



University of Agricultural Sciences and Veterinary Medicine
Cluj-Napoca
Faculty of Agriculture

**Mycorrhizal colonization level of winter wheat in
conditions of differentiated mineral fertilization**

Vlad STOIAN, Roxana VIDICAN



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Introduction

- Matured ecosystems are characterized by the existence of mycorrhizal **hyphal networks**, capable of **interconnecting** the radicular systems of plants.
- *Most common associations of **roots and fungi** are mycorrhizas, vesicular – arbuscular type.*
- By optimizing the food resources, mycorrhizas may decrease the inputs within the ecosystem.

Background / Concept



High Fertilization Experiment

Triticum aestivum – root system



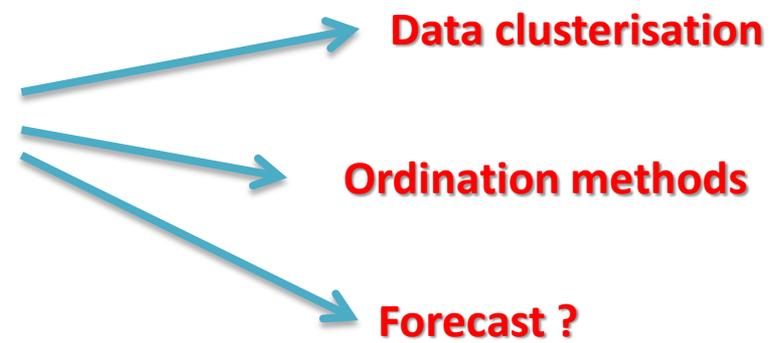
Parameters – **freq%** (frequency)

+ **int%** (intensity) – *sys and frag*

+ **arb%** (arbuscularity) – *sys and frag*

+ **cdeg%** (colonnization degree)

24 Fertilization types



Data clusterisation

Ordination methods

Forecast ?



