INTRODUCTION

Nothing in biology has meaning unless considered in the light of evolution. What has then the evolutionary record to show us about adaptation to stress? What are the successful mechanisms of adaptation that have evolved through natural selection, enabling plants so effectively to colonise such diverse range of environment?

It is now generally accepted that life, as we understand it, originated in the form of anaerobic bacteria some 3.5 billion years ago. Next 1.5 billion years saw the evolution of more complex biochemical processes. Higher plants evolved in the subsequent 1.5 billion years, though basic biochemistry of cells underwent relatively little further change (Broda, 1975). The next phase of evolution is marked by dramatic changes in morphology that developed as plants became adapted to the stress conditions covering the wide range of terrestrial environment. This was possible largely because of the evolution of their morphological and physiological characteristics.

Stress conditions

Environmental factors such as water deficiency, high or low temperature, salt, etc. can affect plant growth and their yield through their influence on the physiochemical processes. This is the reason why certain species survive, or even thrive, in habitats where others fail.
Full understanding of this reality requires an understanding of how plant physiological processes are affected by various environmental factors. It is evident that pronounced differences exist among plants in their ability to grow and survive under contrasting environments. The plants that are most productive in one climatic season, are often unable to cope with other situations (Turner and Kramer, 1980). In order to identify genotypes capable of exploiting limited resources, Boyer (1982) suggested that selection should be made under those adverse conditions likely to be encountered, rather than solely in favourable environment. Same has been felt by Epstein et al. (1980).

Water stress causes inhibition of growth in many plants by affecting photosynthesis (Gate, 1968). However certain crops, like sorghum and millet, can grow under conditions of dry farming (Giles et al., 1972). Many plants, if grown at very low temperatures, show growth inhibition. Their membrane system is damaged by chilling. However there are many other species which are not affected by substantial temperature change. Similarly most plants, if grown at higher temperatures, show depressed protein synthesis. They can not survive under these conditions for long. In contrast to this, there are certain thermophilic bacteria that prefer high temperature (for review Menon, 1977).
Recent studies indicate that plant organisms have developed a protection system against thermal stress that involves synthesis and accumulation of specific proteins, termed as heat shock proteins (hsp), at high temperatures (Burke et al., 1985).

These studies indicate that, in their evolution, certain plant species have acquired mechanisms that help to withstand the environmental stress. Those organisms which lack these systems fail to cope with stress conditions. It is of considerable significance to understand the type of effects, major stress conditions cause in plants when they encounter them, and the way the plants cope up with them.

**Water stress**

Crop plants rarely attain their full potential for yield because of the limitations imposed by the environment, especially lack of water (Levitt, 1972; 1980). Water stress is commonly referred to as 'drought' which could be described as an environmental stress of sufficient duration to cause water deficit in plant tissue, which in turn causes disturbance of physiological process. The degree of plant water deficit depends on the extent to which water potential is reduced below its optimum value (Barlow et al., 1977).

Certain plants complete their life cycle before the onset of unfavourable conditions. These are termed as 'ephemeras'. This is impossible for all types of plants.
Therefore, many 'non-ephimers' develop mechanism to tolerate water deficit.

Plants growing in environment with ample water supply maintain their leaf temperature at or below ambient temperature through transpiration. When exposed to drought conditions these plants experience declining soil water levels, which ultimately result in stomatal closure and reduced transpiration. Drought induced stomatal closure limits carbon assimilation. Yet this may optimize the water use efficiency of plants on a daily basis. As a consequence of reduction in transpiration, leaf temperature increases above the ambient temperature. The elevated temperature may limit dry matter accumulation because of increased respiration, reduced photosynthesis and cellular damage.

Transpiration, increased absorption, thick cuticle, leaf rolling, responsive stomata and deep root systems increase the ability of plants to endure drought for considerable periods (Begg and Turner, 1976). High root/shoot ratio increases the ability of plants to absorb water (Fisher and Turner, 1978). Water loss can also be reduced by reducing the amount of radiation absorbed. This can be achieved by leaf movements or changes in the reflectance characteristics of leaves. Begg and Torsell (1974) showed that *Stylosanthes humilis* leaves are aligned more and more parallel to the incident radiation, as plant water deficit increases.
Dehydration is reported to affect the architecture of membranes and may also affect their permeability (Levitt, 1980). Most higher plants are killed by loss of more than 40% of their optimal water content. The leakage of potassium is reported to have been increased by reducing water content of the tissue to 40% or less. When there is a loss of about 75% of water, and roots are almost dead, the plasma membrane is seen as separated from cell wall and appears somewhat fragmented (Verkleij, 1984).

