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ALLELOPATHIC IMPACT OF SELECTED WEEDS ON THE GROWTH AND DEVELOPMENT OF *ORYZA SATIVA* L.

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ABSTRACT

Rice (Oryza sativa L.) grown under upland condition especially in North- Eastern region is heavily infested with weeds. During the field preparation or in standing crop condition, weeds are destroyed mechanically or chemically and left in the field itself. Due to heavy rainfall the soluble allelochemicals leach out which come into direct contact with crop roots and interfere with the growth of the crop. The present work was undertaken with the objective to make a comparative study on the impact of selected weed plants on the growth of Oryza sativa L. in the soil. The weeds selected were Ageratum conyzoides L. and Commelina benghalensis L.. The results indicated that the growth response was maximum in the control condition compared to the plants grown in the soil containing weed residues. The allelochemicals present in the weeds released due to residue incorporation were inhibitory to the growth and development of rice. Green manures are eco-friendly but it also can have some negative impact on crop due to leached out allelochemicals which may inhibit the growth of plants instead of enhancing it. It is always desirable to clear off all weeds from the field before sowing the crop grains in the field.

Key words: *Ageratum conyzoides* L., Allelochemicals, Allelopathy, *Commelina benghalensis* L., *Oryza sativa* L.

Introduction

Green manuring is a very ancient farm practice. It increases the nitrogen supply and improves the soil health. It also enhances the organic matter contents. At the same time there are certain negative impacts too. The weeds which are used for the production of green manures may contain certain allelochemicals, which can negatively affect the growth of crop plants [1]. It is found that the weeds used for green manuring have certain negative impacts on crop plants. Allelochemicals are a subset of secondary metabolites not required for metabolism (growth and development) of the allelopathic organism. Allelochemicals with negative allelopathic effects are an important part of plant defense against herbivory (i.e., animals eating plants as their primary food) [2]. Cinnamic and benzoic acids, flavonoids, and various terpenes are the most commonly found allelochemicals, but several hundred chemicals have been identified, including many other classes of secondary plant compounds. A few allelochemicals have been developed as herbicides and pesticides, and it may be possible to genetically engineer a crop to produce its own herbicides.

1. Materials and methods

The experimental plant selected was *Oryza sativa* L.. The weeds selected were *Ageratum conyzoides* L. and *Commelina benghalensis* L. The weed plants were uprooted and chopped finely and mixed with the potting mixture thoroughly.

Ageratum conyzoides L.

The word Ageratum is derived from the Greek words 'a geras', meaning non-aging, referring to the longevity of the whole plant. *Conyzoides,* on the other hand, is derived from 'konyz' the Greek name of *Inula helenium,* which the plant resembles. The plant belongs to the family Asteraceae tribe Eupatorieae. The genus Ageratum consists of approximately 30 species but only a few species have been phytochemically investigated.

It is an erect, annual, branched, slender, hairy and aromatic herb, which grows to approximately 1 m in height. The stems and leaves are covered with fine white hairs, the leaves are stalked, ovate, 4-10 cm long and 1-5 cm wide, with tip and base somewhat pointed and with round-toothed margins long. The flowers are purple to white, less than 6 mm across and arranged in

close terminal inflorescences. The fruit is black and are easily dispersed while the grains are photoblastic and often lost within 12 months.

Ageratum conyzoides L. is very rich in polyoxygenated flavonoids. A total of 21 polyoxygenated flavonoids have been reported. This includes 14 polymethoxylated flavones that are tricin derivatives, oxygenated flavones, which include ageconyflavone A, ageconyflavone B and ageconyflavone C, other flavonoids include 5′-methoxynobiletin, linderoflavone B, hexamethoxyflavone etc.The triterpenes isolated from plant are friedelin, and the major sterols are sterols-β-sitosterol (26.7%) and stigmasterol (59.9%). Other minor sterols isolated are brassicasterol (0.3%) and dihydrobrassicasterol (2.7%), spinasterol (5.2%), dihydrospinasterol (5.7%). Lycopsamine and echinatine, two isomeric pyrrolizidine alkaloids, are the only alkaloids isolated from this plant[Other compounds isolated from plant include sesamin, [aurantiamide acetate, fumaric acid, caffeic acid, phytol, HCN and hydrocarbons, heptadecenoic acid[3]

Commelina benghalensis L.

