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Impact of Seeding Rates and Cutting Dates on Two Barley Dual-purpose Cultivars Production

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Abstract

A field experiment was conducted at the Agricultural Faculty Farm of New Valley University during the winter seasons of 2020/2021 and 2021/2022 in order to investigate the potential of enhancing forage production, yield, and the various components of two barley (Hordeum vulgare L.) cultivars by employing varying seeding rates along with different cutting dates. The study laid out in a randomized complete block design (RCBD) under split split-plot arrangement and three replications. The most important results included: Giza 133 barley cultivar had a higher green fodder yield/fad., plant height, number of tillers/m2, number of spikes/m2, grain yields/fad and harvest index in both seasons as well as, straw yield and total dry matter/fad. in the second season only. Dry fodder yield (ton/fad.), plant height, number of tillers/m2, number of spikes/m2, grain and straw yields/fad as well as total dry matter/fad. had a significant response to increase seeding rate in both seasons, where it increased gradually by increasing seeding rate from 45 to 50 or 55 kg/fad. Cutting date had a highly significant effect ($P \leq 0.01$) on amount of green and dry fodders/fad., yield attributes traits, grain and straw yields/fad. as well as total dry matter/fad. and harvest index in both seasons. Sowing Giza133 at a rate of 50 kg grains /fad and leaving it without cut recorded the highest grain yield/fad. in the two seasons. Sowing Giza133 barley cultivar at seeding rate of 50 kg /fad. and the cutting at 65 days recorded the highest significant total dry matter/fad. in the two growing seasons.

Keywords: Seeding Rates; Cutting; Barley; Dual-purpose

Introduction

Barley (*Hordeum vulgare*, L.) is coming globally in the fourth order among grain crops, after wheat, rice, and corn. Barley is primarily grown as animal fodder and as a source of malt **(Singh & Sarlach, 2022).** Barley is a crop that exhibits a remarkable ability to adapt to arid conditions, rendering it a crucial agricultural commodity. Consequently, it is predominantly cultivated in regions across the globe that experience limited rainfall. Additionally, barley possesses a distinctive capacity to withstand salinity, further contributing to its significance. Moreover, when compared to other small grain cereals, barley demonstrates an exceptional productivity even in unfavorable environmental circumstances. Specifically, six-row barley is distinguished by its elevated protein content, thus making it a prevalent choice for animal nourishment. Barley has a variety of uses in feeding animals, as its grains are used in the manufacture of animal feeding, plants can be cut at certain stages to obtain green fodder, the crop can be grazed directly by animals, or it can be used to make silage. Here too, barley possesses morpho-physiological characteristics that render it more conducive for the dual-purpose cultivation of fodder and grain production in comparison to other cereals. The cultivated barley area reached globally 46.9 million hectares in 2019, with productivity of about 141 million tons, **FAOSTAT (2020).** Cultivated area of barley in Egypt occupied about 53.3 thousand fads in 2020–2021, with a production of about 87.6 thousand tons, (According to the Egyptian Ministry of Agriculture and Land Reclamation's 2004/2019 A and B reports). In the growth season of 2020–2021, there were 53.3 thousand faddans of total barley planted, yielding 87.6 thousand tons with productivity of 1.6 tons/fad (Egyptian Ministry of Agriculture and Land Reclamation 2020–2021, c). Barley is among the main crop species serving in the dual-purpose systems in the Mediterranean region but, it is not use commonly in Egypt because the shortage of essential information about the proper management practices that support dual purpose barley production. Management practices for achieving maximum forage production differ from those recommended for optimum grain production **(Salama, 2019).** Thus, as a dual purpose (Green forage and/or grains as feed) crop it provides a part of the requirements of forage growers and fits well for crop diversification in the integrated crop-livestock farming system **(Nand *et al*., 2019).**

Increasing seeding rate led to decrease spike length, grains number/spike, weight of 1000 grains and harvest index. While, plant height, spikes number/m^2 and biological yield fad^{-1} took an opposite trend and increased with increasing seeding rate (**Agwa & Mohamad, 2020** and **Soleymani et al., 2020**). The highest seed rate (300 seeds/m^2) recorded the highest grains and biological yields production. Where, they observed that increasing plant density from 150 to 225 or 300 grain/m^2 rates led to an increase in grain yield 35 and 33%, respectively (**Preiti, et al. 2021**). **Hassan et al., (2021)** exhibited that increasing seeding rate from 40 up to 60, or 80 kg/fad produced the maximum values for each of spikes number/m^2 and grain yield/fad. While the seeding rate of 40 kg/fad recorded the highest value of no. of spike length and grains/spike, weight of grains/spike and 1000 grains weight. (**Rahi & Mihbis, 2021, Seadh et al., 2022 and Singh & Sarlach**, **2022)** noticed that highest values to plant height, as well as the dry weights of stems, leaves, spikes and plant, highest number of spikes/m^2, and the highest yields of grain and straw/fad were recorded at from the seeding at the highest seeding rate.

