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Effect of mechanical and Manuel sowing on quinoa yield and yield components in arid region southeast Algeria.

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Abstract

Quinoa is recognized as a complete, nutritious, and healthy food with considerable genetic variability and adaptability to adverse soil and climatic conditions. Successful quinoa cultivation relies significantly on the sowing method employed. This study, conducted during the 2020/2021 cropping season at the Experimental Annex of the Technical Institute for the Development of Saharan Agriculture in Feliache, Biskra, aimed to evaluate the impact of mechanical and manual (broadcasting, rows, and group) sowing methods on the yield and yield components of quinoa. The experiment, utilizing the GIZA II variety, was designed in a randomized complete block format with three replications. Statistical analysis revealed that the broadcasting method yielded significantly greater plant numbers/m2and grain yield/ha compared to other methods. Noteworthy variations among treatments were observed concerning yield attributes, with mechanical sowing producing the highest number of plants, maximum panicles/plant, greater main panicle weight, and grain yield/plant. However, no significant effects of sowing methods on dry weight/plant, thousand grains weight, and harvest index were detected. Moreover, significant and positive correlations were identified between plant number and seed grain yield. Seed yield/plant exhibited significant positive correlations with plant height, panicles/plant, dry weight/plant, and main panicle weight. The results affirm that mechanical sowing outperformed other methods, showcasing superior outcomes.

Keywords: Arid Region, Quinoa, Mechanization, Sowing Methods, Yield Components.

Introduction

Addressing food security and achieving self-sufficiency in the face of the ever-increasing world population are primary objectives for research in the current century (Ruiz et al., 2014; Yazar et al., 2017). With projections indicating a global population of nine billion within the next few decades, the urgency of these concerns is amplified, particularly given the existing challenges of starvation in underdeveloped countries and the plight of over two billion individuals experiencing undernourishment due to inadequate diets (Ruiz et al., 2014).

In 1996, the Food and Agriculture Organization (FAO) classified quinoa (Chenopodium quinoa Willd.) as one of humanity's most promising crops, recognizing its beneficial properties and versatile uses (Alan, 2011). Positioned as an alternative to addressing serious problems in human nutrition, quinoa emerges as a crucial contributor to improving food security. Noteworthy aspects such as its low production cost (Angeli et al., 2020), nutritional properties, and diverse uses (Haros and Schoenlechner, 2017; Stanschewski et al., 2021) make quinoa an attractive candidate for sustainable agriculture.

Despite its virtues, quinoa remains one of the most underutilized crops among new-world crops. Originating from the Andes in South America, Chenopodium quinoa Willd. exhibits remarkable adaptability and development in extreme weather conditions, including drought, high salinity, and frost (Del Castillo et al., 2008; Cauda et al., 2013; MurphyandMatanguihan, 2015). Its ability to thrive in diverse environments, including lowlands, deserts, and altitudes exceeding 4000 meters above sea level, makes quinoa a valuable crop, especially in drought-prone areas of Africa (Maliro et al., 2017; Bazile et al., 2016a; Alandia et al., 2020).

Introduced to Algeria in 2014 as part of an FAO project, quinoa cultivation underwent experimental trials in eight locations across four institutions, each with distinct agro-ecological characteristics (Maamri et al., 2022). These trials focused on evaluating the adaptability and agronomic performance of quinoa under natural conditions in various regions (Maamri et al., 2022; Mehda et al., 2023). Varied studies explored aspects such as variety performance, sowing dates, water and salt stress, and other parameters influencing yields (Bazile et al., 2016b; Ahmadzai, 2020; Oustani et al., 2023; Gacemi, 2016).

In the evolution of quinoa cultivation practices, sowing has emerged as a crucial stage influencing plant density and final yields (Alan, 2011). Traditionally reliant on manual sowing methods, the surge in demand for quinoa has prompted a shift toward mechanized systems. The manual sowing of quinoa, characterized by the small size of its seeds, has proven laborious, intensive, and requiring high seeding rates (Afzal et al., 2022). Additionally, rising demand has led to price hikes, tripling quinoa seed prices over the last two decades (Alandia et al., 2020; Afzal et al., 2022; Präger et al., 2018).

The transition to more mechanized production methods, particularly in sowing, poses a significant challenge for quinoa growers in developing countries. This study aims to evaluate the impact of mechanical seeding on quinoa crop growth, yield, yield components, and productivity in an arid region, comparing it to three manual seeding methods commonly employed by farmers. This investigation addresses the evolving landscape of quinoa cultivation, providing insights into the potential benefits of mechanization for enhancing agricultural practices and ensuring food security.

Materials and methods

Pedo-climatic conditions of the experimental field

The trials were conducted during the 2020/2021 growing season at the experimental annex of the Technical Institute for the Development of Saharan Agriculture in Feliache (34°82'N, 5°77'E), situated 10 km from the capital of the municipality of Biskra in southeastern Algeria. Before the installation of the experimental device, soil samples were collected at depths of 0-20 cm and 20-40 cm for physicochemical analysis. Soil analysis was performed at the Soil Laboratory of the Scientific and Technical Research Centre for Arid Regions (STRCAR) and the Soil Laboratory of the Agronomic Sciences Department at Biskra University, revealing a loam texture. The physico-chemical characteristics of the soil are presented in Table 1.

