ACTA MYCOLOGICA
Vol. 34 (1): 105–114
1999

Soil fungi of tobacco waste and compost of the waste

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Kornilłowicz-Kowalska T., Szwed A., Gostkowska K.: *Soil fungi of tobacco waste and compost of the waste.* Acta Mycol. 34 (1): 105–114, 1999.

The effect of tobacco dust and composts containing those wastes on soil fungi was determined. It was found that crude tobacco dust, as opposed to composts, acted selectively making the species composition of soil fungal populations poor and changing the interrelations of potentially antagonistic and phytopathogenic fungi.

Key words: fungi, soil, tobacco dust, compost.

INTRODUCTION

The investigations (Russel, Kropisz and Gajewska 1996; Verdonck, De Boodt, Stradiot and Penninck 1985; Szwed and Gostkowska 1997) showed that composting of tobacco wastes with other plant material was a rational way of their utilization.

The aim of the present work is to determine how such composts application and native tobacco wastes can change relations between saprophytic and potentially phytopathogenic fungi.

MATERIAL AND METHODS

Studies were carried out in laboratory model experiments set on sandy podzolic soil developed from loamy sand containing (in %): C org. – 0.302; N tot. – 0.039; pH_{KCl} 3.97; as well as on brown soil developed from clay loam containing (in %): C org. – 0.96; N tot. – 0.11; pH_{KCl} 5.23. From earlier

investigations it followed that the soils were characterised by different composition of potentially phytopathogenic fungi (Korniłłowicz 1989). Soil samples taken from A_p level were averaged and then screened with 2 mm mesh sieve. Tobacco dust and composts were introduced into the soil in amount of about 1% (recalculating in to organic matter) which represented mean manure dose at field (30 t/ha). Compost components and characteristics of basic chemical properties of composts and tobacco dust are presented in Table. 1. After mixing the soil with dust and composts and after moisturizing it up to 60% total water capacity, samples were placed in glass vessels of 1000 cm^3 volume. Soil with no organic matter addition was the control. Two repetitions were applied for each experimental combination. Incubation was carried out at $20\pm2°C$ for 3 months mixing the soil from time to time.

Table 1
Some chemical properties of compost and tobacco dust

Substrate	Component (in %)	PH	Content in dry matter (in %)		C/N
			organic substance	total content N	
tobacco dust	–	6.3	70.3	2.11	19
compost I	tobacco dust – 84 rye straw – 16	8.7	57.6	2.96	23
compost II	tobacco dust – 40 pine bark – 60	7.7	72.1	1.89	44
compost III	tobacco dust – 80 pine bark – 20	8.6	59.5	2.63	24

Mycological tests included counting of fungal populations on Martin's medium (so-called total fungi) and those of *Fusarium* on Nash and Snyder's media (1962). In all the cases, five parallel repetitions were applied. Two plates were chosen from each experimental combination splitting off all grown colonies onto bevels with PDA medium to estimate the species composition of fungi. The identification of isolates was made by macro and micromorphological observations in microcultures and on plates using diagnostic media. The following works were used: Domsch, Gams and Anderson (1980); Gilman (1945); Kwaśna, Chełkowski and Zajkowski (1991); Nelson, Tousson and Marasas (1983); van Oorschot (1980); Raper, Thom and Fennell (1968); Rifai (1969); Skirgiełło and Zadara (1979).

RESULTS AND DISCUSSION

Mycological analysis of the two types of soil pointed to different reaction of soil fungi to fresh tobacco dust and dusts composted with bark or straw. Moreover, compost interaction depended on the proportion of the compost components.

Introducing non-composted tobacco dust into the soil induced an increase of both total fungal populations and *Fusarium* species. Such an effect was particularly pronounced in a combination set on sandy soil (characterised by small amount of organic matter) which should be accounted for by the supply of easily available carbon and nitrogen sources. The introduction of more stabilized organic matter as a tobacco compost did not cause significant quantitative changes in fungal populations, except for compost II which induced an increase of *Fusarium* species in the soil (Tab. 2). The increase in the number of *Fusarium* species is generally considered to be an unfavourable phenomenon since it points to worsening of the phytosanitary state of environment.

