ALLELOPATHY: AN OVERVIEW

AFSHEEN KHAN[1], MOINUDDIN AHMED[2], SYED SHAHID SHAUKAT[3] AND SANA NOSHAD[4]

[1,2,4] Dr Moinuddin Ahmed Research Laboratory of Dendrochronology and Plant Ecology.
Department of Botany. Federal Urdu University.
[3] Department of Environmental Science. University of Karachi.

خلاصہ

ہم نے بہت سے تحقیقاتی مضامین اللوپتی کامطالعہ کیاہے، ہم نے ان لوگوں سے اندازہ کیا ہے کہ یہ واقعہ دوسرے قریبی پرجاتیوں پر فیوٹوکسیک تھا، کبھی کبھی مٹی سے یا کبھی کبھی یہ پودے پر ہی ہوسکتا ہے .ثانوی میٹابولائٹ اللوپاتیک میکانزم کے کلیدی اجزاء ہیں جو پودوں کے اخراجات، لیکچیٹس اور دیگر خارج ہونے والے مادہ کی شکل میں پائے جاتے ہیں .یہ بایو کیمیکل حکمت عملی پودے کی حفاظت کے لئے مفید ہیں، اسی طرح ایک برادری میں ایک پودے کی رسائی کے لئے ضروری ہے، کیڑوں کو اپنی طرف متوجہ کرنے کے لئے، مجموعی طور پر، allelopathy حیاتیاتی تحفظ کے لئے بہت مؤثر آلے کے طور پر کے طور پر یہ نہ صرف انبیاء میں داخل ہوتا ہے بلکہ مؤثر ہو سکتا ہے صحت مند ماحول کو بھی ایڈجسٹ کرتا ہے .یہ اللوپاتیک مرکبات بہت فعال ہیں جسکو مٹی آلودگی، eutrophication اور ہوا آلودگی کی شرح کو ختم یا کم کرنے کے مثبت طور پر استعمال کیا جا سکتا ہے .یہ بایوکیمکیکل مٹی کی ساخت اور زراعت، مائکروبیل اور بیکٹیریل سرگرمیاں، پودوں کی تحابیل اور ماحولیاتی نظام اور کھانے کی زنانی کی دیکھ بھال میں اضافے میں حصہ لے سکتے ہیں .لازمی فائدہ یہ ہےکہ یہ ماحولیاتی اور زراعت کی پیداوار کے اضافے کے لئے ان میٹابولائٹ کی موجودگیانتہائی اہمیت رکھتی ہے.

Abstract

We have studied several research articles on allelopathy, we have assessed from those that the phenomena was supposed to be phytotoxic to other nearby species, sometimes to the soil or sometimes it may be to the plant itself. The secondary metabolites are the key components of allelopathic mechanism which are found in the form of plant extracts, leachates and other exudates. These biochemical strategies are useful for the defense of a plant, likewise important for the penetration of a plant into a community, attracting insects for pollination etc. Overall, allelopathy can be very effective tool for biological conservation as it does not only exert inhibition but it also aids up the healthy environment. These allelopathic compounds are very reactive and can be utilized positively to eliminate or to lower the rate of soil pollution, eutrophication and air pollution. These biochemicals can also contribute in the enhancement of soil structure and fertility, microbial and bacterial activities, plant's metabolism and maintenance of ecosystem and food chain. The application of these metabolites takes importance for the upbringing of required beneficial ecological and agricultural outputs.

Introduction

According to Jelenic (1987) Pigweed inhibitory effect on alfalfa was observed by Theophrastus (372-385, BC). A Chinese pharmacologist She-Jen (1518-1593, AD) wrote a book on Chinese medical herbs, describing their nutritious and toxic nature for humans. Some plants regulate the growth of their adjacent plants. This influential behavior of such plants is not their metabolic property but this is a special characteristic of some plants which is called Allelopathy. This special feature have been identified for the effect within the plant or on the adjacent plant found by Rice (1984) and Putnam and Tang (1986). Allelopathy is one the most advanced and active tool for the environment according to Wardle *et al* (1998) and Putnam. 1998). Allelopathy is a very unpredictable phenomenon as it occurs in different manners within the same vicinity but depends upon species. Term allelopathy based on two Greek words "Allelo and Pathy" mean "mutual harm" was introduced by Molish (1973). It is a phenomenon of phytosuppression but may be stimulative while sometimes appears to be phytotoxic, studied by Bais *et al* (2006, 2003) and Putnam and Weston (1996). An allelopathic species could be suppressive for another particular plant even for the same species at the same time may be productive for the other plant for the other species. This is because of the effect of allelochemicals present in the allelopathic species in the experimental studies conducted by Rice (1984). This is also why, the allelopathy can regulate the ecological condition of a particular habitat. The allelochemicals are very interesting units identified by Langerheim and Lowett (1994), during the studies on barley plant. These have been identified for their effects within the plants and on other plants also indicated by Rice (1984) and Putnam and Tang (1986). These are usually secondary metabolites including phenolic compounds, alkaloids, flavanoids, terpenes, terpenoids and glucosides found by Curir *et al* (1990). These can be aromatic and volatile. Allelopathic species are generally weeds and grasses but there are many crops also been reported for having such characteristic. In the past, it was considered that allelopathy only causes harmful effects on other adjacent plants by their growth inhibiting effect and they compete for nutrient uptake with other plants but they might be stimulatory or could be useful for other plants. Some plants produce toxic exudates but in recent years, many allelopathic plants are discovered as exhibiting beneficial allelopathic activity specially in case of crop yields, plant protection, weed management, soil fertility, soil management, microbial activities, maintaining succession in the fields suggested by Czraran *et al* (2002). All these are ecological features in respect of allelopathy, there are many physiological and medicinal important features also found related to allelopathic plants explained by Khan *et al* (2003) and Shaikirova *et al* (2003). Because of the existence of various kinds of metabolites, these can be a part of many natural herbicides and pesticides that can be helpful to avoid the application of different chemicals in the form of fertilizers or for protection of plants in the field. Weston (1996). Besides allelochemicals, this competitive interaction could also be justified on the basis of CO_2 utilization of weeds *i.e.* in the case of C_4 plants, some weeds mostly grasses in sub tropical areas are effected by drought and high temperature whereas at lower temperature their competitive mechanisms are at their best growth rates. As in the case of C_3 plants/weeds, they grow vigorously in increased CO_2 concentrations and they have sufficient adaptive capabilities in drought and high temperature conditions so they can alter their physiological conditions more efficiently than C_4 weeds in stressed ecological situations according to Rehman *et al* (1991). Pasture plant and even pasture weeds should not be ignored in this regard, as an important element they can be used for the management prospectives. Wardle *et al* (1992), Wardle (1987) and Ahmed and Wardle (1994) used root and shoot leachates of *Senecio jacobeae L*. and other legumes against other pasture weeds like *Lolium perenne L*. They found the legumes causing more inhibition than *S. jacobeae*. They found the flowering stages of pasture legumes were more allelopathic than vegetative stage. They also found out the osmotic comparisions in the effected weeds.

