Physiological Impact of Fenugreek, Guava and Lantana on the Growth and Some Chemical Parameters of Sunflower Plants and Associated Weeds

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Abstract: Allelopathy is considered an effective and environmentally friendly method to control the weeds and consequently enhances crop production. Pot experiments were conducted during two successive summer seasons (2010 and 2011) in the greenhouse of National Research Centre, Egypt to study the effect of incorporating 10% fenugreek seeds or 20% guava leaves or 20% lantana leaves into the soil on sunflower plants and associated weeds. All treatments caused significant decreases in fresh and dry weights of *Echinochloa colonum* L. and *Portulaca oleracea* L at 40 and 100 days after sowing. Fenugreek treatment showed more pronounced effect > lantana treatment > guava treatment.
On the other hand, all treatments caused significant increases in the photosynthetic pigments of sunflower leaves (chlorophyll a, b and carotenoid) relative to unweeded treatment. The total carbohydrate content in sunflower leaf tissues increased significantly with all treatments accompanied by a significant decrease in the total phenolic content relative to unweeded treatment. The head weight, seeds weight/head and 100 seeds weight were increased in the following order weed free treatment > fenugreek treatment > lantana treatment > guava treatment. It was noted that fenugreek treatment is the most effective treatment in increasing oil% followed by guava treatment, while the lowest increase resulted from lantana treatment relative to unweeded treatment. Fenugreek treatment caused the highest decrease in (C16:0 + C18:0) accompanied by the highest increase in (C18:1 + C18:2). Regarding the total essential amino acids, it was noticed that fenugreek treatment showed a noticeable increase whereas lantana and guava treatments showed a decrease in total essential amino acids relative to unweeded treatment. All applied treatments showed significant increases in N%, and non significant increases in P% and K% relative to unweeded treatment.
[Mona G. Dawood, Mohamed E. El-Awadi and Kowthar G. El-Rokiek. **Physiological Impact of Fenugreek, Guava and Lantana on the Growth and Some Chemical Parameters of Sunflower Plants and Associated Weeds.** J Am Sci 2012;8(6):166-174]. (ISSN: 1545-1003). http://www.sciencepub.net/american. 20

Key words: Allelochemicals, *Echinochloa colonum, Helianthus annuus, Lantana camara*, *Portulaca oleracea, Psidium guajava* , *Trigonella foenum graecum*.

1. Introduction

There is no doubt that increasing production of vegetable oils becomes a dire need in Egypt, especially the local production was not exceeding 150,000 tons in 2010, meanwhile the consumption reached 820,000 tons (according to Specialized National Councils).

Sunflower (*Helianthus annuus* L.) is one of the most important oil crops. According to the annual statistical report of the Ministry of Agriculture and Land Reclamation in Egypt, it was grown on about 1498 ha. Increasing sunflower yield could be achieved through introducing high yield producing cultivars and effective management of weeds, diseases and pests.

Weeds are considered to be a serious problem because they compete for water, nutrients, light, and space, and consequently caused great reduction of sunflower yield ranges from 18.6 to 36.3 % (**Singh and Giri, 2001**). In recent years, because of the use of large quantities of herbicides and their potential hazards, such as residual effects, contamination of food chains and groundwater, and other consequences, scientists have been looking for alternative ways to manage weeds and enhance crop production **(Marambe and Sangakkara, 1996).**

Allelopathy is one of the emerging techniques identified and studied as an effective and environmentally friendly method to control weed as well as the safe alternatives to overcome these problems and to achieve sustainability in agriculture and maintenance of clean environment for our future generations. Alleloapthic strategies aim at reducing environmental pollution and maintaining ecological balance through reduced use of chemical herbicides or substituting them with natural products (plant and microbial products).

Rice (1984) defined allelopathy as any direct or indirect and harmful or beneficial effect by one plant (including micro-organisms) on another through production of chemical compounds (allelochemicals) that escape into the environment from leaves, flowers, seeds, stems and roots of living or decomposing plant materials. Under suitable conditions, allelochemicals may suppress the developing of weed seedlings and often exhibit selectivity similar to synthetic herbicides **(Weston, 1996).** Hence, allelochemicals are eco-friendly and free from the problems associated with present herbicides.

Allelochemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates and amino acids. The mixture of different compounds, sometimes having a greater allelopathic effect than individual compound alone. **Einhellig (1995)** mentioned that these metabolites may be selective in their action or plants may be selective in their responses. Moreover, allelochemicals which inhibit the growth of some species at certain concentrations may stimulate the growth of same or different species at different concentrations (**Narwal, 1994**). Allelochemicals once released, are short lived in the environment and therefore do not disastrously upset the balance as the chemicals would do. The allelopathic action of various natural compounds on the growth and development of many plants may be inhibitory or stimulatory depending on their concentration in the surrounding medium and on their physiological activity within plants **(El-Daly and Soliman, 1997).** Phenolic compounds can act on enzymes, phytohormone activity and mineral content **(Einhellig, 2004)**

Fenugreek (*Trigonella foenum graecum*) is an annual herb that belongs to the family Leguminosae widely grown in Egypt and Middle Eastern countries. The seeds of fenugreek contain lysine and L-tryptophan rich proteins, mucilaginous fiber and other rare chemical constituents such as saponins, coumarin, fenugreekine, nicotinic acid, sapogenins, phytic acid, scopoletin and trigonelline (**Bukhari *et al.*, 2008**). In addition, all extracts of the fenugreek seeds (methanol, ethanol, dichloromethane, acetone, hexane and ethyl acetate) exhibit antioxidant activity because of phenolic acids and flavonoids, the phenolic compounds ranged from 1.35 to 6.85 mg/g and total flavonoids are in the range from 208 to 653 µg/g according to the extract type (**Bukhari *et al.*, 2008).** Furthermore, intercropping fenugreek with faba bean can reduce *Orobanche crenata* infection **(Fernández-Aparicio *et al.*, 2006).**

Guava (*Psidium guajava* L.) is a member of the family Myrtaceae. Guava leaf contains volatile oil as quercetin, avicularin, guaijaverin, etc. **(Morant *et al.*, 2008).** Previous studies on the chemical composition of guava leaves have identified chemical products belonging to the groups with allelopathic properties (**Monteiro and Vieira, 2002**) such as terpenoids, flavonoids, coumarins, cyanogenic acids, among others (**Begum *et al.*, 2002; Gutiérrez *et al.*, 2008**). Some studies have already identified guava allelopathic effects on other species, the effect of guava fruit extracts on cucumber germination (*Cucumis sativus*) (**Bovey and Diaz-Colon, 1968**), as well as the effect of guava root exudates on lettuce (*L. sativa*) germination and root growth, and the root growth of bristly foxtail (*Setaria verticillata*) (**Brown *et al.*, 1983). Chapla and Campos (2010**) reported that allelopathic effect of the guava leaf aqueous extract on the germination and growth of lettuce occurred only at 20% concentration.

Lantana camara L. (Verbenaceae) is a large scrambling evergreen shrub which is commonly called as wild sage and lantana weed. Its leaves, roots and fruits contain allelochemicals mainly phenolics, flavonoids, tannins and carbohydrates as mentioned by **Gopie- Shkhanna and Kannabiran (2007)**. These allelochemicals promote or inhibit the crop growth based on their concentrations and species specific (**Ambika *et al.*, 2003**). Moreover, **Basu and Hazra (2006)** indicate that lantana plant has strong antioxidant activities. **Yi *et al.*, (2005)** reported the presence of several phenolic compounds in lantana leaf extract identified by HPLC as salicylic, gentisic, β-resorcylic acid, vanillic, caffeic, ferulic, p-hydroxybenzoic acids, coumarin and 6- methyl coumarin.

This investigation aimed to assess the allelopathic activity of fenugreek seeds, guava leaves, and lantana leaves for improving yield and chemical constituents of sunflower plants as well as management of associated weeds.

2. Materials and Methods

Two pot experiments were conducted during two successive summer seasons (2010 and 2011) at green house of National Research Centre, Egypt. Sunflower seeds (Giza 102 cultivar) were obtained from Agricultural Research Centre, Giza, Egypt.

