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Phytoremediation of herbicide quizalofop-ethyl contaminated soil by *Sesbania sesban* L. for public health

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ABSTRACT

In world food production, agricultural pollution is a major concern. Nowadays in agriculture farmers using different toxic herbicide, pesticide, and other harmful chemical products were used control, the weeds, and pest. So, the presence of this kinds of toxic chemical harmfully affect the Funa and also while consuming the food the chemical reach to the human beings and it will create the cancer also, so that it must be control for public health in that way the present work deals how to remove the chemicals by plants through field experiment. In this field experiment, sandy loam soil was treated with a different level of herbicide (quaizalofop-ethyl) 0.5, 1.0, 1.5 and 2.0%, and *Sesbania sesban* L. seeds were sown in all treatment soil. The morphological parameters were measured after 20, 40, and 80 days. The results indicate that all the morphological parameters were increased in control then it was gradually decreased with increasing the herbicide concentration. Hence, after 80 days plants were harvested and the harvested plant powder was analyzed for absorption of herbicide by the plant with the help of gas chromatography mass spectrum. The obtained data showed that herbicide absorption was concerned in quaizalofop-ethyl treated plant when compared to control. This study reveals that residues of herbicide were reduced by *S. sesban* L.

KEY WORDS: Herbicide, phytoremediation, quaizalofop-ethyl, *Sesbania sesban*

INTRODUCTION

Due to the deficiency of agriculture workers, farmers are using different herbicides and to remove weeds and pest in worldwide, with the earliest uses arising in all the countries are applied in agricultural land to control. The continuous usage of these herbicides and pesticides toxic elements produces contamination of soil and groundwater. It affects the surface nutrients, soil fertility, and agricultural products. Some herbicides cause a variety of health problems ranging from skin rashes to death. The widespread incorporation of herbicides into soil every year is of major concern, since they potentially can pose a threat to our health as well as to the quality of soil, surface water and groundwater resources (Häggblom, 1992; Kearney and Roberts, 1998; Kuo and Regan, 1999; Ashman and Puri, 2002).

However, there is *an* extensive contamination of agricultural products and food with herbicide residues above tolerance limit. A large number of soils in this region are assumed to be contaminated with herbicide residues. Due to their toxic effects, it becomes essential to remove these pollutants from soil and water. Phytoremediation is the use of plants, trees and herbaceous species to eliminate or degrade contaminants or reduce their bioavailability in both water, and soil. The recent green technology that uses plants systems for remediation of contaminated soil.

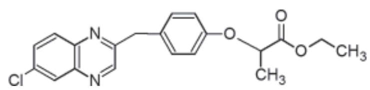
The legume plants play an important role for soil fertility. Not only soil fertility at the same time the plant having the tolerant capacity to the herbicide toxicity. Different plants were used for phytoremediation at herbicide but we did not get the results because all the plants are herbs even though among the plants we got good results from *Sesbania sesban* this plant having more tolerant to the herbicide, finally we selected the plant for phytoremediation. So, the present research work deals with phytoremediation of herbicide polluted soil by *S. sesban* L.

MATERIALS AND METHODS

Herbicide

[(2-(4-((6-chloro-2-quinoxalinyl)oxy)phenoxy)-ethyl ester] (CAS No. 76578-14-8) is a brownies liquid, chemical formula: $C_{19}H_{17}ClN_2O_4$. It is only slightly soluble in water. It was purchased from Agro Agencies, Chidambaram. It is a selective systemic herbicide used for the pre-and post-emergence control of annual grasses.

Characteristics of the Herbicides Quizalofop-ethyl

Herbicide name	Quizalofop-ethyl
Density	1.301 g/cm³
Molecular formula	$C_{19}H_{17}ClN_2O_4$
Molecular weight	372.80228
Chemical structure	
Vapor pressure	6.49×10^{-9} mm Hg at 20°C

Soil Preparation

The field was prepared randomly such as control soil (CS), QS1 (0.5% quizalofop-ethyl treatment soil), QS2 (1.0% quizalofop-ethyl treatment soil), QS3 (1.5% quizalofop-ethyl treatment soil), and QS4 (2% quizalofop-ethyl treatment soil). Soil CS and QS4 herbicide treated soils were used as physicochemical analysis in after 20 day's treatment.