Rice (1979) and Atteri and Nicholls (1999) suggested that a well established ecosystem can manage several environmental problems. For the sustainability of a healthy environment different fundamental aspects should be analyzed and to align them in a proper manner. Allelopathy can play a key role in the establishment and maintenance of an ecosystem. Various ecological systems, whether they are agro-ecological systems or artificially maintained botanical areas or wild vegetation or it may be an aquatic ecosystem, in any case allelopathy occurs producing various degrees of influences. Reigosa *et al* (2006) described that range of allelopathy involved from botany, agriculture, organic chemistry, soil science, plant ecology, nuclear biology, plant physiology, ecophysiology, microbiology, molecular biology, plant biochemistry and many other disciplines of science.

Crop Allelopathy

Batish *et al* (2001) provided a tabulated study of crop plants that produce allelopathy. There are a large number of plants listed, that showed the importance of weed suppression. Some crop plants produce phytotoxicity to the same species called autoallelopathy while some affect the growth and yield of other species. *Avecinia marina* is considered as autoallelopathic species, according to Nazim (2013). Effects of *Withana somenifera* were determined by treating the extract on *Triticum aestivum* and *Cicer aeritinum* studied by Chandra *et al* (2012). Many cover crops have been proven to be allelopathic in nature and are frequently used for crop rotation. Hence, allelopathy has emerged to be a significant phenomenon for the dominance of a certain species and if the species is a crop then it would be more beneficial for the economy as a cash crop even after its death it would remain useful for being served as green manure. Likewise, its pollen can also be productive according to Heradate *et al* (2004) and Dayan *et al* (2009). Allelochemicals produced by these plants in the form of leachates or exudates accumulate in the soil, usually in the form of various glucosides of benzoxazinones which are characterized by different members of the family Poaceae (e.g. Wheat, rice, maize). Similarly, some other kinds of glucosides with volatility produced by members of cruciferae that are used for green manures and natural pesticides. These features provide a healthy prediction to the environment. These compounds can hold the stressful ecological condition and promote it towards sustainability.

The main cash crops in the world are wheat, rice, rye, cotton etc. Rice has appeared to be acute allelopathic with all its species having different degrees of influences, while others are also allelopathic up to some extent explained by Bordorf *et al* (2009). Allelopathy intrinsically a characteristic of herbs and grasses and the major crops usually members of Family Poaceae (Grass family). This appears to be a better way of securing the vicinity in future.

Weed Allelopathy

Weeds are the main competitor of any crop or any plant species inhabiting any community. Hence they can emigrate from any area without any resistance and invade the nearby community, influence the growth parameters of other adjacent plants to be lower down their populations. Wheat fields usually contain *Melilotus alba* (a leguminous weed), that competes well with the wheat plant producing remarkable decrease in the seed germination, seedling growth and other metabolic and mitotic activities of the suffering plants. This decrease usually occurs due to roots of *Melilotus alba* that contains strong allelochemicals studied by Shweta and Sharma (2008). Genus *Inula* has found to be acute allelopathic when various species of the genus were tested, the extracts from roots and shoots of the sample species possess strong inhibitory metabolites that produce cytotoxicity, antioxidants and hypaprotective effects explained by Shaukat *et al* (1983), Zhao *et al* (2006) and Khan *et al* (2008a, 2003). The invasion can cause reduction in growth of native species. It might be responsible for the extinction of plants. *Chenopodium morale* and *Malva parviflora* have been studied to check the allelopathic effectiveness difference between both the species by using barley plant fields as the sample species. *Chenopodium* was found extremely allelopathic on barley while *Malva* exerted lesser effect on barley studied by Johani *et al* (2012). Similarly, inhibitory results shown by Isalm *et a*l (2014) and Jabeen *et al* (2013) while using aqeous extracts of *Chenopodium morale* to observe its effects on seeds germination and redicle elongation of Wheat, Maize, Gram and Mung crops. The weed's allelopathic influence suggested for a drastic change in the environment as it can bring newly adapted hybrids in the community that can compete better in the invaded ecosystem. The occurrence of new combinations can also bring diversity and resistant genomes in the prevailing harsh environmental conditions and would be capable of existing against these allelochemicals produced by the weeds. Different parts of allelopathic plants have different degree of inhibitory capabilities, they can be well organized by thorough biochemical studies and are very useful for weed management concluded by Economou *et al* (2002) and Anne (2000). Effects of Onion weed, Pill bearing spurge and Fumitory plants on the growth and germination of Maize were not appeared in a consistant manner during a petriplate experiment conducted by Jabeen and Ahmed (2009), as it need more investigative attempts to achieve conclusions about their behavior. Same noxious paddy weeds and their distribution in shows Table 1.

Table.1: Following is a list of some noxious paddy weeds and their distribution.

Weeds	Region
Echinocloa crus-galli	Asia, Africa, South Canada.
Monochoria vaginalis	Southeast Asia, China, Japan, Fiji islands, Northern Australia, Hawaii, California, Russia and Italy.
Rotala indica	India, China, Formosa, Thailand, Laos, Vetnam.
Eleocharis acicularis	Europe, Central and Northeast Asia, North America, Northeast and South America.
Scirpus juncoides	Cosmopolitan except Africa and Antarctica.
Doparium juncencum	Southeast Asia.
Linderina pyxideria	Southeast Asia particularly in Japan.
Cyperus diformis	Southeast U.S.A.

