Allelopathy of Brassica. A review

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ABSTRACT

Plant growth regulators also impart important role towards the higher yield of crops. Among different strategies, exogenous application of plant growth regulators (PGR's) are involved in promoting plant growth and development under normal and stressful conditions. However, use of organic fertilizers and green manures, cover crops, smother crops and surface mulch is beneficial for soil health, but their use is uncommon. Allelopathic crops are also a source of organic agriculture and their utilization can enhance crop growth and yield. Allelopathy is a naturally occurring phenomenon based on fact that organic chemicals (allelochemicals) release from the plants and enter into the environment. Allelopathy influences the vegetation pattern and diversity, seed decay is prohibited, enhance plant succession, hence, allelochemicals affect the plants to greater extent. Several chemicals are present in different kinds of soils and the plant materials effect the germination and growth of the other plants which are growing in the vicinity of that plants. Virtually, allelochemicals are components of all plant parts and target plants can be sprayed through foliar application.

Introduction

Allelopathy is defined as an interaction among plants through chemical pathways. The interaction includes both inhibition and promotion. In agricultural practice, the injurious effects are uncertain for pest and weed control (Kohli et al., 1998). The history and the science of allelopathy as an area of research are being reviewed comprehensively by Rick Willis (Willis, 2000). Blum et al. (1999) proposed three criteria to provide proof for allelopathy: (1) There must be production and release of chemicals by the donor or aggressor plants (2) Organic complexes distribution and accumulation in soil must be in adequate quantity to prevent nutrient and water uptake through roots and (3) Plant inhibition patterns found in the field cannot be attributed solely to physical factors or other biotic factors. The physiologists, soil scientists, weed scientists and chemists are continuing to study this challenging area and publications in the field of allelopathy are increasing exponentially (Macias,
The compound does not give the impression of outstanding performance, on the other hand, combination and interaction of many allelochemicals probably give good results when work in synergistic or an additive manner to decrease propagation and growing of weeds (Einhellig, 1996).

**Allelopathy of Brassica**

The brassicaceae family or cruciferae family consists of approximately 375 genera and 3200 species of plants, of which 52 genera and 160 species are present in Australia. The brassica genus consists of approximately 100 species including the species Brassica napus L. and Brassica oleifera L. commonly known as oilseed crop. Brassica napus is not native to Australia and originated in either the Mediterranean area or northern Europe. All the members of cruciferece family are known to be allelopathic. Cultivated or naturally occurring Brassica spp. have been reported as allelopathic or weed suppressive for many years, mustards form relatively pure stands when well established, and in the wild they can be successful invaders of native grasslands (Siemens et al., 2002). Water extracts of black mustard (Brassica nigraL.) plant parts such as leaf, stem, flower and root inhibited seed germination and seedling growth of alfalfa, lentil, wild oat and radish (Turk et al., 2003; Turk and Tawaha 2002, 2003; Turk et al., 2005). Some brassica species have harmful effects on crops reducing seed germination and emergence of subsequent small-grain crops when grown in rotation (Bialy et al., 1990). In a greenhouse trials, rapeseed tissue when added to a sandy soil reduced biomass of hairy nightshade and long spine sandbur by 90 and 83%, respectively (Boydston and Hang, 1995). Some brassica species contain such chemicals which promote the growth of crops. Brassinolide is a natural plant hormone which promotes the growth of plants; it was first isolated from the rapeseed plant pollen (Brassica napus L.)

Allelopathic potential is found many varieties of crucifereae family (Brassicaceae). Canola (Brassica napusL.) is an imperative member of brassicaceae family and considered as one of the prominent crops for the production of vegetable oil for human consumption, animal nutrition, and in recent times, it is a new source of biodiesel (Yasumotoet al., 2010).

