Plants have long been used as a source of food, medicine and many other useful products. At least 3000 plants have been used in human history as a source of food and medicine. And there is still a growing focus on the importance of medicinal plants and traditional health systems in solving the healthcare problems in the world. Even today, eighty percent of world population relies mainly on traditional remedies such as herbs for their medicine (Nasim et al., 2010b). Furthermore, many higher plants are major source of natural products used as pharmaceuticals, agrochemicals, flavor and fragrance ingredients, food additives, and pesticides (Balandrin & Klocke, 1988). The huge importance is, however, posing to be detrimental for this green vegetation which is being continuously depleted by deforestation, overgrazing and environmental pollutants. Also, the propagation of plants through seeds, bulbs, tubers, rhizomes etc. do not always give desirable results, and the traditional cultivation practices are usually associated with limitations such as progeny variations (Nasim et al., 2010b). To overcome these problems and to meet the growing demand, plant tissue culture technology has often been practiced.

Since the last four decades, plant tissue culture techniques have emerged as an inescapable tool with possibilities of complementing the conventional methods in plant breeding and have proved to be efficient and often economical for plant propagation (Murashige, 1974). *In vitro* culture is one of the key tools of plant biotechnology that exploits the totipotency nature of plant cells, a concept proposed by Haberlandt (1902) and unequivocally demonstrated, for the first time, by Steward et al. (1958). The plant tissue culture techniques can also be employed for large-scale propagation of disease-free clones and gene pool conservation besides many other potential applications.

Tissue culture technology has several advantages over conventional agricultural production such as: (a) It is independent of geographical and seasonal variations and various environmental factors; (b) It offers a defined production system, which ensures the continuous supply of products, uniform quality and yield; (c) It is possible to produce novel compounds that are not normally found in parent plant; (d) It is independent of political interference; (e) Efficient downstream recovery and product; (f) Rapidity of production; (g) In addition, plant cell can perform stereo- and region-specific biotransformation for the production of novel compounds from cheap precursors (Nasim et al., 2010b).
1.1 Micropropagation

Also called *in vitro* clonal propagation, micropropagation is a widely and successfully used technology for large-scale propagation of plants. The genetic stability of the new shoot is dependent upon their origin. This is also a kind of rapid vegetative propagation and hence, the products of this process should be considered as a single clone. Micropropagation is used routinely to generate a large number of high-quality clonal agricultural plants, including ornamental and vegetable species, and also plantation crops.

The micropropagation typically involves regeneration through shoot primordia (meristem). *In vitro* cultures may be initiated from the embryo, main apex and axillary buds. It is also possible to initiate cultures from both tissue or organ explants. However, the choice of explant is important in determining the quality of the produced plant. Also the explants should be carefully chosen from healthy and disease-free mother plants cultivated under conditions so as to reduce contamination and promote growth of the tissues to be cultured.

Besides proper choice of explant, development of appropriate nutrient formulation as well as light and temperature also play a vital role in the establishment and further development of the explants.

In tissue culture, plant propagation involves the following five stages:

*Stage I - Establishment of aseptic culture*

*Stage II - Multiplication of propagules*

*Stage III - Root induction and preparation prior to transfer*

*Stage IV - Acclimatization and transfer to field*

Recently, a new stage has been added:-

*Stage 0 - Preparatory stage of the mother plant*- This includes the process where the mother plants to be used as source are grown under strictly hygienic and controlled conditions.
There are two alternative mechanisms by which an explant can regenerate an entire plant, namely organogenesis and somatic embryogenesis. In organogenesis, shoots and roots form sequentially, in response to appropriate culture conditions. This type of development is also characterized by the presence of vascular connections between the mother tissue and the regenerating section (Terzi & Lo Schiavo, 1990). Micropropagation via organogenesis is less effective in terms of altered nature (genetic variations/alterations) of produced plant. However, compared to intervening of callusing, the chances of variations are minimum when plantlets are developed directly by explants such as axillary buds (Zimmerman & Broome, 1980; Mujib et al., 1998).

On the other hand, somatic embryogenesis can be described as the process by which haploid or diploid somatic cells develop into structures that resemble zygotic embryos (i.e., bipolar structures without any vascular connection with the parental tissue) through an orderly series of characteristic embryological stages without fusion of gametes (Raemakers et al., 1995). One remarkable characteristic of the somatic embryo is its continuous growth resulting from the absence of developmental arrest (Faure et al., 1998). Both processes, organogenesis and somatic embryogenesis, have been reported to occur in the same explant (He et al., 1990), but originate from particular tissue layers or cells within explants (Osternack et al., 1999).

