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# Effect of nitrogen fertilizer levels and the number of mows on green and dry forage yield and quality of three barley cultivars Hordeum *vulgare* L

**Fatimah Ali Jamel,**
**Waleed Abdulredha Jabail,**
**Khawla Rashige Hassan**
Department of Field Crop, College of Agriculture, University of Basrah, Iraq
fatima.chamel@uobasrah.edu.iq

**Abstract:** At the Agricultural Research Station of the University of Basra's College of Agriculture, a field experiment was conducted, Karma Ali site during the winter of 2021–2022, Basrah Governorate to study the best level of nitrogen fertilizer, the number of mowing times that give the best yield of green and dry fodder, and some qualitative characteristics of three varieties. The experiment was applied as a split-split plot design according to the randomized complete block design (R.C.B.D) with three replications. The main plots included the number of mowing times (mowing once, twice, three times), which are (C1, C2, C3), and the cultivars occupied the sub-plots (Buraq, Ibaa 99, Ibaa 265), which are symbolized by (V1, V2, V3), while the sub-sub plots included the secondary fertilizer levels are (100, 200, 300) N t $ha^{-1}$, symbolized by (N1, N2, N3). The most important results were: Fertilizer level N3 was significantly superior in all studied traits, green and dry forage yield, protein yield, and fiber yield, with a value of (34.69, 11.13, 143.84, 232.20) t $ha^{-1}$, respectively, in addition, V1 cultivar was significantly superior in the characteristic of green and dry forage yield and protein yield, and fiber, which gave the highest mean (34.33, 10.99, 138.82, 227.40) t $ha^{-1}$, respectively. As for the mowing treatment, the mowing treatment for three times C3 was significantly superior in all the studied traits; it gave the highest mean of (46.42, 14.24, 182.45, 299.40) t $ha^{-1}$, while the binary interaction between cultivars and the number of mowing times showed a significant effect on yield of green, dry forage and protein yield, fiber yield reached the highest average when class V1 and the number of times mowing C3 (50.45, 15.98, 210.55, 316.80) t $ha^{-1}$, respectively.
The interaction between fertilization levels and was significant regarding dry fodder yield and protein yield between level N3 and variety V1 giving the highest average (12.39, 165.11) t $ha^{-1}$, respectively. In contrast, the interaction between fertilization levels and the number of mowing times showed a significant effect between levels N3 and C3, where it gave the highest mean in all the studied traits (50.21, 15.91, 214.75, 336.70) t $ha^{-1}$. The triple interaction significantly affected protein yield only, with the highest mean being 253.73 t $ha^{-1}$.

**Keywords:** green fodder and grain, cultivars, fertilizer

## Introduction

Barley crop, *Hordeum vulgare* L., is one of the most significant and crucial fodder crops in the world. It is used for two important purposes: obtaining and its uses in various industries. The high nutritional value of the barley crop is due to the crop's high proportion of amino acids and protein by 13% and high levels. It contains dietary fiber and vitamins, especially vitamin B (Al-Taie et al., 2015; Al-Taher, 2018; Al-Jayashi, 2020), and its uses in soil reclamation are affected by salinity.

Most of the Iraqi lands are suitable for its cultivation. In central and southern Iraq, the barley fields cultivated in these areas are exploited for mowing or direct grazing (Al-Qaisi, 2001; Shanta, 2019). Several factors, including cultivars, affect green and dry fodder yield. The barley crop gives 2-3 mowing times, with an average of 12-14 t $ha^{-1}$ green fodder per once; the cultivar, its capacity for regeneration, and the density of the vegetative group all play a role in this. The yield of green and dry fodder, and the percentage of protein and fiber, vary according to the varieties and the number of mows (Al-Kinani, 2019; Al-Jayashi, 2020). Another factor is how grain crops respond to nitrogen fertilisation, especially in soils with weak fertility. Nitrogen fertilisation speeds up vegetative growth and boosts forage's nutritional content. Add batches after each mow to stimulate branching and regrowth (Plaza et al., 2017; Al-Rafaei, 2019). Nitrogen

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is an essential nutrient for plants and is classified as one of the macronutrients that plants need in large quantities. It limits plant growth if it is unavailable at the required level. Moreover, its performance weakens and decreases yield (Al-Karkhi, 2013; Vicente et al., 2018, Aljana, et al.2022).

