4. RESULTS

4.1 Reproductive study of adult earthworms

4.1.1 In sheep droppings

Rate of cocoon and hatchling production, hatching success, incubation time and the body weight of adult *E.fetida* and *L.mauritii* exposed to different partly decomposed sheep droppings media (0, 10, 20, 30, 40, 50, 75 and 100 PSR) for 30 days are given in Tables 5 and 6 respectively. A gradual increase from the beginning till the end was noticed in the body weight of adult *E.fetida* and *L.mauritii* respectively exposed to 40 – 100 and 30 – 100 PSR media. However, the same worms kept in soil (0 PSR medium or control) for 30 days respectively showed a reduction of 32 and 9.8% in their body weight over their initial values. Though the worms kept in sheep droppings in general showed increased body weight gain values at the end (after 30 days), the former species in 75 and the latter in 50 PSR dose showed relatively a very high value (95.8 and 52.4%) over other PSR doses. Of the two species studied with high doses (40 – 100 PSR) of sheep droppings as substrate, the gain values of *E.fetida* were relatively very high when compared to *L.mauritii*.

Though the control earthworms showed 100 % survival, only a meagre number of cocoons (3 in *E.fetida* and 6 in *L.mauritii*) were laid for the entire period of study (30 days). However, the same earthworms produced relatively more cocoons if they were in 50 and 40 PSR doses of sheep droppings with a maximum production rate of 0.061 and 0.099 cocoon/ worm/ day respectively for *E.fetida* and *L.mauritii*. But the rate of cocoon production observed in other doses though showed an increasing trend from lower PSR to
higher PSR, their production rate was gradually decreased beyond 50 PSR in *E.fetida* and 40 PSR in *L.mauritii*.

The cocoons collected from control earthworms were hatched out into hatchlings after an incubation period of 8 – 9 and 12 – 13 days with a hatching success of 66.7 and 50 %. But the cocoons collected from *E.fetida* and *L.mauritii* exposed to different doses of sheep droppings took an incubation period 8-11 days in 10 PSR and 12 – 17 days in 100 PSR, and 13 – 16 days in 10 PSR and 23 – 26 days in 100 PSR respectively. Of the seven doses used in the current study, *E.fetida* in 50 PSR and *L.mauritii* in 40 PSR dose though produced relatively more cocoons (132 and 214 cocoons) than the other PSR doses, only 110 in *E.fetida* and 181 in *L.mauritii* were hatched out into hatchlings with a hatching success value of 83.3 and 84.6% and a hatchling production rate value of 0.88 and 0.89 hatchling/ cocoon respectively. Though most of the cocoons laid down by the above earthworms were hatched out usually into single hatchling, but some collected from *E.fetida* in 40, 50, 75 and 100 PSR doses and *L.mauritii* in 30, 40, 50, 75 and 100 PSR doses produced two hatchlings at a time while hatching resulting an improvement in their hatchling production rate in the respective doses. Of the two species studied with sheep droppings as substrate, the reproductive capacity of *L.mauritii* was relatively more when compared to *E.fetida* as far as cocoon and hatchling production rates are concerned.

**4.1.2 In press mud**

Rate of cocoon and hatchling production, hatching success, incubation time and the body weight of *E.fetida* and *L.mauritii* exposed to different partly decomposed press mud media (0, 10, 20, 30, 40, 50, 75 and 100 PSR) for 30 days are given in Tables 7 and 8 respectively. It is important to note here that out of two earthworms studied with press
mud as substrate, only the earthworm belonging to *E. fetida* species were survived well in all PSR doses (10 – 100) till the end of the study period. But the second earthworm *L. mauritii*, on the other hand, showed 100% survival only in the lower doses (upto 50 PSR) and hence the cocoon production study was limited only upto 50 PSR doses. As observed in sheep droppings, here also the press mud exposed earthworms (*E. fetida* in 40 – 100 and *L. mauritii* in 30 – 50 PSR doses) showed a gradual increase in their body weight right from the begining till the end. On the contrary, the respective control earthworms exposed to soil for 30 days experienced a body weight loss of 42.9 and 11.3% over their initial body weight. The body weight in general though showed increased values in both the species after 30 days, the former species cultured in 75/100 PSR and the latter in 40 PSR dose showed relatively a higher gain value with 61.5 and 32.3% increase over their respective initial values. Of the two species studied, the weight gain values observed in *E. fetida* were relatively very high when compared to the weight gain values observed in *L. mauritii* exposed to press mud doses.

As observed in the control earthworms maintained along with the earthworms exposed to sheep droppings, here also the worms kept in soil produced only a meagre number of cocoons (5 in *E. fetida* and 3 in *L. mauritii*). But the same earthworms, *E. fetida* under 75 PSR dose and *L. mauritii* under 30 PSR dose of press mud produced relatively more cocoons (204 and 93) over other PSR doses with a production rate of 0.094 and 0.043 cocoon/ worm/ day respectively. However the rate of cocoon production observed in other press mud media showed an increasing trend with lesser production values at lower doses and higher production values at higher doses with the exception of 100 PSR dose in *E. fetida* and 40/50 PSR dose in *L. mauritii* where a slight deviation (slightly lesser than previous value) was noticed.
The cocoons collected from control *E. fetida* and *L. mauritii* earthworms were hatched out into hatchlings respectively after 9 – 10 days (slightly higher than sheep droppings control) and 12 – 13 days (same as in sheep droppings control) of incubation period with hatchling production rate of 0.40 and 0.67 hatchling/ cocoon respectively. But the cocoons collected from press mud exposed *E. fetida* and *L. mauritii* were emerged into hatchlings after an incubation period of 9 – 12 days under 10 PSR and 14 – 18 days in 100 PSR (*E. fetida*) and 14 – 15 days under 10 PSR and 22 – 25 days in 50 PSR (*L. mauritii*) respectively. Of the seven press mud media studied, the earthworm *E. fetida* exposed to 75 PSR and *L. mauritii* to 30 PSR medium produced relatively more cocoons (204 and 93) over other press mud media, only 170 (83.3%) and 66 (70.9%) of them were hatched out into hatchlings with a hatchling production rate of 0.86 and 0.76 respectively. As observed in sheep droppings exposed cocoons here also some of them produced by *E. fetida* in 50, 75 and 100 PSR doses and by *L. mauritii* in 20, 30 and 40 PSR doses were rarely produced two hatchlings at a time while hatching resulting a slight improvement in their hatchling production rate. Of the two species studied using press mud as substrate, the reproductive efficiency of *E. fetida* was relatively more when compared to *L. mauritii* as far as their cocoon and hatchling production rates are concerned.

