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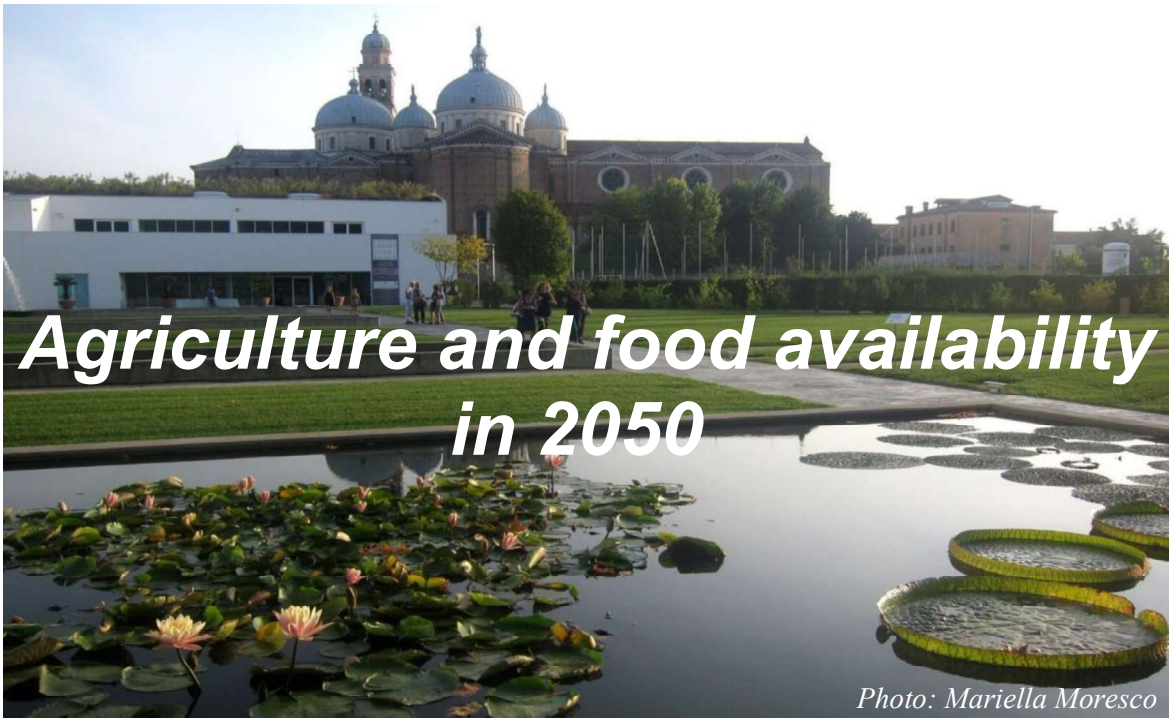

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The Role Of Seed Applied Biostimulant, Hybrid And Starter Fertilization On Maize Early Vigor And Grain Yield

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Introduction

Fast and uniform maize growth is essential to achieve high grain yield and quality, especially with early sowing and in rainy and cold springs, when the uptake of nutrients, mainly nitrogen (N) and phosphorus (P), by the root system, could be restricted. The use of hybrids more resistant to cold returns and the localized application of NP fertilizer in seed furrow guarantee a rapid maize growth, with yield and qualitative benefits (Blandino et al., 2022). Recently, the biostimulants are increasing of interest; they are substances and micro-organisms whose function is to stimulate plants to improve vigor, yield and quality, with no direct action against pests (Drobek et al., 2019). Most of them can be used to increase tolerance to abiotic stresses and in association with fertilizers in order to enhance nutrient uptake efficiency and reduce waste and pollution. Hence, in this study, the use of an innovative biostimulant seed treatment alone and in combination of other agronomic strategies have been evaluated.

Materials and Methods

A growth chamber experiment was set up in order to investigate the effect of a seed biostimulant, based on a bacterium (*Bacillus amyloliquefaciens* strain IT45), and a plant extract (*Cyamopsis psoraloides*). The experimental design was a factorial combination of two maize hybrids (different for early vigor but with the same FAO maturity class), two NP starter fertilizers at sowing placed in bands 5 cm close to the maize seed furrows (unfertilized vs. diammonium phosphate, DAP, applied at 150 kg ha^{-1}) and two seed treatments (untreated vs. biostimulant).