It is possible to grow barley early, especially in the province of Basrah, characterized by animal husbandry, which needs fodder during the winter season when the bush and reed plants dry up. Furthermore, other plants that are the main fodder material for these animals, and by taking one or two mows of it to obtain a quantity of green fodder, especially in the winter season, and to treat the deficiency in this period, and then leave it for grain production, as is the practice of most farmers and animal breeders (Latif et al., 2006; Al-Kafi 2018; Sprague et al., 2018). Barley production for use as green fodder in Iraq is still in its infancy and requires further research before it can be used widely, and due to the lack of studies in Basrah Governorate on the impact of nitrogen fertilizer levels and the varieties circulating in Iraq without clear information and the number of mows in the production of green fodder for barley.

Therefore, the study factors were selected under the conditions of this region to find the optimal nitrogen fertiliser dosage and best variety that give highest green and dry forage yield and the best quality and determine the number of mows that give the highest yield and the best quality.

## Materials and Methods

During the winter of 2021–2022, a field experiment was conducted in Basrah Governorate at the Agricultural Research Station affiliated to the College of Agriculture, University of Basrah (Karmat Ali site affiliated to the University of Basrah) in soil with a texture (clay loam) to ascertain how much nitrogen fertiliser is applied and how many times it is mowed affect crop output, green and dry fodder and its quality for three varieties of barley.

The experiment was carried out using a randomised complete block design (R.C.B.D.) with three replications in accordance with the split-split plot's arrangement. The main plots included three mows time (C1, C2, C3); the symbol C1 is a one-time mow, C2 is a two-time mow, and C3 is a three-time mow. The sub-plots include three barley varieties (Buraq, Ibaa 99, and Ibaa 265), denoted by (V1, V2, V3). The sub-sub plots included quantities of nitrogen fertilizer with three levels (100, 200, 300) kg $ha^{-1}$ is denoted by (N1, N2, N3). The land of the field was divided into planks (2 x 2 = 4 $m^2$). The experimental unit contains 10 lines under cultivation. The seeds were placed in lines, and the lines were 20 cm apart from one another. Sowing took place on the first of November for all experimental units, with a seeding rate of (180) kg $ha^{-1}$ (Yasser, 2016). The phosphate fertilizer is added in an amount of (60 kg $P_2O_5$ $ha^{-1}$) by form triple superphosphate fertilizer ($P_2O_5$ (46%) before planting (Mahdi et al., 2011).

The experimental treatments were watered immediately after planting, while the other irrigations were given according to the need. The nitrogen fertilizers, it added according to the study parameters in three equal batches in the form of urea fertilizer (46% N), the first after emergence and the second edition after the first mowing. The last batch after the second mow was analyzed. The data were statistically according to the analysis of variance method for each of the studied characteristics, In accordance with what was stated by (Al-Rawi and Khalaf Allah, 1980), the averages of the coefficients were compared by calculating the least significant difference (L.S.D.) and under the probability level of 0.05.

## Results and discussion

### Green fodder yield (t $ha^{-1}$)

Table (1) shows a significant differences between the levels of nitrogen fertilization, as the N3 level was superior and with a significant difference from rest levels, by give highest green forage yield of 34.69 t $ha^{-1}$, while the N1 level gave the lowest average for this characteristic amounting to 28.97 t $ha^{-1}$. From this Table, the results show that there are significant effects of number of mowing times on the average yield of green forage, as the mowing treatment was three times more significant than the rest of the other mowing treatments and gave the highest mean for this trait amounted to 46.42 t $ha^{-1}$. In comparison, the one-time mowing treatment gave a lowest mean of 17.52 t $ha^{-1}$). The reason may be due to the increase in the yield of the total green cover due to the repetition of mowing, and this led to an increase in the speed of growth. Also note that there are significant effects of the cultivars on the average of this trait, as the V1 variety gave the highest rate, amounting to 34.33 t $ha^{-1}$, the V2 variety gave a lowest rate. For this characteristic, it amounted

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to 28.37 t ha$^{-1}$. This may be due to genetic nature of the varieties, and this result is agreed with (Al-Jayashi, 2020).