Somatic embryogenesis is a valuable tool for achieving a wide range of objectives, from basic biochemical, physiological and morphological studies to the development of technologies with a high degree of practical application. One of the main uses of somatic embryogenesis constitutes its employment as an approach to investigate the initial events of zygotic embryogenesis in higher plants. Perhaps the primary reason for limited progress in understanding the developmental events in plant embryos is that zygotic embryos of higher plants consist of several tiny cells that grow within maternal tissues, such as the flowers or immature fruits, and it is quite difficult to collect sufficient embryos for biochemical, physiological and morphological analyses of the biological events that occur early in the developmental process. Somatic embryos provide a good model system by which such problems could be circumvented. The knowledge of many of the events that occur during early embryogenesis has resulted from experiments on somatic embryogenesis of a few plant species (Kiyosue et al., 1993, Zimmerman, 1993).
The mass propagation of plants through multiplication of embryogenic propagules is the most commercially attractive application of somatic embryogenesis (Merkle et al., 1990). Somatic embryogenesis has many advantages over organogenesis in this respect: (a) it permits the culture of large numbers of 'reproductive units' (e.g., 60,000 to 1.35 million somatic embryos per liter of medium) with the presence of both root and shoot meristems in the same element; (b) the mode of culture permits easy scale-up transfers with low labor inputs since embryos can be grown individually and freely floating in liquid medium; (c) unlike shoots, somatic embryos frequently originate from single cells and the embryogenic cultures can be synchronized and purified so that one can deal with practically pure cultures of material; and, (d) plants derived from somatic embryos are less variable than those derived by the organogenesis pathway (Terzi & Lo Schiavo, 1990; Osuga et al., 1999, Nasim et al., 2010b).

Another application is in the production of plants with different levels of ploidy, i.e., obtaining haploid embryos by cultivating anthers and raising triploids from endosperm have been suggested and, to a very limited extent, exploited (Terzi & Lo Schiavo, 1990). Also, success in inducing dormancy and the accomplishment of long-term storage, together with the achievement of encapsulation of somatic embryos, has opened up the possibility for their use in the synthetic seed technology (Gray et al., 1995; Litz & Gray, 1995). The use of embryogenic callus and cell suspension cultures, as well as somatic embryos themselves as a source of protoplasts, has been exploited for a range of species, taking advantage of the totipotency of these embryogenic cultures (Merkle et al., 1990). Embryogenic cultures have proven to be especially valuable in providing a source of regenerable protoplasts in graminaceous species (Lyznik & Hodges, 1994; Funatsuki et al., 1996), Citrus species (Jimenez, 1996), and forest trees (McCown & Russell, 1987).

Gene transfer into embryogenic plant cells is already challenging conventional plant breeding, and has become an indispensable tool for crop improvement. One of the most important prerequisites for genetic manipulation of plants in vitro is the ability to grow somatic cells in sterile plant growth medium and to regenerate viable plants from these cultures. Somatic embryogenesis, therefore, is a more efficient pathway for studies involving production of genetically transformed plants (Litz & Gray, 1995; Vicent & Martínez, 1998; Nasim et al., 2010b).
Secondary or recurrent embryogenesis, offers a great potential for *in vitro* production of embryo metabolites, such as lipids and seed storage proteins. However, since the production costs are still higher than the extraction from natural seeds, this technology is not yet commercially viable (Merkle et al., 1990). Finally, the embryogenic development of somatic cells appears to be more sensitive to the application of exogenous chemical compounds than the growth of whole plants or even callus cultures. This offers the possibility of using *in vitro* screening and selection procedures to identify plant genotypes resistant to certain factors, such as aluminum toxicity or toxins produced by pathogens (Merkle et al., 1990).

The biotechnological tools are important for multiplication and genetic enhancement of the medicinal plants by adopting techniques such as *in-vitro* regeneration and genetic transformation. They can improve production of plant chemicals especially plant secondary metabolites, thereby contributing to the medicinal value of the plant (Nasim et al., 2010b). *In vitro* cultures have been found to accelerate production of specific medicinal compounds at a rate similar or superior to that of intact plants by affecting the biosynthetic activity of cultured cells which is done by regulating environmental factors, as well as artificial selection or induction of variant clones (Nasim et al., 2011). Enhanced production of secondary metabolites in plants raised under *in-situ* conditions has been reported and discussed earlier (Nasim et al., 2011).