Barley cutting at early time gave less dry weight of fodder yield. Cutting at 50 DAS gave a higher percent of crude protein than cutting at 60 DAS. However, delay cutting to 60 DAS resulted in a shortage in grain yield (**Dhillon et al., 2020). Mansoor & Jeber,**

(2020) used cut of barley plants at three cuting dates (cut after 45, 65 and 85 days from sowing) comparing to without cut and they revealed that the late cutting (85 days after sowing, DAS) gave significantly higher green forage yield (31.639 ton/ha), than other treatments. Control treatment (uncut) overtopped significantly where gave the highest grain yield/fad., number of spikes/m^2, number of grains/spike and 1000-grain weight. **Rauf et al., (2021)** noted that cutting wheat at 65 DAS gave the higher plant tall, dry matter accumulation and green fodder yield for green fodder than the other cutting schedules. Whereas plants cut at 45 DAS for green fodder then left for grains gave the highest grain yield, which was significantly higher compared to cut at 55 and 65 DAS. **Talib et al., (2021)** indicated that date of cutting at 45 DAS was significantly surpassed the other treatments by giving the highest harvest index and the highest content of nitrogen in the forage. The treatment without cutting gave the highest significant values of biological yield, grain yield, and nitrogen content in grains. The highest grain and straw yields/ha were recorded by no cut and this treatment gave the highest significant values of each the yield traits compared to the other cutting treatments. Delaying cutting of green fodder decreased the regrowth capacity after cut in generally and consequently the grain yield **(Neelam et al., 2022, Yadav et al., 2022 & Ali et al., 2023)**.

In order to address the issue of insufficient food and feed availability, it is imperative to enhance barley production by expanding cultivation areas or improving yield efficiency per unit of land. Barley exhibits a notable characteristic of rapid regrowth following cutting, while still maintaining comparable yield levels to those left ungrazed. **(Moustafa et al., 2021).** So, the objective of this study was to the comparison between two barley cultivars, determine the most suitable seeding rate, fixing the most suitable date and definition the most appropriate interaction treatment between cultivars, seeding rate, and cutting date to obtain the best combination of these treatments to maximize forage and grain yields of barley grown under the conditions of the New Valley Governorate.

Materials and Methods

A field experiments was conducted at the Farm of Agriculture Faculty, New Valley University, during 2020/2021 and 2021/2022 winter seasons to study the possibility maximize forage production, yield, and its components of two barley (*Hordeum vulgare* L.) cultivars through using different seeding rates with cutting dates. The experiment was located in a randomized complete block design (RCBD) with split split-plot arrangement was used in three replicates through the two seasons. Barley cultivars were assigned to the main plot, seeding rates were distributed randomly in the sub plots and cutting dates were distributed in the sub-sub plots.

Experiment Factors

A- Cultivars: Two local cultivars (Giza123 & Giza133) produced by the Field Crops Research Institute - Agricultural Research Center - Ministry of Agriculture, Egypt.

B- Seeding rates: three rates of seed i.e., 45, 50 and 55 kg grain/fad.

C- Cutting dates: three cutting treatments i.e., without cutting (control), Cutting at 65 and 85 days after sowing (DAS).

The land of experiment was prepared and applied the other agriculture practices as the Egyptian Ministry of Agriculture recommendations for barley production in the region. Mono calcium superphosphate (15% P_2O_5) at a rate of 100 kg/fad was added during land preparation. The land of experiment was divided to experimental units its area was 6 m^2 (2 m long * 3 m wide). Barley grains were sown on the 25^{th} of October by the broadcasting method in both seasons. Nitrogen fertilizer (at the form of Ammonia nitrate 33%) was added at a rate of 75 kg N/fad was divided to three equal doses after 21, 65 and

85 days from sowing. Mechanical and chemical properties of the experimental soil were presented in Table 1.

Table (1): Physical and chemical properties of the experimental soil in 2020/2021 and 2021/2022 season

	2020/2021	2021/2022
Mechanical Texture soil		
Clay%	1.55	1.61
Silts%	18.25	18.32
Sands%	80.20	80.07
Texture soil	sandy loam	sandy loam
Chemical analysis		
pH	8.60	8.70
EC (ds/m^{-1})	1.67	1.72
Soluble anions concentration ($meqL^{-1}$)		
CO_3^-	0.02	0.03
HCO_3^-	1.00	1.10
Cl^-	14.50	14.90
$SO4^-$	6.65	6.80
Soluble cations concentration (meq L^{-1})		
Available N (ppm)	60.00	70.0
Available P (ppm)	1.63	1.87
Available K (ppm)	138.0	149.0

Studied traits

A- Fodder traits: At the time of cut the whole experimental unit area was cut then it was weighed immediately after cutting and green fodder yield/fad was calculated based on experimental plot. After cutting immediately sample of 250 g from each plot was taken randomly then left to air dried for three days. All air-dried samples were dried in the oven at 60 or 70°C until a constant weight is reached to determine the dry matter concentration, dry fodder yield/fad was calculated based on experimental plot.

B- Yield attributes: At harvest, plant height (cm), tillers number/m^2, spikes number/m^2 and 1000-grain weight (g) were estimated.

C- Yield traits: Concerning each experimental unit at harvest, whole plot was harvested individually, and it was left to air dried for a week then, it was weighed. Grains and straw were separated and weighed to estimate and calculation the traits i.e., grain and straw yields, total dry matter as ton based on the faddan as well as harvest index. Total dry matter (ton/fad) was calculated as a fallowing formula: Total dry matter/fad = Biological yield/fad + Dry fodder yield/fad. (One faddan =4200 m^2)

Statistical analysis: All obtained data were arranged and subjected to statistical analysis according to **Gomez and Gomez (1984).** Fresh and dry fodder yields traits were analysis statistically without uncut treatment. All averages of factors and their interactions were compared using Revised Least Significant Differences at 5% level of significant (**Steel and Torrie, 1981**). All statistical analysis was performed using analysis of variance technique by "MSTAT-C" computer software package 1990.

