



Evaluation of the performance of two barley varieties at different sowing dates

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Abstract

This study, carried out in the 2023–2024 season at Rashedia Research Station, evaluated two barley cultivars (Mosul 1 and Noor) and three planting dates (15/November, 15/December, 15/January) using a factorial RCBD design. Results showed that the Noor cultivar significantly outperformed Mosul 1 in plant height (53.5 vs. 45.2 cm), spikes.m⁻² (719.6 vs. 412.5), grain yield (552.7 vs. 305.2 g.m⁻²), and biological yield (1785.3 vs. 1279.8 g.m⁻²). The first planting date (15/November) yielded the best results across all traits compared to later dates, including higher spikes.m⁻² (651.0), grain yield (572.3 g.m⁻²), and biological yield (2044.1 g.m⁻²). Notably, interaction of Noor with the first date achieved the highest grain yield (736.6 g.m⁻²) and biological yield (2306.7 g.m⁻²), while Noor with the second date produced the tallest plants (59.6 cm) and most spikes.m⁻² (872). These findings recommend Noor cultivar planted in mid-November for optimal productivity.

Keywords: Barley Varieties; Planting Dates; Biological Yield; Number of Spikes M⁻².

1. Introduction

Barley (*Hordeum spp.*) is an important cereal crop in Iraq due to its diverse uses. It is used as a green or dry fodder crop, and is grown within the rainfall range of (200-350) mm (Al-Fakhri, 1981). One of most significant cereal field crops cultivated to supply farm animals with green feed is barley. Barley varieties vary in their ability to grow and tolerate drought, especially in areas with limited rainfall (Hayawi et al., 2021). It may be used as green fodder produced from hydroponics through barley incubator rooms (Al-Kurdoushi, 2023). Barley stands out from other crops in its rapid growth, drought and salinity tolerance, and high nutritional value (Ali et al., 2000). Barley is used in many countries to make bread and is also used in many industries (Asnawi et al., 2021). After maize, rice, and wheat, barley comes in fourth place worldwide and is cultivable in wide climatic range (Hamid et al., 2012). Many sources and researches have mentioned that barley varieties vary in their ability to withstand drought and climate change (Al-Rajabou, 2014). Heather et al. (2012) concluded during their testing of (16) barley varieties, including two two-row varieties, that the six-row varieties significantly outperformed the two-row varieties in several characteristics, including grain yield, plant height, and quantity spikes/ unit area. Planting time is one of the most crucial field practices, which affects the germination, emergence, growth, development and yield of crops. After preparing the appropriate seedbed, the seeds must be placed in soft soil free of large soil clods in order to ensure that moisture reaches the seed for the purpose of absorption and activation, and then the germination process begins (Al-Muaini and Al-Ubaidi, 2018). So, the planting date is the day the seeds are placed in the soil, provided that the soil is given germination irrigation, which achieves the longest period of time for the growth and development of the crop from emergence until physiological maturity (Al-Huwairis and Ahmed, 2010). The most suitable date for planting barley is mid-November until December in irrigated areas, while in rain-fed areas, the planting date depends on rainfall (Salman and Jasim, 2011).

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2. Materials and Methods

Research was carried out at the Rashidiya Research Station, Nineveh Research Division, and Agricultural Research Department during the 2023–2024 growing season. Field was divided into three sectors for the purpose of distributing treatments to experimental units. Experiment included two factors: first was barley varieties (Mosul 1 and Noor), and the second was planting dates (15/November, 15/December, and 15/January), with seed rate of 100 kg.ha⁻¹. Number of experimental units was (18) units resulting from (2 × 3 × 3), and area of each experimental unit was (1 × 2) m². It contains 4 lines with a distance (25) cm. between each line. Following traits were examined at the end of season: plant height, number of spikes per square meter, and number of grains.spike⁻¹, grain yield, weight of 1000 grains and biological yield. Research was carried out using R.C.B.D. design with three replications (Al-Rawi, 2000). Data were analyzed using a computer according to SAS program and using Duncan's multiple range test (Duncan, 1955) to compare means at 0.05 probability level.