Water stress is reported to cause an increase in proline levels (Singh et al., 1973a) in resistant varieties. The drought tolerant variety of cotton synthesizes more of saturated fatty acids, particularly palmitic acid, and less of linoleic and linolenic acid (Quedragog et al., 1984). Free sterol content of plasma membrane is also increased under drought conditions (Douglas and Peleg, 1981; Liljenberg et al., 1985).

Temperature stress

The effects of temperature stress are often confounded with those of water stress because thermal stress is usually accompanied by drought. Though there is much discussion regarding the probable effects on plant growth and crop yield of a small increase or decrease in the global temperature. However, more immediate concern to
agriculture is the short period of abnormally high or low temperatures that often occur during the growing season.

There is evidence to suggest that abnormally high or low temperatures for a week or less, can measurably affect growth and yield (Powell and Heflman, 1976). Akpan and Bean (1977) showed that year to year variations in temperature affected the yield and quality of the seed of paustor grasses. It has also been shown by the same workers that the temperature regime, in which the seed was developed, affect the subsequent growth of new tobacco seedlings.

Low soil temperature often reduces water absorption and causes water stress, resulting in injury. Temperature stress, both low and high, like water stress, has been shown to affect the functioning of plasma membrane by altering the composition of lipids and proteins in the membrane bilayer. Plant seems to survive in such environment by synthesizing certain organic compounds which may act as osmoregulators and by preserving the membranes in proper gel or sol phase.

**Salinity stress**

Salinity of soil and water is caused by the accumulation of soluble salts, resulting from concentration caused by evaporation and plant transpiration. At low concentra-
Salt suppresses plant growth. Higher concentration can cause death (Maas & Niemen, 1978). Epstein (1976) proposed that salt has both ionic and osmotic effects on plants and most of the known responses of plants to salinity can be intimately linked with these osmotic and ionic effects.

At low salinities, different ionic salts have similar osmotic effects on plants. At high salinities, most harmful effects of salts are non specific. However, some specific symptoms of damage, such as leaf tip burn due to Na⁺ or Cl⁻ ions may be recognized (Shannon, 1984). High ionic concentration may disturb membrane integrity and function, interfere with internal solute balance or cause a shift in concentration of solute ions (Kuiper, 1984).

Na⁺ and Cl⁻, usually the most prevalent ions in saline soils or water, account for most of the deleterious effects that can be related to specific ion toxicities (Okazaki et al., 1984). Osmotic effects of salts on plants are a result of a lowering of the soil water potential due to increasing solute concentration in the root zone. At very low soil water potentials, this condition interferes with the plant's ability to extract water from the soil and maintain its turgor (Wyn Jones et al., 1979).
It appears that in some aspects salt stress may resemble drought stress. However, at low or moderate salt concentration (higher soil water potential), plants adjust osmotically (accumulate internal solutes) and maintain a potential gradient favouring the influx of water. Under these conditions, growth may be retarded, but, unlike drought stress, the plant does not suffer too much from water deficiency (Shannon, 1984).

There have been many reports of salt-induced decrease in several metabolic processes such as respiration, photosynthesis, protein synthesis (Shannon, 1984). Enzyme activity has also been reported to increase in some cases and decrease in others (Greenway and Osmund, 1972).

It should be emphasized that success of an organism in a particular environment rarely depends on the possession of a single adaptive character. According to Bradshaw (1965) fitness or adaptation of an organism to an environment depends on possession of an optimum combination of characters that minimize the deleterious effects and maximize the advantageous effects on the whole.

Ability of an organism to synthesise and accumulate certain organic compounds, like proline, under different stress conditions, appears to be linked with its resistance
(Singh et al., 1972). Synthesis of heat shock proteins, when plants are grown at higher temperature, has been reported in plants that can tolerate high growth temperature (Todd et al., 1985; Mennen et al., 1986).

Structurally, plasma membrane is believed to be the primary site of an injury under stress conditions (Giles et al., 1972) but there are species that not only grow well under these stress conditions but seem to prefer such growing conditions where others will die in no time, e.g. certain halophytes that prefer to grow submerged in sea water (Marx, 1979).

