DISCUSSION

Seed is a miniature plant in dormant stage which becomes viable upon imbibition. After imbibition of seed radical appears first, this stage of radical emergence is called seed germination. Seed germination is a mechanism, in which morphological and physiological alterations result in activation of the embryo. Before germination, seed absorbs water, resulting in the expansion and elongation of seed embryo. When the radicle has grown out of the covering seed layers, the process of seed germination is completed (Hermann et al, 2007). Seed germination is one of the initial and vital stage in the growth cycle of a plants that determine plant development and the yield of the crops.

Studies are carried out in seeds of several plants i.e. Legumes – *Pisum sativum* (AP-3 & Aparna), *Phaseolus aureus* (K-851). Cereals – *Triticum aestivum* (PBW-502 & WH-711), *Hordeum vulgare* (BH-393 & K-508), *Cicer arietinum* (Surya, C-235). Oil yielding plant – *Brassica compestris* (Pusa Bold & PT-303) cultivars treated with water, NaCl, IAA, GA and Cytokinin. The effect of treatments on emergence of young plant and further growth of plumule, epicotyl, hypocotyl, coleoptile and radical is measured and results are:

Seeds of plants are treated with different concentrations of NaCl i.e. $1 \times 10^{-1}$M to $1 \times 10^{-10}$M, thereafter, kept in dark for seed germination.

- Doses of NaCl e.g. $1 \times 10^{-1}$M and $1 \times 10^{-2}$M and $1 \times 10^{-6}$M cause inhibition in seed germination in all the plant cultivars i.e. *Triticum aestivum* cv. PBW-502 and WH-711, *Pisum sativum* cv. AP-3 and Aparana, *Cicer arietinum* cv. C-235 and Surya and *Hordeum vulgare* cv. BH-393 and K-508 except *Phaseolus aureus* cv. K-851, being maximum in *P.aureus* at $1 \times 10^{-5}$M concentration of NaCl. The seed germination is nil in both of cultivar i.e. Pusa bold and PT-303 of *Brassica compestris* at the dose $1 \times 10^{-1}$M of NaCl.
The above results can be related to the earlier findings of Shahid et al (2011) who found that increasing salinity cause a decrease of germination % in Okra (Abelmoschus esculentus) plant. Kumar et al (2012) also stated that higher salinity level reduced germination in wheat. Mehsah and Ihenyen (2009) have also reported that, salinity up to 300 – 400 mM NaCl delayed the germination in mung bean. Akbari et al (2007) observed decrease in germination percentage with increasing the concentration of NaCl. Sivasankaromoorthy et al (2010) have showed that maximum % i.e 100% of seed germination is recorded in fresh water and minimum % i.e. 36% at 200 mM of NaCl concentration. Dantas (2008) investigated that the lower concentration of NaCl can influenced seed germination and the above concentration of 50 mol M⁻³ decreased germination and growth in bean in black gram, salinity caused significant reduction in germination (Gurudevi, 2012). Other studies is also revealed the imbibition effects of salinity on the seed germination of various crops i.e. Oryza sativa (Xu et al, 2011), Triticum aestivum (Akbarimoghaddam et al, 2011), Zea mays (Carpıcı et al, 2009; Khodarahmpour et al, 2012), Brassicaspp. (Ibrar et al, 2003; Ulfat et al, 2007), Glycine max (Essa, 2002), Vigna spp. (Jabeen et al, 2003) and Helianthus annuus (Mutlu and Buzcuk, 2007). Salt stress has negative correlation with seed germination and vigor (Rehman et al, 2000). Higher level of salt stress caused reduction in the germination of seeds while lower level of salinity induced a state of dormancy (Khan and Weber, 2008). Many-fold effects of salinity on the germination process may be due to that it alters the imbibitions of water by seeds having lower osmotic potential of germination media (Khan and Weber, 2008), besides it the cause of toxicity may be due to changes in the activity of enzymes of nucleic acid metabolism (Gomes-Filho et al, 2008), alter action in protein metabolism (Yupsanis et al, 1994; Dantas et al, 2007), disturbance in hormonal balance (Khan and Rizvi, 1994), and it reduces the utilization of seed reserves (Promila and Kumar, 2000; Othman et al, 2006). It may also
negatively affect the ultrastructure of cell, tissue and organs (Koyro, 2002; Rasheed, 2009). However, there are various internal (plant) and external (environmental) factors that affect seed germination under saline conditions which includes nature of seed coat, seed dormancy, seed age, seed polymorphism, seedling vigor, temperature, light, water and gasses (Wahid et al, 2011).

Seeds of plants are treated with different concentrations of NaCl i.e. 1x10^{-1}M to 1x10^{-10}M, thereafter, seedling growth is studied and findings are:

- An inhibited seedling growth of *Triticum aestivum* cv. PBW-502 and WH-711 is observed at treatment of 1x10^{-4}M and it is promoted at 1x10^{-10}M NaCl in cultivar PBW-502, being maximum at treatment of 1x10^{-9}M of NaCl in cv. WH-711.
- The increase in fresh weight and dry weight of coleoptile is observed in doses of 1x10^{-5} to 1x10^{-10} M in *Triticum aestivum* cv. PBW-502.
- The promotory response in seedling growth of *Triticum aestivum* cv. WH-711 is visible at the dose of 1x10^{-10} and 1x10^{-9} M of NaCl.
- All the doses of NaCl (1x10^{-1}M to 1x10^{-10}M) show the decline response in seedling growth of *Hordeum vulgare* cv. K-508.
- An inhibition of seedling growth of *Pisum sativum* cv.AP-3 is observed at treatment of all doses (1x10^{-10}M to 1x10^{-1}M) of NaCl except 1x10^{-3}M and 1x10^{-9}M. While in *Pisum sativum* cv. Aparana, doses show the variable response.
- 1x10^{-1}M, 1x10^{-10} and 1x10^{-9}M doses of NaCl cause inhibition in seedling growth of *Cicer arietinum*.
- All the doses of NaCl inhibit the seedling growth of *Brassica compestris* cv Pusa bold.
- In *Brassica compestris* cv. PT-303, the dose 1x10^{-7}M show a little increment in growth of radical.
- A decline in growth of hypocotyl of *Phaseolus aureus* cv. K-851 is found.
Above findings are similar to the observation of (Shahid et al, 2011) who also reported that increased salinity cause decrease of shoot and root length, plant height, pod weight and pod length in okra plant. Plant length, biomass, weight of seed and yield of soyabean cultivar decrease in 70 mM and 140 mM concentration of NaCl (Humayun et al, 2010). Leaf area and dry matter content decreased in tomato plant, with application of elevated salt stress (Babu, 2012). Kumar (2012) stated that, higher salinity reduce growth and yield attributing parameter in wheat. Fresh weight and dry weight of shoot and root and yield decreased with increased salinity in mung bean (Mensah, 2009). Radical length, seedling fresh weight and dry weight of wheat cultivar is reduced with increasing concentration of NaCl (Akabari et al, 2007). Negative impact on root length, fresh weight and dry weight and number or area of leaf on chilli pepper is reported when salinity increase (Zhani, 2012). Soussi (1998) found that plant growth was affected by the higher NaCl concentration in chick pea. Plant growth decreases in rice plant with increasing NaCl concentration (Amirjani, 2010). Ahmad (2008) reported high NaCl concentration cause great reduction in growth parameters e.g. Fresh weight and dry weight of leaf and root of Pisum sativum. Ndakidemi and Makoi (2009) reported that higher NaCl concentration reduced plant height, dry matter and yield in mung bean cultivar. Gurudevi et al (2012) also investigated this in mung bean. Similarly, Lauchli and Grattan (2007) observed that root and shoot growth inhibited by salinity. The width of seed coat decrease with salinity increase in chick pea (Purohit, 2002).

The level of biochemical compounds i.e. total sugar, reducing sugar, total protein and nitrogen are measured in imbibed seed of plants and observations are:

- The total protein content, total sugar, reducing sugar and total nitrogen are increase in imbibed seeds of Triticum aestivum cv.
PBW-502 at the dose $1 \times 10^{-10} \text{M}$ dose of NaCl while, they show a decline at the dose of $1 \times 10^{-4} \text{M}$ of NaCl. Similar changes are found in imbibed seed of *Triticum aestivum* cv. WH-711, at the treatment of $1 \times 10^{-4} \text{M}$ dose of NaCl.

- Total protein content in imbibed seeds of *Hordeum vulgare* cv. BH-393, increase in both dose i.e. $1 \times 10^{-8} \text{M}$ and $1 \times 10^{-4} \text{M}$ dose of NaCl. While, total sugar, reducing sugar and total nitrogen is also higher in amount at the dose of $1 \times 10^{-8} \text{M}$ of NaCl and it become low at $1 \times 10^{-4} \text{M}$.

- The total protein content, total sugar, reducing sugar and total nitrogen in imbibed seeds of *H. vulgare* cv. K-508 show an increase at the dose $1 \times 10^{-4} \text{M}$ of NaCl.

- Total sugar, reducing sugar, total protein content and total nitrogen in imbibed seeds of *Pisum sativum* cv. AP-3 and cv. Aparana, is also higher at the dose $1 \times 10^{-9} \text{M}$ of NaCl. While, all these components decrease at the dose $1 \times 10^{-1} \text{M}$ and $1 \times 10^{-3} \text{M}$ of NaCl respectively.

- The total protein content, total sugar, reducing sugar and total nitrogen show an increase in imbibed seeds of *Cicer arietinum* cv. C-235 at the dose $1 \times 10^{-8} \text{M}$ dose of NaCl while a decrease is visible at the dose of $1 \times 10^{-9} \text{M}$ of NaCl.

- An increase of total protein content, total nitrogen, reducing sugar and total sugar In imbibed seeds of *Cicer arietinum* cv. Surya is found at treatment of $1 \times 10^{-5} \text{M}$ dose of NaCl. While, $1 \times 10^{-9} \text{M}$ dose of NaCl cause a decline.

- The level of biochemical component i.e. total protein content, total sugar, total nitrogen and reducing sugar show an increase at the dose of $1 \times 10^{-7} \text{M}$ dose of NaCl and decrease at the dose $1 \times 10^{-5} \text{M}$ NaCl in seeds of *Brassica compestris* cv. PT-303.
An increase in biochemical components e.g. total protein content, total sugar, total nitrogen and reducing sugar is found in seed of *B. compestris* cv. Pusabold when treated with dose $1 \times 10^{-2}$M dose and a decrease at $1 \times 10^{-6}$M dose of NaCl.

In imbibed seeds of *Phaseolus aureus* cv.K-851 , Treatment of $1 \times 10^{-7}$M dose of NaCl cause an increase in the level of total protein content, total nitrogen, reducing sugar and total sugar. While at the treatment of $1 \times 10^{-1}$M dose of NaCl show a change in decline.

Seeds contain protein storages, such as globulins and prolamins, whose amounts are increased during seed maturation, especially at the mid- and late-stages of seed maturation, when seeds absorb larger amounts of nitrogen. These proteins are located in the cell membrane or other parts of the seed. During the time of protein translocation into different parts of the seed, negligible amounts of protein are turned into other products. The activation of enzymes such as proteinase results in the mobilization of storage proteins (Wilson, 1986). Storage proteins are also found in the seedling radicle and shoot (Tiedemann *et al*, 2000). The mobilization of storage proteins does not take place at the same time in different parts of the seed. The other enzymes, which are activated during the mobilization of proteins, are carboxypeptidase and aminopeptidase. Among the most important parameters controlling the process of seed dormancy are changes at molecular levels, including the protein and hormonal alterations, and the balance between ABA and gibberellins (Ali-Rachedi *et al*, 2004; Finch-Savage and Leubner-Metzger 2006; Finkelstein *et al*, 2008; Graeber *et al*, 2010).