Commonly known as the Bengal dayflower, tropical spiderwort, or wandering Jew, is a perennial herb native to tropical Asia and Africa. It has been widely introduced to areas outside its native range, including to the neotropics Hawaii, the West Indies and to both coasts of North America. It flowers from spring into the fall and is often associated with disturbed soils.

In both it native range and areas where it has been introduced it is usually considered a weed, sometimes a serious one. In the United States it has been placed on the Federal Noxious Weed List. It is considered as a moderate weed of rice cultivation in Asia. In its native range of sub-Saharan Africa, India, Sri Lanka, and much of Southeast Asia, it is considered as a serious weed of an enormous range of crops from tea and coffee to cassava and peanuts. Additional agricultural damage is caused by the fact that it can host the nematode *Meloidogyne incognita* and the Groundnut rosette virus. The phytochemical screening revealed the presence of phlobatannins, carbohydrates, tannins, glycosides, volatile oils, resins, balsams, flavonoids and saponins [4]

In China it is used as a medicinal herb that is said to have diuretic, febrifugal and anti-inflammatory effects, while in Pakistan it is used to cure swellings of the skin, leprosy and as a laxative. The plant has also been widely introduced beyond its range to the neotropics, the

southeastern United States, California, Hawaii, Cuba, Jamaica, Martinique, Montserrat, Barbados and St Vincent. In Puerto Rico the plant is known from a single collection from Cayey.

In the southeastern states it is present in Florida, Georgia, Louisiana and North Carolina and spreading. It was added to the Federal Noxious Weed List in 1983, and by 2003 was considered the most serious pest of Georgia's cotton crop due to widely used herbicides such as glyphosate having little effect on it. It was introduced separately to California in the 1980s, making it the only introduced species of *Commelina* in the western United States. It is associated with disturbed soils such as yards, lawns and cultivated areas, especially in cotton crops and orange groves.

For performing the experiment the first pot was filled with sand, soil, manure and finely chopped fresh whole plants of *Ageratum conyzoides* L. in 1: 1:1:2 ratio. The second pot was filled with sand, soil, manure and finely chopped fresh whole plants of *Commelina benghalensis* L. in 1: 1:1:2 ratio. In the control pot the soil, sand and farmyard manure alone was filled in 1:1:1 ratio. Equal number of paddy grains was sown in all the pots. Duplicates were maintained. Watering was done regularly.

The parameters considered for the present study are given below:

- Percentage of germination.
- General appearance.
- Height of the plants.
- Length of the roots
- Fresh weight of the plants.
- Dry weight of the plants.
- Chlorophyll *a, b* and Total chlorophyll of the leaves
- Total carbohydrate content of leaves
- Total protein content of leaves:
- Phytomass and productivity

Percentage of germination

The grains were soaked in water for twenty four hours and 50 grains each were sown in the respective pots. The grains were kept under observation. Enough sunlight and water had been provided. The grains started to germinate after one week.

General appearance

The general appearance of the plant was observed and noted and compared at regular intervals.

Height of the plants

Height of each plant was measured once in every week and compared it with plant grown in control.

Chlorophyll, Total Carbohydrate and Total Protein Contents of the leaves

Chlorophyll, Total carbohydrate and Total protein were quantitatively analysed using standard methods [5,6,7].

Phytomass and productivity

In order to find out the phytomass the plants were cleaned carefully, root system was washed with water and the plant parts like leaves, stem and root were separated and kept in separate paper packets. They were dried thoroughly in hot air oven at 80^{o}C till the weights became constant. The weight of each plant pats was found out separately and from this the total phytomass was calculated and compared with that of control. From the Phytomass value, the net primary productivity was found out by dividing the Phytomass value by the plant age expressed in days (g / plant / day).

2. Observation and Results

Result of the present study shows that, in the control condition the paddy grains grew more quickly. But in the case of other four pots with *Ageratum conyzoides* L, *Commelina benghalensis* L. weed residue, the growth rate was lesser than paddy in control condition. In the control condition the paddy plants were healthier than the paddy plants in the experimental set up.