There are reports (Flowers and Yeo, 1981; Yeo, 1983) that some plant species alter their membrane composition in order to withstand unfavourable environmental conditions.

These observations highlight the fact that, if the adaptive nature of an organism is to be evaluated, studies must be focused on a combination of morphological changes, growth pattern, accumulation of organic compounds and, most significantly, at the level of plasma membrane organisation along with the enzyme bound to it.

**Growth**

Living organisms have developed several endogenous protective systems which lead to thermal tolerance. One of these protective systems involves a resistance mechanism that is associated with the synthesis and
accumulation of specific proteins. These proteins have been identified from a number of animal and plant species (Burke et al., 1985a).

Available field data indicates that in some plant species quantitative shifts in many proteins may occur in response to altered growth temperature (Dejong, 1973; Davis and Gilbert, 1970). Some proteins are detected only in certain restricted, usually very high or very low temperature conditions, and appear to be specific to a rather restricted set of growth conditions.

Several kinds of evidences suggest that at least some thermal acclimatization events are accompanied by concomitant changes in protein synthesis and degradation. Das and Prosser (1967) measured the temperature response of $^{14}$C-leucine incorporation into proteins of gold-fish acclimatized to high and low temperatures. When measured at low temperature there was a greater maximal and net synthesis of protein in tissues of low temperature acclimatized animals than in animals acclimatized to 25°C.

Along with the synthesis, protein denaturation also takes place under stress. Protein content, usually of soluble proteins, often falls to about 40 to 60% of the initial content, as water stress becomes intense in drought sensitive plants (Gaff and McGregor, 1979). Protein synthesis may be particularly sensitive to water stress, for example, most polysomes revert to monosomes
in 4 hours at -5 bars in the roots of a number of species (Haiao, 1970).

**Proline**

Most living organisms are subjected, at some stage or the other in their life, to a degree of dehydration which often may be due to water deficit in the environment, high temperature or to an increase in osmotic pressure of an aqueous environment as is the case with salty soils. Such organisms, accumulate substances which are even otherwise normal cell constituents, particularly free amino acids, during a period of stress. The most frequent and extensive response in such situations is an increase in concentration of the amino acid, proline. Accumulation of free proline in water stressed leaves was first observed by Kemble and Macpherson (1954). It has been subsequently confirmed in many other studies.

Proline accumulation is not a response exclusive to a situation of plant water deficit. This accumulation has also been reported to occur following exposure of plants to high temperature (Chu et al., 1974) and high salinity conditions (Stewart and Lee, 1974).

Singh et al. (1972) reported that barley genotypes, that yielded well in drought prone environment, showed higher proline accumulation during water stress at the seedling stage than did drought susceptible genotypes
such as Proctor. This led to speculation that proline accumulation was adaptive. Capacity to accumulate high levels of free proline appeared to be related to improved survival under extreme water stress and to rapid resumption of growth following stress relief (Singh et al., 1973b). Such observations and inferences receive support from comparative biology. For example, when growing in saline conditions to which they are adapted, some halophytes, like *Trichoclin maritima*, accumulate large amounts of free proline, up to 123 μmol/g fresh weight (Stewart and Lee, 1974).

Three main changes are inferred to cause proline accumulation under stress: (I) stimulated synthesis due to loss of feedback inhibition (Bodges et al., 1976a), (II) inhibited oxidation, probably due to effects on mitochondria (Stewart, 1977), (III) impaired protein synthesis (Haico, 1970).

It has been thus shown that accumulated proline acts as a compatible solute regulator, reducing water loss from the cell during episodes of water deficit (Chu et al., 1976b). Proline in solution has also been shown to affect the solubility of various proteins and to protect albumin from denaturation (Schoert and Tachesse, 1978). Plants living in saline environments may accumulate proline as a compatible solute (Stewart and Lee, 1974).
Physiological basis for differences in tolerance among species must be sought largely at the molecular level, perhaps chiefly in membrane structure and enzyme activity. For example, the cellular fine structure of maize is injured by drought more than that of sorghum (Giles et al., 1972). Turner and Kramer (1980) also found that the fine structure of cells of drought susceptible cotton are injured more by water stress than the same in drought tolerant types.

Structure of plasma membrane

There are mainly three accepted models for the structure of membrane. However one of them, the fluid mosaic model proposed by Singer and Nicolson (1972), has so far been supported by most workers (Jain, 1977). According to this model, membrane is made up of a lipid bilayer, with proteins either partially or fully embedded in the matrix. The fluidity of the lipid bilayer is a consequence of the lack of strong attractive forces between the alkyl chains.

