Effect of seeding rate and NPK compound fertilizer on growth and yield of flax (*Linum usitatissimum* L.)

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Abstract

This study was conducted during the winter agricultural season 2019/2020 in two locations, the first in Tel Kaif district, which is 20 km north from the center of Mosul, and the second in Al-Hamdaniya district, 25 km southeast of Mosul, to study the effect of three seeding average(30, 40 and 50 kg.ha⁻¹) and four levels of compound fertilizer N15P15K15 (zero, 100, 150 and 200 kg.ha⁻¹) in growth, yield and quality of flax under dehydrating conditions, the experiment was conducted in the field according to a randomized complete block design (RCBD) with three replications. The results indicated that the seeding average of 30 kg.ha⁻¹ was significantly excelled in the traits: number of fruiting branches. Plant⁻¹ and number of capsules. plant⁻¹, percentage of oil in seeds for both locations, and number of seeds. Capsule⁻¹ and the weight of 1000 seeds at the Tel Kaif location, and the seeding average of 50 kg.h⁻¹ was significantly excelled on the seed yield and the percentage of linolenic acid in both sites, and the plant height at the Tel Kaif location .The level of the compound fertilizer 200 kg.ha⁻¹ was significantly higher in the trait: plant height and number of fruiting branches. Plant⁻¹ and the number of capsules. Plant⁻¹ and the number of seeds. Capsule⁻¹ at Al-Hamdaniya location, while the percentage of linolenic acid was superior at Telkaif location, and the percentage of oil in the seeds and oil yield reached the highest amount at the same level of the compound fertilizer in both locations. The interaction of seed average with the levels of the compound fertilizer indicated a significant and varied superiority in the trait: plant height and number of fruiting branches. Plant-1 and the number of seeds. Capsule⁻¹ and weight 1000 seeds for both locations.

Key words: Linum usitatissimum L., flax seeding average, NPK compound fertilizer.

Introduction

Flax (*Linum usitatissmum* L.) is one of the important industrial crops and comes third in the world in the fiber industry and fifth in the vegetable oil industry (1), where it is grown for the purpose of obtaining oil from the seeds and fiber from the stems, the proportion of oil in flax seeds ranges from 30%- 45% flax seed oil contains fatty acids, the most important of which are linolenic acid (Omega-3) by 48%, linoleic acid (Omega-6) by 20%, oleic acid (Omega-9) by 23%, and citric acid by Streaic acid by 9% of the total fatty acids (2).Despite the great importance of this crop, the productivity average per unit area in Iraq is still

low compared to the global production average, which amounted to (2.8 million) for 2017, and Canada, Kazakhstan, China, and Russia are at the forefront of countries in terms of production and area (3).In view of the low rate of production per unit area, it is necessary to use modern methods in agriculture to improve the production situation, and the expansion of flax cultivation with different seeding rates is one of the strategic goals in developing the cultivation of this crop in the country, where the appropriate seeding average is one of the important factors in providing opportunities Equal to all plants equally to obtain growth sources (water, nutrients, light), which is positively reflected in the growth and yield of flax (4).(5) showed when studying the effect of three seed averages $(30, 40 \text{ and } 50 \text{ kg.ha}^{-1})$ on the flax crop that the low seeding average (30 kg.ha⁻¹) recorded the highest significant rate in the traits: the number of fruiting branches. Plant and the number of capsules. Plant⁻¹, the weight of 1000 seeds and the percentage of oil in the seeds, while the high seeding average (50 kg. ha⁻¹) recorded the highest significant rate in the plant height trait. NPK fertilizer plays an important role in the process of plant nutritional balance, which affects the growth, yield and quality of flax (6). Nitrogen is a vital and important element in plant nutrition and is included in the synthesis of amino and nucleic acids and contributes to the formation of chlorophyll, nucleotides. phosphatides, alkaloids, enzymes, hormones, vitamins, etc. It also leads to an increase in the efficiency of the plant in consuming water and resisting external stresses (7). Phosphorous plays a key role in regulating photosynthesis reactions and as a source of energy and respiration. Potassium contributes to the formation of proteins and carbohydrates and the transfer of sugars from leaves (source) to seeds (sink) and as an activator for enzymes that contribute to photosynthesis, as well as regulating osmotic effort. of the plant cell and thus maintains its swelling pressure and thus increases the plant's ability to resist drought, frost, salinity, fungi and diseases (8).(9)showed that the fertilizer level $(90 \text{ kg N} + 120 \text{ kg P2O5} + 80 \text{ kg K2O.ha}^{-1})$ recorded an increase in the percentage of linolenic acid that amounted to (47.1%) compared to the control treatment (no fertilization), which was equal to (41.3) %), and found (10) a significant increase in the trait: plant height and number of capsules. Plant-1 and the number of seeds. Capsule⁻¹, the weight of 1000 seeds and the seed yield when increasing the levels of NPK fertilizer added to the soil from (zero: zero: zero) to (48: 34.5: 45) and (64: 46: 60) kg of NPK. ha^{-1} . The research aims to determine the most appropriate amount of seeding rate and the best level of NPK fertilizer when cultivating flax seed underwater conditions.