Similarly (Amirjani, 2010) reportes that when NaCl concentration increase in plant then the photosynthetic pigment, soluble sugar and proteins decrease. While Ahmad (2006) observe in *Pisum sativum* that the sugar content
and proline concentration increase with increasing salinity but chlorophyll decrease. Guru devi et al (2012) show that increased salinity cause decrease protein content in Phaseolus mungo. Similar results is reported in soyabean, NaCl decrease content of protein. (Moussa, 2004).

Total activities of enzymes i.e. α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase are measured in treated seeds of plants with NaCl and results are:

- In imbibed seed of Triticum aestivum cv. PBW-502, α – amylase and β – amylase activity increase at the treatment of 1x10⁻¹M dose of NaCl and the activity of Protease, acid phosphatase and alkaline phosphatase become decrease. While the activity of α- amylase and β- amylase inhibits at the dose 1x10⁻¹⁰M and the activity of Protease, acid phosphatase and alkaline phosphatase increase at this dose.
- Simimilarly, the activity of α- amylase and β- amylase increase at the treatment 1x10⁻¹M and the activity of Protease, acid phosphatase and alkaline phosphatase decrease in seeds of Triticum aestivum cv. WH-711. While, at the treatment 1x10⁻⁹M, The activity of α- amylase and β- amylase decrease and the activity of Protease, acid phosphatase and alkaline phosphatase increase.
- In H. vulgare cv. BH-393 , the activity of α-amylase and β-amylose become increase at the treatment of 1x10⁻⁴M dose of NaCl and the activity of Protease, acid phosphatase and alkaline phosphatase decrease. While at the treatment of 1x10⁻⁸M the activity of α- amylase and β- amylase decrease and the activity of Protease, acid phosphatase and alkaline phosphatase increase.
The activity of α- amylase and β- amylase decrease at the treatment of 1x10^{-1}M dose of NaCl and the activity of Protease, acid phosphatase and alkaline phosphatase increase in *Hordeum vulgare* cv. K-508.

The activity of α-amylase, Protease, acid phosphatase and alkaline phosphatase become decrease at the dose of 1x10^{-1}M of NaCl but the activity of β- amylase increase. While the activities of α-amylase, Protease, acid phosphatase and alkaline phosphatase increase and β- amylase activity decrease at the treatment of 1x10^{-9}M dose of NaCl in *Pisum sativum* cv. AP-3.

In imbibed seed of *Pisum sativum* cv. PBW-502, α – amylase and β – amylase activity increase at the treatment of 1x10^{-2}M dose of NaCl and the activity of Protease, acid phosphatase and alkaline phosphatase decrease. While the activity of α- amylase and β- amylase inhibits at the dose 1x10^{-9}M and the activity of Protease, acid phosphatase and alkaline phosphatase show increase.

The activity of α- amylase, β- amylase and protease increase at the treatment of 1x10^{-9}M NaCl and the activity of acid and alkaline phosphatase decrease in seeds of *Cicer arietinum* cv. C-235. While at the treatment of 1x10^{-3}M of NaCl, the activity of α- amylase, β- amylase and protease decrease and acid and alkaline phosphatase increase.

Similarly in *Cicer arietinum* cv. Surya, the activity of α- amylase, β- amylase and protease increase at the treatment of 1x10^{-9}M dose of NaCl and the activity of acid and alkaline phosphatase decrease, At the treatment of 1x10^{-5}M NaCl, the activity of α- amylase, β- amylase and protease decrease and acid and alkaline phosphatase increases.
The activity of α- amylase, β- amylase and protease become increase at the treatment of 1x10⁻³ M NaCl and the activity of acid and alkaline phosphatase decrease in seeds of Brassica compestris cv. PT-303. While, at the treatment of 1x10⁻⁷ M of NaCl, the activity of α- amylase, β- amylase and protease decrease and acid and alkaline phosphatase increase.

There is no effect is observed in activity of protease at the dose 1x10⁻⁶ M of NaCl in Brassica compestris cv. Pusa bold. While, the activity of acid and alkaline phosphatase decrease and α and β amylase activity become increase. At the dose of 1x10⁻² M NaCl, the activity of α-amylase and β- amylase and protease decrease and acid, alkaline phosphatase increase.

The activity of α- amylase, β- amylase and protease show increase at the treatment of 1x10⁻¹ M NaCl and the activity of acid and alkaline phosphatase decrease in P. aureus cv. K-851. While at the treatment of 1x10⁻⁷ M of NaCl, the activity of α- amylase, β- amylase and protease decrease and acid and alkaline phosphatase exhibits increase.

High salinity cause a decrease in nitrate reductase activity and increase peroxidase and catalase activity in Phaseolus mungo (Gurudevi et al, 2012). Amylolytic enzyme activity is high in seeds of P. aureus grown under saline condition reported by Thimmaiah et al (1989). (Ahmad, 2008) measure that nitrate reductase activity decrease at high salt concentration in Pisum sativum. Moussa (2004) also reports that nitrate reductase activity is decreased with increasing NaCl concentration, but Protease activity increased in soya bean.

Now the question aries, “Why the seed germination and seedling growth is inhibited by the NaCl?” It may be due to either the effect of specific ions on metabolism, or adverse water relationship. The soluble salts are chiefly NaCl
and Na$_2$SO$_4$ and sometimes also contain appreciable quantities of Cl$^-$ and SO$_4^{2-}$ of Ca$^{2+}$ and Mg$^{2+}$. These soils contain sufficient neutral soluble salts to pose negative effect on growth of most crop plants. High salinity causes both hyperionic and hyperosmotic stresses and can lead to plant death (Hasegawa et al, 2000). These stresses can be distinguished at several levels (Tester and Davenport, 2003). The root and shoot growth reduces abruptly in salt sensitive plants and this effect does not appear to depend on salt concentration in the growing tissues, it is rather a response to the osmolarity of the external solution (Munns, 2002). Na$^+$ specific damage is associated with accumulation of Na$^+$ in leaf tissues and results in necrosis of older leaves. The high levels of Na$^+$ or Na$^+$:K$^+$ ratio can disrupt various enzymatic processes in the cytoplasm. K$^+$ activates more than 50 enzymes and is an essential element in protein synthesis as it binds tRNA to the ribosomes (Blaha et al, 2000). The disruption in protein synthesis appears to be an important reason of damage by Na$^+$ (Tester and Davenport, 2003). Several studies suggest that the plasma membrane may be the primary site of salt injury (Mansour, 1997). Nonelectrolytes and water permeability get altered markedly upon salt exposure. Osmotic damage (i.e. osmotically driven removal of water from cells) can occur as a result of build up of high concentrations (possibly several hundred mmol) of Na$^+$ in the leaf apoplast, since Na$^+$ enters leaves in the xylem stream and is left behind as water evaporates (Flowers et al, 1991).

Another reasons are that plants growing under saline conditions are affected in three ways: reduced water potential in root zone causing water deficit, phytotoxicity of ions such as Na$^+$ and Cl$^-$ and nutrient imbalance depressing uptake and transport of nutrients. Na$^+$ competes with K$^+$ for binding sites essential for cellular functions (Munns, 2002a). Excess salt concentration also enhances the osmotic potential of soil matrix which restricts the water uptake by plants. Sodium is the primary toxic ion, because it interferes with K$^+$ uptake as well as and disturbs stomatal regulation which ultimately causes
water loss and necrosis. On the other hand, Cl\(^-\) induces chlorotic toxicity symptoms due to impaired production of chlorophyll (Chl). Although both Na\(^+\) and Cl\(^-\) are the major ions which produce many physiological disorders in plants, especially Cl\(^-\), which is the most dangerous than Na\(^+\) (Tavakkoli et al, 2010). In plant cells, Cl\(^-\) is required for the regulation of some enzyme activities in the cytoplasm. It is also a co-factor in photosynthesis and is involved in turgor and pH regulation. However, it is toxic to plants at high concentrations, with critical levels for toxicity reported to be 4–7 mg g\(^{-1}\) for Cl\(^-\) sensitive species and 15–50 mg g\(^{-1}\) for Cl\(^-\) tolerant species (Xu et al, 2000; White and Broadley, 2001). Higher accumulation of Cl\(^-\) led to a significant reduction in growth and water use efficiency in plants. Ions in plants and these ions produce the decisive conditions for plant survival by intercepting different plant mechanisms. Plant roots are generally affected due to Na\(^+\) and Cl\(^-\) along with other cations present in the soils in different concentration (1–150 mM for glycophytes; more for halophytes). However, the uptake of these ions depends on the plant growth stage, genetic characters and environmental factors like temperature, relative humidity and light intensity. Excessive amount of salt in cultivated soils retards the growth, limits economic yield and even lead plants to death.

Some ways for regulation of salt transport is proposed as- (i) selective uptake from the soil solution, (ii) loading of xylem, (iii) removal of salt from the xylem in the upper part of the plant, (iv) loading of the phloem and (v) excretion through salt glands or bladders (Munns et al, 2002a,b). For a salt tolerant plant growing for some time in a soil solution of 100 mM NaCl, the root concentrations of Na\(^+\) and Cl\(^-\) are typically about 50 mM, the xylem concentration about 5 mM, and the concentration in the oldest leaf as high as 500 mM is found (Munns, 2002a). The toxic ions move into the plant with the water flow. The ions move from soil to the vascular system of the root by symplastic and apoplastic pathways. In symplastic pathway, water enters into the roots through plasma membranes of epidermis and further cell-to-cell
movement occurs through plasmodesmata until the xylem becomes saturated. In apoplastic pathway, water enters through intracellular spaces to unload the salt in xylem. Differential osmotic potential is the dynamic force of energy driven pathways, i.e. symplastic, while apoplastic is a non-energy driven pathway. Hence, based on osmotic potential, plant can control the toxic ions like Na$^+$ to enter into the cell through energy driven pathway (Garciadeblas et al., 2003). 

