Combating drought through cultivating tolerant wheat

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Drought is an environmental stress and is the outcome of the interaction of various types of climatic and meteorological factors including rainfall, humidity, temperature, etc. It, thus may be defined as absence of rainfall for a period of time long enough to cause depletion of soil moisture and damage to plant. Drought may be permanent as in deserted areas, seasonal as in areas with well-defined wet and dry season or unpredictable as in many humid climates.

Agricultural drought is defined as the condition that exist when there is insufficient water available to a crop. Generally in arable agriculture, drought describes as condition in which available soil moisture is reduced to a point when plant growth is severely effected. Drought causes plant water deficits that reduce cell turgor, causing closure of stomata and reduction in cell engagement, there by reducing both the leaf surface area and the rate of photosynthesis per unit leaf area. If water deficit becomes more severe, the photosynthetic machinery is damaged, further reducing the rate of photosynthesis.

Environmental factors like water deficit or high temperature, or a change in genetic architecture of the plant, can affect plant growth and yield only by altering certain

Breeding for high yield under drought conditions is generally more difficult than breeding for the same under favorable conditions. However, in spite of the difficulties, genetic improvement for yield is possible and has been made to some extent in many drought prone areas of the world. Although striking increases have been achieved in wheat yields all over the world with the development of modern high yielding and high input responsive varieties after the introduction of dwarfing genes of Norin-10, yields under drought and rained conditions, however, are still low and stagnant. It would be, therefore, desirable to screen the genotype under drought conditions so that better genotype could be identified and utilized in the future breeding programmes.

Breeding crop plants for stable yields under drought and stressed environments has been a prime interest. Various mechanisms involved in drought resistance like escape, avoidance and tolerance etc. have been pointed out by many scientists. Nevertheless, plant breeders are still interested in response of grain yield and its components in selecting for drought resistance due to lack of well defined information on these mechanisms. Testing of traits including grain yield and drought resistance are ploygenic in nature and are governed by the joint action of several genes. Such polygenic traits are difficult to manipulate in a breeding programme as competed to simple Mendelian traits. Drought traits are even more difficult to deal with. If easily detectable DNA marker linked to these pyogenic traits could be found the efficiency of breeding programmes for drought resistance would be increased.

Many such techniques like RFLP restriction fragment length polymorphism RAPD random amplified polymorphic DNA are being used now a days. However once a certain promising traits is identified and as suitable screening techniques has been developed, the next step is to ascertain the genetics and heritability of the trait. This important step has been taken with a few proposed drought resistance traits. For most traits that appear to contribute towards drought, the gene action involved and their heritability is not known. If a drought resistance trait prove to be heritable and related to which 7209 million hectares were irrigated and the rest of 1254 million hectares were planted under conditions of natural precipation. The total production stood at 21.078 million tones of wheat grain Govt of Pakistan 2000 Average per acre yield in Pakistan varies between 2725 to 1142 kg per hectare for irrigated and drought stress conditions, respectively depicting a big yield gap between the two production situations.

The area under wheat in this country has remained almost constant for the last three decades due to compelling agro-economic factors. In contrast, the population of the country is increasing at an alarming rate of 2.6 per cent, which if not rationalized by proper planning and saner management, will likely have serious repercussions on the nations' food security and socio-economic situations. Future requirement of the country for wheat has been estimated at 25.40 million tones, indicative of the distance we still have got to go to bridge the gap of some 4.4 million tones of grain.

Rains and snowfall have

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stresses like drought. A fruitful attempt to breed wheat strains specifically adapted to drought is still awaited due largely to lack of knowledge of the parameters defining such resistance. Modification of the plant's internal environment, through breeding varieties particularly suited to specific locations, is likely to produce significant results by way of enhanced acre yields.

Wheat plant posses great genetic variability towards drought stress. To exploit this potential there is a need to screen the planting material for different stresses. Under drought stress condition inspite of adopting all the soil and water conservation practices there might be drought/soil moisture stress (s) during different growth stages.

A study was conducted to make comparative assessment of the performance of various varieties under irrigated drought conditions. The study comprising eight wheat genotype viz., Parula, Crow, 87094, 85205, Chakwal 97, Kohistan 97, Punjab 96 and MH-97 were planted under irrigated as well as drought stress conditions. The characters studied include days to heading, flag leaf area, specific flag leaf weight, plant height, number of tillers per plant, spike length, spikelets respect of grain yield with desirable values of yielded components. MH-97 was the lowest performer under drouth with marked reduction in grain yield and its components showing lowest values of flag leaf area, specific flag leaf weight, spike length, 1000-grain weight and biomass per plant. The genotype like parula, crow, 87094 and punjab 96 were the best performers under drought on the basis of grain yield and its components.