Materials and methods

This study was conducted in the winter agricultural season 2019-2020 in two locations, the first in Tal Kaif district, north of Mosul, which is 20 km from the center of Mosul, in loam soil, and the second in the Al-Hamdaniya district, southeast of Mosul, which is 25 km from the center of Mosul, in clay soil to study. Effect of three seed average (30, 40, and 50 kg.ha⁻¹) and four levels of compound fertilizer N15P15K15 (0, 100, 150, and 200 kg.ha⁻¹) on the growth of yield and quality of flax cultivar Sharda (Indian origin). NPK fertilizer was added to the soil at once when planting. The experiment was conducted in the field according to a randomized complete block design (R.C.B.D.) with three replications (11). Each experimental unit contained (five lines) with a length of (3 m) for each line and a distance of (30 cm) between one line and another, leaving a distance of (1 m) between an experimental unit and another and a distance of (1 m) between one replicate and another. The weeds were controlled manually whenever needed due to the sensitivity of flax to the growth of the weeds. The crop plants were harvested in the Al-Hamdaniya site on 5/27/2020 and in the Tal Kaif location on 5/28/2020. The physical and chemical properties of the soil were analyzed at a depth of 0-30 cm for both locations. In the soil testing laboratories of the Environmental Protection and Improvement Department / Dohuk (Table 1).Ten plants were randomly selected from the median lines and the following traits were studied: plant height, number of fruiting branches. Plant⁻¹, number of capsules. Plant-1, number of seeds. capsule⁻¹, weight 1000 seeds, seed yield (kg.ha⁻¹), percentage of oil in seeds (estimated using Soxhlett apparatus as mentioned (12). The percentage of linolenic acid estimated using the was Japanese-made Shimedzu LC-2010 AHT HPLC separator (13) and according to the operational conditions

shown in Table (2), and the measurements were made at Mosul University / College of Agriculture and Forestry / Department of Food Sciences. Statistical analysis and Duncan's test were conducted under the probability level of 1 and 5% using the SAS program (14).

| Table (1): The physical and chemical properties of the soil of the two study sites, Tel Kaif | and Al- |
|--|---------|
| Hamdaniya. | |

| Tra | aits | Units | Al-Hamdaniya location (cm30-0) | Tel Kaif location (cm30-0) | |
|-------------------------|--------------------------|---------------------|---------------------------------------|--------------------------------|--|
| availabilit | y nitrogen | mg.kg ⁻¹ | 34.9 | 59.12 | |
| availa phospl | ability horous | mg.kg ⁻¹ | 35.5 | 48.07 | |
| availability | v potassium | mg.kg ⁻¹ | 325.0 | 260.0 | |
| Organic | e matter | g.kg ⁻¹ | 1.3 | 1.2 | |
| The degree of the so | of reaction oil (pH)) | | 7.8 | 7.3 | |
| electrical co meter | onductivity · (EC) | DS.m ⁻¹ | 0.168 | 0.262 | |
| Volume dis soil pa | tribution of articles | g.kg ⁻¹ | 558 | 203 | |
| Soil | Clay | g.kg ⁻¹ | 364 | 452 | |
| Separator | silt | g.kg ⁻¹ | 78 | 345 | |
| S | sand | g.kg ⁻¹ | 78 | 345 | |
| | Soil te | xture | clay | loamy | |

