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Effect of Relative Humidity and Substrate Moisture Content on the Decomposition Pattern of Standard Leaf Litter Species

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Abstract

The decomposition studies were made on the leaves of oak *Quercus leucotrichophora* at five selected sites for a period of one year. Of these sites two did not show significant correlation with weight loss per month to show impact of moisture content. The dry weight loss at all sites increased with the increase in the relative humidity. The weight loss of tree leaf litter at altitudes of 329-2,200 m favored the relative humidity and substrate moisture content values of about 40 and 98%.

Decomposition is primarily a biological process, and its rate is dependent more upon climatic factors. The organisms which play major role in decay processes require free water, and their activity slows as moisture becomes limiting (1). The effect of relative humidity and substrate moisture content was investigated by Hudson (2) and Williams and Gray (3), and it was concluded that these two factors influence significantly the rate of decomposition of plant litter. Relative humidity controls and affects the amount of water in the substrate which is available to microorganisms and this in turn influence the activity of docomposers. In the present study oak leaf litter (*Quercus leucotrichophora* A. Camus) was taken for experiment and placed at five sites along an altitudinal gradient (329—2,100 m).

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Methods

Fresh leaves of *Quercus leucotrichophora* were collected from the middle canopy of a single tree. The decomposition study on all the five sites was conducted for one year period. The vegetation and altitude of the sites were defferent as follows : sal forest (329 m), pine-mixed broadleaf (1,350 m), pine (1,750 m), mixed oak-pine (1,850 m) and mixed oak (2,100 m). Fresh leaves (5 g fresh weight) were placed in nylon net bags (10 × 10 cm, 1 mm mesh) for pine-mixed broadleaf, pine, mixed oak pine and mixed oak forest sites and wire netting bags (10 × 10 cm, 1 mm mesh, painted with synthetic enamel to aviod rusting) for sal forest, because of abundance of termites on the site. Recovery of litter bags were made at one month interval by importing five bags in each month. Substrate moisture contents were calculated on oven dry weight basis as follows :

$$MC\ (\%) = \frac{FW - DW}{DW} \times 100,$$

where MC is moisture content ; FW, fresh weight and DW, dry weight. Relative humidity was calculated by the relative humidity table on the basis of dry bulb temperature and wet bulb depression.

Results

Effect of Substrate Moisture Content on the Leaf Litter Decomposition

Of the five sites taken to investigate the possible impact of moisture content, the two sites did not show significant correlation with weight loss per month such as pine forest (r=0.210), and mixed oak pine (r=0.448). The correlation between moisture content and dry weight loss across all sites are shown in Figure 1. The correlation slope indicated that at below about 98% moisture content (oven dry weight basis), dry weight loss varied from 0.5 to 10% but at above 98% each 30% increase in moisture content resulted in 3% increase in weight loss.

Effect of Relative Humidity on Dry Weight Loss

As was expected dry weight loss on all the sites, namely, sal, pine-mixed broadleaf, pine, mixed oak-pine and mixed oak, increased with the increase in relative humidity. Weight loss was below 5%, between relative humidity 20—40%. However, at or below relative humidity value of 20%, weight loss was less than 1%. All the sites preferred the range of relative humidity between 40—70%. At sal forest site decomposition was well continued and was more than 3% even at 35% relative humidity (Fig. 1).

Discussion

Most of the studies on decomposition of plant litter are based either on micro-faunal and microfloral breakdown or chemical composition of the substrate (4). Effects of microclimatic conditions or physical factors as a whole on the decomposition processes have been concentrated on the influence of temperature (3) and rainfall (5). However, only a few studies have been made on the effect of relative humidity (6), and substrate moisture content on the rate of forest leaf litter break down. However the effects of moisture content using controlled laboratory conditions have been studied (6). Bacause of differences in microclimatic conditions, analysis of variance for weight loss was significant among sites (P<0.01). Analysis of variance for moisture content was also significant among sites (P< 0.01).

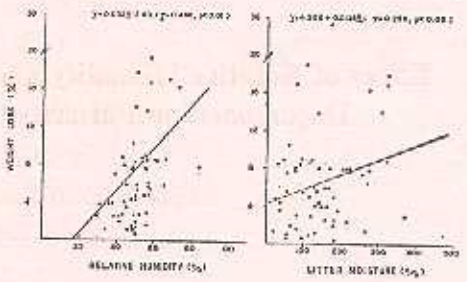

Figure 1. The correlation between moisture content and dry weight loss across all sites at altitudes of 329—2,200 m.

