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Review on the Development of Drought Tolerant Maize Genotypes in Iraq

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Abstract. Stress is any physiological, physical or chemical change that leads to disturbance and imbalance in the plant. Water stress is one of the most important environmental stresses affecting plant growth and production. It is also known as the lack of available water in the soil to be absorbed by the plant at a stage of its growth, or the inability of the plant. On the absorption of water even if it is naturally present in the root environment due to the force affecting the holding of water molecules, as it was described as the state in which the amount of water absorbed by the roots is less than the water lost through transpiration from the vegetative system, meaning that it is the state in which the effort The water content of the plant and the fullness of its cells is low to a degree that affects the conduct of vital and physiological processes. During the occurrence of water stress, as the term “drought” is not accurate in the sense used, but it is sometimes expressed as the phenomenon of water shortage as a result of climatic elements of multiple weather conditions ,As for the agricultural concept of drought (Agricultural Drought), it is according to the growth and formation of the crop, and it is assumed that it begins when the ready water is drained from the root zone, plant goes through three stages: First stage increases the water loss and the transpiration process until it reaches a point where the amount of water lost by transpiration exceeds the amount of water absorbed by the roots. On the water balance between these two processes in adaptation, and when the water stress intensifies, the plant moves to the third stage, after which the plants lose a large part of the water through transpiration, the stomata are closed and the photosynthesis process stops. Therefore water stress (drought) alone is one of the most influential environmental stresses in reducing maize productivity , Therefore, the role of the plant breeder came through the implementation of breeding programs for hybridization and selection until it obtains a plant adapted to drought through the occurrence of morphological changes that make plants phenotypically adaptable to conditions of lack of water and includes an increase in root size and reduction of leaf area.



1.Introduction

Maize (*Zea mays* L.) is one of the most important strategic and economic crops in the world. It is considered the third crop in terms of economic importance after wheat and rice. Maize is used in human and animal nutrition, as well as various other uses such as treatment, production of dyes, and its use as biofuel, and it is considered an alternative to automobile fuel. Traditional or other and called the King of crops. [1, 2, 5] the importance of the crop increased rapidly due to the increase in the world population and the expansion of livestock projects.

The problem of water shortage is an important factor at present and in the future that limits the expansion and development of all social and economic life activities in various fields, especially in the field of agriculture, especially in the arid and semi-arid areas within which Iraq is currently facing a scarcity in quantity and quality. Flowing water of the Tigris and Euphrates rivers and their level fluctuating from one season to another with low rates of rain or their fall at times other than those needed by the plant and high temperatures and evaporation rates, accompanied by weakness in the process of managing water resources and soil, as well as the increasing demand for food due to the development taking place In the current and future population growth, all these factors have greatly affected the scarcity of this water in recent years.

Improving drought-resistant genetic structures is one of the most important means that can be used in response to contemporary climatic changes, and the development of the root system of these structures is at the forefront of mechanisms that will improve their resistance to water stress conditions. UNESCO asserts that about 1.8 billion people will suffer from water shortage and two thirds of humanity will be affected by the consequences of water shortage by 2025, which will negatively affect the production of agricultural crops [3]

As for the agricultural concept of drought (Agricultural Drought), it is according to the growth and formation of the crop, and it is assumed that it begins when the ready water is drained from the root zone , So drought is a complex biophysical syndrome that is affected by climate [8]

When the agricultural area expanded, the population increased, industry developed, and dams increased on rivers, water consumption became greater than what was available, and the global water problem appeared. Tigris and Euphrates rivers are one water basin because they meet at one estuary in the Shatt al-Arab, where Iraq depends mainly on the waters of these two rivers in agriculture and industry. Turkey is building the Anatolia project on the Euphrates River, which includes the construction of 21 dams. If this project is completed, Syria will deprive 40% of the water it currently takes, while Iraq is deprived of about 90% of the water it currently takes. Therefore, the problem of water scarcity will increase in the coming years to a need Very critical, unless engineering and technical measures are taken to store and use water, and new techniques are invented to serve the soil and the crop, Development of the root system of these structures is at the forefront of the mechanisms that would improve their resistance to water stress conditions. UNESCO asserts that about 1.8 billion people will suffer from water shortage and two thirds of humanity will be affected by the consequences of water shortage by 2025, which will negatively affect the production of agricultural crops [10]. One of the crops sensitive to water stress is maize, especially if it coincides with the flowering period, which will lead to a loss in yield that may reach 45-60%..