Sixteen kilograms of natural silty loam sub-alkaline soil, were weighed and placed, after mixing it thoroughly, in each plastic pot (27 cm length x 24 cm width x 28 cm height). Soil was not air dried, sieved, sterilized and mixed with quartz sand or other materials. Pots were placed in a controlled growth room with 50% relative humidity range, 12 h photoperiod, 700 µmol m^{-2} s^{-1} photosynthetically active radiation (PAR) and 14/17 °C (night/day) air temperature range. At 5 leaves emission stage (GS15) the plant height was measured in centimeters from the ground level up to the collar of the tallest fully developed leaf. At the same time, Leaf Area Index (LAI) was estimated according to Ruget et al. (1996). The Normalized Difference Vegetation Index (NDVI) and the Normalized Phosphorous Content Index (NPCI) were measured and calculated respectively by means the pistol grip (above each pot) and the leaf clip bundle (on the last unrolled leaf) using the NaturaSpec™ Portable spectroradiometer RS-5400®. At 49 days after sowing shoot biomass was determined for each plant plot.

In 2018 and 2019 growing seasons two field experiments were set up in North-West Italy: Carmagnola, in the same soil used in the growth chamber experiment, and Poirino (silty loam and sub-acid soil). The same experimental design of the growth chamber trial was adopted in each location and year. The treatments were assigned to experimental units in each site using a completely randomised block design with four replicates. Each plot consisted of 4 rows 0.75 m apart; the plot length and the alleys between the plots were 15 and 1 m, respectively. Ears were collected by hand at harvest maturity from 4.5 m^2 in the two central rows of each plot to quantify the grain yield. Grain moisture was analyzed using a Dickey-John GAC2100 grain analyzer. The grain yield results were adjusted to a commercial moisture level of 14%. Analysis of the variance (ANOVA) was performed for growth chamber and field experiment data with the maize hybrid, starter fertilization and biostimulant seed treatment as independent factors.

Results

As far as the NDVI value at GS15 is concerned (Table 1), the highest benefits in terms of plant growth and development, in the growth chamber experiment, have been observed on average for the starter NP fertilization (+60%), followed by the biostimulant seed treatment (+11%) and the use of a high early vigor hybrid (+8%). All compared factors significantly influenced plant heigh and LAI: on average the starter NP fertilization resulted in the highest increase, followed by the hybrid and the biostimulant seed treatment. The starter fertiliser and seed treatment significantly influenced dry shoot biomass: the fertilized plant at sowing showed the highest effect (+3.6 times than the unfertilized control) while the biostimulant seed treatment enhanced maize biomass by 21%.

In all field experiments starter NP fertilization significantly increase grain yield (+0.9 t ha^{-1}), while a significant effect of hybrid (+1.3 t ha^{-1}) and biostimulant seed treatment (+0.8 t ha^{-1}) were reported only in Poirino 2018 and Carmagnola 2019 (Table 2).

Table 1. Effect of the hybrid, starter fertilization and seed treatment on the agronomical parameters at five leaves emission stage (GS15) in the growth chamber experiment.

Factor	Source of variation	Plant height	LAI	NDVI	NPCI	Biomass
		cm	cm^2			g $plant^{-1}$
Hybrid	Control	11.83 b	164.81 a	0.25 b	0.14 b	1.08 a
	High early vigor	12.96 a	181.11 a	0.27 a	0.18 a	1.17 a
Fertilization	Control	9.84 b	93.33 b	0.20 b	0.12 b	0.40 b
	Starter	15.05 a	254.07 a	0.32 a	0.21 a	1.85 a
Seed treatment	Control	12.09 b	160.93 b	0.25 b	0.15 b	1.02 b
	Biostimulant	12.80 a	186.47 a	0.27 a	0.18 a	1.23 a

Table 2. Effect of the hybrid, starter fertilization and seed treatment on the grain yield (t ha^{-1}) for Carmagnola and Poirino field experiments in 2018 and 2019 growing seasons.

Factor	Source of variation	2018		2019	
		Carmagnola	Poirino	Carmagnola	Poirino
Hybrid	Control	17.15 a	16.13 b	14.88 b	14.98 a
	High early vigor	16.98 a	17.23 a	16.40 a	15.61 a
Fertilization	Control	16.56 b	16.24 b	15.24 b	14.87 b
	Starter	17.72 a	17.12 a	16.07 a	15.72 a
Seed treatment	Control	16.76 a	16.32 b	15.23 b	15.12 a
	Biostimulant	17.40 a	16.99 a	16.15 a	15.47 a

Conclusions

This study showed the importance of agronomic practice on maize development and productivity, especially in early sowings in temperate growing areas. The starter NP fertilization at sowing led to the highest benefit in all agronomic and environmental situation. High early vigor hybrid and the biostimulant seed application are practice that should be considered to increase crop growth and yield. The synergistic effect of a high vigor hybrid and the biostimulant seed treatment had a positive effect on grain yield (+7%) compared to the untreated control; whereas this productive advantage increases by 13% if all the factors analysed are taken into account (high early vigor hybrid, the biostimulant seed treatment and the NP starter fertilizer at sowing).

Literature

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