Results and Discussions

A-Fodder traits

The presented results in **Table 2** show that barley cultivars differed significantly in green fodder yield in both seasons, where Giza 133 cultivar recorded the highest average values of fodder yield (9.88 and 7.76 ton fad^{-1} in the two respective seasons). This difference may be due to the variation in genetic makeup of cultivars and their response to the

environment conditions. This results at the same trend as those reported by **Singh et al., (2016), Moustafa et al., (2021) and Ali et al., (2023).** On the other hand, there are non-significant differences between two barley cultivars in both seasons for fodder dry yield/fad trait**.**

Dry fodder yield (ton/fad) responded significantly to seeding rates, where increased gradually by increasing seeding rate from 45 up to 50 or 55 kg/fad. The highest fodder dry yields (1.87 and 3.09 ton/fad, in the two successive seasons, respectively) were recorded by the highest seeding rate (55 kg/fad) in both seasons. This result may be due to increased plant growth traits such as plant height, tillers number/m^2 and dry weight of plant under the highest seeding rate. These findings are in good line with those obtained by **Naveed et al., (2014) and Salama (2019).** While seeding rates did not exhibited significant effect on fresh fodder yield/fad in both seasons **(Table 2).**

It is clear from the illustrated data in **Table 2** that cutting date had a highly significant effect ($P \leq 0.01$) on amount of green and dry fodder yields in both seasons, where the highest mean values of green fodder i.e. 12.00 and 13.78 ton/fad as well as the highest average values of dry fodder i.e. 2.34 and 2.89 ton/fad were obtained from delay cutting to 85 DAS in the first and second season, respectively. This may be due to the delay cutting resulted in increased plants growth in general, especially biomass. These results are agreement with those reported by **Singh et al., (2016), Moustafa et al., (2021), Yadav et al., (2022) and Ali et al., (2023).**

Table (2): Means of green and dry fodder yields as affected by seeding rate and cutting date of two barley cultivar during 2020/2021 and 2021/2022 seasons

Traits	Green fodder yield (ton/fad)		Dry fodder yield (ton/fad)	
			Season	
Factors	2020/2021	2021/2022	2020/2021	2021/2022
Cultivars				
Giza123	8.54	6.94	1.54	2.52
Giza133	9.88	7.76	1.90	2.81
F. $_{test}$	*	*	N.S.	N.S.
Seeding rate (kg/fad)				
45 kg/fad	9.11	10.25	1.50	1.96
50 kg/fad	9.96	11.64	1.80	2.95
55 kg/fad	8.55	11.17	1.87	3.09
F. $_{test}$	N.S.	N.S.	*	**
R.L.S.D. $_{0.05}$	--	--	0.29	0.27
Cutting days after sowing (DAS)				
65 DAS	6.41	8.23	1.10	2.44
85 DAS	12.00	13.78	2.34	2.89
F. $_{test}$	**	**	**	**

Where, N.S, * and ** means non-significant and significant at 5 and 1% level of probability, respectively.

The effects of all possible interactions from the first order among the studied factors were non- significant on green and dry fodder yields/fad in the two seasons except, the interaction between barley cultivars and cutting dates on dry fodder in the first season only, where the heaviest dry yield of fodder (2.81 ton/fad) was recorded from the interaction between Giza133 cultivar and cutting after 85 days from sowing **(Fig.1)**.

The second order interaction exerted significant effect on dry fodder yield/fad in the second season only, where sowing Giza123 barley cultivar at a rate of 55 kg grains/fad and delay it cutting to 85 days recorded the highest weight of dry matter 3.30 ton/fad in the second season.

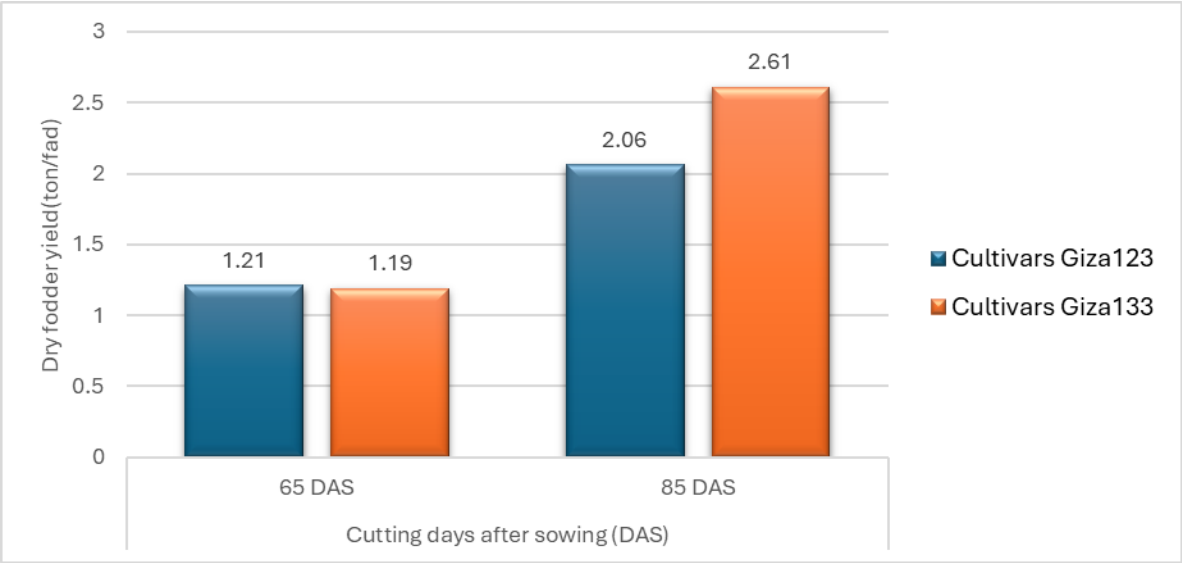

Figure (1): Effect of barley cultivars and cutting date interaction on dry fodder yield (ton/fad) during 2020/2021 season.

