

The effect of thermal collection on the characteristics of the yield and its components for the flowering and maturation stages in coarse wheat (*Triticum durum*)

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Abstract

This study was conducted during the agricultural season 2021-2022 at the Agricultural Research and Experiment Station at the College of Agriculture at the University of Kirkuk, using a randomized complete block design (R.C.B.D) and with three replications, each block included (20) twenty experimental units of wheat. Hard, use of the Zadok scale for crop growth in four stages (flowering stage, lactic maturity stage, doughy maturity stage, and physiological maturity stage), and the study of thermal accumulation when cultivating the crop until maturity the genotypes are significant at the level of probability 1% for the number of spikes, the weight of a thousand grains, the biological yield, the grain yield, Spike weight, Spike length ,Number of spike grains,the Sardar genotype was superior at the beginning of the flowering stage and half of the flowering with the least number of days, reaching (122.66 and 126.66) and in the stage of dough maturity, in the aqueous phase and the milky phase with the least number of days, with an average of (135.66, 142.33), and the stage of doughy maturity in the early phase and the late phase with the least number of days, with a value of (150.33, 157.33). The genotypes (Halio, Sham5, Simito) for the number of grains of the highest spike mean were (38.57, 38.02, 38.15) respectively, Crezo genotype for the spike weight with the highest peak, reaching 3.75, outweighed the genotype DW38 for the thousand grains with the highest peak, with a peak of 64.41. plants needed to enter the flowering stage. The accumulated heat reached 349.5 °C, less than a quarter of the thermal collection. As for the accumulated heat of the milky maturity stage, 239.5 °C, it is less than a quarter of the thermal accumulation. The accumulated heat of the dough maturity stage, 241.0 °C, is less than a quarter of the thermal aggregation. The accumulated heat of the physiological maturity stage, 422.5°C, is less than a quarter of the thermal collection 514.5°C.

Keywords: durum wheat, genotypes, thermal aggregation, Zadok scale,

1. Introduction

A relatively recent Zadok meter for the diagnosis and growth of grain crops was created by a Dutch scientist. (1974 Zadoks Jan C.) Currently widely used in agricultural research, the Decimal Growth Scale is based on ten major growth stages labeled from 0 to 9 Each primary growth stage is subdivided into secondary stages; thus, the scale extends from 00 to 99 (Zadoks et al., 1974).

Hard wheat, durum wheat, or bulgur wheat is one of the types of wheat cultivated in different parts of the world and is mainly used in the production of pasta (Food and Drug Administration 1996). Durum wheat constitutes 8% of the global cultivated areas, and the uses of its grains vary in the manufacture of groats, bulgur, and semolina, and in some countries, it may be used instead of rice in meals (Awwad, 2009).

One study showed that the percentage of total protein in durum wheat ranged from 6% to 20% depending on the order and variety, the environmental conditions as well as the agricultural operations during the growing season, as the rainfall

during the grain ripening stage leads to a decline in the percentage of total protein. The ripening stage of the grain leads to higher protein content. (2001, California wheat commission). The temperatures during the vegetative growth period lead to an acceleration in the vital processes of the plant and thus accelerate flowering, which leads to effects on growth and yield, Faleh and Ramadan (2002). The durum wheat varieties with late flowering and maturity give a good yield in appropriate conditions, but under conditions of stress, their yield decreases as a result of the synchronization of the grain-filled phase with the period in which water decreases (Bahlouli et al., 2005).

The study aimed to study the Zadok scale for some genotypes of durum wheat in different stages of growth (flowering stage, lactic maturity stage, doughy maturity stage, physiological maturity stage).