The results of the same Table show that the interaction between cultivars and the frequency of mowing has a substantial impact as the variety V1 with the treatment of mowing for three times C3 gave a highest average of 50.45 t ha$^{-1}$, while V2 with the treatment of mowing for one time C1 gave the lowest average of 15.54 t ha$^{-1}$. The reason maybe is the genetic nature of the variety, which is reflected positively in increasing the vegetative characteristics of the height and number of branches of the plant thus increasing the yield of green fodder resulting from three mows compared to once. This result agrees with (Al-Qaisi, 2001and Al-Jubouri, 2003).

Take note of the results of the same Table, which show that the second interaction between the degrees of fertilisation and the frequency of mowing has a substantial impact on the average of this trait, as the number of times of mowing with the levels of fertilization gave the highest average of C3 with N3, which amounted to 50.21 t ha$^{-1}$, and The role of nitrogen positive in promoting cell division, activity, and size growth accounts for this. Hence, growth improves, plant height increases, and the number of tillers increases, as well as the number of mowing times, a great role in increasing the yield, which is consistent with (Al-Taie et al., 2015).

Table (1) Effect nitrogen fertilization, mows number and cultivars, and their interaction on characteristic of green forage yield (t ha$^{-1}$)

| Number of mows | Varieties | Fertilizers | | | C×V |
|---|---|---|---|---|---|
| | | N1 | N2 | N3 | |
| C1 | V1 | 17.21 | 19.54 | 21.72 | 19.49 |
| | V2 | 13.56 | 15.53 | 17.53 | 15.54 |
| | V3 | 14.87 | 17.58 | 20.10 | 17.52 |
| C2 | V1 | 30.30 | 32.57 | 36.30 | 33.06 |
| | V2 | 25.23 | 28.87 | 31.53 | 28.54 |
| | V3 | 29.53 | 31.50 | 34.30 | 31.78 |
| C3 | V1 | 47.79 | 49.33 | 54.03 | 50.45 |
| | V2 | 37.37 | 40.07 | 45.63 | 41.02 |
| | V3 | 44.83 | 47.47 | 51.10 | 47.90 |
| Average of Fertilizers | | 28.97 | 31.41 | 34.69 | |
| 1.324 =(C×V) LSD | | | 0.510 =(N) LSD | | Average of Varieties |
| | | | N.S=(C×V×N) LSD | | |
| V×N | V1 | 31.77 | 33.88 | 37.35 | 34.33 |
| | V2 | 25.39 | 28.16 | 31.57 | 28.37 |
| | V3 | 29.74 | 32.18 | 35.17 | 32.36 |
| N.S =(N×V) LSD | | | 0.640 =(V) LSD | | Average of mows |
| C×N | C1 | 15.21 | 17.55 | 19.78 | 17.52 |
| | C2 | 28.36 | 30.98 | 34.04 | 31.13 |
| | C3 | 43.33 | 45.59 | 50.21 | 46.42 |
| 1.251 =(C×N) LSD | | | | 1.220 =(C) LSD | |

**Dry fodder yield (t ha$^{-1}$)**

According to Table 2's findings, there are significant differences between cultivars in terms of this trait's average value, with the V1 variety providing the highest average value—amounting to 10.99 t ha-1—as opposed to the V2 variety, which provided the lowest average value—amounting to 8.77 t ha-1. The reason may be due to a genetic factors of variety, which may contain genetic factors that led to an increase in its efficiency in absorbing nutrients from the soil, an increase in the activity of vital processes within the plant, and an increase in the storage of other substances such as sugars and amino acids, which is evidenced by the rise and activity of vegetative growth of this variety and thus an increase yield of green forage and, as a

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result, the yield of dry forage increased for this cultivar. This result is consistent with (Al-Qaisi, 2005 and Al-Kinani, 2019).

