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Research Article

Effect of vermicompost on *Andrographis paniculata L.* grown in stress condition of Chlorpyrifos

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Abstract: The effect of Vermicompost on a medicinal plant of great economic significance has been monitored. The plant *Andrographis paniculata L.* of family Lamiaceae is widely used all over the world for its biologically active ingredients containing diterpenoid, flavonoids, and polyphenols. The effect of Chlorpyrifos along with Vermicompost has been monitored on this plant. On one hand treatment of Vermicompost has been made to stimulate the growth and development of the test plant, an attempt has also been made to study the growth of the test plant under the stress condition of Chlorpyrifos. It has been noticed that the germination of the test plant increases with the lapse of time in the presence of Vermicompost as 100% growth is attained in 10 days. This value is 42.9% without Vermicompost during the same period of time. Low concentration of Chlorpyrifos (01%) also favors germination up to the extent of 50% in presence of Vermicompost the value is 25% in presence of (01%) of Chlorpyrifos but without Vermicompost. There has been marked reduction in the rate of germination in presence of 02% of Chlorpyrifos in the atmosphere of Vermicompost the germination is reduced by 25% this is further reduced to 15% in 03% of Chlorpyrifos. This value has been 20% and 10% in the presence of 02% and 03% of Chlorpyrifos in presence of Vermicompost. Plant height has also been taken into account for such type of treatment and it shows that with a lapse of time the plant height increases with 15% of Vermicompost. This rising trend continues even in 01%, 02% and 03% of Chlorpyrifos. An increase in the number of leaves means an increase in productivity. A similar trend of increase as described in germination and plant height has been also recorded in the emergence of leaves. With the lapse of time, the number increases during various treatments made. Test plants under treatment exhibited different kinds of morphological variations. As a prelude leaves of different treatments were used for calculating the area of leaves. This feature has also been found to be similar to the results described above i.e. with the increase in days of treatment the area of the leaf increases. The result described above has been presented below.

Keywords: Soil supplements, Chlorpyrifos, Vermicompost, *Andrographis paniculata L.*

Introduction

Andrographis paniculata L. is a member of family Lamiaceae which has been used since long in Asia for various medicinal purposes. The plant possesses Andrographilide (Kushram *et al.*, 2017), a bicyclic diterpenoid lactone and kalmeghine (Koteshwar *et al.*, 2008) which has great pharmacological significance. The plant has widespread occurrence in the plains of India and can also be noticed frequently in the crop field where it encounters various agricultural supplements like fertilizers, fungicides, and pesticides. These supplements have serious environmental repercussions (Schultz, 1999; Cerejeira *et al.*, 2003). One of such leftover residual agricultural supplements in the crop field is Chlorpyrifos. This pesticide has been reported to interfere with growth and development (Boutin *et al.*, 2004; OECD, 2003; White & Boutin, 2007) of a large number of plants. Various agricultural practices can be adopted to minimize the effect of such obnoxious contaminants (Atiyeh *et al.*, 2000 and 2000 a; Azarmi *et al.* 2009). Use of Vermicompost is one of these practices. Vermicompost as organic manure is a well-established soil supplement (Edwards & Burrows 1988). Growth and development of the plant has been favoured in many ways by applications of Vermicompost (Arancon *et al.*, 2004 and 2005; Atiyeh *et al.*, 2000 and 2000 a; Azarmi *et al.*, 2009; Jadia & Fulekar, 2008). It also enhances the tolerance capacity of the plant to the soil contaminants (Chamani *et al.*, 2008;

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Jadia & Fulekar, 2008; Shenthil Kumar *et al*., 2004). It has been found that there has been an increase in various parameters of growth and development in the host plant due to the treatment. Enhanced use of pesticides in agricultural practices was aimed to enhance food requirements of the growing worldwide population. Chlorpyrifos is one of the most extensively used pesticides. It is used throughout the world to control termites and other insect pests. It has been reported that Only 05%- 10% of Chlorpyrifos fall upon the host plants and kills the desired as well as useful insect and pests, remaining 90% - 95% of this pesticide falls on the soil and persist there for unpredictable period of time (Deleorolorenzo *et al*., 2001; Gavrilecu, 2005; Tariq *et al*., 2007). These organophosphorus pesticides may enter into various useful crops and pose a great threat to human health (Cai *et al*., 2004; Mumby & Swinton, 2003). The traditional physicochemical treatment for the remediation of pesticide from polluted site is costly, labour demanding and also disturbing to the environment (Harvey *et al*., 2002). Therefore, there is a need of an eco-friendly and efficient technology for remediation of soil contaminated with such hazardous pesticides. During this study effect of Chlorpyrifos in soil amended with Vermicompost has been evaluated on *Andrographis paniculata L.*

Materials and Methods

The seeds of *Andrographis paniculata L.* were obtained from the Central Institute of Medicinal and Aromatic Plants, Kukrail, Lucknow. Chlorpyrifos was obtained from commercial sources.