1.2 Micro propagation and Secondary metabolite production

Plants are the traditional source of many chemicals used as pharmaceuticals. Most valuable phytochemicals are products of plant secondary metabolism. The production of these secondary metabolites *in-vitro* is possible through plant cell culture. Successful establishment of cell lines capable of producing high yields of secondary compounds in cell suspension cultures has also been achieved (Zenk, 1978). The accumulation of secondary products in plant cell cultures depends on the composition of the culture medium, and on environmental conditions (Nasim et al., 2010b). Different strategies are employed for improving secondary products in suspension cultures, using different media for different species (Ravishankar & Grewal, 1991). The production of secondary metabolites in plant cell suspension cultures has been shown significantly in various medicinal plants such as solasodine.
from calli of *Solanum elaeagnifolium* (Ravishankar & Grewal, 1991); pyrrolizidine alkaloids from root cultures of *Senecio* sp. (Leena & Jairndra, 2003); and Cephaelin and emetine from callus cultures of *Cephaelis ipecacuanha* (Leena & Jairndra, 2003).

Furthermore, using bioreactors is the key step towards commercial production of secondary metabolites by plant biotechnology (Leena & Jairndra, 2003). It has several potential advantages for mass cultivation of plant cells: (a) It gives better control for scale up of cell suspension cultures under defined parameters for the production of bioactive compounds; (b) Constant regulation of conditions at various stages of bioreactor operation is possible; (c) Handling of culture such as inoculation or harvest is easy and saves time; (d) Nutrient uptake is enhanced by submerged culture conditions which stimulate multiplication rate and higher yield of bioactive compounds; and (e) Large numbers of plantlets are easily produced and can be scaled up. Since the biosynthetic efficiency of populations varies, a high yielding variety should be selected as a starting material.

The bioreactor system has been applied for embryogenic and organogenic cultures of several plant species. Bioreactors offer optimal conditions for large-scale plant production for commercial manufacture (Scragg, 1992). Much progress has been achieved in the recent past on optimization of these systems for the production and extraction of valuable medicinal plant ingredients such as ginsenosides and shikonin. Research over the last two decades has established efficient protocols for isolated cell cultures and a large-scale bioreactor system. The acceptance of this process for the industrial production of these invaluable compounds has recently been established and will significantly impact the production of these medicinally-potential pharmaceuticals.

The plants in natural environment are susceptible to various biotic and abiotic stresses, which results in several physiological, biochemical and genetic changes adversely affecting the plant growth, development and thus, its pharmacological value. Plant biotechnology is a promising approach to increase and produce plants tolerant to such stresses.
1.3 Micropropagation and Environmental stress

To date, a rapid change in environmental conditions is observed, which is likely to override the adaptive potential of plants, especially those having long reproductive cycles. These environmental changes mainly originate from anthropogenic activities, which have caused air and soil pollution, acid precipitation, soil degradation, salinity, increasing UV-B radiation, climate change, etc. (Wi et al., 2006b, Jan et al., 2012). In addition, plants are exposed to natural climatic or edaphic stresses, for example, high irradiation, heat, chilling, late frost, drought, flooding, and nutrient imbalances which results in several physiological, biochemical and genetic changes adversely affecting the plant growth, development and thus, its pharmacological value. Some of these stress factors may fluctuate significantly in intensity and duration on time scales of hours, days, seasons, or years; others may change slowly and gradually affect plant growth conditions. Since plants are sessile organisms and have only limited mechanisms for stress avoidance, they need flexible means for acclimatisation to changing environmental conditions. Plant biotechnology is a promising approach to increase and produce plants tolerant to such stresses.

A common consequence of most abiotic and biotic stresses is an increased production of reactive oxygen species (Polle & Rennenberg, 1993; Kapoor et al., 2012) at some stage of stress exposure. The successive reduction of molecular oxygen to H2O yields the intermediates O2−, HO and H2O2, which are potentially toxic as they are relatively more reactive as compared to O2. Reactive oxygen species may lead to unspecific oxidation of proteins and membrane lipids or may cause DNA injury. As a consequence, tissues injured by oxidative stress generally contain increased concentrations of carbonylated proteins and malondialdehyde and show an increased production of ethylene (Dean et al., 1993). Because of these multiple functions of activated oxygen, it is necessary for cells to control the level of reactive oxygen molecules, but not to eliminate them completely.

