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Full Length Research Paper

Nutritional paradigm of vermicompost enhances tolerance to endosulfan in *Cicer arietinum*

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A nutritional factor in vermicompost has been exploited suitably to stimulate growth of chickpea *Cicer arietinum*. It was noticed that incorporating 12.5% of vermicompost stimulates the plant in every aspect of growth and development. Germination rate decreased during 10 to 15 days of treatment. However, it becomes identical to the control after 20 days of treatment. The percentage of increase in total length, internode size, emergence of leaf, emergence of flower and number of pod was 13% (40 days treatment), 205% (15 days treatment), 43% (28 days treatment), 58% (65 days treatment) and 600% (80 days treatment), respectively. Similar impact of vermicompost was also noticed during growth of the plant in 2.5, 5 and 7.5% of endosulfan. An increase in germination to the extent of 6-fold was also noticed. Total length, internode size, emergence of leaf, emergence of flower and number of pod has been triple (5 days treatment in 15% endosulfan), more than 450% (5 days treatment in 5% endosulfan), more than 550% (23 days of growth in 10% endosulfan), 300% (65 days growth in 10% endosulfan) and 600% (85 days growth in 5% endosulfan). Hence, the results obtained partially support stimulation effect of vermicompost in chickpea plant growth. This can be attributed to, as one of the principles, adopted by *Cicer arietinum* in remediation of endosulfan

Key words: Vermicompost, endosulfan, growth parameters, chickpea.

INTRODUCTION

Quality of air, water and soil is known to be degrading due to rapid industrialization. This has been accelerating, to a considerable extent, due to indiscriminate use of fertilizers, pesticides, insecticides and growth regulating substances. Modern agricultural practices, have tried to amend the soil in various ways. The use of fertilizer and manure has become a common practice such practices, in particular, use of various pesticide and insecticide has also been noticed. Whereas, manure enhanced fertility of the soil, pesticides cause degradation by acting as residual contaminant of the soil. Negative role of pesticide surpasses positive contribution of manure. Effect of induced metabolic change in the plant, grown in such conditions, culminates into lower yield or irregular yield. In an attempt, various agricultural practices have been utilized to minimize the loss, amendment of soil to conserve its fertility has quite often been adopted which have yielded fruitful results. In such attempts use of organic manures have received utmost attentions (Atiyeh et al., 2000; Baca et al., 1992). Only during such studies there have been reports of remediation of heavy metals, mineral elements and pesticides by many crop species (Azrami et al., 2008; Jadia and Fulekar, 2008; Atiyeh et al., 2000; Chamani et al., 2008; Mitchell et al., 1980; Edwards et al., 1985; Chan and Griffith 1988; Hartenstein and Bisesi, 1989; Edwards and Burrows, 1988). Crops with unique capacity to fix nitrogen have received

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Table 1. Chemical composition of plain soil and soil mixed with 12.5% vermicompost.

Medium	pH	EC (ds m^{-1})	OC (g kg^{-1})	Available N (KgNa^{-1})	Available P (kgha^{-1}) As P_2O_5	Available K (Kgha^{-1}) As K_2O_5
Plain soil	7.27	0.16	0.2	163	14.2	605
Vermicompost + Plain soil	7.27	0.16	1.01	251	58.6	1008

EC, Electrical conductivity; OC, organic carbon.

little attention towards this aspect of study. Like other crops, nitrogen fixing crops, have also been reported to be grown in pesticides/insecticides studded soil. This may have resulted in various disorders. Growing nitrogen fixing crops in potentially unhealthy soil (pesticide/ insecticide contaminated) hence becomes a subject matter to reckon with. The present study was to evaluate the response of *Cicer arietinum,* a natural nitrogen fixer, under the previous described condition.

MATERIALS AND METHODS

Fresh and healthy seeds of *C. arietinum* were obtained from the Agriculture Research Centre, Patna (Bihar). The vermicompost used was obtained from a commercial source, while the pesticides used were obtained from retailer having the following specification (endosulfan containing 35% of endosulfan manufactured by Excel Crop Care Limited, Bhavnagar, Gujrat).

Preparation of the soil sample

Two kinds of soil sample were used: (a) Plain soil: This was obtained as garden soil, and then filtered to remove bigger grains and dried. (b) Plain soil mixed with vermicompost: In pre-dried soil sample, vermicompost was mixed thoroughly at a value of 12.5% and was used.

Chemical analysis of the soil sample

Details of chemical analysis are described in Table 1. Chemical analysis was done courtesy, ICAR, Regional centre, Patna, Bihar. The data obtained suggested increase in the availability of NPK in the vermicompost mixed soil, an overview of which is represented in Figure 1.

Statistical analysis

In each set of experiment, an average value of 20 used seeds (10 each in two earthen pots) and emerged plants from it was calculated. The Standard deviation was calculated by adopting the formula:

$$\sigma = \sqrt{\frac{\sum (x_i - m)^2}{n-1}}$$

Where, x_i represent each value in the sample (individual score); m is the mean of the value; n is the number of values (Sample size) and Σ is the sigma.

RESULTS AND DISCUSSION

Germination of *C. arietinum* seed was monitored for various period of time such as 5, 10, 15 and 20 days. The number of seeds that germinated during the period is shown in Table 2. It appears that in plain soil, seeds fail to germinate after 5 days in all treatments. After 10 days, however, 5.5 seeds germinated in plain soil but no seed could germinate in plain soil mixed with endosulfan. Moreover, low frequency of germination was recorded in vermicompost mixed soil even in the presence of 5, 10 and 15% of endosulfan. After 15 days of treatment, seeds could germinate to the extent of 100% in plain soil, but germination was inhibited gradually with the endosulfan concentration as 30% reduction was noticed at the concentration of 5%, whereas 90% reduction could be noticed at the concentration of 10% of endosulfan. At 15% concentration of endosulfan (in plain soil) no germination could be noticed.