Preparations of soil bed:

In 1.7 kg of plain soil obtained from fallow land (considered as plain soil) was thoroughly mixed with 300 gm. of Vermicompost to make the final concentration of 15% of Vermicompost to the experimental media in earthen pots. Atiyeh *et al*., 2000 used only 12.5% of Vermicompost during their studies. Soil without Vermicompost i.e. plain soil has been considered as control. Different concentrations (01%, 02%, and 03%) of Chlorpyrifos was mixed in the soil and used as an experimental bed. Earthen pots without Chlorpyrifos served as another control. Seeds of *Andrographis paniculata L.* were first germinated on water-soaked filter papers suitably placed in a sterilized Petri dish. 24 hours after germination ten seedlings were placed in different pots deep in the soil at a depth of 0.2 cm. Water was occasionally sprinkled to allow the growth and development of the plant.

Results and Discussions

Various parameters of growth and development in each set of experiments, plain soil, and plain soil supplemented with Vermicompost and both mixed with different concentration of Chlorpyrifos, has been recorded at regular intervals and described under a different heading.

Effect on germination: The effect of various amendments of soil on germination of seeds has been described in Table 01.

Table 01: Germination of seeds of *Andrographis paniculata L.* showing the effect of Vermicompost on different concentrations of Chlorpyrifos

No. of Days	% Of Chlorpyrifos											
	00			01			02			03		
	+	-.	%	+	-.	%	+	-.	%	+	-.	%
03	02	00		00	00	-	00	00	-	00	00	-
04	04	02	100	00	00	-	00	00	-	00	00	-
05	06	05	20	02	00	-	00	00	-	00	00	-
06	06	06	00	04	02	100	00	00	-	00	00	-
07	09	06	50	04	02	100	00	00	-	00	00	-
08	18	12	50	08	04	100	03	02	50	00	00	-
09	18	14	28.6	09	06	50	04	03	33	02	01	100
10	20	14	42.9	10	08	25	05	04	25	03	02	50

(+) = With Vermicompost, (-) =Without Vermicompost, (%) = Percentage increase or decrease
[The experiment was done in duplicate]

On review of Table 01, it appears that Chlorpyrifos interferes in the germination of seeds adversely as up to 04 days as not a single seed has found to germinate even in 01% of Chlorpyrifos. The record shows that there is a constant and marked decrease in the number of seeds germinated in the soil with Chlorpyrifos in comparison to the seeds germinated in the plain soil. This is consistent with the result noticed by Dubey & Fulekar 2011. Supplementation of soil with Vermicompost favours germination in each case of treatment. When added in plain soil it favours germination gradually as 02 seeds out of 20 seeds germinate after three days of incubation. The number increases to 06, 09, 18 and 20 after 06 days, 07 days, 09 days and 10 days respectively. The extent of germination becomes 02, 04, 08, 09 and 10 after 05 days, 06 days, 08 days, 09 days and 10 days respectively. Hence it appears that Vermicompost minimizes the effect of Chlorpyrifos when the value is compared with the treatment made in plain soil with 01% of Chlorpyrifos. In 02% of Chlorpyrifos, the toxicity of the pesticide becomes apparent because it delays the germination to 08 days and that too only 03 seeds germinate in presence of 02% of Chlorpyrifos supplemented with Vermicompost whereas, this number is 02 without Vermicompost. A concentration of 03% further increases lethality as only 02 seeds germinate in the presence of Chlorpyrifos supplemented with Vermicompost containing soil. This number has been 01 in the soil containing 03% of Chlorpyrifos without Vermicompost. Thus, it becomes imminent that Vermicompost helps in minimizing the toxic effect of Chlorpyrifos when it is present in low concentration in plain soil i.e. the soil without Vermicompost. Thus, Vermicompost favours germinability of the seeds and this is consistent with earlier reports (Edwards & Burrows, 1988 & Orozeo *et al*., 1996). It also appears that the amendment of soil with Vermicompost reduces the inhibitory effect of Chlorpyrifos. Plant height was taken as another parameter for the growth and development of the test plant.

Effect on the height of plant: The effect of various amendments of soil on the height of the plant has been recorded in Table 02.