Table (2): Separation Conditions for High Performance Liquid Chromatography (HPLC)

| No. | Separation conditions | Specifications |
|-----|-----------------------|-------------------------|
| 1 | dovico nomo | High Performance Liquid |
| I | uevice name | Chromatography (HPLC) |
| 2 | column type | C18 (4.6 mm x 250 mm) |
| 3 | detector | UV |
| 4 | wave length | 242nm |
| 5 | injection quantity | 25µl |
| 6 | carrier phase | Water: acetonitrile |
| 7 | running speed | hopefull . 1 minute |
| 8 | column temperature | 40 pm |
| 9 | default runtime | 10 minutes |

Results and discussion

Plant height (cm): The results in table (3) indicate a significant increase in plant height by increasing the seeding average at Tal Kaif location, where the highest plant height was

recorded at the seeding average of 50 kg. ha⁻¹ reached (45.3 cm), and the reason for the increase in plant height at the high seeding average may be due to the decrease in the intensity of lighting as a result of the plants .As the relationship of stem elongation with lighting

is an inverse relationship, the less lighting, the higher the plant height (15). This is consistent with (5) and (16), but in the Al-Hamdaniya location, the seeding average did not have a significant effect on the height of the plant. As for the levels of the compound fertilizer NPK, it did not significantly affect the plant height in the Telkaif location, while in the Hamdaniya location, the differences were significant, and the highest average of plant height at the level of the compound fertilizer was 200 kg. ha⁻¹ and was equal to (48.3 cm), which did not differ significantly from the level of compound fertilizer 150 kg. ha⁻¹, The reason for the increase in plant height in the Al-Hamdaniya location is due to the level of the compound fertilizer 200 kg. E-1 due to the low soil content especially nutrients. nitrogen of and phosphorous (Table 1), which led to an increase in the plant's response to high levels of compound fertilizer and consequently an increase in the elongation of the internodes. These results agree with (10) and (17). It was also observed that this trait was significantly affected when the seed average interacted with the levels of the compound fertilizer in Telkeef site. This characteristic is significant when the seed average interaction with the levels of the compound fertilizer in the Hamdaniya location.

Number of fruiting branches. Plant ⁻¹: Table (3) shows the effect of seeding average significantly on the characteristic of the number of fruiting branches. Plant-1 in both locations, where the seeding rate of 30 kg.ha⁻¹ gave the highest significant average of this trait reached (4.8 and 4.1 fruiting branches. Plant⁻¹) in both locations, respectively, which did not differ significantly from the seeding average of 40 kg.ha⁻¹,

The reason for the increase is due to the low seeding average of 30 kg.ha-1, which led to a lack of competition between plants in obtaining water and nutrients from the soil, and consequently, this improved the ability of the plant to form branches. This result is consistent with findings (5) and (18). As for the NPK

compound fertilizer, it did not show significant differences in this trait in the Telkaif location, while in the Al-Hamdaniya location, the differences were significant, and the highest significant average of the trait was recorded at the level of the compound fertilizer 200 kg.ha-1, which amounted to (4.2 fruiting branches. It did not differ significantly from the level of the compound fertilizer 150 kg.ha⁻¹,The reason for this may be due to the low soil content of nitrogen and phosphorous available at the Al-Hamdaniya location(Table 1) compared to the Telkaif location, which led to the plant's response to high levels of the compound fertilizer, which affected the regulation and action of hormones such as auxins and cvtokines. which led to an increase in meristematic cell division and thus an increase In the number of fruiting branches of the plant (19). The result agreed with what was found by (20) who found a significant increase in this trait by increasing the levels of the compound fertilizer. The results indicated that this trait was significantly excelled on the two interactions between the seed rate and the compound fertilizer at the Telkaif location . The interaction between the seed rate of 30 kg.ha⁻¹ with the level of the compound fertilizer 200 kg.ha⁻¹ achieved the highest significant rate in this trait amounted to $(5.5 \text{ fruiting branches. Plant}^{-1})$, which did not differ significantly from the interaction between the seed rate of 40 kg. ha⁻¹ with a compound fertilizer level of 150 kg. ha ¹,Whereas, no significant differences were observed in this trait when the seed average was interaction with the compound fertilizer in the Al-Hamdaniya location .