Proteins

Membrane proteins have been classified as peripheral and integral proteins (Singer and Nicolson, 1972). Peripheral proteins are weakly bound and may be disassociated from membranes by relatively mild treatments.
The bulk of membrane proteins are integral proteins. In an aqueous environment hydrophilic groups would be preferentially exposed at the surface of the proteins, whereas in a lipid environment hydrophobic groups would be preferred (Nakashima and Konisberg, 1974). Proteins that are associated with membranes are amphiphilic. It is reasonable to suppose that the structural arrangement of the proteins in the membrane is determined by bulk phase interactions of the protein bilayer.

Studies on the temperature dependence of hydrophobic and hydrophilic interaction in defined chemical systems show that the strength of hydrogen bonds, and electrostatic interactions within the water phase, decrease as temperature increases (Oakenfull and Penwick, 1977). These are the forces that contribute to the hydrophilicity of a compound. In contrast, the strength of repulsive interactions of hydrocarbon chains with water increases with increase in temperature. An amphiphilic substance should therefore associate more strongly with the lipid regions of the membrane at high temperature and with the aqueous phase at low temperature.

Extrapolating these arguments to proteins in the lipid bilayer of a membrane, it seems likely that in response to a temperature shift the proteins might move vertically in the plane of bilayer towards the aqueous
interface at low temperature and towards the interior of the bilayer at high temperature (Sklar et al., 1975; Reisner and Chapman, 1976). This type of movement would explain the instability of membrane proteins at both high and low temperature, as under these conditions there would be considerable alteration in the forces maintaining the tertiary structure of the proteins. Furthermore, a decrease in the strength of hydrophilic alterations at high temperatures would weaken the forces linking the subunits of oligomeric membrane proteins.

**Lipids**

Lipid content of the membrane varies from species to species and from condition to condition. The lipids of membrane are largely polar. In fact nearly all the polar lipids of cells are localised in their membranes (Prebha et al., 1985).

Lipids are important in regulation of ionic permeability of plant cell membrane as well as in regulation of activity of membrane enzymes such as (Na⁺-K⁺)-ATPase (Kasemo, 1986). Cells must maintain lipids near the critical point of phase transition in order to achieve the appropriate degree of expansibility and solid-liquid ratio. Variation in the degree of fatty acid saturation could provide an effective means to preserve this particular state (Kuiper, 1985). When organisms are
grown at higher temperatures, there is an increasing tendency to incorporate longer and more saturated fatty acids in phospholipids which then exhibit progressively higher gel to liquid crystalline phase transition temperature. Experiments have shown that transition temperature depends on chain length, degree of unsaturation and branching (Verkleig et al., 1972). Below the transition temperature lipids exist in gel phase characterized by transorientation of all chains. Above the transition temperature the lipid chain exists in liquid crystalline phase, characterised by a mixed gauche transconformation of chains (Singer and Nicolson, 1972).

Certain species, when exposed to lower temperatures, show their membrane to be as leaky as at higher temperatures (Simon, 1974). This leakage is attributed to phase change in the phospholipids of membrane which occur at slightly lower temperature than the change in the activation energy of membrane bound enzymes. Hardening by low temperature treatment results in higher level of phospholipids, especially phosphatidyl choline, more unsaturated phospholipids and higher sterol/pl ratio. All these properties may contribute to higher membrane fluidity at lower growth temperature.

A similar direct relationship between lipid saturation and heat tolerance is found in thermophilic fungi (Menon, 1977). In these cases the fatty acids of
thermophiles were found to be more saturated than those of mesophiles.

A high level of free sterols may contribute to salt tolerance in plants. In grape varieties, differing in salt tolerance, the level of free sterols is lowest in the roots of most sensitive species. The sterol/phospholipids ratio is higher in salt resistant varieties than in the sensitive ones (Grunwald, 1968). During salinity, salt stress tolerant Plantago species (Erdel et al., 1980) and sugarbeet (Stuiver et al., 1981), respond to saline environment by increasing the levels of free plus esterified sterols in their roots, whereas the salt sensitive Plantago media decreased the level of total sterols in its roots. Qualitative and quantitative differences in sterol composition (whether salt induced, varietal or both) may, therefore, reflect the relative abilities of higher plants to regulate membrane permeability to ions and tolerate or adapt to a saline environment.