Healthy *Psidium guajava* and *Lantana camara* leaves were collected from the farm at Giza Governorate and washed thoroughly with running tap water to remove dust and other undesired materials, and undergo air dried in shadow at room place then grinded to fine powder. Whereas, fenugreek and weed seeds [jungle rice (*Echinochloa colonum* L.) (narrow leaved weed) and purslane (*Portulaca oleracea* L.) (broad leaved weed)] were purchased from local market.

2.1. Bioassay test

A simple preliminary bioassay test (data not shown) was carried out for screening the effect of different concentrations of the allelochemicals (guava and lantana leaves as well as fenugreek seeds) on germination and seedling growth of weeds. The different substances were mixed thoroughly with clay sandy soil (2:1, w/w) at the levels of 5, 10, 15, 20 and 25% (w/w). Then, the soil was infested with constant weight of weed seeds (narrow and broad) and watered with distilled water. The bioassay test was conducted for 15 days under laboratory conditions and observations were noted. At the end of bioassay test, it was noted that using 20% guava or lantana leaves and 10% fenugreek seeds are the most effective concentrations for reducing weeds seedling growth.

2.2. Pot experiment

Fine powdered guava and lantana leaves were thoroughly mixed with the soil surface at rate of 200g/kg soil surface (20% w/w), while powdered fenugreek seeds at rate of 100 g/kg (10%, w/w) before sowing seeds of sunflower and weeds.

The sunflower seeds were sown 2 cm deep, and grown under the average maximum and minimum temperature of 35.5±1 and 18.5±1°C. The pots had a 40 cm diameter and 40 cm height contained equal amounts of sieved soil (clay and sand; 2:1 w/w). All pots (except those of weed free) were infested with a constant weight of seeds of jungle rice (*Echinochloa colonum* L.) (narrow leaved weed) and purslane (*Portulaca oleracea* L.) (broad leaved weed). Weed seeds were sown simultaneously and mixed thoroughly at a depth of 2 cm in the soil. Thinning of sunflower was done after 2 weeks from sowing leaving two homogeneous seedlings per pot. Routine fertilizers were added.

The treatments are (1) unweeded (2) weed free (3) 10% powdered fenugreek seeds (4) 20 % powdered guava leaves (5) 20 % powdered lantana leaves. The pots were distributed in a complete randomized design. Each treatment was represented by 10 pots. The experiment was repeated in two successive seasons.

2.3. Data recorded

- Weed samples were taken from 5 pots at two stages (40 and 100 days after sowing) to determine fresh and dry weights.
- Samples of sunflower plant were collected at 40 days old to determine photosynthetic pigments, total carbohydrates and phenolic contents in the leaves.
- At harvest, sunflower plants were collected to determine plant height, head diameter and head weight. Heads were air dried and threshed to determine seeds weight/head, and 100-seeds weight as well as oil, fatty acid composition, amino acid composition and mineral content of the yielded seeds.

2.4. Chemical analysis of sunflower plants:

Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) in the fresh sunflower leaves after 40 days from sowing were determined as the method described by **Moran (1982).** Total carbohydrates were determined in the dry leaves using the colorimetric method described by **Dubois *et al.*, (1956)**. Total phenolic compounds were extracted from dry leaves and determined colorimetrically according to the method defined by **Snell and Snell (1953)** using Folin Ciocalteu phenol reagent. The oil content of the seeds was determined according to the procedure reported by **A.O.A.C. (1990).** As the quality of the oil depends on the proportion of different fatty acids, their composition was determined quantitatively by Gas Liquid Chromatography according to the method described by **Fedak and De La Roche (1977).** Identification and determination of the amino acid composition of the yielded meals was carried out by using HPLC (Eppdrof, Germany) according to **Gehrke *et al.*, (1985).** Nitrogen, phosphorus and potassium contents were determined according to the official and modified methods of analysis **(A.O.A.C. 1984).**

Statistical analysis

Combined analyses of the two seasons were statistically analyzed at 5% probability according to **Snedecor and Cochran (1980).**

3. Results

3.1. Impact of fenugreek, guava and lantana on weeds

The data presented in Table (1) show that incorporation of 10% powdered fenugreek seeds or 20% guava leaves or 20% lantana leaves into the soil caused significant decreases in fresh and dry weight of jungle rice (*Echinochloa colonum*) (narrow leaved weed) and purslane (*Portulaca oleracea*) (broad leaved weed**)** at 40 and 100 days after sowing. It is obvious that the reduction in weed growth taking the order of fenugreek treatment> lantana treatment > guava treatment.