**Brassinolide**

A large numbers of allelochemicals are present in several members of the crucifereae family. Brassinolide is a natural plant hormone found in pollens of rapeseed plant (Brassica napus L.) that promotes growth, proliferate the cereals and fruit yields while induces resistance in plants against drought and cold weather. First time, Brassinolide was isolated and detected from the rape seed (Brassica napusL.) plant pollen (Grove et al., 1979). Wide variety of plants contains interrelated compounds, called brassinosteroids. The most significant charisma of brassica water extract is known as brassinolide, which is a natural hormone. In the presence of a potentially growth-limiting cell wall, they are helpful in keeping and maintaining processes such as plant growth, including photo morphogenesis and cell expansion (Wang et al., 2006). Brassinosteriods are responsible for increasing resistance against heavy metals, temperature, salinity or water stresses and biotic stresses (Fariduddinet al., 2009). Additionally, increase in crop yield up to 20–60% is also attained by genetic manipulation of BRs and it is indication that more exploration on brassinosteroids can improve productivity (Divi and Krishna, 2009).

Brassinolide is conventional plant hormone which acts as growth promoters and yield enhancer in fruit and grain crops, despite the fact it inculcate the resistant factors to cold weather and drought resistance in the plants. Extensive varieties of plants are accompanied with brassinosteroids compound. It is Vital for better growth of all plants; sometimes plants become dwarfs if they cannot comprise the ability to synthesize their own brassinolide. Actually, plant will grow better in the presence of brassinolide and if its availability is more to the plants then growth rate will be higher. brassinolide, provides the opportunity to the plants to grow faster because it increases the rate of photosynthesis and its absence influence the growth and development of plant. When 28-homobrassinolide was applied on mungbean, it showed excellent results on growth and yield of Mungbean (Fariduddinet al., 2005). After conducting the experiment, it was premeditated that the application of BRs has slowed down the abscission and senescence process in the leaves and fruit of citrus (Sugiyama and Kuraishi, 1989). It was also proved that when plant faces different kinds of biotic and abiotic stresses, then BRs play important role (Clouse and Sasses, 1998). When tomato and rice plants were treated with BRs, capacity of resistance was improved at lower temperature. In the same way, drought stress in sugar beet was countered by brassinosteroids and furthermore that compound had favored eucalyptus seed germination and seedling growth.

Brassica water extracts promote the growth of various agronomic crops by affecting different physiological processes of the plants. The charisma of brassica water extracts is a natural hormone known as brassinolide. Anjum (2011) found in his study that brassinolides obtained from brassica species when applied on the maize crop in early growth stages improved the drought tolerance of the crop and improved the ability of the crop to withstand the drought period more efficiently. He came to the conclusions that brassinolides induce more tolerance in plants to withstand the drought period and to in an efficient manner and give more yields as compared to plants that were not sprayed with these compounds. Brassinolide enhances the growth and development of the plants and ultimately the yield if it is applied at early stages of plant growth.

Jeyakumaret al. (2008) found in his research that foliar application of brassinolide at the pre-flowering stage increased plant height, number of branches, and leaf area index and leaf area duration of the black gram. It was also reported that photosynthetic efficiency was greatest in plants treated with brassinolide due to which more carbohydrates were produced and
ultimately greater leaf weight, chlorophyll content as well as more soluble protein contents were produced. brassinolide compound has potential to make plants more resistant to low temperature as proved by Kim (1989), who conducted a research to explore the effect of brassinolide, on the rice seedling under low temperature ranges. Various concentrations of brassinolide were applied on the seed, as well seedlings of rice. Plant height was increased to large extent when seeds were soaked in 1 ppm brassinolide solution, it was found that emergence of leaves was accelerated by brassinolide application. Root length was increased many folds by all treatments of various brassinolide concentrations. In the end it was observed that the number of roots was increased. Root and shoot dry weight was also increased by application of brassinolide.

Foliar application of brassinolide increased the plant height of almost all the crops. This fact was established by Sasse (1991), who conducted a field trial to evaluate the promotive effects of brassinosteroids on the elongation of dwarf pea and cucumber. It was reported that there is a synergism between brassinolide and auxin in order to induce elongation when it is ineffective alone. Application of exogenous auxin affects the mechanism brassinolide response towards crops. Mayumi et al. (1995) found in exhaustive research that brassinolide, enhanced the elongation of epicotyl of the bean seedlings also vegetative growth of bean despite the fact it was applied in a lower concentration. Another characteristic of brassinolide came into light when Choi (1990) conducted a research to investigate the safening effect of a natural plant growth regulator brassinolide against herbicides, 2, 4-D and butachlor. Seeds were soaked in brassinolide at 1ppm concentration and it was observed that it was effective in reducing the herbicidal phytotoxicity of rice seedling on 2, 4-D and butachlor application. The safening effect of 2, 4-D by brassinolide was more visible at low concentration as compared to high concentration of brassinolide. For butachlor, however, safening effect provided by brassinolide was not significantly affected by different brassinolide concentrations but significantly affected by butachlor concentrations, there was increased safening effect with increased butachlor concentrations.

