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Effects of Time of Soil Collection and Storage on Microbial Decomposition of Cellulose in Soil

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GROSSBARD & WINGFIELD (1978) have reported that the response of the cellulolytic soil microflora to herbicides can be affected by factors such as time of year at which soil is collected, moisture content and time of storage. These factors may also modify the composition and activity of the microflora and thus its ability to colonise cellulosic substrates. This paper presents the results of a study into the cellulolytic activity of soil samples taken throughout one year and stored for various lengths of time.

MATERIALS AND METHODS

The soil used was a coarse sandy loam from an area maintained for microbiological experiments (GREAVES et al. 1978) on an arable field at Begbroke Hill Farm. At each sampling date a minimum of 20 x 500g soil samples were removed at random from the top 5cm of an area 12 x 2m. The samples were bulked, sieved through a 3mm mesh and sub-samples taken for determination of moisture content, counts of cellulolytic fungi and for burial of calico strips. The remaining soil, at the same moisture as when collected, was stored at 4°C in a polyethylene bag and the above measurements repeated after different storage times (Table 1).

TABLE 1

Soil sampling dates, temperatures, moisture contents and storage times

Date of collection	Temperature (°C) at collection	Moisture (%) at collection and during storage	Moisture (%) after adjustment to ≃ 80% field capacity	Storage time (months)
1976 June 15	20	3	15	0,2,4,6,8,10,12
Aug 10	22	2	14	0,10
Oct 5	8	17	17	0,2,4,6,8
Nov 30	3	18	17	0,6
1977 April 4	5	12	15	0,1.5
May 17	10	9	15	0

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Soil samples were not taken in January and March 1977 due to waterlogging. Soil temperatures were measured at a depth of 2.5cm at three random points in the sampling area. Values are expressed as mean values.

A dilution plate technique was used to count propagules of cellulolytic fungi (GREAVES et al. 1978). Three replicates of each soil sample at its unadjusted moisture content were taken and three replicate plates of each dilution prepared.

The decomposition of cellulose was measured (GREAVES et al. 1978) but using calico strips as substrate (GROSSBARD & WINGFIELD 1975). At the initial sampling time and after each period of storage the soil moisture was adjusted to approximately 80% field capacity before burying the calico. Adjustment of soils collected in October and November was not necessary due to their high initial moistures. At each sampling time approximately 3kg of soil was placed in 3 plastic boxes and 5 strips of calico then buried in each box. After incubation for 4 weeks at 19$\pm$1°C the strips were removed from the soil, cleaned and percent weight loss and disintegration score determined (0, no disintegration - 10, complete disintegration, GROSSBARD & WINGFIELD 1975).

In a second experiment, soil (moisture content 19%) was collected in December 1976 and air dried (1% moisture). Three sub-samples of the soil were then re-wetted to 5, 10 and 14% moisture respectively and used for determination of decomposition of Shirley Test Cloth (a similar cloth to calico but with more uniform characteristics) after incubation for 8 weeks (GREAVES et al. 1978).

RESULTS

Compared with other dates, weight loss of calico was high (Table 2) in the soil sampled in conditions of very low moisture and high temperature (Table 1) in June and August. Numbers of cellulolytic fungi however were low. In contrast, weight loss of calico was less and numbers of cellulolytic fungi higher in soils sampled at higher moisture contents and lower temperatures in October, November and April. In soil sampled under drier and warmer conditions in May, weight loss of calico was high.

Storage of soil for up to 12 months at 4°C had, generally, little effect on either weight loss of calico or counts of cellulolytic fungi (Table 3). However, weight loss of calico in soil collected in April and stored for 1.5 months was significantly higher (29%) than its initial value (13%). In contrast, weight loss of calico in soils collected in August and November and stored for 10 and 6 months respectively did not significantly differ from initial values.

Very little difference in disintegration score of the calico strips was found between any of the initial or stored samples. None of the strips were greatly disintegrated, the score being no

higher than 3 at any time. In contrast, loss in weight measurements ranged from 13 to 33% indicating that disintegration score is not a sensitive measurement of degradation particularly at low levels.

TABLE 2

Weight loss of calico (% initial wt) and dilution plate counts of cellulolytic fungi (Number/g dry wt x 10^{-2}) in initial soils.

Date	Weight loss	± S.E.	Cellulolytic fungi	± S.E.
1976 June	29	2.3	16	3.1
August	33	2.3	20	2.5
October	21	2.3	118	2.5
November	17	1.8	56	2.5
1977 April	13	1.8	ND	
May	28	1.8	49	2.5

ND Not determined

TABLE 3

Weight loss of calico (% initial wt) and dilution plate counts of cellulolytic fungi (Number/g dry wt x 10^{-2}) in soil collected in June and October and stored at 4°C.

Date		Storage time (Months) 0	2	4	6	8	10	12
June	Weight loss	29	29	22	31	30	24	27
	± S.E.	1.8	1.8	1.8	1.4	1.4	1.4	1.4
	Cellulolytic Fungi	16	24	37	37	ND	ND	23
	± S.E.	3.0	2.4	2.4	2.4			2.4
Oct	Weight loss	21	27	25	19	22	ND	ND
	± S.E.	2.8	2.2	2.2	2.2	2.2		
	Cellulolytic Fungi	118	68	ND	ND	63	ND	ND
	± S.E.	2.0	2.0			2.0		

ND Not determined

Results from the second experiment show, as expected, that decreasing moisture content results in reduction in degradation (Table 4).

TABLE 4

The effect of soil moisture content on the decomposition of Shirley Test Cloth

Moisture content of soil (%)	5	10	14	± S.E.
Weight loss of cloth (% initial wt)	2	18	31	1.7

DISCUSSION

The results indicate that storage of the soil had little effect on numbers of cellulolytic fungi or degradation of calico strips. As may have been expected, the time of year at which the soil was collected did have some effect on the results obtained. These effects may have been influenced by the moisture content and temperature of the soil at collection. Although these conditions varied widely over the sampling period, the variation in degradation of the calico was small. Thus effects may have been to some extent overcome by the standard incubation conditions used. It was particularly noticeable that despite the very dry condition of the soil collected in June and August decomposition was high. These samples were first moistened to 80% field capacity before the cloth was added whereas when the strips were incubated under conditions of low soil moisture cellulolytic activity was reduced. Moistening of the soil may have caused the germination of fungal spores produced in response to the dry conditions and thus restored activity. It is generally accepted that the breakdown of cellulose in soil, especially in humid conditions, is an aerobic process dominated by fungi (ALEXANDER 1977). Thus the cold conditions at sampling, in addition to the very wet and so possibly anaerobic state of the soil collected in November, may account for the low level of cellulose decomposition in the sample, even though numbers of fungal propagules were not affected.

The possible influence of laboratory incubation conditions on the microbial activities already established by the condition of the soil at sampling,indicates that caution must be taken in the extrapolation of effects obtained in laboratory studies to those that may occur in the field.

WINGFIELD et al. (1977) have suggested that different soil treatments, especially soil disturbance, affect the response of the soil microflora to agricultural chemicals. Thus soils sampled during very wet or very dry conditions, which require adjustment before use in studies of the interactions of pesticides and soil microorganisms, should be avoided. Collection of soil of the required moisture content during the autumn may be advantageous as samples are likely to contain large amounts of decomposable organic matter and thus be high in cellulolytic activity. The soil could then be stored at 4°C and used with a minimum of adjustment for experiments on cellulose decomposition during the

winter, when water logging may make collection difficult.

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