However, in vermicompost mixed soil, germination took place to an extent of 90% (plain soil, mixed with vermicompost), 90% (plain soil mixed with vermicompost and 5% endosulfan) and 75% when concentration of endosulfan was increased to 10%; this value remained 20% at the concentration of 15% of endosulfan. Delayed germination of seed was noticed when treatment continued beyond 10 to 15 days. The extent of germination in plain soil was noticed to be 100%, 35% (5% endosulfan), 55% (10% endosulfan) and 30% (15% endosulfan). In vermicompost mixed soil, this value became 100, 95 (5% endosulfan), 85 (10% endosulfan) and 75% (15% endosulfan). Thus, vermi-compost promoted germination in *C. arietinum* quite considerably during prolonged treatment. The percentage of increase or decrease in germination is shown in Figure 2.

The effect of such treatment was evaluated during further course of growth of the plant. Growth of the plant was closely monitored and measured using standard technique. A long span of treatment was made to determine this aspect. The data recorded is presented in Table 3. It appears that mixing of vermicompost in the plain soil allows *C. arietinum* to tolerate higher concentration (10 and 15%) of endosulfan. This was noticed with respect to greater increase in plant height during delayed treatment. Total length of the plant was found to be adversely affected at the concentration of 15% endosulfan when grown in plain soil. In vermicompost

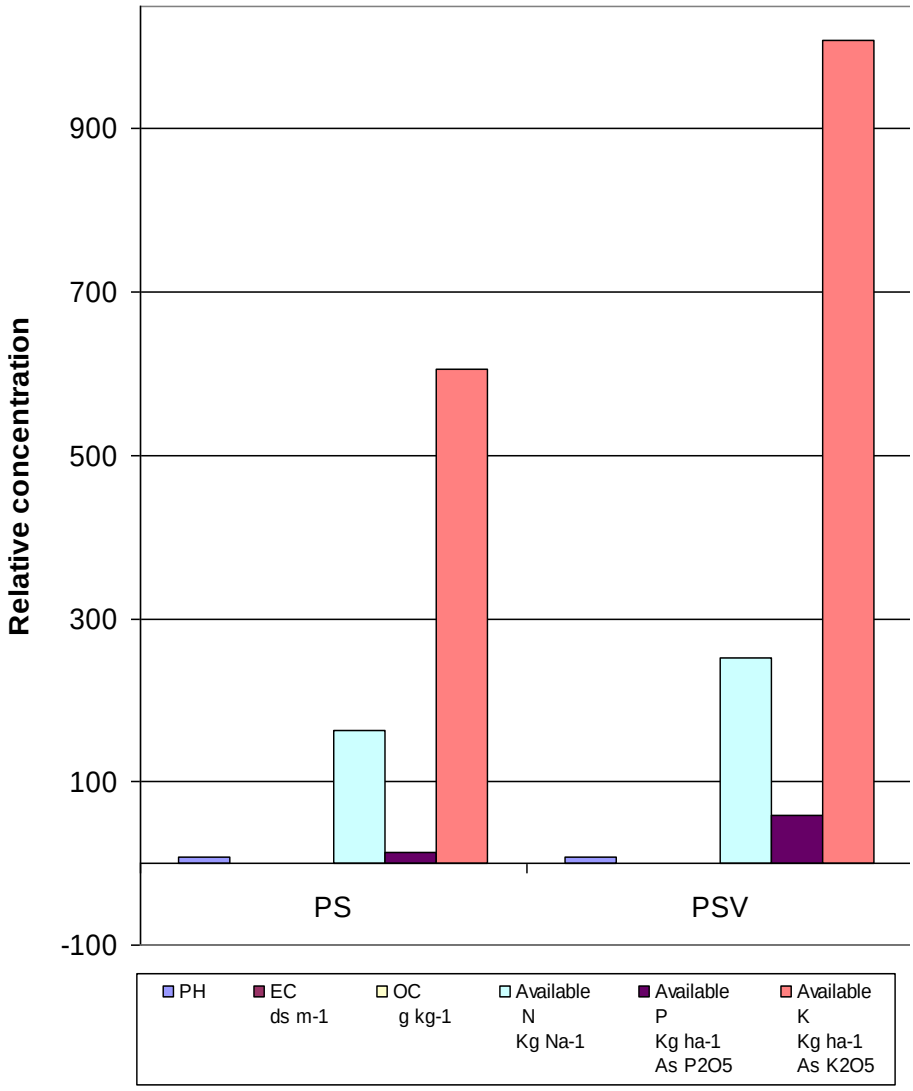


Figure 1. Chemical composition of plain soil and soil mixed with 12.5% vermicompost. (PS = Plain soil, PSV = Plain soil with vermicompost).

Table 2. Effect of endosulfan on germination of *Cicer arietinum* when grown on plain soil and on soil mixed with vermicompost.

Number of days	Without vermicompost				With vermicompost			
	Endosulfan (%)				Endosulfan (%)			
	0	**5**	**10**	**15**	**0**	**5**	**10**	**15**
5	0	0	0	0	0	0	0	0
10	5.5 ± 3.5	0	0	0	0	1.5 ± 1.4	1 ± 0.7	0
15	10 ± 5.6	7 ± 1.4	1 ± 0.7	0	9 ± 5.6	9 ± 4.9	7.5 ±1.4	2 ± 0.7
20	10 ± 5.6	3.5 ± 4.9	5.5 ± 3.5	3 ±2.1	10 ± 9.2	9.5 ± 5.7	8.5 ± 2.8	7.5 ± 2.8

± = Standard deviation.

mixed soil, the effect of 15% endosulfan is found to be marginally favourable. Hence, vermicompost seems to affect the plant variously. We conclude that providing better nutrient translates into the plant growth increase (Figure 3). Better growth of the plant in the presence of vermicompost seems to be an important factor during the present study. This was also confirmed by emergence of leaf (Table 4).