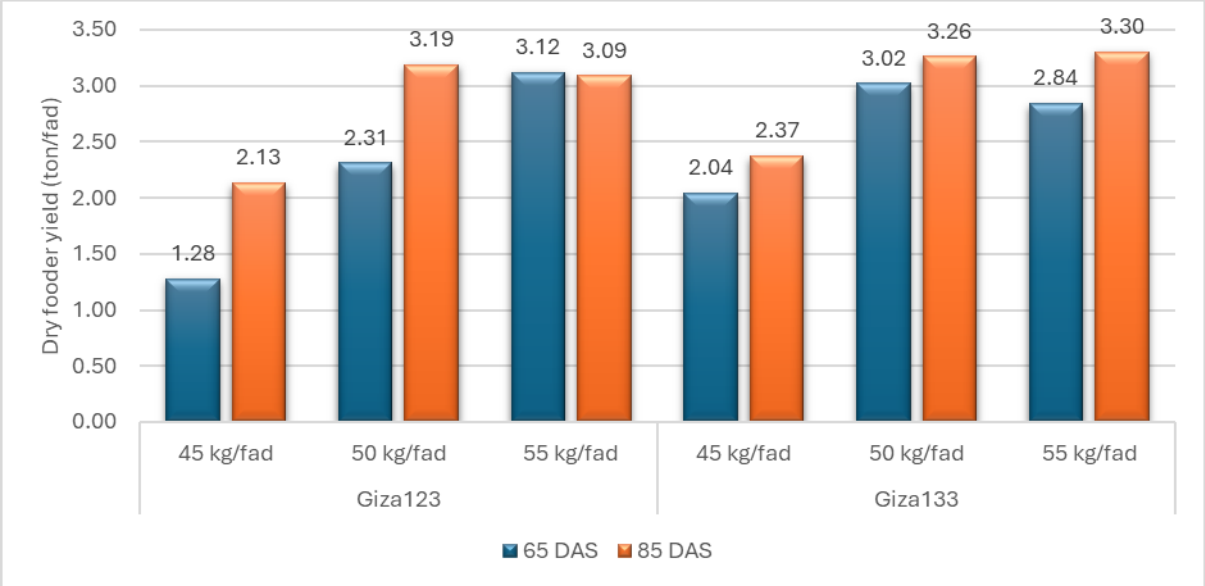

Figure (2): Effect of barley cultivars, seeding rate and cutting date interaction on dry fodder yield (ton/fad) during 20221/2022 season.

B- Yield attributes

The results shown in Table 3 clearly indicate that there is a notable disparity (P≤0.05) among the various barley cultivars in terms of plant height. Moreover, there is a remarkably pronounced variation (P≤0.01) observed in the numbers of tillers and spikes/m^2 in both seasons, where Giza 133 cultivar had highest mean values of these traits compared to Giza 123 in the two seasons. These differences may be due to cultivars differing genetic makeup and it affected by environmental factors. The former results are in same line with that recorded by **Abd El-Monem and Hamed (2017), Al Myali et al., (2020), Seadh et al., (2022), and Neelam et al., (2022).** On the other hand, the results point to barley cultivars did not differ significantly in the weight of 1000-grain in both seasons.

Plant height, number of tillers and spikes/m^2 exerted a highly significant response **(P≤0.01)** with increasing seeding rate in both seasons, as well as 1000-grain weight in the second season **(Table 3)**. Where plant height, numbers of tillers and spikes/m^2 increased gradually by increasing seeding rate from 45 up to 50 or 55 kg/fad. The tallest plants (84.49 and 89.64 cm) and the largest number of tillers/m^2 (414.67 and 433.00) as well as numbers of spikes/m^2 (383.22 and 400.72) were obtained from sowing barley by the highest seeding rate (55kg/fad) in the first and second season, respectively. This result may be due to that increase plant density led to increase the growth hormones activity especially Auxin which resulted in more the cells and tissues elongation and concerning to numbers of tillers and spikes/m^2 these results be logic because that the highest seeding rate increase the number of plants per unit area and thus this reflected on the numbers of tillers and spikes/m^2. These findings are in a good line with those obtained by **Soleymani et al., (2020), Hassan et al., (2021), Rahi and Mihbis (2021), Seadh et al., (2022) and Singh & Sarlach (2022)**. On the other hand, the highest 1000-grain weights (47.66 and 42.55 g in the two successive seasons, respectively) were recorded from a lowest seeding rate (45 kg/fad). The lowest seeding rate resulted in more light interception by individual plants and increase light distribution and its utilization efficiency by the leaves in the plant canopy, as well as more grain filling and thus increase 1000-grains weight. The previous results are consistent with those obtained by **Hassan et al., (2021), Seadh et al., (2022) &Singh and Sarlach (2022)**.

The obvious results in **Table 3** that barley plants were affected negatively with cutting treatments where, leaving barley plants without cutting gave the highest average values of plant height (96.17 and 100.93 cm), numbers of tillers (449.06 and 450.28 tiller/m^2), numbers of spikes (439.17 and 441.83 spikes/m^2), and 1000-grain weights (51.76 and 48.13 g) in the two successive seasons, respectively. While, delaying cutting from 65 up to 85 days after sowing led to record the lowest values of these traits in both seasons. These are logic results, as leaving the plants without cut gives a greater opportunity to produce more photosynthetic products, thus increasing plant growth as generally and plant height, tillers and spikes numbers/unit area unit, and heavy grains as especially unlike which happens when delaying cutting. These results agree with those obtained by **Nand et al., (2019), Salama (2019), Dhillon et al., (2020), Mansoor & Jeber, Neelam et al., (2022) & Ali et al., (2023).**

