Plant Archives Vol. 21, Supplement 1, 2021 pp. 1287-1293 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
doi link : https://doi.org/10.51470/PLANTARCHIVES.2021.v21.S1.203

CONTRIBUTION OF THE MAIN STEM AND TILLERS OF SOME CULTIVARS OF WHEAT (*TRITICUM AESTIVUM* L.) UNDER DIFFERENT LEVELS OF NITROGEN FERTILIZER

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ABSTRACT

A field experiment was conducted at the Agricultural Research and Experiments Station, College of Agriculture, Al-Muthanna University, during the winter season (2019-2020), to determine the contribution of the main stem and tillers of some *Triticum aestivum* L. wheat cultivars to the number of grains per spike. The experiment included a study of the effect of four cultivars of bread wheat (Iraq, Bahoth 22, IBA 99 and Iranian), and five levels of nitrogen fertilizer were 0 kg N. ha^{-1} (without addition); 75 kg N.ha^{-1} (zero emergence, 25 kg tillering, 25 kg elongation, 25 kg booting); 100 kg N.ha^{-1} (12.5 kg emergence, 25 kg tillering, 50 kg elongation, 12.5 kg booting); 125 kg N.ha^{-1} (25 kg emergence, 25 kg tillering, 50 kg elongation, 25 kg booting); and 200 kg N.ha^{-1} (50 kg emergence, 50 kg tillering, 50 kg elongation, 50 kg booting). The experiment was carried out according to the arrangement of the split-plot, using the Randomized Complete Block Design (R.C.B.D) with three replicates, the nitrogen fertilizer levels were placed in the main-plot, and cultivars in the sub-plot. The results showed that the Bahoth22 cultivar was outperformed on the number of grains per spike (57.34 grain. $Spike^{-1}$), as for the contribution of the main stem and body tillers, the largest contribution to the number of grains in the spike came from the main stem of all the studied varieties, the contribution of the first tiller came in the second place, then the second and third tillers, reaching the lowest contribution with the fourth tiller. As for nitrogen fertilizer, the results showed that the amount of fertilizer exceeded 200 kg N. ha^{-1} in the number of grains for the main stem and the first, second, third and fourth tillers, it averaged 50.98, 46.92, 39.23, 27.28 and 21.67 grains per spike, respectively. As for the interaction between the two experiment factors, the combination (Iraq cultivar × 200 kg N. ha^{-1}) outperformed the number of grains for the first, second, third and fourth tillers, which amounted to 53.13, 41.13, 31.67, and 25.00 grain. $spike^{-1}$ respectively. The results of the contribution of the main stem and tillers to the number of spike grains were similar to the results of the factors which are alone, revealed that the high contribution of the main stem does not necessarily mean the efficiency of the fertilizer treatment, in terms of superiority in grain yield at the level of individual yield, or the community yield of plants, because it will be at the expense of the late, which were absent sometimes or coincide with completely unsuitable climatic conditions, limit its contribution to the formation of the yield.

***Keywords*:** contribution, main stem, tillers, bread wheat (*Triticum aestivum* L.), nitrogen fertilizer, number grains per spike.

Introduction

The wheat crop (*Triticum aestivum* L.) is the first in the world in terms of cultivated area and production, the most important of the cereal crops, the main food for more than 60 countries in the world, contributes to providing 20% of the human need for food (El-Fouly, 2011). Iraq is considered one of the original centers of the emergence of wheat, the countries where the factors of success of cultivation are available, the cultivated area during the 2019 season was about 6331 thousand acres, with a productivity of 4,343 thousand tons (Agricultural Statistics Directorate, 2019). It is noticed in Iraq that the increase in production is due to the horizontal expansion, need modern ways and technologies, contributes to increasing crop yield by increasing productivity per unit area, achieving the so-called vertical expansion in agriculture, one of these technologies was the adoption of cultivars with high productivity under local conditions, manage nutrients by determining optimal levels of addition and timing of addition, related to the stages of plant growth and development, to determining the quantity and quality of yield, including the tillering phase, optimal management requires a good understanding of how the plant performs its functions in the field during the growth stages. Tillers formation, including wheat, represents the most important and longest period of crop growth, which most of the components of the crop were determined, including the number of spikes that were determined early in the crop growth, which was controlled by two processes: Tiller production and Tiller death, the importance of the strands comes from intercepting the largest amount of light through the green space of the shins compared to the main stem, it was one of the adaptive mechanisms in cereal crops plants to maintain a balance between source and downstream of the tillers, the stores of photosynthesis products, which was redistributed into grains after expelling the spikes (Al-Hassan, 2011). The tillering process was affected by several factors, including genetic (cultivars), environmental (soil and climate) and other hormonal factors, as well as soil and yield management factors, one of the keys to important crop management was nitrogen fertilization (Tilley et al., 2010). Therefore, researchers continuously seek to investigate possible means to raise the productivity of the wheat crop and improve its quality, one of these methods was the use of nitrogenous fertilizers and the dates for adding them during the growth stages, due to the positive role of nitrogen in

increasing dry matter production during the period of vegetative and reproductive growth and improving the quality of the yield (Al-Haidari and Mohammed, 2007).