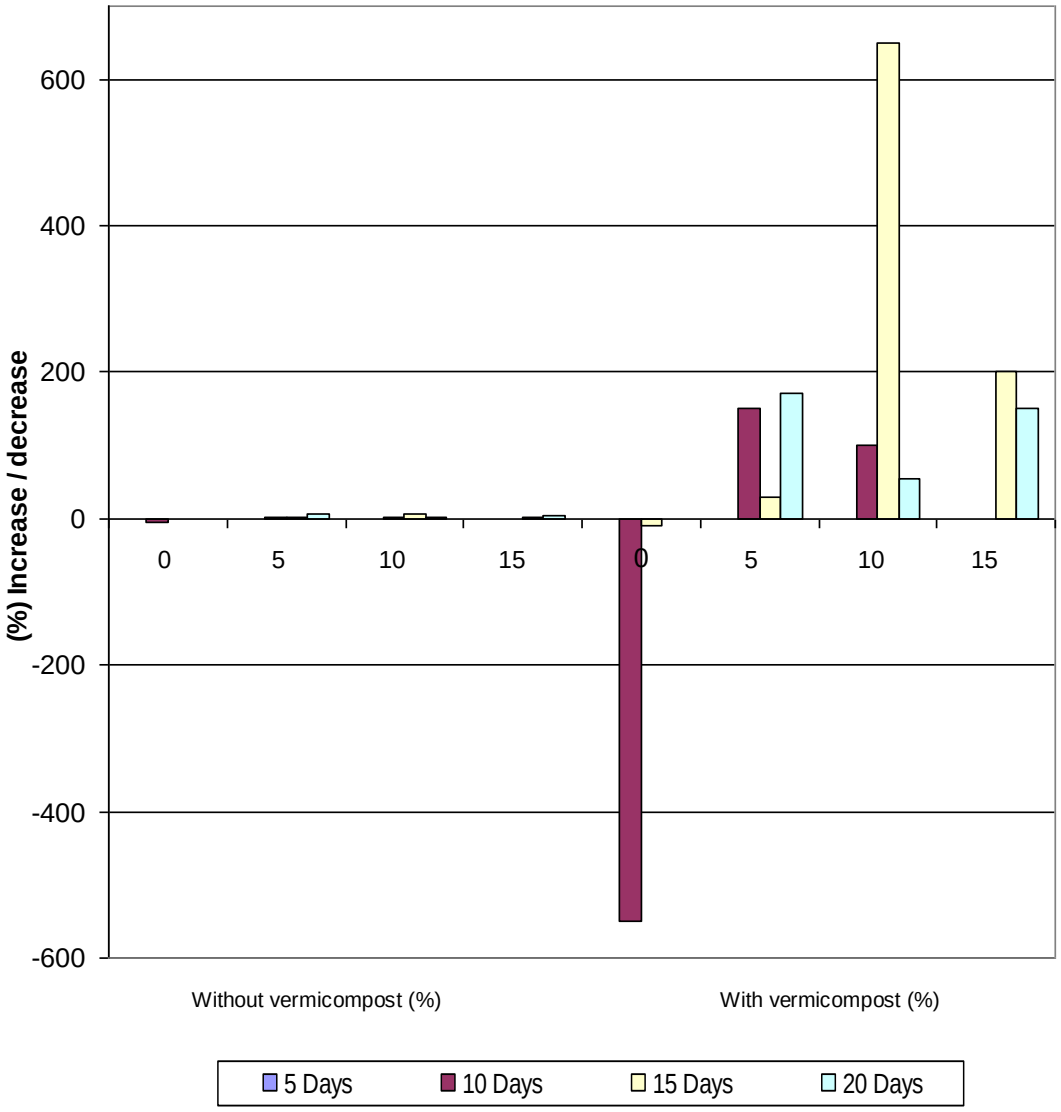


Figure 2. Effect of endosulfan on germination of *Cicer arietinum* when grown on plain soil and on soil mixed with vermicompost.

It becomes evident that the effect of endosulfan on *C. arietinum* exhibits variable response. Both in plain soil and in soil mixed with vermicompost, leaf appeared slowly beyond 17 days of growth. Meanwhile, in plain soil, large number of leaf appeared between 13 to 18 days (11.5) and not a single leaf emerge when endosulfan was mixed in the soil. The trend of appearance of leaf in vermicompost mixed soil was also noticed to be rather slow and fewer in number in the following orders 4 (0%), 1.5 (5%), 1.5 (10%) and 0(15%) after 18 days of treatment. Sudden increase in emergence of leaf was also noticed during 18 to 23 days of growth; the number of leaf in plain soil is in the order of 15.5(0%), 2.5(5%), 1.5(10%) and 0(15%). This was in the described order in plain soil mixed with vermicompost as 13.5 (0%), 12 (5%), 10 (10%) and 0 (15%). A gradual increase in emergence of leaf was noticed when grown beyond 28 days, as each and every plants exhibits emergence of leaf. Percentage increase/decrease in emergence of leaf is shown in Figure 4.

Differences in growth and development of *C. arietinum* in different treatments have also been noticed during differentiation of internodes. This is demonstrated in Table 5. Treatment of endosulfan in plain soil and in soil mixed with vermicompost culminates into identical kind of effect. Marginal increase in the size of internode was affected in the soil mixed with vermicompost. The effect has been more pronounced during treatment beyond 15 days, but it has been observed to be less beyond 25 days. A period beyond 45 days of treatment exhibits similar kind of effect in plain soil and in soil mixed with vermicompost. This is represented in Figure 5. Effect of

Table 3. Effect of endosulfan on total length of *Cicer arietinum* when grown on plain soil an on soil mixed with vermicompost.