2. Materials and Methods

This study was conducted during the agricultural season 2021-2022 at the Agricultural Research and Experiment Station belonging to the College of

Agriculture at the University of Kirkuk, using a simple experiment at a randomized complete block design (R.C.B.D) and with three replications, each block included (20) twenty experimental units that included the genotypes of durum wheat is (DW38, Bejah-6/SLA, Halio, Mikki, Guayacan, Amedakul s, Fadda98, Icarasha 2, Sham 5, Lahnaucan, Sardar, Baghdad, DW10, Exad5, Simito, Crezo, Corvilla, Iraq Oasis, Surat Kul, Um Rabie). The field of the experiment was plowed, and then the land was divided into three replications, and in each replicate, all the genotypes of durum wheat were planted. The experiment was done with 320 kg.e-1 fertilizer di amino phosphate (N% 18, P2O5%), and (200) kg of urea was added as a second batch in the branching stage. The experiment was carried out according to the randomized complete block design system (R.C.B.D) and with three replications, sowing took place on 15/11/2021, and the agricultural operations were carried out, including irrigation and weed control with thin leaves on 2/3/2022, using topic pesticide in an amount of 250 ml, then diluted with 100 liters of water, and broad bushes on 2/3/2022

using a 125 ml D.2.4 pesticide, then diluted with 100 liters of water, in addition to manual control of all bushes as needed during the season. The field was covered with a net to protect it from damage by birds and animals and then harvested on time when ripe. The thermal accumulation was calculated by taking the daily temperatures (DD) from the beginning of the planting date until harvesting, and the base temperature was kept at (4) for wheat, according to the following equation:

$GDD = (\max.t + \min.t) / 2 - \text{base.temp. } (0c)$ where:

GDD = daily temperatures

Max.t = Maximum temperature

Min.t = minimum temperature

Base temp. (0c) = the base temp

The data were analyzed statistically using a computer using the ready-made program (SAS Statistical Analysis System) as a simple experiment, the averages were compared according to Dunkin's multiple range test.

3. Results and Discussion

Table (1)

| Genotypes | The stage of flowering and maturity according to the Zadoks scale | | | | | | |
|------------|---|---------------|------------------------|-------------|-------------------------|-------------|------------------------|
| | Flowering stage | | Milky maturation stage | | Doughy maturation stage | | Physiological maturity |
| | Start flowering | %50 flowering | Lubna phase | Water phase | Late Phase | Early Phase | |
| Dw 38 | 128.00 ed | 133.00 ef | 151.00 de | 144.66 abcd | 167.00 gh | 159.00 ghi | 180.66 h |
| Bejah6/SLA | 126.33 gh | 131.33 gh | 152.66 bc | 144.00 bcde | 168.33 ef | 160.33 def | 180.00 h |
| Halio | 125.66 hi | 131.00 h | 152.66 bc | 143.33 defg | 169.66 cd | 161.66 bc | 184.66 bcd |
| Mikki | 128.66 cd | 133.33 def | 153.66 ab | 146.00 a | 170.00 bc | 160.66 cde | 183.00 fg |
| Guayacan | 130.33 b | 135.33 b | 153.66 ab | 145.00 abc | 170.66 abc | 162.66 ab | 186.00 a |
| Amedakul s | 127.00 fg | 132.33 fg | 147.66 gh | 141.33 hi | 166.00 hi | 157.66 jk | 183.33 efg |
| Fadda 98 | 127.66 ef | 134.66 bc | 151.66 cde | 144.66 abcd | 168.66 de | 161.00 cd | 183.00 fg |
| Icarasha 2 | 126.66 g | 131.66 gh | 149.66 f | 142.33 fgh | 168.66 de | 159.33 fgh | 185.00 abc |
| Sham 5 | 129.00 c | 134.66 bc | 152.00 cd | 145.33 ab | 171.00 ab | 162.66 ab | 185.33 ab |
| Lahnaucan | 129.33 c | 134.33 bcd | 154.00 a | 145.33 ab | 171.33 a | 163.00 a | 184.33 bcde |
| Sardar | 122.66 j | 126.66 i | 142.33 i | 135.66 j | 157.33 l | 150.33 l | 175.00 j |
| Baghdad | 126.33 gh | 131.66 gh | 146.66 h | 140.33 i | 163.66 k | 157.00 k | 175.33 j |
| Dw10 | 128.66 cd | 133.66 cde | 149.33 f | 142.66 efgh | 164.66 jk | 158.00 ijk | 178.00 i |
| Acsad5 | 129.33 c | 134.66 bc | 151.00 de | 142.00 gh | 167.66 efg | 159.66 efgh | 173.33 k |
| Simito | 129.00 c | 133.66 cde | 152.66 bc | 145.33 ab | 169.66 cd | 161.00 cd | 185.00 abc |
| Crezo | 131.33 a | 136.66 a | 151.33 de | 145.66 a | 170.33 abc | 161.66 bc | 183.66 defg |
| Corvilla | 125.00 i | 131.33 gh | 148.00 g | 140.33 i | 165.66 ij | 157.33 k | 182.66 g |
| Iraq oasis | 126.33 gh | 133.00 ef | 150.33 ef | 143.00 efg | 167.33 fg | 159.00 ghi | dcef184.00 |
| Sura Kol | 129.00 c | 135.33 b | 151.00 ed | 143.66 cdef | 167.66 efg | 160.00 defg | 183.66 defg |
| Um rabie | 130.00 bc | 135.33 b | 151.00 de | 143.33 defg | 168.33 ef | 158.66 hij | 184.66 bcd |

