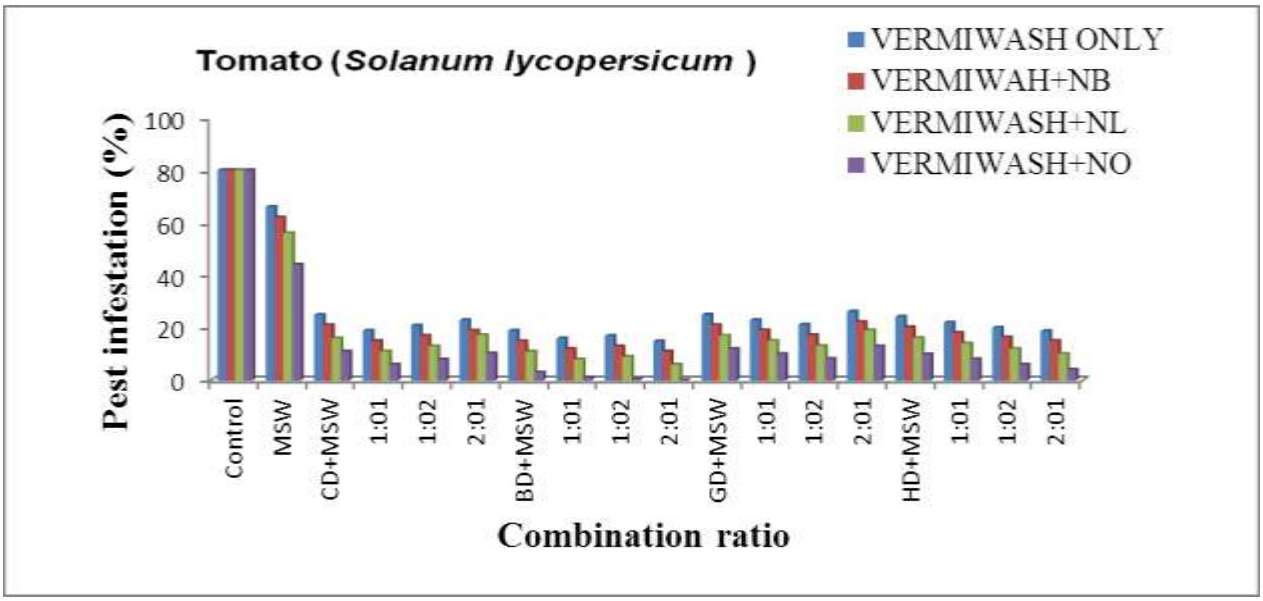

Fig 8: Effect of vermiwash of combinations of animal dung and MSW with biopesticides on productivity of tomato plant at 130 days..NB= Neem bark, NL=Neem leaf, NO= Neem oil, MSW=Municipal solid wastes, CD=Cow dung, BD=Buffalo dung, GD=Goat dung.

regulators such as IAA, gibberellins, cytokinins, by microorganisms. Large amount of humic acid were produced during vermicomposting and these had been reported to have positive effects on plant growth (Chen *et al.*, 1990; Atiyeh *et al*.,2002; Manivannan, 2004; Ramamoorthy, 2004) Vermicomposts had been shown to influence the growth and productivity of a variety of plants, cereals and legumes(Rao *et al.,*2005,Chan *et al.,*1988) vegetable (Atiyeh *et al*.,1999; Atiyeh *et al*.,2001;Edwards *et al.,*1988) Nath and Singh (2009) observed that the treatment of vermiwash shows significant increase in growth, productivity and decreased flowering period.

The highest growth of tomato (50.09±1.29 cm) was observed in foliar application of mixture of vermiwash buffalo dung and municipal solid wastes with neem oil because the vermiwash of buffalo dung and municipal solid wastes contain higher amount of potassium (K) than sodium (Na). Potassium, as one of the essential macro-nutrients, which enhance the better plant growth (Bumb and Hammond, 2005).Vermicompost of these combinations are the rich source of enzymes, vitamins plant growth hormones such as IAA, Gibbereline, Cytokinine along with micro and macro nutrients. The use of combination of vermiwash with biopesticides protect the plant to the pathogens and help in better growth of tomato plant(Nath and Singh, 2011; Mishra *et al.,* 2014). Vermiwash of different animal dung with municipal solid wastes have significant amount of nitrogen, phosphorous, calcium, potassium, vitamins, enzymes and plant hormones (Astaraei and Ivani, 2008). The foliar spray vermiwash