Table (3): Means of plant height (cm), No. of tillers/m2, No. of spike/m2, and 1000-grain weight (g) as affected by seeding rate and cutting date of two barley cultivar during 2020/2021 and 2021/2022 seasons

Traits	Plant height (cm)		No. of tillers/m^2		No. of spikes/m^2		1000-grain weight (g)	
	Season							
Factors	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022
Cultivars								
Giza123	79.86	84.49	337.78	342.37	316.67	320.56	43.83	40.59
Giza133	84.28	88.73	410.74	425.85	374.56	393.93	46.79	40.29
F. test	*	*	**	**	**	**	N.S.	N.S.
	Seeding rate (kg/fad)							
45 kg/fad	77.65	82.75	329.00	333.33	305.94	310.89	47.66	42.55
50 kg/fad	84.09	87.48	379.06	386.00	347.67	360.11	42.82	39.08
55 kg/fad	84.48	89.64	414.67	433.00	383.22	400.72	45.44	39.68
F. test	**	**	**	**	**	**	*	**
R.L.S.D. 0.05	1.8	1.52	7.14	9.85	13.57	13.05	3.66	1.46
	Cutting days after sowing (DAS)							
Without cut	96.17	100.93	449.06	450.28	439.17	441.83	51.76	48.13
65 DAS	82.74	88.47	389.17	392.67	361.28	367.56	44.60	37.59
85 DAS	67.31	70.47	284.50	309.39	236.39	262.33	39.56	35.60
F. test	**	**	**	**	**	**	**	**
R.L.S.D. 0.05	1.96	1.84	5.21	6.94	11.42	9.86	2.19	0.99

Wherein, N.S, *, and ** represent insignificance and significance at the 5 and 1% threshold of probability, correspondingly.

The effects of all most interactions among the studied factors were significant on plant height, and numbers of tillers and spikes/m^2 as well as 1000-grains weight in both seasons. The results in **Table 4** show that barley cultivars × seeding rates interaction exhibited a significant effect on plant height and 1000-grain weight in both seasons as well as numbers of tillers and spikes/m^2 in the first season, only. Sowing Giza133 barley cultivar at a seeding rate of 55 kg grains/fad recorded the tallest plants 87.00 and 93.67 cm in the first and second season, respectively as well as it recorded the largest number of tillers (445.89 m^2) and spikes (403.56 m^2) in the first season. Giza123 and Giza 133 had the heaviest 1000-grains (48.42 and 43.52 g) when they were sown with the seeding rate of 45 kg/fad in the two successive seasons, respectively.

Cultivars and cutting date interaction had a highly significant effect ($P \leq 0.01$) on plant height and number of tillers/m^2 in both season and number of spike/m^2 in the first season only as well as and 1000-grains weight in the second season only **(Table 5)**. In general, leaving the two cultivars without cut recorded the highest values for these traits in both seasons.

Barley sowing with seeding rate 15 and 50 or 55 kg /fad and leaving it without cutting gave the tallest plants and highest number of tillers/m^2 in the two successive seasons as well as number of spikes/m^2 and 1000-grains weight in the second season **(Table 6).**

Table (4): Means of plant height (cm), No. of tillers/m2, No. of spike/m2 and 1000-grain weight (g)as affected by the first order interactions among cultivars, seeding rate and cutting date in 2020/2021 and 2021/2022 seasons

The interaction between cultivars and seeding rate							
Traits		Plant height (cm)		No. of tillers/m^2	No. of spikes/m^2	1000-grain weight (g)	
Cultivar	Seeding rate Kg/fad	2020/2021	2021/2022	2020/2021	2020/2021	2020/2021	2021/2022
Giza123	45	74.21	83.41	293.89	280.44	48.42	41.58
	50	83.42	84.42	336.00	306.67	38.90	39.28
	55	81.96	85.62	383.44	362.89	44.16	40.90
Giza133	45	81.09	82.09	364.11	331.44	40.97	43.52
	50	84.76	90.53	422.11	388.67	41.95	38.89
	55	87.00	93.67	445.89	403.56	42.76	38.46
F. test		*	**	*	*	*	*
R.L.S.D. 0.05		2.84	2.22	11.18	24.41	5.20	2.20

The interaction between cultivars and cutting date							
Traits		Plant height (cm)		No. of tillers/m^2		No. of spikes/m^2	1000-grain weight (g)
Cultivar	Cutting date	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022
Giza123	Without cut	97.33	103.20	412.22	413.56	402.78	47.17
	65 DAS	80.71	86.16	347.33	353.33	321.89	40.15
	85 DAS	61.54	64.10	253.78	260.22	225.33	35.39
Giza133	Without cut	95.00	98.67	485.89	487.00	475.56	46.88
	65 DAS	84.78	90.78	431.00	432.00	400.67	37.41
	85 DAS	73.07	76.84	315.22	358.56	247.44	36.57
F. test		**	**	**	**	**	**
R.L.S.D. 0.05		2.84	2.01	7.99	10.88	16.96	1.51

The interaction between seeding rate and cutting date							
Traits		Plant height (cm)		No. of tillers/m^2		No. of spikes/m^2	1000-grain weight (g)
Seeding rate	Cutting date	2020/2021	2021/2022	2020/2021	2021/2022	2021/2022	2021/2022
45 Kg/fad	Without cut	91.70	99.50	415.50	418.50	409.83	52.67
	65 DAS	75.73	87.07	338.83	342.17	325.17	38.30
	85 DAS	65.52	61.68	232.67	239.33	197.67	36.68
50 Kg/fad	Without cut	98.33	102.33	457.33	458.50	448.83	46.23
	65 DAS	83.40	85.90	395.33	398.17	371.17	35.67
	85 DAS	70.53	74.20	284.50	301.33	260.33	35.35
55 Kg/fad	Without cut	98.47	100.97	474.33	473.83	466.83	45.48
	65 DAS	89.10	92.43	433.33	437.67	406.33	38.81
	85 DAS	65.87	75.53	336.33	387.50	329.00	34.76
F. test		**	**	**	**	**	**
R.L.S.D. 0.05		3.73	2.54	9.47	12.03	18.40	1.82

Wherein, *, and ** represent significance at the 5 and 1% threshold of probability, correspondingly.