4.1.3 In *Pongamia* leaves

The rate of cocoon and hatchling production, hatching success, incubation time and the body weight of adult *E. fetida* and *L. mauritii* exposed to different partly decomposed *Pongamia* media (0, 10, 20, 30, 40, 50, 75 and 100%) for 30 days are given in Tables 9 an 10 respectively. A gradual increase was noticed in the body weight of adult earthworms exposed to 30, 40, 50, 75 and 100 PSR media for 30 days. But the same earthworms maintained under soil substrate (0 PSR) for 30 days showed a weight loss of
24% and 11.5% over their initial body weight with 100% survival value. However the same earthworms kept in 10 PSR medium showed neither increase nor decrease in their body weight over their initial biomass values. But the same earthworms kept in higher doses for 30 days though showed over all increase in their body weight values, the first species exposed to 50 PSR medium and the second to 40 PSR medium showed relatively more gain values (92.0 and 42.6%) over their other PSR values. Of the two species and seven media studied with Pongamia leaves as organic substrate, the weight gain values observed in *E.fetida* were relatively more when compared to *L.mauritii* values.

As observed in the control worms maintained along with sheep droppings and press mud study, the control earthworms (both species) exposed to 0 PSR medium produced relatively a lesser number of cocoons (6 in *E.fetida* and 4 in *L.mauritii*) with only a 50% hatching success value. However, the same earthworms if they were respectively exposed to 50 and 40 PSR Pongamia dose, produced a maximum count of 218 and 197 cocoons with a cocoon production rate of 0.100 and 0.091 cocoon/ worm/day. Though the rate of cocoon production observed in both the species showed an increasing trend from lower PSR to higher PSR, but their production rate was gradually decreased beyond 50 PSR dose in *E.fetida* and 40 PSR dose in *L.mauritii*.

The cocoons collected from control earthworms released their hatchlings after their usual incubation period as noted in the control earthworms maintained along with sheep droppings and press mud exposed earthworms. But the cocoons collected from Pongamia exposed *E.fetida* took a minimum incubation period of 9 – 13 days if they emerged from lower doses (10 – 30 PSR) and a longer time (13 – 18 days) if they emerged from a highest dose (100 PSR). Similarly Pongamia exposed *L.mauritii* cocoons took a minimum incubation period of 14 – 16 days in 10 PSR and a longer period of
23 – 26 days in 100 PSR medium. Out of 218 and 197 cocoons produced by *E.fetida* and *L.mauritii* respectively in 50 and 40 PSR medium, only 186 in *E.fetida* and 160 in *L.mauritii* were successfully hatched out into hatchlings with a hatching success of 85.3 and 81.2% and a hatchling production rate of 0.89 and 0.85 hatchling/cocoon respectively. Most of the cocoons laid down by *Pongamia* exposed earthworms were normally emerged into only one hatchling at a time but some collected from both species exposed to 30, 40, 50, 75 and 100 PSR doses produced rarely two hatchlings at a time from a single cocoon resulting an improvement in their production rate as noted in the above doses. Of the two species studied for their reproductive efficiency using partly decomposed *Pongamia* leaves as substrate, the earthworm *E.fetida* showed relatively more potent than the *L.mauritii* as far as the cocoon production and emergence of hatchlings are concerned.

### 4.1.4 In organic mixture

Rate of cocoon and hatchling production, hatching success, incubation time and the body weight of adult *E.fetida* and *L.mauritii* exposed to different substrate ratios (0, 10, 20, 30, 40, 50, 75 and 100 %) of partly decomposed organic mixture for 30 days are given in Tables 11 and 12 respectively. The above species separately exposed to 30, 40, 50, 75 and 100 PSR media exhibited a gradual increase in their body weight from the beginning till the end of the study. Interestingly the first earthworm, *E.fetida* kept under 10 PSR dose for 30 days showed neither increase nor decrease in its body weight over its initial value. The body weight of control earthworms (both species) on the contrary showed 33.3% and 12.9% reduction over their initial values. But the earthworms (both species) kept in higher doses for 30 days though showed over all increase in their body weight values, the former species exposed to 75 PSR and the latter to 40 PSR dose
showed relatively a very high value with 73.0 and 37.5% increase over their initial values. Of the two species studied using organic mixture as substrate, the weight gain values observed in *E.fetida* were relatively very high when compared to *L.mauritii*.

As observed in other control earthworms maintained along with other organic materials, all the earthworms kept in soil produced only a lesser number of cocoons (5 in *E.fetida* and 4 in *L.mauritii*) and released hatchlings respectively at the rate of 0.6 and 0.5 hatchling/ cocoon. However, the earthworm *E.fetida* kept in 75 PSR dose of organic mixture and *L.mauritii* in 30 PSR dose produced relatively more cocoons (0.079 and 0.049 cocoon/ worm/ day) over their other PSR doses. But the rate of cocoon production observed in these earthworms showed an increasing trend from lower PSR to higher PSR and after 75 PSR dose in *E.fetida* and 30 PSR dose in *L.mauritii* their production rates revealed a declining trend.

The embryos developed from control *E.fetida* and *L.mauritii* cocoons were hatched out into hatchlings after their usual incubation time 8 – 9 and 12 – 13 days as noted respectively in the control cocoons maintained along with sheep droppings. But the embryos emerged from cocoons of earthworms (*E.fetida* and *L.mauritii*) exposed to organic mixture were hatched out only after an incubation period of 8 – 11 days in 10 PSR dose and 13 – 18 days in 100 PSR dose for *E.fetida*, and 13 – 16 days in 10 PSR dose and 23 – 27 days in 100 PSR dose for *L.mauritii* respectively. Of the seven doses studied with two species, the PSR dose, 75 for *E.fetida* and 30 for *L.mauritii* are considered as good medium since it produced relatively more cocoons (172 and 106) and hatchlings (143 and 94) over other PSR doses. As noted earlier here also some of the cocoons collected from *E.fetida* and *L.mauritii* exposed to higher doses were rarely produced two hatchlings at a time from a single cocoon resulting a marginal increase in
their hatchling production rate. Among the two species studied for their reproductive capacity using the organic mixture as substrate, the earthworm *E.fetida* is considered as a good species since it produced relatively more cocoons over other species namely *L.mauritii*.