of municipal solid wastes causes persistence of water droplet on the leaves surface which promotes the leaf succulency, increase photosynthetic activity, internodes growth, improved plant physiology and ultimately increase the yield and quality of plant (Astaraei and Ivani, 2008; Gamaley *et al.,* 2006). Sundararasu and Jeyasankar (2014) reported that the yield of brinjal in response to vermiwash was highly significant in experimental plots which may be due to increased availability of more exchangeable nutrients in the soil by the application of vermiwash. Similarly, Muscolo *et al*., (1999) also found an auxin-like effect of earthworm worked to increase humic substances for cell growth and nitrogen metabolism in *Daucus carota*.

The significant early flowering was observed in all the treatments of vermiwash of buffalo dung and municipal solid wastes with aqueous extract of neem plant parts. Early starting of flowering and prolonged flowering period may be due to the presence of increased amount of nitrogen, phosphorus, calcium and potassium, as well as growth hormone, enzyme, vitamins in different vermiwash (Nath and Singh,2011). Vermicompost and its extract have consistently improve the early starting flowering period much more than could be possible from more conversion of mineral nutrients in to more plant available forms (Atiyeh *et al.,* 1999,2000,2001,2002). It has been suggested that the dramatic increase in microbial in organic matter by earthworms could result production of significant quantities of plant growth regulators such as indol acetic acid,(IAA) gibberellins and cytokinines and hormone like activity in the vermicompost. The highly significant concentration of TKN and TP stimulate the starting of early flowering period of wheat (Muscolo *et al.,* 1999; Atiyeh *et al.,* 2002). It may be possible that the growth hormones (gibberellins) present in significant amount started the early flowering period of the plant. Marschner (1995) reported that K^+ accelerates the osmotic potential of phloem and volume flow rate. Edwards *et al.,* (2004) reported that the hormones produced by high microbial activity in vermicompost present in vermiwash are very effective in growth and flowering of plants., the hormones auxins, promotes the plant growth and gibberellins stimulate the early flowering in long photo period plant (Edwards *et al.,* 2004). Gomathy *et al.,* (2008), reported that the phosphorus is one of the major essential nutrients for biological growth and development. Many soil microorganism are able to solubilize the unavailable forms of calcium bound P through their metabolic activities. Extract of vermicompost had been shown to induce the flowering of plants (Edwards and Burrows, 1988; Atiyeh *et al.,* 2000).

Rao (2005) reported that foliar spray initiate flowering and long lasting the inflorescence of *Anthurium* due to presence of K^+, Ca^{++}, Mn^{++} hormones, enzyme, vitamins plant growth promoting substances. Increase NKP fertilizer rate increase inflorescences of flower, productivity and decreased abscission of flower. The increase nitrogen level had

significantly prolonged flowering period in brinjal (Satpal and Saimbhi, 2003; Anburani *et al.,* 2003). Nitrogen and sulphur are important components that have significantly increase the plant growth, flowering and yield of grains (Farahbakhsh *et al.,* 2006).

The maximum significant early flowering period of tomato was (90.90±1.03) days in treatment of vermiwash of buffalo dung and MSW (2:1 ratio) with neem oil. There was significant reduction in flowering period of cauliflower in all the combination of vermi composts of different animal and agro wastes with neem oil/garlic/custard apple extract with respect to control. The combination of vermicompost with biopesticide caused early flowering of cauliflower plants, possibly due to the presence of TKN, TP in the vermicompost which stimulate the early flowering of crop (Atiyeh *et al.,* 2002 ; Nath *et al.*,2009). The rich amount of TKN and TP stimulate the early flowering period of *Daucus carota* and tomato (Satpal and Saimbhi, 2003; Anburani *et al., 2003*)