Materials and Methods

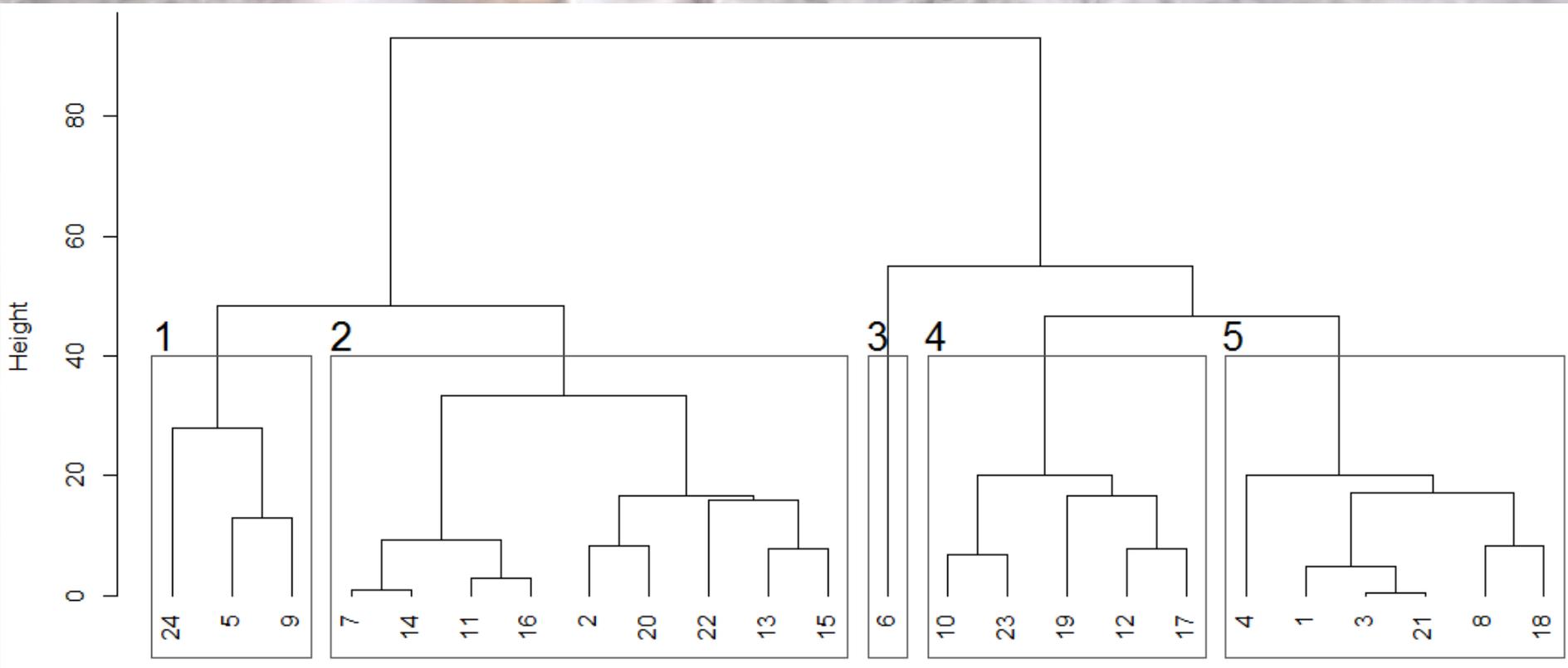


Variant	Starter (kg ha ⁻¹)		Autumn fertilization (kg ha ⁻¹)			Post-winter (kg ha ⁻¹)		Phasial fertilization (kg ha ⁻¹)	
	Type	Quantity	Na	Pa	Ka	Nv	Pv	Nf	Pf
V1	N20P20K0	200	40	40					
V2	N20P20K0	400	80	80					
V3	N20P20K0	600	120	120					
V4	N18P46K0	86	15	40		24 (A.a)			
V5	N18P46K0	174	31	80		49 (A.a)			
V6	N18P46K0	258	46	120		74 (A.a)			
V7	N15P15K15	267	40	40	40				
V8	N15P15K15	534	80	80	80				
V9	N15P15K15	800	120	120	120				
V10	N20P20K0	400	80	80		67 (A.a)			
V11	N20P20K0	400	80	80		67 (Ca. A.a)			
V12	N20P20K0	400	80	80		67 ³² (N27P13K0)			
V13	N20P20K0	400	80	80		67 (Urea)			
V14	N20P20K0	400	80	80		34 (A.a)		34 (A.a)	
V15	N20P20K0	400	80	80		34 (Ca. A.a)		34 (Ca. A.a)	
V16	N20P20K0	400	80	80		34 ¹⁶ (N27P13K0)		34 ¹⁶ (N27P13K0)	
V17	N20P20K0	400	80	80		34 (Urea)		34 (Urea)	
V18	N18P46K0	174	31	80		116 (A.a)			
V19	N18P46K0	174	31	80		58 (A.a)		58 (A.a)	
V20	N18P46K0	174	31	80		116 (Ca. A.a)			
V21	N18P46K0	174	31	80		58 (Ca. A.a)		58 (Ca. A.a)	
V22	N20P20K0	600	120	120		67 (A.a)			
V23	N20P20K0	600	120	120		34 (A.a)		34 (A.a)	
V24	N20P20K0	600	120	120		34 (Urea)		34 (Urea)	
	Commercial formula		Active ingredient			Active ingredient		Active ingredient	
A.a. - ammonium nitrate (N – 34%); Ca. A.a. - calcium ammonium nitrate (N – 27%); Urea (N – 46%)									



