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Performances of four quinoa varieties under agro-environmental conditions of central Italy

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Introduction

In the last fifteen years, quinoa (*Chenopodium quinoa* Willd.) has garnered much attention because of its high protein content and gluten free profile in comparison to other grains [1]. Some research have shown as quinoa can grow under the environmental conditions of the Mediterranean areas, but there is few information on the adaptability of quinoa varieties to the agro-environmental conditions of central Italy [2]. This is a limit for farmers in growing quinoa, despite the interest of industry for the expanding market. For this reason, the aim of this paper was to evaluate the performances of four varieties under agro-environmental conditions of central Italy.

Quinoa (cv. Regalona)

Materials and Methods

Two field experiments were carried out in quinoa in two consecutive years (exp. 1, 2018; exp. 2, 2019) in central Italy (42°57' N - 12°22' E, 165 m a.s.l.) on a clay-loam soil (24.8% sand, 30.4% clay) with 0.9% organic C content. Four cultivars of quinoa (Regalona, Puno, Titicaca and Vikinga) were compared in a randomized block experimental design with four replicates and plot size of 24.3 m^2 (2.7 m width).

Table 1: Agronomic practices in the field experiments

Experiment	1 (2018)	2 (2019)
Preceding crop	Wheat	Wheat
Sowing date	24 April	10 April
Density (no. seeds m^{-2})	100	100
Spacing between rows (m)	0.45	0.45
Emergence date	05 May	21 April
Fertilization (kg ha^{-1})	50 N; 75 P_2O_5	50 N; 75 P_2O_5
Irrigation: m^3 ha^{-1} (no.)	1600 (6)	1600 (6)
Pre-emergence weed control	s-metolachlor (480 g ha^{-1})	s-metolachlor (480 g ha^{-1})
Harvest	06 September	22 August

The main agronomic practices adopted in the field experiments are shown in Table 1.
At the harvest time, the density of plants, their biometric traits, grain yield (adjusted to 13% of moisture content) and harvest index were assessed. Data were subjected to analysis of variance (ANOVA) and means were separated using Fisher's protected LSD at P = 0.05 level. ANOVA was performed with the EXCEL® Add-in macro DSAASTAT [3].

Results

Weather conditions during the two experimental years were in line with the normal trend of the region. However, despite the rains were similar during the crop cycle in the two experiments (255 mm in 2018 and 266 mm in 2019), their distribution was uniform in 2018 and concentrate in the first and last part of crop cycle in 2019. The density of quinoa plants at the harvest was higher in Titicaca and Vikinga than in Puno and Regalona, despite the same number of germinable seeds were sown (Tab. 2).

Table 2: Differences among the quinoa varieties in the field experiments at the harvest time

Variety	Plant density (no. m^{-2})		Plant height (m)		Grain yield (g plant^{-1})		Grain yield (kg ha^{-1})		HI	
	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp.1	Exp.2	Exp.1	Exp. 2	Exp.1	Exp.2
Puno	48	70	0.69	0.87	4.8	2.3	2271	1592	0.54	0.45
Regalona	42	51	0.84	0.88	4.9	3.3	2070	1665	0.39	0.28
Titicaca	61	77	0.51	0.73	2.6	2.4	1554	1829	0.52	0.55
Vikinga	60	89	0.48	0.70	2.2	1.9	1324	1739	0.41	0.39
LSD (p=0.05)	*9*	*11*	*0.11*	*0.11*	*1.5*	*0.6*	*690*	*n.s.*	*0.03*	*0.14*

Grain yield per plant was significantly higher for Puno and Regalona than for Titicaca and Vikinga in the exp. 1, while only Regalona showed the highest yield production per plant in the exp. 2, although lower than the previous year. The values of grain yield per plant showed a negative correlation with the values of plant density (Pearson correlation coefficients based on all data confounding the varieties were: r = -0.70 in exp.1 and r = -0.85 in exp.2), confirming the capacity of quinoa to adapt the grain yield per hectare, at the variation of plants density (Pannacci, unpublished data). In the exp. 1 grain yield per hectare was higher in Puno and Regalona (2.3 t ha^{-1} and 2.1 t ha^{-1}, respectively) than in Titicaca and Vikinga, but these performances were not confirmed in the exp. 2, where not significant differences were observed among the varieties, with values ranging from 1.6 t ha^{-1} for Puno to 1.8 t ha^{-1} for Titicaca. The differences in terms of grain yield, between years for the same varieties, should be due to the different adaptability of the varieties at the different weather conditions, especially in terms of rains distribution, as confirmed by the significant interaction variety x year (ProbF=0.01). Puno and Titicaca showed the highest HI in both experiments.

Conclusions

The differences in the performances of the varieties showed that there is not the best variety, but, rather, the farmers should to use two or three of them in order to exploit their adaptability to different weather conditions, avoiding the risk of crop failure or low production choosing a single variety.

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