Climate changes in most countries of the world, especially Iraq, have led to an increase in global warming, a decrease in rainfall, and a decrease in the water levels of its rivers, Tigris and its tributaries, the Euphrates and Diyala, as a result of several reasons, including external ones represented by the occurrence of all surface water sources outside the borders of the Arab world and the non-compliance of neighboring countries with international agreements on the distribution of quotas Water and internally (human factors) linked to poor water management, as a result of the great waste of these resources as a result of lack of awareness and poor knowledge of their importance. The distribution of water in the soil is affected by the extent of irrigation and the method of cultivation, and the nature of the distribution of water in the soil affects the distribution of the root system in its size, and then the growth of the stem, leaves and other plant organs is affected. exposed to him. Water content of the soil is one of the most important factors that determine and regulate the vital processes

inside the plant. Water plays a crucial role in the life of the plant by playing the role of solvent and the carrier medium, as well as preparing the energy needed for the photosynthesis process in which organic food is manufactured, as well as lowering the temperature of the plant.

Water-consuming crops such as yellow corn, and despite the great development in the production of varieties and hybrids, whether they were developed or recently introduced to Iraq, which are characterized by their high productivity and suitability to different environmental conditions, but they still suffer from a decrease in productivity, so the principals turned to find solutions to address these obstacles, as it was found that The use of drought-tolerant cultivars and hybrids is among the factors leading to an increase in the yield of maize, as some maize cultivars showed a clear superiority in some growth characteristics such as plant height, dry weight and grain yield under drought conditions [7]. Seeds are also the most important factor in the production of crops, as it was found that the ability of seeds to grow and germinate under different environmental conditions is necessary to give a high production of grains. these conditions.

2.Reasons of this study

Any decrease in the water content is accompanied by a loss of cell swelling and leads to a halt in cell growth or an increase in its size, and this in turn leads to stomata closure and a decrease in photosynthesis, and thus the continued exposure of the plant to drought results in a disorder of the protoplasm and the resulting processes.

So the aim of the study was to review some ideas and scientific results that were previously studied and comment on them, and to extract some useful suggestions for the process of soil and crop service under water stress conditions, and to enable plant breeders to raise drought-tolerant crops, especially if we know that the world today is facing a big problem related to global warming. And the scarcity of water for agricultural purposes with rising temperatures and an increase in soil salinity, Which leads to an exacerbation of the problem of desert encroachment in some areas or overflowing in others, and therefore, extensive research must be carried out on the selection of different types and genera of plants that tolerate drought, high heat or salinity, whether by performing the best operations to serve the soil and the crop in a manner that preserves soil water, or by breeding, Or both together, which is better, and the crop in terms of conserving soil water, or by breeding, or both, which is the best.

- 1- Development of hybrids and cultivars that have the ability to resist drought and give the best growth and highest productivity
- 2- The possibility of adopting the characteristics of the root system as selection guides for drought tolerance for a number of crops.
- 3- Evaluation of drought tolerance of genotypes from several crops to the conditions of Iraq.
- 4- Determining the efficiency of drought indicators or evidence criteria used in diagnosing the genotypes of several drought-tolerant and sensitive crops according to the main component analysis.

2.1 Methods of resistance of corn to drought. One of the most important methods that can be used to overcome such a crisis and meet the country's needs for this crop is to select and produce varieties or genetic structures that have the ability to resist water stress while maintaining the highest possible yield according to many criteria for selection, but the root total represents the trait. The most important thing is that it is responsible for the absorption of water and nutrients from the soil. The root system under conditions of limited soil water has an important role in maintaining the water condition in the plant, especially stimulating phenotypic and anatomical changes in the root in response to drought, by making changes. lateral roots) and the rate and direction of root growth or the conductivity of water in the root, This is subject to the influence of a number of factors, the most important of which is the genetic structure of the cultivated variety, the physical and chemical properties of the soil and its water content, within the appropriate environmental conditions for the cultivation of that crop [17].