Anuradha (2003) reported the results of detailed field that when tobacco seeds were treated with brassinolide solution having concentration more than 10 ppm delayed the germination process and also reduced the germination in tobacco seed which means only those seeds treated with low concentration of the brassinolide enhanced the germination. It was also concluded that foliar spray of brassinolide had no effect on tobacco growth as well as tobacco quality and yield when treated with more than 10 ppm brassinolide solution. Xue et al. (1994) reported that brassinolide increased survival rate of Pinus bungeana seedlings in case of higher cold by 14.5%. The mechanism involved in inducing resistance in plant against the cold was due to effect of brassinolide on plasma lemm. In addition, it was also concluded that the ratio of chlorophyll “a” versus chlorophyll “b” had been slightly reduced by brassinolide but the most important thing that was revealed that brassinolides provide ability in plants to withstand the cold periods more efficiently.

Seeds treated with brassinolide gave more vigorous growth and healthy seedling. This fact was revealed by Jones et al. (1996) who concluded that brassinosteroids accelerated plant growth when applied to cress seeds. Small concentration of brassinolide was applied to the cress seeds and it was recorded that it improved the germination but higher concentration of brassinolide inhibited the root germination of cress seeds. Terakado et al. (2005) used in their study, a most effective natural plant hormone brassinosteroids along with brassinazole which is an effective inhibitor of brassinosteroid. It was observed that nodule formation was increased by direct injection of brassinolide into the root of soyabean. They reported that the internodes in the plants treated with the brassinolide were more as compared to non-treated ones. It was also observed that brassinolide application resulted in more nodes formation in soyabean crop. These results showed that number of nodules formation in soyabean plants was regulated by the application of brassinosteroids. Anuradha (2002) studied the results of brassinolide on rice germination and seedling growth under saline conditions and concluded that brassinolide inhibited the negative effects of salinity on germination and seedling growth of rice. This reversed effect produced by the brassinolide was due to the higher levels of nucleic acids, soluble proteins and free praline and in this way the ability of brassinolide to control negative effects of salinity on seed germination came into light. Bach et al. (1991) conducted experiments to study the effect brassinolide on the tumor cells of tobacco and found that brassinosteroids significantly inhibited tumor cell growth in tobacco plant and results were more distinct in case of lower concentration of applied brassinolide.

Upreti and Murti (2004) conducted research and found that epibrassinolide or homobrassinolide enhanced root nodulation and root length of Phaseolus vulgaris. It was also reported that brassinosteroids treatment (5 Ppm) increased pod yield and this yield was even higher in well irrigated plots. This characteristic of brassinolide of improving the growth and yields was further demonstrated in a research work done by Andrzej and Hayat (2009). They found that brassinosteroids are present in a wide range of plants species. These hormones had the potential to make the plants more capable to withstand the abiotic stress in an efficient manner.

Han and Kairong(2007) discovered unique characteristic of brassinolide in an experiment that it enhanced the water stress resistance in plants of HippophaerhamnoidesL. and Amorphafruticosa L. Results revealed that plants treated with 0.2-0.4 mg/L of brassinolide showed more leaf water contents. It was observed that short and minute deficiency of water was compensated by brassinolide. Kim (1989) observed the effects of brassinolide on seedling characteristics of rice under low temperature condition. Various concentrations of brassinolide were applied on the seeds as well as seedlings of rice. Results showed that plant height was increased when 1 ppm brassinolide was applied to seeds and seedlings. Root length was increased but the number of roots per plant was increased only when seeds were treated with 1 ppm of brassinolide. Dry
weight of shoot and root was also increased by application of brassinolide. It was suggested that seed soaking with 1 ppm of brassinolide was most effective in increasing the dry weight as well as root length after transplanting. All the yield parameters were significantly influenced by the application of brassinolide. Jafariehazdi and Javidfar (2011) also performed same study just like the previous experiment they used five different concentrations of water extracts of two brassica species on sunflower crop at two stages (full flowering and straw). According to results of study, all concentrations considerably affected the germination and development of sunflower. It was realistic from experiment that inhibition was more when higher concentration was used. In a greenhouse trials, when rapeseed tissue planted in sandy soil reduced biomass of hairy nightshade and long spine sandbur by 90 and 83%, respectively (Boydston and Hang, 1999). Brassinolide is a natural plant hormone which promotes the growth of plants; it was first isolated from the rapeseed plant pollen (Brassica napus L.).