Number of days	Without vermicompost				With vermicompost			
	Endosulfan (%)				Endosulfan (%)			
	0	5	10	15	0	5	10	15
5	28.3 ± 1.1	8.6 ± 1	2.95 ± 0.5	1.9 ± 0.3	27 ± 1.1	20.5 ± 1.9	11.2 ± 1.4	8.25 ± 0.8
10	41.1 ± 2.1	24 ± 2.4	11.8 ± 1.8	6.3 ± 2.4	41 ± 2.1	40.5 ± 1.8	29.3 ± 2	21.5 ± 1.4
15	52.3 ± 2.4	40.5 ± 2.1	27.5 ± 2.6	1.38 ± 2.8	56 ± 2.1	52.5 ± 1.3	42.9 ± 2.9	55 ± 1.2
20	53.75 ± 3	41 ± 2.7	26.5 ± 2.2	11.8 ± 2	56 ± 1.9	50.5 ± 1.1	43.5 ± 3.1	27.5 ± 1.3
25	54.45 ± 3.8	47.5 ± 2.8	35 ± 2.5	18.1 ± 2.2	57 ± 2.1	52 ± 0.9	44.9 ± 2.9	33 ± 1.7
30	59.45 ± 2.7	59 ± 2.9	46 ± 2.7	24.7 ± 2.6	64.15 ± 1.6	60 ± 2.2	48.4 ± 3.2	37.5 ± 1.6
35	66.6 ± 2.8	69 ± 2.8	54.5 ± 3.2	30.5 ± 2	76.65 ± 1.3	70 ± 1.3	52.1 ± 3.3	43.5 ± 1.6
40	77.7 ± 3.1	77 ± 2.4	64.5 ± 3.1 5	36.7 ± 1.9	87.9 ± 1.5	76.5 ± 1.6	64.8 ± 2.2	54 ± 3.5
45	90.5 ± 3.7	84 ± 2.3	70.5 ± 3.5	40.4 ± 2	96.45 ± 1.2	84 ± 1.3	70.3 ± 2.3	55.5 ± 3.5
50	98.65 ± 3.4	95 ± 2.7	77 ± 4.2	42.7 ± 2.6	102 ± 1.2	95.5 ± 1	75.7 ± 2.6 7	64.5 ± 3.3

± = Standard deviation.

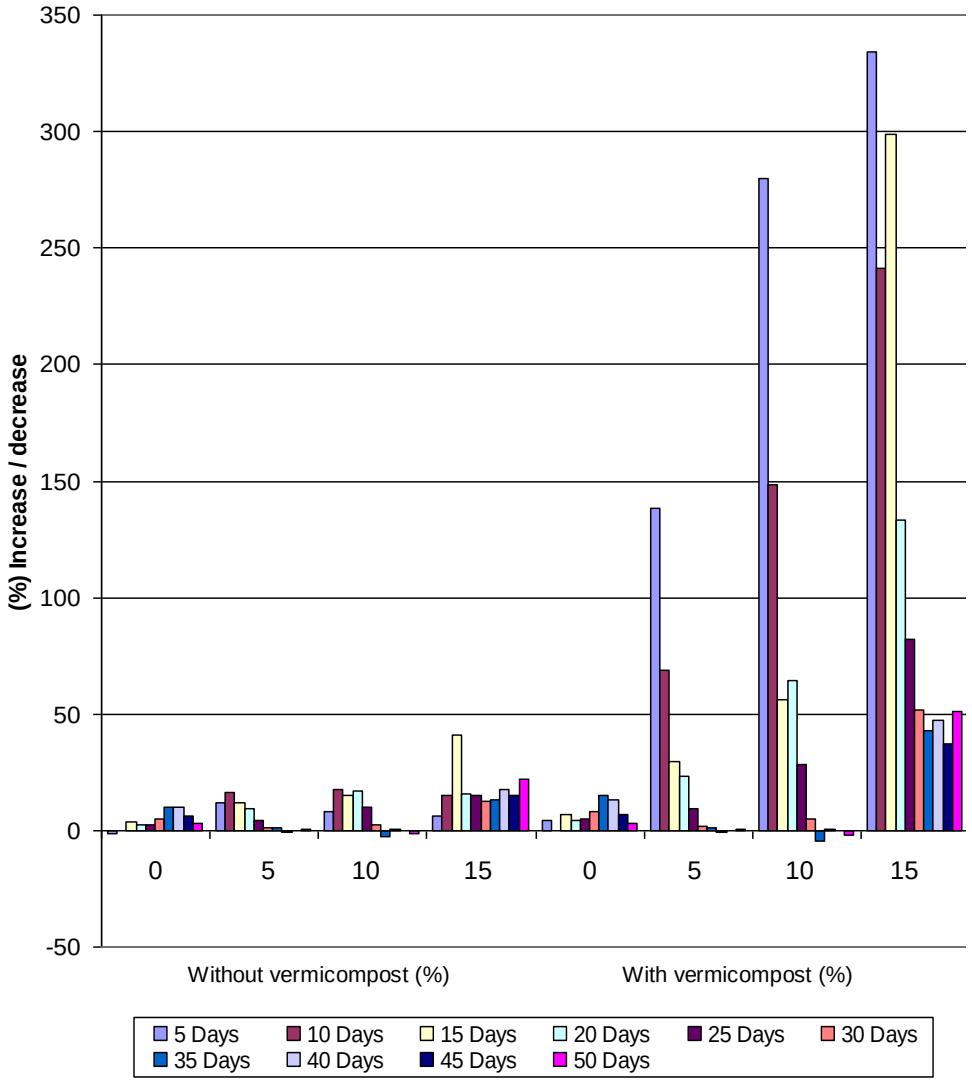


Figure 3. Effect of endosulfan on total length of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

Table 4. Effect of endosulfan on emergence of leaf of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost

Number of days	Without vermicompost				With vermicompost			
	Endosulfan (%)				Endosulfan (%)			
	0	5	10	15	0	5	10	15
13	0	0	0	0	0	0	0	0
18	11.5 ± 0.71	0	0	0	4 ± 1.41	1.5 ± 0	1.5 ± 0	0
23	15.5 ± 0.71	2.5 ± 0.71	1.5 ± 0	0	13.5 ± 2.58	12 ± 2.72	10 ± 2	0
28	19.5 ± 2.12	8.5 ± 4.95	5.5 ± 3.54	3 ± 0	28 ± 3.93	26 ± 5.17	21 ± 2.99	8 ± 1.53

± = Standard deviation.