The experiment was conducted, which aims to link the physiological of the wheat crop and its productivity, by knowing the best quantities of nitrogen fertilizer that should be added, and the date of addition during the growth stages, and their role in the growth and development of the tillers and their contribution to the formation of the yield and its components for different varieties of the wheat crop.

Materials and Methods

Experience treatments:

The experiment included a study of two factors, namely:

First:- Five levels of nitrogen fertilizer (0, 75, 100, 125 and 200) kg N. ha^{-1}, it was symbolized by N0, N1, N2, N3, and N4 in series, a segmentation was added in four batches, the first at the seedling stage, the second at the tillering stage, the third at the elongation stage, and the fourth at the booting stage, as shown below:

1. N0 without adding fertilizer (comparison treatment).
2. N1 75 kg. ha^{-1} (zero emergence, 25 kg tillering, 25 kg elongation and 25 kg booting).
3. N2 100 kg. ha^{-1} (12.5 kg emergence, 25 kg tillering, 50 kg elongation, 12.5 kg booting).
4. N3 125 kg. ha^{-1} (25 kg emergence, 25 kg tillering, 50 kg elongation, 25 kg booting)
5. N4 200 $kg.h^{-1}$ (50 kg emergence, 50 kg tillering, 50 kg elongation and 50 kg booting).

Second: Four varieties of fine wheat which are (Iraq, Bahoth 22, IBA 99 and Iranian), and they are symbolized by the symbols V1, V2, V3, and V4 respectively.

Traits studied:

Plant dry weight (g):

The average dry weight of the five marked plants was taken from each experimental unit at the stage of completion of flowering (100% flowering), it was dried air to complete dryness and then weighed the main stem and slings, when the other five parameterized plants reach full maturity (upon harvest), the weight of the main stem and branches were also taken after the weight of the beans was subtracted.

The number of grains per spike:

Calculated as the average number of grain per spike for ten, randomly selected from the middle lines of each experimental unit, after cleaning and dispensing manually.

Calculating the number of kernels per spike. This includes measurement of MS, T1, T2, T3 and T4 in the five plants marked for each experimental unit.

Results and Discussion

Contribution of the main stem and tillers:

Dry weight (%):

The results showed that the largest contribution to the production of dry matter came from the main stem of all the studied cultivars, which amounted to 30.20, 32.60, 31.13 and 28.48%, the contribution of the first tiller ranked second, then the second and third tillers, reaching the lowest contribution achieved with the fourth tiller, reached 8.83, 8.73, 10.69 and 10.09% in Iraq, Research 22, IBA99, and Iranian, cultivars respectively (Figure 1). The percentage of participation gradually decreases, starting from the main stem all the way to the fourth tiller, they were normal due to the order in which these strands appear in sequence, leads to important results, the first is the short duration of its growth, the second is inadequate climatic conditions, leads to a shorter duration of the photosynthesis process, reduces its efficiency, lack of dry matter production and accumulation the more delayed the tiller appear.

The Iranian cultivar was the most balanced dry matter distribution on the tillers, for several reasons, the first was the lack of a high shareholding in the main stem, the second was the highest contribution to the first tiller among all cultivars, the third was that the gap between the contribution of the first, second and third tillers was relatively small compared to the rest of the cultivars, the fourth was the contribution of the last two tillers (the third and fourth), which were higher, it was followed in that IBA 99 cultivar, by analogy with the two cultivars Iraq and Bahoth22, the percentage of contribution decreased (Figure 1). This can be attributed to the fact that the Iranian cultivar was the lowest among the varieties, saved the dry matter that is consumed in building the height as storage in the storage sites in the main stem and the slats, which increased their weight. Or perhaps it distinguished itself from other cultivars in that it did not appear with large intervals of time, or early in appearance, grew and developed in more favorable climatic conditions than other cultivars studied.