Second order interaction had highly significant effects (P≤0.01) on plant height, numbers of tillers and spike/m^2 in both seasons **(Table 5)**. Sowing Giza123 barley cultivar at a rate of 50 kg grains/fad and leaving it without cutting recorded the tallest plants 102.13 and 105.80 cm in the two respective seasons. Sowing Giza133 barley cultivar at a rate 55 kg grains/fad and leaving it without cutting recorded the largest numbers of tillers and spikes/m^2 (494.00 and 491.67 tiller/m^2 & 486.00 and 484.67 spike/m^2 in the two respective seasons).

Table (5): Means of plant height (cm), No. of tillers/m^2, and No. of spike/m^2 as affected by the second order interaction among cultivars, seeding rate and cutting date in 2020/2021 and 2021/2022 seasons

Traits			Plant height (cm)		No. of tillers/m^2		No. of spikes/m^2	
Cultivar	Seeding rate	Cutting date	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022
Giza123	45 Kg/fad	Without cut	91.87	102.13	354.33	356.00	345.00	347.00
		65 DAS	69.60	86.60	309.67	315.33	293.00	296.00
		85 DAS	61.17	61.50	217.67	220.00	203.33	205.33
	50 Kg/fad	Without cut	102.13	105.80	427.67	428.67	416.67	418.67
		65 DAS	81.47	80.47	345.67	347.00	303.00	312.33
		85 DAS	66.67	67.00	234.67	237.33	200.33	215.67
	55 Kg/fad	Without cut	98.00	101.67	454.67	323.33	446.67	449.00
		65 DAS	91.07	91.40	386.67	456.00	369.67	366.67
		85 DAS	56.80	63.80	309.00	397.67	272.33	274.33
Giza133	45 Kg/fad	Without cut	91.53	96.87	476.67	481.00	462.33	472.67
		65 DAS	81.87	87.53	368.00	369.00	350.67	354.33
		85 DAS	69.87	61.87	247.67	258.67	181.33	190.00
	50 Kg/fad	Without cut	94.53	98.87	487.00	488.33	478.33	479.00
		65 DAS	85.33	91.33	445.00	449.33	407.67	430.00
		85 DAS	74.40	81.40	334.33	365.33	280.00	305.00
	55 Kg/fad	Without cut	98.93	100.27	494.00	491.67	486.00	484.67
		65 DAS	87.13	93.47	480.00	477.67	443.67	446.00
		85 DAS	74.93	87.27	363.67	451.67	281.00	383.67
F. test			**	**	**	**	**	**
R.L.S.D. 0.05			5.22	3.64	12.77	17.01	30.51	24.86

Where, ** means significant at 1 % level of probability.

C- Yield traits

The tabled results in **Table 6** demonstrate that barley cultivars differed significantly in grain yields/fad and harvest index in both seasons as well as straw yield and total dry matter in the second season, only. Giza 133 cultivar gave higher grain yield (2.07 and 2.23 ton/fad in the successive two seasons) and harvest index (35.02 and 33.59% in the successive two seasons) compared to Giza 123. Also, Giza 133 cultivar had higher straw yield (4.30 ton/fad) and higher total dry matter/fad (8.39 ton/fad) compared to Giza 123 in the second season. This difference may

be due to cultivars genetic makeup differences and the response to environmental factors. The previous results are in accordance with those obtained by **Soleymani et al., (2020) & Agwa and Mohamad (2020) Mohamed et al., (2021**), **Moustafa et al., (2021), Seadh et al., (2022)** & **Ali et al., (2023).**

Seeding rates had a highly significant effect (P≤0.01) on straw, grain yields/fad and total dry matter/fad in both seasons as well as harvest index in the first season only, where the highest straw yields 3.97 and 4.16 ton/fad, the highest grain yields 1.94 and 2.06 ton/fad and were recorded from barley sowing with 50 kg grains/fad and the biggest amounts of total dry matter 7.11 and 8.18 ton/fad in the two successive seasons **(Table 6).**

Table (6): Means of straw yield (ton/fad.), grain yield(ton/fad.), total dry matter(ton/fad.), harvest index (%) as affected by seeding rate and cutting date of two barley cultivars during 202/2021 and 2021/2022 seasons

Traits	Straw yield (ton/fad.)		Grain yield (ton/fad.)		Total dry matter (ton/fad.)		Harvest index (%)	
Factors Season	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022
Cultivars								
Giza123	3.53	3.68	1.57	1.62	5.41	6.98	30.31	29.90
Giza133	3.76	4.30	2.07	2.23	6.77	8.39	35.02	33.59
F. test	N.S.	*	*	**	N.S.	**	*	*
Seeding rate (kg/fad)								
45 kg/fad	3.51	3.73	1.35	2.01	6.19	6.77	31.71	30.91
50 kg/fad	3.97	4.16	1.65	2.24	7.11	8.18	31.80	32.30
55 kg/fad	3.45	4.07	1.71	2.03	6.57	8.10	34.49	32.03
F. test	**	**	**	**	**	**	**	N.S.
R.L.S.D. 0.05	0.28	0.20	0.09	0.09	0.35	0.27	1.28	--
Cutting days after sowing (DAS)								
Without cut	4.54	4.82	2.66	2.67	7.20	7.49	36.76	35.50
65 DAS	3.72	3.95	1.76	1.85	6.58	8.24	32.18	31.74
85 DAS	2.67	3.19	1.08	1.24	6.09	7.32	29.05	28.00
F. test	**	**	**	**	**	**	**	**
R.L.S.D. 0.05	0.20	0.20	0.08	0.08	0.24	0.22	1.58	1.67

Where, N.S, * and ** means non-significant and significant at 5 and 1% level of probability, respectively.

