

**ADDIS ABABA UNIVERSITY FACULTY OF LIFE SCIENCE GRADUATE
STUDIES PROGRAM**



**EFFECTS OF EUCALYPTUS GLOBULUS LEAF EXTRACT ON
GERMINATION RESPONSE AND SEEDLING GROWTH OF FIVE
WHEAT SPECIES**

A thesis submitted to the school of graduate studies of Addis Ababa
University in partial fulfillment of the Requirement for the degree of
Masters of Science in Biology

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July 2016
Addis Ababa, Ethiopia

ACKNOWLEDGEMENTS

This work has been in its present shape with considerable professional, financial, and material inputs from various sources. Therefore, I deeply wish to extend thanks to many people and organizations that made this work possible. In grateful recognition, I want to address my sincere thanks to Dr. Habte Jebessa first and foremost for his willingness to accept me as his student with all provision of working facilities. He kindly shared all possible facilities and was available to share ideas whenever required. His comments on the manuscript helped me to make much improvement.

Totally, this research work was formulated with his great support and encouragement.

My appreciation also goes to Dr. Gemedo Dale, Director of the Ethiopian Institute of Biodiversity for his valuable information about the availability of wheat varieties in the institute and provide me five wheat samples to be experimented.

Truthful thanks should also be addressed to Ethiopian Institute of Biodiversity laboratory analysts for their willingness to identify and submit five wheat samples. Above all I am thankful to God.

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THE NEGATIVE EFFECT OF EUCALYPTUS ON GERMINATION AND SEEDLING
GROWTH OF WHEAT

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ABSTRACT

Several volatile and water-soluble toxins were found in Eucalyptus tissues. Cineole and α -pinene, both highly toxic terpenes, were found adsorbed to colloidal soil particles of the litter and bare zones. Adsorbed terpenes were toxic to germinating seeds and seedlings. Eucalyptus is representative of a wide variety of plants capable of establishing gradients of toxicity in an otherwise relatively uniform environment. Such gradients drastically alter the species composition and thus are highly important to the study of vegetation composition. Allelopathic factors interact dramatically with other environmental factors and must be considered as a part of the environmental complex. The leaf litters were collected from 8-year old eucalyptus plantation from Dejazmach Wondirad Preparatory School compound in Addis Ababa Yeka sub city. Leaf litters were washed and dried for two weeks, ground and stored at room temperature. Good quality seeds of five popular wheat varieties (*Triticum aestivum*, *Triticum durum*, *Triticum dicoccum*, *Triticum polonicum*, and *Triticum turgidum*) were obtained from Ethiopian Institute of Biodiversity. The seeds were collected from different regions of Ethiopia.

The experiment was set in North of Addis Ababa, Yeka Sub city Tafo residence area.

The allelopathic influence of aqueous extracts of Eucalyptus on the germination and seedling growth (fresh and dry weight) of wheat have been determined.

It was noted that aqueous extracts at a concentration of 10%, 15% and 20% had inhibitory effect on wheat germination and the effect was found significantly higher than control treatment. Fresh and dry weight of seedling was also reduced significantly over control. The inhibitory effects were increased as the extract concentration increased. These finding indicates that wheat seeds sown in fields which had leaf litter of Eucalyptus will be adversely affected regarding germination, growth and ultimately resulting in lower yields of wheat.

Key words: Allelochemicals, Allelopathy, Eucalyptus, Litter, phytotoxins

CHAPTER ONE

INTRODUCTION

Addis Ababa, the capital city of Ethiopia, was established in Menelik II regime. During this regime, Addis Ababa was running with scarcity of fire wood and wood for construction. For the purpose of resolving these problems, Emperor Menelik II was looking for a tree which could grow fast. Thus, the emperor had introduced Australian eucalyptus, which came to be known in Ethiopia as the *bahr zaff* or tree from across the sea in 1895. Since then it had been grown up in different corners of the country (Zenebe Mekonnen, 2010). The eucalyptus, it may be noted, was not without its disadvantages. It was in particular so thirsty a plant that it dried up rivers, lakes, and wells in its vicinity, and prevented other plants growing beneath it, and in this way significantly encouraged soil erosion.

These days it is natural to see eucalyptus tree/s in every farmer's plot. Naturally plants grow in groups in an ecological zone but when two or more plants grow in an ecological zone; they compete each other for different life requirements. When plants grow close to each other some plants produce chemicals that may interfere the seed germination and seedling growth of other plants. Under integrated land use system a tree crop and a food crop may be grown on the same piece of land with a proper combination of both the tree and agricultural crops (Bene *et al.*, 1977).

An increased productivity in the future plantations both on forest lands and rural areas can only be achieved by planting tree species and agri-crops in a combination which can imply a promontory rather than inhibitory tree crop interaction.