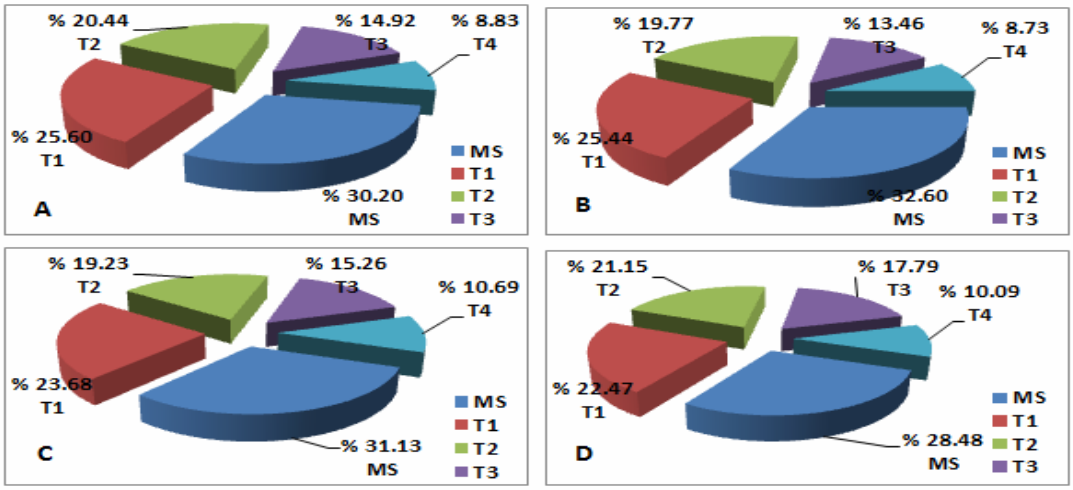

Fig. 1 : Contribution of the MS main stem and the T1, T2, T3 and T4 tillers to the dry weight of plants (g) of the Iraq (A), Bahoth22 (B), IBA99 (C) and Iranian (D) cultivars.

As for the contribution under the influence of nitrogen fertilization, noticed from the results that the main stem contributed the largest percentage, followed by the first tiller, then gradually reaching the fourth tiller, which contributed the least percentage and below all the fertilizer quantities. Also, the best balance in the distribution of dry matter was achieved with the two quantities of fertilizers 125 and 200 kg N. ha^{-1} compared to the rest of the fertilizer quantities. The main stem and the first and second tillers did not account for the largest share of the contribution at the expense of the late tillers (the third and fourth), by doing so, it made a good contribution to dry matter production (Figure 2), this can be explained on the basis that the two mentioned quantities were distinguished from other quantities by being the best in terms of quantity and food supply during the different growth stages, evident in the production of the dry matter of the plant.

The comparison treatment (without adding nitrogen) saw the highest contribution of the main stem and first tiller compared to the rest of the fertilizer quantities, they averaged 40.74 and 31.29%, respectively (Figure 2). This may be due to the delay in the appearance of the rest of the tillers, this made the product of plant activities focused on the main stem and this first tiller, available from nitrogen in the soil has been applied to them and to the second most visible streak, then nitrogen ran out with the emergence of the third tiller, contribution decreased significantly and the fourth tiller whose contribution ceased (without tillering).

The results showed that the minimum fertilizer quantities were 100, 125 and 200 kg N. ha^{-1}, secured a more or less identical contribution for the first and second tillers, and good for the last tillers (third and fourth), due to the quantities of fertilizer, including the addition of nitrogen fertilizer in all stages of vegetative growth, and in the highest quantity, compared to the amount of fertilizer 0 kg N. ha^{-1}, in which no nitrogen fertilizer was added, dependence on the soil, the quantity is 75 kg N. ha^{-1}, which included non-addition during the emergence stage, the addition in the rest of the stages of vegetative growth was in the least amount, reflected on the emergence, growth and development of lysosomes and hence their effectiveness in photosynthesis

Hence, the decrease in dry matter production and double the contribution to the dry weight of the plant (Figure 2).