Table 2

The number of fungi (c.f.u. g^{-1} d.m. of soil) in soil enriched with tobacco dust and compost containing the waste

Fungi	(control)		tobacco dust		compost I		compost II		compost III	
	S	L	S	L	S	L	S	L	S	L
so-called total fungi	$2.4*10^5$	$2.1*10^5$	$1.6*10^6$	$4.2*10^5$	$1.4*10^5$	$1.2*10^5$	$1.3*10^5$	$2.1*10^5$	$1.8*10^5$	$1.9*10^5$
Fusarium	$1.3*10^4$	$8*10^3$	$2.1*10^5$	$2.1*10^4$	$5.5*10^3$	$1.1*10^4$	$2.4*10^4$	$1.9*10^4$	$9.8*10^3$	$9*10^3$

Explanations: S – sandy soil, L – loamy soil

From data in Table 2 it may be inferred that the introduction of tobacco dust induced the selection within micromycetes communities. Micromycetes selection was mainly based on the increase of occurrence frequency of potentially phytopathogenic fungi with simultaneous reduction of occurrence frequency of potentially antagonistic fungi (Tab. 3). Unfavourable relations between potential antagonists and phytopathogens also occurred in the soil enriched with compost II which was manifested in the increase of *Fusarium* populations (Tab. 2). The above phenomenon was mainly observed in the sandy soil. Compost I and II maintained or even increased the number of many potential antagonists (Tab. 3).

Table 3

Growth indicators of fungi in soil enriched with tobacco dust and compost (containing that waste)

Soil with	Number of:									
	strains		species		genus		potentially antagonistic strains[1]		phytopatogenic strains[2]	
	S	L	S	L	S	L	S	L	S	L
non-amended (control)	68	76	*18*	*27*	*9*	*12*	*33*	*45*	*28*	*22*
tobacco dust	96	70	**11**	**18**	**5**	**8**	**17**	**21**	**59**	**39**
compost I	66	74	25	20	11	9	**37**	**32**	**12**	**25**
compost II	75	123	20	36	11	16	27	42	41	54
compost III	84	104	23	34	10	14	**43**	**52**	**21**	**24**

Explanations: 1. The total number of isolates of the genera: *Gliocladium, Paeciliomyces, Penicillium, Trichoderma.* 2. The total number of isolates of the genera: *Botrytis, Cylindrocarpon, Fusarium, Phialophora, Phoma, Rhizoctonia, Verticillium,* S – sandy soil, L – loamy soil

The populations of potential antagonists in both types of soil included mainly species of the genera *Penicillum, Gliocladium* e.g. *G. catenulatum* and *G. roseum* and *Trichoderma* – most frequently *T. viride* (Tab. 4). Potentially phytopathogenic species were: *Fusarium* isolates – among then the most frequent were: *F. solani* and *F. oxysporum* (Tab. 4). Moreover, composts I, II, III (Tab. 4) enriched the soil in species characteristic of the composts e.g. *Myceliophthora termophila* or components of the compost – e.g. *Scopulariopsis brevicaulis* (colonizer of dry tobacco leaves), various *Fusarium* species found in straw, fungi living on bark – e.g *Penicillum restrictum* or *P. daleae* (Florczak 1971; Kowalik 1993).

The increase in the number of potential pathogens in the soil supplemented with tobacco dust was induced by an increase in *Fusarium solani* and *F. oxysporum* population density – mostly in sandy soil. This was accompanied by a decrease in the frequency of occurrence of *Trichoderma* species, mainly *T. viride.* A reverse tendency was noted in soil with composts I and III (Tab. 4). The antagonism between *Fusarium solani* and *Trichoderma viride* populations was also observed in earlier studies connected with colonization of organic wastes by soil micromycetes (Korniłłowicz 1991–1992).

The decrease in the frequency of occurrence of *Trichoderma* strains in soil after tobacco dust introduction was probably associated with the increase in pH of soil during decomposition of wastes (unpublished). This was due to the fact that the above mentioned fungus preferred acid environments.