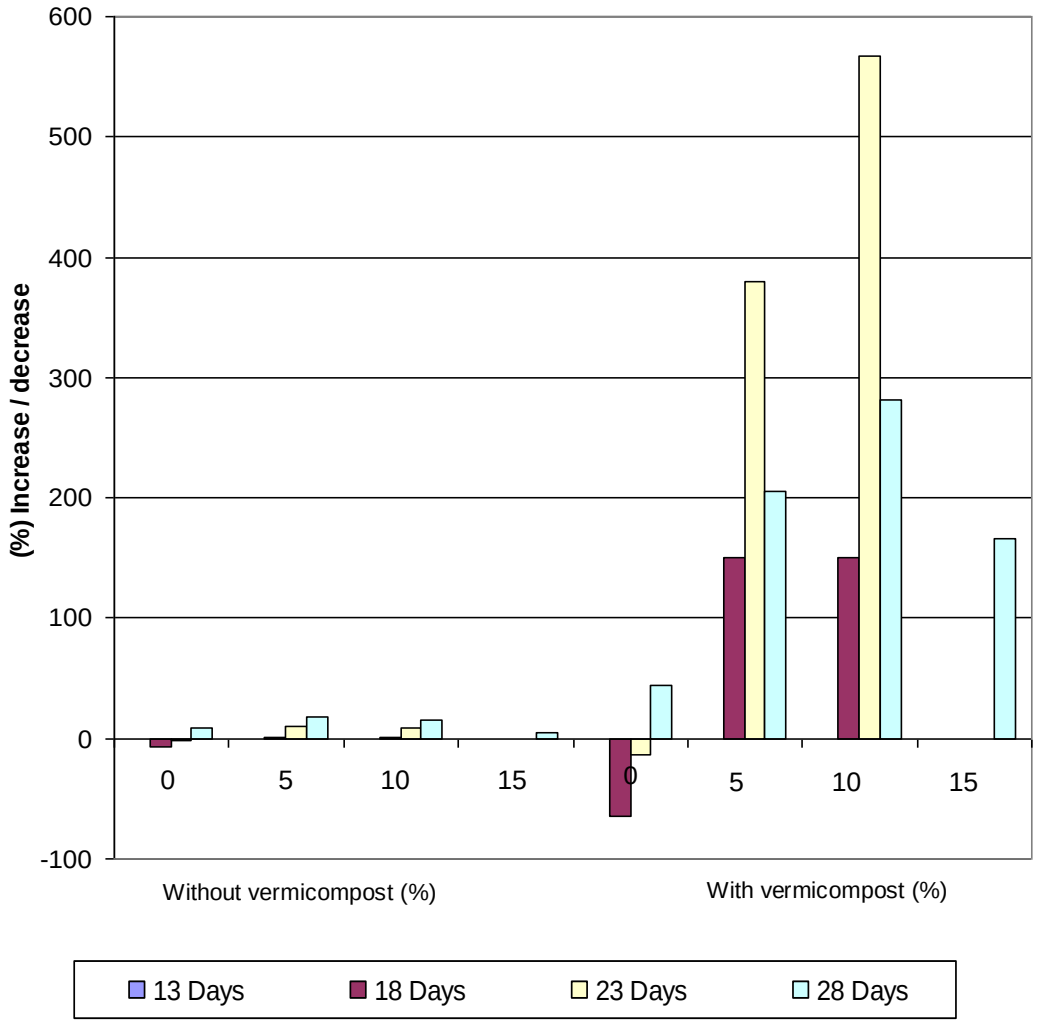


Figure 4. Effect of endosulfan on emergence of leaf of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

endosulfan on flowering has also been observed during differentiation of the plant to the extent of flowering. The number of flower which emerges after various days of treatment is described in Table 6. Endosulfan (5, 10 and 15%) affects flowering in *C. arietinum* both in the plain soil and soil mixed with vermicompost. There has been increase in the number of flower in vermicompost mixed soil. Number of flower was found to increase with the lapse of time. Figure 6 depicts the extent of increase in the emergence of flowers.

To strengthen the contention regarding fate of functional and non-functional flower, the number of pod which

Table 5. Effect of endosulfan on the length of internode (in Cm) of *Cicer arietinum* when grown on plain soil and in soil mixed with vermicompost.

Number of days	Without vermicompost				With vermicompost			
	Endosulfan (%)				Endosulfan (%)			
	0	5	10	15	0	5	10	15
5	2.95 ± 0.24	0	0	0	2.7 ± 0.2	4.45 ± 0.32	3.25 ± 0.31	1.1 ± 0.06
10	2.85 ± 0.32	2.35 ± 0.17	1.5 ± 0.16	1 ± 0.16	3.2 ± 0.29	2.05 ± 0.15	3.65 ± 0.2	2.5 ± 0.13
15	1.05 ± 0.21	2.65 ± 0.27	1.75 ± 0.14	0.9±0.08	3.2 ± 0.29	2.35 ± 0.22	2.45 ± 0.25	2.6 ± 0.25
20	1.5 ± 0.27	2.85 ± 0.27	1.4 ± 0.31	0.95 ± 0.14	1.65 ± 0.26	1.75 ± 0.22	1.4 ± 0.29	1.45 ± 0.26
25	2.1 ± 0.34	1.55 ± 0.12	1.45 ± 0.17	0.55 ± 0.14	2.5±0.23	1.9 ± 0.13	1.15 ± 0.13	1.75 ± 0.22
30	1.1 ± 0.18	2.8 ± 0.36	1.15 ± 0.3	1.8 ± 0.32	1.1 ± 0.2	1.25 ± 0.18	1.05 ± 0.13	1.25 ± 0.21
35	0.75 ± 0.1	1.05 ± 0.29	0.45 ± .09	1.7 ± 0.26	1.15 ± 0.19	1.2 ± 0.18	0.85 ± 0.05	0.95 ± 0.08
40	1.1 ± 0.25	1.15 ± 0.25	0.8 ± .21	0.54 ± 0.09	0.65 ± 0.15	0.8 ± 0.11	0.75 ± 0.13	0.85 ± 0.21
45	0.4 ± 0.19	1.2 ± 0.2	0.5 ± 0. 18	0.4 ± 0.2	0.2 ± 0.24	1.1 ± 0.21	0.55 ± 0.13	0.85 ± 0.15
50	1.05 ± 0.2	1.1 ± 0.19	0.75 ± 5.36	0.5 ± 0.12	1.5 ± 0.23	0.75 ± 0.18	1.05 ± 0.18	0.33 ± 0.14