Any decrease in the water content is accompanied by a loss of cell swelling and leads to a halt in cell growth or an increase in its size, and this in turn leads to stomata closure and a decrease in photosynthesis, and thus the continued exposure of the plant to drought results in an imbalance of protoplasm and the resulting processes.

2.2 Plant genetic response associated with drought tolerance. A very simple progress has been made in diagnosing the genetic determinants of drought tolerance because it is a complex phenomenon consisting of a number of biochemical-functional processes at different levels of cell and tissue formation stages. The study of trait loci (QTL) showed that 27 loci were assigned to seven traits of fitness and the outcome, six loci for five root traits and 38 loci for seven root traits under drought conditions (77). The QTL study also includes the genetic basis for most of the associated traits. With drought tolerance such as asymptomatic modification, cell wall stability [14], ABA acid content, stomata regulation, leaf water condition and root shape, these sites control complex functional traits. In order to understand the molecular mechanisms of drought tolerance in improved crop strains, the genomic tools of the varieties must be used. Methods that depend on the identification of gene expression sites and molecular landmarks give opportunities to direct breeding programs towards this goal [12] for plants that are exposed to many extreme weather conditions such as low or high altitude Temperature, severe shortage of soil nutrients, or water stress, all of these conditions negatively affect the growth of plants and the quality and quantity of the crop. Water affects the growth of plants through its influence on various metabolic processes, they may be affected directly or indirectly, and the building processes in cells are related to their water content . It is recognized that the rates of rapid cell division and elongation and the preparation of organic and inorganic matter necessary for building cell walls and new protoplasm control the amount of plant growth. The lowest degree of cell swelling results in a lack of cell water, and a lack of water determines the elongation of the stem and leaf expansion [11] and the lack of water reduces the photosynthesis process and increases respiration and the consequent action of auxins . Water stress is one of the most important abiotic stresses determining crop productivity, especially maize [16] .

Where it leads to the accumulation of organic dissolved substances such as Proline and the growth regulator abscisic acid and the manufacture of new proteins, mRNA and DNA, and dehydration causes a decrease in metabolic activities such as photosynthesis, respiration, ion absorption, transport, carbohydrates and growth stimulants, as well as water stress leads to inhibition of enzymatic activities, which leads It leads to a decrease in yield and also leads to inhibition of cell elongation and division, stomata closure and a decrease in transpiration rates in plant tissues [20].

2.3 Role of plant breeding in reducing the effect of water stress on some growth parameters of maize. These phenotypic traits have received special attention from researchers of genetics, plant breeding and physiology alike. The shoot is the most sensitive part to drought compared to the root system. The main reason for the slow progress of breeding programs for drought tolerance in some crops is the complexity of drought conditions. There are three types of drought: early, which causes a delay in the planting date, medium, which is standard and cumulative, and late, whose effect is evident in late-ripening structures . Therefore, it can be said that the morphological mechanisms of drought tolerance depend on phenotypic characteristics such as plant height, leaf shape, angle of inclination, flatness, and root characteristics [6] . A certain depth changes the ability to extract water, but it will not be useful under rainy conditions. It was found through the study prepared by [9]. that there is a high degree of phenotypic variance in the community when studying the interaction of genetic structure \times water stress and soil \times water stress.

There is an immature understanding of the functional processes responsible for greening traits [20] found that late-green sorghum hybrids had a higher yield when exposed to drought after flowering compared to hybrids without this trait, that sorghum acclimatization after flowering is related to the genotype. Availability of water not only controls the distribution of the plant on the surface of the earth, but also determines the productivity of the crop if it is compared to the action of any other factor. Water, air, energy, elements and chlorophyll are the five factors that control life on planet Earth to a large extent, availability of water is an important factor in the distribution and spread of the types and quantities of plant groups found in different parts of the world. This importance is also confirmed by ancient civilizations such as the civilization of Babylon, China and the Aztecs in South America. The height of plants has a significant impact in bringing about a change in the penetration of light and its distribution to the different parts, and then its effect is clear in the process of photosynthesis, which increases the period of filling the grain, which results in an increase in the weight of the grain, but in the case of reducing the height of the plant in grain crops, it is among the most reliable traits in

