Biostimulant Effect Of New Seed-Applied Fungicides In Maize Under Different Temperature Regimes

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Introduction

Increased summer temperatures due to global warming are expected to greatly damage maize, and the associated drought stress during flowering stage can reduce ovary fertilization and yield (Bassetti and Westage, 1993). An anticipation of sowing date may be a strategy to overcome drought stress during flowering, but it could be limited by initial low temperatures, excess of rainfall and cold return. It is known that sub-optimal temperatures strongly reduce leaf initiation (Warrington and Kanemasu, 1983), photosynthesis activity (Nie et al., 1992) and root development in maize (Barlow and Adam, 1989).
Seed treatment with fungicides is a useful tool to prevent pathogen injury, and some a.i. can also have a positive impact on plant development. Previous study described the positive effects of some fungicides, such as Sedaxane, classified as SDHI (succinate dehydrogenase inhibitor), on root growth and development, playing a biostimulant role (Dal Cortivo et al., 2017).
The aim of this experiment was to evaluate the biostimulant effect of the commercial fungicides Maxim XL® and Maxim Quattro®, alone or in combination with Vibrance®, which contain the a.i. Sedaxane, on root system under three different temperature regimes.

Materials and Methods

The variety of maize "SY-Gigantic" (Syngenta) was cultivated in wall transparent rhizoboxes at the University of Padova (Legnaro, Padova, NE Italy) under controlled conditions in a climatic chamber Piardi (cycle of 14h/10h dark, 70% R.H., 180 μmol m^{-2} s^{-1} PAR). The experimental design was a completely randomized block with four replicates (n=4). The temperatures regimes were: warm conditions (16°C), cold conditions (10°C) and cold return (16°C at the beginning and -10°C after germination); the treatments tested are reported in Table 1:

Table1. Treatments and a.i. of each commercial fungicide in maize trials.

Treatments	Composition
Untreated control	no seed-treatment
Maxim XL®	12.5mL/50Kseeds (a.i. fludioxonil 2.4% (25 g L^{-1}) + Metalaxyl-M 0.93% (10 g L^{-1}))
Maxim XL® + Vibrance®	12.5 mL/50Kseeds Maxim XL + (2.5mL/50Kseeds; a.i. Sedaxane 50% w/w 500 gL^{-1})
Maxim Quattro®	8.4 mL/50Kseeds (a.i. fludioxonil 3.32% (33.2 g L^{-1}), metalaxil-M 2.65% (26.5 g L^{-1}), azoxystrobin 1.33% (13.3 g L^{-1}), thiabendazole 26.5% (265 g L^{-1}) + 1.26-benzisothiazolin-3-one at 0.019% (0.19g L^{-1}) as preservative
Maxim Quattro® + Vibrance®	8.4 mL/50Kseeds Maxim Quattro + 2.5mL/50K seeds Vibrance

Each experiment/temperature regime ended when roots reached the bottom of the rhizobox. In order to detect the effect of seed treatment on root growth, at the end of the trials it was measured root length, surface area and number of tips. through an imagine analysis software (WinRHIZO Pro 2007d).

Result

All the fungicides enhanced shoot growth (as heigh) at low temperature, both at stable 10°C and with cold return, whereas at warm temperatures there was a slight not significant increase. The addition of Vibrance® to both Maxim XL® and Maxim Quattro® ensured the highest shoot height, particularly at 10°C; in case of cold return the best option was Maxim XL + Vibrance®(Fig. 1).

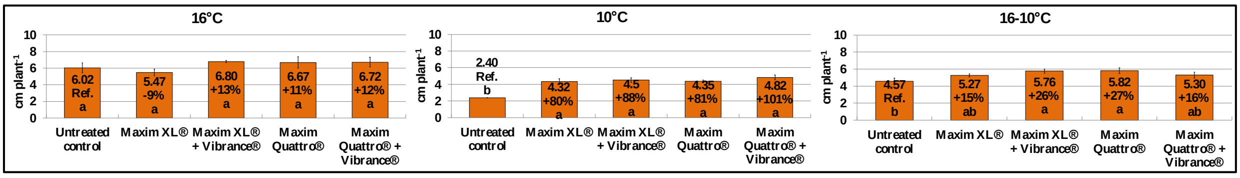

Figure 1. Plant height (n=4; ±S.E; Student Newman Keuls test, P≤0.05) of maize seedlings treated with different seed-coating fungicides under different thermal regimes. Inside histograms: average value of each treatment, % variation vs untreated control and letters for statistical comparison.

As regards root parameters, Maxim Quattro® + Sedaxane reached the highest value of root length under all the three temperatures (+72% at 16°C, +598% at 10°C and + 124% at 16-10°C vs. untreated controls, P≤0.05). This treatment also greatly improved the root surface area at 10°C (+1136%, P≤0.05) and alternate temperatures (+105%, P≤0.05). Maxim XL® coupled with Vibrance® increased root area at 16°C (+61% vs. untreated controls, P≤0.05). Significative improvement of the number of root tips was obtained with Maxim XL® alone at warm temperature (+75% vs. untreated control, P≤0.05) and with Maxim Quattro® + Vibrance® at the base temperature of 10 °C (+1061% vs. untreated control, P≤0.05).

Table 2 Main root parameters (n=4; ±S.E; Student Newman Keuls test, P≤0.05) of maize seedlings treated with different seed-applied fungicides under different thermal regimes. In brackets: % variation vs untreated controls. Letters for statistical comparison.

Treatments	Root Length (cm plant^{-1})			Root surface area (cm^2 plant^{-1})			Root tips (n plant^{-1})		
	16°C	10°C	16-10°C	16°C	10°C	16-10°C	16°C	10°C	16-10°C
Untreated control	765b (Ref.)	28b (Ref.)	310b (Ref.)	122b (Ref.)	3.6b (Ref.)	60.2b (Ref.)	1069b (Ref.)	25b (Ref.)	639**a** (Ref.)
Maxim XL®	1180ab (+54%)	146**a** (+429%)	572ab (+84%)	166ab (+35%)	34.6**a** (+860%)	108ab (+79%)	1874**a** (+75%)	196ab (+683%)	998**a** (+56%)
Maxim XL® + Vibrance®	1327**a** (+74%)	149**a** (+437%)	447ab (+44%)	197**a** (+61%)	35.8**a** (+895%)	85.8ab (+43%)	1683ab (+57%)	227**a** (+806%)	886**a** (+39%)
Maxim Quattro®	1037ab (+36%)	134ab (+386)	428ab (+38%)	151ab (+23%)	33.2**a** (+822%)	83.7ab (+39%)	1650ab (+54%)	195ab (+681%)	842**a** (+32%)
Maxim Quattro® + Vibrance®	1312**a** (+72%)	193**a** (+598)	695**a** (+124%)	185ab (+51%)	44.5**a** (+1136%)	123.7**a** (+105%)	1679ab (+57%)	290**a** (+1061%)	936**a** (+47%)

Conclusions

Sub-optimal temperatures strongly impaired both shoot and root growth, but fungicide treatments can positively address this environmental stress. This may be explained by the activation of some physiological mechanisms, such us biosynthesis of antioxidants (Prasad, 1997), and by the auxin-like effect of some a.i. which accelerate initial growth. Besides protection against soil-born pathogens, the application of fungicides to the seeds can help to anticipate maize sowing for better coping against summer drought and improve cultivation sustainability. Seed-applied fungicides can sustain plant wellbeing, by protecting seedlings from pathogens and prevent damage from abiotic stresses, such as low temperatures, and possibly nutrient deficiency.

References

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