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Qualitative Response and Nitrogen Use Efficiency of Durum Wheat to Precision Farming Techniques

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Introduction

The current social context requires an increase in food production, improvement of its quality characteristics and greater environmental sustainability in the management of agricultural systems. Technological innovation plays a great role in making agriculture more efficient and sustainable. One of the main aim of precision farming (PF) is optimizing yield and its quality, while minimizing environmental impacts.

The present work, carried out by the Department of European and Mediterranean Cultures (DiCEM) of the University of Basilicata, in the framework of the project LUCAN CEREALS financed by PSR of Basilicata Region–mis. 16.1, has the aim to evaluate the application of PF, on the sustainability, grain quality and efficiency of the use of nitrogen on durum wheat cultivation.

Materials and Methods

The trial was conducted in 2018-19 at Genzano di Lucania (PZ) latitude: 40.82° N, longitude: 16.08° N. The study area (4.93 ha) is geologically located on the clayey hills of the Bradanica grave and the basin of Sant'Arcangelo.

The soil characteristics were detected to quantify the spatial variability of the experimental area, first by mean of low induction electromagnetic technique in order to define homogeneous areas and subsequently soil samples were collected inside the homogeneous areas to measure the main physical-chemical characteristics. The amount of nitrogen fertilizer to be applied was calculated on the base of estimated crop nitrogen uptake and soil characteristics of each homogeneous area. Three different homogeneous areas were detected and three different nitrogen fertilizer doses were applied through a variable rate spreader (VRT). The nitrogen dose applied in each homogeneous area are reported in Tab. 1. In order to verify the efficiency and effectiveness of fractional fertilization related to uniform fertilization, inside each homogeneous area in plots of 2x2 m^2 replicated three times, a dose of nitrogen equal to 120 Kg/ha (the amount generally applied by the farmer) was manually spreaded (UA).

Table 1. Units of N supplied in the different experimental conditions.

Distribution mode	Dose of nitrogen (Kg/ha N)
Unitary (UA) area 1,2,3	120 Kg/ha of N
Variable Rate (VRT)	area 1: 121.44 Kg/ha N + 35 Kg/ha N (pre-sowing) = 156.4 Kg/ha N tot.
	area 2: 63.44 Kg/ha N + 35 Kg/ha N (pre-sowing) = 98.3 Kg/ha N tot.
	area 3: 35.9 Kg/ha N + 35 Kg/ha N (pre-sowing) = 70.9 Kg/ha N tot.

At harvest, in each homogeneous and unitary area, on a sample area of 2x2 m^2 replicated three times was measured production and its qualitative parameters. Nitrogen use efficiency was calculated as ratio between total nitrogen uptake by the crop of each experimental treatment and nitrogen applied with fertilizer (*Moll et al. 1982*).

Results

The main qualitative parameters and nitrogen use efficiency measured in each experimental treatment are reported in tab. 2. Area 1 reached an average of 15.7 % grain protein content, positions 2 and 3, with an average of 13.6 %, do not show statistically difference between them.

According to this parameter no significant differences about the way of distribution, uniform over the whole area (UA) and fractionated according to soil characteristics (VRT), were observed.
In each treatment, the protein content was higher than 13 %, and was suitable for a product of a good technological quality.

Table 2. Qualitative parameters of durum wheat. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' Significance at P<0.05;**, significance at P< 0.01; ns, no significant difference.

Treatment	Grain Protein (%)	Grain Color	Grain Gluten (%)	Gran N (%)	Tot. N Uptake (kg/ha-1)	NUE tot.
Area						
1	15.7 a	14.9 a	11.7 a	2.70 a	112.0 a	0.82 b
2	13.3 b	14.5 b	10.2 b	2.40 b	63.6 b	0.60 b
3	13.9 b	14.5 b	9.7 b	2.30 b	114.9 a	1.30 a
Significance	**	**	**	**	***	**
Area x destr.mod.						
1 UA	15.0 ab	14.9	11.1 ab	2.60 ab	110.2 a	0.92 b
1 VRT	16.4 a	14.9	12.4 a	2.80 a	113.8 a	0.73 bc
2 UA	12.9 b	14.5	9.4 b	2.22 b	60.1 b	0.50 d
2 VRT	13.6 b	14.5	10.0 b	2.34 b	67.0 b	0.68 cd
3 UA	13.3 b	14.5	9.7 b	2.28 b	119.3 a	0.92 b
3 VRT	14.6 ab	14.4	10.8 ab	2.50 b	110.6 a	1.68 a
Significance	**	.	***	**	***	***

A similar response was recorded for the yellow (Color) index and the gluten content of the grain.
The data about the removal efficiency of the nitrogen supplied with the fertilizer, calculated on the basis of total straw + grain removal (NUE), showed a significant interaction between the three homogeneous areas and the distribution mode (UA and VRT); at the position number 3, the fractional fertilization technique is more efficient, and employing the VRT (Variable Rate Technology) fertilization technique has reached high levels of N removal using less nitrogen inputs, thus reaching the highest NUE and a good protein content.
On the contrary, in positions 1 and 2 no significant differences were observed between UA and VRT in terms of NUE.
However, further investigations are needed considering other Nitrogen use efficiency parameters. The application of the principles of precision agriculture and variable rate fertilizer distribution technology, even if they did not lead to a significant improvement in quality parameters and nitrogen removal efficiency (net of position 3 where they led to an improvement of the NUE), resulted in savings of 25% of the amount of fertilizer, thus minimizing the environmental impact of agricultural systems.

Conclusions

The first results obtained on durum wheat cultivation using precision farming technologies (PF) and "variable-rate" fertilizer distribution (VRT), show the possibility to join crop profitability and grain quality standard with nitrogen use efficiency. In this experiment PF and VRT did not lead to a significant improvement in quality parameters and nitrogen removal efficiency (net of area 3 where they led to an improvement of the NUE), resulted in savings of 25% of the amount of fertilizer, thus reducing the environmental impact of agricultural systems.

Literature

Moll R.H. et al. 1982. Analysis and interpretation of factors which contribute to efficiency of nitrogen utilization. Agron. J., 74: 562–564.