Table 1. Physico-chemicalcharacterization of the soil.

Characteristic	Value

Clay (%)	20
Loam (%)	40.5
Sand (%)	39.5
Texture class	Loam
pH (1/5)	7.35
CE (1/5) (ms/cm)	4.33
Total N (%)	0.064
P_2O_5 (ppm)	332.72
K_2O (ppm)	15.37

Climatic Data

Climatic data, including temperature, relative humidity, and dew point, were recorded by sensors placed 1.5 meters above the soil in the middle of the experimental area. The trial period (November 2020 - May 2021) experienced cold and dry conditions, with average minimum and maximum temperatures of 12.55°C and 24.25°C, dew points of 4.25°C and 8.52°C, and relative humidity ranging from 24.25% to 57.34%.Local climat information are given inFigure 1.

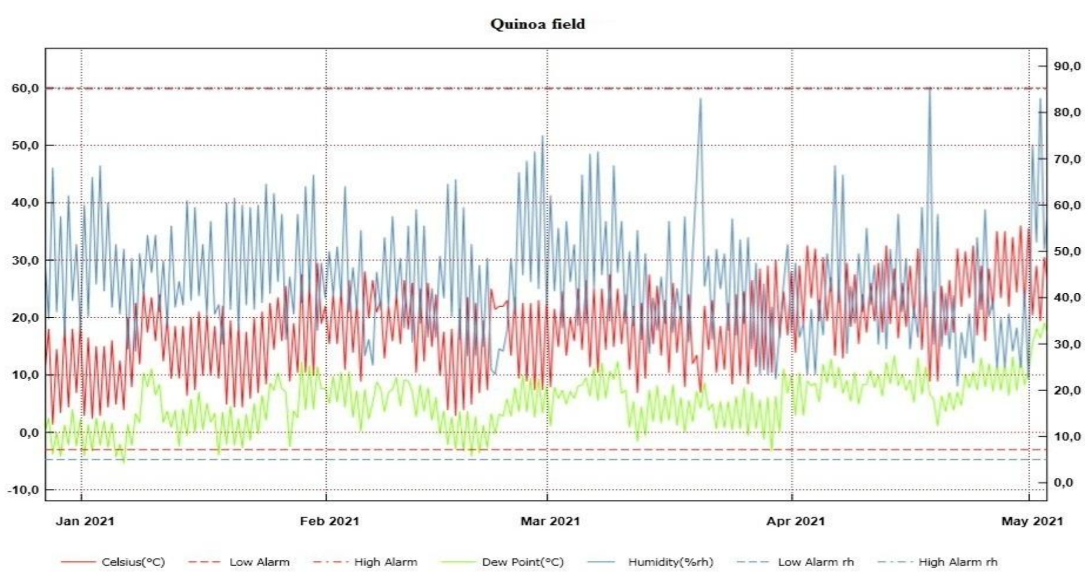

Figure 1. Daily climate data of the experimental field during trial conduction.

Vegetal Material and Germination Test

Quinoa seeds of the Giza II variety from the Technical Institute for Development of Saharan Agriculture in Biskra (ITDAS) were used for the trial. Germination tests were conducted with 25 seeds per Petri dish in four replicates. The seeds, manually selected to eliminate damaged or deformed ones, were placed on filter paper, kept moist, and subjected to a hot, humid, and dark environment at 25°C. The germination rate, determined after a week, averaged 98%.

Soil Preparation and Experimental Device

To ensure a high-quality seed bed, the soil underwent deep plowing (40 cm) using a disc plow, followed by two cross passages of cover crop for clod destruction and thorough mixing with the basal fertilizer (200 kg ha^{-1} of NPK 20.20.20). The experimental device, arranged in random blocks with three replicates, consisted of units measuring 36 m^2 (3 m x 12 m) for mechanical row sowing and 6 m^2 (3 m x 2 m) for manual sowing. Each plot, whether mechanical or manual, had 9 rows spaced 33 cm apart.

Cultivation Plant

Sowing of experimental plots occurred on November 14th, 2020, using either mechanized or manual methods. For manual sowing, three methods—Row, Broadcast, and Group—were employed, with seed rates of 12 kg, 15 kg, and 6 kg per hectare, respectively. Mechanized sowing utilized a cereal row seeder with a working width of 3 m and 21 rows spaced 14.28 cm apart, resulting in a seed rate of 1.70 kg ha^{-1}, equivalent to a density of 32 plants m-². Nitrogen fertilizer (urea 46%) was added four weeks after emergence at a rate of 130 kg ha^{-1}. Weed control was manual, with no herbicides used. Drip irrigation, applied every 2 to 4 days for 3 to 4 hours, ensured proper moisture levels.

Measurements

At the harvesting stage in mid-April, 10 samples from each plot were taken for the quantification of the number of plants at harvest (NP m^{-2}). The harvested plants were air-dried for 7 to 15 days, and various measurements were obtained, including dry matter (PDW), plant height (PH), number of panicles per plant (NPP), main panicle length (MPL) and weight (MPW), grain yield per plant (GYP), total grain yield (GY), thousand grain weight (TGW), and harvest index (HI %).