Abiotic stresses, notably extremes in temperature, photon irradiance, supplies of water, heavy-metal concentration in soil and inorganic solutes leading to temperature stress, radiation stress, drought stress, anaerobic stress, heavy-metal stress and salinity stress negatively influence survival, biomass production and accumulation, and grain yield of most crops (Grover et al., 1998; Khush & Baenziger,
With the fluctuation in intensity and duration of these stresses, the degree of susceptibility of different plant species to these stresses is often varied. There is also some level of variation associated with specific developmental stages of the plant. Traditional approaches to breeding crop plants with improved abiotic stress tolerances have so far met limited success (Richards, 1996) since the focus has been on yield rather than on specific traits. The use of biotechnological approaches to improve plant tolerance to abiotic stresses holds promise in the future and need to be exploited.

1.3.1 Radiation stress

The effects of low doses of radiations on living plant tissues have been ascribed to physiological and biochemical changes induced concomitantly with the phenomenon of growth arrest, changes which do not affect the safety of the product as a food (Diehl, 1990). The biochemical changes associated with growth inhibition processes in irradiated plant tissues have not yet been fully elucidated. However, low doses of gamma irradiation have been used to advantage in order to control the degree of ripeness and extend the shelf life of fruits and vegetables. In particular, the effects of ionizing radiations on the lipids of irradiated garlic have received relatively little attention in the literature (Kwon et al., 1988). At gamma irradiation with 100 Gy, no differences in the levels of linoleic, palmitic, oleic and linolenic acids, the predominant fatty acids of Korean garlic cultivar bulbs has been reported. However, a low, sprouting inhibitory dose of irradiation may have effects on lipids and fatty acids that become apparent several months afterwards (Perez et al., 1998).

Nowadays, gamma radiations have also found a potential use in ensuring food safety and upgrading the nutritional quality of food products across the world. With the ban on ethylene oxide used in sterilization, food irradiation is emerging as a major food processing and preservation technology. It, however, may even cause nutritional losses, especially of some important micronutrients in our diet. Thiamine and ascorbic acid are a few examples of nutrients that are highly sensitive to irradiation (Kilcast, 1994). In several medicinal herbs, radiations are also reported to cause dose-based changes in the content of essential biologically active substances and their pharmacological activity (Venskutonis et al., 1996; Chatterjee et al., 2000). Huang & Mau (2007) have reported an increase in the extraction yields of flavonoids such as luteolin with radiation treatment in plants. A similar increase in phenolic acid content
has been reported by Variyar, Bandhopadhyay and Thomas (1998) in irradiated cloves in nutmeg. The effect of radiations on the secondary metabolite content needs to be further studied due to lack of concrete and reinforcing research.

The generation of somaclonal variation has also been applied in crop improvement with the intention of including and exploiting useful and economically valuable characters that may not be readily available within other sources of germplasm (Humera & Iqbal, 2010; Juned et al., 1991). A useful source of generating variations in plants is by mutagenesis (physical and chemical). Radiation induced mutations and chemical mutagenesis have been extensively used for the improvement of crop plants (Shah et al., 2008). There are several agricultural crops in which positive mutations have been induced using different mutagens. Improved crops like high-yielding barley variety with early maturity, high protein contents and stiff straw have been successfully developed using mutation breeding techniques (Rehman et al., 1987; Javed et al., 2000). The cumulative number of officially released mutant varieties in the world indicates that Asia tops the rest of the continents.

A combination of in vitro culture methods with the application of radiation mutagenesis can be valuable in crop improvement programmes aimed at the generation of variability, selection and multiplication of the desired genotypes in a much shorter duration and smaller space than conventional methods (Ahloowalia, 1998). It is hence desirable to study the radio-sensitivity of in vitro cultures to optimize the suitable dose for mutagenesis. In vitro techniques can be employed in various steps of a breeding programme and offer a number of advantages for mutation breeding. In several crop plants, gamma irradiation is known to affect tissue culture response (callus growth and plant regeneration) and often higher doses result in low or no regeneration frequency (Kulkarni et al., 2007).