Reduction in yield of agri-crops and or poorer growth of tree seedlings is often blamed on mismatching of crop combinations. Part of the problems, in fact, lies in the selection of tree and food crop combination, and inhibitory effects of some leaf leachates on adjacent agricultural crops. King (1979) pointed out the need for investigations of allelopathy in various tree species used in agro forestry where there is a good chance of allelochemicals released by the intercrop trees affecting food and fodder crops.

Therefore, it seems essential that the allelopathic compatibility of crops with trees should be checked before introducing into agro forestry system (Khan and Alam, (1996). Eucalyptus has been planted in degraded areas as well as in the agro forestry programmes for the uplift of socioeconomic condition of the rural people for a long time. There have been a number of studies on allelopathy of Eucalyptus, particularly in India where planting of Eucalyptus is greatly controversial. Willis (1991) and Luo (2005) stated that less vegetation exists under Eucalyptus canopy than indigenous trees. Study by Lin *et al.*, (2003) showed that water, ethanol, or acetone extracts from Eucalyptus also have allelopathic effect on *Pisolithus tinctorius*, a common fungus in South China. Though many works are being done all over the world on allelopathy, it is still very new (Uddin *et al.*, 2000; Hossain *et al.*, 2002; Hoque *et al.*, 2003a, b, c, d).

These chemicals are termed as allelopathic chemicals and examining the effects of such chemicals in situation where there is biodiversity is important. Particularly the effects of allelopathic chemicals on major crops consumed by majority of residents need to be examined. While this is the case, studies of this sort are lacking in developing countries like Ethiopia. So, the purpose of the present study is to elucidate the allelopathic potential of Eucalyptus on some common crops such as wheat.

CHAPTER TWO

REVIEW OF RELATED LITERATURE ON EFFECTS OF EUCALYPTUS GLOBULUS LEAF EXTRACT ON GERMINATION RESPONSE AND SEEDLING GROWTH OF WHEAT

Allelopathy is an important mechanism of plant interference mediated by the additional phytotoxins to the environment, chemicals with allelopathic potential are present in virtually all plants as in most tissues. Under appropriate conditions, these chemicals may be released into the environment, in sufficient quantities to affect neighboring plants. Several researches conducted on many species of forest trees such as Acacia, Eucalyptus and Walnut which produce allelochemicals that could suppress the growth and germination of other crops and weeds growing near to them (El-Khwas and Shehata, 2005). Eucalyptus is a large perennial woody tree and its leaves have shown allelopathic activity. It is a representative of a wide variety of plants capable of establishing gradients of toxicity in an otherwise uniform environment.

Such gradients drastically alter the species composition and thus are highly important to the study of vegetative composition. Eucalyptus species release volatile compounds such as benzoic, cinnamic and phenolic acids which inhibit the growth of crops and weeds near to it. Guo (2006) studied the allelopathic effects of Eucalyptus spp. on seed germination and seedling growth of some crops, revealing that maximum inhibition of seed germination rate and seedling growth were recorded when using the highest concentration of the aqueous extract of Eucalyptus leaves. Reduction in yield of agri-crops and or poorer growth of tree seedlings is often blamed on mismatching of crop combinations. Part of the problems, in fact, lies in the selection of tree and food crop combination, and inhibitory effects of some leaf leachates on adjacent agricultural crops. King (1979) pointed out the need for investigations of allelopathy in various tree species used in agroforestry where there is a good chance of allelochemicals released by the intercrop trees affecting food and fodder crops. Therefore, it seems essential that the allelopathic compatibility of crops with trees should be checked before introducing in agroforestry system (Khan MS and Alam MK, (1996). Allelopathic chemicals secreted by some plants are natural compounds that have shown far-reaching effects on the growth and development of plants even at low concentration (Moradshahi, Ghadiri, and Ebrahimikia, (2003). One of the plants which produce allelopathic chemicals on other plants in the same ecology zone is eucalyptus tree.

In that study which was conducted in Bangladesh, it was found out that leaf litters of Eucalyptus induced inhibitory effects and the effect depends on not only on dose of extract and litter fall but also on type of receiver species.

Eucalyptus spp. dominates the world's crop plants, and its allelopathy offers a ready explanation of eucalyptus dominance (Van Steenis, 1971). Eucalyptus as an agro-forestry component tree has been used for a long time. Recently a controversy among the planters has been arisen due to adverse effect to the adjoining crops; much of it came from neighboring countries (Dhillon *et al.*, 1982) Other controversies linked with the tree include lowering of water table, depletion of nutrients due to lesser leaf production, in delayed decomposition due to presence of volatile oils and wax coating in the leaves and more soil sap requirement to meet the demands of fast growing and dividing cells (Kohli, 1991).