Statistical Analysis

Data analysis was performed using IBM SPSS version 20.0 software for Windows. Mean ± Standard deviation (mean ± SD) of three replicates was reported. Statistical significance was determined using one-way ANOVA and Kruskal-Wallis test. Shapiro-Wilk's test checked the normal distribution of all parameters ($P > 0.05$). Tukey's LSD test at $P < 0.05$ was used to compare treatment means. Pearson's correlation analysis assessed the relationships between yield and component traits.

Results and discussion

Number of plants at harvest

The variation of the average NP m^{-2} for each sowing method is presented in "Figure 2", Large significant differences ($p < 0.05$) were observed between the seeding methods tested in terms of NP m^{-2}. The highest average NP m^{-2}(78.67) was obtained in broadcasting method, while the mechanical sowing produced minimum average of NP m^{-2}(24.30).

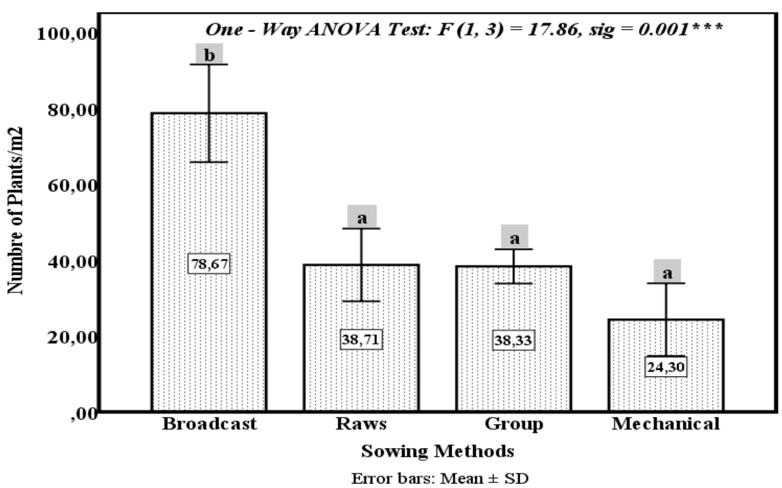

Figure 2. Variation of number of plants as a function of sowing methods.

The statistical analyses of the data reveal a notable increase in plant population density per m² with rising planting density, particularly under high density using the manual broadcasting method. Despite the mechanical mode employing a seeding dose eight times lower than that of broadcasting sowing (1.70 kg ha^{-1} compared to 15 kg ha^{-1}), the difference in plant population was only 3.23 times less. Notably, the three sowing methods (broadcasting, row, and group) belong to the same group "a," suggesting no seeding dose effect between these methods “Table 2”. These findings, which present a plant population higher than that reported by Mehda et al. (2022), suggest variations in NP m-² under similar agronomic conditions in the arid region of Ouargla, southeast Algeria.

Table 2. Multiple comparisons of means with post hoc tests.

Sowing	methods	PN/m^2	PH	NPP	MPL	MPW	GYP	GY	TGW	HI
Broadcast	Rows	39.95*	3.23^{NS}	-0.66^{NS}	-10,83^{NS}	1.79^{NS}	2.31^{NS}	0.02^{NS}	0.11^{NS}	-3.27^{NS}
	Group	40.33*	4.00^{NS}	-0.26^{NS}	-1,50^{NS}	2.09^{NS}	4.47^{NS}	8.69*	0.19^{NS}	-0.68^{NS}
	Mchanical	54.37*	-11.03*	-3.46*	-6,00^{NS}	-5.82^{NS}	-8.68^{NS}	8.98*	-0.10^{NS}	-6.59^{NS}
Mechanical	Broadcast	-54.37*	11.03*	3.46*	6.00^{NS}	5.82^{NS}	8.68^{NS}	-8.98*	0.10^{NS}	6.59^{NS}
	Rows	-14.41^{NS}	14.26*	2.80^{NS}	-4.83^{NS}	7.62*	11.00*	-8.95*	0.21^{NS}	3.31^{NS}
	Group	-14.03^{NS}	15.03*	3.20^{NS}	4.50^{NS}	7.92*	13.15*	-0.29*	0.29^{NS}	5.90^{NS}

Difference in means according to Tukey and LSD test. asterisk “*” and “NS” represent significant and non-significant, respectively, at $P < 0.05$. plants number m-^{2} (PN), plant height (PH), number of panicles/plant (NPP), main panicle length (MPL), plant dray weight (PDY), main panicle weight (MPW), grain yield/plant (GYP), grain yield (GY), thousand grain weight (TGW) and harvest index (HI).