flowering stage according to the Zadok scale. At the beginning of flowering, it is noted that the Sardar genotype had the lowest number of days, with an average of 129.66, in contrast to the crezo genotype, which took the most number of days for the beginning of flowering, with an average of 131.33 days. As for 50% of flowering, the Sardar genotype was also superior to the lowest number of days with an average of 126.66 in contrast to the crezo genotype, which had the most number of days with an average of 136. Significant at the probability of 1% for the number of days for the two flowering. These results agree with the researchers Al Jbury (2013), the stage of lactic maturity according to the Zadok scale, is noted for the aqueous phase, the

superior of the genotype Sardar with the least number of days, with an average of 135.66 days, in contrast to the genotype mikki and crezo, with the most number of days for the aqueous phase, with an average of 146.00 and 145.66 days, respectively. As for the milky phase, the Sardar genotype was also superior in the least number of days, with an average of 142.33 days, in contrast to the lahnaucan genotype, which had the most number of days, with an average of 154.00 days. Shown in the genotypes table is a significant at the probability of 1% number of days for the two stages of the lactic phase. Bell et al. (2015), the stage of dough maturity according to the Zadok scale. It is noted for the early stage that the Sardar genotype had the lowest number of days,

with an average of 150.33 days, in contrast to the lahnaucan genotype, with the highest number of days for the early stage, with an average of 163.00 days. As for the late prophase, the Sardar genotype had the lowest number of days, with an average of 157.33 days, in contrast to the lahnaucan genotype, which had the highest number of days, with an average of 171.33 days. Shown in the genotypes table is a significant at the probability of 1% number of days for two stages of the doughy phase. Bell et al. (2015), the stage of physiological maturity according to the Zadok scale, and it is noted that the genotype Sardar and Baghdad had the lowest number of days, with an average of 175.00 and 175.33 days, respectively, in contrast to the genotype guayacan, with the most number of days, with an average of 186.00 days. Shown in the genotypes table is a significant number of days to the stage of physiological

Table (2)

in the traits of spike length, the genotype Exad 5 gives the highest peak, as its peak reached 10.63, unlike the genotype guayacan and amedakul, which gives the lowest peak, as its peak reached 7.69 and 7.66, respectively. Lozhkin et al. (2020). As for the spike weight, the crezo genotype gives the highest peak, reaching 3.75, unlike the amedakul s

genotype, which gives the lowest peak, reaching 2.26. As for the traits of the number of spikes, the Sardar genotype gives the highest rate of 561.83, unlike the crezo genotype, which gives the lowest peak of 328.37, The genotypes vary in the characteristic of the number of spike cereals the Genotypes Halio, Sham5, Simitu Gives the highest peak 38.57, 3802, 38.15 respectively Reverse genotype Crezo Gives the least peak30.57 . As for the weight characteristic of 1000 grains, the genotype DW 38 gives the highest rate 64.41 The opposite of the genetic Crezo structure gives the lowest peak where it reached, as it reached its peak42.96 Abd al-Taweel and Abd al-Dahi(2021). The genetic Sardar structure gives the highest rate of bioquotient characteristic, as it reached its peak 10.40, unlike the genetic DW10 structure gives the lowest peak, where it reached 4.00. As for the grain quotient characteristic, the genotype Sardar gives the highest rate, as it reached5.73, unlike the genetic structure DW10, it gives the lowest peak, where it reached 2.00.(Al-Tahir 2014) It is shown in the genotypes table that is significant at the 1% probability level,of the length of the spike, and the weight of the spike of the number of spikes ,Number of grains spike, Weight 1000 Pieces, Biological yield, Grain yield.