Brassinolide also increased the micro and macronutrient uptake in grain and straw of wheat. Turk et al. (2005) used different plant parts extract of black mustard and studied their effect on the germination and seedling growth of radish. All extracts introverted the germination and seedling growth. Leaf extract showed more inhibitory effect as compared to other parts. Radical length was most affected than hypocotyl length. Brassinolide and salicylic acid can be used as seed soaking treatment and foliar spray reduced the effect of NaCl on maize. It was found that NaCl at 50mM or 100mM along with irrigation water decreased the shoot growth but the brassinolide and salicylic acid at 0.25ppm and 0.15ppm, respectively increased the photosynthetic pigments and shoot growth of three to five days old maize plant. Brassinolide treated plant showed highest level at three weeks old maize plant. Brassinolide and salicylic acid increased the nitrate and ammonia activity as compared to salt stress (Samia et al., 2009). Tang, et al (1989) used the brassinolide at 0.01ppm and 0.05ppm in Tartary buck wheat at seedling and flowering stage. Results shown that brassinolide increased the plant height, chlorophyll content and dry matter accumulation. The 0.01 ppm concentration was found best at seedling stage.

Brassinosteroids can reduce the negative effects of the external environment such as low or high temperatures (Qianet al., 2005), drought stress, saline soil, influence of pesticides and phytopathogenic organisms (Opender and Walia, 2009). It has been suggested that the effect of BRs is mediated through auxins or probably through increasing tissue sensitivity to endogenous auxins (Mandava, 1988). Numerous physiological studies addressed BRs-auxin interaction: they act synergistically with auxin in elongation (Yoppe et al., 1981), in laminja joint bending (Takeno and Pharis, 1982) and in ethylene formation (Arteca, et al., 1983). Additive effect of BRs with cytokinins was also demonstrated by Sasaki (2002)

Shahidet al. (2011) conveyed that brassinosteroids are effective in alleviating hostile effects of abiotic stresses salinity and drought and they promote the growth of plants. Grain yield was improved underneath saline circumstances. Previously, it was found that brassinosteroids application, improved the wheat growth. In this study, it is proved that root applied 24-epibrassinolide was responsible for increasing the growth and yield of two wheat cultivars. Salt tolerant (S-24) plant and a moderately salt sensitive (MH-97) plant were grown in continuously aerated Hoagland’s nutrient solution of NaCl at 0 or 120 mM. Various concentrations of 24-epibrassinolide (0, 0.052, 0.104, 0.156 M) were also retained in the solution culture. In salt stress conditions, exogenous application of 24-epibrassinolide counteracted the growth and grain yield inhibition of both wheat cultivars. Different ratios of 24-epibrassinolide concentrations were chosen for practical purposes, under normal and saline circumstances, the greatest operational concentrations correspondingly for growth promotion were 0.104 and 0.052 M. On the other hand, total grain yield and 1000 grain weight of salt effected plants of both cultivars was enhanced, when 24-epibrassinolide was applied on roots of wheat plants at the rate of 0.052 M. Generally, it is recommended that increase in total grain yield was due to increase in grain size which might have effectiveness owing to 24-epibrassinolide induced compound and also rapid increase in translocation of more photoassimilates leading towards grain. It was determined that improvement in the growth and development of both cultivars of wheat was due to root applied 24-epibrassinolide and it was associated with improved photosynthetic capacity. Photosynthetic rate changes in composition of 24-epibrassinolide application were found to be interconnected with non-stomatal restrictions, other than efficiency of photosynthetic pigments of PSII. Growth promotion ability was not associated with leaf turgor potential. Germination of tested species like wheat (Triticumaestivum L.), barnyardgrass (Echinochloa crusgalliL.), spiny sowthistle (sonchusasper L.), blackgrass (alopecurusmyosuroides) were strongly suppressed by Isothiocyanates, and most likely interaction with weed seeds occurs in the soil solution and such as vapor in soil pores (Petersen et al., 2001).

