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Grain yield and rutin content in buckwheat (*Fagopyrum esculentum*) cv. Lileja, as affected by planting time and density

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Introduction

Common buckwheat (*Fagopyrum esculentum* Moench) is an outcrossing, self-incompatible, melliferous species of the *Polygonaceae* family. Compared to other spring crops, its short cycle is a key feature. Buckwheat grains are a gluten-free source and proteins have a high biological value. A number of health beneficial effects are reported (Brunori and Vegvari, 2007). The flavonoid rutin (quercetin-3-rutinoside), a medicinal agent for the treatment of vascular disorders, is present in vegetative organs and achenes. Buckwheat plants produce many flowers but seed set and grain production are highly variable: key factors are temperature and/or water-deficit stresses. An experiment was run in order to gain information about crop adaption to lowland areas, grain yield levels and rutin deposition, as affected by planting dates and densities.

Materials and Methods

Field tests were run in 2017 and 2018 at Udine (46°03’ N) on a loamy, superficial soil (Chromi-Skeletic Cambisol, FAO-UNESCO). A temperate-humid climate (Cfa, Köppen) is reported for the location. Irrigation water was supplied at 180 and 140 mm, respectively in the two seasons. A black polyethylene film was placed in advance above the soil to facilitate successive plantings and maintain weed-free conditions. The experiment was arranged in a split-plot design with four replications. Planting dates (T1, late May; T2, early July; T3, mid-August) were assigned to main plots, seeding rates (150, 250, or 350 achenes m^{-2}) to sub-plots. No mineral or organic fertilization was used. Rutin content was assessed by HPLC according to Bai et al. (2015), with modifications. Statistical analyses (GLM univariate and Graph) have been performed by IBM® SPSS Statistics 25.

Results

Temperatures were consistently above crop requirements in early 2017 summer and late 2018 one. No surprise that yield responses to planting dates changed according to the erratic stressful conditions. Grain yields differed between years, planting dates and crop densities (Table 1). Late May (T1) planting caused poor performances in 2017 (666 kg grains ha^{-1}) but a decent one in 2018 (1495 kg ha^{-1}).

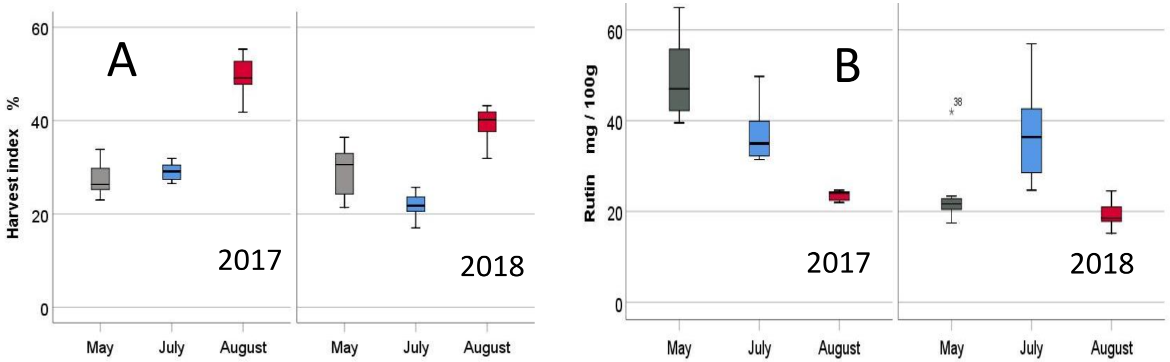
Top yields (1604 kg ha^{-1}) were obtained with T3 in 2018. The 250-seed dose, for an average density of 206 plants m^{-2} at harvest was linked to the highest yields, with no impact on other traits (Table 1).

Table 1. Main effects of year, planting time and seed dose on grain yield and achene composition.

	Grain Yield kg/ha		Harvest Index %		Stem length cm		Proteins g/kg		Polyphenols mg/100 g		Rutin mg/100 g	
2017	1022	b	35.1	a	86.4	b	128	b	618	b	35.9	a
2018	1436	a	30.2	a	111.4	a	131	a	1161	a	26.2	b
T1 - Late May	1081	b	28.3	b	101.8	a	121	b	835	b	34.8	a
T2 - Early July	1221	ab	25.4	c	109.0	a	136	a	1082	a	36.9	a
T3 -Mid August	1385	a	44.4	a	90.1	b	134	a	752	b	21.4	b
D-150	1081	b	32.1	a	103.3	a	130	a	912	a	31.3	a
D-250	1358	a	33.5	a	102.7	a	130	a	893	a	31.8	a
D-350	1247	ab	32.4	a	94.9	a	130	a	864	a	30.0	a

Mid-August planting boosted HI (Table 1; Figure 1A): reduced stems biomass and improved seed set probably co-operated. Different polyphenols (PP) and rutin levels were found in grains from the two seasons and planting dates. For both variables, interaction was significant (Figure 1B for rutin).

Figure 1. Box plots of harvest index (panel A) and grain rutin (panel B) by years and planting times.



Conclusions

Shifting plantings from late May to mid August impacted on grain yields, total polyphenols and rutin levels, albeit in a different manner in the seasons. Late plantings allowed buckwheat to improve seed set and harvest index. Lower grain rutin levels were detected with late planting, higher levels when plants were exposed to stressful conditions occurring erratically at seed-set or grain filling periods.

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