How to increase efficacy of *Metarhizium* plant growth promoter product?

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Introduction

There has been a growing interest in environmentally sustainable methods of arthropod control, such as mycoinsecticides. *Metarhizium* spp. are entomopathogenic fungi with a wide variety of insects and nematode hosts (Figure 1). Members of the genus *Metarhizium* can be isolated worldwide from all types of climatic conditions, soil types, and arthropod taxa. If a suitable host is not present, members of this genus are able to survive in the rhizosphere of plants or non-living particles in the soil.

Metarhizium sp. has been isolated from a wide range of natural environments, but this does not mean it can be isolated with the same success from all soil samples. Undisturbed or natural soils seem to be more likely to have successful entomopathogenic fungus isolations than frequently disturbed agricultural lands. Increased N sources in the growth medium are beneficial to conidial growth, pathogenicity and morphological features (Figure 2).

It is not enough to isolate an effective strain, we must also ensure that the formulation of the product promote the agronomical performance of the biological active.

Figure 1. White grubs killed by *Metarhizium* infection

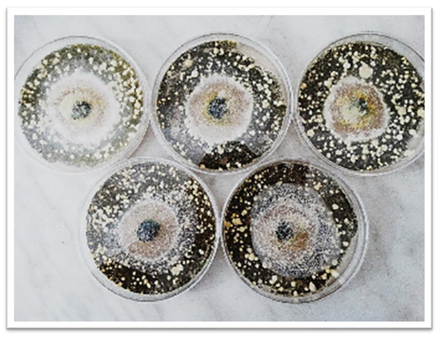

Figure 2. *Metarhizium* and *Trichoderma* competition test

Objectives

Our aim is to test the effectiveness of the *Metarhizium* strain under different growing conditions (soil type, crop, mulching, application technology etc).

Materials and methods

Field experiments were carried out at several locations and different plant cultures. Plants used in the field experiments were potato, indeterminate and determinate tomato varieties, cucumber and sweet potato in both field and potted conditions. Locations that were in compliance with organic growing principles meant that no chemical contamination was expected to be present. The effect of different mulching materials was also observed. In the experiments, multiple modes of application were used, and untreated plants as control.

Spore suspensions were created for the tomato experiments, meaning 2 g of product diluted in 2 dl of water for each treated plant. At the same time, control plants would receive 2 dl of clear water. In all locations, uniformly extensive growing methods were used to fit the locations. The plants were given a large growing area (4 m^2) and a combination of agrotextile and mulching material was used (Figure 4).

The field experiment sweet potatoes were supplied with water from an irrigation system. The high soil moisture made an environment more favourable to white grubs, which could lead to higher population density in the area. Treatment was applied three times and was randomised. The irrigation system allowed for application under the agrotextile (Figure 3).

The soil of the location of the cucumber experiment was heavily infested with root-knot nematodes (*Meloidogyne incognita*). The location was an unheated foil tunnel with irrigation system. The *Metarhizium* formulation was applied into the soil by compost or water at different concentrations.

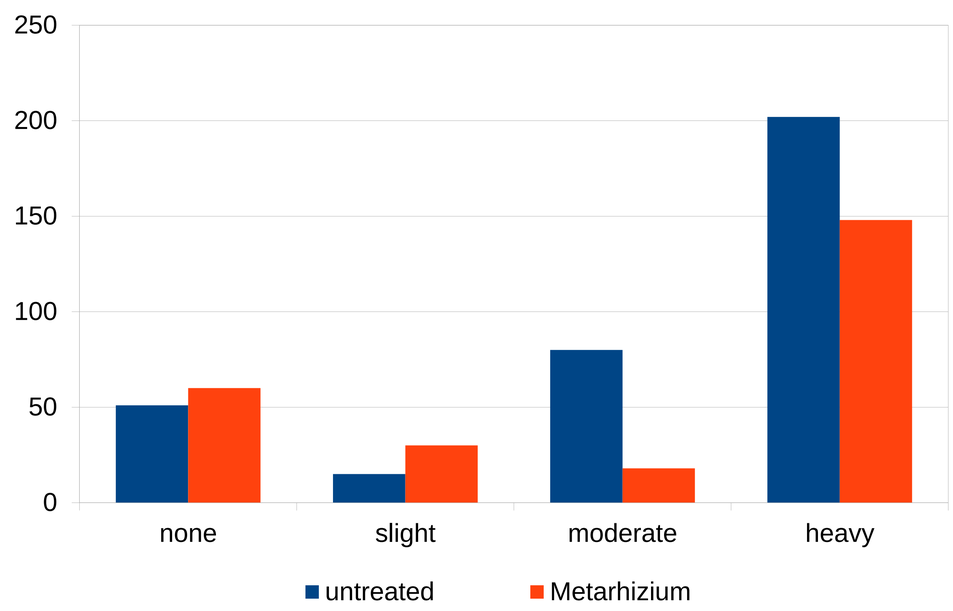

Figure 3. Comparison of number of tuber damage by white grub categories from untreated and *Metarhizium* treated sweet potato (Inárcs, 2018)