Plant Material and Growth Conditions

S. sesban L. seeds were sown in the herbicide-treated soils. After 20, 40, and 80 days of treatment; the plant from each treatment were randomly selected for the measurement of root length and shoot length using centimeter scale, and their fresh weight was taken by using electrical single pan balance. The fresh plant materials were kept in a hot air oven at 80°C for 24 h and then their dry weight also determined.

Gas Chromatography-Mass Spectrometry (GC-MS) Analysis

The GC-MS analysis was performed on a Shimadzu series GC 17A gas chromatograph equipped with split/splitless injector and interfaced with QP-5050 Shimadzu MC The GC was equipped with capillary column BPX-5 (Phenomenex) (30 m × 0.25 mm I.D. with 0.25 µm film thickness) connected to the split/splitless injector. The optimized oven temperature program was at first 80°C (5 min), then from 80°C to 280°C (at 20°C/min). The final temperature was held for 5 min. A column head pressure was 56.7 kPA, and an injector temperature was 220°C. Helium was used as the carrier gas at a flow rate of 9.8 ml/min. The MC was operated in the electron impact ionization, and the applied energy was 70 eV. MC was acquired in the mass range from m/z 50 to 650. The detection of Quaizalofop-ethyl was also accomplished in selected ion monitoring mode, using the following fragment ions: m/z 25000 [(2-(4-((6-chloro-2-quinoxalinyl)oxy)phenoxy)-ethyl ester]. The instrumentation was controlled by software CLASS 5000 with NIST107 and NIST21 library of MC.

RESULTS AND DISCUSSION

Morphological Studies on *S. sesban* L.

Shoot and root length

The mean value of the *S. sesban* L. plant grown with four doses rate of herbicide quaizalofop-ethyl showed a various morphological parameters on 20, 40, and 80 DAS of observations [Figures 1 and 2]. The effect of lower concentration (0.5%) of herbicide in minimum reduction on root length (88%) and shoot length (89%) of *S. sesban* plant were observed in of 20, 40, and 80 DAS intervals when compare with control. The average and

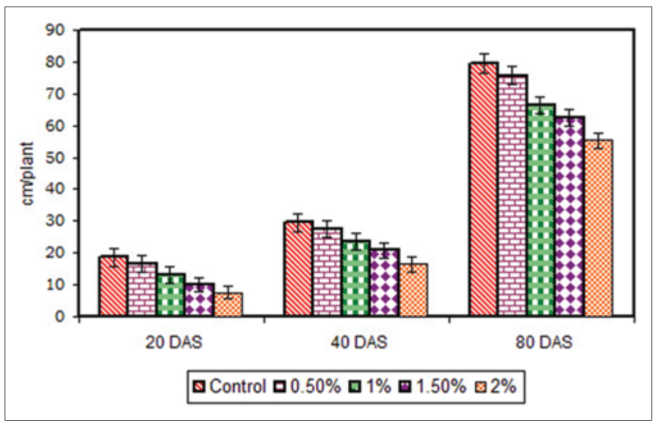


Figure 1: Effect of different concentrations of herbicide (quizalafop-ethyl) on shoot length of *Sesbania sesban* L.

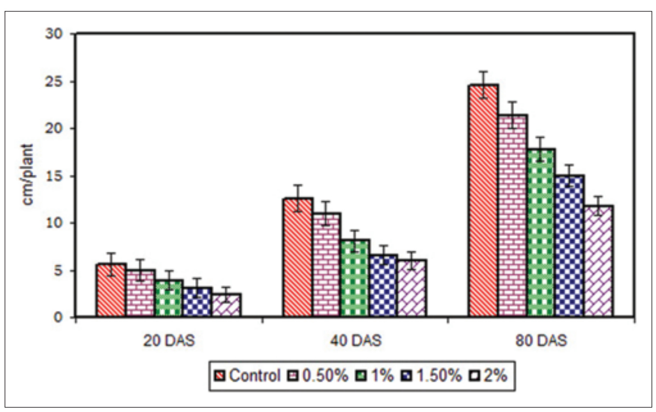


Figure 2: Effect of different concentrations of herbicide (quizalafop-ethyl) on root length of *Sesbania sesban* L.