Salinity affects plants in different ways also such as osmotic effects, specific-ion toxicity and/or nutritional disorders (Läuchli and Epstein, 1990). The extent by which one mechanism affects the plant over the others depends upon many factors including the species, genotype, plant age, ionic strength and composition of the salinizing solution, and the organ Munns (2002a, 2005) have developed the concept of the ‘two-phase growth response to salinity’. The first phase of growth reduction happens quickly (within minutes) after exposure to salinity. This response is due to the osmotic changes outside the root causing changes in cell-water relations (osmotic effect). The osmotic effect initially reduces the ability of the plant to absorb water. This effect is similar to water stress and shows little genotypic differences. Several minutes after the initial decrease in leaf growth, there is a gradual recovery of the growth rate until a new steady state is reached, dependent upon the salt concentration outside the root (Munns, 2002a). The second much slower effect, taking days, weeks or months is the result of salt accumulation in leaves, leading to salt toxicity in the plant, primarily in the older leaves (i.e. salt-specific effect). This salt toxicity can result in the death of leaves and reduce the total photosynthetic leaf area. As a result, there is a reduction in the supply of photosynthate to the plant, affecting the overall carbon balance necessary to sustain growth (Munns, 2002a). Salt toxicity primarily occurs in the older leaves where Na$^+$ and Cl$^-$ build up in the transpiring leaves over a long period of time, resulting in high salt concentration and leaf death.
Seeds of plants are imbibed with different concentrations of IAA i.e. $1 \times 10^{-1} \text{M}$ to $1 \times 10^{-10} \text{M}$, the results are:

- The seed germination and seedling growth are completely retarded at treatment of $1 \times 10^{-1} \text{M}$ in all the plants except *H. vulgare* cv. BH-393 and K-508. While the seed germination is only visible in *H. vulgare*, cv. BH-393 and K-508, *Pisum sativum* cv. Aparana, and *Brassica komestris* cv. PT-303 and Pusabol at the treatment of $1 \times 10^{-2} \text{M}$ dose.
- 100% seed germination is found in all the dose of IAA treated seeds of *Hordeum vulgare* cv. K-508.
- Inhibited seed germination in *P. sativum* (AP-3 and Aparana) and *C. arietinum* (C-235) or *T. aestivum* (WH-711) is found at $1 \times 10^{-3} \text{M}$ to $1 \times 10^{-6} \text{M}$ IAA treatment.
- All the doses of IAA show the increase in seedling growth of *Triticum aestivum* PBW-502.
- $1 \times 10^{-1} \text{M}$ to $1 \times 10^{-4} \text{M}$ doses of IAA show an stimulation effect. While the lower concentration $1 \times 10^{-8} \text{M}$ and $1 \times 10^{-10} \text{M}$ show an inhibition in seedling growth of *Hordeum vulgare* cv. BH-393. While, in cv. K-508, all the dose of IAA show the increment except $1 \times 10^{-10} \text{M}$ dose.
- In *Pisum sativum* cv. AP-3, $1 \times 10^{-3} \text{M}$ dose to $1 \times 10^{-7} \text{M}$ of IAA have a decline while $1 \times 10^{-8} \text{M}$ to $1 \times 10^{-10} \text{M}$ dose shows the increment in seedling growth. While in cv. Aparana, all the dose indicate the inhibitory response but the dose $1 \times 10^{-7} \text{M}$ show a little increment in seedling growth.
- All the dose except $1 \times 10^{-8} \text{M}$ inhibits seedling growth of in *Cicer arietinum* cv. C-235. $1 \times 10^{-7} \text{M}$ to $1 \times 10^{-10} \text{M}$ make increment in seedling growth of cv. Surya.
- The dose $1 \times 10^{-4} \text{M}$ stimulate and $1 \times 10^{-7} \text{M}$ dose inhibit the seedling growth in *Brassica komestris* cv. Pusa bold. While, there is a variable effect of IAA treatments in cultivar PT-303.
The higher dose $1\times 10^{-3}$ M of IAA show the inhibitory effect and the lower dose ($1\times 10^{-10}$ M) show the increment in fresh weight and dry weight of epicotyl and hypocotyl of *Phaseolous aureus* cv. K-851.

The above results are related with findings of Akbari *et al* (2007) who have reported that auxin increase length of hypocotyl, seedling fresh weight and dry weight but not influence seed germination and growth in wheat cultivar. Yania (2012) have observed that IAA increase all the growth parameters of onion. Higher concentration of IAA shows high germination % and growth parameters in black gram and horse gram (Chauhan *et al*, 2009). Gehan *et al* (2011) reports, 2000 ppm of IAA concentration gives best results by increasing growth, germination, plant height and phytochemical composition in *Balanites*. Chawdhary *et al* (2012) observe that 20 ppm concentration of IAA gave highest germination percentage in *Dianthus caryophyllus*. Fan li *et al* (2012) have reported similar finding that IAA could promote seed germination of *Jacarand mimosifolia*.

The level of biochemical components (total sugar, reducing sugar, total protein and nitrogen are measured in treated seed with different doses of IAA and findings are:

- The level of biochemical components i.e. total sugar, reducing sugar, total protein and total nitrogen show an increase in imbibed seed of *Triticum aestivum* cv. PBW-502, WH-711, *Hordeum vulgare* cv. BH-393, K-508, *Brassica compestris* cv. Pusa bold, PT-303 and *Phaseolus aureus* cv. K-851 treated with doses $1\times 10^{-5}$ M, $1\times 10^{-6}$ M, $1\times 10^{-7}$ M, $1\times 10^{-8}$ M, $1\times 10^{-9}$ M and $1\times 10^{-10}$ M IAA respectively and there is a decline in all content in seeds as treated with doses $1\times 10^{-9}$ M, $1\times 10^{-9}$ M, $1\times 10^{-8}$ M, $1\times 10^{-10}$ M, $1\times 10^{-7}$ M, $1\times 10^{-8}$ M and $1\times 10^{-9}$ M of IAA respectively.
In imbibed seed of *Cicer aeritinum* cv. C-235 and Surya, treatment of $1 \times 10^{-8}$M dose of IAA cause an increase the level of biochemical components i.e. total sugar, reducing sugar, total protein and total nitrogen. While a decline observed at the dose $1 \times 10^{-3}$ of IAA.

Total sugar, reducing sugar, total protein and total nitrogen in imbibed seeds of *Pisum sativum* cv AP-3 and Aparana exhibits increase at the dose $1 \times 10^{-8}$M and $1 \times 10^{-7}$M respectively. While decrease at the dose $1 \times 10^{-5}$M of IAA.

Gehan *et al* (2011) report that the concentration of 2000 ppm of IAA cause the total protein content and total carbohydrate increase.

The total activities of some enzymes e.g. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase are measured in imbibed seeds of some plants treated with IAA. The observations are:

- Activities of all the enzymes in imbibed seeds of *Triticum aestivum* cv. PBW-502 (e.g. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-9}$M dose of IAA. While increase at the dose $1 \times 10^{-5}$M of IAA.
- All the enzymes e.g. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase show the decrease activity at the treatment of $1 \times 10^{-9}$M of IAA and increase at the $1 \times 10^{-6}$M IAA in *Triticum aestivum* cv. WH-711.
- The activity of $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase increase at the treatment $1 \times 10^{-8}$ M of IAA and decrease at $1 \times 10^{-2}$M of IAA in *Hordeum vulgare* cv. BH-393.
- In *Hordeum vulgare* cv. K-508, the activities of all the enzymes decrease at the treatment of $1 \times 10^{-10}$M and increase at the treatment of $1 \times 10^{-3}$M of IAA.
Activities of all the enzymes in imbibed seeds of *Pisum sativum* cv. AP-3 (e.g. α-amylase, β-amylose, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-5}$M dose of IAA. While increase at the dose $1 \times 10^{-8}$M of IAA.

All the enzymes e.g. α- amylose, β- amylose, protease, acid phosphatase and alkaline phosphatase show the decrease activity at the treatment of $1 \times 10^{-5}$M of IAA and increase at the $1 \times 10^{-7}$M IAA in *Pisum sativum* cv. Aparana.

In *Cicer arietinum* cv. C-235, the activities of all the enzymes decrease at the treatment of $1 \times 10^{-5}$M and increase at the treatment of $1 \times 10^{-8}$M of IAA.

The activities of all the enzymes in imbibed seeds of *Cicer arietinum* cv. Surya (e.g. α- amylose, β- amylose, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-3}$M dose of IAA. While increase at the dose $1 \times 10^{-9}$M of IAA.

Activities of all the enzymes in imbibed seeds of *Brassica compestris* cv. PT-303 (e.g. α-amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-3}$M dose of IAA. While increase at the dose $1 \times 10^{-6}$M of IAA.

All the enzymes e.g. α- amylose, β- amylose, protease, acid phosphatase and alkaline phosphatase show the decreased activity at the treatment of $1 \times 10^{-7}$M of IAA and increase at the $1 \times 10^{-4}$M IAA in *Triticum aestivum* cv. WH-711.

In *Phaseolus aureus* cv. K-851, the activities of all the enzymes decrease at the treatment of $1 \times 10^{-3}$M and increase at the treatment of $1 \times 10^{-10}$M of IAA.

Pre-soaking seeds with optimal concentration of phytohormones enhance their germination, growth and yield of some crop species under condition of environmental stress by increasing nutrient reserves through
increased physiological activities and root proliferation (Asana et al., 1955; Dave and Gaur, 1970; Garg and Srivastava, 1970; Singh and Darra, 1971; Darra et al., 1973; Bozeuk, 1981). This result can be related with the findings of (Northern, 1972) and (Salisbury and Ross, 1997) that hormones generally decrease viscosity of cytoplasm and increase diffusion of water into the cell. Not only decreasing the viscosity of the cytoplasm, the hormones may induce growth by production of substances within the endosperm prior to radicle emergence, which may as well increase the osmotic potential of the cell. This observation can be related with the work of (Dias et al., 1993) who have reported that growth of embryo increases the osmotic potential thereby increasing water uptake into the cell.

Auxin stimulates the transcription of a large number of genes called primary auxin response genes. (Hagen and Guilfoyle 2002). Audi and Muktar (2009) have observed that 5ppm of IAA showed significant increase in germination percentage and seedling growth in cow pea and the results also emphasized that presowing hardening treatment of cow pea seeds in IAA significantly enhance their germination and seedling growth.

When seeds are treated with different concentrations of cytokinin i.e. $1 \times 10^{-1} \text{M}$ to $1 \times 10^{-10} \text{M}$, thereafter, the response of seed germination and seedling growth are mentioned as:

- The higher dose ($1 \times 10^{-1} \text{M}$) of cytokinin cause retardation of the seed germination and seedling growth of *P. sativum* cv. AP-3 and Aparana, *Brassica compestris* cv. Pusabold and PT-303. While in *Cicer arietinum* cv. C-235 and *Phaseolus aureus* cv. K-851, being maximum at the dose $1 \times 10^{-1} \text{M}$ and $1 \times 10^{-2} \text{M}$.
- The doses i.e. $1 \times 10^{-9} \text{M}$ and $1 \times 10^{-10} \text{M}$ and doses ($1 \times 10^{-1}, 1 \times 10^{-2} \text{M}$ and $1 \times 10^{-3} \text{M}$) of cytokinin show the little increment in fresh
weight and dry weight of coleoptile in *Triticum aestivum* cv.PBW-502. While, it is reverse in case of radicle.

- All the doses of cytokinin show the inhibitory effect in seedling growth while the dose $1 \times 10^{-8}$M show an increment in seedling growth of *Triticum aestivum* cv. WH-711.
- All the doses of cytokinin show the increment in seedling growth of *Hordeum vulgare* cv. BH-393. While, inhibition at all the doses of cytokinin in *H. vulgare* cv. K-508.
- Seedling growth of *Pisum sativum* cv. AP-3 show an increment effect in all the doses of cytokinin except $1 \times 10^{-7}$M.
- Seedling growth of *Pisum sativum* cv. Aparana indicate the increment at $10^{-10}$M to $1 \times 10^{-5}$M of cytokinin while the $1 \times 10^{-3}$M and $1 \times 10^{-4}$M show inhibition.
- The doses $1 \times 10^{-3}$M to $1 \times 10^{-8}$M of cytokinin cause inhibition and the higher dose ($10^{-9}$M and $1 \times 10^{-10}$M) show stimulation in seedling growth of *Cicer arietinum* cv. C-235.
- All doses of cytokinin except $1 \times 10^{-5}$M inhibit seedling growth of *Cicer arietinum* cv. Surya.
- $1 \times 10^{-1}$M and $1 \times 10^{-4}$M cytokinin doses stimulate the seedling growth of *Brassica compestris* cv. Pusa bold and PT-303, and $1 \times 10^{-8}$ M to $1 \times 10^{-10}$M doses inhibits.
- All dose of cytokinin inhibit the seedling growth of *P. aureus*. While, dose $1 \times 10^{-10}$M cause stimulation.