3. Results and discussion

3.1. Plant height (cm)

Plant stems generally grow longitudinally through the elongation of internodes. The cultivar, along with the prevailing environmental conditions in the region, is the determining factor for this trait. Plant stem elongation is usually rapid, especially in the late stages of growth (March and April). This may be due to the growth of the upper cuttings (Evans and Wrdlaw, 1976). Results of table (1) indicate that Noor barley variety significantly outperformed Mosul 1 barley variety in the average plant height trait with increase rate (18.36)%, and The genetic composition of the two types differed, which could be the explanation of this discrepancy (Al-Adhari, 2000). In addition to the difference between the varieties in exploiting the surrounding environmental conditions, which led to the emergence of variation in plant height (Al-Hadithi, 2018).

Table 1 Effect of varieties, planting dates and their interaction on plant height (cm)

Barley varieties	Planting dates			Average varieties
	15 / Nov.	15 / Dec.	15 / Jan.	
Mosul 1	55.6 a	42.0 bc	38.0 c	45.2 b
Noor	52.0 ab	59.6 a	49.0 abc	53.5 a
Average date	53.8 a	50.8 ab	43.5 b	

At the 0.05 probability level, there is no discernible difference between similar letters.

The average height of the plants varied along with the planting dates, as maximum plant height was reached at first date (15/November), which was (53.8) cm, thus significantly exceeding the third date (15/January), with an increase rate of (23.67)%. This may be due to fact that late planting dates may expose the plants in the field to many negative effects resulting from high temperatures during the elongation and branching stages, which leads to pushing the plants to enter the flowering and ear-extrusion stage, which negatively affects the plant height characteristic (Jassim et al., 2024). The average height of the plants varied along with the planting dates, and the second date (15/December) resulted in recording the highest plant height, which reached (59.6) cm, hence surpassing all encounters by a significant margin. As for lowest height, it was achieved when interacting between the Mosul 1 barley variety and the third date (15/Jan.), as the height reached (38.0) cm.

3.2. spikes .m⁻²

Number spikes per unit area is an important trait that results in increased yield. This characteristic is typically associated with a number of circumstances, such as cultivated variety, appropriate sowing date for each variety, and the surrounding environmental conditions (Al-Fakhri, 1981). Any crop that is planted on the right date will have good growth qualities, which are represented in the crop's components and attributes (Al-Amin, 2015). Table 2 that Noor barley variety significantly outperformed Mosul 1 variety with a numerical difference of (298.1) spikes.m⁻² and an increase rate of (41.42)%. This could be explained by the variations in genetic makeup between two varieties, which was reflected in ability of each variety to better exploit surrounding growth factors and the reflection of this on the increase in this trait, in addition to the difference between the two varieties in the formation of the shoots (Al-Hade et al, 2020).

Table 2 Effect of varieties, sowing dates and interaction on spikes.m⁻²

Barley varieties	Planting dates			Average varieties
	15 / Nov.	15 / Dec.	15 / Jan.	
Mosul 1	493.0 b	407.0 b	364.6 b	421.5 b
Noor	809.0 a	872.0 a	478.0 b	719.6 a
Average date	651.0 a	639.5 a	421.3 b	

At the 0.05 probability level, there is no discernible difference between similar letters.

Results of same table indicate that difference between first and second dates in average number of spikes. m⁻² failed to attain the significance level, and that they were significantly superior to third date in average characteristic, spikes number for three dates reached (651.0, 639.5, 421.3) spikes. m⁻². This can be explained by a lengthy period of time that plants remain in the field, which may allow them to pass through the different growth stages without any pressure from environmental factors, including low soil moisture and high temperatures, which push plants to flower early, thus reducing spikes / unit area (Mawloud, 2022). The outcomes of two elements' interactions show that combination between Noor variety and first and second dates, between which no significant difference was found, resulted in recording highest number of spikes m⁻², as they reached (809, 872) spikes. m⁻², thus showing significant superiority over all interactions. As for lowest number of spikes. m⁻², it was achieved in combination between barley variety Mosul (1) and third date (15/Jan.), as it reached (364.6) spikes. m⁻².