As for the fertilization levels, can note significant differences between the levels, as the N3 level, compared to other levels, gives 11.13 t $ha^{-1}$. The same Table's results indicated significant differences in mowing times number on average dry fodder yield, as the mowing treatment was three times C3, significantly superior to the rest of the treatments of the other treatment and gave a highest average of 14.24 t $ha^{-1}$. This might be because this particular treatment outperformed the other treatments by a wide margin in the total green fodder yield as a result of collecting the yield of the three mows of green fodder for the reasons mentioned previously by (Al-Qaisi 2001; Al-Jubouri et al. 2003; Al-Jayashi, 2020), who indicated that the total green fodder yield from three mows increased more than the green fodder from one mow.

The same Table indicates that there are significant differences due to the binary overlap between cultivars and the number of times of mowing on the average of this trait, as the cultivar V1 with a three-time mowing treatment gave C3 a highest rate at 15.98 t $ha^{-1}$. The V2 variety with a one-time mowing treatment gave the lowest rate. This capacity is 4.79 t $ha^{-1}$. The genetic make-up of this variety, which may contain genes that increased growth abundance, such as the number of branches and leaves, leading to a rise in the yield of green forage for the same treatment, may be the cause of this. Also, the yield of total green fodder from mowing three times was much more than the yield of the total green fodder resulting from one-time mowing, This increased the output of dry fodder for this treatment. This outcome is consistent with that obtained by (Al-Qaisi, 2001 and Al-Jubouri et al., 2003).

The same Table's findings show that the bilateral interaction has a substantial impact. between fertilization levels and number of times of mowing on average of this trait, as the fertilizer level N3 with the three-time mowing treatment C3 gave the highest mean to 15.91 t $ha^{-1}$ compared with the one-time mowing treatment C1 It provided the lowest average for this attribute, it achieved level N1 at 4.89 t ha-1. Possible explanations for this include the fact that the rise in plant density increased the number of plants per unit area, increasing the production of green forage as a result. Additionally, the frequency of mows increased the rate of growth and the quantity of forks, boosting the yield of green forage. This outcome is congruent with the conclusions that were drawn (Al-Lahif, 2022). The results of the same Table show that the bilateral overlap between fertilisation levels and cultivars has a significant impact, with the overlap between cultivar V1 and fertiliser level N3 having the highest average value of this trait (12.39 t ha-1) when compared to other cultivars.

Table (2) Effect nitrogen fertilization, mows number and cultivars, and their interaction on dry fodder yield (t $ha^{-1}$)

| Number of mows | Varieties | Fertilizers | | | C×V |
|---|---|---|---|---|---|
| | | N1 | N2 | N3 | |
| C1 | V1 | 5.95 | 6.63 | 7.29 | 6.63 |
| | V2 | 4.13 | 4.22 | 6.03 | 4.79 |
| | V3 | 4.61 | 5.57 | 6.95 | 5.71 |
| C2 | V1 | 9.62 | 9.85 | 11.62 | 10.37 |
| | V2 | 8.54 | 8.67 | 9.54 | 8.92 |
| | V3 | 9.35 | 10.01 | 10.95 | 10.10 |
| C3 | V1 | 14.07 | 15.60 | 18.25 | 15.98 |
| | V2 | 11.37 | 12.37 | 13.96 | 12.57 |
| | V3 | 11.74 | 15.23 | 15.51 | 14.16 |
| Average of Fertilizers | | 8.820 | 9.80 | 11.13 | |
| 1.324 =(C×V) LSD | | | | 0.510 =(N) LSD<br>N.S=(C×V×N) LSD | Average of Varieties |
| V×N | V1 | 9.88 | 10.69 | 12.39 | 10.99 |
| | V2 | 8.01 | 6.42 | 9.84 | 8.77 |
| | V3 | 8.56 | 10.27 | 11.40 | 9.99 |
| 0.574 =(N×V) LSD | | | | 0.376 =(V) LSD | Average of mows |
| C×N | C1 | 4.89 | 5.48 | 6.76 | 5.71 |