Germination and seedling growth of alfalfa seriously influenced by substances of several black mustard (Brassica nigra L.) plant parts. Results of experiment trials shows that all aqueous extracts of black mustard considerably inhibited alfalfa seed germination and seedling growth when assessed was done with distilled water as a control treatment. Increasing the concentration rate of aqueous extract of isolated Brassica nigra plant parts inhibited alfalfa germination, seedling length and weight. Accumulative increase in the concentration of flower extracts of water reduced the water uptake of germinated alfalfa seeds to greater extent. When alfalfa seeds were soaked for 8 hours then greatest inhibition in water uptake happened at 12 g kg⁻¹ extract concentration rate (Turk et al., 2003).

Brassinolide has the ability to decrease the specified time of germination as it is observed by Takeuchi et al. (1991) who also realized the potential of brassinolide in reducing the germination time and to counter the negative effects of various toxic substances which hindered the germination. Clouse and Zurek (1991) treated the seeds of witch weed (StrigaasiaticaL.) with brassinolide and presented that it not only reduced the germination time but also changes mode of actions by which the
inhibitory affluences are formed. He further provided the evidence about true plant growth regulator and real one growth promoter brassinolide. When he applied it on soybean crop in less quantity it increased the epicotyl length because it is a plant steroid lactone and substitution of auxin.

Qayyum et al. (2007) described after conducting an experiment that brassinolides induced tolerance in plants to survive in salinity conditions. He also found that brassinolide boost up the growth, enhanced chlorophyll pigments of rice plants and it was also observed that rate of gas exchange was less in brassinolide untreated and higher in case of treated rice plants even in salinity dominant areas. It was recorded that total dry matter, net assimilation rate as well as grain yield was increased by brassinolide application. Brassinosteroids can reduce the negative effects of the external environment such as low or high temperatures (Qian et al, 2005), drought stress, saline soil, influence of pesticides and phytopathogenic organisms (Takeuchi et al., 1991). It has been suggested that the effect of BRs is mediated through auxins or probably through increasing tissue sensitivity to endogenous auxins (Mandava, 1988). Numerous physiological studies addressed BRs-auxin interaction: they act synergistically with auxin in elongation (Yopp et al., 1981), in lamina joint bending (Takeno and Pharis, 1982) and in ethylene formation (Arteca, et al., 1983). Additive effect of BRs with cytokinins was also demonstrated (Sasaki, 2002).

Fujii et al. (1992) checked the efficiency of brassinolide in stimulating the ripening process of rice grain and also increased grain weight of rice plants. Brassinolide application resultantly, increased net assimilation rate and improved the translocation of assimilates into panicles. It was determined that brassinolide application enhanced starch deposition in panicle in much quantity Ripening of rice plant was due to effect of brassinolide application otherwise it would not ripened. And it was attributed by synthesis and translocation of photosynthetic carbohydrates. Besides it was also investigated that brassinolide application affected the endogenous abscisic acids and indole acetic acids in panicles. In recent times, additional property brassinolide compound came into light by Yun et al. (1991) when he applied it on the maize plants in order to evaluate the influence of this hormone on the production of ethylene and its tremendous role in elongation of primary roots of maize. It was illustrated that this substance is responsible for increasing quantity of produced ethylene and also increased the root length of maize plants. It was also understood that specific type of association between the auxins and brassinolide is helpful in increasing the production of ethylene.

Meudt et al. (1983) conducted research work on brassinolide activity; it enhanced the yield of many crops like radish lettuce, bush bean and pepper. When brassinolide applied on wheat and mustard it had improved the yield of both crops (Braun and Wild, 1984). Yokota and Takahashi (1986) established a fact that brassinolide application improved the yield of rice, corn and tobacco. Cucumber corn, tobacco, watermelon, and grape yield were increased with the foliar Application of 24 epibrassinolide (Ikekawa and Zhao, 1991). Cutler (1994) described that ability of brassinolide is not confined to few crops but it is fairly effective in increasing the yield of several cereals particularly the wheat crop. It was determined by extensive research work that wheat. It yield increased up to 10-15%. After this experience, almost on 2300 hectares of wheat brassinolide was applied, it significantly increased the wheat productivity in China.