| Genotypes | Studied qualities | | | | | | |
|------------|-------------------|------------------|----------------------|-------------------------|------------------------|-----------------------------|-----------------------|
| | Spike length(cm) | Spike weight (g) | Number of spikes(m2) | Number of grains/spikes | Weight 1000 Pieces (g) | Biological yield (tons.E-1) | Grain yield tons. E-1 |
| Dw38 | 8.15 gh | 2.78 fg | 379.48 k | 34.23 f | 64.41 a | 4.80 k | 2.66 j |
| Bejah6/SLA | 8.75 cdefg | 3.22 cd | 427.21 h | 36.16 cd | 46.10 j | 4.66 k | 3.20 ghi |
| Halio | 8.87 cdefg | 3.02 def | 465.56 f | 38.57 a | 49.14 gh | 4.80 k | 3.60 efg |
| Mikki | 9.08 cdef | 3.11 cde | 462.27 f | 34.26 f | 48.62 h | 7.20 efg | 4.40 bc |
| Guayacan | 7.69 h | 2.69 gh | 490.80 d | 36.10 cd | 50.10 g | 7.06 fg | 3.73 def |
| Amedakul s | 7.66 h | 2.26 j | 363. 65 l | 34.44 f | 53.23 cde | 7.60 e | 4.40 bc |
| Fadda98 | 8.69 defg | 3.33 bc | 349.56 m | 36.48 bc | 46.49 j | 4.80 k | 2.80 ij |
| Icarasha 2 | 9.58 bc | 2.91 efg | 478.00 e | 35.60 de | 61.10 b | 6.93 gh | 3.86 ed |
| Sham 5 | 9.20 cdef | 3.51 b | 395.47 j | 38.02 a | 53.17 de | 6.53 hi | 3.33 fgh |
| Lahnaucan | 8.67 efg | 3.21 cd | 489.13 d | 34.71 f | 53.79 cde | 9.60 b | 4.13 cd |
| Sardar | 10.28 ab | 3.34 bc | 561.83 a | 37.08 b | 54.04 cd | 10.40 a | 5.73 a |
| Bagdad | 8.68 defg | 2.95 ef | 525.96 b | 36.41 bcd | 52.89 ef | 8.00 d | 4.13 cd |
| Dw10 | 8.79 cdefg | 2.35 ij | 395.40 j | 32.63 h | 47.60 i | 4.00 l | 2.00 k |
| Acsad5 | 10.63 a | 2.53 hi | 500.83 c | 34.99 ef | 46.93 ij | 5.33 j | 3.20 ghi |
| Simitu | 9.05 cdef | 3.31 bc | 344.05 m | 38.15 a | 40.95 l | 6.53 hi | 2.80 ij |
| Crezo | 8.38 fgh | 3.75 a | 328.37 n | 30.57 i | 42.96 k | 4.66 k | 2.93 hij |
| Corvilla | 9.59 bc | 2.51 hi | 525.31 b | 36.32 bcd | 49.46 gh | 6.40 i | 3.73 def |
| Iraq oasis | 9.08 cdef | 3.52 b | 441.51 g | 36.46 bc | 53.52 cde | 8.26 d | 4.40 bc |
| Sura kol | 9.52 bcd | 2.67 gh | 414.17 i | 33.40 g | 52.00 f | 8.80 c | 4.66 b |
| Um rabie | 9.49 bcde | 2.36 ij | 443.73 g | 36.33 bcd | 54.30 c | 7.46 ef | 4.53 bc |