Germination percentage.

Germination percentage of the grains was found out on the 6th and 15th day of germination. The results were as follows:

The grains grown in the soil amended with *Ageratum conyzoides L.* showed 40% of germination on the first day. On the 15th day it increased up to 60%. The grains treated with *Commelina benghalensis* L. showed 60% germination on1st day and it increased to 84% on the 15th day.

The control grains started to germinate on the 6th day there was 75% of germination. But this had increased to 98% by the 15th day.

Shoot length.

Shoot length of plant was measured at 2 weeks interval.

***Oryza sativa L*. grown in the soil containing *Ageratum conyzoides L.* weed residue:**

The mean shoot length observed on the 15th, 30th, 45th, 60th, 75th and 112th days was 13cm, 20cm, 30 cm, 39cm, 41cm and 44.1cm respectively

***Oryza sativa L*. grown in the soil contains *Commelina benghalensis L.* weed residue:**

The mean shoot length observed on the 15th, 30th, 45th, 60th, 75th and 112th days was 21.7cm, 30.9cm, 49.8cm, 56.1cm, and 64.7 cm respectively

***Oryza sativa L*. grown in the soil contains manure weed residue:**

The shoot length observed on the 15th, 30th, 45th, 60th, 75th and 112th days was 23.7cm, 33.5cm, 52.8cm, 59.3cm, 68.1cm, and 74cm respectively

Root Length

The mean root length *of Oryza sativa L*. grown in the soil containing *Ageratum conyzoides L.* weed residue was 2.2cm. on 112th *day* and it was 2.4 cm in the soil containing *Commelina benghalensis L.* weed residue. The mean root length of the control plants on 112th *day of Oryza sativa L*. was 2.7cm.

Fresh Weight of the Whole Plant.

Fresh weight was found out after uprooting the plant on 30th, 45th and 112th day. Fresh weight of the whole plant grown in soil containing *Ageratum conyzoides L*. weed residue was measured on the 30th day, 45th day and 112th day was 1.43 g, 1.53g and 3.6g respectively. Fresh weight of the whole plant in *Commelina benghalensis L* weed residue was measured on the 30th day, 45th day and 112th day was 1.46 g, 1.57 g and 5 g. respectively. Fresh weight of the control plants whole plant on the 30th day, 45th day and 112th day was 1.50 g, 1.61 g and 5.2 g. respectively.

Dry weight of the whole plant

The dry weight of the plant was taken on 35th day, 50th day and 112th day. Dry weight of *Oryza sativa L*. grown in the soil contains *Ageratum conyzoides L.* weed residue on 35th day, 50th day and 112th day was 0.57 g. 0.73 g. 0.8 g. respectively. Dry weight of *Oryza sativa L*. grown in the soil contains *Commelina benghalensis* L.weed residue on 35th day, 50th day and 112th day was 0.62 g. 0.86 g and 0.99 g. respectively. Dry weight of the control plants on 35th day, 50th day and 112th day was0.64 g. 0.92g. and 1.2g respectively.

Chlorophyll and Carotenoid Content.

Leaf Chlorophyll content was calculated colorimetrically on 30th day.

Chlorophyll a, Chlorophyll b and Total Chlorophyll content of *Oryza sativa L*. grown in the soil containing *Ageratum conyzoides L.* weed residue were 0.119 mg/g, 0.021 mg/g and 0.132 mg/g respectively. Chlorophyll a, Chlorophyll b and Total Chlorophyll content of *Oryza sativa L*. grown in the soil containing *Commelina benghalensis L.* weed residue were 0.141mg/g, 0.049 mg/g and 0.170mg/g respectively. Chlorophyll a, Chlorophyll b and Total Chlorophyll content of *Oryza sativa L*. grown as control were 0.148 mg/g, 0.059 mg/g and0.174mg/g respectively.

Total Carbohydrate Content

The total carbohydrate content of plants grown in control was 94.82mg/g whereas the total carbohydrate content of the plants grown in the soil containing the weeds *Ageratum conyzoides L.* and *Commelina benghalensis L* was 28.57mg/g and 59.18mg/g respectively. The total carbohydrate content of control plants was 94.82mg/g.