Number of capsules plant⁻¹: Table (3) shows a significant decrease in this trait by increasing the seeding average in both locations, where the seeding average of 30 kg.ha⁻¹ gave the highest significant average for the trait reached (16.8 and 14.0 capsules. Plant⁻¹) in the two locations respectively, The reason for the superiority of

the low seeding average in this trait may be due to the increase in the number of fruiting branches. Plant⁻¹ (Table 3) as a result of improved vegetative plant growth, reduced competition, and the plant obtained a sufficient amount of water and nutrients from the soil, as well as the lighting, which was reflected in the increase in the number of capsules. plant⁻¹, and the results agreed with (5) and (16). Non significant differences were recorded between the levels of the compound fertilizer in this trait at the Telkaif location, while at the Al Hamdaniya location, a gradual and significant increase was observed with an increase in the levels of the compound fertilizer, and the highest average of the trait was recorded at the level of the compound fertilizer 200 kg.ha ¹),This may be due to the positive role of the compound fertilizer NPK in the formation of chlorophyll pigment and the increase in the efficiency of the photosynthesis process and thus the increase in the accumulation of dry matter through the division and expansion of cells and its reflection in the increase in the number of flowers and more fruit set in the plant due to the increase in the effectiveness and vitality of pollen (21). These results are consistent with what was found (10) and (17). No significant differences were observed in this trait when the two interactions between seed average and compound fertilizer levels.

Number of seeds, capsule⁻¹: Table (3) indicates that the seed average was significantly affected by this trait at Telkef location , as the seed average 30 kg.ha⁻¹ excelled by giving it the highest significant average of the trait amounted to (9.4 seed. capsule⁻¹), which did not differ. Significantly, the seeding average is 40 kg.ha⁻¹ ,The reason for the excelled of the low seeding rate in this trait may be due to the lack of competition between plants, which increases their access to the largest possible amount of nutrients, moisture and light, which led to the improvement of plant growth and the increase in the efficiency of the photosynthesis process, which led to an increase in the number of seeds. capsule-1.The results agreed with (16) and (22), but in the Al-Hamdaniya location, there were no significant differences between seed averages in this trait. Non significant differences were observed between the levels of the compound fertilizer in this trait at the Telkef location , In Al-Hamdaniya site, the level of the compound fertilizer 200 kg.ha⁻¹ was significantly excelled by giving it the highest average of the trait reached (9.3 seeds. capsule), which did not differ significantly from the level of the compound fertilizer 150 kg.ha⁻¹

Perhaps the reason is the increase in the number of seeds. Capsule⁻¹ by increasing the levels of the compound fertilizer to the role of the compound fertilizer NPK in improving plant growth and increasing the efficiency of the photosynthesis process and increasing the fertilization rate in flowers (19), which led to an increase in the number of seeds. capsule⁻¹. The results agreed with what was obtained (10) and (17).As for the bi-interaction, it was observed that this trait was significantly affected when the interaction between the seed rate and the compound fertilizer at the Telkeif location achieved, where it achieved the interaction of the seed rate of 30 kg. The interaction of the seed average 40 kg.ha⁻¹ with the level of the compound fertilizer 150 kg.ha⁻¹ was the highest average for the character reached (9.5 seeds. capsule-1) for each one, which did not differ significantly from the interaction of the seeding average of 50 kg.ha- 1 with the level of the compound fertilizer 200 kg.ha-1, while in the Hamdaniva site, the interaction of the seeding average with the compound fertilizer did not show significant differences in this trait.

Weight of 1000 seeds (g): Table (3) shows that to increase the seeding average a gradual and significant decrease in the weight of 1000 seeds at the Telkef location , where the seeding average 30 kg was excelled. Decreased seed weight by increasing the seeding average to an increase in competition between plants for water, nutrients, and lighting, which led to a decrease in the number of leaves per plant and its content of chlorophyll, which affected the decrease in photosynthesis and consequently, the decrease in the accumulation of dry matter in the seeds, which led to a decrease in the weight of seeds (23). The results agreed with what was found (16) and (24), but in the Al-Hamdaniya site, there were no significant differences between the seeding average in this trait. The results indicated that the compound fertilizer did not have a significant effect on this trait in both study sites, and the results agreed with (17) and (25). The results showed that there were significant differences in this trait when the two interactions between the seed rate with the compound fertilizer at the Telkeif location interaction with the seed average of 30 kg.ha-1 with the level of the compound fertilizer 200 kg.ha⁻¹ by giving the highest significant rate for the trait amounted to (8.0 g). In Al-Hamdaniya location, the interaction of the seed average with the compound fertilizer did not show significant differences in this trait.