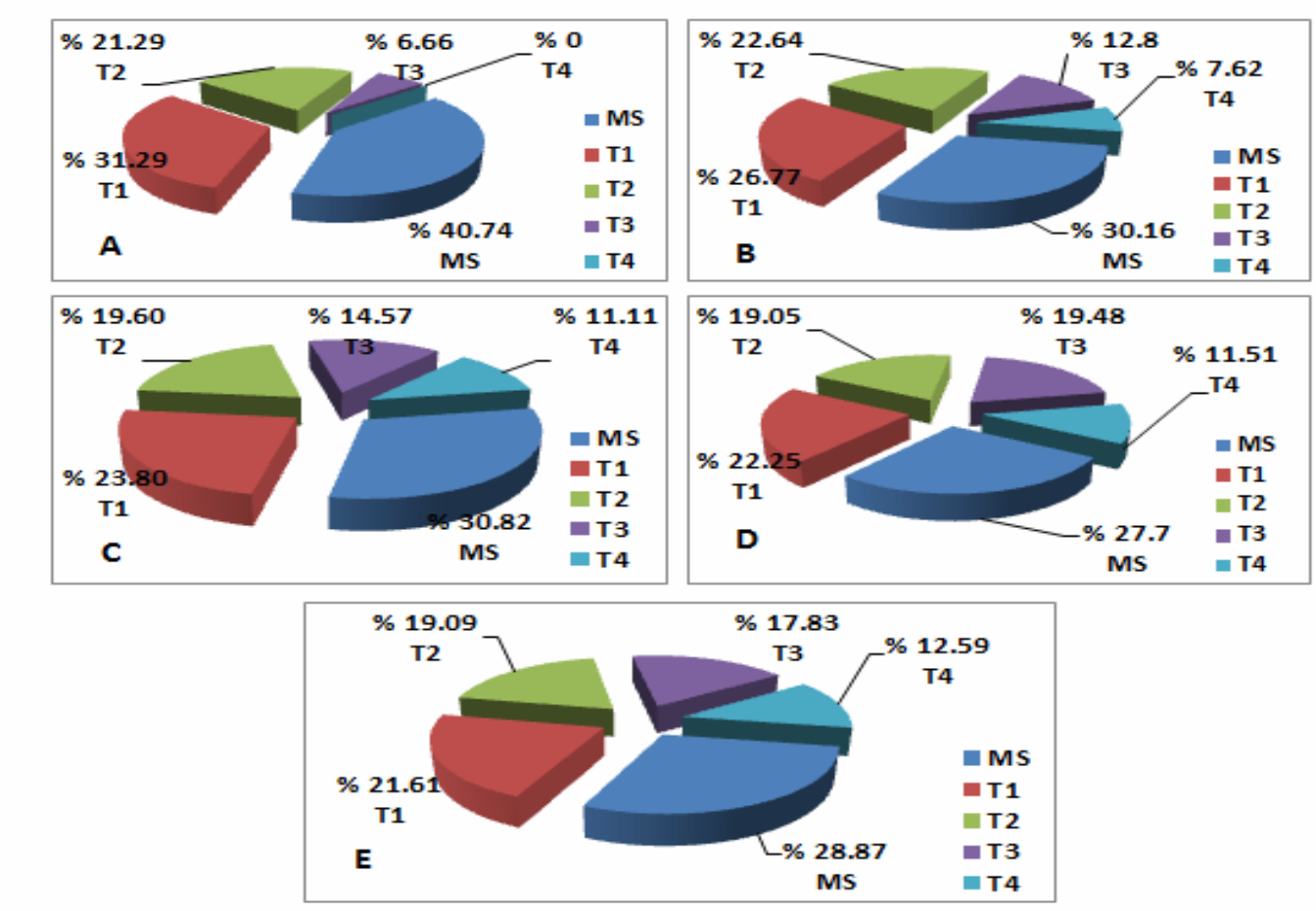

Fig. 2 : The contribution of the MS main stem and the T1, T2, T3 and T4 tillers to the dry weight trait of the plant (g) of the nitrogen fertilizer level 0 kg N. ha^{-1} (A), 75 kg N. ha^{-1} (B), 100 kg N. ha^{-1} (C), 125 kg N. ha^{-1} (D) and 200 kg N. ha^{-1}(E).

Number of grain per spike (%):

The results revealed that the largest contribution of the main stem was in Bahoth 22 cultivar, which amounted to 33.57%, the contribution of the main stem to the rest of the cultivars was largely the same, which amounted to 31.97, 31.85 and 31.47 for the 99, Iranian and Iraq cultivars respectively, the largest contribution was in the number of grains per spike of the first and second tillers in the Iraq cultivar, which amounted to 26.55 and 18.54%, respectively. The largest contribution of the third and fourth tillers in the Iranian cultivar, with averages of 15.82 and 10.09%

respectively (Fig. 3). The variation in the contribution of the main stem and tillers with different cultivars can be traced back to their variation in the time of appearance of the tillers, which was affected by the genetic aspect, the period of growth of each tiller, the climatic conditions in which it grows, and its suitability for the growth and development of tillers, to become a bearer of natural spikelets whose florists synchronize with suitable climatic conditions for pollination to produce seeds.

The cultivars that excelled in the contribution of the main stem and the first and second tillers, weakened the contribution of the third and fourth tillers, the time out for these two tillers will be late, makes its growth and development under completely unsuitable climatic conditions, shortens their growth time, it was not allowed to produce a large number of flower arrangements, as a result of the great competition within the plant, that is, between the parts of the same plant, especially on nutrients and light (between the tillers and between the tillers and other parts of the plant), which impairs the photosynthesis process, reduces dry matter production and contribution, produces natural florets ready for fertilization and the production of grains and other unnatural florets (not fully developed), fail to complete fertilization, weakens its contribution to grain formation.