The above results can be compared with findings of (Yania , 2012) who reported that cytokinin concentrations ($10^{-12}$M, $10^{-10}$M and $10^{-2}$M) cause increase seed germination and seedling growth in onion. Similar finding is also reported by Chowdhary *et al* (2012), 20 ppm of cytokinin concentration increase seed germination in *Dianthus caryophyllus*. Cytokinin application increase the yield of rice by 45.8%. (Zahir *et al*, 2001).
The level of biochemical components i.e. (total sugar, reducing sugar, total protein and nitrogen are measured in imbibed seed of plants, after treatment of different doses of cytokinin. The key observations are:

- The level of biochemical components e.g. total sugar, reducing sugar, total protein and total nitrogen show an increase in imbibed seed of *Triticum aestivum* cv. PBW-502, WH-711, *Hordeum vulgare* cv. BH-393, *Pisum sativum* cv. AP-3, Aparana, *Cicer arietinum* cv. C-235, Surya, *Brassica compestris* cv. Pusa bold, PT-303 and *Phaseolus aureus* cv. K-851 treated with doses $1 \times 10^{-9}$ M, $1 \times 10^{-8}$ M, $1 \times 10^{-7}$ M, $1 \times 10^{-6}$ M, $1 \times 10^{-5}$ M, $1 \times 10^{-4}$ M, $1 \times 10^{-3}$ M and $1 \times 10^{-2}$ M of cytokinin respectively and there is a decline in content in seeds as treated with doses $1 \times 10^{-6}$ M, $1 \times 10^{-5}$ M, $1 \times 10^{-4}$ M, $1 \times 10^{-3}$ M, $1 \times 10^{-2}$ M, $1 \times 10^{-1}$ M and $1 \times 10^{0}$ M of cytokinin respectively.

The total activities of some enzymes e.g. α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase are measured in imbibed seeds treated with cytokinin. The key observations are:

- Activities of all the enzymes in imbibed seeds of *Triticum aestivum* cv. PBW-502 (e.g. α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-6}$ M dose of Kn. While increase at the dose $1 \times 10^{-9}$ M of Kn.
- All the enzymes e.g. α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase show the decrease activity at the treatment of $1 \times 10^{-2}$ M of Kn and increase at the $1 \times 10^{-8}$ M Kn in *Triticum aestivum* cv. WH-711.
- The activity of α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase increase at the treatment $1 \times 10^{-8}$ M of Kn and decrease at $1 \times 10^{-4}$ M of Kn in *Hordeum vulgare* cv. BH-393.
In *Hordeum vulgare* cv. K-508, the activities of all the enzymes become decrease at the treatment of $1 \times 10^{-3}$M and increase at the treatment of $1 \times 10^{-1}$M of Kn.

Activities of all the enzymes in imbibed seeds of *Pisum sativum* cv. AP-3 i.e. $\alpha$-amylase, $\beta$-amylase, protease, acid phosphatase and alkaline phosphatase decrease at the treatment of $1 \times 10^{-7}$M dose of Kn. While increase at the dose $1 \times 10^{-5}$M of Kn.

All the enzymes i.e. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase show the decrease activity at the treatment of $1 \times 10^{-3}$M of Kn and increase at the $1 \times 10^{-8}$M Kn in *Pisum sativum* cv. Aparana.

In *Cicer arietinum* cv. C-235, the activities of all the enzymes decrease at the treatment of $1 \times 10^{-8}$M and increase at the treatment of $1 \times 10^{-9}$M of Kn.

The activities of all the enzymes in imbibed seeds of *Cicer arietinum* cv. Surya (e.g. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-6}$M dose of Kn. While increase at the dose $1 \times 10^{-5}$M of Kn.

Activities of all the enzymes in imbibed seeds of *Brassica compestris* cv. PT-303 (e.g. $\alpha$-amylase, $\beta$-amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-5}$M dose of Kn. While increase at the dose $1 \times 10^{-4}$M of Kn.

All the enzymes i.e. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase show the decreased activity at the treatment of $1 \times 10^{-8}$M of Kn and increase at the $1 \times 10^{-3}$M Kn in *Brassica compestris* cv. Pusa bold.

In *Phaseolus aureus* cv. K-851, the activities of all the enzymes decrease at the treatment of $1 \times 10^{-9}$M and increase at the treatment of $1 \times 10^{-10}$M of Kn.
Cytokinins are also able to enhance seed germination by the alleviation of stresses such as salinity, drought, heavy metals and oxidative stress (Khan and Ungar, 1997; Atici et al, 2005; Nikolic et al, 2006; Peleg and Blumwald, 2011). They can be inactivated by the enzyme cytokinin oxidase/dehydrogenase (Galuszka et al, 2001) catalyzing the cleavage of their unsaturated bond. Different activities of cytokinins, such as their effects on seed germination, have been attributed to the various functions of cytokinins in different cell types (Werner et al, 2001).

When seeds of plants are treated with different concentrations of GA i.e. $1\times10^{-1}$M to $1\times10^{-10}$M, thereafter, kept in dark for seed germination and seedling growth. Findings are:

- Seed germination of *Triticum aestivum* cv. PBW-502 and WH-711 is not affected by GA.
- $1\times10^{-1}$ M to $1\times10^{-6}$M doses of GA stimulate the seedling growth i.e. being maximum at $1\times10^{-1}$M dose of GA while $1\times10^{-9}$M of GA inhibit the seedling growth of *Triticum aestivum* cv. PBW-502.
- Inhibited seedling growth of *Triticum aestivum* cv. WH-711 is noticed at the treatment $1\times10^{-9}$M of GA.
- The doses ($1\times10^{-5}$M to $1\times10^{-9}$M) of GA cause promotory effect. While $1\times10^{-3}$M shows inhibitory response in *H. vulgare* cv. BH-393.
- A variable response is visible in seedling growth of *H. vulgare* cv. K-508 i.e. maximum inhibition at $1\times10^{-6}$M and promotion at $1\times10^{-8}$M.
Stimulation of seedling growth of *P. sativum* cv. AP-3 is found with treatment of GA, being maximum at $1 \times 10^{-4}$M. But response of cv. Aparana is different, i.e. inhibition at $1 \times 10^{-3}$M and promotion at $1 \times 10^{-9}$M.

Inhibited seedling growth of *C. arietinum* cv. C-235 is observed at dose of GA i.e. $1 \times 10^{-3}$M and $1 \times 10^{-9}$M while dose $1 \times 10^{-7}$M cause stimulation.

Variable response of seedling growth of *Cicer arietinum* cv. Surya is found when treated with different doses of GA i.e. inhibition at $1 \times 10^{-9}$M and promotion at $1 \times 10^{-4}$M.

Higher doses ($1 \times 10^{-2}$M and $1 \times 10^{-3}$M) show the stimulation in seedling growth of *B. compestris* cv. Pusa bold.

The dose $1 \times 10^{-8}$M show the promotory effect on seedling growth of *Brassica compestris* cv. PT-303. And dose $1 \times 10^{-5}$ show the reduction.

The lower dose of GA i.e. $1 \times 10^{-10}$ M cause stimulation and dose $1 \times 10^{-5}$ M express inhibition of seedling growth of *Phaseolus aureus* cv. K-851.

Now the question aries that "How seed germination and seedling growth is enhanced by the GA?" Tsai *et al* (1997) have the metabolism of gibberellins and suggested that gibberellins are important in seed germination affecting enzyme production that mobilizes food production used for growth of new cells. The above results can be related with findings of Bechelard (1968) who reported that 50mg/l GA affected seedling growth, shoot extension growth and stimulation of hypocotyl in *Eucalypt* seedlings. Similar finding is reported by Yania (2012), who observe GA increase germination attributes. The concentration of GA (10 ppm) show highest germination % and length of radical and plumule in horse gram and black gram, (Chauhan, 2009). Khan *et al* (2013) reports that GA₃ have stimulated effect on growth and development of plants.
Gehan et al (2011) have stated that 50 ppm of GA increase germination and growth of Balanites plant. Chawdhary et al (2012) have measured that 20 ppm dose of GA show good germination in Dianthus caryophyllus. Bhore et al (1998) suggests that 100 µM concentration of GA promotes maximum root elongation in Lycopersicon esculentum. Nagwa et al (2013) have also reported that 100 ppm concentration of GA show highest plant growth and yield. Christian M (2013) show that GA with $10^{-5}$M are better for percent germination and seedling vigour index in fresh and partially aged seeds.

The level of biochemical components i.e. (total sugar, reducing sugar, total protein and nitrogen are measured in imbibed seed of plants, after treatment of different doses of GA.

- The level of biochemical components i.e. total sugar, reducing sugar, total protein and total nitrogen show an increase in imbibed seed of Triticum aestivum cv. PBW-502, WH-711, Hordeum vulgare cv. BH-393, Pisum sativum cv. Aparana, Cicer arietinum cv. C-235, Surya, Brassica compestris cv. Pusa bold, PT-303 and Phaseolus aureus cv. K-851 treated with doses 1x$10^{-1}$ M, 1x$10^{-7}$M, 1x$10^{-5}$M, 1x$10^{-8}$M, 1x$10^{-9}$M, 1x$10^{-7}$M, 1x$10^{-4}$M, 1x$10^{-3}$M, 1x$10^{-8}$M and 1x$10^{-10}$M of GA respectively and there is a decline in content in seeds as treated with doses 1x$10^{-9}$M, 1x$10^{-9}$M, 1x$10^{-2}$M, 1x$10^{-6}$M, 1x$10^{-3}$ M,1x$10^{-9}$M, 1x$10^{-7}$M, 1x$10^{-5}$M and 1x$10^{-5}$M of GA respectively.

- Total sugar, reducing sugar, total protein and total nitrogen, in imbibed seeds of Pisum sativum cv AP-3 exhibits an increase at the dose 1x$10^{-4}$M IAA.

Gehan et al (2011) have reported that at the concentration of 50 ppm of GA, the total protein content and total carbohydrate increase in Balanites plants. Audi and Mukhtar (2009) observe that seeds treated with 5ppm GA
show significant increases in percent germination and seedling growth in the two cowpea varities and germination and seedling growth decreased markedly with increasing hormone concentration the result also emphasized that pre sowing hardeing treatment of cow pea seed in GA could significantly enhance the seed germination and seedling growth. Mello et al (2009) have observed that GA$_3$ concentration 1000 mg/l increase seed germination of *Penstemon digitalis* cv. Husker red.

The level of biochemical components i.e. (total sugar, reducing sugar, total protein and nitrogen are measured in imbibed seed of plants, after treatment of different doses of GA. The key observations are:

- The level of biochemical components i.e. total sugar, reducing sugar, total protein and total nitrogen show an increase in imbibed seed of *Triticum aestivum* cv. PBW-502, WH-711, *Hordeum vulgare* cv. BH-393, *Pisum sativum* cv. Aparana, *Cicer arietinum* cv. C-235, Surya, *Brassica compestris* cv. Pusa bold, PT-303 and *Phaseolus aureus* cv. K-851 treated with doses $1 \times 10^{-1}$ M, $1 \times 10^{-7}$ M, $1 \times 10^{-5}$ M, $1 \times 10^{-8}$ M, $1 \times 10^{-9}$ M, $1 \times 10^{-7}$ M, $1 \times 10^{-4}$ M, $1 \times 10^{-3}$ M, $1 \times 10^{-8}$ M and $1 \times 10^{-10}$ M of GA respectively and there is a decline in content in seeds as treated with doses $1 \times 10^{-9}$ M, $1 \times 10^{-9}$ M, $1 \times 10^{-2}$ M, $1 \times 10^{-6}$ M, $1 \times 10^{-3}$ M, $1 \times 10^{-9}$ M, $1 \times 10^{-9}$ M, $1 \times 10^{-7}$ M, $1 \times 10^{-5}$ M and $1 \times 10^{-5}$ M of GA respectively.