Seed yield (kg. ha⁻¹): Table (3) shows that there was a significant increase in the trait of seed yield with an increase in seeding average in both locations. The seeding rate was 50 kg.ha⁻¹, the highest significant average of the trait was (1530.9 and 1386.7 kg. .ha⁻¹) in both sites respectively, which did not differ significantly from the seeding average of 40 kg.ha⁻¹. The increase in seed yield at the high seeding average was due to the increase in the number of plants per unit area. The results agreed with what was found (16) and (26). The results showed that the compound fertilizer was not significantly affected by this trait in both sites, and these results agreed with (27). The results showed that this trait was not significantly affected in both locations when the seeding average was interaction with the compound fertilizer.

The percentage of oil in the seeds: Table (3) indicates that the seeding rate had a significant effect on this trait in both study sites, as the

seeding rate exceeded 30 kg.ha⁻¹ by giving it the highest significant rate of the trait amounted to (40.0%) in the Telkaif location, and in the Tal Kaif location. Al-Hamdaniya location, the seed average of 30 kg.ha⁻¹ was superior by giving it the highest significant average of the trait amounted to (41.4%), which did not differ significantly from the seed average of 40 kg.ha⁻ ¹. The reason for the increase in the oil percentage may be due to the increase in the dry weight of the plant and the leaves due to the lack of competition between plants for water and nutrients, which led to an increase in the outputs of photosynthesis and its transmission from leaves to seeds, and the results agreed with what was found (5). The results indicated that there was a gradual and significant increase in this trait when increasing the levels of the compound fertilizer in the two locations, where the level of the compound fertilizer 200 kg.ha⁻¹ recorded the highest significant average for the trait, which reached (40.1 and 41.9%) in the two locations, respectively. Which did not differ significantly from the level of the compound fertilizer 150 kg.ha⁻¹ in Al-Hamdaniya locations and the reason for the increase in the percentage of oil in the seeds may be due to the increase in fertilizer levels to the transformation of a large amount of carbohydrates manufactured through the photosynthesis process into fats, while the remaining amount of carbohydrates was lost. It turned into protein, which led to an increase in the percentage of oil at the expense of the percentage of protein, and this is consistent with what he obtained (29). The results showed that this trait was not significantly affected by the biinteraction between the seed average and the levels of the compound fertilizer in both locations. The percentage of linolenic acid: The results of Table (3) showed that the increase in the seed average led to an increase in linolenic acid in the two locations, where the seeding rate exceeded 50 kg.ha-1 by giving it the highest significant rate of the trait amounted to (47.2 and 47.4%) in the two locations, respectively, which did not Significantly different from the

seeding locations of 40 kg.ha⁻¹ in Telkef location. The results agreed with what was found by (26) and (30). The results showed that this trait was significantly affected by the levels of the compound fertilizer in Tal Kaif locations, where the compound fertilizer level of 200 kg.ha⁻¹ recorded the highest significant average for the trait amounted to (47.8%), which did not differ significantly from the level of the compound fertilizer 150 kg.ha⁻¹.The reason for the increase in linolenic acid with an increase in the levels of the compound fertilizer may be due to the conversion of a large amount of processed carbohydrates to fats and the remaining amount of carbohydrates converted to protein (31) and as a result the increase in linolenic acid in the seeds compared with the low levels of the compound fertilizer. The results agreed with what was obtained (9). As for the Al-Hamdaniya location, the differences did not reach a significant level between the levels of the compound fertilizer in this trait. As for the bilateral interaction between the seeding average and the compound fertilizer, no significant differences were found in this trait in both study location.