3.3. Grains. spike⁻¹:

A significant factor in yield is the number of grains per spike. It is made up of a number of elements that interact with one another and with other elements to affect the grain's increased dry matter content. This process is the culmination of all the physiological functions and environmental factors that the plant has encountered during its several growth phases (Al-Jader, 2024). Results of table 3 show that Noor barley variety significantly outperformed Mosul (1) variety average trait of number of grains in spike, as number of grains in the spike reached (23.8, 25.1) grains. spike⁻¹ for the two varieties. One explanation for this could be genetic differences between two varieties in spike length, which is positively related to trait number of grains in spike (Rekani et al. 2017 and Ali et al. 2021).

Table 3 Effect of varieties, sowing dates and interaction on grains . spike⁻¹.

Barley varieties	Planting dates			Average varieties
	15 / Nov.	15 / Dec.	15 / Jan.	
Mosul 1	26.6 a	22.3 b	22.6 b	23.8 a
Noor	28.3 a	27.6 a	19.3 b	25.1 a
Average date	27.5 a	24.9 b	20.9 c	

At the 0.05 probability level, there is no discernible difference between similar letters.

The same table's results show that variations in planting dates were matched by variations in average number of grains per spike, as first date (15/November) outperformed second and third dates (15/December and 15/January). Apart from the fact that the second date is far better than the third, for same trait. Number of grains per spike for three dates reached (27.5, 24.9, 20.9) grains.spike⁻¹, respectively. This may be attributed to fact that delaying The planting date and the temperature increase that coincides with flowering may cause pollen grains to die and the pollination and fertilization processes to fail reducing number of grains in spike (Al-Minshawi, 2019). Combination between Noor barley variety and first date (15/Nov.) shows moral superiority of interaction between two factors, because it led to the largest amount of grains in the spike being recorded, reaching (28.3) grains/spike, while lowest number of grains in spike was achieved in combination between Noor variety and third date (15/Jan.), as it reached (19.3) grains. spike⁻¹.

3.4. Weight of 1000 grains (g):

Results of table (4) show that barley varieties under study (Mosul 1 and Noor) didn't show any significant differences in average 1000- grain weight, with the weights reaching (45.6 and 45.0) g for the two varieties, respectively. First and second planting dates (15/November and 15/December), between which no significant differences were found,

significantly outperformed third planting date (15/January) in average 1000-grain weight. Reason for increase in weight of 1000 grains at first and second dates may be attributed to longer period of time plants remained in soil compared to late date, which had a positive impact on growth characteristics, resulting in increase in weight of 1000 grains (Aglan et al., 2020). Regarding outcomes of two factors' interaction, they appear through combination between Noor barley variety and first date, which recorded highest weight of 1000 grains, reaching (54) g, and thus it was significantly superior to all interactions. The combination of the Noor variety and the third date (15/Jan.) produced the lowest weight of 1000 grains, which came to 30.6 g.

Table 4 Effect of varieties, planting dates and interaction in weight of 1000 grains (g)

Barley varieties	Planting dates			Average varieties
	15 / Nov.	15 / Dec.	15 / Jan.	
Mosul 1	46.0 bc	43.0 c	48.0 b	45.6 a
Noor	54.0 a	50.3 ab	30.6 d	45.0 a
Average date	50.0 a	46.6 a	39.3 b	

At the 0.05 probability level, there is no discernible difference between similar letters.

3.5. Grain yield (g.m^{-2}):

Final result of biological activity taking place within plant during its different growth stages is grain yield, which is defined by its constituents: Spike length, Number of grains, Number of spikes/unit area, and thousand-grain weight. Grain yield is influenced by numerous genetic and environmental factors surrounding variety (Hayawi, 2015). Results of table 5 show significant superiority of Noor barley variety over Mosul 1 variety in average grain yield trait, with an increase rate of (44.80)%. The correlation between this feature and traits related to growth and yield may be the cause of this.