\((\text{Na}^+\text{-K}^+)-\text{ATPase}\)

There is considerable variability among plants of different species with regard to the extent to which their metabolic processes can adjust when the organism is exposed to changes in temperature. Their degree of adjustment is subject to both environmental and genetic control. It has been demonstrated in a number of species
that the ability of different genotypes to regulate
growth over a range of temperatures appears to be
correlated with seasonal and daily temperature ranges of
their native habitat.

There is increasing evidence that in many cases
the ability of an organism to adjust metabolic rate to
changes in temperature is strongly correlated with the
degree of temperature dependence of enzyme catalyzed
reactions (Kahr and Moller, 1976). It has been demons-
trated for malate dehydrogenase in *Nicotiana tabacum*
(Dejong, 1973) that either photoperiod or growth tempera-
ture can alter the relative staining intensity of the
isoenzyme bands and the electrophoretic ability of some
of the proteins. These studies also suggest that the
degree of a particular enzyme to environmental modulation
is under genetic control.

Root membrane ATPase from bean roots, adapted to lo-
temperatures, shows much smaller temperature response.
Such roots contain larger quantities of membrane bound
ATPase and smaller amount of soluble ATPase than roots
adapted to a high temperature (Kuiper, 1972).

Ion stimulated ATPases seem to be involved in energ
dependent ion transport in plant cells. However, in
many cases the quantitative coupling between ATPase
activity and ion flux remains to be demonstrated (Hodges
For salinity studies the \( (\text{Na}^+ + \text{K}^+) \) activated ATPase and its relation to transport of these ions are most important. It should not be surprising that \( (\text{Na}^+-\text{K}^+) \)-activated ATPases occurs in both salt tolerant and salt sensitive species since the latter often possess a mechanism of exclusion of \( \text{Na}^+ \) from the plant tissue (Erdei and Kuiper, 1979).

**Aim of the study**

The selection of plant material that is potentially suitable for improving the species response to adverse conditions, is generally mediated by mass screening of phenotypes as a whole. The condition to which resistance is sought is imposed upon the plants and those entries showing the lowest mortality, or least obvious damage, are selected. This approach has resulted in the formation of the majority of agricultural and horticultural varieties produced so far. This is a very time and resource consuming procedure. In this method large numbers of accessions and hybrids must be grown for prolonged periods. There is an additional problem with physiological disorders, such as salt toxicity, wherein the measured criterion (usually visual damage assessment) is a remote consequence of the actual lesions and is subject to considerable bias in its expression due to uncontrolled environmental conditions (Shannon, 1984).
The aim of our present work, therefore, was to create artificial stress under controlled laboratory conditions; grow the plants under these stress conditions, i.e. under conditions of water, temperature and salt stress, and then evaluate the effects on the plants at various levels like morphology, growth, metabolic intermediates and plasma membrane. Performance of different plants under these stress conditions, as compared with the normal conditions, will certainly help in determining the adaptive capability of the given plant species and point out the level where most important reactions have taken place that, in their turn, have led to visible responses observed. In this way, we feel, not only the visible response can be colated with other levels of plant organisation, but, if colated in a number of cases and situations, may ultimately lead to identification of level(s) organisation and type of test(s) that may result in quickening the pace of investigation leading to reduction in the total time consumed in evaluating the plant for its stress responses.

Why study on Triticale?

Triticale is an intergeneric hybrid of Triticum and Secale. The purpose of this hybridization was to develop a plant which would have the better baking qualities of wheat and high yield and disease resistant characteristics of rye. Several lines of Triticale have been produced
and are being tested under field conditions.

There are reports that Triticale grows and yields better than normal wheat under Indian field conditions (Gill, 1983; Gill, 1980). It's nutritive value is reported to be higher than wheat (Shingari, 1976). Triticale has also been reported to grow better under various environmental stress conditions (Gorham et al., 1985; 1986).

Most of the studies on Triticale are carried out at morphological levels. There is no systematic attempt to study the physiological and biochemical basis for the better morphological performance of Triticale under adverse conditions. If Triticale is able to tolerate the stress then this must have a basis at molecular level.

Therefore we studied the various morphological, physiological and biochemical parameters in Triticale under control and stress conditions. The results from Triticale are compared with Sonalika. We selected Sonalika for comparison because this is a very common wheat variety grown all over India. It grows very well under normal conditions. Therefore, the comparison with such variety would have some meaning for a very large part of India as a whole and assess the potentiality of using Triticale, if otherwise desirable.