Keeping aside such controversies linked with the tree, the area under eucalyptus plantation often houses poor vegetation. It is alleged that in spite of sufficient light intensity, nutrients or space to support vegetation, there is low biodiversity on its floor. For such an anti-phyto-social property, allelopathy has been proposed to be the reason (Kohli, 1990). Taking this into consideration, researchers have examined the allelopathic effects of eucalyptus on different plant species. One of these species which has received researchers' attention is wheat species.

Allelopathic effects of eucalyptus on wheat are also reported in different research works here and there.

In those studies it has been found out that aqueous extracts from eucalyptus at a dose of 10%, 15% and 20% had inhibitory effect on wheat germination and the effect was found significantly higher than the control treatment. It was revealed that fresh and dry weight of seedling was also reduced significantly over the control. This study was aimed at evaluating the effect of aqueous leaf extract of *Eucalyptus globulus* against five wheat species.

Statement of the problem

There have been discussions over the socio-economic benefits of eucalyptus trees and their side effects on biodiversity. Some argued that eucalyptus plantations generate large economic returns because of their rapid growth rates, wide adaptability and high productivity (Zenebe Mekonnen, 2010). Farmers have remarked that planting fast growing trees like Eucalyptus is the best alternative strategy to minimize the existing fire wood scarcity in that locality rather than the use of cow dung and crop residue. Price of poles and posts for construction is higher in dry season (high demand) as there are more house and fence construction.

While this is the fact on the ground, the researches conducted on the side effects of eucalyptus trees had argued against eucalyptus plantations.

Table 1. Arguments on side effects of Eucalyptus spp.

Negative arguments	Sources
<ul style="list-style-type: none"> • Eucalyptus trees compete for water and other nutrients with crops in their vicinity, and deprive of healthy growth of crops • Eucalyptus spp. need plenty of water, and drain away sub-soil water and cause water scarcity. • Eucalyptus trees suppress undergrowth and cause degradation of land • Eucalyptus trees do not support wildlife. • –Eucalyptus is nothing less than ecological fascism, which can be described as a species that destroys the hydrological balance, impoverishes the soil of its nutrients, and reduces biodiversity.” • –Eucalyptus is not only a soil degrader but also a crop destroyer, a depriver of fodder, flattener of natural forests, destroyer of security, creator of poverty and dependence, and killer of knowledge of future generations about how to live on one hand and livelihood and environment on the other.” 	<p>Shiva and Bandyopadhyay 1985; Poore and Fries 1985; FAO 1988, 1992, 1996; IUCN 1992; Evans 1992; Lisanevork 2000; El-Khawas and Sheheta 2005; Lohmann (1990) cited in Turnbull (1999).</p>

While this is the fact, there is lack of research endeavors which examines the side effect of eucalyptus tree on wheat in Ethiopia. Therefore, the present study will try to fill this gap by assessing the side effects of eucalyptus tree on wheat.

Hypothesis

Three hypotheses were set for this experiment, for germination, fresh weight and dry weight of seedling and based on the results of the experiment, the null and alternatives hypothesis were tested using one-way ANOVA for multiple means.

Hypothesis 1:

H_0 = Different levels of *Eucalyptus globulus* leaf extract has no significant impact on wheat germination.

H_1 = Different levels of *Eucalyptus globulus* leaf extract has significant impact on wheat germination.

Hypothesis: 2

H_0 = Different levels of *Eucalyptus globulus* leaf extract has no significant impact on wheat seedlings fresh weight.

H_1 = Different levels of *Eucalyptus globulus* leaf extract has significant impact on wheat seedlings fresh weight.

Hypothesis 3

H_0 = Different levels of *Eucalyptus globulus* leaf extract has no significant impact on wheat seedlings dry weight.

H_1 = Different levels of *Eucalyptus globulus* leaf extract has significant impact on wheat seedlings dry weight.

CHAPTER THREE

Objectives

3.1 General objective

To investigate the allelopathic effects of eucalyptus on germination and seedling growth of wheat

3.2 Specific objectives

Specifically this study will try to:

- Look into the effects of Eucalyptus leaf extract on Wheat Seed Germination
- Examine the effect of Eucalyptus leaf extract on Wheat Seedling Fresh weight
- Assess the effect of Eucalyptus leaf extract on Wheat Seedling Dry weight

3.3, Significance of the study

It is believed that the present study will have the following major benefits:

1. Wheat is one of the most consumed crops in Ethiopia. At the same time, these days eucalyptus is grown in almost every farmer's land. Thus examining the effects of eucalyptus on wheat will benefit farmers who grow both eucalyptus and wheat.

It gives them the direction on how they could grow eucalyptus and other crop plants in a single plot or take other majors.