Total Protein Content

The total protein content of the plants treated with *Ageratum conyzoides L.* and *Commelina benghalensis was* 0.112mg/g and 0.29mg/g respectively. The protein content of control plant was 0.34mg/g.

Fresh weight of spikelets

A single spikelet in the plants grown in soils amended with *Ageratum, Commelina on* 112th day had a fresh weight of *1.52* g and 5.4 g respectively, while the control plant produced a spikelet that had a fresh weight of 5.8g.

3. Discussion

The present work was carried out to understand the growth response of *Oryza sativa* L. to selected weed residues in the soil. The weeds were *Ageratum conyzoides* L.*and Commelina benghalensis* L.From the results of the present study it was found that, the *Ageratum conyzoides* L, is more troublesome. *Commelina benghalensis* L. also inhibited the paddy growth but to lesser extend compared to *Ageratum conyzoides* L.

The Department of Social Science and Land Resources Management University of Nigeria conducted an experiment about the allelopathic potentials of six dominant weeds. The decomposing mulches showed varied but less inhibitory effects on the grains with a trend toward increasing inhibitory power with increasing mulch level and decreasing grains size. The results revealed that a possible relationship between the low grains germination and poor seedling growths often observed in the area [8]. The result was same in the present study too where, the plant growth in the control showed higher growth rate than the rice plant grown in the soil amended with *Ageratum conyzoides* L. *and Commelina benghalensis* L. In a study on weed infestation it was found out that *Echinochola colona* L. is a very problematic weed in upland and medium land rice causing significant reduction in the yield [9] . The decomposing leachets of *Echinochola colona* L. showed strong toxic effect on root and shoot growth of rice. The highest being noted with 10% leachets of 60 days old plant residue, it inhibited the root and shoot growth by 100% and 43.9% respectively as compared to the control. The corresponding decomposed leachets inhibited rice germination by 90%, root and shoot growth by 70% and 25% respectively.

In the present work the plants grown in control showed higher growth rate than the plants grown in soils with weed residues like *Ageratum conyzoides* L. , *Commelina benghalensis* L. The shoot length and root length of the plant grown in the control were higher than that of other plants. The allelochemicals produced by the weeds may be the reason for the growth retardation.

The aqueous weed extract of *Ageratum conyzoides* L. caused a significant inhibition on germination of sesame seeds [10]. The intensity of inhibition differed depending upon the concentration and weed species. As the concentration of the weed extract increased the degree of inhibition on germination percentage was increased. In the present study, the grain germination rate was least in the pot containing *Ageratum* weed residue, out of 50 grains only 25 grains germinated . But in the control condition 42 grains germinated. The effect of weed plants *Ageratum conyzoides, Lantana camara and Eupatorium adenophorum* on the growth of *Triticum aestivum* and Maize was conducted [11]. The shoot weight of wheat seedlings grown in the soil amended with *Lantana camara* (5g/100g soil) and *Eupatorium adenophorum* (5g/ 100g soil) was significantly lesser compared to the control. In the present study also the similar result were obtained. The shoot weight of *Oryza sativa* in control was more than the plants grown in weed residue. The allelochemicals present in the weed plants must have inhibited their growth. According to the study a study it was found that the leaf extracts of the weed *Tridax procumbens* L. suppresses the germination of leguminous plants [12]. The maximum seed germination percentage was shown in the control where no extract was used. The present work also produced comparable results. Germination percentage was more in control compared to the treatment plants.

Studies have revealed that, the aqueous extracts and the volatiles of *A. conyzoides* are allelopathic to crops like rice, wheat, corn, cucumber, radish, tomato, peanut, soybean and mungbean [13]. *A. conyzoides* L. often invades the cultivated fields and reduces the crop productivity through interference. However, it is also beneficial to some crops in several agro-ecosystems. In south China, *A. conyzoides L*. is traditionally used as green manure in fields, to increase the crop yields and to control the weeds. Its allelopathic effects depend upon the time of green manuring and its decaying period in soils .Such allelopathic effects have been observed up to 30 days after soil incorporation.