Plant height

The data presented in “Figure 3” shows significant variation between different methods, the effect of sowing techniques on the plant height was found significant the highest value was obtained by the mechanical seedling plants (88.53 cm) and the lowest by group method (73.50 cm)

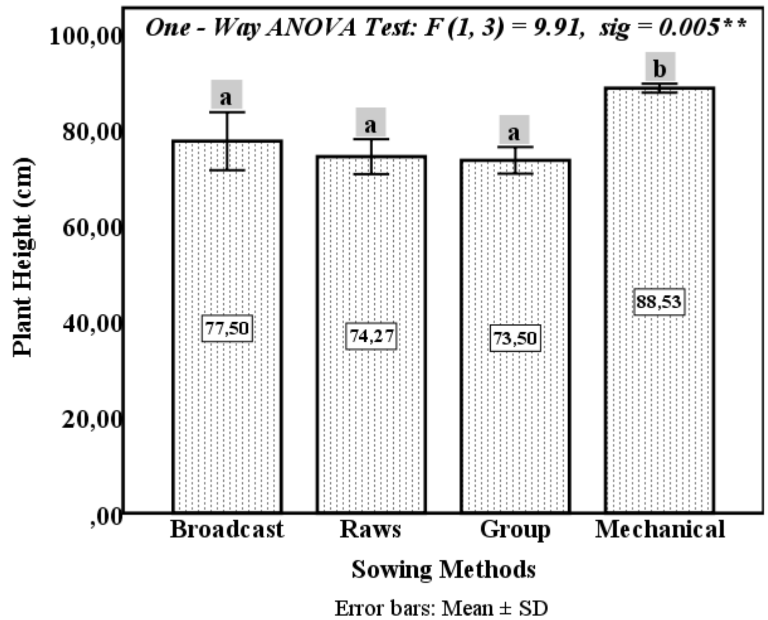

Figure 3.variation of plant height as a function of sowing methods.

Concerning sowing methods, mechanical sowing with low density resulted in taller plants compared to manual methods such as broadcasting, row, and group sowing “Table 2”. Higher density sowing generally leads to weaker and smaller plants (Aguilar and Jacobsen, 2003). The increased seed density in manual methods may be attributed to reduced light quality, nutrient absorption, and plant competition (Wang et al., 2020). Environmental conditions, including temperature and precipitation, have been noted in other studies (Ciftci et al., 2020; Ali et al., 2020; TemelandYolcu, 2020; Maamri et al., 2022), to play a crucial role in plant height.

Number of panicles per plant

The results show that large differences (*p*< 0.05) were observed between sowing methods in terms of panicles number/plant “Figure 4”. The highest NPP were observed in the mechanical seedling technique with an average number of (9,067); while the lowest NPP were produced by broadcasting technique with an average of (5.60) panicles/plant.

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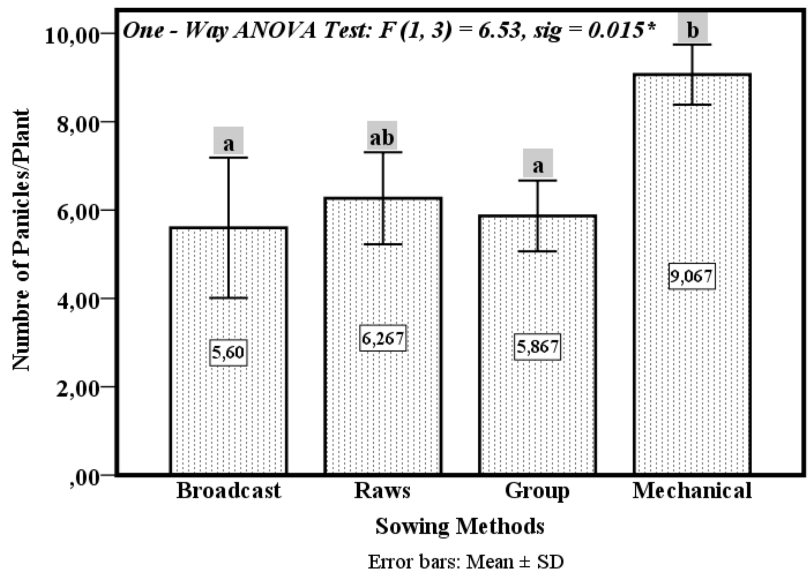

Figure 4. Variation of panicles number per plant as a function of sowing methods

Mechanical sowing in rows caused an increase in NPP (Figure 4), consistent with the findings of Hamza et al. (2021). This increase is attributed to the homogeneous distribution of seeds, supporting root system development and deeper roots compared to other methods (Ali et al., 2020; Hamza et al., 2022). Similar results were reported by Dao et al. (2020), showing an increase in the number of branches and panicles under low-density rates. Lower plant density led to increased branching and, consequently, a higher proportion of panicles (Wali et al., 2022).

Main panicle length

As can be seen in Figure 5, it was found that in which different methods sowing, was statistically insignificant in term of MPL. The maximum average of MPL was recorded in row sowing method (25.12 cm), followed by mechanical seedling (20.29 cm) While broadcasting method produced the minimum MPL (14.29 cm).