However, at field conditions if other microclimatic factors such as temperature, rainfall and atmospheric vapor pressure could be coincided with the relative humidity and substrate moisture content, even then these later two factors exhibited significant positive relationships with dry weight loss. At mixed oak-pine forest site moisture content did not show significant relationships. We might predict the scarcity of rainfall at this site have major negative influence on the substrate moisture content and relative humiditity (Table 1). So, at natural conditions in the Himalaya (329—2,200 m) rate of decomposition would be slower below relative humidity and moisture content values of 40 and 98%, respectively. However, significant weight loss occurred along all the sites between 98—250% (on oven dry weight basis). Mork (7) has also recommended 290% moisture level oven dry weight basis is most suitable for rapid decomposition. Several workers (8—10) have also investigated the range of relative humidity values for optimum microbial activi-

Table 1. Annual percent weight remaining, rainfall, mean annual temperature, relative humidity and litter moisture of forest sites.

Forest site	Percent weight remaining	Rainfall (mm)	Mean annual temperature (C)	Relative humidity (%)
Sal forest	1±0.37	207	23.04	49.98
Pine-mixed broadleaf forest	12±0.71	200	17.50	51.17
Pine forest	26±1.55	218	15.80	54.21
Mixed oak-pine forest	23±1.10	131	15.80	56.13
Mixed oak	12±0.62	248	14.90	61.94

ties. Our values are also within the range reported by earlier investigators (11, 12) for other plant materials.

The correlation between moisture content and relative humidity along the sites was not significant. The reason of predictance for this correlation might be due to different microclimatic conditions on the sites which interferred with the moisture content and relative humidity on the sites.

So within the limitation of our experiment the results suggest that weight loss of tree leaf litter in the altitudinal range of 329—2,200 m favored the relative humidity and substrate moisture content values of approximately 40 and 98%.

References

1. Edwards C. S. 1973. Determination of lignin and celluloses in forages by extraction with triethyelene glycol. J. Sci. Fd. Agric. 24 : 381—388.
2. Hudson H. J. 1968. The ecology of fungi on plant remains above the soil. New Phytologist 67 : 837—874.
3. Williams S. T. and T. R. Gray. 1974. Decomposition of litter on the soil surface. Pages 611—632 *in* C. H. Dickinson and G. J. F. Pugh, editors. Biology of plant litter decomposition, volume 2. Academic Press, London, UK.
4. Dickinson C. H. and G J.F. Pugh, editors. 1974. Biology of plant litter decomposition, volumes 1 and 2. Academic Press, London, UK.
5. Pandey U. and J. S. Singh. 1982. Leaf litter decomposition in an oak-conifer forest in Himalaya : the effect of climate and chemical composition. Forestry 55 : 47—59.
6. Nagy L. A. and B. J. Macauly. 1982. Eucalyptus leaf litter decomposition : effects of relative humidity and substrate moisture content. Soil Biol. Biochem. 14 : 233—236.
7. Mork E. 1938. The decomposition in humus layer at different temperatures and degrees of moisture. Medd. Norske Skogsforsokav 6 : 219—222.
8. Bonner R. D. and C. L. Furgus. 1960. The influence of temperature and relative humidity on growth and survival of silage fungi. Mycologia 52 : 642—647.
9. Diem H. G. 1971. Effect of low humidity on the survival of germinated spores commonly found in the phylosphere. Pages 211—219 *in* T. F. Preece and C.H. Dickinson, editors. Ecology of leaf surfaces organisms. Academic Press, London, UK.
10. Fahey R. C., S. D. Milazczyk and S. Broody. 1978. Correlation of enzyma-

tic activity and thermal resistance with hydration state in ungerminated *Neurospora conidia*. J. Bact. 25 : 865—875.

11. Bartholomev W. V. and A. G. Norman. 1946. The threshold moisture for active decomposition of some mature plant meterials. Proc. Soil Sci. Soci. Am. 11 : 270—279.

12. Sain P. and F. E. Broadbent. 1975. Moisture absorption, mold growth and decomposition of rice straw at different relative humidities. J. Agronom. 67 : 759—762.