Sowing with the moderate seeding rate, might result in enhancement yield components in general, and especially numbers of fertile tillers, spikes weight/m^2, and thus increase grain yield. The previous results are consistent with those obtained by **Omar, (2013), Naveed et al., (2014), Soleymani et al., (2020), Hassan et al., (2021), Rahi and Mihbis (2021), Singh and Sarlach (2022)** & **Seadh et al., (2022)** whose got on similar results. The highest harvest index (34.49%) was recorded when barley was sown at the highest seeding rate (55 kg/fad). This result may be due to increasing plant density resulting from seed rate increasing led to more spikes and grain yield increase which is reflected on the total harvest index. These findings are in a good line with those obtained by **Soleymani et al., (2020) & Singh and Sarlach, (2022).**

The straw yield, grain yield and dry matter/fad as well as harvest index were affected at highly significant (P≤0.01) by cutting treatments in both seasons **(Table 6)**. Uncut plants gave the highest straw yield 4.54 and 4.82 ton/fad and the highest grain yields/fad 2.66 and 2.67 ton/fad as well as the highest values of harvest index 36.76 and 35.50% in the first and second season,

respectively. Concerning total dry matter, the highest value 7.20 was recorded in the first season from uncut treatment and 8.24 ton/fad from cutting at 65 DAS in the second season. Also, all these traits decreased by delaying the cutting date up to 85 days after sowing. These results may be since the shortage vegetative growth period in the two cases of cutting time was shorter than uncut treatment. These results agree with those pointed by **Dhillon et al., (2020), Mansoor and Jeber, (2020), Talib et al., (2021), Neelam et al., (2022), Yadav et al., (2022)and Ali et al., (2023)**.

The effect of cultivars × seeding rate interaction was a significant on grain yield and total dry matter/fad in both seasons. Giza 133 achieved the greatest yield of grain 2.24 and 2.43 ton/fad, as well as the highest total dry matter content 7.78 and 9.09 ton/fad in the two successive seasons, respectively when it was sown with a seeding rate of 50 kg/fad **(Table 7)**.

Concerning the interaction between the cultivars and cutting treatments, the results in **Table 7** reveal that there are significant effects of the cultivars × cutting treatments interaction on straw yield, grain yield and dry matter/fad in both seasons as well as harvest index in the first season only. Where, leaving Giza123 and Giza133 cultivar without cut recorded the highest straw yield (4.64 and 4.95 ton/fad in the first and second season, respectively) while, Giza133 cultivar without cut recorded the highest grain yields (2.97 and 2.98 ton/fad in the first and second season, respectively). Leaving Giza133 cultivar without cut recorded the highest total dry matter (7.41 ton/fad) in the first season while, in the second season the highest total dry matter (9.10 ton/fad) was obtained from cutting the same cultivar at 65 DAS. The highest percent of harvest index (40.08%) was recorded from Giza133 without cut in the first season.

For the interaction between seeding rates and cutting treatments, the results in **Table 7** point to there are significant effects of seeding rates × cutting treatments interaction on straw and grain yields/fad in both seasons as well as total dry matter/fad in the second season and harvest index in the first season only. Sowing barley with a seed rate of 50 and 55 kg/fad and leaving it without cut recorded the highest straw yield (4.64 and 4.94 ton/fad in the first and second season, respectively). Sowing barley with a seed rate of 50 kg/fad and leaving it without cut recorded the highest grain yield (2.87 and 2.90 ton/fad in the first and second season, respectively).

Table (7): Means of grain yield(ton/fad.), and total dry matter(ton/fad.) as affected of the first order interaction among cultivars, seeding rate and cutting rate in 2020/2021 and 2021/2022 seasons

The first order interaction between cultivars and seeding rate					
Traits		Grain yield (ton/fad)		Total dry matter (ton/fad)	
Cultivar	Seeding rate	2020/2021	2021/2022	2020/2021	2021/2022
Giza123	45 kg/fad	1.35	1.38	5.60	5.94
	50 kg/fad	1.65	1.69	6.45	7.28
	55 kg/fad	1.71	1.78	6.32	7.71
Giza133	45 kg/fad	2.01	2.08	6.78	7.60
	50 kg/fad	2.24	2.43	7.78	9.09
	55 kg/fad	2.03	2.17	6.82	8.50
F. $_{test}$		**	**	*	*
R.L.S.D. $_{0.05}$		0.13	0.14	0.54	0.42
The interaction among cultivars and cutting rate					

Traits		Straw yield (kg/fad)		Grain yield (kg/fad)		Total dry matter (kg/fad)		Harvest index
Cultivar	Cutting date	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021
Giza123	Without cut	4.64	4.69	2.38	2.37	6.98	7.06	33.44
	65 DAS	3.53	3.66	1.43	1.49	5.98	7.38	29.26
	85 DAS	2.42	2.69	0.93	1.00	5.41	6.48	28.26
Giza133	Without cut	4.45	4.95	2.97	2.98	7.41	7.93	40.08
	65 DAS	3.91	4.242	2.09	2.22	7.19	9.10	35.15
	85 DAS	2.93	3.70	1.23	1.48	6.77	8.16	29.84
F. test		**	**	**	*	**	**	*
R.L.S.D. 0.05		0.31	0.32	0.11	0.13	0.36	0.34	2.51