Table (1): Impact of fenugreek, guava and lantana on fresh and dry weight (g) of broad and narrow weeds associated with sunflower plant (combined analysis of the two seasons)

Treatments	*Portulaca oleracea*			*Echinochloa colonum*		
	40 days		100days	40 days		100days
	FW	DW	DW	FW	DW	DW
Unweeded	40.57	5.94	17.97	67.87	20.58	29.78
Weed free	0.00	0.00	0.00	0.00	0.00	0.00
Fenugreek seeds	16.95	3.42	13.40	33.69	9.88	14.99
Guava leaves	31.02	4.79	16.37	48.90	15.61	27.16
Lantana leaves	23.99	4.20	13.70	37.68	11.86	22.62
LSD 5%	1.07	0.30	0.79	3.15	1.06	0.95

FW (fresh weight) DW (dry weight)

3.2. Impact of fenugreek, guava and lantana on sunflower plants

Incorporation of 10% fenugreek seeds or 20% guava leaves or 20% lantana leaves into the soil caused significant increases in photosynthetic pigments (chlorophyll a, b and carotenoid) (Table, 2) relative to unweeded treatment. The highest values of chlorophyll (a) are 1.34 and 1.25 mg/g and of chlorophyll (b) are 0.54 and 0.49 mg/g resulted from fenugreek and lantana treatments respectively. It is worthy to mention that, relative to weed free treatment, all treatments caused non significant changes in chlorophyll (a), chlorophyll (b) and chlorophyll (a+b).

Data presented in Table (2) indicate that total carbohydrate content of sunflower leaf tissues increased significantly due to all treatments accompanied by significant decrease in total phenolic content relative to unweeded treatment. Fenugreek treatment is the most pronounced treatment, showed the highest significant value in carbohydrate content (14.77%) and at the same time the lowest significant value in total phenolic content (13.20 mg/g). Relative to weed free treatment, all treatments showed significant decreases in carbohydrate content concomitant with significant increases in phenolic content.

Table (2): Impact of fenugreek, guava and lantana on photosynthetic pigments, total carbohydrate and total phenolic content of sunflower leaves (combined analysis of the two seasons)

Treatments	Chlorophyll a	Chlorophyll b	Carotenoids	Chlorophyll a + b	Carbohydrate content	Phenolic content
	mg/g fresh weight				% dry weight	mg/g dry weight
Unweeded	0.82	0.32	0.35	1.14	13.43	21.12
Weed free	1.32	0.51	0.51	1.83	15.34	11.86
Fenugreek seeds	1.34	0.54	0.48	1.88	14.77	13.20
Guava leaves	1.22	0.48	0.50	1.70	14.13	17.61
Lantana leaves	1.25	0.49	0.45	1.74	14.38	16.62
LSD 5%	0.11	0.03	0.04	0.14	0.52	0.52

Table (3) indicates that all treatments caused significant increases in the values of plant height, head weight, seeds weight/head and 100 seeds weight relative to unweeded treatment. The head weight, seeds weight/ head and 100 seeds weight were increased in the following order weed free treatment > fenugreek treatment > lantana treatment > guava treatment.

Regarding oil content of the yielded sunflower seeds, it was noted that fenugreek treatment is the most effective treatment in increasing oil% followed by guava treatment, while the lowest increase resulted from lantana treatment relative to unweeded treatment (Table, 3). On the other hand, relative to weed free treatment, oil% was decreased with fenugreek, lantana and guava treatments.

Table (3): Impact of fenugreek, guava and lantana on sunflower yield, yield components and oil content (combined analysis of the two seasons)

Treatments	Plant height	Head diameter	Head weight	Seeds weight/head	100 seeds weight	Oil content
	Cm		g			%
Unweeded	95.5	6.5	31.39	13.82	1.95	26.30
Weed free	135.0	12.3	45.05	25.67	4.21	34.66
Fenugreek seeds	131.0	12.5	40.81	22.32	3.91	33.10
Guava leaves	122.5	9.5	38.89	17.74	2.59	32.36
Lantana leaves	109.0	8.8	39.96	19.76	2.85	30.15
LSD 5%	11.6	4.3	2.30	2.25	0.71	2.16