Table 02: Effect on height of plants of *Andrographis paniculata L.* when grown in Vermicompost on different concentrations of Chlorpyrifos

No. of Days	% Of Chlorpyrifos											
	00			01			02			03		
	+	-	%	+	-.	%	+	-	%	+	-	%
20	06	09.5	-37	07	08	-12.5	06.3	10	-37	06.5	04	62
30	14	12	16.6	18	15	20	17	15	13.3	16	09	77
40	17.5	19	-79	29.5	25.3	16	29	33	-12	28.3	15	86.6
50	24	24	00	040	36	11	39	40	-25	39	27	44
60	27	27	00	44.5	40	09	47	50	-06	46	33	39

(+) = With Vermicompost, (-) =Without Vermicompost, (%) = Percentage increase or decrease
[The experiment was done in duplicates]

The plant height was noticed to increase after 20 days of incubation in the pot to a noticeable and recording state. It appears that growth in the plain soil was better (09.5 cm.) than the soil supplemented with Vermicompost (06.0 cm) after 20 days of treatment. A marginal increase over vermicompost treated soil as the height increased from 12 to 14 cm. after 30 days. The pattern of increase in height remains unchanged in both the Vermicompost treated soil and plain soil as no change in height was observed even after 50 days and 60 days of treatment. In Chlorpyrifos treated soil an increase in height was noticed in Vermicompost treated soil to the extent of 03 cm. (after 30 days), 04 cm (after 40 days), 04 cm. (after 50 days) and 04.5 cm. (after 60 days) respectively. During treatment of 02% Chlorpyrifos, Vermicompost appears to cause no favorable effect as height increase or decrease to extent of 02 cm increase (after 30 days), decrease to 04 cm after 40 days, a decrease of 01 cm. (after 50 days) and 03 cm (after 60 days). However, in a concentration of 03% of Chlorpyrifos, Vermicompost favors increase to the extent of 02.5 cm (after 20 days)

07 cm. (after 30 days), 13.3 cm. (after 40 days), 12 cm. (after 50 days), 13 cm. (after 60 days). Hence it appears that Vermicompost helps to minimize the effect of higher concentration (03%) of Chlorpyrifos and less on (02%) of Chlorpyrifos.

Atiyeh *et al.,* 2000 have also reported enhancement in the growth of marigold and tomato seedlings quite significantly when the soil has been amended with 10% and 20% of Vermicompost. The present finding seems to be more effective as enhancement of growth in *Andrographis paniculata L.* has been noticed even in presence of 01% and 02% of Chlorpyrifos. Overall the effect of Vermicompost appears to favor the growth of the plant. To strengthen this contention data was recorded on the emergence of leaf and number count of the leaf. This has been described in Table 03.

Effect on emergence/number of leaves: The effect of various amendments of soil on emergence as well as the number of leaves has been recorded in Table 03.

Table 03: Comparative study of emergence and number of leaves in *Andrographis paniculata L.* showing the effect of Vermicompost on different concentrations of Chlorpyrifos

No. of Days	% Of Chlorpyrifos											
	00			01			02			03		
	+	-	%	+	-	%	+	-	%	+	-	%
10	02	02	--	02	02	--	02	02	--	02	02	--
20	04	04	--	04	04	--	04	04	--	04	04	--
30	06	06	--	08	06	33	08	06	33	08	06	33
40	08	08	--	10	08	25	10	08	25	10	08	25
50	10	10	--	15	12	25	15	12	25	18	13	38.4
60	14	12	16	21	17	23.5	21	18	16.6	24	18	33

(+) = With Vermicompost, (-) =Without Vermicompost, (%) = Percentage increase or decrease
[The experiment was done in duplicates]

Chlorpyrifos shows a supporting effect on the emergence of leaves showing increase in number. Up to 40 days neither positive nor negative effect has been seen as number of leaves in each set is almost same. After 50 days an increase of 20% to 50% increase has been reported in 01% and 03% of Chlorpyrifos. It becomes 65% in the case of 03% of Chlorpyrifos after 80 days. After 100 days a decline of 28.5%, 42.8% and 50% has been seen in case of 01%, 02% and 03% Chlorpyrifos respectively. Neither positive nor negative effect of Vermicompost has been seen up to 50 days as a number of leaves are almost the same in both plain as well as Vermicompost amended soil. After 60 days an increase of 16% has been reported in the soil amended with Vermicompost. It declines gradually 12.5%, 05% and 04% after 70, 80 and 90 days. But after 100 days a 14% of increase has been observed.

Using 01% of Chlorpyrifos in plain and Vermicompost amended soil show a similar trend. Up to 20 days the number of leaves is the same in all set of experiments. After 30 days a 33% increase has been reported in the case of Vermicompost amended soil. It gradually declines with the passage of time lowering to 00% after 70 days. Again, ascending trend 10%, 21.8% and 30% has been found after 80, 90 and 100 days respectively.