Table (3): The effect of seed rate and compound fertilizer N15P15K15 and the interaction between them on the studied traits in the
two study location, Tal Kaif and Al Hamdaniya.

| Linolen ic acid (%) | oil (%) | Seed yield (kg.h a-1) | Weig ht of 1000 seeds (gm) | numb er of seeds. capsul e ⁻¹ | numbe r of capsule s. plant ⁻¹ | Number of fruiting branche s. Plant | plant heig ht (cm) | seedin g rate (kg.h ⁻ ¹) |
|---------------------------|----------------|--------------------------------|--|--|---|---|-----------------------------|--|
| | | | Т | el Kaif lo | cation | | | |
| 45.0 b | 40. 0 a | 1262. 6 b | 7.4 a | 9.4 a | 16.8 a | 4.8 a | 41.3 b | 30 |
| 46.1 ab | 38. 7 b | 1422. 3 ab | 7.2 b | 9.2 ab | 15.1 b | 4.6 ab | 43.1 b | 40 |
| 47.2 a | 36. 4 c | 1530. 9 a | 6.7 c | 9.1 b | 13.2 c | 4.3 b | 45.3 a | 50 |
| | | | Al-H | lamdaniya | location | | | |
| 45.5 b | 41. 4 a | 1192. 0 b | 7.7 | 9.2 | 14.0 a | 4.1 a | 44.0 | 30 |
| 46.8 a | 40. 8 a | 1288. 7 ab | 7.6 | 9.1 | 12.1 b | 3.9 ab | 45.5 | 40 |
| 47.4 a | 39. 8 b | 1386. 7 a | 7.4 | 8.9 | 11.3 b | 3.7 b | 46.7 | 50 |

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| Linolenic | acid (%) | oil | (%) | Seed yiel | ld (kg.ha- l) | Wei 1000 (g | ght of) seeds gm) | numbe r of seeds. capsul e ⁻¹ | nui cap pl: | nber of sules. ant ⁻¹ | Nui fru bra s. Pi | Number of fruiting branche s. Plant ⁻¹ | | nt gh 1) | Compoun d fertilizer N15P15K 15 (kg.h-1) | | | |
|---------------------------|----------|-----------------|--------------|------------------|---------------------|-------------------|--------------------------|--|------------------------------|---|-------------------------------|---|----------------|----------------|--|--|--|-----|
| | | | | | Tel | Kaif loo | cation | | · | | | | | • | | | | |
| 44.8 с | | 37.0 c | | 129 | 94.4 | 7 | 7.0 | 9.1 | 1 | 4.0 | 4. 4 | 1 | 41.7 | | 0 | | | |
| 45.1 cb | | 37.6 c | | 13. | 35.8 | 7 | 7.1 | 9.2 | 1 | 4.2 | 4.4 | 1 | 43.1 | | 100 | | | |
| 46.8 ab | | 38.9 b | | 14 | 57.1 | 7 | 7.1 | 9.3 | 15.6 | | 15.6 | | 4.7 43.5 | | 15.6 4.7 | | | 150 |
| 47.8 a | | 40.0 a | | 15. | 33.7 | 7 | 7.3 9.4 16.2 4.8 | | 3 | 44.7 | | 200 | | | | | | |
| | I | | | | Al-Ha | ndaniya | location | I | | | | | | I | | | | |
| 45.8 | | 39.6 с ₹ | | 120 | 04.2 | 7 | 7.4 | 8.8 b | 10 | .2 d | 3.7 | 3.7 c 42.8c | | 0 | | | | |
| 46.3 | | 40.1 bc | | 12. | 30.8 | 7 | 7.5 | 8.9 b | 11 | 11.7 c 3.8 bc 44.6 bc | | 3.8 bc 44.6 bc | | 100 | | | | |
| 46.9 | | 41.0 ab | | 13 | 16.5 | 5 7 | | 9.2 a | 13.3 b 4.1 ab 45.9 ab | | b | 150 | | | | | | |
| 47.4 | | 41.9 a | | 14 | 04.9 | 7 | 7.8 | 9.3 a | 14 | .7 a | 4.2 a | | 18.3 a | L | 200 | | | |
| Linolen ic acid (%) | oil (% |) | Seed (kg. | l yield ha-1) | Weight o seeds (| f 1000 gm) | numbe seeds capsul | r of s. ca e ⁻¹ s. j | mber of psule plant | Num of fruit bran s. Pla 1 | ber f ing che ant | plar heig (cm | nt ht 1) | | Compo und fertilize r N15P15 | | | |