Table 4

The species composition of micromycetes isolated from soil enriched with tobacco dust and compost containing that waste

Species or genus	Number of isolates (dilut. 10^{-4})									
	Soil with: control		tobacco dust		compost I		compost II		compost III	
	S	L	S	L	S	L	S	L	S	L
Absidia glauca Hagem.								1		
Acremonium butyri (van Beyma) W. Gams					1				1	
Acremonium strictum W. Gams								1	1	
Aspergillus fumigatus Fres.									4	
Botrytis cinerea Pers: Fr.		2						2		3
Chaetomium globosum Kunze ex Stend.						1				1
Cylindrocarpon destructans (Zins.) Scholten				1						1
Cylindrocarpon didymum (Hartig) Wellenw.							1			
Fusarium avenaceum (Corda: Fr.) Sacc.				3				1	2	3
Fusarium aqueductum (Radlk. et Rabenh.) Lagerh.									2	
Fusarium culmorum (W.G.Sm.) Sacc.				2	4	2			4	2
Fusarium equiseti (Corda) Sacc.						1			1	1
Fusarium graminearum Schwabe						1				
Fusarium merismoides Corda			1							
Fusarium nivale (Fr.) Ces.								1		
Fusarium oxysporum (Schlecht.) Sny. et Hans.	15	6	22	12	4	4	4	3	5	1
Fusarium redolens Wellenw.			10	1			5	2	4	1
Fusarium sacchari (Butler) W. Gams								1		1
Fusarium sambucinum (Fuckel) Sny. et Hans.								1		

Tab. 4 cont.

Species or genus	Number of isolates (dilut. 10^{-4})									
	Soil with: control		tobacco dust		compost I		compost II		compost III	
	S	L	S	L	S	L	S	L	S	L
Fusarium semitectum Berk. et Rav.				2						
Fusarium solani (Mart.) (Appel et Wr.) Sny. et Hans.	9	6	26	14	2	7	31	29	3	7
Fusarium sporotrichioides Sherb.		1						2		4
Fusarium tricinctum (Corda) Sacc.		1				2				
Gliocladium catenulatum Gilman et Abbott		2		4		6		3		6
Gliocladium roseum Bain.	1			10		2	1	2	1	6
Gliomastix murorum (Corda) Hughes					1			1		
Monocillium exsolum Batista et Heine		1								
Mortierella alpina Peyronel		1		1			1		2	1
Mortierella hyalina (Herz) W. Gams	1			1	4	2	1	6	2	
Mortierella humilis Linn.		3				1		1		
Mortierella spp.	1			2				1		1
Mortierella verrucosa Linn.				1	1					
Mucor hiemalis Wehmer	1		4				1	5		3
Mucor ramonissimus Samutsevitsch								1		
Myceliophthora thermophila (Apinis) van Oorschot					2		1	2		3
Paeciliomyces farinosus Holm et Gray	3				2		8		12	
Paeciliomyces liliacinus (Thom) Samson					1					
Paeciliomyces marquandii (Masse) Hughes					2					
Paeciliomyces varioti Bain.							2			

Penicillium brevicompactum Dierck										1
Penicillium chrysogenum Thom	3	2	1		1	4	3	1	1	5
Penicillium corylophilum Dierck								1		
Penicillium corymbiferum Westling		1			1			2		1
Penicillium cyclopium Westling		1				2		6		2
Penicillium daleae Zaleski							2			1
Penicillium decumbens Thom								1		
Penicillium granulatum Bain.										1
Penicillium janthinellum Biourge	4	3	5	3	3		3	3	2	6
Penicillium lanosum Westling		4						4		
Penicillium luteum Zukal							3	1		1
Penicillium nigricans Bain. ex Thom	2				2		1		1	
Penicillium phoeniceum van Beyma				2						1
Penicillium purpurogenum Stoll									1	
Penicillium restrictum Gilman et Abbott									2	1
Penicillium rubrum Stoll										1
Penicillium rugulosum Thom		1								
Penicillium spinulosum Thom			1				2	1		
Penicillium spp.	6	4	5	1	9	4		9	4	9
Penicillium steckii Zaleski		1								
Penicillium vermiculatum Dangeard					2				3	
Phoma eupyrena Sacc.		1								
Phoma sp.								1		
Phialophora sp.								1		
Rhizoctonia solani Kuhn.		1		3						

Tab. 4 cont.