± = Standard deviation. Plants grown in earthen pots (20) were used to determine the value. Data described were converted into mean value.

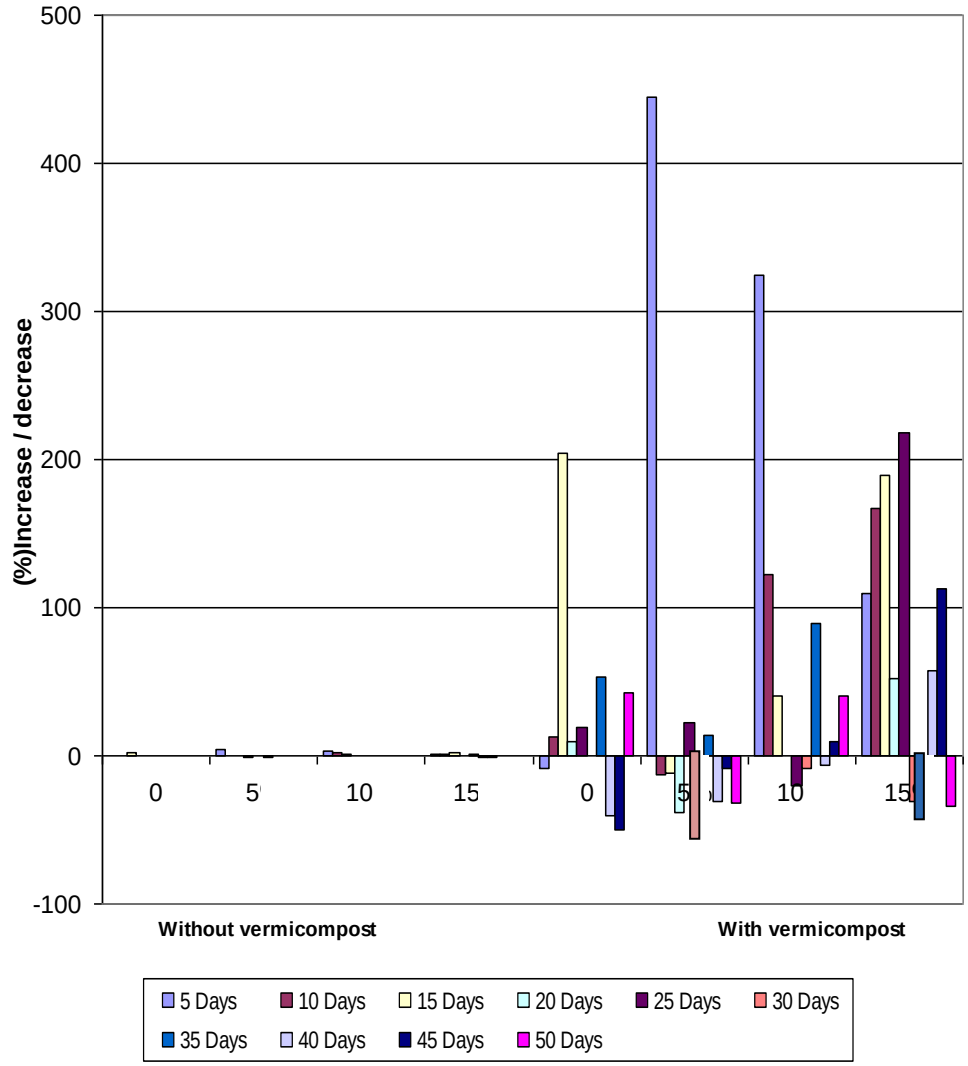


Figure 5. Effect of endosulfan on the length of internode of leaf of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

Table 6. Effect of endosulfan on number of flower of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

Number of days	Without vermicompost				With vermicompost			
	Endosulfan (%)				Endosulfan (%)			
	0	5	10	15	0	5	10	15
55	0	0	0	0	1	1	0.5	0
60	2 ± 1.4	0.5	0.5	0	3.5 ± 0.71	3.5 ± 0.71	2	0.5
65	6 ± 2.3	1.5 ± 0.71	2	2 ± 1.4	9.5 ± 0.71	5.5 ± 3.54	5.5 ± 3.54	2.5 ± 0.71
70	8.5 ± 5	3 ± 1.41	2.5 ± 2.12	3 ± 1.41	12 ± 2.83	10 ± 1.41	7.5 ± 4.95	4.5 ± 2.12

± = Standard deviation.