Green Manures

It has been seen in many field studies that weeds are more likely to possess strong allelopathic behavior in them and are responsible for ecological fluctuations. Weeds are capable of widespread occurrence themselves and can invade any locality. The effect of Allien weed is considered to be more drastic for any kind of community existing in any particular area. (Wakjira *et al* (2009) quoted their experiment on *Parthenium spp* as IAS in a lettuce field. *Parthenium* effects less adversely the growth and germination of lettuce in the form of compost as compared to its weed effect as a herb. Green manure can provide a rich amount of N as well as legumes contribute biologically fixed N with addition of large amounts of C to the cropping systems concluded by Hangrove (1985) and Sharma and Mitra (1998). Using chemical fertilizers the soil ionic capability and salinization becomes higher while animal manure assists in such practices identified by Hao and Chang (2003) while manure by plants debris or other biomass from plants remains, balances N/P ratio were also found in the studies of Royer *et al* (2003), Royer and Dickson (1999) and Hao *et al* (2004a and b). Unlike chemical fertilizers green manure has no hazardous effect on fauna and flora of a particular habitat. Green manure provides better opportunities for the establishment of new bacterial communities and new plant varieties by assisting in the maintainance of an ecosystem studied by Bugg *et al* (1991), Nicholls and Altieri (2001). Green manure are a good source for soil fertility, as a primarily crop used material and recycled for crop usage as a nutrient or biofertilizer according to Cheirs *et al* (2006). Green manures or compost is an organic product (that lacks oxygen) which contains a greater number of organic acids that are sometimes toxic or inhibitory to other plants, this is due to the presence of metabolites in the plants remains or exudates that prevent other undesired plants to be grown in the applied area. Organic molecules bear lots of advantages in the weed management practices concluded by Schonbeck (2012). Use of Eucalyptus tree residues in organic compost increases the level of soluble salts, heavy metals, primary nutrients and it also lowers the soil pH. Provides greater yield and growth of Onion, Lettuce, Snapdragon and Turfgrass concluded in the experimental studies by Benacqua and Mellano (2008, 1993) and Benacqua (2008).

Crop Rotation

For the maintenance of a firm ecosystem as well as a healthy agricultural environment, crop rotation is a very important technique because of being naturally equipped mechanism and of less harmful outputs. Rye, barley, mustard and oats are the high demand crops worldwide that also posses' allelopathic characteristics and are highly beneficial for intercropping period according to Weston (1996). Similarly, Xiao *et al* (2008) found out that leguminous plants if used for crop rotation can also produce allelopathy as well as various ecological benefits for the environment like nitrogen enhancement, soil nutrient availability becomes much better in the presence of leguminous plants, their fruits are rich in nutritional variation. Khan *et al* (2009) studied two genus from northern regions of Pakistan which were tested for their effects on lettuce seeds, leaf leachates of the plants were used for the test. The stimulatory effect was concluded after the results as the *Anthemis nobolis* produces mild stimulatory effects while *Lectuca dissecta* produces much better stimulation upto 40% promotion on hypocotyls growth. The plants that have stimulatory allelopathic potential can be beneficial for the rotation mechanism in the agriculture but they must have to be identified for their crop compatibility for the enhancement of growth and germination of the relevant crop. Annual crops mostly winter crops possess great importance in crop rotation by giving better outputs like rapid growth with high nutritive values in the next crop. Greater effects seen on the cotton yield in the studies conducted by Hulugalle and Scot (2008) by using leguminous plants for crop rotation.

Herbicides, Pesticides, Fungicides & Allelopathy

The use of herbicides, pesticides and other biologically active compounds have become a regular practice in agroecosystem. The use of chemicals to avoid non-required biological activities have been erupted since many years but the requirement have not been met without ecological destructions. These chemicals leach out from the field in the aquatic biome to cause pollution in the water medium or if persist in the soil then destruct the texture and structure of soil that results in reducing the soil fertility. This problem could be solved by the use of allelopathic weeds and (Table 2) crops that can induce such kind of biochemicals that inhibit the growth and production of undesired weeds, microbes and fungal communities in the habitat observed by Anwarulhaq *et al* (1981). *Sorghum* appeared to be an active phyto-herbicide. Besides, sorghum, there are a large number of grain varieties that can be used as bioherbicide like wheat, rye, sunflower, oats, barley etc. sunflower has lesser herbicidal characteristics that other mentioned varieties found by Einhellig and Leather (1988). Tollsten and Bergstrom (1988) isolated many volatile compounds from Brassica spp that help in the suppression of some weeds production. *Vulpia spp* has tested by An *et al* (1998) for its weeds inhibitory activities as well microbial suppression. Moreover, *Vulpia* extracts, even at low concentrations possess inhibitory effects on biological dynamics. Same plant exhibit various allelopathic interactions that can be elaborated by the study of extracts collected from different parts of a plant body and can be used for weed management as herbicides identified by Chon and Kim (2002), Zhao *et al* (2006) and Khan *et al* (2008b) experimented on different species of Genus *Inula* which have been discovered for their severe inhibitory effects on many kinds of bacterial colonies.

Table.2: Presents the nativity of some important weeds.

Herbicidal/pesticidal weeds	Regions
Alpinia zerumbet	China, Hainan, Japan.
Ageratum conyzoides	Columbia, Costa Rica, Ecuador, Nicargua, Peru, Solomon Islands.
Azadiracta indica	Burma, India, Pakistan, Nigeria, Sudan.
Piper methysticum	Southern Japan, Korea, America, Asia.
Leucaena leucocephalo	Mexico, Central America, Phillipine.
Melia azedarach	U.S.A commonly in South Carolina, Georgia, Virginia, Oklahama, Australia, South East Asia.

Soil Fertility

It is necessary for a creature to be stable on its habitat. If the conditions of the vicinity of a species are hospitable then the existence of that species will persist for a longer period or generations. By this way, the species might become dominant in the area by invading the area. For a plant soil conditions are the most alarming features to predict the future and current condition of the particular plant. If conditions are threatening for the community and if the vegetation is passing through rapid successsional stages then the soil conditions have to be managed properly. The chemical nature and nutrient levels must be altered. Soil moisture level should also be monitored with the soil texture. Allelopathy can also be helpful in such aspect as there are many plants that are allelopathic and are very useful to maintain the soil fertility. These plants would be either in the form of crop, weeds, herbs, shrubs or trees or may be in the form of manure or compost. As they possess different metabolites, they can stimulate or inhibit plant growth and production, effects nutrient uptake, soil water retention capability also enhances by the presence of these allelochemicals. pH level also lowers with the decrease in salinity, soil texture and structure improves hence makes the soil more fertile as it acts like humus, as providing better opportunities to the microbial and bacterial communities to survive the area and to contribute more C and N in the environment suggested by Benacqua and Mellano (1994). Sugarcane derived compost resulted very effective in soil amendments. Taking part not only in increasing the soil fertility but also in mobilizing the nutrients and made enhanced bioactivities. Moreover, it seemed that the experimented soil contained some levels of Arsenic in it. It could be eliminated out when sugarcane composted soil was mixed with the original soil. Significant amount of N, P, K were added to the soil by the plantation of Soybean legume that increases soil fertility with the enhancement of soil structure explained by Khan *et al* (2014a and b). Organic compost is the best replacement for pesticides, phytopathogenic chemicals and chemical fertilizers according to Bertoldi (2010). Some important pathogens that can aid the improvement of soil have been appeared in the allelopathic world by different workers are *Corticum rolfsii, Fusarium solani, Pyricularia grisea, Pythium spp, Rhizopus stolonifer, Taphrina deformans, Thanatephorus cucumeris* etc.