- Total sugar, reducing sugar, total protein and total nitrogen, in imbibed seeds of *Pisum sativum* cv AP-3 exhibits an increase at the dose $1 \times 10^{-4}$ M IAA.

The total activities of some enzymes e.g. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase are measured in imbibed seeds of some plants which is treated with GA. The key observations are:
Activities of all the enzymes in imbibed seeds of *Triticum aestivum* cv. PBW-502 (e.g. α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of 1x10^{-9}M dose of GA. While increase at the dose 1x10^{-4}M of GA.

All the enzymes e.g. α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase show the decrease activity at the treatment of 1x10^{-5}M of GA and increase at the 1x10^{-7}M GA in *Triticum aestivum* cv. WH-711.

The activity of α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase increase at the treatment 1x10^{-5} M of GA and decrease at 1x10^{-2}M of GA in *Hordeum vulgare* cv. BH-393.

In *Hordeum vulgare* cv. K-508, the activities of all the enzymes decrease at the treatment of 1x10^{-6}M and increase at the treatment of 1x10^{-8}M of GA.

Activities of all the enzymes (e.g. α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) show increase at the treatment of 1x10^{-4}M dose of GA in imbibed seeds of *Pisum sativum* cv. AP-3.

All the enzymes e.g. α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase show the decrease activity at the treatment of 1x10^{-3}M of GA and increase at the 1x10^{-9}M GA in *Pisum sativum* cv. Aparana.

In *Cicer arietinum* cv. C-235, the activities of all the enzymes decrease at the treatment of 1x10^{-9}M and increase at the treatment of 1x10^{-7}M of GA.

The activities of all the enzymes (e.g. α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) exhibit decrease at the treatment of 1x10^{-9}M dose of GA in imbibed seeds.
of *Cicer arietinum* cv. Surya. While increase at the dose $1 \times 10^{-4}$M of GA.

- Activities of all the enzymes (e.g. \(\alpha\)-amylase, \(\beta\)-amylase, protease, acid phosphatase and alkaline phosphatase) decrease at the treatment of $1 \times 10^{-5}$M dose of GA in imbibed seeds of *Brassica compestris* cv. PT-303. While increase at the dose $1 \times 10^{-8}$M of GA.

- All the enzymes e.g. \(\alpha\)-amylase, \(\beta\)-amylase, protease, acid phosphatase and alkaline phosphatase show the decreased activity at the treatment of $1 \times 10^{-7}$M of GA and increase at the $1 \times 10^{-3}$M GA in *Brassica compestris* cv. Pusa bold.

- In *Phaseolus aureus* cv. K-851, the activities of all the enzymes decrease at the treatment of $1 \times 10^{-5}$M and increase at the treatment of $1 \times 10^{-10}$M of GA.

Gibberellins stimulate the synthesis and production of the hydrolases, especially amylase, resulting in the germination of seeds. Gibberellins are able to induce a range of genes, which are necessary for the production of amylases including amylase, proteases and glucanases (Appleford and Lenton, 1997; Yamaguchi, 2008). Different processes in the seed indicate that seed aleurone is appropriate for the evaluation of transduction pathways at the time of plant hormones production, including gibberellins (Ritchie and Gilroy, 1998; Penfield *et al.*, 2005; Achard *et al.*, 2008; Schwechheimer, 2008).

Effect of inhibitory dose of NaCl and promotory dose of growth hormones (IAA, GA and cytokinin) on seedling growth of plants is observed and data are compared with inhibitory dose response of NaCl. Findings are:

- The promotory response in seedling growth is noticed in all the plants when seed treated with NaCl and the growth hormones (IAA, GA, Cytokinin), being maximum at combined growth hormone treatment (NaCl+IAA +GA+ cytokinin).
-Stimulating seedling growth of *Triticum aestivum* cv. PBW-502 is found when $1 \times 10^{-1}$M NaCl stressed seeds treated with $1 \times 10^{-5}$M of IAA + $1 \times 10^{-1}$M of GA + $1 \times 10^{-9}$M of cytokinin.

-When $1 \times 10^{-1}$M NaCl stressed seeds of *Triticum aestivum* cv. WH-711 treated with $1 \times 10^{-6}$M of IAA+ $1 \times 10^{-7}$M of GA + $1 \times 10^{-9}$M of cytokinin, then it is show the maximum increase in seedling growth.

-Seedling growth of *H. vulgare* cv. BH-393 also stimulated when $1 \times 10^{-4}$M NaCl stressed seeds treated with $1 \times 10^{-2}$M of IAA+1$\times 10^{-5}$M of GA + $1 \times 10^{-8}$M of cytokinin.

-The seedling growth of *H. vulgare*cv. K-508 is enhanced when $1 \times 10^{-1}$M NaCl stressed seeds treated with $1 \times 10^{-3}$M of IAA+1$\times 10^{-8}$M of GA+ $1 \times 10^{-1}$M of cytokinin.

-When $1 \times 10^{-1}$M NaCl stressed seeds of *Pisum sativum* cv. AP-3 treated with $1 \times 10^{-8}$M of IAA+ $1 \times 10^{-4}$M of GA+ $1 \times 10^{-2}$M of cytokinin, then it is show the maximum enhancement of seedling growth.

-When $1 \times 10^{-2}$M NaCl stressed seeds of *Pisum sativum* cv. Aparana treated with $1 \times 10^{-7}$M of IAA+ $1 \times 10^{-9}$M of GA + $1 \times 10^{-8}$M of cytokinin, the seedling growth show a maximum increase.

-The maximum increase in seedling growth of *Cicer arietinum* cv. C-235 is observed when $1 \times 10^{-9}$M NaCl stressed seeds treated with $1 \times 10^{-6}$M of IAA+ $1 \times 10^{-7}$M of GA + $1 \times 10^{-9}$M of cytokinin.

-The maximum increase in seedling growth of *Cicer arietinum* cv. Surya is found when $1 \times 10^{-9}$M NaCl stressed seeds treated with $1 \times 10^{-8}$M of IAA+ $1 \times 10^{-4}$M of GA + $1 \times 10^{-5}$M of cytokinin.

-When $1 \times 10^{-6}$M NaCl stressed seeds of *Brassica compestris* cv. Pusa bold treated with $1 \times 10^{-4}$M of IAA+ $1 \times 10^{-3}$M of GA + $1 \times 10^{-3}$M of cytokinin, then it show the maximum enhancement in seedling growth.
Seedling growth of *Brassica compestris* cv. PT-303 is enhanced when $1 \times 10^{-3}$M NaCl stressed seeds treated with $1 \times 10^{-6}$M of IAA + $1 \times 10^{-8}$M of GA + $1 \times 10^{-4}$M of cytokinin.

The maximum increased in seedling growth of *Phaseolus aureus* cv. K-851 is found when $1 \times 10^{-1}$M NaCl stressed seeds treated with $1 \times 10^{-10}$M of IAA+ GA + cytokinin.

Plant hormones are considered effective molecule in development of seeds. The hormones affect seed germination and dormancy by acting on different parts of the seed. Walz *et al*, 2002 have stated that there is a correlation of auxins and cytokinins in plant, known as a $A/C = \text{constant}$. They further hold that a gene encoding a protein modify by the phytohormones, indoleacetic acid acting by modulating chromosomal transcription. Gibberellins include a large range of chemicals that are produced naturally within plants and are important in seed germination, affecting enzyme production that mobilizes food production used for growth of new cells (Agrawal and Dadlani, 1987). Gopikumar and Moktan (1994) studies the effects of plant hormones on seed germination and growth of true seedlings in the nursery and found that plant hormones are suitable to cover the dormancy due to storing of seeds and initiate germination. Plant hormones like GA$_3$ and KIN act upon a responsive plant system by interaction the molecules and effect the morphological, physiological and biochemical responses.

The exogenous application of Plant growth regulators, auxins (Khan *et al*, 2004), gibberellins (Afzal *et al*, 2005), cytokinins (Gul *et al*, 2000) produces some benefit in alleviating the adverse effects of salt stress and also improves germination, growth, development and seed yields and yield quality (Egamberdieva, 2009). In wheat, seed germination decreased with increasing levels of salinity, while the adverse effect of salinity is alleviated by soaking seed with IAA (Gulnaz *et al*, 1999). In addition, exogenous IAA show high stimulatory
effect on the root and shoot growth of wheat seedling in saline condition (Egamberdieva, 2009). Growth and yield parameters of rice are significantly increased in response to application of cytokinin under saline stress (Zahir et al, 2001). Javid et al (2011) have reported that increasing salinity is associated with decrease in the presence of auxin, cytokinin, gibberellins and SA in the plant tissue. Induced reduction in the plant growth by NaCl can be mitigated by application of plant growth regulators. The role of phytohormones under salinity stress is critical in modulating physiological responses that eventually lead to adaptation of plants to an unfavourable environment.

Other researchers also reported that pre-sowing wheat seeds with plant growth regulators like IAA alleviate the growth inhibiting effect of salt stress (Sastry and Shekhawa, 2001; Afzal et al, 2005). In wheat, seed germination decreased with increasing salinity level, while the adverse effect of salinity was alleviated by treatment of seeds with IAA or NAA (Balki and Padole, 1982; Gulnaz et al, 1999). In addition, Akbari et al (2007) have showed that application of auxin increase hypocotyls length, seedling fresh and dry weigh and hypocotyls dry weight of the three cultivars of wheat plants under salinity. Iqbal (2014), Naseer (2001) have reported that application of growth regulators (IAA, 25 mg/ L) either at the time of salinization proved beneficial in alleviating the adverse effect of salinity on growth and yield parameter, and more pronounced effect is of growth treatment of the growth regulator which is applied at the time of salinization.

Gibberellic acid (GA) accumulates rapidly when plants are exposed to both biotic (McConn et al, 1997) and abiotic stresses (Lehmann et al, 1995). In order to alleviate deleterious effects of salinity, different types of phytohormones have been used. Among them, gibberellins have been the main focus of some plant scientists (Basalah and Mohammad, 1999; Hisamatsu et al, 2000). For instance, gibberellic acid (GA$_3$) has been reported to be helpful in enhancing wheat and rice growth under saline conditions (Parasher and Varma,
1988; Prakash and Prathapasenan, 1990). Maggio et al (2010) reports that GA$_3$ treatment in tomato reduce stomatal resistance and enhance plant water use at low salinity. GA$_3$-priming-induced increase in wheat grain yield is attributed to the GA$_3$-priming-induced modulation of ions uptake and partitioning (within shoots and roots) and hormones homeostasis under saline conditions (Iqbal and Ashraf, 2010). Under saline conditions, seed germination has been improved by application of GA$_3$ Kim et al (2006) have reported that 10 µM concentration of GA$_3$ increase germination under salinity stress and this increase is more pronounced in IAA soaked seeds of rice. Similarly, Kaya et al (2013) have observed that IAA proved to be effective in alleviating the adverse effect of saline stress on growth and yield of maize plants. Kaya et al (2009) reports that, 20 mM concentration of cytokinin and IAA treatments overcome to the adverse effect of NaCl stress. Sadak et al (2013) also suggests that 50mg/L of IAA and 75 mg/ L of Kn treatment have positive effect on growth e.g. plant height , leaves number , fresh weight and dry weight of Faba bean plant stressed by saline soil. Similar investigation are reported by (Iqbal et al, 2010), 150 mg/ L treatment of GA$_3$make a decrease in Na concentration in both shoot and root fresh weight and dry weight. Seed enhancement (seed priming) with cytokinins is reported to increase plant salt tolerance (Iqbal et al, 2006a). Exogenous application of kinetin have resulted in increased growth of chickpea seedlings (Boucaud and Ungar, 1976). It is suggested that the decrease in CK content is an early response to salt stress, but that the effects of NaCl on salt-sensitive varieties is not mediated by CKs since the reduction in growth rate preceded any decline in CK levels (Walker and Dumbroff, 1981. Cytokinin in numerous important processes of plant growth and development has been demonstrated by exogenous applications (Arshad and Frankenberger, 1998). Increase in yield and yield components of rice may be discussed with the work of Mathew and Rayan (1995) and Hanada et al (1994) who have reported positive response of rice to cytokinin application. In a field trial, cytokinin application have increased
the yield of rice by 45.8% compared to control (Zahir et al, 2001). However, endogenous levels of zeatin-type CKs remained unaltered in both roots and leaves during salt-stress in the facultative halophyte Mesembryanthemum crystallinum (Thomas et al, 1992). Exogenous application of kinetin overcome the effects of salinity stress on the growth of wheat seedlings (Naqvi et al, 1982) and treatment of potato plants with kinetin prior to salt stress diminished salt-related growth inhibition (Abdullah and Ahmad, 1990).