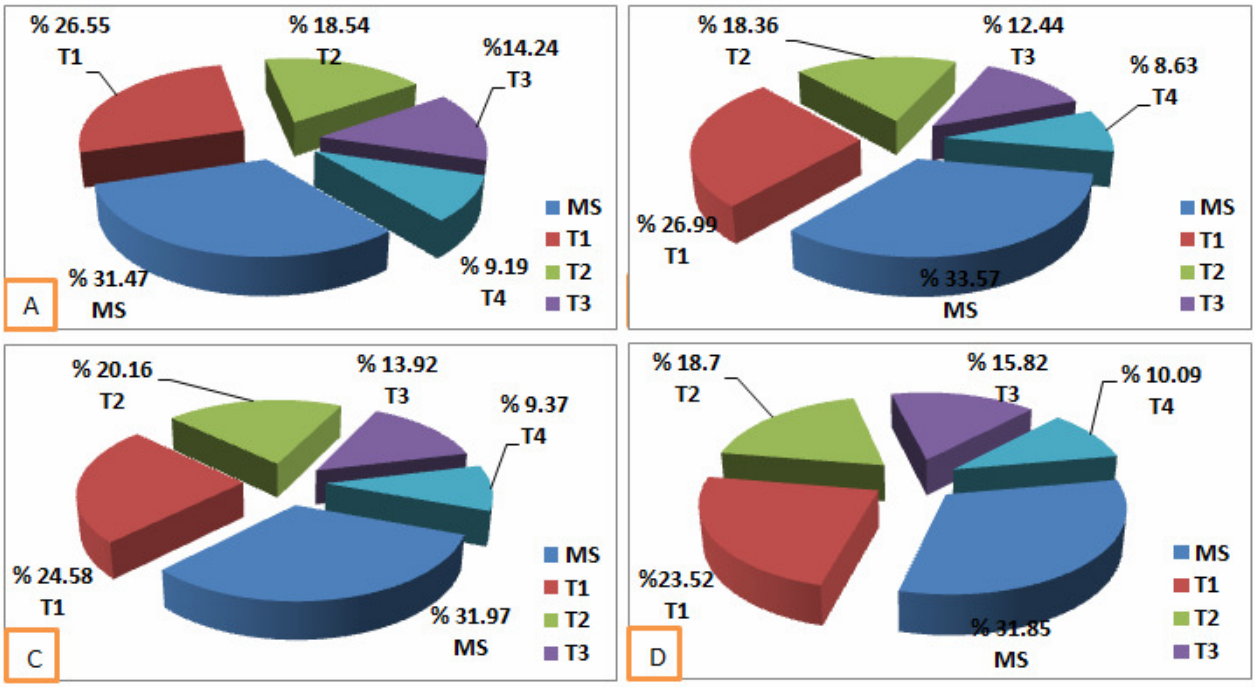

Fig. 3 : Contribution of the MS main stem and the T1, T2, T3 and T4 tillers on the number of grains of Iraq (A), Bahoth22 (B), IBA99 (C) and Iranian (D) cultivars.

As for the contribution of the main stem and tillers to the number of grain per spike under the influence of nitrogen fertilizer, the results showed a decrease in the contribution of the main stem and the first tiller with an increase in the nitrogen fertilizer added, which amounted to the main leg of 29.19 and 27.39%, while for the first tiller it amounted to 24.94 and 25.22% for the two quantities 125 and 200 kg N. ha^{-1}, respectively, the exact opposite happened with respect to the second, third and fourth tillers, contribution increased with the increase in the amount of added fertilizer (Fig. 4). The increase in nitrogen fertilizer with its addition in batches (fractionation) in the growth stages of the crop, provide the food supply in the right quantity and time with more efficiency than low levels of fertilizer, the quantities of 125 and 200 kg N. ha^{-1} included early batch additives (emergence and tillering), in higher quantities compared to the rest of the quantities, which established good tillering and efficient growth, resulted in the production of a dry matter with a high contribution to the dry weight of the main stem and tillers (Fig. 2).