The significant increase in productivity of tomato was observed in all the combinations of vermiwash of buffalo dung and municipal solid wastes singly and in binary combination with neem- oil, aqueous leaf and bark extract. The combinations of buffalo dung MSW with neem oil have maximum productivity of tomato (8.01 kg/m^2) in comparison to all the treatments. Large amount of humic acids was produced during vermicomposting (Gupta, 2005; Albanell *et al.,* 1988) and, humic acid extracted from vermicompost of cattle, food and paper wastes were applied to young marigold, pepper, and strawberry plant increases the fruit growth and number of fruits of strawberries (Ramamoorthy, 2004; Canellas *et al.,* 2000; Atiyeh *et al.,* 2002). Darzi *et al.,* (2012) reported that the application of vermicompost and phosphate solubilizing bacterium on *Anise* (*Pimpinella anisum* L.) causes expression of good morphological character better seed yield of Anise. The presence of significant amount of enzymes, hormones and vitamins were responsible for better results. The significant productivity of spinach (*Spiracia oleracea*), onion (*Allium sepa*) and potato (*Solanum tnburosum*) obtained by the use of foliar spray of vermiwash, indicate the better growth of plants and higher yield by slow release of nutrients. Gibberellins, auxine increase the bio availability of nitrogen, phosphorus and more exchangeable nutrients by the organic inputs (Tiwari, 1989; Lalitha *et al.,* 2000).

The foliar spray of K^+ plays an important role in translocation and synthesis of carbohydrate and protein (Tisdale and Nelson, 1976; Venkatarayappa *et al.,* 1969). Application of worm casts enhance nutrient uptake by plants, stimulate plant root initiation, increase root biomass, enhance plant growth, increase crop yield, plant productivity, and also increase protein synthesis in plants. Increased growth and yield have been reported in a variety of plant (Atiyeh *et al.,* 2001, 2000). Supplementation of NPK with presumed vermicast enhanced the yield in black gram (*Vigna mango*) and groundnut

(*Arachis hypogea*) (Parthasarathi and Rangnathan, 2002).Selective use of organic amendments like vermin wash has significantly promotes the soil conditioning value and varying degrees of influence on soil property (Ansari, 2007, 2008). The organic foliar spray is better because of more persistence of organic droplets on leaf surface and more uptake of nutrient and ensure the adequate nutriments supply (Mangle, 2002; Neri *et al.,* 2002). Gamaley *et al.,* (2006) reported that foliar applications of vermiwash have promoted the plant physiology that ultimately caused higher yield and quality of crops.

The combinations of buffalo dung and MSW with neem oil have maximum productivity of tomato (8.01 kg/m^2) in comparison to all the treatments. Presence of essential nutrients in vermi compost increased the metabolic activity of plant as well as garlic extract check the nematodes infestation in cauliflower (Mangle, 2002; Talarposhti and Kambouzia, 2007). Reduction of plant parasitic nematodes directly affects the productivity of crops (Akhtar and Mahamood, 2004; Musabyimana and Saxena, 2008).The significant reduction in infestation *H. armigera* was observed in foliar application of all the combinations of vermiwash with neem plant parts. There is minimum pest infestation of *H. armigera* was obtained in combination of vermiwash of buffalo dung and MSW with neem oil in ratio of 2:1. Mishra *et al*., (2014) reported that the foliar spray of water extract of single and binary combinations of vermiwash with biopesticides control the infestation of the *Lucinodes orbanalis* and increases the crop productivity. Significant decrease in *Lucinodes orbanalis* population was observed after foliar spray of vermiwash with neem oil followed by aqueous garlic and *Annona* leaf extract. The combination of neem oil with vermiwash caused complete removal of the *Lucinodes orbanalis* infestation. Neem extract obtained from different plant part have bio-active compound *Azadirachtin*, a limnoid (Tri-terpenoid) which is potent anti-feedant ,growth regulator, antifungal, bactericidal, antiviral effect in animals (Wondafrash, 2012; Champagne, 1992). Chitra *et al.,* (1993) observed 69.55% control of *L. orbonalis* after spraying of 0.10% leaf extract of *Azadirachta indica*. Esakkiammal *et al.,* (2015) reported that the combination of vermi compost and vermi wash of organic wastes have significant growth and yield of *Dolichous lablab*.

CONCLUSION

It is evident from the present study that vermiwash with pesticide for management of *Helicoverpa armigera* population in tomato plant. Combination of buffalo dung and MSW with neem oil is very effective combination for growth, productivity and early flowering of tomato plant. It is also clear that foliar spray of vermiwash provides all the necessary nutrients to the plants which are required for growth, early flowering and enhanced productivity. The bio-pesticide are more effective against *Helicoverpa armigera* without contamination of fruit. So it is best alternative of chemical fertilizer and pesticide for management of *Helicoverpa*

armigera. These by products are easily preparable, less expensive and eco-friendly.