maximum reduction of root length (75, 61 and 54%) and shoot length (78, 70 and 62%) occurred at (1% soil), (1.5%), and (2%) concentrations. Generally, the effect of the herbicide quaizalofop-ethyl on plant morphological parameters such as root length and shoot length were decreased gradually with an increase in rates of herbicide. The reduction of shoot and root length of *S. sesban* by herbicide might be due to abiotic stress. The presence of herbicide create the stress, and it will affect the ascent of sap physiology process in plant cells, and also it will arrest the cell elongation, and it the auxin regulation in shoot system. The same finding observed by (Fayez and Kristen, 1996) it was observed that the tomato seeds plantlet and seedling growth was significantly delayed after insecticides application, affecting the plantlets shoots as well as root. However, many studies reported an inhibitory effect of growth after application of pesticides (i) Around 50% decreasing of root in *Phaseolus vulgaris* and *Pisum sativum* after treatment with chlorsulfuron during the germination process. (ii) Low root growth in *Zea mays* seedlings in the presence of pesticides such as chlorsulfuron and metsulfuron methyl (Fayez *et al.,* 1994). Reduction in growth parameters were observed with 0.5% herbicide application followed by 1, 1.5, and 2%, in black gram field (Mahakavi *et al.,* 2014).

Chouychai and Lee (2012) have studied that the four plants (corn, pumpkin, sunflower, and water morning glory) were tested for their ability to grow in contaminated with lindane and alpha-endosulfan. The presence of lindane decreased the shoot and root length of all the plants tested. The presence of alpha-endosulfan decreased only the root length of sunflower, water morning glory, and pumpkin plants.

Fresh and dry weight

The effect of lower concentration (0.5% soil) of herbicide in minimum reduction on fresh weight (88%) and dry weight (84%) of *S. sesban* plant were observed in of 20, 40, and 80 DAS intervals. The average and maximum reduction of fresh weight (71, 50 and 39%) and dry weight (65, 46 and 38%) occurred at (1% soil), (1.5% soil), and (250% soil) concentration [Figures 3 and 4]. Generally, the effect of the herbicide quaizalofop-ethyl on plant morphological parameters such as root length and shoot length were decreased gradually with an increase in rates of herbicide. We showed similar to results the recommended dosage of Sigma Broad for wheat is not safe to Radix Isatidis seedlings. It causes the damage of growth and reduces the photosynthetic rate Yuan *et al*. (2013). Our results are comparable to the observations made by Aida *et al*., 2006 and recently done by El-Shahate *et al*. (2011). The fresh and dry weight of both root and shoot also decreased while the increased for each concentration of profenofos suggested by Mishra *et al.* (2014).

Physicochemical analysis

Physicochemical CS polluted soil, remediate soil were nearby neutral at the time of herbicide treatment in

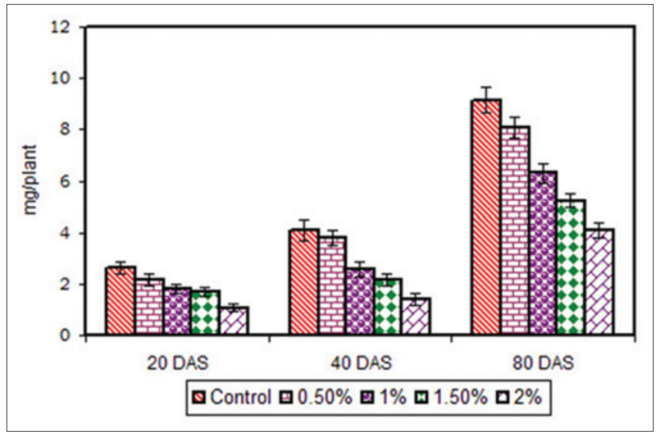


Figure 3: Effect of different concentrations of herbicide (quizalafop-ethyl) on fresh weight of *Sesbania sesban* L.