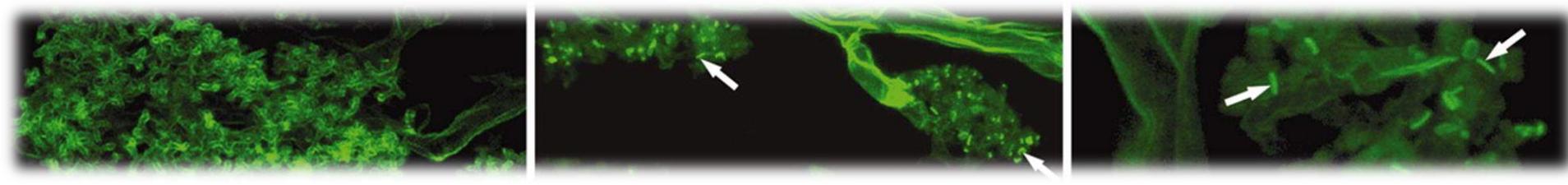


Similarity of mycorrhizal response to fertilization



Similarity of mycorrhizal response to fertilization

Cluster	Variant	freq (%)	int SYS (%)	Int Fg (%)	arb Fg (%)	arb SYS (%)	Cdeg (%)
1	V5	93.33	64.50	69.11	37.00	23.87	60.20
	V9	100.00	69.17	69.17	32.84	22.72	69.17
	V24	90.00	56.00	62.22	26.22	14.68	50.40
2	V2	100.00	58.67	58.67	3.69	2.17	58.67
	V7	100.00	63.33	63.33	0.03	0.02	63.33
	V11	100.00	66.83	66.83	2.14	1.43	66.83
	V13	100.00	53.00	53.00	1.64	0.87	53.00
	V14	100.00	63.67	63.67	0.47	0.30	63.67
	V15	100.00	49.33	49.33	5.47	2.70	49.33
	V16	100.00	68.50	68.50	1.95	1.33	68.50
	V20	100.00	56.83	56.83	10.29	5.85	56.83
	V22	90.00	54.07	60.07	2.16	1.17	48.66
3	V6	83.33	40.97	49.16	38.53	15.78	34.14
4	V10	100.00	45.33	45.33	3.09	1.40	45.33
	V12	100.00	33.83	33.83	0.89	0.30	33.83
	V17	96.67	36.83	38.10	4.89	1.80	35.61
	V19	93.33	37.17	39.82	13.63	5.07	34.69
	V23	96.67	42.20	43.66	4.03	1.70	40.79
5	V1	90.00	30.97	34.41	0.00	0.00	27.87
	V3	86.67	29.23	33.73	0.71	0.21	25.34
	V4	76.67	22.17	28.91	0.00	0.00	16.99
	V8	93.33	21.50	23.04	0.71	0.15	20.07
	V18	86.67	23.57	27.19	1.70	0.40	20.42
	V21	86.67	29.00	33.46	0.54	0.16	25.13