ACKNOWLEDGEMENT

Authors are thankful to University Grant Commission (UGC) New Delhi Project F. No- 42-527/2013 (SR) for financial assistance.

REFERENCES

AGARWAL A AND RAO A.V. (2000). Tomato lycopene and its role in human health and chronic diseases. Can. Med. Assoc. J. 163, 739-744.

AKHTAR M. AND I. MAHAMOOD, (2004). Organic soilamendment in relation of nematode management withParticular reference to India. J. Integrated PestManagement Reviews, 1: 201-215

ALBANELL E., PLAIXATS,J., AND CABRERO,T., (1988). Chemicalchanges during vermicomposting (*Eisenia fetida)* of sheep manure mixed with cotton industrial wastes. *BiolFertil Soil*. 6, 266–269.

ANBURANI A., K. MANIVANNAN AND S. ARUMUGAM,(2003). Integrated nutrient management on quality parameters in brinjal. Plant Archives, 3(2): 279-281.

ANSARI A A, AND ISMAIL S A (2008). Reclamation of sodic soils through vermitechnology. Pakistan J. Agric. Res., 21(1-4): 92-97.

ASTARAEI A.R. AND IVANI R. (2008): Effect of organic sources as foliar spray and root media on Cow pea plant. American – Eurasian & Environ. Sci, 3(3), 352-356.

ATIYEH R. M., ARANCON, N., EDWARDS, C. A. AND METZGER J. D. (2000a) Influence of earthworm-processed pig manure on the growth and yield of greenhouse tomatoes. Bioresource Technology 75, 175–180.

ATIYEH R. M., ARNACON N. Q., EDWARDS C. A. AND METZGER J. D., (2001). The influenced of earthworm processedpig manure on the growth and productivity of marigolds,Bioresource Technology 81, 103-108.

ATIYEH R. M., SUBLER S., EDWARDS C. A. AND METZGERJ. D., (1999). Growth of tomato plant in horticulture pottingmedia with vermicompost, Pedobiologia. 43, 1-5.

ATIYEH R.M., ARANCON N.Q., EDWARDS C.A. AND METZGER J.D., (2002)The influence of earthworm processed pig manure on the growth and productivity of marigolds. Bioresour Technol 81: 103-108.

BORGUINI R., AND TORRES, E. (2009). Tomatoes and tomato products as dietary sources of antioxidants. Food Rev. Intern. 25, 313–325.

BUMB B. L. AND HAMMOND L. L. (2005)Encyclopedia of SoilScience. 2ndEd. (Rattan Lal CRC Press).

CANELLAS L. P., OLIVARES F. L., OKOROKOVA A. L. AND FACANHA A. R. (2000). Humic acids isolated from earthworm compost enhance root elongation, lateral root emergence, and plasma H+ -ATPase activity in maize roots. Plant Physiology 130, 1951–1957

CHAMPAGNE D.E., KOUL O., ISMAN M.B., SCUDDER G.G.E. AND TOWERS G.H.N. (1992). Biological activity of limonoids from the Rutales. Phytochemistry 31:377-394.

CHAN P. L. S. AND GRIFFITH D. A., (1988). The vermicomposting of pretreated pig manure. Biol. Wastes. 24, 57-69.

CHAUDHARI N., (2000). Insect pest constrains of tomato (*Lycopersicon esculentum* Mill.) and their management under terai region of West Bengal. Ph.D thesis submitted to the University of North Bengal. Raja Rammohanpur, Darjeeling.

CHEN Y. AND AVIAD T. (1990). Effect of humic substances onplant growth. In: Mac Carthy, P., Clapp, C.E., Malcolm,R.L. Bloom, P.R. (eds.); Humic substances in soiland crop sciences selected readings. ASA and SSSA,Madison, pp. 161-186.

CHITRA K.C., RAO K.P. AND NAGAIAH K. (1993). Field evaluation of certain plant products in the control of brinjal pest complex Indian J. Entomol., 55(3): 237-240

CLINTON S.K. (1998). Lycopene; chemistry, biology and implications for human health and diseases. Nutr. Rev. 56, 35–51. .

DARZI M.T., MOHAMMADREZA H.S.H., AND FARHAD R._(2012) Effects of the application of vermicompost and phosphate solubilizing bacterium on the morphological traits and seed yield of anise (*Pimpinella anisum* L.). Journal of Medicinal Plants Research, 6(2), 215-219.