The the best balance between the main stem and the tillers and between the tillers in terms of contribution, achieved at the highest fertilizer amount is 200 kg N. ha^{-1}, followed by the amount of fertilizer 125 kg N. ha^{-1}, then the quantity 100 kg N. ha^{-1}, whereas, the gap was large between the contribution of the main stem and the tillers and between the tillers with the quantities of fertilizer 0 and 75 kg N. ha^{-1}, the contribution of the main stem was 46.87 and 34.05% for the two quantities, respectively. The absence of the fourth tiller was observed with the comparison treatment (0 kg N. ha^{-1}), due to the lack of nitrogen added, the lack of addition in the comparison treatment made the plant rush to promote the growth of the main stem and the first tiller with the available fertilizer, it directs all its potentials to enhance their growth, which made it lose the ability to promote the growth of late strands, which were sometimes absent due to lack of nitrogen.

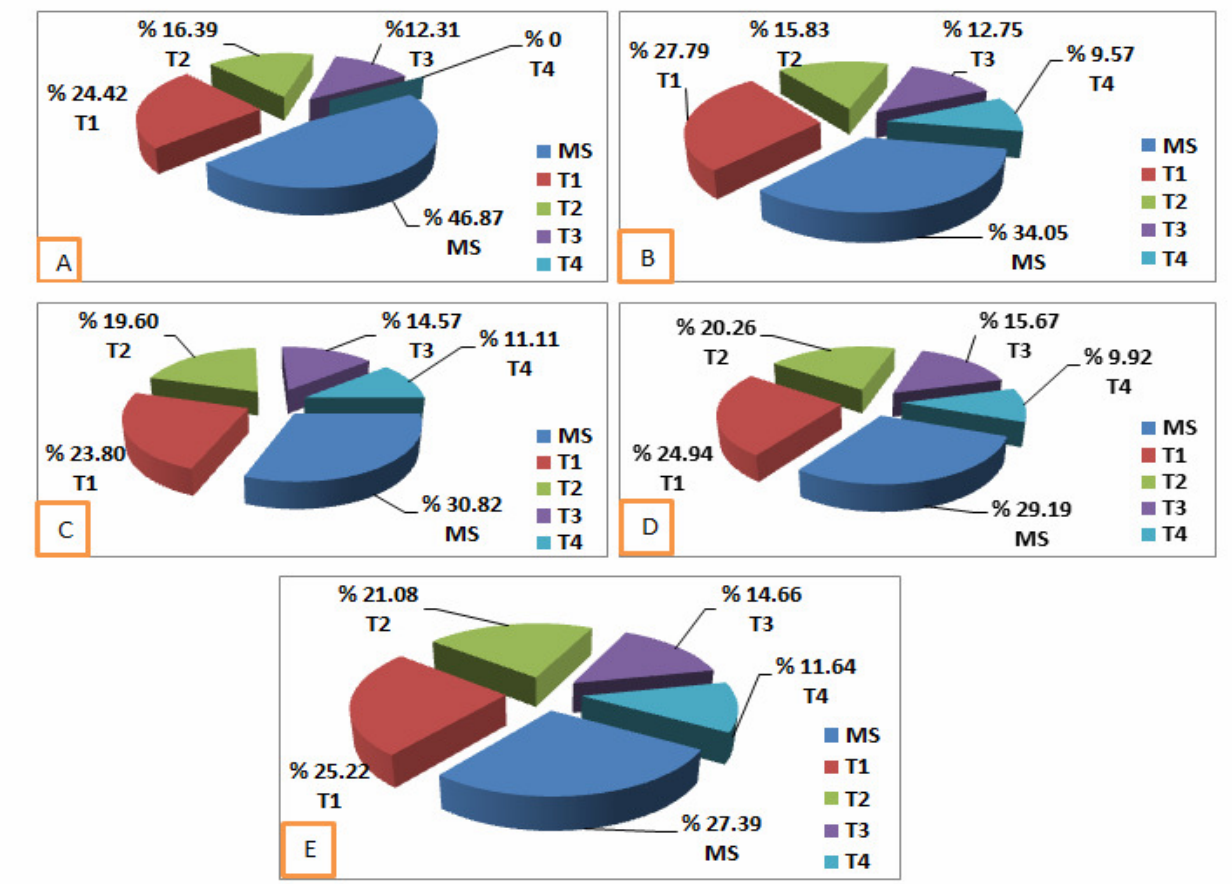

Fig. 4 : Contribution of the MS main leg and the T1, T2, T3 and T4 modules to the grain number traits of the nitrogen fertilizer level 0 kg N. ha^{-1} (A), 75 kg N. ha^{-1} (B), 100 kg N. ha^{-1} (C), 125 kg N. ha^{-1} (D) and 200 kg N. ha^{-1}(E).