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|---|---|---|---|---|---|
| | C2 | 9.17 | 9.51 | 10.71 | 9.80 |
| | C3 | 12.39 | 14.40 | 15.91 | 14.24 |
| 0.756 =(C×N) LSD | | | | | 0.725 =(C) LSD |

**Crude protein yield (t ha$^{-1}$)**

According to Table 3's findings, cultivars and fertilisation levels have a significant impact on the percentage of crude protein. The V1 variety gave the trait's highest average value, which came to 138.82 t ha-1, while the V2 variety gave the trait's lowest average value, which came to 104.34 t ha-1. This is explained by the genetic characteristics of the V1 variant and its containment of genes that enable its leaves to increase the formation of amino acids because of its efficiency in absorbing nutrients, especially nitrogen and phosphorous, which are included in the composition of amino acids, and thus an increase in the formation of protein and its percentage in green fodder (Al-Atabi, 2011 and Al-Jayashi, 2020). The highest average fertilizer was at the N3 level, which amounted to 143.84 t ha$^{-1}$.

The findings of the same Table show that there are notable variations in the percentage of crude protein in green fodder depending on the number of times it has been cut, with the treatment of cutting it three times (C3) producing the highest average for this characteristic, amounting to 182.45 t ha$^{-1}$ While the one-time mowing treatment, C1, gave a lowest mean for this characteristic, amounting to 65.02 t ha$^{-1}$. The reason for this may be attributed to the increase in total yield of green forage and dry matter yield for the three-time C3 treatment compared to one-time C1-mowing treatment. This result is consistent with (Al-Atabi, 2011).

The results of the same Table also show that the bilateral interaction between the number of mows and cultivars has a considerable impact, as mowing for three times C3 with cultivar V1 gave the highest average of 210.55 t ha$^{-1}$, while between fertilization levels and cultivars, the highest average was at level N3 and cultivar V1 amounted to 165.11 t ha$^{-1}$. From the results, can notice differences in the interaction between fertilization levels and the number of mows. It was at the N3 level. Mowing three times, C3, the highest average was 214.75 t ha$^{-1}$. Additionally, a remark from the same Table indicating that the triple interactions between the amounts of fertilisation differ significantly cultivars, and the number of mows, where the highest average was in the combination N3×V1× C3 amounted to 253.73 t ha$^{-1}$. These results agree with (Al-Atabi, 2011 and Bothhamer, 2018).

Table (3) Effect nitrogen fertilization, mows number and cultivars, and their interaction on crude protein yield (t ha-**1**)

| Number of mows | Varieties | Fertilizers | | | C×V |
|---|---|---|---|---|---|
| | | N1 | N2 | N3 | |
| C1 | V1 | 65.56 | 77.03 | 87.44 | 76.68 |
| | V2 | 43.20 | 46.66 | 68.81 | 52.89 |
| | V3 | 50.28 | 63.73 | 82.46 | 65.49 |
| C2 | V1 | 109.36 | 124.20 | 154.16 | 129.24 |
| | V2 | 93.14 | 103.26 | 118.25 | 104.88 |
| | V3 | 103.45 | 123.79 | 139.21 | 122.15 |
| C3 | V1 | 169.89 | 208.03 | 253.73 | 210.55 |
| | V2 | 129.68 | 155.41 | 180.62 | 155.23 |
| | V3 | 135.82 | 198.96 | 209.89 | 181.56 |
| Average of Fertilizers | | 100.04 | 122.34 | 143.84 | |
| 9.882 =(C×V) LSD | | | | 4.418 =(N) LSD<br>14.099=(C×V×N) LSD | Average of Varieties |
| V×N | V1 | 114.93 | 136.42 | 165.11 | 138.82 |
| | V2 | 88.67 | 101.77 | 122.56 | 104.34 |
| | V3 | 96.52 | 128.83 | 143.58 | 123.07 |
| 7.570 =(N×V) LSD | | | | 4.705=(V) LSD | Average of mows |
| C×N | C1 | 53.02 | 62.47 | 79.57 | 65.02 |
| | C2 | 101.98 | 117.08 | 137.21 | 118.76 |