### 4.1.5 Comparative study of cocoon production of adult earthworms

Among the two earthworm species (*E.fetida* and *L.mauritii*) studied for their cocoon production and hatching efficiency separately under different PSR doses (10, 20, 30, 40, 50, 75 and 100) of partly decomposed sheep droppings, press mud, *Pongamia* leaves and organic mixture, the exotic species, *E.fetida* kept in 50 PSR dose of *Pongamia* (Table 9) and 10 PSR dose of sheep droppings (Table 5), and the local species, *L.mauritii* kept in 40 PSR dose of sheep droppings (Table 6) and 10 PSR dose of press mud (Table 8) produced relatively more and less cocoons and hatchlings respectively over their other PSR doses and other organic materials used (Tables 7,10,11,12). Similarly the weight gain values observed in these earthworms kept under different PSR doses of partly decomposed sheep droppings, press mud, *Pongamia* leaves and organic mixture also showed relatively more in *E.fetida* and *L.mauritii* respectively exposed to 75 and 50 PSR of sheep droppings (Tables 5,6) and less if they were in 10 PSR dose of sheep droppings (Table 5) and organic mixture (Table 12) over other PSR doses and other organic materials studied (Tables 7-11).
4.5 Growth and yield of black gram

4.5.1 In sheep droppings

Mean values of total leaves, shoot height, petiole length, total flowers, total pods, pod length, total seeds and total seed weight of black gram, *Vigna mungo* raised in pots using different PSR doses (0, 2.5, 5.0, 7.5, 10, 15, 20, 25, 30, 40, 50 and 75) of partly decomposed sheep droppings and their vermicompost produced by *E.fetida* and *L.mauritii* are given in Table 30. The black gram plants that are raised in soil alone as substrate (earthworm exposed and unexposed) (Figs. 1-4) showed poor growth and in turn a lesser yield over other doses of partly decomposed (Figs.1-4), *E.fetida* exposed (Figs.1,2) and *L.mauritii* exposed (Figs.3,4) sheep droppings. Over all the results of all parameters observed in black gram plants revealed a differential and dose dependent effect with more growth and yield if they were in higher doses and less in lower doses. Of the 3 sheep droppings used, the plants raised in partly decomposed sheep droppings showed relatively lesser growth and yield (Figs. 1-4) over the plants raised in *E.fetida* exposed (Figs.1,2) and *L.mauritii* exposed (Figs.3,4) sheep droppings. And of two earthworm exposed sheep droppings studied, the growth and yield of black gram raised in *L.mauritii* exposed sheep droppings was relatively high (Figs.3,4) when compared to *E.fetida* exposed sheep droppings (Figs.1,2). The pod length of black gram plants raised in earthworm unused, *E.fetida* exposed and *L.mauritii* exposed soil were relatively very short (3.8 ± 0.1, 3.9 ± 0.1 and 4.0 ± 0.1 cm) when compared to their pod length observed respectively in the least dose, 2.5 PSR (3.9 ± 0.1, 4.0 ± 0.1 and 4.1 ± 0.1 cm) and in the highest dose, 75 PSR (4.4 ± 0.1, 4.5 ± 0.1 and 4.6 ± 0.1 cm) of respective sheep droppings. Similarly the seed weight also showed relatively more 13.030 ± 1.222, 14.257
$1.114 \pm 1.796 \pm 0.253, 1.823 \pm 0.274$ and $2.012 \pm 0.197$ gm in 2.5 PSR dose with per cent change over soil (earthworm unexposed) values respectively as 949.1, 1047.9 and 1104.6, and 44.6, 46.8 and 62.0.

### 4.5.2 In press mud

Mean values of total leaves, shoot height, petiole length, total flowers, total pods, pod length, total seeds and total seed weight of black gram plants raised in pots using different PSR doses (0, 2.5, 5.0, 7.5, 10, 15, 20, 25, 30, 40, 50 and 75) of partly decomposed, *E.fetida* exposed and *L.mauritii* exposed press mud are given in Table 31. As noticed in sheep droppings, here also the plants that are raised in soil alone (Figs.5-8) showed poor growth and in turn a poor yield over other PSR doses of partly decomposed (Figs.5-8), *E.fetida* exposed (Figs.5,6) and *L.mauritii* exposed (Figs.7,8) press mud. Similarly as noted in sheep droppings, here also all parameters of black gram plants raised in different PSR press mud doses revealed a differential and dose dependent effect with a high yield in higher doses and a low yield in lower doses. Of the 3 different press mud materials used, the plants raised in partly decomposed press mud showed relatively lesser growth and yield (Figs.5-8) over the plants raised in *E.fetida* exposed (Figs.5,6) and *L.mauritii* exposed (Figs.7,8) press mud as was noticed in sheep droppings (Figs.1-4). Similarly the mean values of all parameters (growth and yield) observed in black gram plants raised in *L.mauritii* exposed press mud were relatively more (Figs.7,8) when compared to the plants raised in *E.fetida* exposed press mud (Figs.5,6). A significant ($P < 0.01$) improvement was noticed in the pod length of black gram plants raised in partly decomposed, *E.fetida* exposed and *L.mauritii* exposed press mud over their pod length raised in soil. Similarly the seed weight (mean values) of black gram plants raised in 75 PSR dose also showed significant change over their control value
with a per cent change over value as 1268.4 and 1347.9 respectively observed in partly decomposed and *E. fetida* exposed press mud.

### 4.5.3 In *Pongamia* leaves

Mean values of total leaves, shoot height, petiole length, total flowers, total pods, pod length, total seeds and total seed weight of black gram plants raised in pots using different PSR doses (0, 2.5, 5.0, 7.5, 10, 15, 20, 25, 30, 40, 50, and 75 PSR) of partly decomposed, *E. fetida* exposed and *L. mauritii* exposed *Pongamia* leaves are given in Table 32. As shown in sheep droppings and press mud control plants, the control plants maintained in soil medium (0 PSR) (Figs.9-12) showed poor growth and yield over other doses prepared from partly decomposed (Figs.9-12), *E. fetida* exposed (Figs.9,10) and *L. mauritii* exposed (Figs.11,12) *Pongamia* leaves. Similarly all the growth and yield parameters of black gram plants raised in different doses of *Pongamia* leaves revealed a differential and dose dependent effect irrespective of their varied chemical composition. Among the 3 decomposed *Pongamia* materials used, the plants raised in partly decomposed *Pongamia* showed relatively low growth and yield (Figs.9-12) values over the plants raised in *E. fetida* exposed (Figs.9,10) and *L. mauritii* exposed (Figs.11,12) *Pongamia* leaves as noted in the sheep droppings (Figs.1-4) and press mud (Figs.5-8). Likewise the mean values of all parameters observed in black gram plants raised in *L. mauritii* exposed *Pongamia* were relatively high (Figs.11,12) when compared to the plants raised in *E. fetida* exposed (Figs.9,10) *Pongamia*. A significant (P < 0.01) improvement was also noticed in the pod length of black gram plants raised in partly decomposed, *E. fetida* exposed and *L. mauritii* exposed *Pongamia* over their control pod length as observed in other organic matters. Similarly the production of seeds (in terms of weight) observed in 75 PSR dose were relatively more with per cent change over soil
values as 1219.3, 1341.6 and 1386.9 respectively for partly decomposed, *E.fetida* exposed and *L.mauritii* exposed *Pongamia* leaves.