Similarly, the hybrids performing best under irrigated conditions include Parula x MH-97, Crow x Kohistan-97, 85205 x MH-97, Punjab-96 x MH-97, x Parula, MH-97 x 85205 and MH-97 x Punjab 96. the hybrids showing best performance under drought were parula x 87094, Crow x MH-97, Chakwal-97 x Crow, Kohistan-97 x Chakwal-97, and MH-97 x Punjab-96.

The studies indicated that hybrid vigour was generally low under drought condition as compared to that under irrigated conditions. Magnitude of hybrids showing significant positive increase for flag leaf area, specific flag leaf weight, plant height, spike length, spikelets per spike, 1000-grain weight and harvest index was greater under irrigated condition while magnitude of hybrid increase for tillers per plant and grains per spike was greater in hybrids under drought stress conditions. The results suggested at the exploitation of hybrid vigour of certain

plant, can affect plant growth and yield only by altering certain important physiological and metabolic processes in plants. Thus to know the survival of some plant species in habitats where others fail requires a better understanding of the response of their physiological processes to varical environmental factors. Ppus plant breeder may then able to produce a higher yielding variety that has combined various efficient physiological processes under a particular environment.

Drought resistance in crop plants is a prime factor for stabilization of crop performance in the drought prone environments. More than 40% of the world's land is within the arid and semi-arid regions where water is the major limiting factor to plant productivity. Yield reduction in wheat occurs even in the US plains which is one of the most favored rained farming areas of the world. The problem of drought is acute in the developing areas of the world where there are few opportunities for adopting drought avoiding strategies such as irrigation.

mechanisms. Testing of performance and evaluation of genotype under drought is a very useful step in breeding programmes because it allows a direct estimate of drought resistance or susceptibility of genotype. Drought stress is conditioned by different physiological as well as morphological characteristics. Selection for a certain morphological character associated with high grain yield under drought stress rather than selecting for grain yield would increase the efficiency of breeding programme for drought resistance.

Breeding in the past has been done primarily has been done primarily the use of empirical breeding approaches by concentrating on yield and yield components. However further breeding programmes for increasing yield and yield stability of crop in drought susceptible areas as likely to remain modest if breeders continue to regard empirical approaches as the only dependable rout. In the latest literature DNA marker assisted selection has been advocated to crop plan for quantitative traits. Economically important

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Wheat tritium aestivum L em Thell is an important food staple of people of the world over marginal are and tropical regions of the world most falling between latitudes 23 S. In Pakistan South Asia where annual rainfall ranges between 500 mm and 1000 mm, wheat is planted on 39% of the total cropped area.

Agriculture is our single largest source of foreign exchange earning. During the year, 1999-2000 the area under wheat crop stood at 8463 million hectares, out of

become erratic over the past several years, causing a debilitating shortage of canal water supply for high yielding irrigated wheat plantings, rendering it more and more prone to drought-like conditions with obvious decline in wheat production with all its unpleasant prospects. A way therefore, has to be found to compensate for the calamitous shortfall looming large on the horizon.

Development of wheat varieties with low moisture requirements and able to withstand moisture stress may well be an answer to this problem. Our scientists should focus on the evolvement of whet genotype well adapted to ecologies characterized by various types of environmental

plant, spike length, spikelets per spike, grains per spike, 1000-grain weight, biomass per plant, grain yield per plant and harvest index.

The objective of the studies was to identify potential parental genotype or crosses that can be used in future bradding programmes for developing promising genotype for irrigated as well as drought areas.

Highly significant differences were found among genotype for all the characters studied under both irrigated and drought stress conditions. All of the parental genotype exhibited a reduction in all traits in response to drought. This reduction was much severe in case of important yield components like flag leaf area, specific flag leaf weight, number of tillers per plant, grains per spike and 1000-grain wight which showed a reduction of 32.33, 22.90, 32.45, 25.05 and 30.05%, respectively. Due to reduction in these characters grain yield per plant also registered a marked reduction of 46.49% under drought condition.

Under irrigated conditions, Parula, Punjab 96 and MH-97 were the best genotype in

of hybrid vigour of certain crosses like, MH-97 x Chakwal-97, Parula x MH-97 and Crow x MH-97 for flag leaf area, tillers per plant, spike length, grains per spike, 1000-grain weight and grain yield per plant.

The presence of these traits suggested the utilization of certain genotype and crosses to evolve new wheat genotype for irrigated as well as drought environments. Use of dialled mating with recurrent selection and integration with pedigree selection will yield new recombinations with accumulation of desirable genes. This can be done by using parental genotype like parula, MH-97 and 87094 and specific crosses like 85205 x MH-97, Parula x MH-97, Parula x 87094, Crow x MH-97 and Chakwal-97 x Kohistan-97.

As the study results indicated there is greater possibility of evolving wheat varieties which can give better yield under drought conditions. The research scientists should make more efforts to evolve such wheat varieties in view of persistent drought conditions in the country.