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Agronomical and Qualitative Benefits Effect of Nitrogen and Phosphorus Starter Fertilization at Maize Planting

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Introduction

Since the early 2000's the productivity of maize grain in Italy is almost steady, although in the presence of an active genetic improvement. The main reason is the progressive reduction of profitability and the consequent simplification of crop techniques. Therefore, it is increasingly important to develop simple and effective practices in supporting yield and quality. Among those practices, starter fertilization at maize planting has a growing interest, due to the potential influence on the first crucial stages of the plant development, supporting early planting and hence grain production and quality (Kaiser et al., 2005; Blandino et al., 2019). The aim of this research is to verify the benefit on plant development and yield of different treatments of nitrogen and phosphorus localized in furrow, in different soils.

Materials and Methods

The study was carried out in the experimental farm of the University of Turin (Carmagnola, TO) over four growing seasons (2014 - 2017), on three soils placed side by side:

- a sandy silt loam soil (SSL, sand 41%, silt 54%, clay 5%), characterized by a medium cation-exchange capacity and N content (0.09%) and a low P-Olsen content (8 ppm);
- a silt loam soil (SL, sand 12%, silt 56%, clay 32%), with a medium cation-exchange capacity and N content (0.08%) and a high P-Olsen content (32 ppm);
- a silty clay loam soil (SCL, sand 18%, silt 67%, clay 16%), with a high cation-exchange capacity and N content (0.12%) and a high P-Olsen content (23 ppm).

In each soil and growing season, three different in furrow localized fertilisation treatments (starter fertilization) at maize planting have been compared to an untreated control:

- N fertilization, 27 kg N ha^{-1} was applied as ammonium nitrate (27% N w/w);
- P fertilization, 69 kg P_2O_5 ha^{-1} was applied as triple superphosphate (46% N w/w);
- NP fertilization, 27 kg N ha^{-1} and 69 kg P_2O_5 ha^{-1} were applied as diammonium phosphate (18-46%, for N and P_2O_5, respectively w/w).

The treatments were assigned to experimental units in each soil using a completely randomised block design with four replicates. A full maturity hybrid (Pioneer P1543) was used. The previous crop was maize each year. Mechanical planting was carried out at the end of March – beginning of April, according to a prompt sowing time for the growing area, after an autumn 0.3 m deep ploughing. Before sowing, 100 kg ha^{-1} of K_2O (as potassium chloride, 60% K_2O w/w) were applied, whereas with the exception of starter in seed furrow application, no other P fertilization have been distributed. At 7-leaf stage, 250 kg ha^{-1} of N were applied as urea (46%) to all soils and fertilization treatments as side-dressing fertilization. A hand-held optical sensing device, GreenSeekerTM® was used to measure every 7 days the normalized difference vegetation index (NDVI) from the 3-leaf stage to the tassel emission. The date of flowering was recorded when 50% of plants of each plot were at tips of stigmata visible and expressed as days after sowing (DAS). At maturity grain yield and grain moisture were recorded. Data were analyzed through the analysis of variance (ANOVA) in accordance with the REGW-Q test ($P < 0.05$).

Results

The maize canopy growth was influenced by the fertilization treatments. Independently from the soil and the meteorological condition, NP fertilization has enhanced early vigor and canopy growth mainly from the 3-leaf stage (GS14) to tassel emission (GS55) (Figure 1). These effects were detected progressively through the NDVI index during the vegetative stages, while the distribution of the single N or P element

not always significantly boosted canopy development compared to the untreated control. With NP application, ceiling growth (NDVI 0.8) was reached between 14 and 22 days earlier compared to single N or P applications due to faster development; therefore, anthesis was anticipated by 3 days in all the soils.

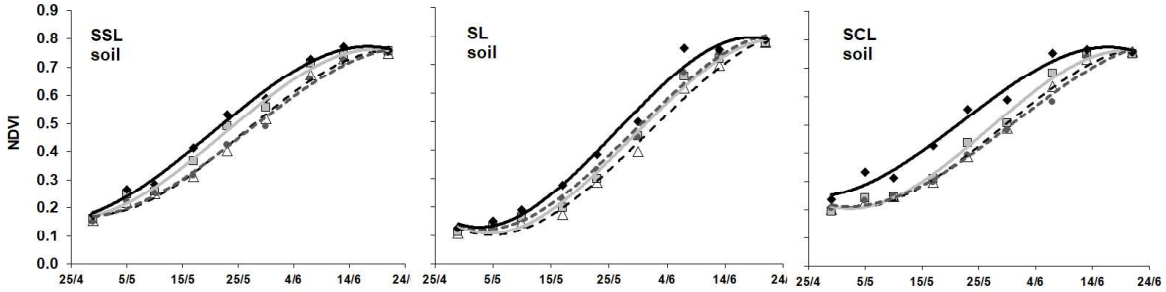

Figure 1. Effect of starter fertilization with nitrogen (N), phosphorus (P) and their combination (NP) on the maize canopy development expressed as NDVI from 3 leaf stage to tasseling.

The faster plant development with NP application has contributed to enhance competitiveness of maize, since a delay in anthesis and consequent ripening is associated to lower grain yield, delay in harvest date or higher grain moisture content (Table 1). Hence, compared to single N or P applications, yield was higher with NP application; however, over the four years, significant advantages have been highlighted in SL and SLC soils, while no difference was appreciated in SSL soil. Compared to control, single application of N or P has affected yield only in SL soil and has never showed a significant effect on grain moisture.

Table 1. Effect of starter fertilization with nitrogen (N), phosphorus (P) and their combination (NP) on maize date of flowering, grain moisture at harvest and grain yield, in soils with different texture[a].

Factor	Source	Date of flowering (DAS)[b]			Grain moisture (%)			Grain yield (t ha^{-1})		
	of variation	SSL	SL	SCL	SSL	SL	SCL	SSL	SL	SCL
starter	control	97.3 a	95.9 a	96.5 a	28.3 a	26.3 a	28.5 a	12.9 b	11.1 c	13.5 b
fertiliz.	N	97.5 a	94.7 b	95.3 b	28.3 a	25.9 a	27.2 b	13.3 ab	12.1 ab	13.9 b
	P	96.4 b	94.9 b	96.6 a	28.1 a	26.0 a	28.1 a	13.4 ab	11.6 bc	13.8 b
	NP	94.9 c	92.4 c	93.4 c	26.1 b	24.0 b	26.3 c	13.8 a	12.7 a	15.0 a
	Sign	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.029	< 0.001	< 0.001

[a] Experiment carried out in three natural soils with different texture placed side by side; SSL: sandy silt loam, SL: silty-loam, SCL: silty-clay-loam. [b] the date of flowering is expressed as day after sowing (DAS).
Means followed by different letters are significantly different. The level of significance (Sign) is shown in table.

Conclusions

This research underlines the synergic effect of NP furrow localized fertilization, as a strategic tool to enhance yield by an increased absorption of these elements during the first critical stages. Finally, early vigor and yield advantages were not related to soil Olsen-P,

Literature

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