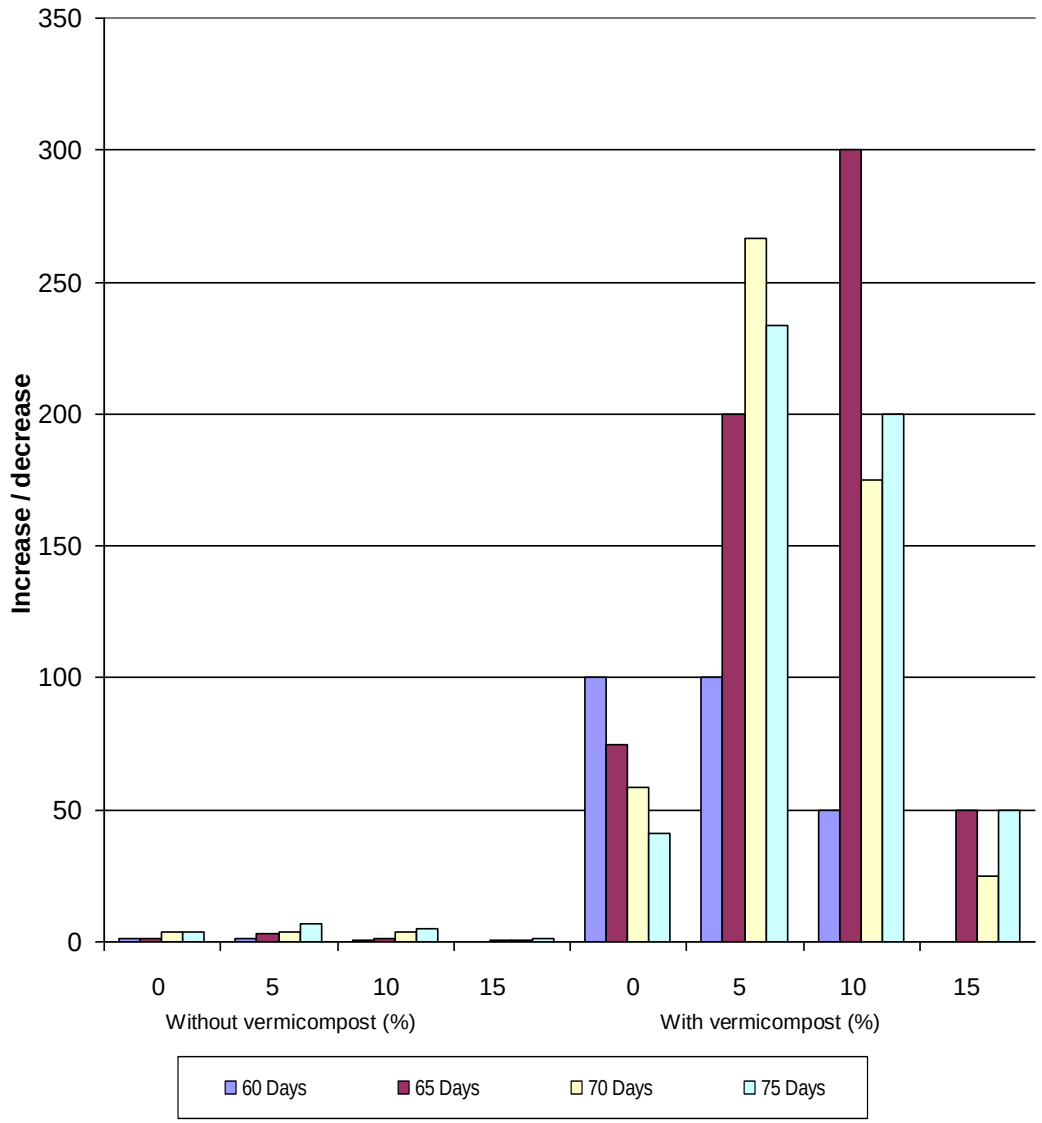


Figure 6. Effect of endosulfan on the number of flowers of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

appeared after different days of treatments counted is recorded in Table 7. An analysis of data described ealier suggests that many of the flowers could not attain maturity. Flowers which emerged in the vermicompost mixed soil were seen to attain maturity in a better way and in larger numbers. Even in the presence of

Table 7. Effect of endosulfan on the number of pod of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

Number of days after treatment	Without vermicompost				With vermicompost			
	Endosulfan (%)				Endosulfan (%)			
	0	5	10	15	0	5	10	15
75	0	0	0	0	2.5 ± 0.7	1 ± 0	0	0
80	1.5 ± 0.7	0	0	0	10.5 ± 9.2	4.5 ± 2.12	3.5 ± 2.12	0
85	5.5 ± 1.4	1.5 ± 0.7	1.5 ± 0	1 ± 0	15 ± 14.14	8.5 ± 6.36	7.5 ± 4.95	4.5 ± 3.54

± = Standard deviation.

