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DECOMPOSITION OF *DIPLACHNE FUSCA* (L.) BEAUV AND *SUAEDA FRUTICOSA* FORSK IN SALT-AFFECTED SOILS

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Abstract

Decomposition of *Diplachne fusca* and *Suaeda fruticosa* in saline soil with resultant changes in cellulolytic soil mycoflora and soil chemical properties have been studied in beakers for 42 days. Celluloytic soil mycoflora increased with prolonged incubation and was greater in case of *D. fusca* amendment. *D. fusca* supported a comparatively wider variety of mycoflora. Cellulase activity increased in both the amendments but was greater in case of *D. fusca* amendment. Soluble Na^{+1} and Ca^{+2} and Mg^{+2} increased with prolonged incubation in both the cases; the increase was greater in case of *S. fruticosa* amendment. Organic matter decreased but the decrease was slightly less in case of *S. fruticosa* amendment. Humic acid content was greater in case of *S. fruticosa* amendment.

Introduction

Organic matter added to the soil undergoes microbial decomposition fairly rapidly and serves as an energy and carbon source for the soil microflora which in turn is responsible for maintaining the soil fertility (Waksman 1938; Kononova, 1961). The decomposition of freshly added plant residues forms an important step in the plant succession scheme proposed by Sandhu & Malik (1975) for reclamation of salt affected soils. For this a salt-tolerant grass, *Diplachne fusca*, which grows well in naturally waterlogged and saline-sodic soils is used as a primary colonizer. This grass not only gives a green cover but its extensive root system also improves soil leaching. It can also grow well with saline and sodic water. After the grass is well-established it is ploughed under and allowed to decompose. A salt-tolerant legume, *Sesbania aculeata* though not as tolerant as *Dipachne fusca* is then grown for green manuring. This plant has been recommended for soil reclamation (Kanwar et al, 1965; Uppal, 1955; Yadav & Agarval, 1961). The beneficial effects of this plant succession scheme are mainly due to the release of carbon dioxide from growing roots (Bower & Goertzen 1958; Kelley et al, 1961) and from decaying roots as well as mineralization of ploughed under plant residues (Puttaswamygowda & Pratt 1973; Malik & Haider, 1977).

The decomposition of plant residues of *Diplachne fusca* (Kallar-grass) and its composting have been previously studied (Malik & Sandhu, 1973 a, b). *Suaeda fruticosa*, a halophyte, has also been reported for desalination of saline soils as these accumulate salts in their body which can then be removed and burnt away (Chaudhry et al, 1961). The removal of plants makes this method unpracticable when thousands of acres of saline land is involved. Therefore, it was thought worthwhile to study the possibilities of ploughing under this plant material and allowing it to decompose in the soil instead of removing and burning it.

The decomposition of *D. fusca* and *S. fruticosa* in saline sodic soil associated with cellulolytic mycoflora was examined. Effect of increased microbial activity on solubilization of soil calcium carbonate and humus formation was also studied.

Material and Method

Soil used in this experiment was collected from upper 15 cm of one of our experimental fields at Lahore. It had ECx10^3=8.0, pH. 8.9 and organic matter (O.M.) 0.6%. The soil was air dried and passed through a 2 mm sieve before use. Soil in 200g portions was taken in 12 beakers of 250 ml capacity. It was amended with powdered *D. fusca* or *S. fruticosa* @ 2% w/w keeping six replicates of each. The two types of organic material had the following chemical composition:—

	D. fusca	*S. fruticosa*
Na^{+1}ppm	5300	25000
$Ca^{+2}+Mg^{+2}$ppm	93.3	214.8
N_2%	0.44	1.58

The moisture level was brought to 60% water holding capacity and was maintained at this level throughout the experiment. Incubation temperature during the experiment was 30°C.

Isolation of cellulolytic soil mycoflora

Cellulose medium (Eggins & Pugh, 1962) was used for all the isolations employing Warcup's direct plate medthod (Warcup, 1951) and modified soil dilution plate method(Booth, 1971). Frequency of occurrence was determined by recording its presence or absence in each Petri dish; fungus being given positive record if it occurred on any of the six replicate plates.

Chemical Analysis of Soil

Soil samples were analysed for soluble Na^{+1} and $Ca^{+2}+Mg^{+2}$, O.M.% age, using methods given in Handbook 60 of United States Department of Agriculture. For estimation of cellulase activity the method used by Pancholy & Rice (1973) was followed. For organic matter fractionation extraction with a mixture of sodium hydroxide and sodium pyrophosphate was made (Kononova, 1961).

Results and Discussion

Results of the cellulolytic soil mycoflora are given in Table 1. Results of fungal isolations indicate that *Alternaria alternata* (Fr.) Keissler, *Aspergillus fumigatus* Fresenius, *A. niger* van Tieghem, *Cladosporium herbarum* (Pers.) Link ex S.F. Gray, *Curvularia lunata* (Wakker) Boedjn, *C. ovoidea* (Hiroe & Watan) Mantanola, *Fusarium solani* (Martius) Appel & Wollenwebe and *Monosporium* sp. were isolated from both the amendments. *Chaetomium globosum* Kunze, *Cladobotryum* sp., *Drechslera sp.* and *Sporotrichum pruinosum* Gilman and Abbott were isolated from *D. fusca* amendment and *Aspergillus sydowi* (Bain & Sart.) Thom & Church was isolated from *S. fruticosa* amendment only. However, the relative frequency of occurrence of these fungi differed considerably.

A. alternata and *A. niger* which were isolated from both the amendments; were psesent throughout the incubation, and showed a high frequency of occurrence. *A. fumigatus* could be isolated during the first 10 days after which it was never isolated.