Table (3)

the flowering stage starts in mid-March, when it reached a peak of 116.5C, until half of April when it reached 233.0C, and the accumulated heat during flowering at 349.5 C is less than a quarter of the thermal collection. As for the stage of milky maturity, it starts from mid-April until the end of April. The accumulated temperature reached 239.5 C, less than a quarter of the thermal accumulation. The dough

ripening stage starts from the beginning of May until the middle of May. The accumulated temperature reached 241.0 C, less than a quarter of the thermal accumulation. The stage of physiological maturity starts from half of the month of May until the end of the month of May, and the accumulated temperature reached 422.5 C, and less than a quarter of the thermal collection of the plant reached full maturity and completed its life cycle.

| Months | Daily accumulated temperatures | | | | | Total |
|----------|--------------------------------|------|------|------|------|-------|
| | 11.5 | 10.0 | 9.5 | 8.5 | 9.0 | |
| November | 12.5 | 11.5 | 11.5 | 10.5 | 10.0 | 147.5 |
| | 10.5 | 10.0 | 10.0 | 10.5 | 11.0 | |
| | 12.0 | | | | | |
| | 13.0 | 5.0 | 5.0 | 6.0 | 7.5 | |
| December | 9.5 | 9.0 | 12.0 | 8.0 | 8.0 | 187.0 |
| | 6.5 | 6.0 | 6.0 | 6.0 | 10.5 | |
| | 10.5 | 8.5 | 7.0 | 7.0 | 8.0 | |
| | 4.0 | 1.0 | 3.5 | 2.0 | 0.5 | |
| | 1.5 | 1.0 | 3.0 | 4.0 | 3.5 | |
| | 4.0 | | | | | |
| | 4.0 | 3.0 | 2.5 | 1.5 | 3.0 | |
| January | 1.5 | 3.5 | 3.5 | 5.0 | 7.0 | 94.0 |
| | 8.0 | 14.5 | 8.0 | 7.5 | 4.0 | |
| | 2.0 | 0.0 | -1.5 | 0.0 | 4.5 | |
| | -4.0 | -4.0 | -1.5 | 4.0 | 5.0 | |
| | 4.0 | 4.0 | 2.0 | 1.0 | 2.0 | |
| | 1.5 | | | | | |
| February | 4.0 | 4.0 | 5.5 | 7.0 | 4.0 | 198.0 |
| | 3.5 | 3.5 | 3.5 | 6.0 | 7.0 | |
| | 5.5 | 7.0 | 7.5 | 7.5 | 6.0 | |
| | 6.5 | 7.5 | 8.0 | 12.0 | 7.0 | |
| | 7.5 | 11.0 | 10.0 | 11.0 | 11.0 | |
| March | 8.5 | 8.0 | 8.5 | | | 221.0 |
| | 9.0 | 12.0 | 11.0 | 10.5 | 5.0 | |
| | 4.0 | 8.0 | 7.5 | 7.0 | 8.0 | |
| | 8.0 | 5.0 | 5.5 | 8.0 | 4.0 | |
| | 1.0 | 3.0 | 4.0 | 7.0 | 4.0 | |
| | 3.5 | 8.5 | 12.0 | 7.0 | 7.5 | |
| | 6.0 | 7.5 | 5.5 | 9.5 | 11.0 | |
| April | 11.5 | | | | | 457.5 |
| | 13.5 | 16.0 | 19.5 | 16.5 | 16.5 | |
| | 16.0 | 18.5 | 18.5 | 15.5 | 9.0 | |
| | 19.0 | 15.5 | 11.0 | 9.5 | 11.0 | |
| | 13.0 | 14.5 | 18.0 | 18.5 | 20.0 | |
| | 15.5 | 9.5 | 16.5 | 18.0 | 18.0 | |
| May | 9.5 | 8.5 | 18.0 | 19.0 | 15.5 | 589.0 |
| | 18.5 | 15.0 | 16.5 | 21.0 | 18.0 | |
| | 15.5 | 6.5 | 8.5 | 8.5 | 15.5 | |
| | 17.0 | 17.0 | 16.0 | 19.0 | 21.0 | |
| | 20.5 | 21.0 | 21.5 | 23.0 | 23.0 | |
| | 20.0 | 20.5 | 20.0 | 21.0 | 19.0 | |
| | 21.0 | 23.5 | 26.5 | 22.0 | 27.0 | |
| 26.0 | | | | | | |
| June | 29.5 | 28.5 | | | | 58.0 |

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