breeding programs because by reducing the height of the plant, the harvest index increases and the competition of plants to each other decreases. Thus, it is more tolerant of environmental stress conditions than others [4]. Also, the leaf is the main plant on which the crop depends in the process of photosynthesis and metabolism in general. One of the harmful effects of drought is the lack of leaf area for the plant. Which in turn reduces water loss and leaf area. Leaf area plays a key role in the process of photosynthesis, as it represents a major factor in determining the reception of intercepted solar radiation, and thus contributes to determining the growth and productivity of plants due to its relationship to the yield of dry matter. Drought reduces the leaf area as a result of the lack of leaf expansion and the lack of leaf area, which is a preliminary indicator of the plant's exposure to water stress and reduces the emergence of new leaves, and dropping the leaves to cope with drought and thus leads to a decrease in the leaf area evidence and then the yield. One of the strategies of plant breeding to withstand drought in maize, for example, is to develop early varieties for maturity because these varieties consume less irrigation water and bear drought stress and contribute to the cultivation systems of many crops during one year, and they are also suitable for loading systems with other crops and since their plants are less competition for ground moisture, light and nutrients than the late-ripening varieties. The duration of male and female flowering in maize gives an estimate of the extent to which the studied genotypes are delayed or early, as the male inflorescence appears after the completion of the vegetative growth of the plant, the awareness of which is responsible for the production of pollen, while the female inflorescence appears. Its stigma is usually with the beginning or 3-7 days after pollen release. As the exposure of the plant to water stress prolongs the period to reach the female flowering and this is reflected in the yield of the plant, as the water stress leads to a delay of the female inflorescence 6-9 days compared to the one that was not exposed to stress and this is an indication that the vegetative growth stage has ended to the stage of reproductive growth. The period between male and female flowering is very sensitive to water stress due to the decrease in the products of photosynthesis dedicated to the growth and formation of the ear due to part of it heading to the male inflorescence. Where the genetic structures increase the speed of the dry matter accumulation rate and its accumulation early as a result of the increase of the genetic action to show the genetic expression and to complete the life cycle of the plant in an early manner [5, 8]. The production of dry matter is affected by major environmental factors, including the availability of water and light intercepted by the leaves of the plant and the availability of nutrients. Plants exposed to a lack of moisture differ in their ability to intercept light according to the difference in the leaf area, the height of the plant, and the time required for flowering produced by the plant under the influence of moisture tension levels, if the appropriate moisture is available. Soil leads to a clear increase in the dry matter of yellow corn by 11% when irrigation is cut off at the beginning of vegetative growth, where indicated that water stress leads to a decrease in the relative water content of the plant, which determines the division and expansion of cells and that the expansion of cells more influential than its division, especially in the developing summit region, The continued exposure of the plant to drought results in a disturbance of the protoplasm and thus leads to weak vegetative growth and a lack of yield, as the stage of grain filling is one of the stages most affected by drought stress.

Water stress does not affect the change in the number of erects for the plant, as the number of erects does not change much under the prevailing water tension conditions. However, the effectiveness of the ear in owning the number of grains is more affected by water stress. Lack of irrigation during the maize growing season causes a significant reduction. In the result of ears. The water stress before the stage of silk formation has led to a decrease in the grain yield in maize by 25% and 50% when it is formed. 50% and a decrease in the percentage of the result to an average of 40% [4, 19].

The weight of the grain in the yellow corn crop, as is the case in the rest of the crops, is affected by the genetic structure and the surrounding environmental factors. It is also affected by water stress. As the decrease in the arrival of water and nutrients during the period of seed filling, the inefficient absorption of mineral elements and the decrease in the rate of transfer of photosynthetic products from the source to the downstream leads to a decrease in the weight of the grain. Thus, it is reflected in the yield, which is one of the field measures. Yield reflects the final outcome of the vital activities carried out by the plant. The grain yield of the plant is determined by three main factors: the genetic factor (of the variety, sex, or species) and the environmental factors (such as temperature, humidity, radiation, soil, irrigation, etc.) and the factor of soil and crop service technologies (from fertilization,

irrigation, planting dates, and...) [7 , 15] where it was found that the yield of plant grains decreased when treated with mutual irrigation by 21% compared to its counterpart every week. Water stress leads to a lack of preparation of photosynthetic materials, which causes abortion of emerging grains, so their number decreases, and some of them wither, and the yield decreases accordingly (Anjum et al., 2011) (10). In order to improve the yield components, it was found that the effect of water stress was little on grain yield when it is in the vegetative growth stage compared to the flowering stage.