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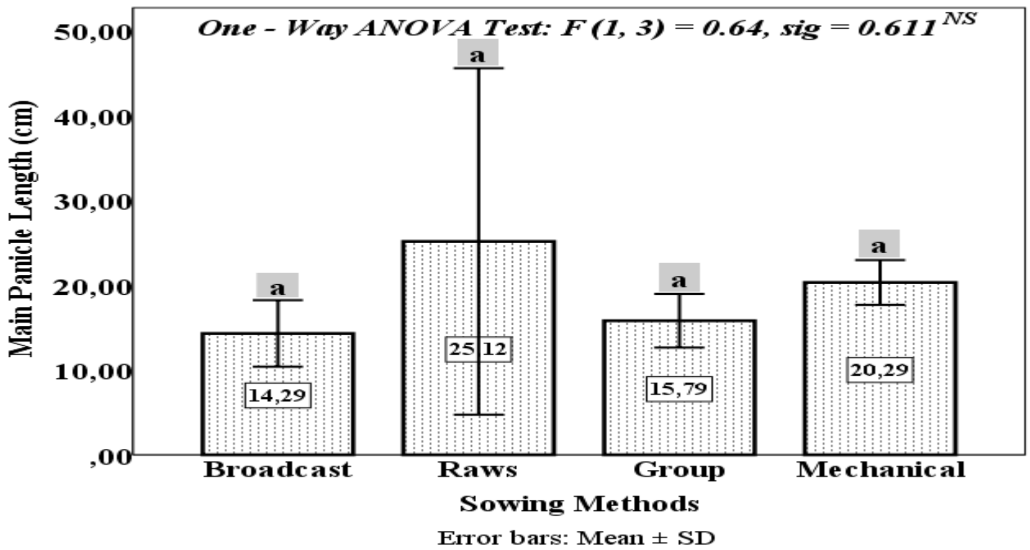


Figure 5.variation of main panicle length as a function of sowing methods.

Main panicle length results indicated no significant effect of sowing techniques “Figure 5”. However, quinoa sown in rows (seedling) produced lengthier panicles in both manual and mechanical seedlings compared to other tested techniques. These findings align with the results of Biswas et al. (2021), who reported higher panicle length in seedling planting. Conversely, Ali et al. (2020) noted that the panicle length in the bad seed technique performed relatively better, indicating the positive effect of homogeneous seed distribution on this parameter.

Plant dry weight

Dry weight per plant was found to be insignificantly affected by sowing methods. the plots sown by the seeder (mechanical seedling) were superior (57.27 g) to the rest of the planting techniques, followed by broadcasting, group and raw method.

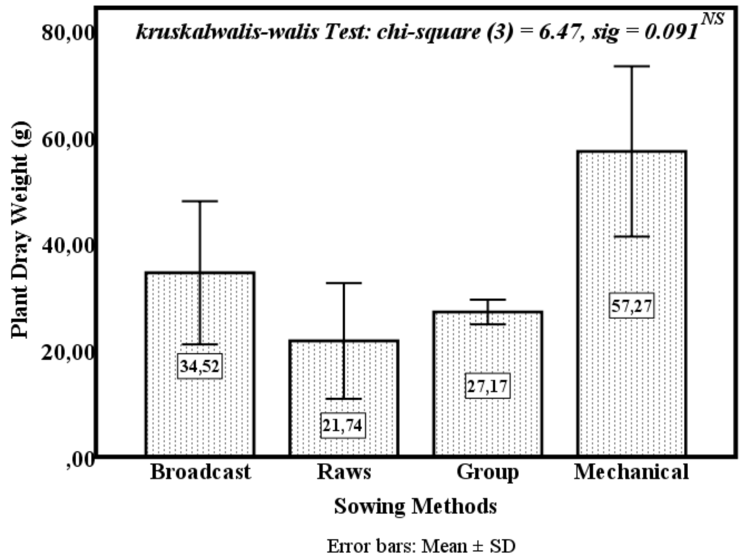
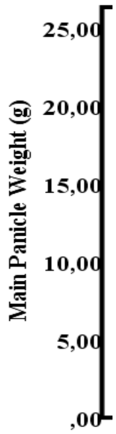


Figure 6.variation of dray weight as a function of sowing methods.

Statistical analysis showed that values of PDW were statistically insignificant, with the greater dry weight obtained with the lower dose in mechanical sowing. Our results are consistent with Wang et al. (2020), who reported that plant density had no effect on the dry matter of quinoa leaves and stems. Improvements in dry matter were attributed to irrigation, nitrogen rate, and plant density.

1.1. Main panicle weight

Difference between quinoa samples obtained from trial was found statistically significant in term of MPW "Figure 7". It has been observed that the MPW varies between (17.66 g) as highest value produced by mechanical method, and the lowest value produced by group method (9.74g).



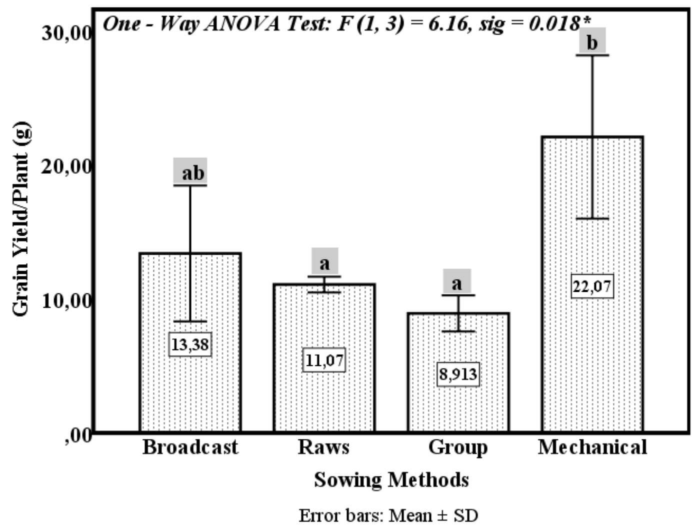


Figure 7.variation of panicle weight as a function of sowing methods.