Cai and Jinqiao (1989) carried out a study, in which canola plants were treated to brassinolide growth promoters, it was observed that small concentration of brassinolides like 0.1 ppm per plant enlarged the hypocotyls length of the Brassica napus plants. It was also found that root initiation was increased from the hypocotyls due to application of this hormone. Chang and Detian (1988) verified the above discussed results by applying brassinolides on the seeds of Brassica napus as seed treatment. It provided the satisfactory results as it increased the germination tendency of seeds and reduced the time period of germination. Ability of brassinolide in keeping and maintaining the height of plants as well as proper vegetative growth was revealed by Nomura et al. (1997) in a comprehensive study who also determined the level of applied brassinolide in the normal plants of garden pea and in dwarf mutant. They found that normal plants contained high level of brassinolide and dwarf plants contain the lower concentration. They suggested that main factor in garden pea dwarfism was low level of brassinolide hormone. The reason is that shoots of dwarf plants almost contained 50 % less amount of brassinolide as compared with wild plants. Lee and Kim (1988) investigated that, when peanut subjected to brassinolide treatment; it increased the lamina of peanut and ultimately the final yield of plant.

Brassinolide increased the root length and ultimately increased the growth and development of various plants. Kwaket et al. (2009) indicated that application of lower concentration of brassinolide on tobacco plants not only increase the length of adventitious roots but also enhanced the number of adventitious roots. However, higher concentration up to 10 M, interferes with root initiation due to which Cluster development happened and root differentiation seems difficult. According to Nguyen et al. (2008) experimental details greater concentration of brassinolide compound not only affected the rice seedling shape as well as decrease the size of leaf sheath as comparison was performed with the plants treated with smaller concentration of brassinolide. It is proposed that unusual structure of rice stem seedling and reduction in leaf sheath consequently, decreased the yields due to higher concentration of brassinolide.

**Glucosinolate**

Allelochemical compounds name as glucosinolate found in brassica specie. The said compound is, released in specific environment under special conditions and affects seed germination and plant growth (Bones and Rossitter, 1996). The key factor in the invasion success of brassicaceae species is specific plant defense mechanism and various interactions of
allelochemicals (Halkier and Gershenzon, 2006). Brassica species residues are also allelopathic in nature for example, black radish, round white radish, little radish turnip, garden radish, and rapeseed were investigated on johnsongrass under both laboratory and field conditions and the extract of all species inhibited johnsongrass in field and laboratory experiments. The lowest suppression was noted in case of garden radish.

**Hbr**

Ramrajet al. (1997) conducted experiment in order to evaluate the yield response of some important crop plants from economic point of view and 28-homobrassinolide (HBR) was applied at lower concentration. Foliar spray of HBR was applied at various degree of concentration at tillering and spike/panicle beginning in wheat (0·5 and 1·0 mg/L) and rice (0·25, 0·50 and 1·00 mg/L); at flowering and pegging in groundnut (0·25 and 0·50 mg/L); after the thirty and forty five days of sowing (DAS) in mustard (0·25 and 0·50 mg/L); and in potato 25 and 35 days after emergence (0·25 and 0·50 mg/L); and in cotton 30, 50, 70days after sowing (0·1 and 1·0 mg/L). It was found that the grain yield of wheat, rice and mustard, groundnut pod yields, potato tuber yields and seed yields in case of cotton, was significantly increased when treated with BRs over control treatment. HBR, yield improving trend was influenced due to the nature of crop species, application of HBR concentrations at various plant growth stages and frequency of application has maximum contribution in yield enhancement.