Interactive effect of inhibitory dose of NaCl and promotory dose of growth hormone (IAA, GA and cytokinin) on the level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) of plants are observed and data are compared with inhibitory dose of NaCl. And key observations are:

- The level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) is raised in seeds treated with NaCl + the growth hormones (IAA, GA, Cytokinin) and being maximum at combined growth hormone treatment (NaCl+IAA +GA+ cytokinin).
- The less increase in the level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) is observed in seeds of plants at treatment of IAA + NaCl except Pisum sativum cv.Aparana and P. aureus cv. K-851.
- In P. sativum cv. Aparana, the mimimun increment in the level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) is noticed when seed treated with NaCl+GA. While in P. aureus the least increase observed at the treatment of NaCl+Kn.
- Increased level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) of Triticum aestivum cv. PBW-502 is found when 1x10^{-3} M NaCl stressed seeds
treated with $1 \times 10^{-5}$ M of IAA + $1 \times 10^{-1}$ M of GA + $1 \times 10^{-9}$ M of cytokinin.

- When $1 \times 10^{-1}$ M NaCl stressed seeds of *Triticum aestivum* cv. WH-711 treated with $1 \times 10^{-6}$ M of IAA + $1 \times 10^{-7}$ M of GA + $1 \times 10^{-9}$ M of cytokinin, it shows the maximum increase in the level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen).

- The level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) of *H. vulgare* cv. BH-393 is also stimulated when $1 \times 10^{-6}$ M NaCl stressed seeds treated with $1 \times 10^{-2}$ M of IAA + $1 \times 10^{-5}$ M of GA + $1 \times 10^{-8}$ M of cytokinin.

- The level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) of *H. vulgare* cv. K-508 is enhanced when $1 \times 10^{-1}$ M NaCl stressed seeds treated with $1 \times 10^{-3}$ M of IAA + $1 \times 10^{-8}$ M of GA + $1 \times 10^{-1}$ M of cytokinin.

- When $1 \times 10^{-1}$ M NaCl stressed seeds of *Pisum sativum* cv. AP-3 treated with $1 \times 10^{-9}$ M of IAA + $1 \times 10^{-4}$ M of GA + $1 \times 10^{-2}$ M of cytokinin, then it shows the maximum enhancement in the level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen).

- When $1 \times 10^{-2}$ M NaCl stressed seeds of *Pisum sativum* cv. Aparana treated with $1 \times 10^{-7}$ M of IAA + $1 \times 10^{-9}$ M of GA + $1 \times 10^{-8}$ M of cytokinin, the level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) show a maximum increase.

- The maximum increase in level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) of *Cicer arietinum* cv. C-235 is observed when $1 \times 10^{-9}$ M NaCl
stressed seeds treated with $1 \times 10^{-8}$M of IAA+ $1 \times 10^{-7}$M of GA + $1 \times 10^{-9}$M of cytokinin.

❖ The maximum increase in level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen) of *Cicer arietinum* cv. Surya is found when $1 \times 10^{-9}$M NaCl stressed seeds treated with $1 \times 10^{-8}$M of IAA+ $1 \times 10^{-4}$M of GA + $1 \times 10^{-5}$M of cytokinin.

❖ When $1 \times 10^{-6}$M NaCl stressed seeds of *Brassica compestris* cv. Pusa bold treated with $1 \times 10^{-4}$M of IAA+ $1 \times 10^{-3}$M of GA + $1 \times 10^{-3}$M of cytokinin, then it show the maximum enhancement in level of biochemical components (total sugar, reducing sugar, total protein content and total nitrogen).

❖ The level of biochemical component (total sugar, reducing sugar, total protein content and total nitrogen) of *Brassica compestris* cv. PT-303 is enhanced when $1 \times 10^{-3}$M NaCl stressed seeds treated with $1 \times 10^{-6}$M of IAA+ $1 \times 10^{-8}$M of GA + $1 \times 10^{-4}$M of cytokinin.

❖ The maximum increased level of biochemical component (total sugar, reducing sugar, total protein content and total nitrogen) of *Phaseolus aureus* cv. K-851 is found when $1 \times 10^{-1}$M NaCl stressed seeds treated with $1 \times 10^{-10}$M of IAA+ GA + cytokinin.

Similarly, Kim *et al* (2006) have reported that the total sugar and reducing sugar are increased when NaCl stressed seeds of different plants is treated with IAA and GA in rice. Similar study is reported by Sadak *et al* (2013), when salt stressed faba bean seed treated with IAA and Kn treatment gives positive effect and total carbohydrate, free amino acid, proline and phenolic compounds are increased.
Interactive effect of inhibitory dose of NaCl + promotory dose of growth hormone (IAA, GA and cytokinin) on total activities of some enzymes (α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) in imbibed seeds of plants are studied and data are compared with inhibitory dose response of NaCl and key observations are:

- Enhanced activities of some enzymes (α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) is noticed in all the plants when seed treated with NaCl and the growth hormones (IAA, GA, Cytokinin) and being maximum at combined growth hormone treatment (NaCl + IAA + GA + cytokinin).

- Increased activities of enzymes (α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) in seeds of Triticum aestivum cv. PBW-502 is found when 1x10^-1M NaCl stressed seeds treated with 1x10^-5M of IAA + 1x10^-1M of GA + 1x10^-9M of cytokinin.

- When 1x10^-1M NaCl stressed seeds of Triticum aestivum cv. WH-711 treated with 1x10^-6M of IAA + 1x10^-7M of GA + 1x10^-9M of cytokinin, then it is show the maximum enhancement in activities of some enzymes i.e. α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase.

- Activities of some enzymes (α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) in seeds of H. vulgare cv. BH-393 also stimulated when 1x10^-4M NaCl stressed seeds treated with 1x10^-5M of IAA + 1x10^-5M of GA + 1x10^-8M of cytokinin.

- Activities of enzymes (α-amylase, β-amylase, protease, acid phosphatase and alkaline phosphatase) in seeds of H. vulgare cv. K-508 is enhanced when 1x10^-1M NaCl stressed seeds treated with 1x10^-5M of IAA + 1x10^-8M of GA + 1x10^-1M of cytokinin.
When 1x10^{-1} M NaCl stressed seeds of *Pisum sativum* cv. AP-3 treated with 1x10^{-8} M of IAA+ 1x10^{-4} M of GA+1x10^{-2} M of cytokinin, then it is show the maximum enhancement in activities of some enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase).

When 1x10^{-2} M NaCl stressed seeds of *Pisum sativum* cv. Aparana treated with 1x10^{-7} M of IAA+ 1x10^{-9} M of GA +1x10^{-8} M of cytokinin, the activities of enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) show maximum increase.

The maximum increase in activities of some enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) of *Cicer arietinum* cv. C-235 is observed when 1x10^{-9} M NaCl stressed seeds treated with 1x10^{-8} M of IAA+ 1x10^{-7} M of GA + 1x10^{-9} M of cytokinin.

The maximum increase in activities of some enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) in seeds of *Cicer arietinum* cv. Surya is found when 1x10^{-9} M NaCl stressed seeds treated with 1x10^{-8} M of IAA + 1x10^{-4} M of GA + 1x10^{-9} M of cytokinin.

When 1x10^{-6} M NaCl stressed seeds of *Brassica compestris* cv. Pusa bold treated with 1x10^{-4} M of IAA+ 1x10^{-3} M of GA + 1x10^{-3} M of cytokinin, then it show the maximum enhancement in activities of some enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase).

The activities of enzymes i.e. α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) is enhanced when 1x10^{-3} M NaCl stressed seeds of of *Brassica compestris* cv. PT-303
treated with $1 \times 10^{-6}$ M of IAA + $1 \times 10^{-8}$ M of GA + $1 \times 10^{-4}$ M of cytokinin.

- The maximum increased activities of enzymes i.e. $\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase) is found when $1 \times 10^{-1}$ M NaCl stressed seeds of *Phaseolus aureus* cv. K-851 treated with $1 \times 10^{-10}$ M of IAA + GA + cytokinin.

- The activities of enzymes i.e.$\alpha$- amylase, $\beta$- amylase, protease and acid phosphatase ) show little increase in se seeds of *Triticum aestivum* cv. PBW-502, at the treatment of $1 \times 10^{-1}$ M NaCl + $1 \times 10^{-5}$ M IAA and minimum activity of alkaline phosphatase is also seen at the treatment of NaCl + Kn.

- Activities of enzymes i.e. $\alpha$- amylase, $\beta$- amylase) show little increase In seeds of *Triticum aestivum* cv. WH-711 treated with $1 \times 10^{-1}$ M NaCl+ $1 \times 10^{-7}$ M GA. The activities of protease, acid phosphatase and alkaline phosphatase is also increased at the treatment of $1 \times 10^{-1}$ M NaCl +$1 \times 10^{-6}$ M IAA.

- The activities of enzymes i.e. $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase) sxhibit a increase at the treatment of $1 \times 10^{-4}$ M NaCl+ $1 \times 10^{-2}$ M IAA. The activity of $\alpha$- amylase is also increased at the treatment $1 \times 10^{-4}$ M NaCl+ $1 \times 10^{-8}$ M Kn in *H. vulgare* cv. BH-393.

- The increased activities of enzymes ($\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase) is observed at the treatment of $1 \times 10^{-1}$ M NaCl+ $1 \times 10^{-3}$ M IAA in *H. vulgare* cv. K-508.

- Similarly, in *P. sativum* cv. AP-3, at the treatment of $1 \times 10^{-1}$ M NaCl +$1 \times 10^{-8}$ M IAA, the activities of enzymes ($\alpha$- amylase, $\beta$- amylase, protease, acid phosphatase and alkaline phosphatase) is also enhanced.
The activities of α- amylase, β- amylase and alkaline phosphatase is increased at the treatment of $1 \times 10^{-2}$M NaCl+$1 \times 10^{-7}$M IAA. The activities of acid phosphatase and protease is also increased at the treatment of $1 \times 10^{-2}$M NaCl+$1 \times 10^{-9}$M GA in *P. sativum* cv. Aparana.

The activities of α- amylase, protease, acid phosphatase and alkaline phosphatase is higher at the treatment of $1 \times 10^{-9}$M NaCl+$1 \times 10^{-8}$M IAA. The activity of β- amylase is raised at the treatment of $1 \times 10^{-9}$M NaCl+$1 \times 10^{-7}$M GA in *C. arietinum* cv. C-235.