The present results indicate a significant effect between different methods tested ($P < 0.05$), with the mechanical technique producing higher MPW compared to other sowing methods “Table 2”. Our findings align with those of Ali et al. (2020), suggesting that MPW is significantly affected by sowing techniques based on homogenous seed distribution. Moreover, the lower density in the mechanical technique was identified as the best sowing technique that resulted in the maximum MPW “Figure 7”. These results are in accordance with Ciftci et al. (2020), who noticed that the decrease in plant density significantly improves panicle weight. However, our findings are lower than those reported by Sajjad et al. (2014) and Mehda et al. (2022), who found higher MPW values.

1.2. Grain yield per plant

The application of mechanical sowing methods significantly increased the seed yield per plant of quinoa compared to the Manuel methods ($p < 0.05$). Where the highest seed yield (22.07 g) was obtained by mechanical sowing and the lowest seed yield (8.91 g) produced in the plots sown in group technique as Shawn in “Figure 8”.

Figure 8.variation of grain yield per plant as a function of sowing methods

The results show that mechanical seedling had a positive significant effect on GYP "Table 2" compared with the rest of the techniques. Mechanical sowing (22.07 g/plant) produced GYP 1.64, 1.99, and 2.47 times higher than that under broadcasting, row, and group methods, respectively. The increase in GYP can be explained by the combination of taller PH, higher NPP, and MPW, as observed in the mechanical method (Oustani et al., 2023). Dao et al. (2020) found that the highest productivity per plant (8.43 g) occurred under low-density rates in ridge sowing, which had the same idea of seed distribution as mechanical rows sowing (low density and sown in rows). Other studies confirm that seed yield per plant decreases with increasing plant density due to competition for light and nutrients (Wang et al., 2020). Ali et al. (2020) reported that the low yield might be due to soil compaction by flooding irrigation and poor development of the root system in other techniques, negatively affecting the yield.

Grain yield

According to the values obtained, there was significant variation of seed yield, it was considerably influenced by the sowing methods "Figure 9". whereas the maximum seed rate (broadcasting and rows) recorded the highest values of seed yield (13.30 and 13.27 qx/ha) at seed rates of 15 and 12 kg/ha. Which was increased the yield by about 8.70 and 9 qx /ha "Table 2" more than the lowest seed rates (6kg/ha and 1.70 kg/ha) in group and mechanical methods, with yield of (4.61 and 4.32 qx/ha) respectively.

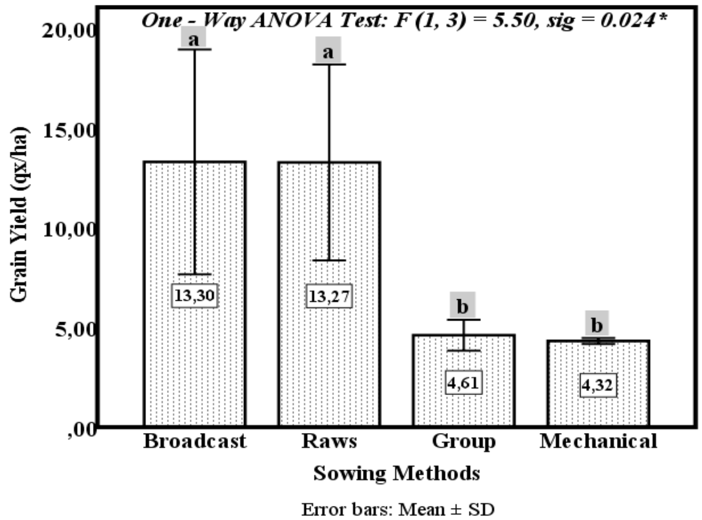


Figure 9.variation of total yield as a function of sowing methods

The results of the research clearly indicate that the increase in sowing density significantly improves GY. These results are in harmony with those achieved by Sayed et al. (2018) and Wali et al. (2022), reporting a significant increase in seed yield per area, especially under high density. The seed yield per hectare under low density in the mechanical method (4.32 qx ha^{-1}) significantly decreased, being 3 times less compared with the high sowing density of broadcasting. However, the seeding dose applied in mechanical mode was 8 times lower than those applied in broadcasting. Meanwhile, quinoa seed yield did not differ significantly ($P > 0.05$) between the group method and mechanical sowing on the one hand, and between broadcasting and rows on the other hand "Table 2". The greater GY ha^{-1} under high sowing rows in the manual method was reported to a higher NP m^{-2} at harvest, leading to a significant increase in seed yield of quinoa (Hammad et al., 2021; Hamza et al., 2021). The results of total grain yield recorded in this field trial remain different compared to the yields obtained in studies carried under similar conditions in Algeria (sowing in November, in arid regions, sowing density of 15 kg ha^{-1}, and irrigation with a drip system), where the GY ranged from (2.8 t ha^{-1}) to (9.6 qx ha^{-1}) (Mahda et al., 2022; Oustani et al., 2023). The variation in yield between these trials might be due to the response of quinoa genotypes to different agro-climatic conditions (temperature, rainfall, soil humidity, soil, and water salinity) (Oustani et al., 2023) and a number of management factors (soil preparation, sowing methods, application of irrigation, nature and level of fertilizers) (Ali et al., 2020; Präger et al., 2018).

