Integrating Soil And Crop-Based Methods For Maize Variable Nitrogen Fertilisation

Eleonora Cordero[1*], Louis Longchamps[2], Raijv Khosla[3], Dario Sacco[1]

[1*] Dept. of Agricultural, Forest and Food Sciences, University of Turin, Grugliasco, Italy eleonora.cordero@unito.it
[2] St-Jean-sur-Richelieu R&D Centre, Agriculture and Agri-Food Canada/Government of Canada, Saint-Jean-sur-Richelieu, QC, Canada
[3] Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523, USA

Introduction

Nitrogen (N) is one the most important nutrients determining maize yield. Two main approaches can be used to tailor N supply considering field variability: management zones (MZ) delineation and crop N status monitoring during the growing season. Several studies demonstrated separately the advantages of these approaches on driving variable rate N application (VRA) in maize. This study aimed at verifying if their combination further improves the overall sustainability of maize cropping system.

Materials and Methods

The experiment was carried out in 2014 in three different experimental sites in Colorado (USA), located in Fort Collins, Ault, and Iliff. In each location, the trial compared four different N management strategies on maize cropping system:

- uniform N rate used by the farmer (UR);
- variable rate N management based on MZ (MZ);
- variable rate N management based on crop proximal sensing (PS);
- variable rate N management based on both MZ and crop sensing (MZPS).

Management Zone Analyst free software (Fridgen *et al*., 2004) was used to delineate MZ, isolating areas of similar productivity potential within the field. The UR received the farmer's conventional N amount uniformly distributed. The MZ approach reduced N supply where productivity potential was lower. The PS increased N rates when NDVI values were lower. The MZPS applied different N rates based on NDVI values, but increasing them according to the MZ. Greenseeker (Trimble©, Sunnyvale, California, USA) handheld active optical sensor was used to determine geo-referenced NDVI values. Grain yield was determined at harvest. The QGIS Software (QGIS Development Team, 2015) was used to link each observation to its productivity potential. The R software (R Core Team, 2016) was used for the statistical analysis, performing one-way ANOVA to evaluate significant differences in maize grain yield and PFP_N, determined as a ratio between grain yield and total N supply (Ladha *et al*., 2005).

Results

Table 2 reported grain yield obtained with the different N management practices.

Table 2: Grain yield (Mg ha^{-1}) obtained in the different locations with the four N management strategies

Treatment	Ault		Iliff		Fort Collins	
	Grain yield (Mg ha^{-1})	Mean N rate (kg ha^{-1})	Grain yield (Mg ha^{-1})	Mean N rate (kg ha^{-1})	Grain yield (Mg ha^{-1})	Mean N rate (kg ha^{-1})
UR	8.0 c	106	5.4 a	130	11.8 a	150
PS	10.0 b	71	4.3 b	98	11.6 a	113
MZ	10.9 a	71	4.5 ab	98	11.7 a	113
MZPS	9.7 b	71	5.2 ab	98	11.7 a	113

In Ault, variable rate N management increased grain yield with respect to conventional farmer's practice. Conversely, in Iliff, MZPS and MZ approaches slightly reduced grain yield with respect to UR. Moreover, N supply based on PS led to obtain a lower grain yield. In Fort Collins, maize grain yield was not affected by the different N management. However, in all locations, VRA strategies allowed to reduce mean N supply.

Compared to UR, mean N supply was 33% lower in Ault, and 25% lower in Iliff and Fort Collins. Consequently, PF techniques might lead to a potential increase in PFP_N.

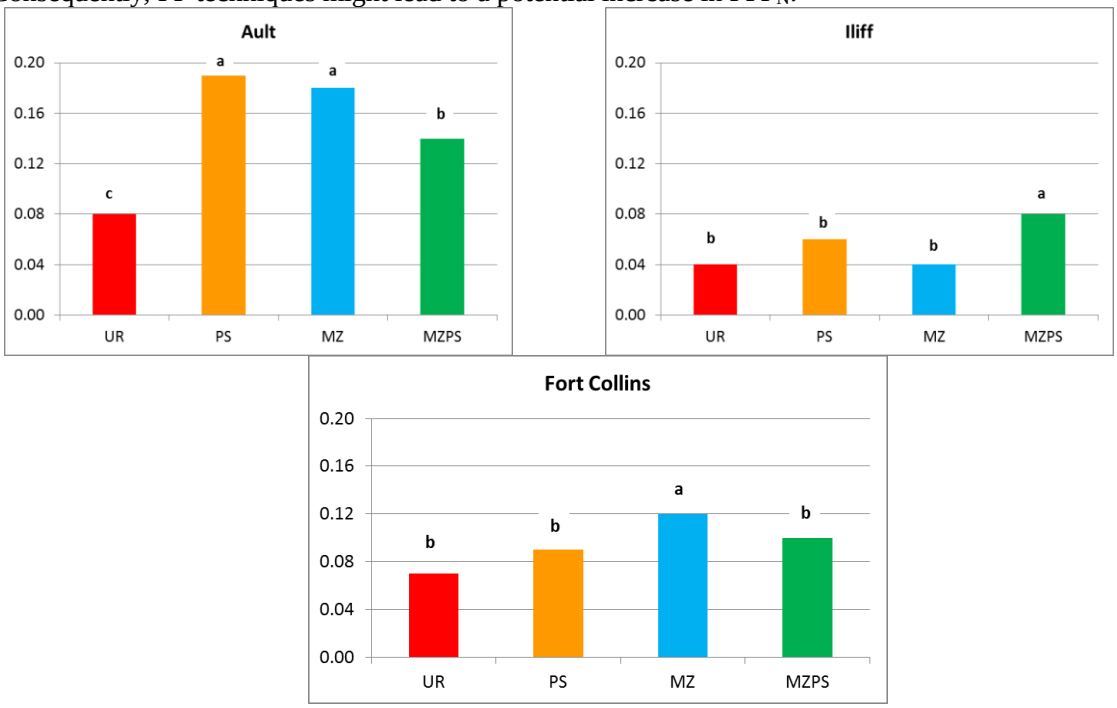

Figure 1: PFPN values for the different treatments, in the different locations

In Ault, VRA techniques increased PFP_N over UR, with PS and MZ approaches showing the highest improvement (+130%) (*Figure 1*). In Iliff, MZPS approach allowed to obtain the highest PFP_N value, that was almost twofold the other N management strategies. In Fort Collins, N supply based on MZ delineation increased PFP_N by 70% over UR.

Conclusions

This study confirmed the advantages of using VRA strategies in a farming contest. However, the best N management varied across the different locations, thus showing the importance of evaluating the best strategy in each agro-environment to increase PFP_N without compromising grain yield. Moreover, the results obtained in Iliff suggest that merging MZ and PS approach should potentially further improve maize fertilisation. Consequently, this approach needs to be tested in different agro-environment, also considering different N levels.

References

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