It is well known that, fatty acid composition of oil is an indication for oil quality. So, GLC of main fatty acid composition of the yielded sunflower oil is presented in Table (4). All treatments showed a marked decrease in (C16:0 + C18:0) concomitant with a marked increase in (C18:1 + C18:2) relative to unweeded and weed free treatments. The data reveals that, oleic acid (C18:1) is the predominant unsaturated fatty acid that showed a marked increase, meanwhile, linoleic acid (C18:2) decreased under all treatments relative to unweeded and weed free treatment. Fenugreek treatment caused the highest decrease in (C16:0 +18:0) accompanied by the highest increase in (C18:1 +C18:2).

Table (4): Impact of fenugreek, guava and lantana on fatty acid composition of the sunflower oil

Treatments	C16:0	C18:0	C18:1	C18:2	C16:0+C18:0	C18:1+C18:2
	%Total fatty acids					
Unweeded	7.58	8.69	54.49	20.00	16.27	74.49
Weed free	6.09	9.36	58.94	22.98	15.45	81.92
Fenugreek seeds	5.38	4.57	69.98	17.19	9.95	87.17
Guava leaves	6.47	4.77	64.23	19.95	11.24	84.18
Lantana leaves	7.83	4.87	70.35	15.42	12.70	85.77

Data presented in Table (5) show the amino acid composition of sunflower meals (after oil extraction). The predominant non essential amino acids are glutamic acid and proline whereas; leucine is the predominant essential amino acid. It is clear that, the promotive effect of fenugreek treatment > lantana treatment > guava treatment in increasing total non essential amino acids relative to unweeded and weed free treatments. Regarding total essential amino acids, it was noted that fenugreek treatment showed a noticeable increase whereas; lantana and guava treatments showed a decrease in total essential amino acids relative to unweeded treatment. Meanwhile, the three applied treatments caused a marked decrease in total essential amino acids relative to weed free treatment.

Regarding the minerals content of the yielded meals (Table, 6), It was noted that the applied treatments showed significant increases in N%, and non significant increase in P% and K% relative to unweeded treatment. On the other hand, relative to free weed treatment, all treatments showed non significant decrease in P%, and significant decrease appeared in K%. Meanwhile, fenugreek treatment caused significant increase in N%.

Table (5): Impact of fenugreek, guava and lantana on amino acid composition (mg/g) of the sunflower meal

Amino acids	Unweeded	Weed free	Fenugreek seeds	Guava leaves	Lantana leaves
Aspartic acid	21.79	23.01	26.39	22.57	25.00
Threonine*	8.51	8.56	8.37	7.73	8.25
Serine	11.79	11.00	13.87	10.51	12.37
Glutamic acid	60.79	67.28	85.41	81.04	95.91
Glycine	5.33	8.62	5.81	5.84	5.30
Alanine	10.39	22.62	26.31	24.31	24.50
Valine	11.62	12.42	8.50	8.39	10.25
Methionine*	0	2.81	0	0	0
Isoleucine*	0	0	0	0	3.49
Leucine*	36.15	39.42	35.16	29.93	32.44
Tyrosine*	19.86	19.11	19.25	17.33	16.77
Phenylalanine*	20.33	27.74	27.55	21.55	22.55
Proline	54.33	69.04	74.30	66.01	70.34
Histidine	10.82	14.95	16.32	14.40	7.54
Lysine*	12.82	16.14	16.45	14.71	11.85
Arginine	0.33	0	5.00	0	0
Total EAA*	97.67	113.78	106.78	91.25	95.35
Total Non EAA	187.19	228.94	261.91	233.07	251.21
EAA* / Non EAA	0.52	0.50	0.41	0.39	0.38

(EAA)*: Essential amino acids (Non EAA): Non essential amino acids

Table (6): Impact of fenugreek, guava and lantana on mineral content of sunflower meal (combined analysis of the two seasons)

Treatments	N%	P%	K%
Unweeded	1.85	0.97	0.95
Weed free	2.17	1.32	1.36
Fenugreek seeds	2.42	1.06	1.04
Guava leaves	2.11	1.25	1.02
Lantana leaves	2.25	1.29	1.06
LSD 5%	0.23	N.S	0.27