Beneficial For Biofuel Industry

Biofuels are the future necessity of the world. The whole world’s future requirement could not be fulfilled by the conventional crude oil, so it has to be replaced by biofuels to meet the requirements. By the exploration of biofuel species, researches should be taken on the conservation of these plants with the increased oil content to produce a quality biodiesel. Allelopathy can also be workable in this respect. Palm oil’s growth hinders by the presence of some weeds like *Asystesia gangetica* and *Pennisetum polystachion*. Another weed *Axonopus compressus* also grows nearby palm oil that is found inhibitory for the other weeds while stimulatory for the palm tree. Samedani *et al* (2013). *Prangos ferulacea*, a herb studied by Razavi (2012a) which exhibits alleloopathic characteristics, the herb releases such compounds in the soil that were found to be stimulatory for the production of essential oils in oil producing plants. According to Erler and Tune (2005) some plants contain metabolites that are secondary and derived from hydrocarbons of fattyacids hence produce lipophillic substances. The use of essential oil as biodiesel has been prevailing worldwide, it must have to be taken in consideration that edible crops could not be utilized for our non edible purposes. Allelopathy provides a safe pathway which is biological itself to achieve the desired products without hitting the food industry. Biofuel crops that they are mostly grains including wheat, rice, barley, grains and cereals may also produce oil. Sesame seeds, peanuts, walnuts, soybean, oats, barley, rye are major oil crops and edible as well. Angelini *et al* (2003) explained about *Jatropa, Brassica spp, Thespesia spp* and many other non edible plants that are also known for their oil production and their growth and yield could be enhanced by the use of allelopathic cultivars. *Eucalyptus globules* and *E. citriodora* contain pure terpenes- cineole and limonene isolated by Kohli and Singh (1991), these are crude volatile oil that are inhibitory and toxic for many species and stimulatory for some other species. These are non edible plants and should be used to obtain biofuel.

Aquatic Allelopathy

Aquatic flora contributes an extensive variety of botanical diversity. There have been a numerous range of plants exhibiting various economical, medicinal, edible and environmentally important features. World’s largest area has been occupied by water and the water world is rich in biota. This botanical combo can be utilized for the human welfare as the production of beneficial varities could be enhanced biologically by using allelopathy. These plants also contain allelochemicals that are usually noxious to the other like hydrilla, spikebrush, sago pondweed, Ipomea equate etc. The use of allelopathic species can suppress the growth of undesired weed or any plant and the desired species dominates which would be beneficial for mankind and environment. Two equatic species were tested while studies undertaken on aquatic plants interrelationship. The biomass of reed (*Phragmites communis*) and sledge (*Carex hudsonii Bonnet)* when mixed with soil, brought stimulatory effects on different crop plants. They also increased the soil fertility with the enhanced texture of soil according to Szcepanska (1971). Columba, western elodea, American eelgrass, giant duckweed and water milfoil were studied by using their extracts on the growth of lettuce. They suppressed the germination of lettuce seeds inhibiting radical growth. El-Ghazal and Reimer (1986) found out the growth activity of Barnyard grass, ivy leaf, morning glory and wheat also disturbed and slowered by these plants. Some phenolic compounds found in seagrasses which are allelopathic in nature explained by Zapata and Mc Millan (1979). Hydrilla is a famous aquatic plant, commonly known as oxygen-plant. Due to allelopathic exploratory studies conducted by Kulshreshta and Gopal (1983), it is confirmed that the plant is extremely noxious and it dominates in aquatic habitat because of its inhibitory nature on growth and germination of nearby plants most commonly on *Ceratophyllum demersum* and *Ceratophyllum muricatum*. Aquaria studies of Dwarf spikebrush (*Eleocharis coloradoensis*) by Yeo (1980), revealed that the plant displaces the population of other neighbor plants by its suppressive effects.

Allelochemicals

The allelochemicals are the key for making a plant dynamic in the medium. These are the tools of an allelopathic plant by which it can invade any particular area or if applied in combination with any other material then it can alter the path of a reaction. These are the combination of organic compounds that are not primarily required by the plants for their metabolism but these can be formed by the metabolic activities in lower quantities but if any disturbance occurs in the environment or a plant undergoes into any stress then the secretion of these metabolites accelerates and suppress the activity of other nearby creatures. Neighbouring individuals might be botanical varieties or microbial or fungal, they could participate or overrule the normal functions of other genomes. These compounds have variable combinants like aromatic compounds, flavanoids, alkaloids, phenols, glucosides etc with their classified groups. These groups and their functions are summarized below.

Biohemistry of Allelochemicals

Allelochemicals are mostly aromatic hence possess odour and volatile nature like benzoic acid, phenolic compounds, alkaloids etc, while some possess flavorness like flavanoids. Some allelochemicals are aliphatic but possess odour like terpenes, isoprenoids, fattyacids and other hydrocarbons like lipoic acid etc described by Harborne (1973). The aromaticity of allelochemicals plays a defensive role against pathogens or herbivory for the plants. The fruit of *Prangos ferulacea* contains alphapinene that protects the plant from bacteria as it acts as antibacterial agent against gram positive bacteria concluded by Razavi *et al* (2010). It also helps in pollination and hybridization mechanism among the plant species. According to Tzakou *et al* (2004) volatile compounds are helpful in pollination. Some important aromatic allelochemicals frequently found in plants are listed and described below.

Phenols

Phenols are the benzene rings with hydroxyl group/groups attached to one or more ringed carbon/s. These are easily soluble in water due to their unsaturated structure as the presence of double bond at every alternate Carbon in the ring. E.g Hydroquinone, 2,6 – dimethanobenzoquinone, salicylic acid, cafeic, ferulic acid (phenolic acids), Napthoquinones, Xapthanoid, Juglone, Tyrosine, Tryptophane, Phenylalanine etc, isolated by Asghari and Tewari (2007).

Alkaloids

Alkaloids are tricyclic benzene rings with amino group attached at any carbon. Weston and Duke (2003) mentioned that these are volatile and unsaturated compounds. Constituents of phenolic acids or form large aromatic compounds. e.g. di methyl butanoic acid, Trans cinamic acid, pyrine, purine, pyrimidine etc.

Flavanoids

These are like phenols, but there is a multiple number of benzene rings with alchoholic groups attached to the rings. Berger (2007), Dastagir and Hussain (2013) found out that it is a large molecule with intense behavior and effectiveness. Its saturation is same as of phenolic compounds. E.g. Quersitin, Cyanidin, Pinoresinol, isoflavanoid, Neoflavonoids, Rutin, Kaempfrol etc.