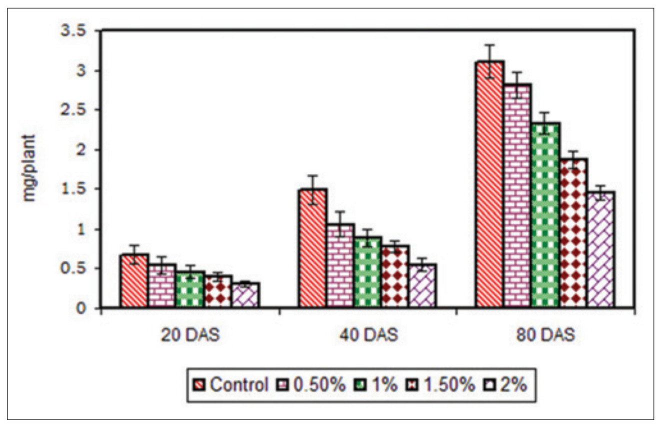


Figure 4: Effect of different concentrations of herbicide (quizalafop-ethyl) on dry weight of *Sesbania sesban* L.

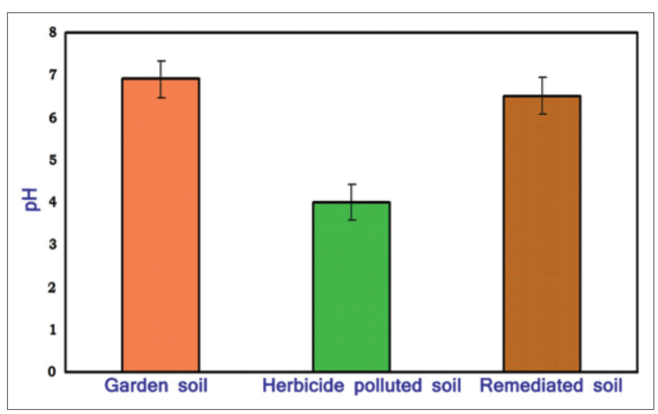


Figure 5: Effect of herbicide (quizalafop-ethyl) on soil pH of before and after remediated soil.

soil medium. It decreased up to 4.0, the decrease soil pH from nearly neutral to acidic was because of the metabolic activities involved in the quaizalofop-ethyl. The pH analysis of CS, polluted soil very low in herbicide polluted soil when compare CS at the same time some enhancement observed in phytoremediated soil by *S. sesban* [Figures 5-11].

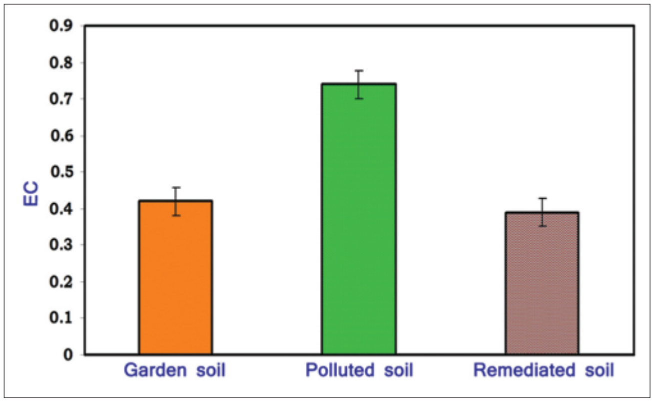


Figure 6: Effect of herbicide (quizalafop-ethyl) on soil EC of before and after remediated soil.

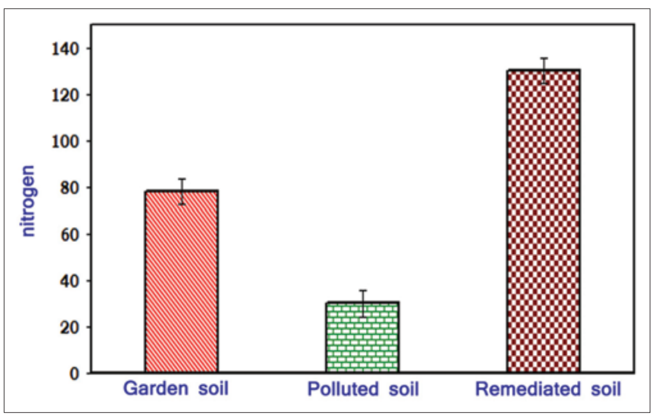


Figure 7: Effect of herbicide (quizalafop-ethyl) on soil nitrogen of before and after remediated soil.