**Benefits**

There are different techniques of using promotory effect of chemicals such as crop rotations, exhausting the residues of the crops and exogenously application of plant water extracts, all these show promotive effect on the other crops. A lot of work has been performed by the scientists in order to investigate the nature and charisma of allelochemicals. Results of voluminous studies indicate that allelochemicals, at higher concentrations have detrimental effects but, stimulate the growth of same or different species at lower concentrations (Narwal, 1994). Hence, these metabolites have promotory effects on others plants and they can be used to develop eco-friendly, easy, cheap and effective growth promoters (Oudhia et al., 1998). Delabays (2002) conducted different field experiments and reported that beside competition effects, existence of certain positive interactions between plant species was observed. These conclusions were made by burying down the dry tissues of allelopathic species such as wheat and sorghum into the soil and assessment was made about their effects on the growth of weeds and crop. It was found that several species, such as wheat and sorghum were involved in strong reduction of the weed growth.

Natural environment can be modified to both to aerial and root environments for better crop yield, prolonging growing season, providing safeguard against vulnerabilities and features of plant growth during any time of the year. In modern agriculture, plant growth regulators (PGR) play vital role and their significance is essential for every crop. Plant growth regulators act as stimuli which directly or indirectly influence physiological developments and plants action and functions at lower concentrations (Frankenberg and Arshad, 1995). According to Nickell (1982) research work, PGRs are natural or non-natural compounds which are exogenously applied directly to a target plants to change its structure, function, its life processes or they improve quality and increase yields.

Recently, Allelopathy has gained the status of well established and emerging discipline. During the last few decades a lot of research work has been done in a wide range of allelopathy arenas but little bit knowledge is available regarding the existence of allelopathy in natural environment. Putnam (1985) reported that allelochemicals are produced in almost all parts of plants species. These secondary metabolites escape into the surroundings in many ways like disintegration of plant residues, root exudation, and also by the process of leaching and volatilization. Bhowmick and Inderjit (2003) reported that all plants release chemicals into the environment which inhibit or promote growth of receiving plants, directly or indirectly. El-Atta and Bashir (1999) reported that fresh oil extracts are extraordinary effective and better for germination and growth of many crops. The water extracts of some plants and trees influence the germination and growth of wheat. Allelopathic potential has been found in many crops like maize, sunflower, alfalfa, sorghum and wheat and extracts of these crops contain allelochemicals which released from dead and decaying parts of plants body. These allelochemicals have the capability to limit the weeds growth and also have proficiency of effecting the donor plants, when they are applied on specific plants in a proper dose, either they encourage or reduce the germination and growth of different plants (Khanhet al., 2005).

Accumulation of secondary metabolites i.e. (quaternary amines, sugars, proline, polyols, ions, polyamines, etc.) and the osmotic adjustment under water stress may be connected with assertive functions of the phytohormones (Mckersie and Leshem, 1994). It is therefore, need of hour to explore such plant growth promoters which should be inexpensive, cost-effective, environmental friendly non-toxic to the users and they can rise the productivity of crop plant. Temple and Bonke (1989) described that seaweed extracts (SE) encompass the characteristics like cytokinin growth regulator and exhibit various roles in the life cycle of crops. Mettinget al. (1990) concluded that seaweed extracts encourages shoot growth and branching, and aqueous solution also increases root growth and lateral root development. Furthermore, nutrient uptake is also improved by seaweed extracts (Yan, 1993), boost the plant to resist against diseases (Featoby-Smith and Staden, 1983) and to counter drought and salinity and other environmental strains (Nabatiet al., 1994).
It is concluded that allelopathy role is evident both in natural and manipulated environments. It plays dynamic role in land-dwelling areas as well as in progression of phytoplankton, induces dormancy to the seeds and avoiding seed decay, plant succession, and patterning of vegetation (Rice, 1984). In a nutshell, allelochemicals have the advantages in wide spectra of scientific fields and incorporation of allelopathy has improves the production potential of many crops.

**Conclusion**

A great opportunity is also available for those who want to study the combinations of different crop water extracts as a potential tool for growth regulations. Application of allelopathy has been increased in sustainable agriculture due to environmental issues implications. The role of allelopathy is evident in capturing the extraterrestrial and new plant species and in pest management. Allelopathic interactions with plant nutrition are also very important in modern agriculture. So, it is need of hour to develop new eco-friendly and sustainable agriculture system through the utilization of plants allelochemicals. Allelopathy can be successfully, manipulated for weed control and enhancing crop productivity. Allelopathic compounds are more important because they are non-harmful, low-priced, environment friendly, feasible below soil and in plant system.

**References**