Lignin

These are very complex aromatic phenols. These can also be polymers of phenolic acids. Its basic characteristics remain but differ only in the complexity of benzene rings and number and variety of attachment as some have only hydroxyl group attached while some have additions of acetic groups to form phenolic acids. E.g. Cinamic acid, Tannic acids, Polyphenols, Polyphenol proteins, Chlorogenic acid etc described by Ahmed *et al* (2011), Waller (1987). These are aliphatic hydrocarbon chains that are also volatile, odoured compounds but saturated in nature. These are listed below.

Table 3. Summary of commonly occurring weeds in pakistan

S. No.	Botanical Name/Common Name of the Species	Researched by:	Stimulatory/ inhibitory.	Effected Crop	Allelochemics	Distribution in Pakistan
1	*Convolvulus arvensus*. (Field Bind /Naro)	Shah *et al* (2006).	-ve	Wheat and Maize	p-hydroxybenzoic, p-coumaaric, Caffeic, Chlorogenic, Slicylic acid, Catechol, Vanillic, Ferulic, Shikimic, Gallic, Synergic, Sinapinic, Pyrogallic acid, Protocatechuic acid and trans-Cinnamic acids, Resorcinol. Hegab and Gahrib (2010).	Throughout Pakistan
2	*Melilotus alba* (White sweet clover)	Memon *et al* (2013),	-ve	Lettuce, sunflower.	Phenylbutanone glucosides, Cyanogenic glucosides, Cyclitol, Hydroquinone glycoside. Joy and George (2014).	Found in full sunny or poorly shaded ares all over Pakistan.
3	*Cyperus iria* (Flate sedge /Bhoian)	Khalid and Siddiqui (2014).	-ve	Maiz and Wheat.	Benzokuinone, naftokuinone, anthraquinone, isoprenoid, saponins, flavanoids. Hidayat and Nuranjah (2016)	Tropical and sub tropical regions.
4	*Polygonium plebejum* (Prostrate knot weed/Warank)	Ullah *et al* (2013).	-ve	Wheat, Gram, Lentils, Mustard.	Tannins, Saponins, Oxymethylanthraquinone. Ullah *et al* (2013).	Water logged areas.
5	*Trianthema portuclacastrum* (Horse/ pursalane)	Mehmood *et al* (1999), Asghar *et al* (2013), Mubeen *et al* (2011),	-ve	Maize, Mustard, Pigeon pea, Mungbean, Potato, Onion, Rice, Millet, Guar, Sunflower, Mash, Sorghum.	Trianthenol, Ecdysterone, 3-Acetylaleuritolic acid, 5,2-dihydroxy-7-methoxy-6-8-dimethylflavone, Leptorumol, 3-4-dimethoxy cinnamic acid, 5-hydroxy-2-methoxybenzaldehyde, p-methoxybenzoic acid, betacyanin. Mandal and Bishayee (2015)	Mainly found in Northern regions and hilly areas of Pakistan.
6	*Euphorbia prostrate* (Spurge. /Dhodak)	Khan *et al* (2012a)	-ve	Wheat, Soybean, Peanut, Cowpea.	Ellagic acid, Xylopyranosyl, beta-terpineol, Gallic acid, Kaempferol, Quercetin, Campesterol, Corilagin. Ahmad (2011).	Tropical and Sub tropical regions. Balochistan, KPK, Punjab, Gilgit and Kashmir.
7	*Digitaria sanguinalis*. (Crab grass/ Mooti/ Khabbal)	Rasheed *et al* (2006)	-ve	Corn, Sunflower.	Veratric acid, Maltol, - loliolide. Zhou *et al* (2013).	Temperate and tropical areas.
8	*Cyperus esculantus* (Yellow nutsedge)	Humayun *et al* (2005)	-ve	Maize, Peanuts, Cotton, Tomato, Potato.	p-hydroxybenzoic acid, p-hydroxymandelic acid, Cinnamic acid, m-Coumaric acid, p-Coumaric acid, Ferulic acid. Heiderzade and Esmaeli (2013).	Tropical and sub tropical areas.
9	*Echinocloa crus gali L Beauv* (Barnyard grass)	Afridi *et al* (2014)	-ve	Rice, Lettuce, Maiz, Sunflower, Cucumber, Mash, Beet.	p-hydroxybenzaldehyde, p-hydroxybenzene, p-hydroxybenzoic acid. Esmaeli *et al* (2012).	Warm, temperate and tropical regions. Sindh, Punjab, KPK, Balochistan, Gilgit and Kashmir.

10	*Euphorbia granulate* (Garden spurge)	Khan *et al* (2012b)	+ve on seed germination level whereas –ve on growth stage.	Wheat, Soybean, Peanut, Cowpea.	Vanillic acid, Isoferulic acid, Caffeic acid, Methylgallate, Quercetin. Ahmad (2011).	Found in deserts and semi deserts of Pakistan.
11	*Digera muricata* (False amaranth. /tandla)	Aziz and Shaukat (2014), Bughio *et al* (2013)	-ve	Bull rush, Millet, Sorghum.	Alpha-Spinasterol, Coumarin, Rutin, Hyperoside, Anthraquinone. Sharma and Vijayvergia (2013).	Tropical regions of Pakistan.
12	*Fimbris stylis* dichotoma (Hoora ghass. /choti bhoian)	Siddiqui and Ismail (2013).	-ve	Rice, Soybean.	Saponins, Cardiac glycosides. Ismail and Siddiqui (2012).	Himalyan ranges and mostly hilly areas.
13	*Amaranthus viridis* (Slender amaranth. /jungle chaulai).	Hussain *et al* (2003).	-ve	Pearl millet, Wheat, Corn.	Alpha-pinene, 1-8-Cineole. Ahmed *et al* (2013).	Tropical to sub tropical regions. (cultivated grounds).
14	*Seteria viridis* (Green foxtail. /loomar ghass)	Asghari and Tewari (2007).	-ve	Onion, Oats, Beetroot, Cabbage, Cauliflower, Chinese mustard, Carrot, Soybean, Barley, Sweet potato, Tobacco, Pea, Rye, Tomato, Potato, Sorghum, Wheat, Maize.	p-methane-3-8-cis-diol, Vanillic acid, Chlorogenic acid, p-Coumaric acid, Ferulic acid. Asghari and Tewari (2007).	Cooler regions of Pakistan. (Punjab, KPK, Balochistan, Gilgit and Kashmir).
15	*Imperata cylinderica* (Pogan grass)	Anjum *et al* (2005), Rehman and Habib (1989), Samad *et al* (2008).	-ve to weeds, slightly +ve to alfa alfa.	Alfa alfa, Corn, Sorghum.	p-Coumaric acid, Ferulic acid, o-Coumaric acid, Vanillic acid, Gentistic acid, p-hydroxybenzaldehyde, Caffeic acid, Chlorogenic acid, Syringic acid. Roger *et al* (2015).	Humid regions. (Sind)
16	*Sorghum helpense* (Johnson grass /Barn)	Rehman *et al* (2010).	-ve but slightly +ve at seedling stage.	Wheat, Almond, Chickpea, Soybean, Mustard, Wild Oat, Rye grass, Grass pea.	p-Coumaric acid, Ferulic acid, Vanillic acid, p-hydroxybenzoic acid, Caffeic acid, Benzoquinone sorgoleone, Syringic acid. Alsaadawi and Dayan (2009).	Hot and dry areas.
17	*Chenopodium album* (Lambs quarter /Goose foot)	Alam *et al* (1997), Majeed *et al* (2012), Shafique *et al* (2011), Tanveer *et al* (2010a).	-ve	Rice, Wheat, Wild Oat, Corn, Soybean, Lentil, Tomato, Chickpea.	Chlorogenic acid, Cinnamic acid. Majeed *et al* (2012).	Almost cosmopolitan. Found in tropical and cooler regions of Pakistan.