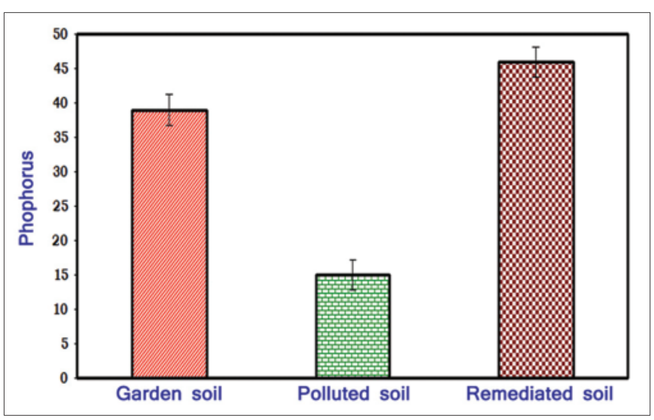


Figure 8: Effect of herbicide (quizalafop-ethyl) on soil phosphorus of before and after remediated soil.

Accumulation of the [(2-(4-((6-chloro-2-quinoxalinyl) oxy)phenoxy)-ethyl ester] Residues in *Sesbania* Tissues after Treatment with Various Doses of the Herbicide

GC-MS showed the presence of the [(2-(4-((6-chloro-2-quinoxalinyl)oxy) phenoxy)-ethyl ester] within the studied *S. sesban* L. plant. After GC-MS separation, the 2-[4-(6-Chloro-2-quinoxalinyl)-phenoxy]ethyl propionate

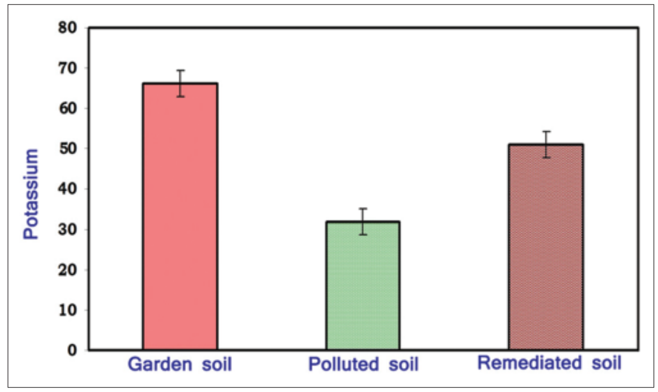


Figure 9: Effect of herbicide (quizalafop-ethyl) on soil potassium of before and after remediated soil.

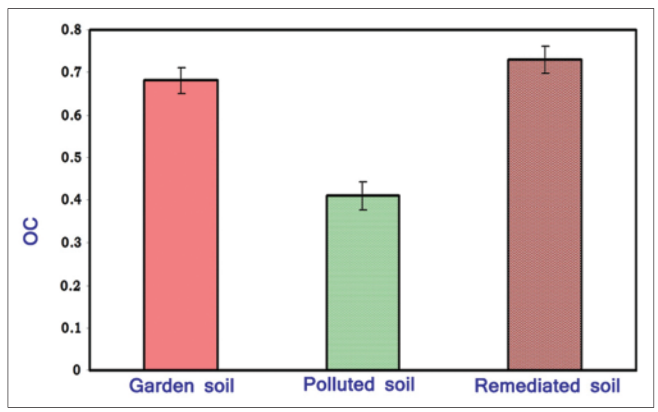


Figure 10: Effect of herbicide (quizalafop-ethyl) on soil organic carbon of before and after remediated soil.