### 4.5.4 In organic mixture

Mean values of total leaves, shoot height, petiole length, total flowers, total pods, pod length, total seeds and total seed weight of black gram plants raised in pots using different PSR doses (0, 2.5, 5.0, 7.5, 10, 15, 20, 25 30, 40, 50 and 75 PSR) of partly decomposed, *E.fetida* exposed and *L.mauritii* exposed organic mixtures are given in Table 33. The control plants maintained in earthworm exposed or unexposed soil (Figs.13-16) showed poor growth and yield over other doses prepared from partly decomposed (Figs. 13-16), *E.fetida* exposed (Figs.13,14) and *L.mauritii* exposed (Figs.15,16) organic mixtures as observed in control plants maintained along with black gram plants raised in sheep droppings, press mud and *Pongamia* leaves. Similarly all the parameters of black gram plants raised in different doses of organic mixtures showed significant variation and dose dependent effect with a lesser effect in lower doses and a maximum impact in higher doses. As observed in the black gram plants raised in other organic materials, the black gram plant raised in partly decomposed organic mixture also showed relatively lesser growth and yield (Figs.13-16) over the plants raised in *E.fetida* exposed (Figs.13,14) and *L.mauritii* exposed (Figs.15,16) organic mixtures. Similarly, of the two earthworm exposed organic mixtures used, the mean values of black gram parameters observed in *L.mauritii* exposed organic mixture were relatively high (Figs.15,16) when compared to the mean values observed in *E.fetida* exposed organic mixture (Figs.13,14). A significant (P<0.01) improvement was noticed in the pod length of black gram plants raised in partly decomposed, *E.fetida* exposed and *L.mauritii* exposed organic mixtures over their pod length of control plants. Similarly the seed
production observed in the plants raised in 75 PSR dose also showed a significant improvement (P<0.01) with a per cent change over soil (earthworm unexposed) value as 1014.1, 1137.7 and 1171.5 respectively noted in partly decomposed, *E.fetida* exposed and *L.mauritii* exposed organic mixtures.

### 4.5.5 Comparative study of black gram cultivation

Of the three organic materials (sheep droppings, press mud and *Pongamia*) used in the cultivation of black gram plants after anaerobic decomposition and vermicomposting by *L.mauritii* and *E.fetida*, the black gram plants raised in press mud media produced relatively more seeds (Table 31) over the same plants raised in other organic matters namely sheep droppings (Table 30) and *Pongamia* (Table 32) and the order of seed production was as follows press mud > *Pongamia* > sheep droppings. Similarly, of the three decomposed (partly decomposed, *L.mauritii* exposed and *E.fetida* exposed) organic materials used for the cultivation of black gram plants, the plants raised in *L.mauritii* exposed organic matters produced relatively more yield over the plants raised in *E.fetida* exposed and partly decomposed organic matters and the order of seed production was as follows *L.mauritii* exposed > *E.fetida* exposed > partly decomposed organic matters. One important observation noted in the black gram cultivation study was that the plants raised in all higher doses (40, 50 and 75 PSR) (except sheep droppings) though showed improved growth but are severely affected with insect pest of saprophytic type due to their tender nature.
4.4 Physico–chemical analysis

4.4.1 In soil

The levels of physico–chemical parameters such as pH, EC, macronutrients (OC, TN, TP, TK, TNa and TCa) and micronutrients (Fe, Mn, Zn and Cu) measured/determined in the samples of initial soil, *E.fetida* and *L.mauritii* exposed soil (after one month) are given in Table 25. The pH values measured in the initial soil samples (before earthworm exposure) showed basic nature with 8.40 ± 0.09 as mean pH. But the soil samples obtained after exposure to *E.fetida* and *L.mauritii* showed slightly alkaline in nature with 7.72 ± 0.26 and 7.25 ± 0.05 as mean pH respectively. The levels of EC (as a measure of soluble salts level) measured in the initial soil samples showed relatively more values over the samples obtained after earthworm exposure which indicate that the soluble salts level was reduced during ingestion of soil. Of the six macronutrients (OC, TN, TP, TK, TNa and TCa) and four micronutrients (Fe, Mn, Zn and Cu) analysed in the initial soil samples, the levels of OC in macronutrients and Fe in micronutrients were relatively very high when compared to other macro and micronutrients. It is important to note here that the soil used in the vermiculture study was drastically improved all its levels except TNa during ingestion of soil by *E.fetida* and *L.mauritii*. However the increase observed in *L.mauritii* exposed soil was relatively more when compared to the increase observed in *E.fetida* exposed soil. As observed in other soil nutrients, the C:N ratio was also increased during earthworm exposure even in the absence of sufficient organic matter in the soil.
4.4.2 In sheep droppings

The levels of physico–chemical parameters such as pH, EC, macro and micronutrients measured/ determined in the samples of partly decomposed, *E. fetida* exposed and *L. mauritii* exposed sheep droppings are given in Table 26. The pH values measured in the samples of partly decomposed sheep droppings showed slightly acidic in nature with 6.38 ± 0.16 as mean pH. But the samples obtained after *E. fetida* and *L. mauritii* exposure (after vermicomposting practice) showed slightly alkaline in nature with their mean pH as 7.33 ± 0.05 and 7.22 ± 0.17 respectively. The levels of EC measured in partly decomposed sheep droppings showed relatively more values (0.24 ± 0.02) than the samples obtained after vermicomposting process which indicate that the soluble salts level was reduced during vermicomposting. As observed in earthworm unused soil, here also the levels of OC in macronutrients and Fe in micronutrients were relatively very high when compared to other macro and micronutrients. While vermicomposting the partly decomposed sheep droppings, the earthworm *E. fetida* and *L. mauritii* drastically increased all the levels of macro and micronutrients barring the parameters TNa and C:N ratio. However the levels of increase observed in *L. mauritii* exposed sheep droppings were relatively more when compared to *E. fetida* exposed sheep droppings.

4.4.3 In press mud

The levels of physico–chemical parameters such as pH, EC, macro and micronutrients measured/ determined in the samples of partly decomposed, *E. fetida* exposed and *L. mauritii* exposed press mud are given in Table 27. The pH values observed in press mud samples showed slightly acidic in nature with a mean pH value of
6.72 ± 0.27. But the press mud samples obtained after *E. fetida* and *L. mauritii* exposure showed slightly alkaline in nature with a mean pH value respectively as 7.38 ± 0.19 and 7.18 ± 0.15. As noticed in soil and sheep droppings samples, the levels of EC observed in partly decomposed press mud showed relatively more mean value (0.43 ± 0.03) than the samples obtained after earthworm exposure. As observed in soil and sheep droppings samples, here also the levels of OC among macronutrients and Fe in micronutrients were relatively very high when compared to other macro and micronutrients. During vermicomposting of partly decomposed press mud, the earthworm *E. fetida* and *L. mauritii* drastically increased all its macro and micronutrients barring the soil parameters namely TNa and C:N ratio as observed in sheep droppings. However the magnitude of increase observed in *E. fetida* exposed press mud was relatively high when compared to the increase observed in *L. mauritii* exposed press mud samples.