In *Cicer arietinum* cv. Surya, activities of enzymes (β- amylase, protease, acid phosphatase and alkaline phosphatase) show increase at the treatment of $1 \times 10^{-9}$M NaCl+$1 \times 10^{-8}$M IAA. The activity of α- amylase is also increased at the treatment of $1 \times 10^{-9}$M NaCl+$1 \times 10^{-5}$M Kn.

The activities of α- amylase, protease and acid phosphatase is higher at the treatment of $1 \times 10^{-5}$M NaCl+$1 \times 10^{-6}$M IAA. The activity of β- amylase and alkaline phosphatase is also raised by the treatment of $1 \times 10^{-3}$M NaCl+$1 \times 10^{-4}$M Kn in *Brassica compestris* cv. PT-303.

In *Brassica compestris* cv. Pusa bold, activities of enzymes (α- amylase, β- amylase, protease and acid phosphatase) show stimulation at the treatment of $1 \times 10^{-6}$M NaCl+$1 \times 10^{-4}$M IAA. The activity of alkaline phosphatase is higher at the treatment of $1 \times 10^{-6}$M NaCl+$1 \times 10^{-3}$M GA.

In *P. aureus* cv. K-851, activities of enzymes (β- amylase, protease, acid phosphatase and alkaline phosphatase) is raised at the treatment of $1 \times 10^{-1}$M NaCl+$1 \times 10^{-10}$M IAA. The activity of α- amylase show a little increase at the treatment of $1 \times 10^{-3}$M NaCl+$1 \times 10^{-10}$M Kn.
Kim et al (2006) have also reported that the activity of α-amylase increased when NaCl stressed seeds of different plants is treated with IAA and GA in rice. The effects of plant hormones on seed germination, researchers have found that both under stress and non-stress conditions, N compounds, including nitrous oxide can enhance seed germination through enhancing amylase activities (Zhang et al, 2005; Hu et al, 2007; Zheng et al, 2009). Through decreasing the production of O₂ and H₂O₂ such products can also alleviate the stress by controlling the likely oxidative damage, similar to the effects of antioxidant enzymes including superoxide dismutase (SOD), catalase (CAT) and peroxidase (POD) on plant growth under various stresses (Song et al, 2006; Tian and Lei, 2006; Tseng et al, 2007; Li et al, 2008; Tuna et al, 2008; Zheng et al, 2009; Sajedi et al, 2011).

So the question arises that, Why the seed germination and seedling growth is enhanced by the growth hormones when seeds are stressed with NaCl? One reason may be that the ability of plants to tolerate salts is determined by multiple biochemical pathways that facilitate retention and/or acquisition of water, protect chloroplast functions and maintain ion homeostasis. Essential pathways include those that lead to synthesis of osmotically active metabolites, specific proteins and certain free radical enzymes to control ion and water flux and support scavenging of oxygen radicals. (Parvaiz and satyawati, 2008). There is strong evidence that glycinebetaine (quaternary ammonium compound) and proline (amino acid) play an adaptive role in mediating osmotic adjustment and protecting the subcellular structures in stressed plants. In a number of studies, a positive correlation between the accumulation of these two osmolytes and stress tolerance has been recorded (Yamada et al, 2003 and Yang et al, 2003). Due to increased environmental stress, the balance between the production of reactive oxygen species (ROS) and the quenching activity of the antioxidants is upset, often resulting in oxidative damage (Spychalla and Desborough, 1990). ROS can
be important mediators of damage to cell structures, nucleic acids, lipids and proteins (Valko et al, 2006). The hydroxyl radical is known to react with all components of the DNA molecule, damaging both the purine and pyrimidine bases and also the deoxyribose backbone (Halliwell and Gutteridge, 1999). Mittova et al (2002) have demonstrated that higher salt tolerance of wild tomato (Lycopersicon pennellii) as compared to cultivated tomato (Lycopersicon esculentum) can be correlated with increased activities of SOD (superoxide dismutase), APX (ascorbate peroxidase), and POD (guaiacol peroxidase). The overproduction of osmoprotectants, increasing expression of antioxidant enzymes helps the plant to withstand the environmental stress. Plants adopt various strategies to overcome the adverse effects of salinity stress. In recent years, phytohormones and osmolytes have been involved in reducing the adverse effect of salinity stress. Under salinity stress, osmolyte such as proline maintains cellular homeostasis through osmotic regulation and induces physiological processes favorably. The role of phytohormones under salinity stress is critical in modulating physiological responses that eventually lead to adaptation of plants to an unfavorable environment.(Iqbal et al, 2013) The primary effects of salt stress are caused by the presence of ions in rhizosphere limiting extraction of water by roots and reduced plant growth, while the secondary effects are caused by ionic disequilibrium resulting in inactivation of enzymes, nutrient starvation, ionic toxicity in tissues and oxidative stress. Salinity stress induces over production of reactive oxygen species (ROS) (Nazar et al, 2011; Khan et al, 2012) that triggers lipid peroxidation, DNA damage, inhibition of photosynthesis and disturbance in mineral nutrient status (Nazar et al, 2011; Turan and Tripathy, 2012). For alleviation of adverse effects of salinity stress, several strategies have been adopted and efforts are made to explore mechanisms for salinity tolerance. The accumulation of compatible compounds (osmolytes) is related to improvement of plant tolerance to salt because of its ability to overcome osmotic and water stress and maintain
nutrients homeostasis and ion compartmentalization (Nazar et al., 2011; Khan et al., 2012). Among the osmolytes, proline plays an important role in salinity tolerance. Phytohormones have also been shown to influence salinity tolerance through modulating several physiological processes and biochemical mechanisms (Fatma et al., 2013). Their role in salinity stress is critical in modulating physiological responses that lead to adaptation of plants to an unfavorable environment. The role of phytohormones such as ethylene (Iqbal et al., 2013; Khan et al., 2012), gibberellins; GAs (Iqbal et al., 2011a), abscisic acid; ABA (Gurmani et al., 2013), cytokinins; CK (Wu et al., 2013), salicylic acid; SA (Nazar et al., 2011; Khan and Khan, 2013; Khan et al., 2013), nitric oxide; NO (Uchida et al., 2002), jasmonates; JAs (Khan and Khan, 2013) and brassinosteroids (Sharma et al., 2013) in stress tolerance has been reported. Darra et al. (1977) suggests that plant hormones increase the rate of absorption of water and available nutrients thereby resulting in better growth. The hormones might also have substantially enhanced cell enlargement and rapid increase in cell division as suggested by (Magome, 2004).

IAA plays a major role on regulating plant growth. For example, it controls vascular tissue development, cell elongation, and apical dominance (Wang et al., 2001). IAA also responds to salinity in crop plants. However, little information seems to be available on the relationship between salinity stress and auxin levels in plants and the role of auxin in alleviating salt stress. The variations in IAA content under stress conditions appeared to be similar to those of abscisic acid (Ribaut and Pilet, 1991). The increased level of IAA has reportedly been correlated with reduced growth (Ribaut and Pilet, 1994). Therefore, the reduction in plant growth under stress conditions could be an outcome of altered hormonal balance. Hence, their exogenous application provides an attractive approach to counter the stress conditions. However, Prakash and Prathapasanam (1990) have reported that NaCl caused a significant reduction in IAA concentrations in rice leaves. GA$_3$ application during the
salinisation period partly overcomes the effect of salinity on reducing IAA levels and this shows that salinity may influence hormone balances by affecting plant growth and development. There is also a significant reduction in IAA levels in rice five days after NaCl treatment (Nilsen and Orcutt, 1996). Salinity causes 75% reduction in IAA levels of tomato (Dunlap and Binzel, 1996). Sakhabutdinova et al (2003) have reported that salinity causes a progressive decline in the level of IAA in the root system of plants. Other researchers also report that presowing wheat seeds with plant growth regulators like IAA alleviated the growth inhibiting effect of salt stress (Sastry and Shekhawa, 2001; Afzal et al, 2005). In wheat seed germination decreased with increasing salinity level, while the adverse effect of salinity is alleviated by treatment of seeds with IAA or NAA (Balki and Padole, 1982; Gulnaz et al, 1999). In addition, Akbari et al (2007) show that application of auxin increased hypocotyls length, seedling fresh and dry weight and hypocotyls dry weight of the three cultivars of wheat plants under salinity. Auxin stimulates the transcription of a large number of genes called primary auxin response genes. A large number of auxin-responsive genes have been identified and characterized from different plant species, including soybean, Arabidopsis and rice (Hagen and Guilfoyle, 2002). These auxin-responsive genes have been classified into three gene families: auxin/indoleacetic acid (Aux/IAA), GH3 and small auxin-up RNA (SAUR) gene families (Guilfoyle 1993). Liu et al (2011) report that auxin inhibits the outgrowth of tiller buds in rice (Oryza sativa L.) by down regulating OsIPT expression and cytokinin biosynthesis in nodes. However, the identification of novel genes are involved in salt stress responses provides the basis for researchers to set further genetic engineering strategies to improve more stress tolerance cultivars (Zhu, 2002). Auxins are known to regulate salinity stress effect in plants. A molecular link between auxin signaling and salt stress has been established by Jung and Park (2011). They suggest that a membrane bound transcription factor (NTM2) incorporates auxin signaling seed
germination which modulates seed germination under salinity stress. Similarly, Park et al. (2011) have observed that over expression of IAA30 gene of NTM2 mediates salt signaling pathway. Tirkayi (2007) reports that signaling arx1 gene provides protection to Arabidopsis thaliana under salt stress. Fang and Yang (2002) report that auxin responsive gene (AtMEKK1, AtRSH3, Cat1, Fer1) expressions are down regulated and NIT1, NIT2 are induced in Arabidopsis thaliana to alter the level of IAA and to interact with salt stress responses.