EDWARDS C. A, AND BURROWS I. (1988). The potential of earthworm composts as plant growth media. In: Edwards CA, E Neuhauser (Eds.) Earthworms in Waste and Environmental Management. SPB Academic Press. The Hague, The Netherlands 21-32.

EDWARDS C.A., J. DOMINIGUEZ AND ARANCON N.Q.[2004). The influence of vermicompost on plant growthand pest ncidence. (In: Shakir SH and Mikhail WZAeds. Soil Zoology for Sustainable Development in the21st century). Self Publisher, Cairo, Egypt,pp: 397-420.

ESAKKIAMMAL B, LAKSHMIBAI L. AND SORNALATHA S.(2015) Studies of combined effect of vermicompost and vermiwash prepared from organic wastes by earthworms on the growth and yield parameters of *Dolichous lablab*. Asian journal of pharmaceuticl sciences and technology Volume 5, Issue 4 246-252

FARAHBAKHSH H, PAKGOHAR N AND KARIMI, A. (2006) Effect of nitrogen and sulphur fertilizer on yield components and oil contents of oil seed rape(*Brassica napus*) Asian journal of plant sciences 5,112-115).

FENEMORE P. G. AND THANEE, N. (1990), Oviposition preference andlarval food quality in *Helicoverpa armigera* Symp. Biol. Hung. 39: 461–462.

GAMALEY A.V., NADPOROZHSKAY M.A., POPOV, A.I.,CHERTOV O.G.,KOVSH, N.V. AND GRAMOVA, O.A.(2006): Non rootnutritonal with vermicompost extract as the way of ecological optimization, Plant nutrition-food security and susceptibility of agro ecosystem,862-863

GARCIA M. F. J. (2006).Analysis of the spatiotemporal distribution of *Helicoverpa armigera* (Hübner) in a tomato field using a stochastic approach. Biosystems Engineering, Bedford, v. 93, n. 3, p. 253-259.

GOMATHY M., THANGARAJU M., GUNASEKARAN S, GOPAL NO, AND GOPAL H. (2008). Method and quantity of liquid formulation of phosphobacteria required for seed inoculation. Pak. J. Biol. Sci. 11(1):86-91.

GUO Y. Y. (1997) Progress in the researches on migration regularity of *Helicoverpa armigera* and relationships between the pest and its host plants. Acta Entomologica Sinica, Beijing, v. 40, n. 1, p. 1-6,.

GUPTA P.K., (2005). Vermicomposting for sustainableagriculture: Bharat Printing Press, Jodhpur, India,pp: 11-14.

INAYATULLAH M., (2007). Biological control of tomato fruitworm (Helicoverpa armigera) using egg parasitoid *Trichogramma chilonis* (Trichogrammatidae: Hymenoptera) and Chrysoperla carnea (Chrysopidae: Neuroptera). First Annual Technical Report, HEC Funded Project, pp. 99.

KAUSHIK P. AND GARG V.K. (2003) Vermicomposting of mixed solid textile mill sludge and cow dung with the epigeic earthworm *Eisenia foetida*. *Bioresource Technol* 90:311–316

KOTKOV Z., HEJTMNKOV A. AND LACHMAN, J. (2009). Determination of the influence of variety and level of maturity of the content and development of carotenoids in tomatoes. Czech J. Food Sci. 27, S200-S203.

KOTKOV Z., LACHMAN J., HEJTMNKOV A. AND HEJTMNKOV K. (2011). Determination of antioxidant activity and antioxidant content in tomato varieties and evaluation of mutual interactions between antioxidants. LWT - Food Sci. & Technol. 44, 1703- 1710.

KRISHNAMOORTHY R.V. AND S.N. VAJRANBHAIAH(1986).Biological activity of earthworm casts: An assessment of plant growth promoter levels in the casts. Proc Indian Academic Sciences (Animal Sciences).,95:341-351

LAL O.P. AND LAL S.K.(1996). failure of control measures against *Heliothis armigera* (Hubner) infesting tomato in heavy pesticidal application areas in Delhi and satellite towns in western Uttar Pradesh and Harayana(India). Journal of Entomological Research,20(4):355-364.

LALITHA R, FATHIMA K, AND ISMAIL SA (2000). The impact of biopesticide and microbial

fertilizers on productivity and growth of Abelmoschus esculentus. Vasundara the Earth. (1-2): 4-9.