4.4.4 In *Pongamia* leaves

The levels of physico – chemical parameters such as pH, EC, macro and micronutrients measured/ determined in the samples of partly decomposed, *E. fetida* exposed and *L. mauritii* exposed *Pongamia* leaves are given in Table 28. The pH values observed in the samples of partly decomposed *Pongamia* leaves showed a mean pH of 5.96 ± 0.45 with strong acidic nature. But the samples of *E. fetida* and *L. mauritii* exposed *Pongamia* showed slightly alkaline and acidic with mean pH values of 7.15 ± 0.18 and 6.43 ± 0.05 respectively. The levels of EC measured in partly decomposed *Pongamia* leaves samples showed relatively more values (0.24 ± 0.04) than the samples obtained after vermicomposting process as observed in the samples of soil, sheep droppings and press mud. As noticed in soil, sheep droppings and press mud samples, here also the
levels of OC in macronutrients and Fe in micronutrients were relatively very high when compared to other macro and micronutrients. While vermicomposting, both the earthworms drastically increased (P<0.01 or P<0.05) the levels of OC, TP, TK, TCa, Fe, Mn and Cu and decreased the levels of C:N ratio (P>0.05) and TNa (P>0.05 or P<0.01) over partly decomposed *Pongamia* leaves. However the increased levels observed in *L.mauritii* exposed *Pongamia* leaves were relatively more when compared to *E.fetida* exposed *Pongamia* as was observed in sheep droppings.

### 4.4.5 In organic mixture

The levels of physico-chemical parameters such as pH, EC, macro and micronutrients measured/ determined in the samples of partly decomposed, *E.fetida* exposed and *L.mauritii* exposed organic mixtures are given in Table 29. The pH values observed in the samples of partly decomposed organic mixture showed slightly acidic in nature with 6.35 ± 0.22 as mean pH. But the samples of organic mixture obtained after *E.fetida* and *L.mauritii* exposure showed a basic pH with a significant change (P<0.01) in their mean pH as 7.33 ± 0.11 and 7.28 ± 0.03 respectively. As noticed in other organic matters, here also the levels of EC observed in partly decomposed organic mixture showed relatively more values (0.26 ± 0.01 as mean) than the same organic mixture obtained after vermicomposting process. As observed in soil and in other organic materials, here also the levels of OC among macronutrients and Fe in micronutrients were relatively very high when compared to other macro and micronutrients. During vermicomposting by *E.fetida* and *L.mauritii* the partly decomposed organic mixture drastically increased all its macro and micronutrients levels barring the parameters such as TNa and C:N ratio. However the levels of increase observed in *L.mauritii* exposed
organic mixture were relatively more when compared to the increase observed in *E. fetida* exposed mixture as noted in sheep droppings and *Pongamia* leaves.

The levels of macro and micronutrients observed in partly decomposed organic matters were in the following descending order: OC > TCa > TN > TP > TK > TNa > Fe > Mn > Zn > Cu, OC > TCa > TP > TK > TN > TNa > Fe > Zn > Mn > Cu and OC > TCa > TN > TK > TP > TNa > Fe > Zn > Mn > Cu respectively for sheep droppings, press mud and *Pongamia* leaves. But this descending order was slightly changed during vermicomposting by *E. fetida* and the changed order was OC > TCa > TN > TK > TP > TNa > Fe > Mn > Zn > Cu, OC > TCa > TN > TK > TP > TNa > Fe > Zn > Mn > Cu and OC > TCa > TK > TN > TP > TNa > Fe > Mn > Zn > Cu for sheep droppings, press mud and *Pongamia* leaves respectively. However, the nutrient levels observed in *L. mauritii* exposed organic matters showed the same trend as followed in the *E. fetida* exposed organic samples except *L. mauritii* exposed press mud where a slight modification was noticed and the modified expression was OC > TCa > TP > TN > TK > TNa > Fe > Zn > Mn > Cu.

**4.4.6 Comparative study of macro and micronutrients analysis**

Among the three organic materials (sheep droppings, press mud and *Pongamia*) analyzed, the levels of all macronutrients (OC, TN, TP, TK, TNa and TCa) and micronutrients (Fe, Mn, Zn and Cu) present in decomposed press mud were relatively very high (Table 27) when compared to the levels observed in sheep droppings (Table 26) and *Pongamia* leaves (Table 28). Similarly the levels of TN, TP, TK, TCa, Fe, Zn and Cu, and OC, TNa and Mn respectively in partly decomposed sheep droppings and *Pongamia* leaves were relatively the least (Tables 26,28) among the organic matters.
studied (Table 27). As observed in partly decomposed press mud, the levels of all macro and micronutrients present in *E. fetida* exposed press mud were relatively very high (Table 27) when compared to the levels observed in other organic materials (sheep droppings and *Pongamia* leaves) (Tables 26,28). Similarly the levels of TN, TP, TK, TNa, TCa, Fe, Mn and Cu, and OC respectively in *E. fetida* exposed sheep droppings and *Pongamia* leaves were relatively the least (Tables 26,28) among the *E. fetida* exposed organic matters analyzed (Table 27). As observed in partly decomposed and *E. fetida* exposed press mud, the levels of macronutrients observed in *L. mauritii* exposed press mud were relatively very high (Table 27) when compared to the levels observed in other *L. mauritii* exposed organic materials (Tables 26,28). Micronutrients of *L. mauritii* exposed organic matters on the contrary, the levels of Fe in sheep droppings, Zn in press mud and Mn and Cu in *Pongamia* were relatively very high (Tables 26,27, 28) when compared to other organic matters studied. Similarly among *L. mauritii* exposed organic matters, the levels of TN, TP, TK and TCa in sheep droppings, Fe, Mn and Cu in press mud and OC, TNa and Zn in *Pongamia* leaves were relatively the least (Tables 26,27,28) among the 3 organic matters analyzed. Among the levels of C:N ratio observed in partly decomposed, *E. fetida* exposed and *L. mauritii* exposed organic matters, the C:N ratios observed in sheep droppings and press mud respectively were the highest (Table 26) and lowest (Table 27) among the organic matters studied (Table 28).
4.2 Hatchling’s growth study