Grain yield per plant (%):

The results of the comparison of the cultivars showed in terms of the contribution of the main stem and the tillers to the grain yield of the plant, there are cultivars that excel in the main stem and the first and second tillers, were Bahoth22 and IBA99, reached 34.69, 27.26 and 18.41%, while IBA99 reached 33.65, 25.63 and 19. 37% for the main stem and the first and second tillers, the highest was scored with the cultivar, while there were cultivars such as Iraq showed a high contribution in the main stem and the first tiller, and recorded the highest contribution of the third and fourth tillers with the Iranian cultivar, which averaged 14.86 and 10.64% respectively. However, the best grain weight balance was achieved with the Iranian cultivar, the contribution was more balanced between the main stem and the tillers, especially the late grains which were the best contributors to the grain yield, it was followed in that by the two cultivars IBA99 and Bahoth22 (Fig. 5). This can be attributed to the increase in the number of grains (Fig. 3), which contributed to an increase in their weight, which was reflected in the increase in the grain yield of the plant.

The contribution of the main stem is similar to the weak contribution of the tillers the longer it appears, for all the cultivars studied, it is the dominant characteristic under any influence, whether genetic, environmental, or subject to any specific field practice. However, the variation between one cultivar and another in the amount of the main stem or tillers contribution, it is mainly due to genetic and environmental determinants and agricultural processes, whose action is often interaction, the main cause of this discrepancy, related to when the shoots appeared, some extent genetically related and the time available for them to grow and develop, which were often governed by climatic conditions and competition, growth factors (light, water, and nutrients), under the influence of different field practices.

As for the effect of nitrogen fertilizer, it was increase in the contribution of the main stem and tillers with an increase in the amount of nitrogen fertilizer added, the best balance of the weight of the spike seed was achieved between the main stem and the tillers and between the tillers with two quantities of fertilizer 125 and 200 kg N. ha^{-1}, the amount of fertilizer 100 kg N. ha^{-1} ranked second, while the balance seemed to diminish in the amount of fertilizer 75 kg N. ha^{-1}, it was null in the comparison treatment (without adding fertilizer), the best results were achieved with the amount of fertilizer 200 kg N. ha^{-1}, which recorded contributions of 28.85, 24.59, 21.06, 14.86 and 10.64% for the main stem and the first, second, third and fourth tillers (Fig. 5), the aforementioned equilibrium condition was imposed by the nature of each treatment in terms of quantity and time of adding fertilizer, which targeted specific phases sensitive to nitrogen deficiency, made it coincide with the dates of the emergence, growth and development of the tillers in light of an abundance of nitrogen while not neglecting the effect of climatic conditions, accompanies the growth and development of the tillers, one of the main determinants in determining the contribution of each of the main stem and tillers, makes them vary under the influence of the same amount and different amounts of nitrogen fertilizer

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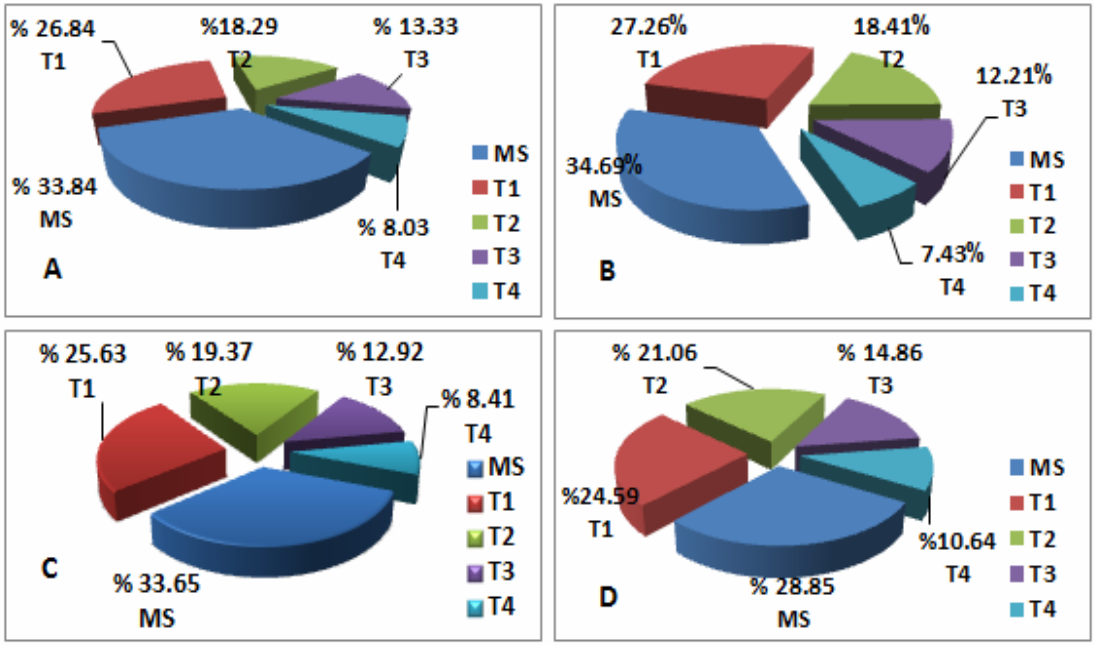

Fig. 5 : Contribution of the main stem MS and the T1, T2, T3 and T4 tillers to the grain yield trait of the plant (g) of Iraq (A), Bahoth22 (B), IBA99 (C) and Iranian (D) cultivars.