Parameters: (a) Morphological parameters

We first studied the morphological response of Triticale to stress conditions to establish an over all visible
criteria that it can tolerate stress. The obvious parameters for our morphological observations were visible changes, growth and water potential in leaves. As pointed out in literature, exposure to any stress affects leaf morphology (Hodson et al., 1985); leaf growth (Acevedo et al., 1971; Francois et al., 1982; Wilson et al., 1987) and leaf water potential (Kramer, 1950).

(b) Physiological parameters

Various metabolic intermediates are synthesized under stress. This is specially so in plants that are adapted to stress conditions. Proline has been shown to be the most important factor amongst a number of others (Stewart and Lee, 1974). This "imino" acid is reported to play an adaptive role especially in conditions of water stress (Singh et al., 1972); temperature stress (Chu et al., 1974) and salt stress (Pandey and Ganapathy, 1985; Weinberg, 1987). Therefore we assumed that proline content of the two types would give us an idea about the level of critical in relation to a number of adverse conditions.

(c) Biochemical parameters:

As it has been widely reported in literature, membranes are the primary site of an injury when an organism is exposed to unfavourable conditions (Aloni et al., 1977; Airo et al., 1987; Blum and Ebercon,
We studied the changes in plasma membrane as it acts as a barrier between the cell and its environment. The transport of ion takes place at the plasma membrane level and various lipids and (Na\(^+\)-K\(^+\))-ATPase, bound to this membrane layer, play an important role in ion transport. There are also a number of studies pointing to plasma membrane as the primary site of injury under stress conditions (Bartholomew and Mace, 1972; Booz and Travis, 1983; Kuiper, 1984; Douglas, 1985).

Proteins and lipids are the most important constituents of plasma membrane. They form the bilayer structure of plasma membrane. Any change in protein and lipid content of plasma membrane will have a bearing on its function (Levitt, 1980; Yoshida and Uemura, 1984; Kuiper, 1984) as well as on the activity of the enzymes like (Na\(^+\)-K\(^+\))-ATPase bound to it (Kuiper, 1982).

When plants are exposed to stress conditions the composition of various lipids is reported to undergo a change. Glycolipids and sulfolipids (Kuiper, 1984), phospholipids (Chetal et al., 1980; Erdei and Kuiper, 1980) sterols (Benz and Cross, 1978; Hatu et al., 1987) undergo compositional changes under stress conditions.

These findings suggest that the morphological, physiological, and biochemical parameters, described above, must have some links and be studied together under stress in order to investigate the mechanism of plant
adaptation to unfavourable conditions. We have, therefore, studied all these parameters in Triticale and in wheat under control as well as test conditions to bring out differences at various levels.

Seeds of DTS (Delhi Triticale Selection) 940, which grows well under drought and adverse temperature conditions, and DTS 138 which grows well under saline conditions, were procured from Dr. H.J. Joshi, Department of Genetics and Plant Breeding, Indian Agricultural Research Institute, New Delhi. These seeds were germinated, along with the seeds of wheat, var. Sonalika, used as control, under laboratory conditions with 25°C constant temperature for day and night. After the plants attained certain height at the age of 9 days, Sonalika and DTS 940 were subjected to water deficit and low and high temperature stress. DTS 138 and Sonalika were used in salt stress studies. All these varieties of Triticale and wheat were also grown under normal conditions as control of each experiment.

Changes in morphology visible to naked eye were recorded. Growth under different conditions was assessed in terms of fresh weight accumulation. Proline, accumulated under various stress conditions, was chemically estimated from the leaf tissues.

Plasma membranes were isolated from the roots of all the three plant species grown under normal and stress
conditions. Proteins and lipids were extracted from these isolated plasma membranes. Protein changes in *Triticale* and *Sonalika* under normal and stress conditions were noted. Lipids were extracted from the plasma membranes. Various lipid groups were separated with the help of the silicic acid column. Individual lipids were separated on TLC plates and quantitatively estimated. Sterols were estimated separately. Activity of \((\text{Na}^+ + \text{K}^+)\)-ATPase was estimated as marker for plasma membrane and as a measure of metabolic activities in plants that were grown under normal and different stress conditions.

Studies of these parameters under normal and abnormal conditions were used to determine the ability of *Triticale* variety to tolerate stress conditions.