Cladosporium herbarum appeared after 17 and 24 days in case of *D. fusca* and *S. fruticosa* amendments respectively after which it remained fairly constant. *Chaetomium globosum* appeared after 38 days and was still present after 45 days of incubation but only in case of *D. fusca* amendment. *Fusarium solani* appeared after 17 days of incubation in *S. fruticosa* and showed quite a high frequency of occurrence throughout the remaining incubation period. The rest of the fungal species were isolated occasionally and at irregular intervals. The total fungal counts were comparatively high in case of *D. fusca* amendment and increased with prolonged incubation in both the amendments. Number of fungal species ranged from 4-6 and 5-7 in *S. fruticosa* and *D. fusca* amendment respectively.

TABLE 1. Percentage frequency of occurrence of cellulolytic fungi isolated from saline soil amended with *D. fusca* (DF) and *S. fruticosa* (SE)

Mycoflora	Days of incubation											
	4		10		17		24		38		45	
	DF	SF	DF	SF	DF	SF	DF	SF	DF	SF	DF	SF
Alternaria alternata (Fr.) Keissler	17	33	33	33	33	50	—	33	33	33	33	17
Aspergillus fumigatus Fresenius	17	33	17	33	—	—	—	—	—	—	—	—
A. niger van Tieghem	50	17	17	17	33	17	33	17	17	50	50	33
A. sydowi (Brain & Sart) Thom & Church	—	—	—	—	—	—	—	33	—	17	—	—
Chaetomium globosum Kunze	—	—	—	—	—	—	—	—	33	—	50	—
Cladabotryum sp.	—	—	—	—	17	—	17	—	17	—	50	—
Cladosporium herbarum (Pers.) Link ex S.F. Gray	—	—	—	—	17	—	33	17	50	33	33	33
Curvularia lunata (Wakker) Boedjn	—	—	17	17	—	—	—	17	—	—	—	17
C. ovoidea (Hiroe & Watan) Mantanola	—	—	—	—	17	17	—	—	—	—	—	—
Drechslera sp.	17	—	—	—	—	—	—	—	—	—	—	—
Fusarium solani (Martius) Appel & Wollen weber	33	—	33	—	—	33	50	50	17	33	—	50
Monosporium sp.	—	33	—	50	17	—	50	—	—	—	—	—
Sporotrichum pruinosum Gilman and Abbot	—	—	—	—	33	—	—	—	—	—	—	—
No. of species isolated	5	4	5	5	7	5	5	6	6	5	5	6
Total fungal counts $\times 10^3$/g dry soil	33	24	36	30	42	36	48	48	51	52	69	1

D. fusca amendment supported a comparatively larger population and wide variety of cellulolytic fungi as compared to *S. fruticosa* amendment. This may be attributed to the difference in the content of easily decomposable substances in the two organic materials inspite of the fact that *S. fruticosa* has a higher nitrogen content. But the higher salt content of the latter may be a factor in allowing relatively less number of fungi to colonize and decompose it.

The cellulase activity showed an increase in both amendments (Table 2). However, in case of *D. fusca* amendment it was higher than that of *S. fruticosa* amendment. This difference is probably due to relatively greater population of cellulolytic mycoflora. The same difference was again observed in case of organic matter left after incubation, indicating a slower rate of decomposition of *S. fruticosa* plant material. There was more of C, N and humic acid in case of *S. fruticosa* as compared to *D. fusca* amendment. In both the amendments the C/N ratio was nearly the same. *S. fruticosa* plant material used for soil amendment was much harder and seemed to be more lignified than *D. fusca* which might have resulted in greater humic acid carbon and nitrogen.

TABLE 2. Chemical analysis and organic matter fractionation of saline soil amended with *D. fusca* and *S. fruticosa* plant material.

	D. fusca amendment		*S. fruticosa* amendment	
Parameters	A	B	A	B
Cellulase activity (g. glucose/100g soil)	0.06	0.14	0.06	0.10
O. M. %	2.15	1.52	2.41	1.72
Extract C mg/g soil	N.D.	0.45	N.D.	0.63
Extract N mg/g soil	,,	0.018	,,	0.028
Humic acid C mg/g	,,	0.15	,,	0.30
Humic acid-N mg/g soil	,,	0.015	,,	0.025
Na^{+1} mg/l	40.2	85.x	41.2	156.2
$Ca^{+2} + Mg^{+2}$ mg/l	3.75	11.0	3.75	15.75

A. Before incubation.
B. After incubation.
N.D. Not determined.

Na^{+1} and $Ca^{+2} + Mg^{+2}$ in soil before and after incubation show a marked increase in all these cations. As the incubation was conducted in a closed system having no provision for leaching, the accumulation of sodium released from exchange complex of the soil took place. The amount of Na^{+1} released in case of *S. fruticosa* was much greater than that of *D. fusca*. This can be attributed to the high sodium content in the *S. fruitcosa* plant body which might have also been released during the process of decomposition.

Similarly, soluble $Ca^{+2} + Mg^{+2}$ also increased in the soil. This increase was nearly three times than that at 0 time thus indicating the solubilization of some of the native $CaCO_3$. These preliminary results have demonstrated the possibility of decomposing *S fruticosa* in salt affected soils with a view to have enough CO_2 pressure to solubilize soil CaCO . However, this method could only be adopted in a soil with good permeability, as the sodium released from the plant body would also have

to be leached down. On the other hand, the economic factor does not favour *S. fruticosa* as a primary colonizer as it gives no economic return as compared to *D. fusca* which is used as animal fodder.

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