Thousand grain weight

In this study, the impact of sowing methods on the TGW of quinoa was determined to be statistically insignificant ($p > 0.05$). According to these results, the thousand weights varied between 3.80 and 4.10 g "Figure 10".

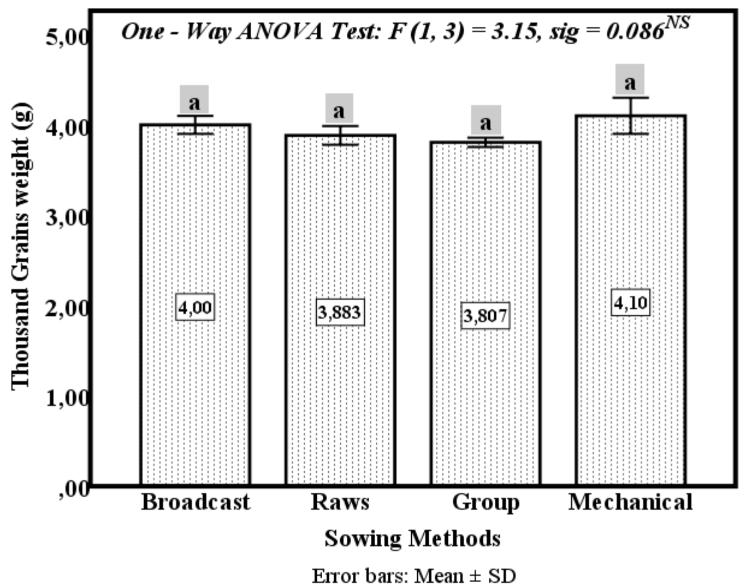


Figure 10. Effect of sowing methods on thousand grains weight.

In the data from our study, it was noted that the differences in the weight of a thousand grains due to applications of sowing methods were statistically insignificant. However, the results indicate that the crop sown with a seeder machine had a higher grain size (4.10 g) than all other sowing methods. Our results are close to those recorded by Shoman (2018), who found TGW ranging between 4.00 and 3.96 g, and noticed that the higher value of TGW is probably due to the critical role of nitrogen, contributing to the increase in metabolites employed in building yield components. A similar trend was obtained by Biswas et al. (2021), who observed that the analyses of 1000-seed weight were not affected by the planting method applied. The obtained results are in concordance with previous studies that reported no significant difference between different agricultural practices (nitrogen application and sowing time) in relation to the TGW. Likewise, they considered that this parameter is a genotypic characteristic dependent on quinoa genetics and cultivar (Altuner et al., 2019; Ebrahimikia et al., 2021;). On the other hand, Ali et al. (2020) and Dao et al. (2020) studied the effect of different planting techniques on quinoa and found that the 1000-seeds weight was affected by the planting technique, resulting in significant effects.

Harvest index

The application of different sowing methods was found statistically insignificant in term of harvest index “Figure 11”. The numerically higher harvest index (47.26%) was observed in broadcasting sowing compared to that of group method (33.01%).

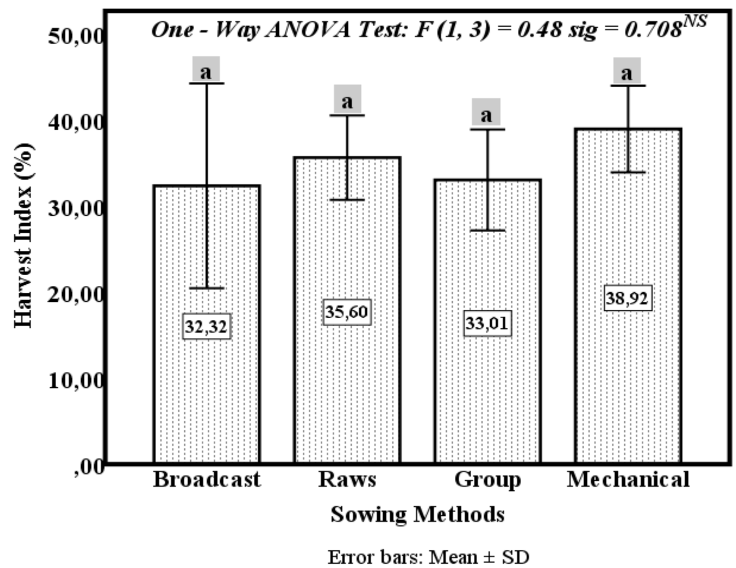


Figure 11. Effect of sowing methods on harvest index.

The present results reveal that no significant variations for HI are observed between the four sowing methods. The HI values in our case were lower compared to those of Maamri et al. (2022), which varied between 31% and 64%. The relative variation of HI can also be related to the low temperatures at the time of flowering (Maamri et al., 2022; Oustani et al., 2023). This parameter was directly linked to the grain yield of the plant and the dry weight of this plant. Therefore, this ratio between vegetative and reproductive parts might be affected by a number of agronomic practices such as sowing date, plant density, fertilization, and irrigation (Bhargava et al., 2007; Geren, 2015). These results confirmed those obtained in previous research by Wali et al. (2022) showing that the response of quinoa in terms of the harvest index was unaffected by nitrogen application.