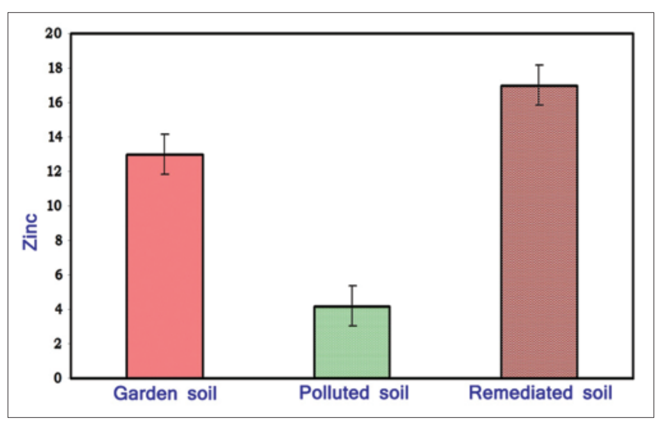


Figure 11: Effect of herbicide (quizalafop-ethyl) on soil zinc of before and after remediated soil.

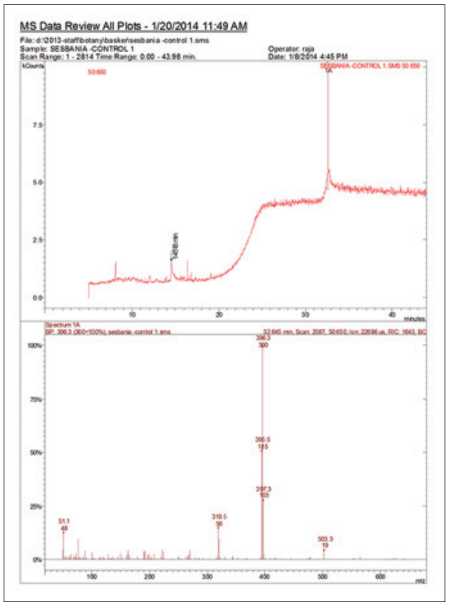


Figure 12: GC-MS analysis of Quizalofop-ethyl accumulation of Sesbania sesban L (control plant).

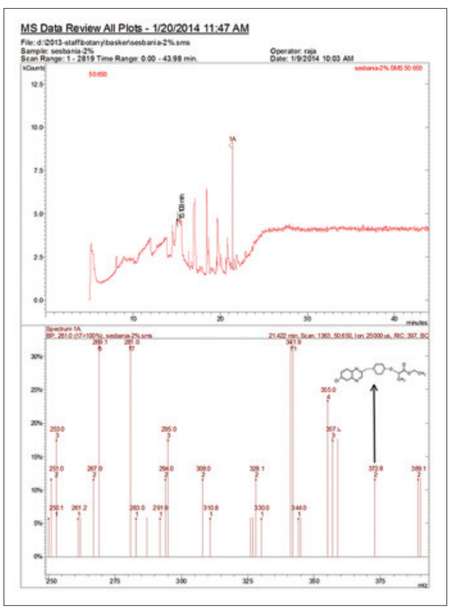


Figure 13: GC-MS analysis of Quizalofop-ethyl accumulation of Sesbania sesban L (2% quizalofop-ethyl treatment

showed a single peak that was identified after the comparison of MS spectrum these herbicide and NIST spectrum library (http//webbook.nist.gov/chemistry) [Figures 12 and 13].

The selectivity of the method was confirmed by GC-MC from of the plant sample prepared with and without herbicide pollution. Than, the retention time was used the ions (m/z) to identify quizalofop-ethyl (380, 400, 410) in the concentration of 2%. The results revealed that residues of quizalofop-ethyl were detected in *S. sesban* plant samples analyzed (25.5%) during the 80 days.

CONCLUSION

Phytoremediation is the use of plants to remove toxic foreign chemicals, including herbicides from the environment. As *S. sesban* L. is cultivated in agricultural soils characterized by pH (6.8-7.2) and high organic matter content, these could have imparted more stability to herbicide molecules, as well as, helped in a higher rate of adsorption of these xenobiotics. The transport, persistence or degradation of herbicide in soil depends on the chemistry of the herbicide as well as physical, chemical, and biological properties of the soil. The presence of this herbicide in the soils of *S. sesban* is likely to adversely affect soil flora and fauna and may even cause pollution of surface soil. So, this study reveals that residues of herbicide were reduced by *S. sesban* L. and improve the soil fertility.

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