1.3.2 Salinity stress

Salinity in soil or water is one of the major abiotic stresses that reduce plant growth and crop productivity worldwide. Soil salinity is characterised by the presence of an abnormally high content of readily soluble salts, primarily chlorides, sulphates and carbonates of sodium, magnesium and potassium. NaCl is reportedly the dominant and more toxic than other salts for plant growth and development (Shimpose, 1972). Sodium is an essential micronutrient for some of the plants, but
most crop plants are natrophobic. Salinity is detrimental to plant growth as it causes nutritional constraints by decreasing uptake of phosphorus, potassium, nitrate and calcium, ion cytotoxicity and osmotic stress. Under salinity, ions like Na$^+$ and Cl$^-$ penetrate the hydrated shells of proteins and interfere with the function of these proteins. Ionic toxicity, osmotic stress, and nutritional defects under salinity lead to metabolic imbalances and oxidative stress.

More than 800 million hectares of land throughout the world are salt-affected (including both saline and sodic soils), equating to more than 6% of the world’s total land area (FAO, 2008). Low rainfall, high evaporation, native rocks, saline irrigation water, and poor water management increasingly cause salinity problems in agricultural areas. It is estimated that of the current 230 million hectares of land under irrigation, 45 million hectares are salt-affected (20%) and of the 1500 million hectares of dryland agriculture, 32 million hectares are salt-affected (FAO, 2008). Overall, it was estimated that the world is losing at least 3 ha of arable land every minute because of soil salinity (FAO, 2008).

In India, of a total of 328.3 million hectares of geographical area, only 138.3 million hectares is under cultivation and out of this nearly 7 million hectares is affected by salt stress (Bhargava & Sharma, 1978). Soil salinity is a serious threat to crop productivity in arid and semiarid regions of Haryana, Uttar Pradesh and Rajasthan and the coastal regions stretching from Gujarat to Kanyakumari in the west.

The deleterious effects of salinity on plant growth are associated with (a) low water potential of the root medium which causes a water deficit within the plant; (b) toxic effects of ions-mainly Na$^+$ and Cl$^-$; and (c) nutritional imbalance caused by reduced nutrient uptake and/or transport to the shoot (Hasegawa et al., 2000). In addition, there is evidence that salt stress can induce conditions of oxidative stress such as generation and accumulation of reactive oxygen species, including hydrogen peroxide (H$_2$O$_2$), superoxide anion, and hydroxyl radicals (Kovtun et al., 2000).

Improving irrigation techniques and reclamation of salinized land are prohibitively expensive and short-term methods of controlling salinity (Singh & Singh, 2000). Therefore, to maintain global food production, enhancement of the salt tolerance of crops through various plant breeding programs is an increasingly important aspect. Plant salt tolerance mechanisms can be grouped into cellular...
homeostasis (including ion homeostasis and osmotic adjustment), stress damage control (repair and detoxification), and growth regulation. Considerable efforts have been invested to unravel these plant salt tolerance mechanisms. The success of breeding programs with the ultimate goal of improving crop productivity is limited by the lack of a clear understanding of the molecular basis of salt tolerance. Recent advances in the genetic analysis of Arabidopsis mutants defective in salt tolerance, and molecular cloning of these loci, have given some insight into salt stress signaling and plant salt tolerance. Plant tissue culture techniques provide a promising and feasible approach to develop salt tolerant plants through various in vitro culture approaches (Lu et al., 2007; Dasgupta et al., 2008).

Somaclonal variation and in vitro-induced mutagenesis can be used to create variability from which crop plants can be improved. Moreover, the use of plant cell and tissue cultures offers a means to focus on those physiological and biochemical processes inherent to cells, which contribute to the adaptation to salt stress.

1.3.3 Selenium stress

A group 6B metalloid with an atomic weight of 78.96, selenium (Se) shares several similar chemical properties with sulphur (S). Like S, Se can exist in five valence states, selenide (2⁻), elemental Se (0), thioselenate (2⁺), selenite (4⁻), and selenate (6⁺) (Lauchli, 1993). The speciation of Se depends on redox conditions and pH of the environment. Selenium also exists in volatile forms.