Interaction Between Yield Parameters According to Sowing Methods

Correlation analysis was performed to understand the behavior and relationships between morphological characteristics, yield, and yield components according to the applied sowing methods. Pearson correlation results "Table 3" showed strong positive correlations between morphological parameters and grain yield. A significant positive correlation was observed between NP and GY. PH showed a significant relationship with NPP, PDY, MPW, GYP, and TGW. Similarly, there was a positive correlation between NPP with PDY, MPW, and GYP, and PDY with MPW and GY. A strong and positive correlation was noted between MPW and GYP.

Table 3. Pearson Correlation analysis of yield and yield components parameters of quinoa

	GY	PN/m^2	PH	NPP	MPL	PDW	MPW	GYP	TGW	HI
GY	1	-	-	-	-	-	-	-	-	-
PN/m^2	0.661*	1	-	-	-	-	-	-	-	-
PH	-0.421	-0.359	1	-	-	-	-	-	-	-
NPP	-0.340	-0.464	0.728**	1	-	-	-	-	-	-
MPL	0.038	-0.205	0.272	0.350	1	-	-	-	-	-
PDY	-0.474	-0.338	0.710**	0.684*	-0.185	1	-	-	-	-
MPW	-0.467	-0.398	0.774**	0.744**	0.213	0.882**	1	-	-	-
GYP	-0.109	-0.239	0.587*	0.727**	0.049	0.734**	0.809**	1	-	-
TGW	-0.176	-0.078	0.763**	0.388	0.214	0.395	0.543	0.448	1	-
HI	0.521	0.402	-0.253	-0.150	-0.343	-0.183	-0.198	0.355	-0.065	1

*correlation Significant at $P < 0.05$, **highly significant at $P < 0.01$,among grain yield (GY), plants number m^{-2} (PN), plant height (PH), number of panicles/plant (NPP), main panicle length (MPL), plant dray weight (PDY), main panicle weight (MPW), grain yield/plant (GYP), thousand grain weight (TGW) and harvest index (HI).

Regarding the Pearson correlation analysis performed "Table 3", a significant positive correlation was observed between PN and GY. This reveals that an increase in PN significantly increases grain yield. The obtained results are in concordance with Altuner et al. (2019) and Hammad et al. (2021). They reported that the decrease in the number of plants per m² negatively affects the seed yield of quinoa.

In our study, the higher PH in the quinoa crop had a direct and positive effect on different morphological and yield characteristics, indicating that plants with greater height also developed a greater NPP. This is attributed to the better plant structure with good plant and panicle weight (PDY, MPW), naturally having more seed weight and size (GYP, TGW). In general, these results agreed with ranges reported for studies by Bhargava et al. (2007) and Oustani et al. (2023), which are confirmed by the correlation analysis where the morphological parameters showed a positive relationship with the GYP, which was positive and highly significant for most characters. Among other variables, a significant positive association existed between NPP and some yield components (PDY, MPW, GY), indicating that plants with the largest NPP have the ability to improve their production qualitatively (PDY, MPY) and quantitatively (GYP) (Bhargava et al., 2007). On the other hand, PN, PH, NPP, and MPW in the quinoa crop are directly related to the other production parameters, and the positive correlation between these variables is a clear indication of their role in raising and improving the yield, a fact also reported by Ali et al. (2020).

Conclusion

Sowing is one of the most important activities because the emergence of seedlings impacts plant density and final yields depends on this stage. As a result of the present work, wherein the effects of differentsowing methods on the growth, production and yield components of quinoa were tested, it can be concluded that the quinoa crop responded significantly to sowing techniques with different seeding rates. The application of mechanical method with a low seed rate led to a significant increase in most of the studied parameters of growth and quality of the quinoa crop, such as PH, NPP, MPW and GYP. However, in all cases, the Manuel sowing Whatever the method, whether in broadcasting, row or in group, higher sowing density results in weaker and smaller plants, few panicles with lower yield per plant. The maximum seed rate in broadcasting significantly influenced the PN that contributed to increase the GY it was 3 time moreas compared with the low sowing density of mechanical method. However, the seeding dose applied in those was 8 times lower than applied in broadcasting. In terms of yield properties (TGY and HI) it was observed that there was no significant effect of different sowing methods were tested. the results of the present study demonstratedthat The PN had positive significant correlation and directly influenced the GY.Whereas, a strong positive correlation existed between PH, NPP, PDY and MPW with GYP. Ultimately, the mentioned results permitted us to evaluated the adaptability of this new crop to the environment arid conditions of southern Algeria, particularly in Biskra. It is necessary to encourage the mechanization of different cultural operations, especially at sowing stages that have a great influence on the economic (reducing production expenses) and agricultural (growth, morphology and yield) levels, as illustrated in the results obtained. Further, future research is needed on quinoa crop with various agricultural practices, planting density, sowing time, with different levels of fertilizers, irrigation and agronomic treatments under different Agro-ecological zones. To make better adjustment of quinoa in cropping system and crop rotation.

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