The forests are the key sites to sustain mountain agro-ecosystems. The leaf litter plays a very important role in the protection and formation of humus layer leading to soil enrichment and habitat to many beneficial microbes. The litter protects the top soil from wind erosion and heat generated by long sunny hours. It feed and shelters many microbes and invertebrates playing key role in nutrient dynamics and soil fertility. Earthworms contribute significantly in the formation of fertile and healthy soil required to maintain the healthy ecosystem (Edwards et al. 1995, Kale 1998, Lalitha et al. 2000). Earthworms feed on organic matter and alter its physico-chemical properties. Their number and diversity in soil is considered as an indicator of healthy and fertile soil. Their feeding and burrowing activity increases soil aeration and distribution of accessible nutrients in soil.

Vermicomposting is a bio-oxidative and stabilization process of organic matter. It is a joint action of earthworms and microorganisms; unlike composting it does not include thermophilic stage and microbes. It's a quicker process in comparison to conventional composting as in this a series of events are involved like grinding of organic matter in the gizzard and its interaction with various gut microbes before pelleting out the cast. Earthworms consume as much as their own body weight per day and excrete waste in the form of highly fertile vermicast. The casts contain higher moisture content, organic carbon and inorganic nutrients in comparison to the rest of soil layer (Bhaduria and Ramakrishnan, 1989, Edwards, 1988) and conventional compost. Their potential has been proved in decomposition of organic waste and leaf litter conversion to vermicompost. Vermicomposting ensures the slow and steady release of nutrients trapped within and enables the plants to uptake these nutrients over a period of time (Sharma, 2003). Due to their burrowing nature and conversion of organic waste into nutrient rich vermicompost many workers have drawn towards vermiculture biotechnology. Selection of earthworm species for vermicomposting is very important factor as few species are able to convert the organic waste into nutrient rich vermicompost at commercial scale and get acclimatized in a particular environment. The species selected are endemic to Himalayan region and their vermicomposting potential was studied first time and comparison has been made with widely known exotic species Eisenia fetida commonly known as red worm. Amynthas gracilis (Kinberg, 1867)
(Megascolecidae) and Octolasion cyaneum (Savigny, 1826) (Lumbricidae) are the two endemic species inhabiting the Himalayan montane region. It has been found by many workers that they can be successfully colonized in disturbed environment (Falco et al. 1995, Falco and Momo 2010, Momo et al. 1993, Momo et al. 2003). Due to easy availability of these species and their effective colonizing behavior on decomposition of litter fall and vermicomposting potential, these need to be compared with well established exotic species Eisenia fetida (Savigny, 1826) (Lumbricidae). Present study focuses on evaluating vermi-conversion of leaf litter into nutrient rich organic matter, assessing the vermicomposting potential of two endemic species Amythas gracilis and Octolasion cyaneum with exotic species Eisenia fetida with special reference to nutrient value of casts - faecal like mass cast (O. cyaneum and A. gracilis) and granular pellet cast (E. fetida) of the candidate earthworm species.

MATERIALS AND METHODS

Pre-decomposition experiment: The organic waste used for this study was leaf litter of Quercus leucotrichophora, which is a commonly found oak species along the study site. The fallen leaves were collected and cattle dung was procured from the local farm. A. gracilis and O. cyaneum were collected from the local areas nearby whereas E. fetida was obtained from a local vermicomposting centre. Later all earthworm species were cultured in the dark room and a stock culture was developed.

Vermi-beds and bins: Plastic circular containers were used with a diameter of 40 cm and depth of 16 cm for the experiment. During pre-composting water was sprinkled regularly to bring down the raised temperature. The plastic container was filled from bottom up with the mixture of soil, pre-decomposed mixture of cattle dung and leaf litter up to 12 cm. Ten adult earthworms with well developed clitellum were taken from the stock culture and were uniformly released over the surface of the vermibed of all the six experimental containers. These containers were later covered with fine mesh cloth to avoid the escape of the worms during night when their activity is higher and to maintain the proper aeration.

The experiment was conducted in the dark room to avoid the disturbance and direct sunrays on the containers which can affect the feeding activity of worms. The moisture content of vermibed was maintained in between 50-60% and the containers were observed daily to check the different parameters.

Cast collection: Surface cast collection was made from the six experimental containers every fortnight and weighed. The experiment was continued for 60 days. Collected casts were analyzed for pH, total carbon, total nitrogen, available phosphorus and available potassium content.

Physico-chemical analysis of casts: The pH of the casts was measured using HANNA HI 208 pH meter. Organic carbon was determined by the Walkey-Black method (Walkey and Black, 1934), phosphorus was determined by the wet washing method (Jackson, 1958) and potassium by flame photometry and nitrogen was determined using the Kjeldhal method (Allen et al. 1989).

