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INFLUENCE OF THE POLYMER BURIED IN SOIL ON THE PLANTS' GROWTH III. POLYPROPYLENE/LIGNOSULFONATES BLENDS

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Abstract: The culture of the *Vicia x hybrida* hort. in a soil containing polypropylene / 8-10 % lignosulfonates blends or photooxidated polypropylene/5-13 % lignin/blends, in both greenhouse and field conditions has been followed. The vegetative mass, pigments and blooming were rich, higher lignin content was. Some influences on the inorganic content of the plants by the polymer blends' disintegration was noticed.

Introduction

The introduction of polypropylene (PP) blends containing lignosulfonates (by-product from cellulose and paper industry) in the manufacture of various commercial products requires tests of their environmental or human health impact. Terrestrial plants'growth test is one of the most suitable and reliable.[1]

Experimental

Two kinds of PP/ lignosulfonates (LS) of ammonium (LSA) or calcium (LSCa) blends have been studied. These ones have been prepared by the procedures described in our previous papers [2,3], namely by Brabender -mixing-press and extrusion processing procedures. By application of the first procedure, films were obtained, while by the second procedure the samples were as rods. The films were photooxidated in order to increase the biodegradation rate. The compositions are presented in the following tables. All experimental details concerning the plants'growth test were mentioned in the parts I and II of this series of papers.

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Results and Discussion

According to the literature data [4] and our soil-pH-measurements, the photo- and/or biodegradation of polyolefins/lignosulfonate blends results in a series of compounds as: acids, phenols, aldehydes, ketones, esters and hydrocarbons, that lead to the increased soil acidity. This could affect the plant's growth, especially if the biodegradation/disintegration reached a high level.

After at least seven months of soil burial, all PP/LS blends showed water absorption, weight loss, discoloration, loss of physico-mechanical properties, environmental cracking, etc.

All comparisons concerning influence on the plants'growth have been made only in respect with a reference plant grown in the same conditions, even if several of the soil nutrients were lost after several vegetation cycles. No polymer blends were buried in the pot with the reference plant.

The data related to the plants'growth are given in the table 1 and 2. The data examination indicates a positive influence of the blends buried in soil on the general aspect of the plants (Fig. 1), plant had high heights and dried mass content; the negative influence was observed only on the blooming of the plants grown in soil containing photodegraded film blends (Tab. 1).

The extrusion - processed blends influenced much more the plants'growth in the greenhouse conditions. The final dried mass becomes lower for the blends containing 10% LS. This difference could be explained by the small quantity of the buried films in respect with the extrusion-processed samples. The results are enough well correlated with the weight losses. For example, as a 20% weight loss (sample S4, in the greenhouse conditions) a negative influence is remarked, the plant being sensitive to the change in its environment conditions. No influence in the field conditions was observed (the second part of the table 2). The chlorophyll and carotenoidic pigments were not modified.

The mineral content – Table 3 – was changed only in respect with the microelements and for the plants grown in presence of photooxidized sample and also those with high LS content in greenhouse conditions.

Conclusions

The *Vicia x hybrida* hort. growth test should be considered as a reliable test for polymer degradation in soil burial conditions. It becomes sensitive for a weight loss of sample higher than 10 - 20 %, during a vegetation cycle.

In the greenhouse conditions, the plant's growth is much more sensitive to the changes in the soil than in the field conditions. Slow degradation rate did not influence *Vicia x Hybrida* hort's growth.

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Table 1

Dynamics and data related to *Vicia x Hybrida* hort. plants' growth. Films of PP/epoxy modified lignosulfonates blends were buried in the culture soil, greenhouse conditions (g) (27.04.1996 - 7.06.1996)

No.	Blend buried in the culture soil	X_m Average height (cm) after			Plant mass / plant height	Dried mass (% of crude mass) at 30 days	Dried mass (% of crude mass at 50 days)	Final dried mass	Lignin (%)	Blooming	
		14 days	30 days	50 days	(g/cm)					Height (cm)	No. of buds
1	Reference plant	15	68	82	0.21	11.1	12.5	2.0	20.3	52	50
Photooxidized films											
2	PP	16	59	80	0.19	10.1	14.5	2.25	21.3	33	36
3	S6 PP / 4%LE	16	61	84	0.23	10.1	14.0	2.66	21.5	52	44
4	S5 PP / PP-g-GMAII / 6.97%LER / DDM	14	61	83	0.24	11.1	12.9	2.50	20.5	53	47
5	S1 PP / PP-g-GMAI / 9%LER / DDM	15	60	88	0.18	11.0	12.7	2.00	19.8	42	34
6	S3 PP / PP-g-GMAI / 13.06%LER / DDM	15	58	82	0.21	11.0	13.9	2.38	21.5	45	46
7	S4 PP / PP-g-GMAII / 13%LER / DDM	15	79	96	0.21	10.1	13.2	2.60	19.3	40	21
Unphotooxidized films											
8	PP and reference plant	16	42	70	0.21	12.7	13.5	2.50	-	49	36
9	S6	13	40	55	0.29	12.5	14.0	2.00	-	49	36
10	S5	17	32	45	0.32	10.2	12.5	2.50	-	45	49
11	S1	17	32	48	0.20	14.4	15.5	2.75	-	48	36
12	S3	20	29	40	0.21	14.2	15.0	2.33	-	45	38
13	S4	21	40	75	0.23	13.7	14.0	3.00	-	40	33