3. Plant breeding for drought tolerance

The drought-tolerant plants were poorly screened, but there were many attempts to select for phenotypic traits such as a dense root system and fewer stomata. [15] distinguished high yield genotypes using repeated selection of maize crop, as some structures showed stability in Acclimatization of plants to the conditions of semi-arid regions. Some varieties of the type of grain crops showed significant differences among themselves in grain yield, number of days to maturity, plant height and grain weight, and that both dry weight, plant height and grain weight were positively correlated with grain yield, which indicates that they contributed directly or indirectly. In grain yield under low humidity conditions, Therefore, these traits should be included as criteria in the selection for drought tolerance [18] that the use of heat stress conditions showed a genetic variance for the characteristics of grain yield, the number of days up to 50% of male flowering, the period between male and female flowering, the number of fertile ear and the number of ear corn at specific times. During the stages of formation of maize plants under selection. The improved tolerance to drought may be attributed to selection under good water conditions and under well-managed water stress when flowering, which may result in greater dry matter fractionation towards the ear and thus increasing the harvest index. Benefit of indirect selection is that the selection for moisture tension conditions improves the yield under tension better than selection under natural humidity conditions (without tension).

The breeding plans based on selection on the geometric mean followed by selection on the basis of yield under tension, is an effective method in improving the drought tolerance of the bean crop [13] Selection in irrigation experiments without stress may improve yield in drought conditions better than selection in stress experiments for some crops such as soybeans [7] reviewed several ideas and results for a number of crops using the methods of breeding and improvement in field crops, which are by selection or cross-breeding or both together, and in order to take advantage of the variations of the physiological-phenotypic genetic components to produce the crop under water stress, and thus the variations in genera are wider than species Variations in the latter are wider than variations of the same type. Established the foundations and prospects for raising leguminous seed crops to withstand various environmental stresses to ensure good productivity and high phenotypic stability from season to season and in different locations. Review of breeding methods with molecular parameters such as RFLP, SNP, AFLP, RAPD [19], which save a lot of time, effort and money needed in traditional breeding programs, and contribute to understanding the mechanisms of drought tolerance.

Several researchers proceeded in different ways to determine the drought mechanism and the genes responsible for it in several plant genera in order to develop a program to derive or develop drought-tolerant genetic materials that must be From the following:

- 1- Cultivation of several highly variable cultivars with high heritability of drought tolerance mechanisms.
- 2- Cultivation of large areas to evaluate tens of thousands of plants for each variety or genetic composition under a certain water tension, determined either by the irrigation period or by the water stress.
- 3- The cultivation or selection is by the honeycomb program. Drought-tolerant plants are selected, their growth rate and yield are measured, and all scientific measurements related to the mechanisms of drought tolerance are measured.
- 4- If it is possible to molecularly diagnose the QTL for these structures, then a cross-breeding process takes place between the structures with integrated traits in tolerance to benefit from the action of the host gene first and then superiority secondly.
- 5- Crosses are cultivated and isolates again, and the process of self-pollination and selection is carried out under specific conditions of water stress, and the growth rates, yield and harvest index are

determined and the rate (RWC) under which they were, as well as the measurement of water stress rate (dMPa).