Regional cultivar treatment frequency		Ceglédi				Faddi				Máriapócsi				Mátrafüredi				Tolna megyei			
		0×	1×	2×	3×	0×	1×	2×	3×	0×	1×	2×	3×	0×	1×	2×	3×	0×	1×	2×	3×
02.aug	1.	720	495	702	854	2113	1431	1814	1034	704	579	584	932	1405	843	503	971	824	611	1042	270
	2.	325	956	490	920	1976	874	2241	1009	974	486	1152	1032	987	751	495	775	403	907	1207	1008
	3.	167	534	242	391	1745	1202	2413	1754	752	844	1083	741	1042	807	623	652	417	873	992	847
	4.	175	485	713	1024	847	2570	2886	1350	318	677	951	1068	1219	685	547	707	183	624	847	857
	5.	208	322		1113	963	2486	1957	1214	843	1453	976	853	1054	712	461	812	385	671	935	794
15.szept	1.	291	691	351	835	1079	1794	1815	1282	1550	1644	1485	1065	1087	825	872	219	941	1554	2148	1744
	2.	653	593	532	957	1130	1487	1577	1400	1222	1562	1709	1265	1039	650	826	223	1193	1435	1296	1560
	3.	701	506	1030	877	1110	2100	1692	1679	1070	1388	1520	1299	852	900	367	458	1810	1100	1599	1144
	4.	931	1013	806	831	830	1985	1640	1520	1403	1298	1380	1226	763	883	387	324	1620	1480	1584	1796
	5.	580	480		1308	977	2207	1590	1390	1170	1141	1651	1183	533	655	583	427	1448	1540	1419	1693
28.szept	1.	374	380	220	283	402	385	805	240	1238	507	1128	300	253	1070	738	203	241	60	200	98
	2.	327	103	103	199	745	356	300	345	862	411	537	447	135	2115	800	811	71	237	425	37
	3.	318	134	325	376	623	304	837	972	465	627	398	913	970	405	722	907	222	191	102	240
	4.	100	347	189	373	549	412	698	291	325	495	483	308	802	648	1142	302	235	28	114	115
	5.	220	272		241	525	1148	1120	467	369	504	423	317	1120	524	504	407	185	197	497	128
04.okt	1.	175	67	241	230	123	245	121	137	1100	768	305	240	364	324	70	86	85	163	104	107
	2.	102	206	128	268	357	217	35	241	870	338	357	227	209	794	130	50	174	172	96	112
	3.	151	221	237	117	184	157	83	285	915	456	298	348	421	389	212	10	117	84	108	145
	4.	134	136	121	193	238	167	201	189	1300	399	285	357	198	178	74	171	29	93	73	98
	5.	99	115		103	255	117	266	312	525	425	376	309	452	211	195	143	127	114	88	137

Figure 4. The progression of the quantity of undamaged tomato (g/plant) in experimental *Metarhizium* treatment applied at different frequencies in indeterminate regional cultivar tomato plants (Nagyar, 2018)

Conclusions

From multiple laboratory, potted and field studies it can be concluded that the success of the microbiological plant protection agent significantly depends on the presence or absence of suitable conditions for its survival, root colonisation, establishment, as well as the conditions needed for its nematicide and entomopathogenic properties to manifest. Spores applied through irrigation or other conventional methods enter a vulnerable vegetative state due to the moisture. In that state, the hyphae may die due to a lack of substrate or the presence of antagonistic organisms. This problem can be prevented with the use of suitable quality compost as medium. Thermophilic composting likely deactivates the microorganisms that could potentially be antagonists to *Metarhizium*, and *Metarhizium* is free to take advantage of the opening left by the deactivated microorganisms.

Another potential problem is that soil surface application in the absence of mulching material can leave the fungus exposed to UV radiation. The use of mulch not only protects the fungus, it is also beneficial to the plant due to its help in temperature regulation and moisture retention. The materials used did not appear to be detrimental to the fungus.

Outcome

Based on the preliminary development results, a product **Meta Pro** with Metarhizium active agent - Kwizda Agro succesfully applied for registration in Hungary.

Kwizda Agro

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