The interaction between seeding rate and cutting date

Traits		Straw yield (kg/fad.)		Grain yield (kg/fad.)		Total dry matter (kg/fad)	Harvest index
Seeding rate	Cutting date	2020/2021	2021/2022	2020/2021	2021/2022	2021/2022	2020/2021
45 kg/fad	Without cut	4.38	4.73	2.38	2.40	7.14	35.03
	65 DAS	3.68	3.82	1.71	1.77	7.25	31.56
	85 DAS	2.47	2.65	0.95	1.03	5.92	28.53
50 kg/fad	Without cut	4.64	4.79	2.87	2.90	7.69	38.12
	65 DAS	4.27	4.09	1.82	1.95	8.71	29.81
	85 DAS	3.00	3.59	1.14	1.33	8.15	27.48
55 kg/fad	Without cut	4.61	4.94	2.72	2.72	7.66	37.14
	65 DAS	3.22	3.94	1.75	1.85	8.76	35.18
	85 DAS	2.54	3.34	1.15	1.36	7.89	31.14
F. test		**	*	**	*	**	*
R.L.S.D. 0.05		0.41	0.43	0.15	0.16	0.41	3.46

Where, * and ** means significant at 5 and 1% level of probability, respectively.

The highest total dry matter/fad (8.76 ton) was obtained from seeding rate 55 kg/fad with cut at 65 DAS in the second season. The highest value of harvest index 38.12% was obtained from seeding rate 50 kg/fad without cut.

The second order interaction exert significant effects (P≤0.01) on straw and grain yields/fad as well as total dry matter/fad and harvest index in both seasons **(Table 8).** The highest yield of straw (4.77 ton/fad in the first season) was obtained from sowing Giza 133 cultivar with a rate of 50 kg grains/fad then the cut at 65 days after sowing a seed rate while in the second season, the highest straw yield (4.99 ton/fad) was recorded from sowing Giza 133 cultivar with a rate of 45 kg grains/fad without cut. Sowing Giza133 barley cultivar at a rate 50 kg seed/fad and leaving it without cut recorded the highest grain yields (3.16 and 3.18 ton/fad in the two respective seasons, respectively). On the other hand, sowing Giza123 barley cultivar by the lowest seed rate (45 kg/fad.) and delaying cut at 85 DAS recorded the lowest grain yield/fad in the two seasons. Sowing Giza133 barley cultivar with a rate of 50 kg/fad and the cut at 65 days recorded the highest total dry matter (8.22 and 9.76 ton/fad in the two respective seasons, respectively). Sowing Giza133 barley cultivar with seed rates 45 kg/fad and leaving it without cut recorded the highest harvest index 41.43% in the first season while, in the second season the highest harvest index 39.15% was

obtained from the same cultivar when was sown by 50 kg/fad and leaving it without cutting also.

Table (8): Means of straw yield (ton/fad), grain yield(ton/fad), total dry matter(ton/fad), harvest index (%) as affected by the interaction among cultivars, seeding rate and cutting date on during 2020/2021 and 2021/2022 seasons

Traits			Straw yield (kg/fad)		Grain yield (kg/fad)		Total dry matter (kg/fad)		Harvest index	
Cultivar	Seeding rate	Cutting date	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022	2020/2021	2021/2022
G.123	45 kg/fad	Without cut	4.66	4.48	1.86	1.89	6.52	6.36	28.62	29.65
		65 DAS	3.75	3.50	1.31	1.34	5.88	6.12	26.04	28.02
		85 DAS	1.83	2.29	0.86	0.92	4.39	5.34	32.05	28.66
	50 kg/fad	Without cut	4.52	4.63	2.59	2.62	7.11	7.25	36.31	36.17
		65 DAS	3.76	3.90	1.41	1.44	6.19	7.66	27.85	27.27
		85 DAS	2.93	2.71	0.95	1.01	6.04	6.91	24.48	27.39
	55 kg/fad	Without cut	4.73	4.96	2.59	2.60	7.32	7.56	35.38	34.37
		65 DAS	3.09	3.57	1.57	1.67	5.87	8.36	33.76	31.83
		85 DAS	2.50	3.06	0.97	1.06	5.78	7.20	28.25	25.71
G.133	45 kg/fad	Without cut	4.10	4.99	2.90	2.92	6.99	7.91	41.43	37.02
		65 DAS	3.61	4.15	2.11	2.19	6.71	8.37	37.09	34.57
		85 DAS	3.12	3.00	1.03	1.14	6.63	6.51	25.00	27.56
	50 kg/fad	Without cut	4.76	4.95	3.16	3.18	7.91	8.12	39.92	39.15
		65 DAS	4.77	4.28	2.22	2.46	8.22	9.76	31.76	36.74
		85 DAS	3.08	4.47	1.34	1.65	7.20	9.39	30.49	27.01
	55 kg/fad	Without cut	4.48	4.91	2.85	2.83	7.33	7.75	38.90	36.66
		65 DAS	3.34	4.30	1.92	2.02	6.64	9.16	36.61	32.03
		85 DAS	2.58	3.63	1.33	1.66	6.49	8.58	34.02	31.59
F. $_{test}$			**	*	**	**	*	*	**	**
R.L.S.D. $_{0.05}$			0.55	0.63	0.20	0.20	0.70	0.65	4.07	4.76

Where * and ** means significant at 5 and 1 % level of probability, respectively.

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