Drought is a complex bio-physical syndrome that is affected by climate factors and is subject to complex dimensional models according to the linear curve. The climatic concept supports the visions of avoiding drought in the management and breeding of crops, as drought tolerance and escape from it do not have an absolute genetic basis, and this was confirmed by the studies that were applied using molecular parameters to study sites (QTL), and this concept is exploited in the fields of physiology, genetics and plant breeding. Some crop management processes may be useful in overcoming drought, such as the use of different covers, plowing, planting depths and growth regulators because they are affected by factors surrounding the crop that may increase the yield partially or completely. The study of sensitivity to drought indicates the link between drought tolerance and modification of the water condition of the plant, The measurement of some climatic parameters is of great importance in the study of drought, such as the efficiency of radiation use, efficiency of rain water use and efficiency of irrigation water use. . The high temperatures increase the lack of tolerance of crops to drought due to the low production of dry matter, so the plants take several mechanisms, including avoiding drought and drought tolerance in order to overcome the water deficit. It is necessary for the parental breeds to have good levels of drought tolerance, This is to give a greater chance for the hybrid resulting from cross-breeding among them to have acceptable performance under severe drought stress conditions. The longevity of the leaf with the breeding methods of new hybrids is more related to the relationship of the source and the estuary during the filling of the grain, so the efficiency of water consumption can be increased with correct management with the analysis of the stability characteristics system to increase the grain yield under the lack of water supply. Main ways to increase the efficiency of water consumption are by increasing the outputs per unit of water and reducing water losses. The components of the genetic-physiological product are a trait linked to heredity on the one hand and affected by growth inputs on the other hand.

Genetic characteristics must be studied with some seriousness under drought conditions, because the efficiency of water consumption improves by regulating irrigation operations and appropriate levels of N₂ with cultivation at somewhat early dates within tight breeding programs. To the largest fragmentation of the dry matter of the stalk and increase the harvest evidence. The stability analysis is of great importance in knowing the performance of stable genotypes towards water stress conditions, as the stability of the yield is one of the most important principles of breeding for drought tolerance. Each stage of the growth of the crop has its own importance in the performance of the crop under drought, so none of them should be neglected, especially the stage before flowering and the stage of physiological maturity.

3.1 Drought Tolerance Indices. It is one of the criteria used to measure the stability of grain yield to genotype under water stress conditions compared to its yield under normal conditions.

Deserts are formed as a result of the low annual rate of rainfall, while small plants and shrubs of limited growth grow in them. The water relations of the vegetation may be affected as a result of temperature because this leads to high rates of evaporation-transpiration (ET) Selection for higher yield incorporates all known and unknown influencing factors that contribute to the cultivar's tolerance to drought [11] . Genotypes exposed to different environmental stresses show different responses to the decrease in grain yield, and the genotype is more stable under water stress conditions. It may have stress tolerance mechanisms that prevent further decrease in yield when exposed to water stress. One of the Indices of drought is the sensitivity index, [15] found that the sensitivity index to stress (SSI) Stress Susceptibility Index ranged between 0.55 - 0.63 when using four cultivars of wheat, and they indicated that high values indicate that ,selection for drought tolerance in the bread wheat crop can be estimated through several indicators, the most important of which are the Geometric Mean Productivity Index (GMP), the Stress Tolerance Index (STI) and the Mean Productivity Index when their values are high under tensile conditions, which gives a clear indication. This breed is tolerant of drought conditions.

According to what Fernandez [10] found, the genotypes are divided into four groups depending on the yield and its response to stress conditions, which are as follows:

cultivar is more sensitive to stress. And since the water stress is positively correlated with the grain yield given by the genetic structure in natural conditions, and this may be attributed to the difference in the intensity and time of stress to which the plant is exposed.

- 1- Group A, the genotypes that give a high yield under natural and stressful conditions.
- 2- Group B genotypes that give a high yield under natural conditions compared to other genotypes.
- 3- Group C, which are the genotypes that give a high yield under stress conditions compared to other genotypes.
- 4- Group B genotypes that are poorly performing under normal and stressful conditions.

In order to distinguish the drought-resistant genotypes, several indicators were selected, and their selection was based on the mathematical relationships of the yield under natural and stress conditions

- 1- Stress Tolerance Index (STI)
- 2- Geometric Mean Productivity (GMP)
- 3- Stress Susceptibility Index (SSI)
- 4- Mean Productivity (MP)
- 5- Stress Tolerance Index (STI)
- 6- Tolerance Index (TOI)

The grain yield of genotypes decreases under stress and is accompanied by a high sensitivity to drought, as the SSI index is useful for the maize crop breeding program when the stress conditions are strong, while,

While MP, GMP, TOI, STI, these indicators are useful in the breeding program when the water stress conditions are less effective or harmful.

