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Application of Precision Farming for the Sustainability of Durum Wheat Cultivation

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Introduction

Cereal crops cultivation systems are those in which precision farming (PF) technologies could be usefully applied. Generally cereal crops are cultivated on medium-large fields, in which emerges the low efficiency of the agronomic management in terms of time and space (MIPAAF, 2015).

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 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 quantify 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 Table 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)
Uniform (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 components (n ears/m^2, n seeds/ear, total production).

Results

Average field grain yield being the same (2,5 t/ha), the application of precision farming, gave as a result a reduction of 25% of nitrogen application in VRT respect to UA (373 Kg in VRT and 498 in UA Kg of N in 4,15 ha). Grain yield of area 2 (1,72 t/ha) was significantly lower respect to the average of area 1 and 3 (3,1 t/ha as average), both in VRT than in UA treatments (Tab.2), confirming the effect of soil variability on wheat productivity.

Table 2. Production 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	Total yield (q/ha^{-1})	Grain yield (q/ha^{-1})	Straw yield (q/ha^{-1})
area			
1	92.0 a	30.0 a	61.0 ab
2	65.0 b	17.5 b	48.0 b
3	108.0 a	32.0 a	75.0 a
Significance	***	***	**
Area x destr.mod.			
1 CU	91.0 ab	31.0 a	61.0 ab
1 VRT	92.0 ab	29.0 a	62.0 ab
2 CU	63.0 b	17.0 b	46.0 b
2 VRT	67.0 b	18.0 b	49.0 b
3 CU	107.0 a	32.0 a	74.0 a
3 VRT	109.0 a	32.0 a	76.0 a
Significance	*	***	.

It should be noted that, within the homogeneous areas, no significant differences were measured between the two techniques of the fertilizer application, uniform (UA) or variable rate (VRT). VRT 3 produced more (3,2 t/ha) with the lower nitrogen application rate (70,9 Kg/ha of N), also compared to the uniform application UA (120 Kg/ha of N). In position 2, on the contrary, an average production of 1,75 t/ha (the lowest one) was obtained notwithstanding was applied more fertilizer compared to position 3. It should be noted, however, that in position 2, due to plant emergency problems, there were fewer plants and ears per unit area (Tab. 2). In this situation, yield was compromised by the low plant density, as confirmed by the relationship between n of ears/m^2 and yield shown in figure 1.

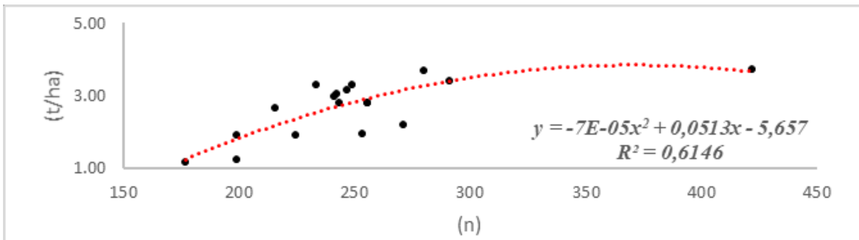

Figure 1. Relationship between yield and number of ears.

On the basis of this last observation, it follows that, for the correct application of the VRT (Variable Rate Technology) technology applied to nitrogen fertilization, the calculation of nitrogen fertilizer rate, on the basis only of the variability of the physicochemical characteristics of the soil is not sufficient. The nitrogen rate should be corrected considering also the actual number of plants/m^2 measured at the time of fertilization or by mean of indexes of cover crop as NDVI.

Conclusions

The results of this first year of study indicate the concrete possibility of using precision farming and Variable Rate Technology (VRT) to nitrogen fertilization of wheat. It is in fact possible to maintain satisfactory production levels by adapting the fertilization inputs to the real needs of the crop and its real development according to the spatial variability of the soil. The application of VRT gave as a result a reduction of 25% on nitrogen fertilizer maintaining the same level of yield respect to the uniform application on the whole field area.

Literature

MIPAAF 2015. "Linee guida per lo sviluppo dell'agricoltura di precisione in Italia", Ministero delle politiche agricole alimentari e forestali, Gruppo di lavoro per lo sviluppo dell'Agricoltura di Precisione.