Table 2

Dynamics and data related to *Vicia x Hybrida* hort. plants' growth, greenhouse (g) (27.04.1996 - 7.061996) and natural (n) (10.05.1996 - 18.09.1996) conditions extrusion-processed PP/lignosulfonates blends were buried in the culture soil

No.	Blend buried in the culture soil	X_m Average height (cm) after				Plant mass / plant height (g / cm)	Dried mass % of crude mass at 30 days	Dried mass / % of crude mass at 50 and 132 days	Final dried mass (g)	Lignin (%)	Blooming		Fruits	
		14 days	30 days	50 days	132 days						Height (cm)	No. of buds	No. of fruits	Fruit mass
1	Reference plant	15	68	82	-	0.21	11.1	12.5	2.00	20.3	52	50	-	-
Greenhouse conditions														
2	PP	15	55	75	-	0.19	10.1	14.5	2.25	16.0	33	36	-	-
3	PP / 8 % LSA	15	62	80	-	0.21	10.0	12.5	2.50	21.0	75	54	-	-
4	PP / 8 % LSCa	18	56	100	-	0.15	9.7	11.7	1.66	22.0	40	32	-	-
5	PP / 10 % LSA	12	67	114	-	0.14	10.7	11.2	1.75	21.5	46	51	-	-
6	PP / 10 % LSCa	12	69	89	-	0.27	10.9	12.8	3.00	22.5	52	43	-	-
7	PP / 10 % LSAE	14	61	95	-	0.18	10.5	10.5	1.75	19.6	51	30	-	-
8	PP / 10 % LSCaE	21	69	114	-	0.15	8.9	10.8	1.75	20.5	86	51	3	4
Field conditions														
9	Reference plant	11	31	52	83	0.51	12.5	32.0	12.00	24.7	40	30	10	5
10	PP	7	31	60	101	0.44	13.4	32.5	15.70	22.5	24	26	-	-
11	PP / 8% LSA	15	54	70	101	0.64	14.6	36.4	17.00	24.9	47	46	9	15
12	PP / 8% LSCa	11	40	60	114	0.59	15.5	32.9	17.50	23.5	36	38	17	18
13	PP / 10% LSA	11	40	62	112	0.37	13.6	31.6	14.80	23.7	60	30	-	-
14	PP / 10% LSCa	7	29	41	68	0.71	15.7	31.4	11.00	24.2	50	55	10	14
15	PP / 10% LSAE	7	30	62	113	0.76	15.5	31.4	16.30	23.7	50	50	20	30
16	PP / 10% LSCaE	10	24	41	126	0.38	12.8	31.8	21.00	23.2	33	30	9	17

Table 3

Mineral Content of the *Vicia x Hybrida* hort. grown in the presence of the PP/LS blends buried in soil

No	Blend buried in Culture soil	Mineral Content (%)	Macroelements (mg/100g dried mass)			Microelements (mg/100g dried mass)			
			Na	Ca	Mg	Fe	Mn	Cu	Zn
1	Reference plant	10.4	632.70	278.63	86.23	0.28	0.38	0.37	1.73
Photooxidized films - greenhouse conditions									
2.	PP	7.2	1059.25	299.11	75.18	0.41	1.27	0.78	0.97
3.	S6	8.0	693.75	376.91	104.48	0.56	1.33	0.38	1.51
4.	S5	8.5	849.15	276.13	110.32	0.31	1.45	0.56	3.74
5.	S1	8.2	886.82	318.85	107.89	0.88	1.59	0.66	2.42
6.	S3	8.6	1068.75	444.68	101.66	1.09	1.54	1.21	2.43
7.	S4	9.6	725.72	348.76	114.02	2.15	1.40	0.80	2.16
Unphotooxidized films									
8.	PP	11.6	729.30	1056.64	243.54	2.04	2.71	1.05	2.72
9.	S6	12.0	762.70	675.54	205.64	0.52	2.30	0.48	2.42
10.	S5	11.6	731.58	911.02	244.29	0.36	2.09	0.50	2.43
11.	S1	13.1	897.95	534.48	253.89	0.86	1.75	0.25	1.07
12.	S3	14.7	1072.08	675.45	299.04	5.46	2.48	0.76	4.52
13.	S4	11.2	1019.05	527.38	185.62	0.41	1.34	0.59	2.34
Extrusion - processed blends - greenhouse conditions									
14.	PP/8% LSA	9.9	686.68	262.76	86.07	0.84	0.78	0.10	0.68
15.	PP/8% LSCa	12.6	579.45	297.28	77.20	0.24	0.25	0.05	0.20
16	PP/10% LSA	8.2	735.86	286.78.	90.25	0.13	1.32	0.17	0.85
17.	PP/10% LSCa	9.9	493.06	245.42	97.58	0.43	0.78	0.05	0.39
18.	PP/10% LSAE	10.1	601.62	174.41	66.69	0.28	0.73	0.22	1.62
19.	PP/10% LSCaE	10.9	593.37	247.96	92.02	0.28	0.88	0.07	0.47
Extrusion - processed blends - field conditions									
20.	Reference plant	6.7	319.85	462.62	90.91	6.09	2.93	0.76	1.81
21.	PP/8% LSA	4.9	398.91	552.1	106.8	0.57	1.41	0.97	1.91
22.	PP/8% LSCa	9.3	572.02	977.3	162.41	10.26	2.24	2.15	2.02
23	PP/10% LSA	5.6	319.78	1004.12	142.26	11.12	2.66	2.43	2.18
24.	PP/10% LSCa	5.9	267.68	1332.0	239.18	2.90	2.73	2.06	2.54
25.	PP/10% LSAE	8.7	479.39	742.14	104.07	0.64	1.10	0.36	0.32
26.	PP/10% LSCaE	6.5	351.99	384.12	98.06	0.96	1.26	0.56	1.44