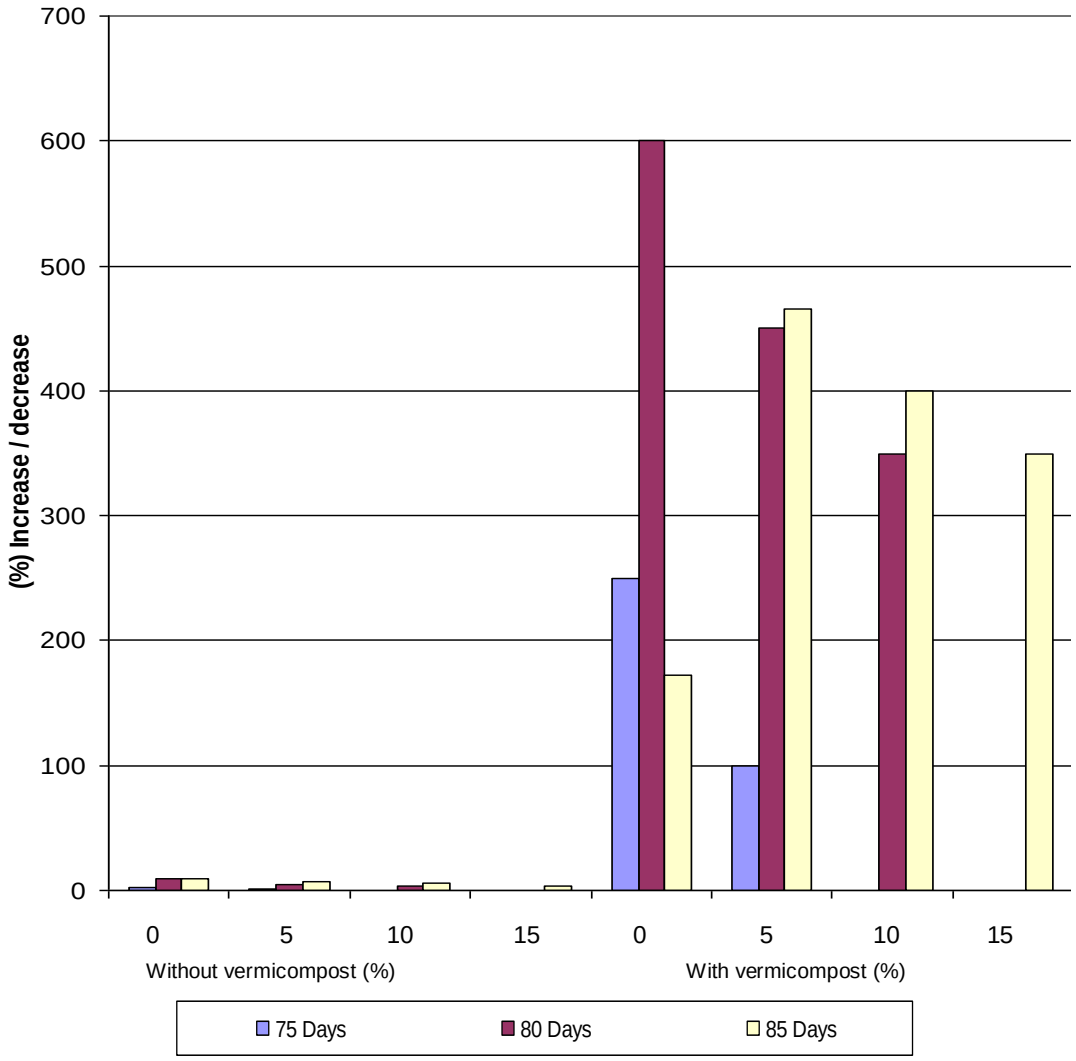
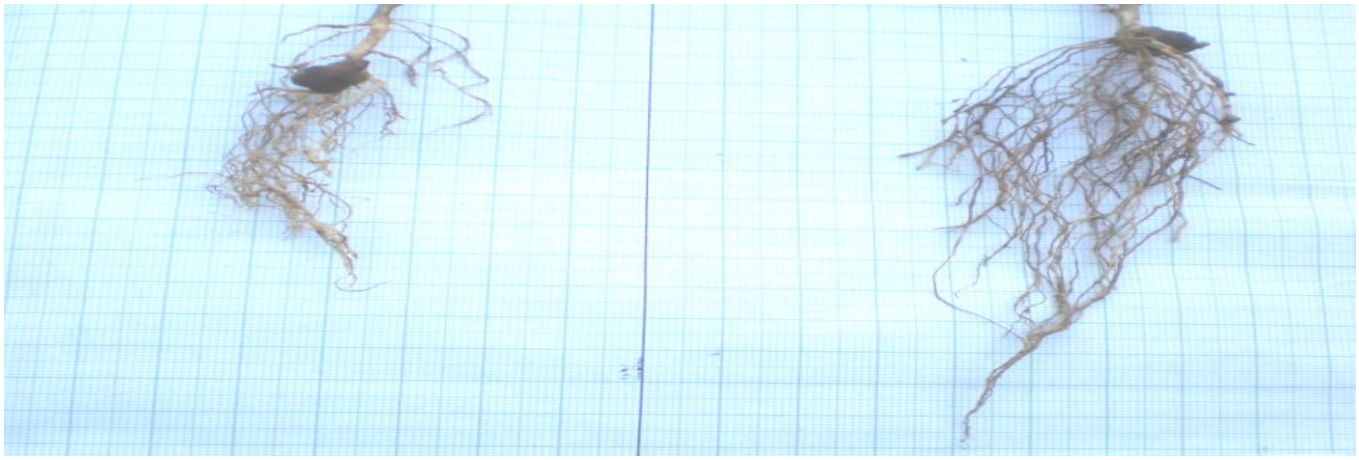


Figure 7. Effect of endosulfan on the number of pods of *Cicer arietinum* when grown on plain soil and soil mixed with vermicompost.

endosulfan (5, 10 and 15%), large number of flower got matured as pod. This exhibits greater tolerance to endosulfan by *C. arietinum* in an atmosphere of vermicompost (12.5%). Increase in the number of pod has been noticed after 80 days of treatment in vermicompost amended soil. This trend continued in the presence of 5 and 10% of endosulfan. Delayed treatment to 85 days results in an increase in the number of pod (Figure 7). Jadia and Fulekar (2008) have also indicated increase in the dry weight of root and shoo t during treatment with vermicompost in *Helianthus annus*. They reported greater root metal uptake and shoot metal

Plain soil Plain soil-Vermicompost

Plate 1. Biomass of the root in vermicompost amended soil.



Plain soil-Endosulfan Plain soil-Endosulfan-Vericompost

Plate 2. Biomass of the root in endosulfan mixed soil.

uptake in *H. annus* during treatment with vermicompost. Gondek and Filipek-Mazur (2003) also observed an increase in biomass yields of shoots and roots of plants cultivated in soil amended with vermicompost based on tannery sludge.

An article by Jadia and Fulekar (2008) and Gondek and Filipek-Mazur (2003) showed that only few morphological characters of the host plant have been taken into consideration to draw a conclusion. During the present study, however, the effect has been evaluated during the entire life cycle of *C. arietinum*. Greater biomass of the root in vermicompost amended soil and also in endosulfan mixed soil (Plates 1 and 2) supports the remediation property of the plant.

Therefore, on the basis of the results obtained herein, it can be postulated that *C. arietinum* has internal mechanisms to remediate endosulfan. Remediation can be further enhanced in vermicompost amended soil. Meanwhile, a further study to strengthen this contention has been planned and is being carried out.

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