4.2.1 In sheep droppings

Measurements of length, body weight and growth rate of \textit{E.fetida} and \textit{L.mauritii} F\textsubscript{1} hatchlings (obtained from parents exposed to 10, 20, 30, 40, 50, 75 and 100 PSR doses of sheep droppings for 30 days) cultured in different PSR doses for 97 and 122 days are given in Tables 13 and 14 respectively. The hatchlings (of both species) exposed to different sheep droppings doses showed a gradual increase in their body length and weight values throughout the study period. But the same hatchlings kept in soil medium (0 PSR) though showed initially a slight improvement in their growth parameters, but after 40 days of exposure all of them were died due to shrinkage of body segments. Among the seven PSR media studied with these earthworms, \textit{E.fetida} exposed to 100 PSR dose attained sexual maturity during the age of 50 – 53 days after reaching a mean body length of 106 ± 6 mm and a total body weight of ± 416 mg. However, the same hatchlings kept in 75, 50, 40, 30, 20 and 10 PSR doses attained sexual maturity only after 60 – 63, 61 – 64, 70 – 74, 72 - 76, 81 – 86 and 92 – 97 days of exposure after reaching a body weight of ± 391, ± 316, ± 308, ± 300, ± 294 and ± 283 mg respectively. A dose and time bound effect was also noticed in their sexual maturity with longer period while they were in lower doses and shorter period if they were in higher doses. And in contrast the hatchlings of \textit{L.mauritii} exposed to 50 PSR dose, attained sexual maturity somewhat later than \textit{E.fetida} hatchlings but it was earlier than other PSR doses (after 67 – 70 days of exposure) once they reached a body size with a mean length, 155 ± 3 mm and a biomass value, ± 912 mg. Although \textit{L.mauritii} hatchlings kept in 10, 20, 30, 40, 75 and 100 PSR doses attained sexual maturity later than the hatchlings kept in 50 PSR dose, but
their growth parameters (length and weight) were greatly reduced over their counterpart in 50 PSR dose. Instead of dose dependent and time bound effect, *L. mauritii* hatchlings took more time for their sexual maturity when they were in lower and higher doses but a least in middle dose. Though the hatchlings of both species showed a gradual increase in their body length and weight values, but their growth rate observed at 60 (10 PSR), 50 (20 – 75 PSR) and 40 (100 PSR) days in *E. fetida* and at 30 (10 PSR) and 50 (20 – 100 PSR) days in *L. mauritii* was the maximum among other periods.

### 4.2.2 In press mud

Measurements of length, body weight and growth rate of F<sub>1</sub> hatchlings (of both species) cultured in different PSR doses as mentioned in sheep droppings for 95 and 127 days are given in Tables 15 and 16 respectively. The hatchlings of both species exposed to different press mud doses showed a gradual increase in their body length and weight through out the study period. But the same hatchlings lived in soil (0 PSR), a slight improvement (upto 20 days) followed by a decline (upto 40 days) in their body weight was noticed. As in previous study here also all the control worms were died before they reached the age of 50 days. Of the seven PSR doses studied with *E. fetida* hatchlings, the hatchlings kept in 100 PSR dose attained sexual maturity with in a short span of 49 – 52 days, after they reached a mean length of 109 ± 2 mm and a total body weight of ± 427 mg. Though the clitellum formation time observed in the hatchlings of other press mud doses was relatively longer than the hatchlings kept in 100 PSR dose, but the time of attainment of sexual maturity observed in press mud exposed hatchlings was relatively earlier than the hatchlings kept in sheep droppings (Table 13). Similarly the body length and weight values of press mud exposed *E. fetida* were relatively very high when
compared to the hatchlings exposed to sheep droppings. As observed in the hatchlings of sheep droppings, here also a dose dependent effect was noticed in the growth parameters such as length and weight and in the time of sexual maturity. As noted in 50 PSR sheep droppings exposed *L. mauritii* hatchlings, the same hatchlings exposed to 40 PSR press mud dose attained sexual maturity somewhat earlier (74 – 76 days) than the other press mud doses after they reached a mean body length of 148 ± 2 mm and a total body weight of ± 875 mg. Though the time of clitellum formation observed in *L. mauritii* hatchlings exposed to lower doses (10 – 30 PSR) of press mud was relatively very long when compared to hatchlings of same species exposed to similar doses of sheep droppings. And in contrast their length and weight values observed in press mud doses were relatively less when compared to the hatchlings kept in sheep droppings. As observed in *E. fetida* hatchlings exposed to sheep droppings doses, the same hatchlings exposed to press mud doses showed exactly a similar trend with a maximum growth rate at 60 days in 10 PSR, 50 days in 20 – 75 PSR and 40 days in 100 PSR doses. But the hatchlings of *L. mauritii* cultured in press mud doses showed variations in their growth pattern with a maximum growth rate at 30 days in 10, 30 and 50 PSR and at 50 days in 20 and 40 PSR doses as against their observation made in the same species exposed to sheep droppings.

**4.2.3 In Pongamia leaves**

Measurements of length, body weight and growth rate of F₁ hatchlings (of both species) cultured in different PSR doses as mentioned in sheep droppings for 92 and 123 days are given in Tables 17 and 18 respectively. The hatchlings of both species exposed to different *Pongamia* doses, though showed a gradual increase in their body length and weight throughout the study period as noticed in other organic matters but the magnitude
of increases observed in *E.fetida* were relatively very high when compared to the hatchlings kept in sheep droppings and press mud doses. As noticed in other control hatchlings here also all the hatchlings kept in soil were died after 40 days of exposure. Of the two species studied with seven PSR doses, the hatchlings of *E.fetida* kept in 100 PSR dose attained sexual maturity very quickly (46 – 50 days) after they reached a mean length of 112 ± 2 mm and a total body weight of ± 440 mg. Though the time of attainment of sexual maturity observed in *E.fetida* hatchlings exposed to other *Pongamia* doses was relatively longer than 100 PSR, but shorter than the hatchlings kept in sheep droppings (Table 13). Similarly the body length and weight values of *Pongamia* exposed *E.fetida* were also relatively very high when compared to the hatchlings exposed to sheep droppings. As noticed in the hatchlings exposed to sheep droppings and press mud doses, here also a dose dependent effect was noticed in all the growth parameters of *E.fetida* hatchlings. By deviating this dose dependent effect, *L.mauritii* hatchlings exposed to 40 PSR dose of *Pongamia* attained sexual maturity somewhat earlier (69 – 72 days) than the hatchlings kept in lower or higher *Pongamia* doses or in 40 PSR dose of press mud after reaching their body weight (± 905 mg) somewhat higher than the hatchlings in press mud. Hatchlings of *E.fetida* exposed to different *Pongamia* doses also showed variations in their growth rate as was in the hatchlings exposed to sheep droppings and press mud doses with a maximum rate at 60 days in 10 PSR, 50 days in 20 PSR, 40 days in 30, 50, 75 and 100 PSR and 20 days in 40 PSR doses. But the hatchlings of *L.mauritii* cultured in *Pongamia* doses showed exactly a similar trend as was in the same hatchlings exposed to sheep droppings doses, but a different trend with press mud doses where a maximum growth rate was noticed at 30 days in 10, 30 and 50 PSR and at 50 days in 20 and 40 PSR doses (Table 16).
4.2.4 In organic mixture