The chlorophyll content and soluble protein contents were high in plants grown as control. Whereas in plants grown in soil amended with various weed plants had less chlorophyll and

protein contents. Especially chlorophyll content was very less in plants grown in soil containing A. *conyzoides* L. Comparable results were obtained in the case of present study too. The shoot length and the root length of the plant grown in control was more than that of other plants. The growth of the plants grown in weed residue was inhibited by the allelochemicals produced by weeds. The reduction in chlorophyll contents observed in all the concentrations might be due to the degradation of chlorophyll pigments or reduction in their synthesis and the action of flavonoids, terpenoids or other phytochemicals present in the leaf extracts [14]. The more reduction of chlorophyll b than chlorophyll a indicated its susceptibility to stress and during stress situation, in tolerant species conversion of chlorophyll b to chlorophyll a may occur [15]. Reduction in pigments was previously reported as a result of allelochemical stress [16], [17]. A study conducted in rice verities revealed that weeds can produce allelopathic effects on the chlorophyll content of rice plant leaves[18].

4. Conclusion

The studies conducted by researchers prove that weed plants are capable of producing growth and yield inhibition of crop plants. In many parts of the world, the weed plant growing in the crop field are uprooted and are left in the field and mixed with soil as source of green manure. Some of these weeds may be possessing allelochemicals which in turn can produce an allelopathic impact negatively affecting the growth of the crop. While amending the soil with weed plants as green manure, the farmers have to be very careful so as to avoid such troublesome weeds. The results obtained from the present study also exhibited the allelopathic effects of the weeds on the chlorophyll content of rice plant leaves. Rice plant in control condition showed a higher chlorophyll content than the treated plants.

From the results it can be observed that weed plant residues left in the soil can become detrimental to the growth of crop plants. Ploughing the field and leaving the weeds in the field itself as a green manure is a very common practice in many rice growing countries. At times these weeds may be possessing allelochemicals which in turn can produce certain allelopathic impacts, negatively affecting the growth of the crops. Therefore care must be taken while selecting the plants for preparing green manure.

Table I: Growth performance of *Oryza sativa* L.grown under different experimental conditions

Sl. No.	Soil condition	Day	Shoot length
1.	*Ageratum conyzoides L.*	112th day	44.1cm
4.	*Commelina benghalensis L.*	112th day	71cm
5.	Control	112th day	74cm

Table II: Root length of *Oryza sativa* L. grown under different experimental conditions

Sl. No:	Soil condition	Day	Root length
1.	*Ageratum conyzoides L.*	112th day	2.2 cm
4.	*Commelina benghalensis L.*	112th day	2.4 cm
5.	Control	112th day	2.7 cm

Table III: Fresh and dry weights and Productivity of *Oryza sativa* L. grown under different experimental conditions

Sl. No:	Soil condition	Day	Fresh weight	Dry weight	Productivity
1.	*Ageratum conyzoides L.*	112th day	3.6g	0.8g	0.0071
4.	*Commelina benghalensis L.*	112th day	5g	0.99g	0.0088
5.	Control	112th day	5.2g	1.2g	0.0107

Table IV: Chlorophyll content of *Oryza sativa* L. grown under different experimental conditions

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Sl. No:	Soil condition	Day	Chloropyll a (mg/g)	Chloropyll b (mg/g)	Total chlorophyll
1.	*Ageratum conyzoides L.*	30th day	0.119	0.021	0.132
4.	*Commelina benghalensis L.*	30th day	0.141	0.049	0.170
5.	Control	30th day	0.148	0.059	0.174

Table V: Total Carbohydrate and Protein of *Oryza sativa* L. grown under different experimental conditions

Sl. No:	Soil condition	Carbohydrate content(mg/g)	Total protein content(mg/g)
1.	*Ageratum conyzoides L.*	28.57	0.112
4.	*Commelina benghalensis L.*	59.18	0.29
5.	Control	94.82	0.34

Table VI

Fresh weight of spikelet of *Oryza sativa* grown under different experimental conditions

Sl. No	Soil condition	Day	Fresh weight
1.	*Ageratum conyzoides L.*	112^{th}	1.52g
4.	*Commelina benghalensis L.*	112^{th}	5.4g
5.	Control	112^{th}	5.8g

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