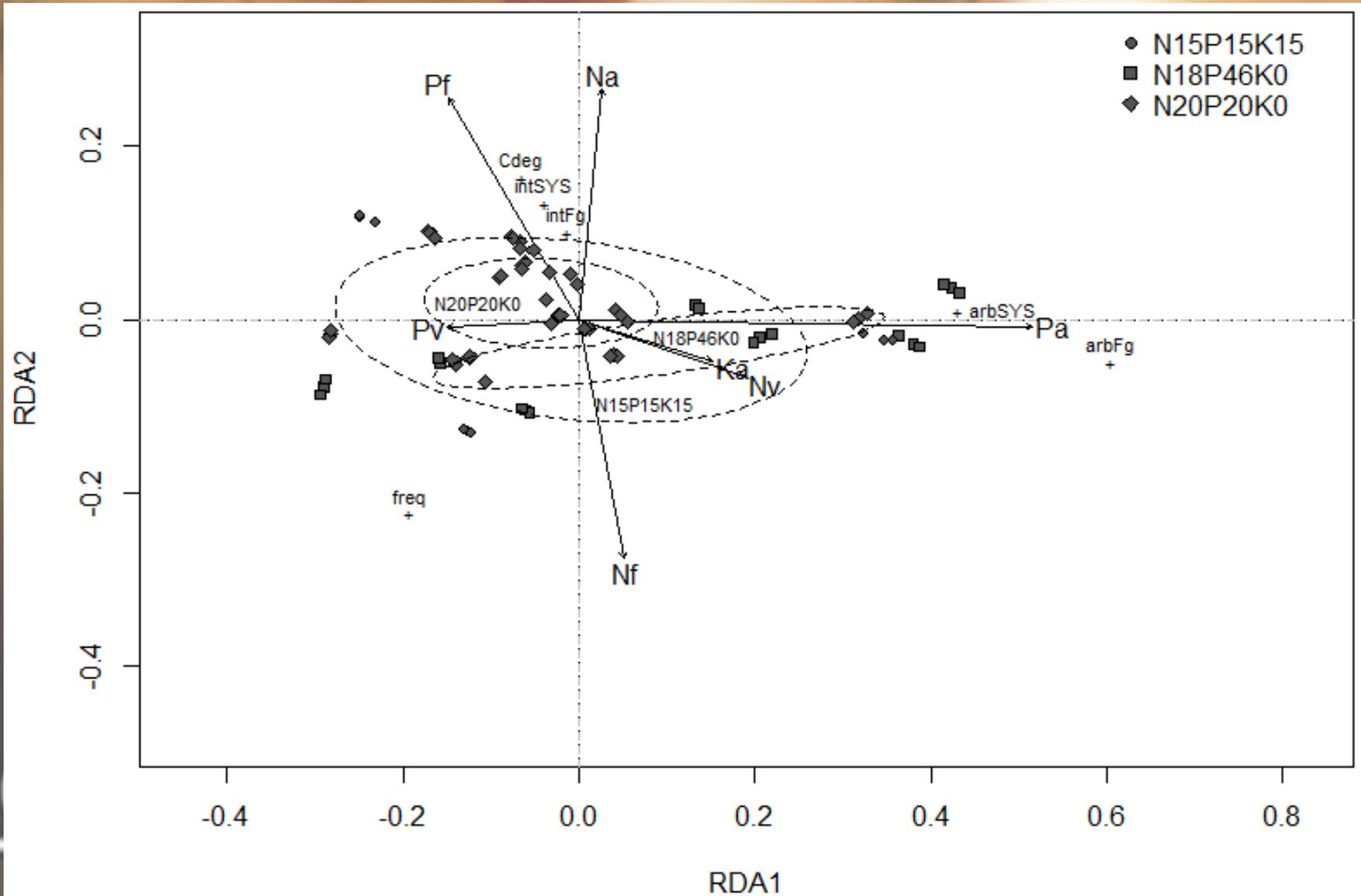


Correlation between colonization parameters and fertilization

<i>Param</i>	<i>Na</i>	<i>Pa</i>	<i>Ka</i>	<i>Nv</i>	<i>Pv</i>	<i>Nf</i>	<i>Pf</i>	<i>N20P20</i>	<i>N18P46</i>	<i>NPK15</i>
<i>freq</i>	0.33**	0.02	0.17	-0.04	0.22	-0.16	0.16	0.36**	-0.53***	0.19
<i>int SYS</i>	0.29*	0.19	0.12	-0.04	-0.04	-0.28*	0.29*	0.19	-0.29*	0.11
<i>int Fg</i>	0.27*	0.23	0.09	-0.03	-0.08	-0.28*	0.27*	0.15	-0.22	0.08
<i>arb Fg</i>	-0.01	0.44***	0.24*	0.08	-0.16	-0.12	-0.10	-0.38***	0.35**	0.09
<i>arb SYS</i>	0.04	0.41***	0.33**	0.01	-0.15	-0.16	-0.09	-0.36**	0.28*	0.16
<i>Cdeg</i>	0.29*	0.15	0.14	-0.05	-0.01	-0.27*	0.29*	0.22	-0.34**	0.14

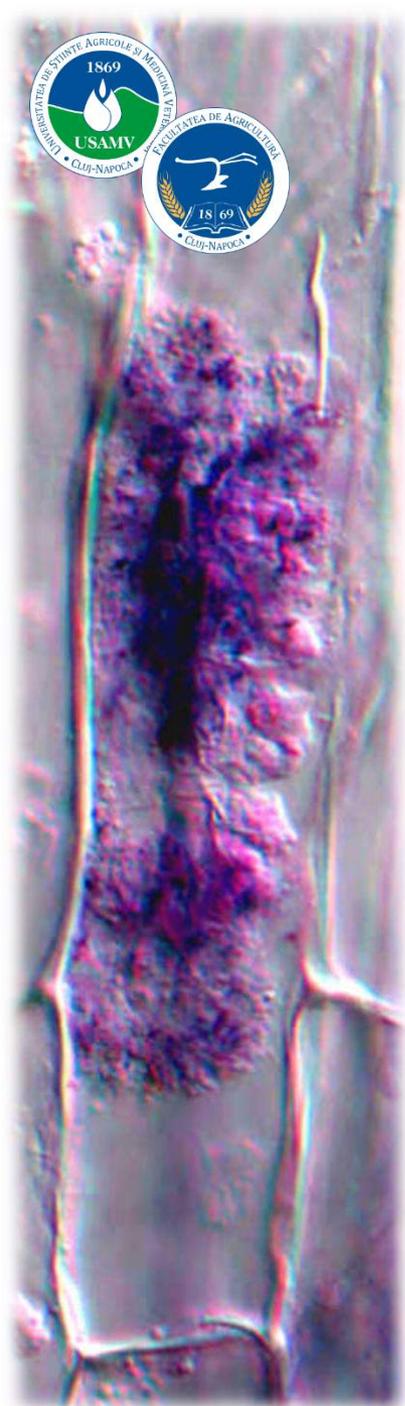
*** - $p \text{ val} < 0.001$; ** - $p \text{ val} < 0.01$; * - $p \text{ val} < 0.05$

Mycorrhizal response to fertilization gradients





- *Fertilization with reduced nitrogen and phosphorus doses act to a drastic reduction in the percentage of arbuscules formed in the root cortex, along with the reduction of operational efficiency of mycorrhizal symbiotic mechanism.*
- *The highest values of the colonization parameters were recorded in variants fertilized with products that contains a greater quantity of phosphorus than nitrogen (N18P46), but only at a level of phosphorus above 80 kg/ha (a.i.) and an additional mineral nitrogen fertilization at the end of winter.*



- *Mineral fertilization of winter wheat with high doses of phosphorus applied at sowing favors the development of mycorrhizal intra-radicular hyphal networks, and provides a high efficiency of symbiosis especially in the case of phasal fertilization with nitrogen at the end of winter.*
- *Mycorrhizal are strongly influenced by the synergistic effect of starter fertilizer type and phasal fertilization, phosphorus being restrictive to active stages of colonization and nitrogen for maintaining the level of colonization.*



*Thank you
for attention*