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|---|---|---|---|---|---|
| | C3 | 145.13 | 187.46 | 214.75 | 182.45 |
| 9.753 =(C×N) LSD | | | | | 9.154 =(C) LSD |

**Crude fiber yield (t ha$^{-1}$)**

As the N3 level provided the greatest mean for this feature in comparison to the N1 level, then the results of Table (4) suggest substantial differences between the fertilisation levels, which amounted to 232.2 t ha$^{-1}$. As for the number of mows times and cultivars, we can notice from the Table that results show significant differences for each, as the V1 variety gave the highest average of 227.4 t ha$^{-1}$. This indicates that the production of the same type of fiber changes according to environmental conditions, and the three-time mowing treatment indicated the highest average for this characteristic, which reached 299.4 t ha-1. This is because the number of mowing times controls the increase and decrease in the percentage of fiber in green fodder, which is consistent with (Hajighasemi et al. 2016).

One may observe from the same Table that the binary interaction between cultivars and the frequency of mowing has a substantial impact, where the cultivar V1 and the treatment of mowing for three times C3 gave a highest average to 316.8 t ha$^{-1}$, while the interference between a levels of fertilization and number of times of mowing gave level N3 with the treatment of mowing three times higher an average for this characteristic amounted to 336.7 t ha$^{-1}$. The reason for this may be due to repeated mowing, which led to an increase in dry matter yield, which has a positive role in the yield of fibers. This result is consistent with (Al-Lahif, 2022).

Table (4) Effect nitrogen fertilization, mows number and cultivars, and their interaction on crude fiber yield (t ha$^{-1}$)

| Number of mows | Varieties | Fertilizers | | | C×V |
|---|---|---|---|---|---|
| | | N1 | N2 | N3 | |
| C1 | V1 | 142.8 | 159.4 | 148.1 | 150.1 |
| | V2 | 101.2 | 111.2 | 140.4 | 117.6 |
| | V3 | 118.7 | 134.1 | 146.0 | 132.9 |
| C2 | V1 | 218.4 | 200.3 | 227.2 | 215.3 |
| | V2 | 201.9 | 191.6 | 194.1 | 195.9 |
| | V3 | 236.8 | 203.8 | 224.0 | 221.5 |
| C3 | V1 | 284.4 | 297.5 | 368.5 | 316.8 |
| | V2 | 265.6 | 273.5 | 311.5 | 283.5 |
| | V3 | 264.5 | 298.8 | 330.3 | 297.8 |
| Average of Fertilizers | | 203.8 | 207.8 | 232.2 | |
| 22.18 =(C×V) LSD | | | | 8.95=(N) LSD<br>N.S=(C×V×N) LSD | Average of Varieties |
| V×N | V1 | 215.2 | 219.1 | 247.9 | 227.4 |
| | V2 | 189.6 | 192.1 | 215.3 | 199.0 |
| | V3 | 206.7 | 212.2 | 233.4 | 217.4 |
| N.S =(N×V) LSD | | | | 7.56=(V) LSD | Average of mows |
| C×N | C1 | 120.9 | 134.9 | 144.8 | 133.5 |
| | C2 | 219.0 | 198.6 | 215.1 | 210.9 |
| | C3 | 271.5 | 289.9 | 336.7 | 299.4 |
| 22.75 =(C×N) LSD | | | | | 22.35 =(C) LSD |

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