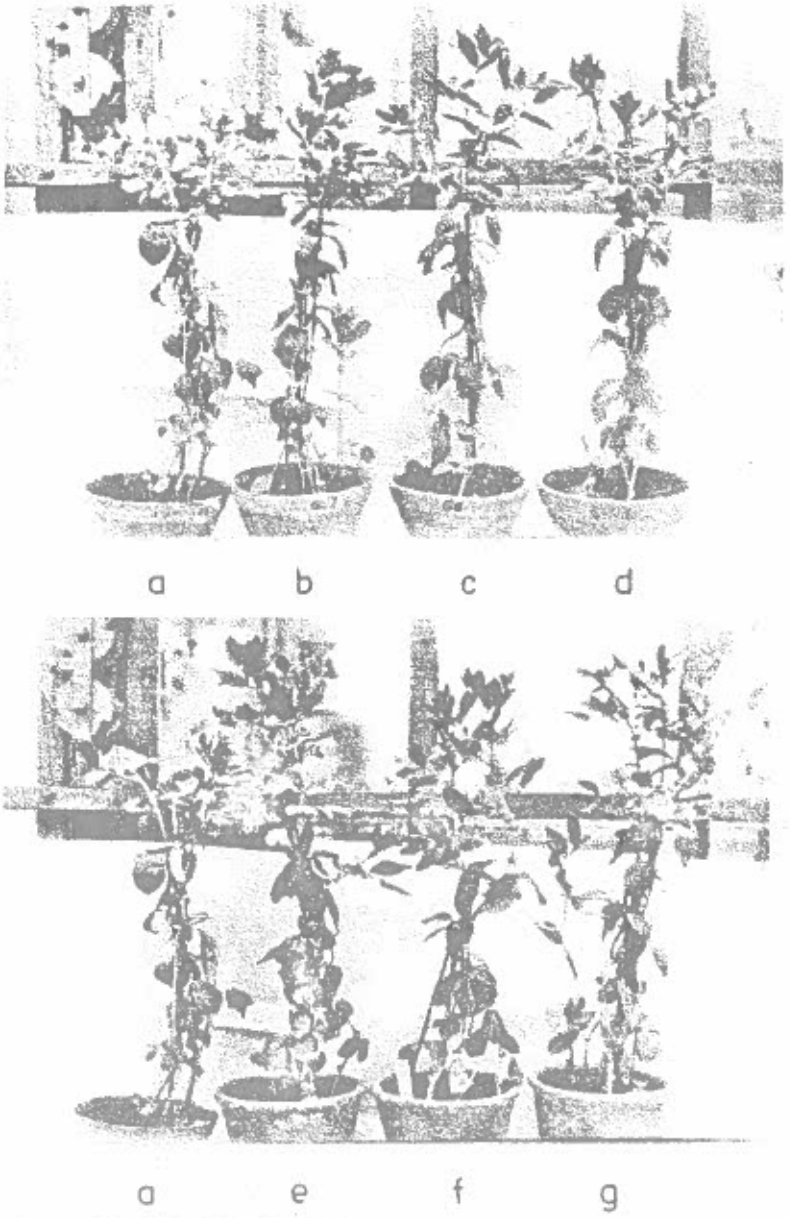

Fig. 1 – Aspects of the VICIA X HYBDRIDA hort. plant grown in absence (a) and in presence(b-g) of PP/LS blends buried in the culture soil: b - S1; c - S3; d - S-4; e - PP/8%LSA; f - PP/8%LSCa; g - PP/10%LSCaE