4. Discussion

It is worthy to mention that, controlling weeds through allelopathy is one focal point for researchers working to sustain the world′ s food supply for future generations. Since, many researchers have speculated that allelochemicals (secondary metabolites) might prove useful in controlling weeds and increasing grain yield **(Minorsky, 2002).**

The data of the present study demonstrate the potentiality of allelochemicals that released from decomposition of lantana or guava leaves or fenugreek seeds on sunflower plants and associated weeds. It has been mentioned by several authors that, leaves are the most potent source of allelochemical, however, these metabolites are also distributed in all other plant parts in various concentration.

Data show clearly that incorporation of fenugreek seeds, guava leaves or lantana leaves into the soil have significant effect in controlling broad weed (*Portulaca oleracea*) and narrow weed (*Echinochloa colonum*). The fresh and dry weights of both weeds at two different physiological stages were reduced significantly by the three plant materials (Table, 1) and the degree of inhibition varied may be according to the type, concentration and potentiality of allelochemicals which released from decomposition of each used material.

Allelopathy offers potential for biorational weed control through production and release of allelochemicals from leaves, flowers, seeds, stems and roots of living or decomposing plant materials. Under appropriate conditions, allelochemicals may release in quantity which suppress the developing weed seedlings and often exhibit selectivity similar to synthetic herbicides **(Weston, 1996).**

The aqueous extracts from fresh and dry leaves of *Lantana camera* inhibited the growth of water hyacinth and killed the plant within six days because of salicylic acid which is major allelochmicals in lantana **(Zhung *et al*., 2005).** In addition, it has been found that aqueous extracts from *L. camara* twigs inhibit, to various degrees, germination and seedling growth in rice-associated weeds, such as *Echinochloa colonum, Digitaria sanguinalis, Panicum psilopodium,* and *Commelina benghalensis* (**Bansal, 1987).**

In respect to fenugreek, **Fernández-Aparicio *et al.*, (2006)** suggested that intercropping fenugreek with faba bean can reduce *Orobanche crenata* infection. Furthermore, **Haoula *et al.*, (2008 a)** mentioned that different parts of fenugreek have allelopathic potential and fenugreek extracts may be act as an attractive alternative for the use of a natural product to control fungi avoiding chemical fungicides. These allelochemicals should certainly serve to integrated weed management.

Guava leaf contains volatile oil (quercetin, avicularin, guaijaverin, etc.) that serve as an immediate chemical defense against herbivores and pathogens **(Morant *et al.*, 2008)**. The antibacterial activity of guava leaf aqueous extract has also been reported by **Sanches *et al.*, (2005).**

On the other hand, the results of the present study reveal that different treatments have stimulatory effects on sunflower growth, yield and chemical composition of the yielded seeds. Relative to unweeded, it was noted that all treatments caused significant increase in photosynthetic pigments and total carbohydrates of sunflower leaves (Table, 2) as well as yield and yield components (Table, 3). Special attention was paid to the chemical composition of the yielded seeds. Since, all treatments caused significant increases in oil% (Table,3)as well as marked increases in (C18:1+C18:2) accompanied by a decrease in (C16: 0+C18:0) (Table, 4). Total essential amino acids decreased due to all treatments concomitant with increase in total non essential amino acids (Table, 5). Non significant increase was observed in P% and K% in sunflower meals, meanwhile, a significant increase was observed in N% (Table, 6).

The increase in the growth of sunflower plants that appeared in photosynthetic pigments and carbohydrate content of leaves reflected in the increase of yield and concomitant with significant decrease in fresh and dry weight of associated weeds. This was proved by several researchers who mentioned that the inhibition of weed growth caused an increase in the competitive ability of plant and leads to increase in growth and yield **(Sanchez *et al.*, 2003, Stephanie *et al.*, 2004)**

It is worthy to mention that, as the allelopathic effects are both positive and negative, both of these effects can be utilized for higher production. Negative (stimulatory) allelopathic effects of any weed or crops can be utilized to develop ecofriendly, cheap and effective green growth promoters. Similarly, the positive (inhibitory) allelopathic effects of any weed or crops on weeds can be utilized to develop green herbicides **(Oudhia, 1999).**