| K15 | | | | | | | | | | | |
|-------------------|-----|-------------|--------------|------|-----------|-------------|--------|------|------|--|--|
| (kg.h-1) | | | | | | | | | | | |
| Tel Kaif location | | | | | | | | | | | |
| | 0 | 38.6 e- | 4.5 bc | 15.0 | 9.5 a | 7.1 bcd | 1212.3 | 38.3 | 42.5 | | |
| 30 | 100 | 44.3 abc | 4.8 bc | 17.0 | 9.5 a | 7.2 bcd | 1154.1 | 39.4 | 43.7 | | |
| | 150 | 39.1 de | 4.5 bc | 16.4 | 9.4 ab | 7.5 b | 1294.0 | 39.8 | 47.2 | | |
| | 200 | 43.2 bde | 5.5 a | 18.8 | 9.3 abc | 8.0 a | 1389.8 | 42.6 | 46.6 | | |
| | 0 | 42.9 bdc | 4.3 c | 14.8 | 8.9 c | 6.9 bce | 1202.2 | 37.2 | 44.4 | | |
| 40 | 100 | 41.3 bde | 4.3 c | 14.3 | 9.1 abc | 7.2 bcd | 1226.5 | 38.0 | 45.3 | | |
| | 150 | 43.6 abc | 5.1 ab | 15.6 | 9.5 a | 7.2bcd | 1630.9 | 39.3 | 46.9 | | |
| | 200 | 44.7abc | 4.6 bc | 15.5 | 9.4 ab | 7.3 bc | 1629.6 | 40.1 | 48.0 | | |
| | 0 | 43.7 abc | 4.2 c | 12.2 | 9.0 bc | 6.9 bde | 1468.8 | 35.4 | 47.5 | | |
| 50 | 100 | 43.6 abc | 4.2 c | 11.2 | 8.9 bc | 6.8 de | 1626.9 | 35.4 | 46.3 | | |
| | 150 | 47.9 a | 4.4 c | 14.8 | 9.1 abc | 6.7 de | 1446.3 | 37.5 | 46.3 | | |
| | 200 | 46.1 ab | 4.3 c | 14.5 | 9.4 a | 6.4 e- | 1581.7 | 37.5 | 48.7 | | |
| | | 1 | | 1 | alocation | Al-Hamdaniy | 1 | | | | |
| 30 | 0 | 41.7 | 3.8 | 11.5 | 8.8 | 7.9 | 1072.6 | 40.4 | 44.5 | | |
| | 100 | 43.1 | 3.9 | 13.6 | 9.1 | 7.7 | 1036.2 | 41.0 | 46.1 | | |

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| | 150 | 44.6 | 4.5 | 14.9 | 9.4 | 7.5 | 1320.0 | 41.7 | 44.7 |
|----|-----|------|-----|------|-----|-----|--------|------|------|
| | 200 | 46.5 | 4.3 | 16.2 | 9.5 | 7.8 | 1339.0 | 42.6 | 46.7 |
| | 0 | 42.7 | 3.8 | 10.0 | 8.8 | 7.5 | 1290.4 | 39.7 | 47.2 |
| 40 | 100 | 44.7 | 3.7 | 11.5 | 9.0 | 7.4 | 1254.6 | 40.1 | 45.6 |
| | 150 | 46.0 | 4.0 | 12.8 | 9.2 | 7.8 | 1244.6 | 41.3 | 47.0 |
| | 200 | 48.6 | 4.2 | 14.1 | 9.3 | 7.7 | 1365.0 | 42.0 | 47.6 |
| | 0 | 43.9 | 3.5 | 9.1 | 8.7 | 6.8 | 1249.6 | 38.6 | 45.6 |
| 50 | 100 | 46.0 | 3.7 | 10.0 | 8.8 | 7.3 | 1401.4 | 39.3 | 47.3 |
| | 150 | 47.2 | 3.7 | 12.3 | 9.1 | 7.6 | 1385.0 | 40.2 | 49.0 |
| | 200 | 49.9 | 4.0 | 13.9 | 9.2 | 8.0 | 1510.7 | 41.1 | 47.8 |

Similar letters within the same column or row are not significantly different from each other at the 1 and 5% probability level.

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