In case of 02% of Chlorpyrifos similar trend has been reported. Numbers of leaves are same in both plain and amended soil up to 20 days. After 30 days there is an enhancement of 33% increase which gradually declines to 25%, 16.6% and 08% after 40, 60 and 70 days respectively. From 80 days again there is an ascending trend of 10%, 14.7% and 17.5% in enhancement after 80, 90, and 100 days. A similar trend has been seen using 03% of Chlorpyrifos i.e. up to 20 days neither increase nor decrease has been noticed. After 30 days there is an increase of 33% in case of Vermicompost amended sets with a gradual enhancement maximum to 38.4 after 50 days. There is gradual decline in enhancement coming down to 07.6% after 70 days. After that there is again an ascending trend has been seen as 09%, 13% and 21.4% after 80, 90 and 100 days. There has been a marginal

increase in the number of leaves when test plant has been treated with Vermicompost even in the presence of Chlorpyrifos. This finding is consistent with the report made by Chamani et al., 2008 on *Petunia hybrida*. Overall the effect of Vermicompost appears to favor the growth of the plant. To strengthen this contention data was recorded on increase in the area of leaves. This has been described in Table 04.

Table 04: Comparative study of leaf area (in cm^2) in *Andrographis paniculata L.* showing the effect of Vermicompost on different concentrations of Chlorpyrifos

No. of Days	% Of Chlorpyrifos											
	00			01			02			03		
	+	-		+	-	%	+	-	%	+	. -	%
20	20	18	11	40	30	33	42	30	40	50	30	66
30	65	40	62.5	95	40	137	110	43	156	120	43	179
40	85	45	88	130	63	108	140	60	133	150	60	150
50	127	60	111.6	160	80	100	175	85	103	170	77	120

(+) = With Vermicompost, (-) =Without Vermicompost, (%) = Percentage increase or decrease
[The experiment was done in duplicates]

Effect on area of leaves: Effect on area of leaves: The effect of various amendments in soil on Area of leaves has been recorded in Table – 04. After 20 days of treatment, the percentage increase in the area of the leaf has been to the extent of 100%, 100% and 150% in case of presence of 01%, 02% and 03% of Chlorpyrifos grown on Vermicompost treated plant. However, this has been 66% in the case of non-Vermicompost treated soil.

Chlorpyrifos decreases the area of leaves up to the extent of 66% after 20 days of treatment in 01%, 02% and 03% of Chlorpyrifos. In the case of 01% of Chlorpyrifos neither increase nor decrease up to 30 days has been reported. Maximum increase of 50% has been reported after 60 days. This trend of enhancement gradually declines to 16% after 100 days. There is again a rising trend of 24%, 30%, 28.5% and 22.5% after 110, 120, 130 and 140 days of treatment respectively. In case of 02% of Chlorpyrifos gradual increase of 07.5%, 33.3%, 41.6% to a maximum of 61.6% after lapse of 30, 40, 50and 60 days of growth has been noticed. This trend gradually declines to 46.6%, 38.8%, and 39% to 12% after 70, 80, 90 and 100 days of treatment. There has been an increase of 20%, 26%, 21.4% and 22.5% after 110, 120, 130 and 140 days of treatment. In case of treatment with 03% of Chlorpyrifos after a lapse of 30 days, it seems to favour the rate of increase in area of leaves from 07.5% to maximum 50% after 60 days however the increase declines to 46.6%. This value of decline becomes 44.4%, 42% to 20% after 70, 80, 90 and 100 days of treatment respectively. Again there is a constant rise of 28%, 34.6%, 35.4% and 35.7% in enhancement has been reported after 100 days to 140 days respectively.

The enhancement effect of Vermicompost has been seen a minimum of 11% to a maximum of 179%. In the absence of Chlorpyrifos, there is a gradual decline in trend to 76% after 100 days. This decline continues to 67.7% after 140 days with somewhat fluctuating ones. The remedial activity of Vermicompost has been seen against Chlorpyrifos as there is an increase of 33%, 40%, and 66% after 20 days of growth in 01%, 02% and 03% of Chlorpyrifos. Increase in area of leaves is maximum 137% in 01%, 156% in 02% and 179% in 03% of Chlorpyrifos. After that, there is a gradual declining trend up to 57%, 61.8% and 47.6% after 140 days in the case of 01%, 02% and 03% of Chlorpyrifos.

Microbial degradation has been reported to be a promising way to alleviate anthropogenic compounds from the environment (Jain *et al.*, 2005). It is also reported that the inoculation of pesticide degrading bacteria enhanced plant growth and pesticide degradation (Germaine *et al.*, 2006; Korade & Fulekar, 2009). Since Vermicompost helps in increasing the buildup of microbial flora in the soil, this may have a helping hand in the remediation of pesticides.

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