18	*Malva parviflora* (Cheese cake)	Farooq *et al* (2013).	+ve at low concentration	Onion, Wheat, Cucumber.	Vanillic acid, Catechin, Gallic acid. Ghani *et al* (2013).	Self spreaded on tough and waste land.
19	*Medicago denticulate*(Clover/Mania)	Khan *et al* (2012b).	Slightly –ve	Corn.	Saponins, Medicagenic acid, Cinnamic acid, Ferrulic acid, Vanillic acid, Hydroxybenzoic acid, p-Coumain, trans-Cinnamic acid, Caffeic acid. Chon *et al* (2002).	Widely distributed all over Pakistan except deserts and tropics.
20	*Medicago polymorpha* (Bur clover/Mania)	Khan *et al* (2012b), Zohaib *et al* (2014).	No effect at seed germination stage. Slightly –ve at growth stages.	Wheat, Maiz, Sunflower, Rice, Lettuce.	Saponins, Medicagenic acid, Cinnamic acid, Ferrulic acid, Vanillic acid, Hydroxybenzoic acid, p-Coumain, trans-Cinnamic acid, Caffeic acid. Chon and Kim (2002).	Widely distributed all over Pakistan except deserts and tropics.
21	*Melilotus indica* (Blue sweet clover/Blue flower singi)	Waheed *et al* (2009).	-ve	Wheat.	Coumarin, o-Coumarin. Joy and George (2014).	Warm temperate regions.
22	*Mukia maderasputane* (Wild cucurbit /Chabbar)	Rajput *et al* (2008), Tauseef *et al* (2012)	-ve	Cotton, Onion, Cucurbita.	Beta-sisterol, Saponins, Glycosides, Ursolic acid, Oleanolic acid, alpha-spinasterol, Stearic acid, Gypsogenim, 3-beta-o-benzoyl-11-oxo-ursolic acid, 3-o-beta-D-glucoronosyl gypsogenim, 3-beta-o-benzoyl-6-oxo-ursolic acid. Balaraman *et al* (2010).	Found in tropical and sub tropical regions of Pakistan.
23	*Panicum antidolate* (Blue pan ic/Bansi ghas)	Hussain *et al* (2004).	-ve	Zea mays, cowpea, water melon, Soybean, Lady finger, Peanut, Mustard, Rice, Lettuce.	Saponons, Anthroquinone. Riechers *et al* (2010).	Mainly in Punjab.
24	*Paspalum distichum* (Water grass/Naru ghas)	Shah and Khan (2006).	-ve	Rice, Tobacco, Walnut, Wheat, Maiz.	Coumarin, Gholamlipour. Riechers *et al* (2010).	Widely spreaded all over Pakistan.
25	*Tribulus terristris* (Puncture clover/Bhakra)	Dastagir and Hussain (2013), Riaz *et al* (2009).	-ve	Wheat, Rice, Maiz, Cereals and pulses.	Caffeoyl derivatives, Quercetin glycosides, Kaemferol glycosides. Riechers *et al* (2010).	Common in sandy lands of Pakistan. Frequently found in Karachi.
26	*Cyperus rotundus* (Purple nutsedge/Mork)	Khan *et al* (2014b), Mehmood and Cheema (2004), Iqbal *et al* (2012).	-ve	Chickpea, Maize, Sorghum.	Linolenic acid, Myristic acid, Stearic acid, Camphene, Alpha-Cyperone, Isocyperol, Oleonolic acid, Sitosterol, Cineole, Limonene. Sharma *et al* (2005b).	Mostly found in tropical and sub tropical regions of Pakistan.

27	*Rumex dentatus* (Broad leaf dock/Jungli Palak)	Anwer *et al* (2013), Afridi *et al* (2014).	-ve	Wheat, Maize, Sunflower, Rice.	Ferrulic acid, Cinnamic acid, Benzoic acid, Gallic acid, Coumaric acid, Sinapic acid. Chon *et al* (2002).	Found in plain lands of Pakistan.
28	*Rumex obtusifolius* (Broad leaf dock/Jungli Palak)	Gulshan *et al* (2006)	-ve	Spring barley.	Caffeoylquinic, Chlorogenic acid, Dicaffeoylquinic, Rosmarinic acid, Eriocitrin, Rutin, Miquelianin. Nisa *et al* (2014).	Widely distributed in meadows, waste land all over Pakistan.
29	*Solanum nigrum* (Black night shade/Mako)	Gilani *et al* (2010).	-ve	Soybean, Peas, Broad beans, Lettuce, Rice.	Ferrulic acid, p-Coumaric acid, Vanillic acid, Gallic acid, p-Hydroxybenzoic acid, p-Vanillin. Reigosa *et al* (2006).	Cosmopolitan but mainly in deserts of Pakistan.
30	*Euphorbia heliscopia* (Cats milk/Chatri dhodak)	Tanveer *et al* (2010b), Bajwa *et al* (2013).	-ve	Wheat, Chick pea, Lentil, Wild oat.	Vanillic acid, Iso ferulic acid, Caffeic acid, Methylgallate, Quercetin. Dastagir and Hussain (2013).	Almost cosmopolitan, usually found in humid regions of Sindh.
31	*Euphorbia grannulata* Forssk.	Hussain *et al* (2012).	-ve	Dicanthium annulatum, Cynodon dactylon, Setaria italica, Pennietum americanum, Euphorbia pilulifera, Oxalis corniculata, Lactuca sativa.	Vanillic acid, Iso ferulic acid, Caffeic acid, Methylgallate, Quercetin. Dastagir and Hussain (2013).	Cosmopolitan.
32	*Innula felconeri*	Khan *et al* (2008b)	-ve	Lettuce	3-3-5-Trihydroxy-4-7-dimethoxyflavone, 3-3-5-Trihydroxy-4-7-dimethoxyflavone-3-0-sulphate. Khan *et al* (2009).	Himalaya, Kurakaram, Hindukush, Kashmir.
33	*Sorghum bicolor* (Jawar).	Mahmood and Cheema (2004).	-ve	Maize	p-Coumaric acid, Ferulic acid, Vanillic acid, p-hydroxybenzoic acid, Caffeic acid, Benzoquinone sorgoleone, Syringic acid. Alsaadawi and Dayan (2009).	Cosmopolitan.
34	*Teucrium royleanum*.	Ahmed *et al* (2011).	-ve	Lettuce	Subfractions of hexane, Ethylacetate, Butanol, Monoterpenes, Sesquiterpenes, Hydrocarbons. Ahmed *et al* (2011).	Cosmopolitan.
35	*Acacia modesta, Cassia oxydentalis, Plantago major, Senecio carthimoides, Verbascum Thapsus.*	Shinwari *et al* (2008)	-ve	Lettuce	Alpha-amyrine, Betulin, Octacosanol, e-sistosterol, Pinitol, Octacosanol, Lentrioctanol, Alpha-amino-beta-oxalylaminopropionic acid. Seigler (2003).	Cosmopolitan.