LATIF M., AHEER G.M. AND SAEED M., (1997). Quantitative losses in tomato fruits by *Heliothis armigera* Hb. Abstr. PM-9. Third International Congress of Entomological Science, Pak. Entomol. Society, March 18-20,. National Agricultural Research Center, Islamabad. 95 p.

LENUCCI M.S., CADINU D., TAURINO M., PIRO G., AND DALESSANDRO G. (2006). Antioxidant composition in cherry and high-pigment tomato cultivars. J. Agric. Food Chem. 54, 2606-2613.

MANGLE K., (2002). Alternative or complementary role of foliar supply in mineral nutrition. Liebig University Giessen, Institute of Plant Nutrition

MANIVANNAN S.(2004) Standardization and nutrientanalysis of vermicomposting sugarcane wastes,pressmud-trash-bagasse by *Lampito mauriti* (kingberg) and *Perionyx exacavates*(Perrier) and crop productivity.Ph.d Thesis Annamalai University,India.

MARSCHNER H. (1995). Mineral nutrition of higher plants. 2n ed. Academic Press, Harcourt Brace & Co. p. 299-312.

MISHRA K., SINGH K. AND TRIPATHI C.P.M.,(2014) Management of infestation of pod borer (*Lucinodes orbonalis Guenee*) and productivity enhancement of brinjal (*Solanum melogena*) through vermiwash with bio-pesticide International Journal of Advanced Research (2014), Volume 2, Issue 1, 780-789.

MOCO S., BINO R.J., VORST, O., VERHOEVEN H.A., DE GROOT J., VAN BEEK T.A., VERVOORT J., AND DE VOS J.H.R. (2006). A liquid chromatography-mass spectrometrybased metabolome database for tomato. Plant Phys. 141, 1205-1218.

MUSABYIMANA AND SAXENA,(2008).Efficacy of neem seed deravatives against nematodes affecting banana phytoparasitica, 27: 43-49.

MUSCOLO A, BOVALO F, GIONFRIDDO F,AND NARDI F_(1999). Earthworm humic matter produces auxin-like effects on *Daucus carota* cell growth and nitrate metabolism. Soil Biol Biochem 31: 1303-1311.

NATH G. AND SINGH K. (2011). Combination of vermicomposts and biopesticides against nematode (*pratylenchus sp*.) and their effect on growth and yield of tomato (*Lycopersicon sculentum*) *IIOABJ; Vol. 2; Issue 5:27–35*

NATH G., AND SINGH K.,(2009) Utilization of vermiwash potential on certain summer vegetables crops. Journal of central European of agriculture volume 10 No.4 (417-426).

NATH G., SINGH K., AND SINGH D.K.,(2009) Chemical analysis of vermicompost/vermiwash of different combination of animal, agro, and kitchen

wastes Australian journal of basic and applied sciences 3(4):3671-3676

PARTHASARATHI K. AND RANGANATHAN L.S. (2000). Aging effect on enzyme activities in the pressmud vermicasts of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae*(Kinberg). *Biol. Fertil. Soils,* 30:347-350.

PATHAK RK, AND RAM RA. (2004). Manual on Jaivik Krishi, *Central Institute for Subtropical Horticulture,* Rehmankhera, Lucknow 24: 31–32.

POGUE M. G. A (2004). A new synonym of *Helicoverpa zea* (Boddie) and differentiation of adult males of H. zea and *H. armigera* (Hübner) (Lepidoptera: Noctuidae: Heliothinae). Annals of the Entomological Society of America, Lexington, v. 97, n. 6, p. 1222-1226,

RAMAMOORTHY P., (2004). Standardization and nutrient analysis of vermicomposting sugarcane wastes, press-mud trash, bagasse by *Eudrilus eugeniae*(Kinberg) and *Eisenia foetida* (Savigny) and theeffect of vermicompost on soil fertility and crop productivity. Ph.D. Thesis, Anna. Univ. India.

RAO A.V. AND AGARWAL S. (1998). Bioavailability and in vivo antioxidant properties of lycopene from tomato products and their possible role in the prevention of cancer. Nutr. Cancer 31, 199–203.

RAO B., AND CHANDRA C., (2005). Vermicomposting, IEC CELL-KUDCEMP, Mysore.