Table 5 Effect of varieties, planting dates and interaction in grain yield (g/m)

Barley varieties	Planting dates			Average varieties
	15 / Nov.	15 / Dec.	15 / Jan.	
Mosul 1	408.0 b	289.6 c	218.0 c	305.2 b
Noor	736.6 a	693.6 a	228.0 c	552.7 a
Average date	572.3 a	491.6 b	223.0 c	

At the 0.05 probability level, there is no discernible difference between similar letters.

Difference in sowing dates was accompanied by gradual significant difference in average grain yield characteristic, as (15/November) was significantly superior to second and third dates (15/December and 15/January), Along with the fact that the second date was noticeably better than the third, in average grain yield characteristic, as the yield reached (572.3, 491.6, 223.0) g^{-2} for each of the three dates. This could be because of the variation in the length of the crop's stay in soil with different planting dates, and result was similar to what was obtained by (Bhateshwar et al., 2020). Outcomes of two factors interacting show the combination between Noor variety and first date (15/Nov.) obtained the maximum grain yield, which came to (736.6) g/m, thus it was significantly superior to all interactions, while combination between Mosul 1 barley variety and third date (15/Jan.) resulted in recording lowest grain yield, which reached (218) g.m^{-2} .

3.6. Biological yield (g.m^{-2}):

Biological one of the metrics used in agricultural studies to calculate the total dry matter produced by plants at various growth stages is yield. It typically results from variations in photosynthetic processes, which heavily rely on the effectiveness of the vegetative system in absorbing sunlight. Along with the nutrients and moisture that the root system supplies, respiration (Al-Jader, 2024). Results of table 6 show that is a difference in average biological yield between two barley varieties under study, as Noor variety outperformed Mosul 1 variety significantly in average biological yield trait, with an increase rate of (39.49)%. This attributed to fact that bio-yield trait reflects extent of physiological and

genetic differences between cultivars in growth strategies, as some cultivars tend to produce large biological, while other cultivars focus on improving efficiency of conversion to economic yield (Knezevic et al., 2019).

Table 6 Effect of varieties, planting dates and interaction on biological yield characteristic (g/m)

Barley varieties	Planting dates			Average varieties
	15 / Nov.	15 / Dec.	15 / Jan.	
Mosul 1	1781.7 b	1136.0 c	922.0 c	1279.8 b
Noor	2306.7 a	2107.7 b	941.7 c	1785.3 a
Average date	2044.1 a	1621.8 b	931.8 c	

At the 0.05 probability level, there is no discernible difference between similar letters.

The results of the same table show that the biological yield was clearly affected by the different planting dates, as we notice a gradual significant decrease in the average this trait with difference in sowing dates, as early date (15/Nov.) was significantly superior to rest of dates with an increase rate of (20.65, 54.40)%. This could be because varied planting dates resulted in distinct growth periods, as early date plants were exposed to longer periods of time and benefited more from the surrounding environmental elements like sunlight and appropriate humidity. Along with absorbing soil nutrients, barley crop plants developed favorable vegetative growth traits, increasing the buildup of dry matter throughout the plant and, consequently, the biological yield. These outcomes were in line with what was found by

(Al-Dahi, 2021) . Results of interaction between Noor variety and (15/Nov.) is recording highest biological yield, which reached (2306.7) g.m⁻², thus significantly outperforming all interactions, while combination between Mosul 1 barley variety and date (15/Jan.) recorded lowest biological yield, which reached (922.0) g.m⁻².

4. Conclusion

The results showed that the Noor barley variety significantly outperformed the Moussal 1 variety in most growth characteristics and yield components. Planting date also had a clear impact; early planting (November 15th) resulted in the highest yield, while delayed planting led to a gradual decrease in yield. Planting the Noor variety early is considered the optimal combination for maximizing barley productivity under the conditions of the study area.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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