The results showed an important, the high contribution of the main stem, the efficiency of the fertilizer treatment does not necessarily mean the superiority in the yield of grains at the level of the individual plant or the yield of a community of plants, because it will be at the expense of the late contribution, which were absent or coincide with completely unsuitable climatic conditions, limits its contribution to yield formation as is the case with fertilizer quantities 0, 75 and 100 kg N. ha^{-1}, which gave the lowest yield for both plant and total yield, the state of equilibrium in the contribution is between the main stem and the tillers and between the tillers between them, it was capable of achieving the best results for the individual plant and plant community, evident with high fertilizer quantities of 125 and 200 kg N. ha^{-1} (Fig. 6), explains the different percentages of contribution to the grain yield of a plant is completely related to the yield components, discrepancy and discrepancy, including the number of spike grains, which was one of the main controls for the yield of seeds of the plant (Fig. 4).

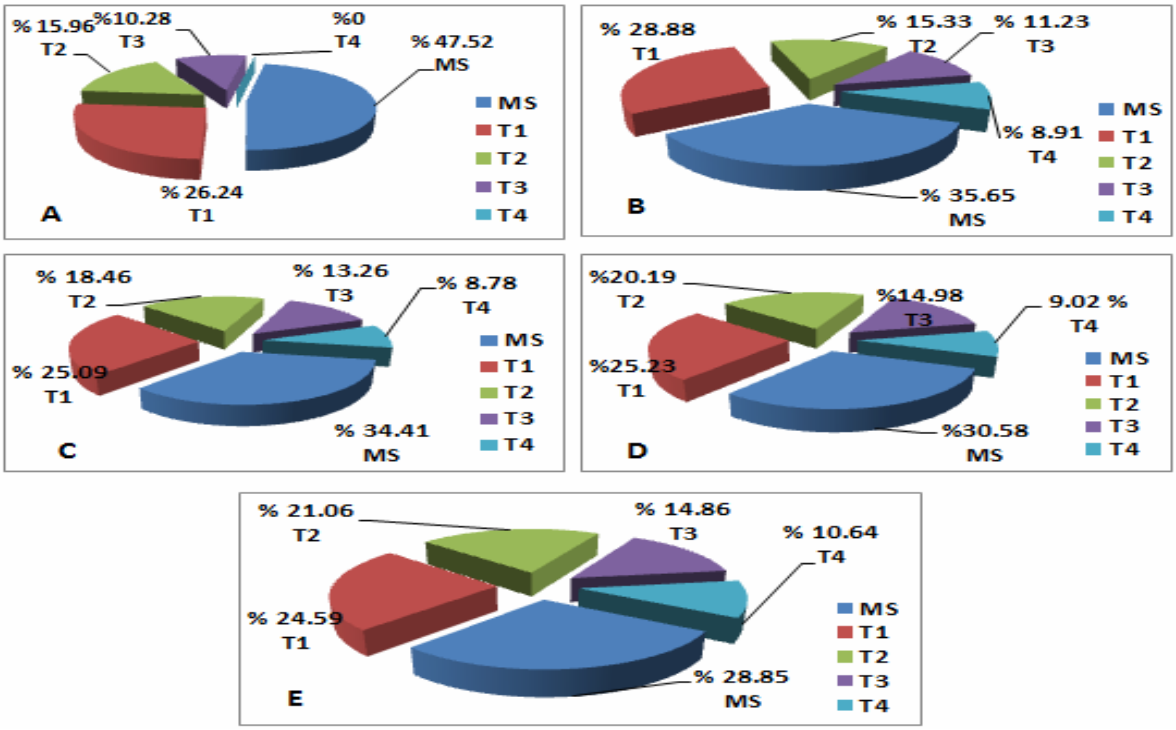

Fig. 6 : The contribution of the MS main stem and the T1, T2, T3 and T4 Tillers to the grain yield traits of the plant (g) to the level of the nitrogen fertilizer level 0 kg N. ha^{-1} (A), 75 kg N. ha^{-1} (B), 100 kg N. ha^{-1} (C), 125 kg N. ha^{-1} (D) and 200 kg N. ha^{-1}(E).

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