36	*Euphorbia helioscopia. L.*	Tanveer *et al* (2010a).	-ve	Wheat, Chickpea, Lentil.	Ellagic acid, Gallic acid, Kaempferol. Ahmed *et al* (2011).	Cosmopolitan.
37	*Helianthus annus* (Sunflower).	Khaliq *et al* (2013).	-ve	Wheat, Canary grass, Wild Oat.	p-Coumaric acid, Ferulic acid, Vanillic acid, p-hydroxybenzoic acid, Caffeic acid, Benzoquinone sorgoleone, Syringic acid. Alsaadawi and Dayan (2009).	Cosmopolitan.
38	Brassica spp.	Ayub *et al* (2013).	-ve	Rice, Sorghum, Millet.	Canavanine sulphate, Saponins, Phlobatannins. Alsaadawi and Dayan (2009).	Cosmopolitan.
39	*Conyza Canadensis.*	Shaukat *et al* (2003).	-ve	Tomato, radish, Wheat, Corn, Millet, Mungbean.	Scutellarin, Luteolin-7-o-beta-D-glucuronoid, Quercetin, Quercetin-3-o-beta-D-glucopyranoside, Luteolin. Liu *et al* (2011 and 1994).	Cosmopolitan.
40	*Argentone mexicana.(Mexican prickly poppy).*	Shaukat *et al* (2010), Burhan and Shaukat (1999).	-ve	Pearl, Millet, Mustard, Wheat, Carrot, Corn, Turnip.	Quercetin, Quercetin-3-o-beta-D-glucopyranoside, Luteolin. Liu *et al* (2011).	Cosmopolitan.
41	*Solanum forskii.*	Shaukat *et al* (2004).	-ve	Mustard, Corn, Wheat.	p-Coumaric acid, Ferulic acid, Vanillic acid, p-hydroxybenzoic acid, Caffeic acid, Benzoquinone sorgoleone, Syringic acid. Zhao *et al*. (2010).	Cosmopolitan.
42	*Anagallis arvesii.(Scarlet Pimpernel).*	Burhan and Shaukat (1999).	-ve	Pearl millet, Mustard, Carrot, Turnip, Wheat, Corn.	2-2-phenyl-1-picrylhydrazyl, Gallic acid, Quercetin, Rutin, Myricetin, Catechin, Caffeic acid, Kaempferol. Amoros and Girre (1987).	Cosmopolitan.
43	*Launea procumbins*. (Creeping Launea).	Shaukat and Siddiqui (2002).	-ve	Meloidogyne javanica.	Orientin, Rutin, Hyperoside, Vitexin, Myricetin, Saponins, Tannins, Phlobatannins. Mishra *et al* (2012).	Cosmopolitan.
44	*Digera muricata. (False Amaranth).*	Aziz and Shaukat (2014).	-ve	Bulrush millet	Alpha-spinasterol, Coumarin, Rutin, Hyperoside, Anthraqionone. Sharma and Vijayvergia (2013).	Cosmopolitan.
45	*Citrullus colosynthesis*	Hussain *et al*(2012).	-ve	Bitter apple, deser gourd, wild gourd, bitter cucumber.	p-Cymene, Alpha- thujene, 1-8-Cineol, Borneol. Soliman. Roger *et al* (2015).	Mostly in Sindh.
46	*Cassia occidentals. (Coffee weed).*	Shinwari *et al* (2008)	-ve	Lettuce.	Aspigenin. Taiwo *et al* (2013).	Found in all temperate areas of Pakistan.