All specialists' opinions today agreed that the Earth's climate has become hotter, and that this will undoubtedly be reflected again on the water balance in the region, whether for agriculture, environmental protection, or for human and animal uses. Frederick (33) summarized some future climate changes as follows:

- 1- Increasing the surface temperature of the Earth at a rate of 1.4 to 5.8 °C by the end of the twenty-first century.
- 2- The occurrence of severe fluctuations in rain, so that it recedes in some areas and increases significantly in other areas.
- 3- The climate prediction equations indicate that the increase in the Earth's temperature by 3# to 15% will be concentrated in the high regions of the world, especially in the winter season.
- 4- Increasing the ET rate by increasing the temperature, will reduce the ground water storage rate.
- 5- Increasing the severity of river floods in some areas and the scarcity of their water in others.
- 6- Expansion of areas exposed to drought in the world due to the increase in ET and the lack of rainfall in them (Table 1)
- 7- The occurrence of severe seasonal fluctuations in water in high areas, especially if rain falls in the form of water and not snow, because the water will flow into the rivers at a specific time, causing flood problems and raising the levels of lakes and seas, which may cause the sinking of some cities, while the snow melts with the passage of time. Days, it will feed the rivers better, without causing flood problems.
- 8- Increasing the severity of water pollution in several regions of the world due to the lack of sufficient quantities of water to ensure the flow and exchange of water.

Table 1. ET rates, productivity and water use efficiency WUE (kg yield / m³ of water).

Crop type	evaporation - transpiration (mm)	Productivity (tons/ha)	Water consumption efficiency (kg/m³)
Maize	800 - 700	12 – 6	1.6 – 0.6
wheat	600 - 500	44351	1 - 0.8

barley	500 - 400	44319	1.1 – 1
Sorghum	600 – 500	44350	1 – 0.5
Cotton	13000 - 1000	44350	0.6 – 0.4
Sugar cane	2500 - 2000	150 - 100	8 – 5
Sunflower	1000 - 800	44257	0.5 – 0.3

4. Suggested solutions to treat water scarcity and its impact on plants

It requires a review of how to use these materials in an optimal manner and redistribute them on a regular and efficient basis and reduce waste from them to a minimum. The horizontal increase along with the vertical increase in the production of the water resources themselves. Failure to follow an irrigation schedule in adding the irrigation quantities in each irrigation will lead to a decrease in the irrigation efficiency as a result of the wastage getting into the quantities of water either by evaporation or deep permeation, hence the importance of scheduling irrigation and studying water consumption, which secures the actual need of water for the crop and the attendant minimum losses. This is done by giving small amounts of water at close intervals to moisten the effective root zone, which will increase the efficiency of water use and determine the number of irrigations and the amount of water added. In each irrigation the plant needs to produce the best yield.

5. Conclusion

Iraq is located in arid and semi- arid areas, so it suffers from drought, which is one of the greatest common environmental stresses that hinder growth and production in crops. And this, in turn, affects the morphological characteristics of the plant, which is reflected in the productivity per unit area, so it is imperative for the plant breeder to devise appropriate genetic structures for these areas, with high productivity, low water needs, bearing water stress and high efficiency of water use, and in order to raise the productivity of crops in a unit. Surveying requires the use of breeding and improvement programs to devise genetic structures with high productivity and agricultural specifications that suit abiotic stresses, as well as improving local varieties. Accordingly, the study aims to obtain genetic variations for the purpose of increasing the chances of selection from these structures, and evaluating the selection of these structures under water stress conditions to determine the most stable ones in yield under drought tolerance conditions (water stress) to determine the most stable ones in yield, registering it and adopting it as a new variety or taking advantage of it. In improving local varieties and determining their efficiency in using water, growth characteristics, yield and components, Introducing new drought-resistant varieties suitable for Iraqi environmental conditions. - Using other breeding programs such as selection and cross-breeding among species to obtain better genetic structures than the local ones

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