Changes of Mycorrhizal Colonization in Winter Wheat Due to Mineral Inputs

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Bulletin UASVM series Agriculture 73(2)/2016

Print ISSN 1843-5246; Electronic ISSN 1843-5386

DOI 10.15835/buasvmcn-agr: 12396

Abstract. Winter wheat is a plant commonly used in agronomic systems. Potential for adaptation of this species has lead to connecting its roots with mycorrhizal symbiotic fungi. Mineral inputs, especially phosphorous, produces oscillation in the functioning of mycorrhizal mechanism. Autumn fertilization is beneficial for the arbuscular circuit, stimulating the plant to enter into symbiosis. The degree of colonization increases due to fertilization applied in the spring, but has low values when the supplement is missing. The maximum intensity of colonization is less than 66% and is achieved only under 27-13,5-0 NPK fertilization.

Keywords: *mineral fertilizer, phosphorus, symbiosis, winter wheat.*

Introduction. Agricultural ecosystems have evolved towards a climax dependent on technological inputs, with wide variations due to crops and applied fertilizers (Horton, 2015). Winter wheat is a plant cultivated on large areas having a lengthy history for human food production. Mycorrhizal symbiosis is a positive interaction of fungi in soil with higher plants, with a role in increasing the surface for nutrients acquisition by plants (Souza, 2015).

Aims and objectives. The aim of this paper is to evaluate the potential of mineral fertilizers to influence the efficiency of mycorrhizal symbiotic mechanism, by increasing the abundance of nutrients in easily accessible areas for plants root of winter wheat.

Materials and methods. Colonization parameters were analyzed in relation to the basic fertilizer, represented by NPK 20-20-0 and additional fertilization based on ammonium nitrate, calcium ammonium nitrate and NPK 27-13.5-0 (Tab. 1). Identified significant correlations between the level of mycorrhizas and doses of fertilizers were selected to explore the disturbances on symbiotic system.

Results and Discussion. The correlations established between colonization parameters and fertilization indicates a strong effect of nitrogen applied in the autumn and calcium ammonium nitrate (spring) over arbuscular senescent transfer network (Tab. 2). Phosphorus plays an important role in development of hyphae, but only when applied during fall. Fertilization at the start of spring has a positive effect on mycorrhizal colonization.

The intensity and degree of colonization (Tab. 3) are over 60% at the application of fertilization with 67 kg ha⁻¹ ammonium nitrate during spring (V5). The same result is obtained for the application in two fractions (spring and on vegetation) of ammonium nitrate (V7) and N27P13.5 (V9). The minimum of the colonization degree is achieved at a fertilization with 120 kg N ha⁻¹ and P applied as starter during autumn (V3) but with no fertilizer in the spring. Arbuscules are present in 2.0% at a fertilization rate of 80 kg ha⁻¹ of N and P in the autumn (V2), but are missing at the application of small doses (40 kg ha⁻¹) of N and P (V1).

Conclusion. The colonization degree is a parameter stimulated by an fractionated application

Tab. 1. Experimental design of applied fertilizers

Variant	Type	Autumn (kg ha ⁻¹)		Post-winter (kg ha ⁻¹)		Phasial (kg ha ⁻¹)	
		Na	Pa	Nv	Pv	Nf	Pf
V1	N20P20K0	40	40				
V2	N20P20K0	80	80				
V3	N20P20K0	120	120				
V4	N20P20K0	80	80	67 (A.a)			
V5	N20P20K0	80	80	67 (Ca. A.a)			
V6	N20P20K0	80	80	67 (N27P13.5) ³²			
V7	N20P20K0	80	80	34 (A.a)		34 (A.a.)	
V8	N20P20K0	80	80	34 (Ca. A.a)		34 (Ca. A.a.)	
V9	N20P20K0	80	80	34 (N27P13.5) ¹⁶		34 (N27P13.5)	16
V10	N20P20K0	120	120	67 (A.a)			
V11	N20P20K0	120	120	34 (A.a)		34 (A.a.)	

A.a. - ammonium nitrate (N – 34%); Ca. A.a. - calcium ammonium nitrate (N – 27%);

Tab. 2. Correlations of mycorrhizal development with applied inputs

	Na	Pa	Nv	Pv	Nf	Pf	A.a.	Ca. A.a.	N27P13.5
Int %	-0.03	-0.03	0.26	-0.16	0.36*	0.43*	0.13	0.29	0.04
Arb %	0.15	0.15	0.12	-0.25	0.36*	0.11	-0.01	0.53*	-0.16
Cdeg %	-0.08	-0.08	0.27	-0.11	0.39*	0.43*	0.11	0.31	0.07

Marqued correlations (*) are significant at p<0.05

Tab. 3. Oscillation of mycorrhizal parameters due to fertilization

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11
Int %	31.0 ^d	56.9 ^{a-c}	29.2 ^d	44.2 ^{b-d}	65.4 ^{ab}	32.3 ^d	62.4 ^{a-c}	47.6 ^{a-d}	66.4 ^a	53.8 ^{a-c}	42.2 ^{cd}
Arb %	0.0 ^d	2.0 ^{ab}	0.2 ^{cd}	1.3 ^{bc}	1.4 ^{a-c}	0.3 ^{cd}	0.3 ^{cd}	2.7 ^a	1.4 ^{a-c}	1.2 ^{b-d}	1.7 ^{ab}
Cdeg %	27.9 ^{cd}	56.3 ^{ab}	25.3 ^d	43.7 ^{a-d}	64.7 ^a	31.9 ^{cd}	61.7 ^{ab}	47.1 ^{a-d}	65.6 ^a	48.4 ^{a-c}	40.8 ^{b-d}

Note: Margins sharing a letter in the group label are not significantly different at p<0.05

of fertilizers, while the arbuscular system is higher at 80 kg ha⁻¹ phosphorus in the autumn.

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