47	*Plantago major.* (Broadleaf Plantain).	Shinwari *et al* (2008)	-ve	Lettuce.	Caffeic acid and derivatives, Iridoid glycosides. Roger *et al* (2015).	Temperate areas of Pakistan mostly.
48	*Senecio carthimoides*	Shinwari *et al* (2008)	-ve	Lettuce.	Chrysanthimoides, Coumarins, Saponins, Benzofurans, Pyrrolozidine, Sesquiterpenes. Seigler (2003).	Northern areas of Pakistan.
49	*Trifolium alexandrium.* (Berseem)	Ayub *et al* (2013).	-ve	Rice, Sorghum, Millet.	Phlobatannins, Saponins, Chlorogenic acid, Coumarins. Bhowal and Das (2014).	All over Pakistan.
50	*Verbascum Thapsus.*(Great mullin)	Shinwari *et al* (2008)	-ve	Lettuce.	Iridoid glycoside, Phenylethyl glycoside, 6-Hydroxylucteolin-7-glucoside, 3-methylquercetin, 7-4-Dihydroxyflavone-4-rhamnoside. Pnachal and Murti (2010).	All over Paksiatn.
51	*Brassica compestress.*	Ayub *et al* (2013).	-ve	Rice, Sorghum, Millet.	Brassinosteroids, glucosinolate. Alsaadawi and Dayan (2009).	Punjab and Sindh mostly.
52	*Morus alba.* (Mulberry).	Khaliq *et al* (2013, 2011).	-ve	Wheat, Canary grass, Wild oat.	Hydroxycinnamic acid esters, Alpha glucosides, Kaempferol-3-o-beta-D-glucopyranoside, Kaempferol-3-o-beta-D-rutinoside, Chalcones, p-Hydroxybenzoic acid, Protocatechuic acid, Methyl esters, Pyrocatechol. Zafar *et al* (2013).	Punjab abundantly in Islamabad.
53	*Oryza sativa.* (Rice)	Mahmood and Cheema (2004).	-ve	Maize.	p-Hydroxybenzoic acid, p-Coumaric acid, Ferulic acid. Olofsdotter *et al* (2002).	Punjab and Sindh mostly.
54	*Helianthus annus.* (Sunflower)	Khaliq *et al* (2013).	-ve	Sunflower.	Sesquiterpenes lactones, Helivypolide-D, Helivypolide-E. Alsaadawi and Dayan (2009).	All over Pakistan.
55	*Anthemis nobilis.* (Chamomile)	Khan *et al* (2009).	-ve	Lettuce.	Caffeic acid, Chlorogenic acid, Rutin, Qercetin, Laempferol. Khan *et al* (2009).	Northern areas of Pakistan.
56	*Lactuca dissecta*	Khan *et al* (2009).	-ve	Lettuce.	Caffeic acid, Chlorogenic acid, Rutin, Qercetin, Laempferol. Weston and Czarnota (2001).	Himalaya, Kurakaram, Hindukush, Kashmir.
57	*Inula koelzii*	Khan *et al* (2009).	-ve	Lettuce.	Caffeic acid, Chlorogenic acid, Rutin, Qercetin, Laempferol. Khan *et al* (2009)	Himalaya, Kurakaram, Hindukush, Kashmir.

Note: -ve = inhibitory effect.
+ve = stimulatory effect.

Terpenes

Terpenes are also odoured compounds having 5 carbon rings that can be attached to any group. These are a unit of essential oil in plants as polymers of terpenes form oil molecules. Terpenes have been classified into mono terpenes, isoprenoids, diterpenes, sesquinones, depending upon the submergence of molecules. E.g. Linaloo, Myrcene, Menthone, Thujone, Menthol, Camphor, Thymol, Pinocamphone etc. Terpenes also flavoured compounds. (Aliotta *et al*., 1989).

Glycoside

Mandava (1985)., Shaukat *et al* (2003) explained that Glycosides are hydrocarbons that also exhibit certain aroma with flavoured characteristics for the self defence of a plant explored by Berger (2007) These are simple carbon chains with certain elements or side chains attached. E.g. saponins, triterpenes etc.

Essential Oils

Allelochemicals possess essential oils in them that are lipophilic and aromatic. They have moisture trapping capabilities. These are extremely volatile compounds formed from polyterpene biosysnthesis with the fattyacid group attached such as sesame oil, peppermint, spearmint etc.

All these compository compounds are useful for us as in the form of medicinal purpose, soap making, fabric production, food industry, herbal medicines, skin treatments, paper industry, herbicidal uses, fertilizer production, biodiesel formation, antibacterial products, antifungal products etc studied by Razavi (2012b).

Environmental Impacts of Allelopathy

Plants are the figures that are capable of surviving in any medium with the collaboration of any set of condition. If the conditions are not native then they are capable of producing modifications in them by the help of adaptations. It is believed in the allelopathic research world that stressed environmental conditions are the resources of allelopathy *i.e* plants secrete allelopchemicals but they release these chemicals in stress conditions more frequently hence the other neighbouring plant which is itself in a state of unstability could be depressed by the influence of these chemicals. The allelopathy works in bringing the diversified vegetational ecology as the adaptations provided by the phenomenon, plants adapt some new morphological characters, wide spreading seeds with new genetic combinations that is immune to the rapidly changing environmental conditions. Plants with allelopathic characters can be used as biological weapon for weed management and can make the soil environmental less disturbed while sometimes it could bring many positive effects on the soil. The conventional methods for weed management or fungal or pests management are herbicides, fungicides, pesticides by spraying the chemicals on the plants, however, the chemicals usually leach out from the sprayed plants into the soil, underground water or the residues remain in the soil making the soil structure disturbed and disqualify the crop requirements as the nutrients level could not be maintained in such conditions. These chemicals also harm friendly micro organisms and insects suitable for crop production and help in pollination. The moisture level of the soil has also been degraded because of the temperature of these chemicals being higher. The soil environment becomes disturbed by the use of these applications but allelopathy can overcome this effect by the exudates of biochemicals the habitat can be escaped from extra chemical activities that can make the soil barren and also distorting the microbial colonization, microbes are very important segment for a fertile soil. The microbial and bacterial activities maintain the organic concentration of a soil, capture oxygen in the soil components by which they could be able to convert complex minerals into available form.

Allelopathy conserves the soil structure as well as it protects the soil to be polluted by other additives from the human advancements. This could also be helpful for preventing water pollution as the leachates from the soil can add up their residues into lakes, rivers, canals, oceans or any other water cavities that can damage or bring distortion to the aquatic life. When the soil ecological conditions would be improved or to be conserved then the atmospheric conditions would also be displaceable towards healthy environment. In the way that the accumulation of gases in the atmosphere from the transpiration of plants takes place. The gaseous excretions of plants in the form of nitrogen, carbon, phosphorus and other methods of recycling can be made manageable by the plants in purified form (actual standard percentage of the elements recycled). The water pollution also managed when the soil depositions enters water fragments. The allelopathic plants in aquatic habitat counter the water problems in a controllable, in such a way that these chemicals do not make the water toxic, it only influences the nearby species. The pollutants are responsible for the contaminating the oceans not the allelochemicals.

Current environment is facing war conditions whether it is endemic or atmospheric. The natural disasters like flood, volcanic eruptions, forest fire etc can be avoided by human activities by conserving our soil and atmosphere by avoiding industrialization and maximizing the use of natural blessings.

For the use during war, protection measures or detective/investigatory applications, plants can also be used as for the forensic studies could be made useful. Allelopathy can be used for making the biological weapons, allelochemicals are the specialized natural rapid effecting compounds. Researches can be made on the allelochemicals to provide significant findings this could escape the mankind and our environment from the tragic uses of guns and bullets. Allelochemicals can be used for pscychological treatments as a drug this could be very useful for the investigatory purposes. Overall, allelochemicals are biological tools for the environmental safety but more research should be conducted in this field.

Some common weeds of Pakistan

Following are the commonly occurring weeds in different regions of Pakistan that are known to be responsible to disturb the crop fields. A review is given according to their habitat.
Table.3: presents list of weeds commonly found in Pakistan; allelochemicals constituents and effects on other crops.

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