RESULTS AND DISCUSSION

The formation of abscission layer takes place at the time of senescence and leaf falls. Though much of the nutrients get lost during various physical processes but it still holds substantial nutritive value. Hence leaf litter can be utilized as a good source of soil nutrients. It is well known that nutrients can leach from leaves under natural forest conditions but with the help of vermicomposting hill agriculture could be provided with adequate amount of organic fertilizers. In most of the Himalayan states still use of insecticides and inorganic fertilizer
is at a very low scale, farmers usually depend on the cattle manure for providing the nutrients to the growing crop and to conserve the soil fertility. The leaves of *Quercus leucotricophora* can be utilized to fulfill the nutrient requirement of the cultivated land in the hills. It is a commonly found oak species at the higher altitude where human population sustains. The release of nutrients trapped within can be eased with the help of locally available earthworm species. The two species *A. gracilis* and *O. cyaneum* are endemic to higher Himalayan region and reported by other workers too (Najar and Khan, 2011, Paliwal and Julka, 2005). *E. fetida* (Savigny, 1826) (Lumbricidae) is a manure worm, which is used at commercial level to produce the vermicompost. It is one of the most promising worms that can be utilized in the vermicomposting process. Its physiology and environmental conditions are suitable for its existence has been studied by many workers (Kaplan *et al.* 1980, Hartenstein, 1981, Reinecke and Venter, 1987, Edwards, 1988) and a range of temperature tolerance has been observed which

![Fig. 2- Faecal cast *Amynthas gracilis* and *Octolasion cyaneum* (A) and granular pellet cast *Eisenia fetida* (B).](image)

Table 1: Organic properties of the faecal cast (*Amynthas gracilis* and *Octolasion cyaneum*) and pellet cast (*Eisenia fetida*) (mean±SE; n=10).

<table>
<thead>
<tr>
<th>Organic Properties</th>
<th><em>Amynthas gracilis</em> Mass Cast</th>
<th><em>Octolasion cyaneum</em> Mass Cast</th>
<th><em>Eisenia fetida</em> Pellet Cast</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.5±0.1</td>
<td>7.4±0.05</td>
<td>7.7±0.05</td>
</tr>
<tr>
<td>% Carbon</td>
<td>9.25±0.05</td>
<td>9.15±0.05</td>
<td>9.3±0.1</td>
</tr>
<tr>
<td>% Nitrogen</td>
<td>0.87±0.075</td>
<td>0.9±0.05</td>
<td>0.97±0.02</td>
</tr>
<tr>
<td>% Phosphorus</td>
<td>0.01±0.0015</td>
<td>0.0082±0.0006</td>
<td>0.009±0.0001</td>
</tr>
<tr>
<td>% Potassium</td>
<td>0.05±0.004</td>
<td>0.05±0.003</td>
<td>0.04±0.0092</td>
</tr>
<tr>
<td>C:N</td>
<td>12.3</td>
<td>14.1</td>
<td>11.5</td>
</tr>
</tbody>
</table>
enables its easy culturing.

Faecal cast produced by the *A. gracilis* and *O. cyaneum* appears miniature granules tightly held together and usually don’t get crumbled when touched. The mean weight of the surface cast produced by the *A. gracilis* was fast in the first fortnight and went up to high as 33.88±8.44 g on 30th day of the experimental duration which was found highest among all the other candidate earthworm species in the first initial days of the experiment. Later on the surface cast production by *A. gracilis* dropped with the advent of the experimental days. *A. gracilis* (Kinberg, 1867) (Megascolecidae) is an epi-endogeic species (Bouche 1977) associated with litter (Falco *et al.* 2007). The surface cast production by this species was slight higher in the first two fortnights which later on decreased gradually. The mean surface cast production of *E. fetida* increased gradually and the highest mean surface cast was recorded on the fourth fortnight of the experiment 26.35±1.17 g. The pellet cast produced by *E. fetida* is made of tiny aggregates and gets crumbled when touched while collecting (Fig. 1). *O. cyaneum* (Savigny, 1826) (Lumbricidae) is the endemic species, reported first time by the authors in Kumaun region of Himalayas (Paliwal and Julka 2005). The highest mean surface cast weight produced on the fourth fortnight was found 39.69±15.47 g by *O. cyaneum*. The species has been known to inhabit in the forest system and feed on the mixture of organic matter and mineral soil. The described statistics of cast production of three candidate earthworm species showed the result that the production of surface cast increased gradually from starting week. Among all the three candidate species, *O. cyaneum* showed the highest production of surface cast (faecal like mass cast) as the days passed in comparison to *A. gracilis* where the surface cast (faecal like mass cast) production dropped down in upcoming weeks and *E. fetida* which showed increased cast (granular pellet cast) production but not as high as mass cast of *O. cyaneum*. The *O. cyaneum* produced highest surface cast in comparison to the *E. fetida* and *A. gracilis* (Fig. 1).

The result of periodic observation of organic properties of casts revealed that the pH of the pellet cast is slightly more alkaline as compared to the faecal like mass cast of the other two candidate earthworm species. The % total C, % N and % P was found high in the pellet cast than faecal like mass cast. The C:N ratio was found at par (11.5) in case of *E. fetida* which is a well established vermicomposting species (Table 1). On comparing the nutrient value of the cast of three candidate earthworm species - *O. cyaneum* (faecal like mass cast), *A. gracilis* (faecal like mass cast) and *E. fetida* (granular pellet cast) it was found that the nutrient quality of the pellet cast is much promising than the other cast type. The % C, % N, % P and C: N ratio is found par in quality as compared to the mass cast. The pH of pellet cast was slight more towards alkalinity. The higher nutrient content of pellet cast shows that there is higher energy and electron source which can help in proliferation of microbes (Atlas, 1997) which in turn can cause rapid degradation of the organic matter in comparison to mass cast.

Present study established that the local endemic species *O. cyaneum* could be employed in future for mass scale vermicomposting as there is no sizable difference between the properties and activity of exotic species *Eisenia fetida* acclimatization will be an additional advantage while using endemic species for vermicomposting. *Eisenia fetida* produced the nutrient rich pellet cast and showed the promising potential of vermicomversion of oak leaf litter along with the *Ocotolasion cyaneum*.

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