Seed characteristics such as seed size and seed coat permeability may influence the uptake and effects of allelochemicals in seeds. In seed germination bioassays, it was shown that species with small seeds were more inhibited than larger seeded species at a given concentration of allelochemicals **(Chase *et al.*, 1991).**

In respect to the chemical composition of the sunflower plants under the effect of allelochemicals, the results of this investigation are confirmed earlier by **Bansal (1998)** who reported that incorporation of *Lantana camara* into soil under field conditions significantly increased chlorophyll content in transplanted rice and subsequently grain yield. Moreover, allelochemicals mode of actions was species dependent. Thus the concentration of allelochemicals that is inhibitory to chlorophyll synthesis in a particular plant species could be stimulatory to the same process in another plant species. Furthermore, lantana compost at 4 t/ha gave significantly higher grain yield of rice over the control due to more tillers/hill and higher growth rate **(Singh and Angiras, 2005).**

Romero-Romero *et al.*, (2002) showed that aqueous extract of *Lantana camara* induced an overall increase in protein synthesis in roots of *Zea mays*, *Phaseolus vulgaris* and *Lycopersicom esculentum*. Furthermore, leaf extract of *Lantana camara* increased amino acids, soluble carbohydrate levels as well as amylase enzyme in *Miosa pudica* seeds pretreated with leaf extract **(Maiti *et al.*, 2008).** Moreover, **Verma and Rao (2006)** mentioned that aqueous extract of 4 weeds species (10% w/v) (Ageratum *cnyzoides* L., *Cynodon dactylon* L., Pers., *Pathenium hysterophorous* L., *Solnum nigrum* L.) increased the total protein content in different soybean varieties with all the weed extract. Meanwhile, **Dawood and Taie (2009)** reported that lantana treatments caused non significant decrease in oil content of lupine seeds.

In respect to fenugreek treatment, **Al- Qurashi (2005)** reported that incorporating fenugreek residue into the soil gives the highest value in growth attributes; leaf N content and non significant difference appeared in P and K content of guava leaves. In addition, **Haouala *et al.*, (2008 b)** mentioned that incorporation of fenugreek residues from aerial plant parts in peat stimulated the root and shoot growth of *P. vulgaris* by 4 and 8 times, respectively. The aqueous extracts or residues of fenugreek plants had potent allelopathic activity and the activity differed with target species and plant parts.

Regarding guava treatment, **Chapla and Campos (2010**) reported that allelopathic effect of the guava leaf aqueous extract on the germination and growth of lettuce occurred only at 20% concentration.

Generally, incorporation of plant residue into the soil provides organic matter, improves the overall soil quality, and fixes significant amounts of nitrogen into the soil and consequently yields in an economic and environmentally friendly manner (**Upendra *et al.*, 2001 and Al-Qurashi, 2005).**

The stimulatory effect of all treatments on photosynthetic pigments, yield and chemical composition of the yielded seeds may be explained on the basis that the allelochemicals absorbed by plant cells should be detoxified **(Rice, 1984).** Detoxification processes and also other responses of plant cells to stressed conditions (as weed infection) causes the increased activity of antioxidant enzymes due to high level of free oxygen radicals under the stimulation activity of allelochemicals **(Lara-Nanez *et al.*, 2006).** Theoretical analysis of allelopathic phenomena revealed that decomposing allelochemicals may either inhibit or stimulate plant growth and that inhibition may be confined to a limited period, i.e. the most sever inhibition by plant residue occurs at the early stages of residue decomposition whereas at later stages the inhibition decline while stimulation gradually emerges. The inhibition and stimulation periods can be manipulated through a wide variety of management means **(An *et al.*, 1996).**

There is no common mode of action or physiological target site for all allelochemicals. The physiological and environmental stresses, pests and diseases, solar radiation, herbicides and less than optimal nutrient, moisture and temperature levels regulate production of allelochemicals as well as their effect. Target processes of allelochemicals are cell division, production of plant hormones and their balance, membrane stability and permeability, pollen germination, mineral uptake, and movement of stomata, pigment synthesis, photosynthesis, respiration, amino acid synthesis, nitrogen fixation, specific enzyme activities and conductive tissue **(Wink *et al.*, 1998).**

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5/2/2012