Species or genus	Number of isolates (dilut. 10^{-4})									
	Soil with: control		tobacco dust		compost I		compost II		compost III	
	S	L	S	L	S	L	S	L	S	L
Rhizomucor pusillus (Lindt) Schpper		1				4		7		1
Rhizopus stolonifer (Ehrenb. ex Link) Lind.						7				1
Scopulariopsis brevicaulis (Sacc.) Bain.					4					
Scopulariopsis chartarum (Ehrenb. ex Link) Hughes					1					
Talaromyces flavus (Klocker) Stolk et Samson								2		
Thielavia heterothallica Klopotek	1						1			3
Thielavia terricola (Gilman et Abbott) Emmans		1								2
Trichoderma aureoviride Rifai	3									
Trichoderma hamatum (Bon.) Bain.		1								
Trichoderma harzianum Rifai	4	4	2		3	1				2
Trichoderma koningii Oudem.	1	5			3	1			5	1
Trichoderma polysporum (Link et Pers.) Rifai					3			2		
Trichoderma pseudokoningii Rifai		1				1				
Trichoderma viride Pers. ex Gray	6	16	3	1	5	11	2	4	11	8
Verticillium chlamydosporium Goddard	1	2			1					
Verticillium nigrescens Pethyor.	3	2		1	1	8		10		7
Zygorrhynchus moelleri Vuill.	3		13		1		2		5	
non-sporulating fungi		1		1		2		1	5	4
Yeast			3	4						
unidentified fungi		1			2					
total	68	77	96	70	66	74	75	123	84	104

The decrease in the frequency of occurrence of *Trichoderma* species in soil with compost II is more difficult to explain. Earlier studies (Szwed and Gostkowska 1997) showed that the above genus dominated in the compost. Perhaps, *Trichoderma* strains from the compost were inhibited by autochtonic population of soil fungi. Such a phenomenon is also observed when introducing the antagonist into the rhizosphere of plants (Ahmad and Baker 1987; Papavizas 1981). *Trichoderma* species are regarded as passive antagonists competing weakly in the environment with stabilized microbiocenotical relations (Adams 1990). Hence, the introduction of compost characterised by a high frequency of occurrence of *Trichoderma* not always effect on the phytosanitary state of the soil. It appeared that stabilized autochtonic microflora can counteract the colonization of the soil by *Trichoderma* strains from compost.

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Kształtowanie się populacji grzybów w glebie wzbogaconej pyłami tytoniowymi oraz kompostami z tymi odpadami

Streszczenie

Przeprowadzone badania wykazały, że wprowadzenie do gleby piaszczystej oraz gliniastej pyłów tytoniowych powodowało wzrost ogólnej liczebności grzybów, w tym gatunków z rodzaju *Fusarium*. Natomiast komposty sporządzone z pyłów tytoniowych zmieszanych z korą lub słomą na ogół nie wywoływały tego efektu. Nieprzekompostowane pyły tytoniowe, w przeciwieństwie do kompostów z tym odpadem, działały selekcjonująco zubożając skład gatunkowy zbiorowisk grzybów glebowych. Selekcja grzybów uwidoczniła się spadkiem częstotliwości występowania grzybów antagonistycznych z rodzaju *Trichoderma* czemu towarzyszyła stymulacja wzrostu potencjalnych fitopatogenów z gatunku *Fusarium solani* i *F. oxysporum*. Korzystne zależności między grzybami antagonistycznymi a potencjalnymi fitopatogenami stwierdzono w obu badanych glebach wzbogaconych kompostami o stosunku C/N ok. 20.