Measurements of length, body weight and growth rate of $F_1$ hatchlings of \textit{E.fetida} and \textit{L.mauritii} cultured in different PSR doses of organic mixture for 93 and 125 days are given in Tables 19 and 20 respectively. The hatchlings (of both species) exposed to different PSR doses showed 100 per cent survival with a gradual increase in their body length and weight throughout the study period as noticed in other organic materials. As observed in other control earthworms here also all the hatchlings exposed to soil were died before they reached the age to 50 days. Among the seven PSR doses studied with \textit{E.fetida} hatchlings, the hatchlings kept in 100 PSR after reaching their age 47 to 50 days, all of them attained sexual maturity once they reached a body size with 111 ± 2 mm as length and ± 435 mg as weight. Though early maturity was observed in \textit{E.fetida} hatchlings over sheep droppings and press mud exposed hatchlings, but their length and weight values were relatively very high when compared to the hatchlings exposed to sheep droppings and press mud doses. A dose dependent effect was noticed in all the growth parameters of \textit{E.fetida} hatchlings exposed to different doses of organic mixture as observed in other organic matters. But \textit{L.mauritii} hatchlings, exposed to 40 PSR dose (organic mixture) attained sexual maturity only after a longer period (72 – 75 days) (longer than the hatchlings exposed to 40 PSR dose of \textit{Pongamia} and shorter than the hatchlings exposed to 40 PSR dose of press mud or sheep droppings) after reaching a size with body weight, ± 888 mg and body length, 152 ± 3 mm. The growth rate observed in \textit{E.fetida} hatchlings exposed to different doses of organic mixture showed exactly a similar trend as was in the hatchlings exposed to similar doses of sheep droppings and press mud with a maximum growth rate at 60 days in 10 PSR, 50 days in 20 – 75 PSR and 40 days in 100 PSR doses. Similarly \textit{L.mauritii} hatchlings exposed to organic
mixture doses showed exactly a similar trend as was in the hatchlings exposed to sheep droppings and Pongamia with a maximum growth rate at 30 days in 10 PSR and 50 days in all other PSR doses.

### 4.2.5 Comparative growth study of F₁ hatchlings

Among the hatchlings of two earthworm species (*E. fetida* and *L. mauritii*) studied for their growth and sexual maturity under different PSR doses of partly decomposed sheep droppings, press mud, Pongamia leaves and organic mixture, the F₁ hatchlings of *E. fetida* which were kept in 100 PSR Pongamia dose attained sexual maturity very early (46 – 50 days) after attaining a mean biomass of 440 mg (Table 17) over other earthworm species, other PSR doses and other organic materials studied (Tables 13,15,19). Similarly the hatchlings of *L. mauritii* grown in 50 PSR sheep droppings dose attained sexual maturity some what early (but some what late when compared to *E. fetida*) but only after reaching a mean biomass of 912 mg (Table 14) over other PSR doses and other organic materials used (Tables 16,18,20). It is important to note here that the hatchlings belonging to *L. mauritii* species attained sexual maturity only after 74 – 76 days of development under 40 PSR press mud dose (Table 16) but with relatively lesser biomass value (875 mg) over other organic materials studied (Tables 14,18,20).

Though a gradual and dose dependent effect with higher values in higher doses and lower values in lesser doses was noticed in the overall growth rate of *E. fetida* hatchlings exposed to different organic materials until they attained sexual maturity, the overall growth rates observed in Pongamia leaves doses (Table 17) were relatively high when compared to other organic materials or their doses studied (Tables 13,15,19). And in contrast the overall growth rate observed in *L. mauritii* hatchlings exposed to the same
organic materials showed such a gradual and dose dependent effect but only up to 40 or 50 PSR doses of all the organic materials studied. Out of 7 PSR doses in each organic material studied (barring press mud), the growth rate observed in *E. fetida* F1 hatchlings exposed to 100 PSR dose of *Pongamia* leaves (Table 17) and *L.mauritii* hatchlings exposed to 50 PSR dose of sheep droppings (Table 14) was relatively high (8.68 and 12.87 respectively) when compared to other PSR doses or organic materials studied (Tables 13,15,16,18,19,20).
4.3 Cocoon production of F$_1$ offsprings

4.3.1 In sheep droppings

The rate of cocoon production and per cent weight gains observed in 12 mature F$_1$ $E. fetida$ and $L. mauritii$ exposed to 10, 20, 30, 40, 50, 75 and 100 PSR doses of partly decomposed sheep droppings for 30 days are given in Tables 21 and 21a, respectively. The mature F$_1$ earthworms of both species exposed to different sheep droppings doses (10 – 100 PSR), though showed a gradual significant ($P<0.01$) increase in their body weight throughout the study period, $E. fetida$ and $L. mauritii$, respectively fed with 75 and 50 PSR dose showed relatively a higher weight gain (30 and 40.8%) over their weight gains fed with other PSR doses. Of the two F$_1$ species studied with sheep droppings as substrate, the weight gains observed in $E. fetida$ were relatively less when compared to $L. mauritii$. If comparison made between the weight gains of parental earthworms (adult) with that of F$_1$ mature earthworms exposed to different PSR sheep dropping doses, the weight gains observed in all the F$_1$ earthworms were relatively less when compared to the weight gains observed in adult earthworms except the worms kept in 10 and 20 PSR doses. Of the two F$_1$ mature earthworms studied with seven PSR doses, $E. fetida$ kept in 50 PSR and $L. mauritii$ in 40 PSR dose produced relatively more cocoons (70 and 66, respectively) with a production rate as 0.194 and 0.183 C/W/D over other PSR doses, respectively. Though the rate of cocoon production observed in both the species showed an increasing trend from lower PSR to higher PSR, but their cocoon production rate was gradually decreased beyond the PSR dose, 50 in $E. fetida$ and 40 in $L. mauritii$. However, the rate of cocoon production observed in F$_1$ earthworms exposed to sheep droppings (all doses) were relatively more when compared to the cocoon production observed in adult earthworms.
4.3.2 In press mud