The essentiality of selenium as a micronutrient has been well known since 1957 (Shamberger, 1986). Selenium displays anticarcinogenic potentials through its incorporation into various selenoenzymes which function to reduce free radical injury to cells (Burk, 1990). It has also been found to in vivo bind to, and therefore inactivate toxic metals (Hansen, 1988). It has also been shown that selenium supplementation complements vitamin E in neutralizing free radicals (Bork, 1986). Se also forms an integral part of the antioxidant enzyme, glutathione (GSH) peroxidase (Rotruck et al., 1973).

The concentrating of essential minerals, vitamins, and bioactive phytochemicals into human foodstuffs is gaining importance in our rapidly expanding world. Although a potential anticarcinogen, this mineral is unfortunately deficient in
most soils worldwide, and as a result most geographical food chains contain highly inadequate amounts of selenium. A recommended dietary allowance (RDA) has been established for Se (55 µgd⁻¹ for adults). This requirement is readily met by North Americans but large numbers of people in Europe, Asia and parts of Africa have intakes less than the RDA level (National Academy of Sciences, 2001). At high dosages, however, it may be toxic to animals (Lemly, 1997), humans (Von Vleet & Ferrans, 1992) and plants (Kapoor et al., 2012). The narrow margin between the beneficial and harmful levels of Se has important implications for human health. Plants play a pivotal role in this respect. Plants that can accumulate Se may be useful as a “Se-delivery system” to supplement the mammalian diet in many areas that are deficient in Se. On the other hand, the abilities of plants to absorb and sequester Se can also be harnessed to manage environmental Se contamination by phytoremediation (Terry & Zayed, 1998) whereby they can convert inorganic Se to volatile forms, predominantly dimethylselenide (DMSe), by a process called phytovolatilization.

Common vegetable members of the genera *Allium* (El-Bayoumy et al., 1996) and *Brassica* (Banuelos & Meek, 1990) are highly seleniferous in nature, they readily uptake inorganic selenium from the soil and incorporate it into bioactive organic chemicals. They produce various seleno amino acids and potentially bioactive organic selenium-containing phytochemicals. Due to the high concentrations of natural phytochemicals, and the additional assimilation of selenium, the commercial or small scale production of selenium-enriched seleniferous plants is thus, a progressive strategy to introduce therapeutically valuable phytochemicals to human diet.

The growth conditions have been reported to significantly alter the production of secondary metabolites in plants (Rout et al., 2000; Verpoorte et al., 2002) and *in vitro* cultures have been reported to accelerate production of specific medicinal compounds (Stafford et al., 1986). Thus, the use of biotechnological approaches such as plant cell and tissue cultures provides a useful mean to study not only the physiological and biochemical changes during the growth and various developmental stages in seleniferous plants and but also enable commercial production of these 'medicinally valuable plants and phytochemicals by micropropagation.'
1.4 Aims and Objectives of the Present Study

It is evident from the information presented above that quite a few medicinal plants have been studied in detail for the production of secondary metabolites by using tissue culture techniques. However, studies on the influence of environmental stresses such as radiation stress, salt stress, selenium stress etc. on secondary metabolite production and biochemical activity in various *in vitro* grown tissues and organs are very limited. The information on the morphogenetic, biochemical and physiochemical variations in response to alterations in plant growth regulators and medium composition in different *in vitro* raised tissues or organs is also scanty. Though extremely beneficial in terms of medicinal value, information on potential aspects of garlic like embryogenesis, evaluation of bioactive compounds in different tissues and organs is also limited.

Thus we have chosen *Allium sativum* as our experimental plant material so as to illustrate the influence of different environmental factors on different *in vitro* grown tissues or organs of garlic at different developmental stages for their regeneration potentiality and secondary metabolite production. And to demonstrate the impact of alteration in growing medium compositions on phytochemical and biochemical activity in various tissues and organs of garlic grown under *in vitro* conditions.

In order to achieve these objectives following experimental approaches have been undertaken:

- Selection of suitable varieties of garlic
- Cell culture establishment after identification of suitable explants
- Establishment of media and hormonal requirements for *in-vitro* study
- Induction of somatic embryos
- Study of maturation and germination of somatic embryos
- Study of root regeneration programme of the regenerated plants
- Acclimatization and transplantation
Study or quantification of alliin content in garlic raised \textit{in-vitro}

Different biochemical studies in response to various morphogenetic development

For better conclusion of our research, response of cultures to various abiotic stresses such as Salt stress, Selenium stress and Gamma radiations has also been studied.