Cytokinins (CKs) regulate several plant growth aspects and developmental processes, including cell division, apical dominance, chloroplast biogenesis, nutrient mobilization, leaf senescence, vascular differentiation, photomorphogenic development, shoot differentiation and anthocyanin production (Mok and Mok, 2001; Davies, 2004). Cytokinins 728 can also enhance resistance to salinity and high temperature in plants (Barciszewski et al., 2000). Seed enhancement (seed priming) with cytokinins is reported to increase plant salt tolerance (Iqbal et al., 2006a). CKs are often considered as ABA antagonists and auxins antagonists/synergists in various processes in plants (Pospisilova, 2003). It is hypothesized that cytokinins can increase salt tolerance in wheat plants by interacting with other plant hormones, especially auxins and ABA (Iqbal et al., 2006b). CKs retard senescence, having effect on membrane permeability to mono and divalent ions, and localized induction of metabolic sinks (Letham, 1978). They are generally considered to be antagonists of ABA, with the two hormones having opposing effects in several developmental processes including stomatal opening (Blackman and Davies, 1984), cotyledon expansion and seed germination (Thomas, 1992). A general view has emerged that during stress, a reduction of CK supply from the root alters the gene expression in the shoot and thereby elicits appropriate responses to ameliorate the effects of stress (Hare et al., 1997). Kinetin is capable to break stress-induced dormancy during germination of tomato, barley and cotton seeds (Bozcuk, 1981). Moreover, the observed reduction in endogenous cytokinins
under stress conditions points towards the possibility that cytokinin levels could be a limiting factor under stress conditions. It can thus explain the fact that an exogenous application of kinetin resulted in increased growth of chickpea seedlings (Boucaud and Ungar, 1976). It is suggested that the decrease in CK content was an early response to salt stress, but that the effects of NaCl on salt-sensitive varieties is not mediated by CKs since the reduction in growth rate preceded any decline in CK levels (Walker and Dumbroff, 1981). It is generally accepted that cytokinins are produced in the root tips and developing seeds of plants (Zahir et al, 2001). They are translocated to the shoot, by xylem, from roots where they regulate development and senescence processes. However, the involvement of cytokinins in numerous important processes of plant growth and development has been demonstrated by exogenous applications (Arshad and Frankenberger, 1998). Increase in yield and yield components of rice may be discussed with the work of Mathew and Rayan (1995) and Hanada et al (1994) who have reported positive response of rice to cytokinin application. In a field trial, cytokinin application have increased the yield of rice by 45.8% compared to control (Zahir et al, 2001). However, endogenous levels of zeatin-type CKs remained unaltered in both roots and leaves during salt-stress in the facultative halophyte Mesembryanthemum crystallinum (Thomas et al, 1992). Exogenous application of kinetin overcame the effects of salinity stress on the growth of wheat seedlings (Naqvi et al, 1982) and treatment of potato plants with kinetin prior to salt stress diminished salt-related growth inhibition (Abdullah and Ahmad, 1990). However, earlier studies reports that application of kinetin to bean plants during salinity stress exacerbated its effects (Kirkham et al., 1974). Addition of benzyl adenin (BA) inhibits growth during stress of a salt-sensitive variety of barley, but overcame the decline in growth rate, shoot/root ratio and internal CK content in a salt-tolerant variety (Kuiper et al, 1990). Kinetin acts as a direct free radical scavenger or it may involve in antioxidative mechanism related to the protection of purine breakdown.
(Chakrabarti and Mukherji, 2003). A possible involvement of genes in stress responses is often inferred from changes in the transcript abundance in response to a given stress trigger. An overview of the many changes in the transcript abundance of cytokinin genes in Arabidopsis in response to environmental factors is given elsewhere (Argueso et al., 2009). Functional analysis of cytokinin receptor mutants in stress-response assays have showed that all three cytokinin receptors of Arabidopsis act as negative regulators in ABA signaling and in the osmotic stress responses. For CRE1/AHK4 cytokinin dependence of this activity is demonstrated (Tran et al., 2007). Cytokinin receptor genes of other species are regulated by changes in the osmotic conditions as well, indicating that their function in the osmotic stress response might be common although mechanistically is not well understood (Merchan et al., 2007).

Gibberellins (GA) are generally involved in growth and development. Gibberellins (GA₃) regulate major aspects of plant growth and development. It is known to alleviate salt stress effects (Hisamatsu et al., 2000; Iqbal et al., 2011a) They control seed germination, leaf expansion, stem elongation and flowering (Magome et al., 2004). The favorable effects of GA₃ has been shown to be through increasing the water status of the seedlings and partially by sustaining protein and RNA levels (Banyal and Rai, 1983). GA-promoted destabilization of DELLA proteins is modulated by environmental signals and other plant hormone signalling (Achard et al., 2006). Recently, elongated uppermost internode (EUI) is identified in rice, which encodes a cytochrome P450 mono oxygenase and epoxidizes GA₄ and GA₅ in deactivation reaction (Zhu et al., 2006). GA metabolism and signaling (Sun and Gubler, 2004), tightly control the GA homeostasis. However, this homeostatic mechanism is still unclear. In addition, it has been long known that there is cross-talking between GA action and other hormones signaling or environmental stresses to control the plant growth and development, although the real mechanism remains unclear. Recently, the GA-
promoted destabilization of DELLA proteins is modulated by environmental signals (such as salt and light) and other plant hormone signaling (such as auxin and ethylene), which reveals the mechanisms of this cross-talking at the molecular level (Achard et al, 2006). The biosynthesis of GA is regulated by both developmental and environmental stimuli (Yamaguchi and Kamiya, 2000; Olszewski et al, 2002). Gibberellic acid (GA) accumulates rapidly when plants are exposed to both biotic (McConn et al, 1997) and abiotic stresses (Lehmann et al, 1995). In order to alleviate deleterious effects of salinity, different types of phytohormones have been used. Among them, gibberellins have been the main focus of some plant scientists (Basalah and Mohammad, 1999; Hisamatsu et al, 2000). For instance, gibberellic acid (GA$_3$) has been reported to be helpful in enhancing wheat and rice growth under saline conditions (Parasher and Varma, 1988; Prakash and Prathapasenan, 1990). Maggio et al (2010) have reported that GA$_3$ treatment in tomato reduced stomatal resistance and enhanced plant water use at low salinity. GA$_3$-priming induced increase in wheat grain yield is attributed to the GA$_3$-priming-induced modulation of ions uptake and partitioning (within shoots and roots) and hormones homeostasis under saline conditions (Iqbal and Ashraf, 2010). Under saline conditions, seed germination has been improved by application of GA$_3$ and in this experiment, growth and grain yield of wheat are decreased with increasing salinity levels, but it is increased relatively by seed treatment with GA$_3$ (Kumar and Singh, 1996). In another study, wheat seeds, after treatment with various growth regulators including GA$_3$, have showed highest percent germination when treated with 20 mg/l GA$3$ (Nayyar et al, 1995). Free radicals are induced lipid peroxidation inhibition by GA (Choudhuri, 1988). These results show that GA$_3$ application can improve salinity tolerance in crop plants grown under saline condition. In addition, GA interacts with other hormones to regulate various metabolic processes in the plants. However, many conflicting theories have been put forward concerning their interactions (Yang et al, 1996; Van Huizen et al, 1997).
It has recently been discovered in different species that the auxin (IAA) promotes GA biosynthesis (Wolbang et al, 2004). On the other hand, GA application enhances the catabolism of ABA (Gonai et al, 2004). However, the mechanisms by which GA₃-priming could induce salt tolerance in plants are not yet clear. Salinity perturbs the hormonal balance in plants. Therefore, hormonal homeostasis under salt stress might be the possible mechanism of GA₃-induced plant salt tolerance (Iqbal and Ashraf, 2010). But, How all plant growth hormones i.e. IAA, GA and Kn enhance the salt stressed growth remain a question. Further, to find out the effect of interaction on enzyme activity are studied.

*In vitro* activities of some enzymes e.g. α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase are measured when enzyme extract of water imbibed seeds of *Phaseolus aureus* cv. K-851 treated with NaCl, IAA, GA and Kn. The key observations are:

- The inhibited enzyme activities are observed at the treatment of $1 \times 10^{-1}$M of NaCl.
- The activities of α- amylase, β- amylase, acid phosphatase and alkaline phosphatase are enhanced at the dose $1 \times 10^{-10}$M of GA.
- The activity of protease is also increased at the treatment of $1 \times 10^{-10}$ M IAA.

Interactive effect of inhibitory dose of NaCl and promotory dose of growth hormone (IAA, GA and cytokinin) on *in vitro* activities of some enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) in enzyme extract of water imbibed seeds of *P. aureus* cv. K-851 are observed and data are compared with inhibitory dose response of NaCl and key observations are:

- The maximum increased activities of enzymes (α- amylase, β- amylase, protease, acid phosphatase and alkaline phosphatase) is
noted when enzyme extracts treated with $1 \times 10^{-1} \text{M} \text{NaCl}$ and $1 \times 10^{-10} \text{M} \text{IAA} + \text{GA} + \text{cytokinin}$.

- A little increase in activities of $\alpha$- amylase, $\beta$- amylase, protease and alkaline phosphatase is observed when enzyme extract treated with $1 \times 10^{-10} \text{M} \text{IAA} + 1 \times 10^{-1} \text{M} \text{NaCl}$. The activity of acid phosphatase also shows minimum increase at the treatment of $1 \times 10^{-5} \text{MNaCl} + 1 \times 10^{-10} \text{M} \text{GA}$ to extract.

It is very interesting to note that activities of enzymes in vitro, is enhanced by growth hormones when they are in salt stress but how it occurs, remain a question.

When seeds of *Phaseolus aureus* cv. K-851 are grown in the MS medium. Callusing begin on 3th day, shoot initiation at 14 days and after 18 -20 days multiple shoots are formed and plantlets are well developed and these plant leaves are used for the in vitro development of plant. Growth of callus in different treatments i.e. IAA, GA, Kn + NaCl is compared with treatment of NaCl alone.

- The leaf of *P. aureus* cv.K-851 are placed into the Murashige and Skoog medium treated with the $1 \times 10^{-1} \text{M} \text{NaCl}$, inhibited callus formation, shoot growth and root growth are observed at treatment of NaCl. Callus formation initiation after 9 days of inoculation and callus is not well developed after 17th days.

Demirkiran et al (2013) reported that mature embryo culture in MS medium containing 0. 50, 100 mM NaCl. All the concentration of NaCl inhibit the shoot growth, decreased fresh weight and protein in plant tissue.

- The leaf of *Phaseolus aureus* cv. K-851 is inoculated in the Murashige and Skoog medium treated with $1 \times 10^{-10} \text{M} \text{IAA}$ and $1 \times 10^{-1} \text{M} \text{NaCl}$. It is observed that IAA reduces the inhibitory effect of NaCl in the growth medium. After 4 days of inoculation, the callus initiation occurs and
after 4 days it show the chlorophyll development i.e. well developed green callus is formed. The root initiation is started after 3 days. Multiplication shoot formation is occurred after 5 days.

- The leaf of *Phaseolus aureus* cv. K-851 is inoculated in the Murashige and Skoog medium treated with $1 \times 10^{-10}$ M Kn and $1 \times 10^{-1}$ M NaCl. The effect of cytokinin also decreases the inhibitory response of NaCl. Meristem proliferation and multiple shoot initiation are best in this medium after 4 days of inoculation, callus initiation occurs and after a week, it showed shoot formation. The root initiation occurs after 2 days of regeneration.

- The leaf of *Phaseolus aureus* cv. K-851 is inoculated in the Murashige and Skoog medium treated with $1 \times 10^{-10}$ M GA and $1 \times 10^{-1}$ M NaCl. The colorless callus formation occurred after 3 day of inoculation and after 2 days chlorophyll development occurred in callus. After 3 days multiplication of shoot formation occurred. The root initiation occurred after 5 days of shoot initiation. It show that GA affect the negative response of NaCl.

- The leaf of *Phaseolus aureus* cv. K-851 is inoculated in the Murashige and Skoog medium treated with $1 \times 10^{-10}$ M GA, $1 \times 10^{-10}$ M IAA and $1 \times 10^{-10}$ M Kn and $1 \times 10^{-1}$ M NaCl. It is found that the selected concentration of growth hormone reduces the effect of NaCl. The early callus initiation is observed after 2 days of inoculation and chlorophyll development occurred after 2 day of it. The multiplications of shoot formation are also triggered after 2 days and the early root and shoot initiation and the elongation of shoots occurs after 4 days. As compared to above responses growth is very fast and earliest and adverse effect of NaCl is maximally lowered.

Patil *et al* (2012) reported that when seeds were cultured in vitro on MS medium, addition of all types of concentration of cytokinin and auxin stimulated
the rate and percentage of seed germination. Priyanka et al (2013) also reported that the best callus formation is observed on 1mg/L, 2,4D. It is very interesting to note that interaction of plant hormone i.e. IAA, Ga and Kn stimulate the salt stressed plant growth in vitro.

The above studies indicate that salinity (NaCl) affect the metabolic machinery that express in retarded seed germination and seedling growth. On other hand, growth hormones i.e. IAA, GA and cytokinin individually and in mixed form, stimulate the biochemical reaction expressed in enhancement of growth. The combined effect of growth hormones show the maximum impact on plant growth in vivo and in vitro to minimise the stress of salt. These experiments may help to devlop a new avenue for further research to make the salt tolerant plants and that help to eradicate the salinity stress.