The rate of cocoon production and the per cent weight gains of 12 mature F$_1$ E. fetida and L. mauritii exposed to 10, 20, 30, 40, 50, 75 and 100 PSR doses of partly decomposed press mud for 30 days are given in Tables 22 and 22a, respectively. The F$_1$ mature earthworms lived in all the PSR doses, though showed gradual significant (P<0.01) increase in their body weight right from the beginning till the end, E. fetida fed with 100 PSR and L. mauritii with 40 PSR dose showed relatively a maximum weight gain with 29.1 and 40%, respectively over their other PSR doses. As observed in sheep droppings, here also the weight gains observed in F$_1$ E. fetida exposed to 30 – 50 PSR doses were relatively less when compared to F$_1$ L. mauritii. However, the weight gains observed in F$_1$ E. fetida were relatively less when compared to the weight gains observed in parental earthworms except the worms in 10 – 30 PSR doses. But in F$_1$ L. mauritii the weight gains observed in all the PSR doses were relatively high when compared to parental earthworms. Of the seven and five PSR press mud doses studied with F$_1$ E. fetida and L. mauritii, respectively E. fetida exposed to 75 PSR and L. mauritii to 30 PSR dose produced relatively more cocoons (76 and 31, respectively) over their other press mud doses with a production rate as 0.211 and 0.086 C/W/D, respectively. The rate of cocoon production observed in F$_1$ earthworms though showed an increasing trend from lower PSR to higher PSR, but the rate of cocoon production observed in 100 PSR dose of E. fetida and 40 PSR dose of L. mauritii, was suddenly decreased to 0.186 and 0.069 C/W/D, respectively from 0.211 and 0.086 C/W/D. As in sheep droppings doses, here also the rate of cocoon production of F$_1$ earthworms observed in all doses were relatively more when compared to their parental earthworms except E. fetida exposed to 10 PSR dose.
4.3.3 In *Pongamia* leaves

The rate of cocoon production and the per cent weight gains of mature F₁ *E. fetida* and *L. mauritii* exposed to 10, 20, 30, 40, 50, 75 and 100 PSR doses of partly decomposed *Pongamia* leaves for 30 days are given in Tables 23 and 23a, respectively. The F₁ mature earthworms (of both species) exposed to these doses, though showed a gradual significant (P<0.01) increase in their body weight right from the beginning till the end, the former species lived in 50 PSR and the latter in 40 PSR dose showed relatively a high weight gain (33.9 and 40.9%, respectively) over the respective earthworms lived in other PSR doses. As in sheep droppings and press mud, here also the weight gains observed in F₁ *E. fetida* were relatively less when compared to F₁ *L. mauritii* except the earthworms kept in 30 – 50 PSR doses. However, the weight gains observed in F₁ *E. fetida* were relatively less when compared to the weight gains observed in parental earthworms except the worms kept in 10 and 20 PSR doses. But the weight gains observed in F₁ *L. mauritii* exposed to *Pongamia* doses were relatively high when compared to their parental earthworms except the worms kept in 40 PSR dose. It is important to note here that the first and second earthworms, respectively exposed to 50 and 40 PSR dose produced relatively more cocoons (78 and 60, respectively) over their other PSR doses with a cocoon production rate as 0.216 and 0.166 C/W/D, respectively. Though the cocoon production rate (in both species) showed an increasing trend from lower doses to higher doses, but their production rate was gradually decreased from 50 PSR in *E. fetida* and 40 PSR in *L. mauritii*. As noticed in other organic matters, here also the rate of cocoon production observed in F₁ earthworms (of both species) exposed to all doses of *Pongamia* leaves was relatively more when compared to their respective parents exposed to the same *Pongamia* doses.
4.3.4 In organic mixture

The rate of cocoon production and per cent weight gains of mature F₁ *E. fetida* and *L. mauritii* exposed to 10, 20, 30, 40, 50, 75 and 100 PSR doses of partly decomposed organic mixture for 30 days are given in Table 24 and 24a, respectively. The F₁ earthworms separately exposed to these doses, though gradual significant (P<0.01) increase was noted in their body weight during the course of this study, the former species exposed to 75 PSR and the latter to 40 PSR dose showed relatively more weight gains, 30.4 and 41.1%, respectively over other PSR doses. As in press mud and *Pongamia*, here also the weight gains noticed in F₁ *E. fetida* were relatively less when compared to F₁ *L. mauritii* barring the worms kept in 30 – 50 PSR doses. As noticed in sheep droppings and *Pongamia*, here also the weight gains observed in F₁ earthworms (of both species) were relatively high when compared to the gains observed in parental earthworms with the exception of *E. fetida* in 30 – 100 PSR doses. Of the seven PSR doses studied, F₁ *E. fetida* exposed to 75 PSR and F₁ *L. mauritii* to 30 PSR dose produced relatively more cocoons (0.205 and 0.155 C/W/D, respectively) over other F₁ earthworms exposed to different PSR doses. The rate of cocoon production observed in F₁ earthworms though showed an increasing trend with dose dependent effect, but a sudden decline in *E. fetida* and a gradual drop in *L. mauritii* were noticed, respectively after 75 and 30 PSR dose. As noticed in F₁ earthworms kept in *Pongamia*, here also the rate of cocoon production observed in all F₁ earthworms showed increased values over their adult parents exposed to the same organic mixture.
4.3.5 Comparative study of cocoon production of F₁ offsprings

Among the two mature F₁ earthworms studied for their cocoon production separately kept in 10, 20, 30, 40, 50, 75 and 100 PSR doses of partly decomposed sheep droppings, press mud, *Pongamia* leaves and organic mixture, *E. fetida* kept in 50 PSR dose of *Pongamia* (Table 23a) and *L. mauritii* under 40 PSR dose of sheep droppings (Table 21a) produced relatively more cocoons over their other PSR doses or organic materials used (Tables 21a, 22a, 23a and 24a). The body weight gains on the other hand, observed in F₁ *E. fetida* exposed to 50 PSR dose of *Pongamia* (Table 23) and *L. mauritii* exposed to 40 PSR dose of *Pongamia* (Table 23) were relatively more over other PSR doses or organic materials studied (Tables 21, 22, 23 and 24). Similarly, the same earthworms, respectively kept in 10 PSR sheep droppings dose (Table 21a) and 10 PSR press mud dose (Table 22a) produced relatively lesser cocoons than the one in other doses or organic materials studied (Tables 21a, 22a, 23a and 24a). Similarly, the weight gains observed in the same earthworms, respectively kept in 10 PSR dose of press mud (Table 22) and 10 PSR dose of press mud (Table 22) were relatively less when compared to other doses or organic materials studied (Tables 21, 22, 23 and 24).