REED W. (1965).Heliothis armigera (Hb.) (Noctuidae) in western Tanganyika: II. Ecology and natural and chemical control. Bulletin of Entomological Research, Cambridge, v. 56, n. 1, p. 127-140,

ROBINSON G. S.; P. R. ACKERY; I. J. KITCHING; G. W. BECCALONI AND L. M. HERNÁ (2010). "HOSTS - A Database of the World's Lepidopteran Host plants". London: Natural History Museum.

SATPAL AND M.S. SAIMBHI, (2003). Effect of varying levels of nitrogen and phosphorus on earliness and yield of brinjal hybrids. Research on crops,4(2): 217-222.

SHAH J.A., M. INAYATULLAH K. SOHAIL S.F. SHAH S. SHAH T. IQBAL AND M. USMAN.(013). Efficacy of botanical extracts and a chemical pesticide against tomato fruit worm, *Helicoverpa Armigera* (Lepidoptera: Noctuidae). Sarhad J. Agric. 29(1): 93-96.

SHARMA H.C., (2001). Cotton bollworm/legume pod borer, *Helicoverpa armigera* (Hubner) (Noctuidae: Lepidoptera): Biology and management. Crop Protect. Compend. CAB International, Wallingford, pp. 70.

SINGH V, PANDE PC, AND JAIN DK. (2005). A Text book of Botany Angiosperm. Rastogi publication, Meerut, India.

SOKAL, R.R. AND ROHLF, F.J.,(1973). Introduction of biostatics. W.H. Freeman. San Francisco.

SUNDARARASU, K. AND JEYASANKAR, A.(2014) Effect of vermiwash on growth and yield of brinjal *Solanum melogena* (Eggplant or aubergine) *Asian Journal of Science and Technology Vol. 5, Issue 3, pp. 171-173, March,* ISSN: 0976-3376

SUTHAR S. (2008). Bioconversion of post harvest crop residues and cattle shed manure into value added products using earthworm *Eudrilus eugeniae*, (Kinberg). *Ecological Engineering* 32:206–214.

TALARPOSTHI, R.M. AND J.KAMBOUZIA, (2007). Influence of organic and chemical fertilizers on growth and yield of tomato (*Lycopersicon sculentum*) and soil chemical properties, Tropentag October 9-11, Witzenshausen.

TALEKAR N.S., OPEN R.T. AND HANSON P., (2006). *Helicoverpa armigera* management: a review of AVRDC's research on host plant resistance in tomato. Crop Protect., 5: 461-467.

TISDALE S. L. AND JW. L. NELSON. (1975). Soil fertility and fertilizers 3rd ed. Macmillan, New York, p. 66-80.

TIWARI. (1989). Fertilizer management in cropping system for increased efficiency. Fen. News.25(3):3-20.

TRIPATHY M. K., KUMAR R. AND SINGH H. N., 1999, Host range and population dynamics of *Helicoverpa armigera* Hübn. in eastern Uttar Pradesh.Journal of Applied zoological Research10: 22-24.

VALLVERDÚ-QUERALT A., MEDINA-REMÓN A., MARTÍNEZ-HUÉLAMO M., JÁUREGUI O., ANDRES-LACUEVA C. AND LAMUELA-RAVENTOS, R.M. (2011). Phenolic profile and hydrophilic antioxidant capacity as chemotaxonomic markers of tomato varieties. J. Agric. Chem. 59, 3994–4001.

WANG N. C. AND LI Z. H. (1984).Studies on the biology of cotton bollworm (*Heliothis armigera* Hübner) and tobacco budworm (Heliothis assulta Quenee). Journal of the Shandong Agricultural University, Taian, v. 1-2, n. 1, p. 13-25.

WONDAFRASH M., GETU E. AND TEREFE G. (2012): Survival and Feeding of African Bollworm, *Helicoverpa armigera*(Hubner) (Lepidoptera: Noctuidae) Affected by Neem, *Azadirachta indica* (A. Juss) Extracts. World Journal of Agricultural Sciences 8 (3): 280-285, 2012 ISSN 1817-3047.

ZALUCKI M. P. (1986).The biology and ecology of *Helicoverpa armigera* (Hübner) and *H. punctigera* Wallengren (Lepidoptera: Noctuidae) in Australia: what do we know? Australian Journal of Zoology, Melbourne, v. 34, n. 6, p. 779-814.