2. This study was conducted in Addis Ababa. Thus the study would also benefit those who work with and care for farmers in the region. The findings of the study will inform all stake holders who need to scale up best practices to other areas. The study would also benefit other researchers who want to conduct a similar study at a larger scale.

CHAPTER FOUR

Materials and Method

4.1. Study design

The present study employed experimental research design. In its specific case, it is planned to conduct field trials to determine the allelopathic effects of *Eucalyptus globulus* on five different wheat species, in doing so, seed germination and seedling survivorship of wheat species were determined in the presence and absence of *Eucalyptus globulus* leaf extract.

4.2 Data collection and statistical analysis

The data was recorded on germination count, fresh weight and dry weight of wheat seedlings. The data, then, was analyzed and significant means were separated. Statistical procedures and fresh weight and dry weight of seedlings were calculated.

4.3 Field trial procedures

The leaf litters were collected from 8-year old eucalypt plantation from Dejazmach Wondirad Preparatory School compound in Addis Ababa Yeka sub city. The experiment was set up in North of Addis Ababa, Yeka Sub city Tafo residence area. Leaf litters of *Eucalyptus globulus* were washed and dried for two weeks, ground and stored at room temperature. Good quality seeds of five popular wheat species (*Triticum aestivum*, *Triticum durum*, *Triticum dicoccum*, *Triticum polonicum*, and *Triticum turgidum*) were collected from different regions of Ethiopia as shown in table 1 below.

Table 2. Seed sample collection regions

S.N ^o	Name of the five wheat species	Samples collected center	
		Region	Zone
1	<i>Triticum aestivum</i>	SNNP	Hadiya
2	<i>Triticum durum</i>	Amhara	Semen Wello
3	<i>Triticum dicoccum</i>	Oromiya	Misrak Shewa
4	<i>Triticum polonicum</i>	Amhara	Semen Shewa
5	<i>Triticum turgidum</i>	Amhara	Mierab Gojam

Twenty seeds of each variety were planted in steel trays (with 24 cm diameter and 8 cm depth). Each tray was filled with 500 g of soil that was collected from bare land and used as growing medium. The ground leaves material was soaked in distilled water in the ratio of 1:20 and kept for 24 hours.

The filtrate was designated as stock solution of 100% concentration. From this stock solution, other levels (doses) viz., 10%, 15% and 20% were prepared by diluting them with distilled water and the control contained only distilled water.

CHAPTER FIVE

RESULTS

5.1. Germination Counts

Table 3. Allelopathetic effects of *Eucalyptus globulus* on germination counts of wheat species

Wheat species	Number of seeds germinated on different level of <i>Eucalyptus globulus</i> leaf extract				Species Means
	0% (Control)	10%	15%	20%	
<i>Triticum aestivum</i>	20	17	13	9	13.00
<i>Triticum durum</i>	19	16	8	7	10.00
<i>Triticum dicoccum</i>	17	9	5	3	5.67
<i>Triticum polonicum</i>	18	15	9	4	9.3
<i>Triticum turgidum</i>	20	19	16	13	16.00
	Means= 18.8	15.20	10.20	7.20	10.9

One-way ANOVA for the comparison of multiple means showed that the four treatments (with 0%, 10%, 15% 20% level of leaf extract) are significantly different at 99% Confidence interval ($p < 0.0001$). This means the leaf extract of *Eucalyptus glubulus* significantly impacts seed germinations of the five wheat species under consideration.

All the five popular wheat species (*Triticum aestivum*, *Triticum durum*, *Triticum dicoccum*, *Triticum polonicum*, and *Triticum turgidum*) responded to the aqueous extract application (Table-2). *Triticum turgidum* and *Triticum aestivum* showed resistance to the allelopathic effect (Table-2). The interaction clearly indicated that *Triticum turgidum* produced the maximum while *Triticum dicoccum* the lowest number of germinated seeds. Interaction also shows that reduction in germination counts becomes more pronounced with increasing doses of Eucalyptus aqueous extract. At 20% level of leaf extract all wheat species resulted in a significant reduction in germination counts when compared with control. *Triticum dicoccum* and *Triticum polonicum* were worst affected at the highest levels, 15% and 20% respectively. Evidently all wheat species were adversely affected by extract application regarding the number over control. There was direct relationship between number of germinated seeds and extract level. These results could lead to the thought that Eucalyptus leaf aqueous extract could reduce the number of germinated seeds even in low level of leaf extract.

5.2. Percentage of Germination

Table.4. Percentage of germinated seeds with different levels of *Eucalyptus globulus* leaf extract

Wheat species	0% (Control)	Percentage of germinated seeds with different levels of conc. of Eucalyptus leaf extract			Varietal Means
		10%	15%	20%	
<i>Triticum aestivum</i>	100%	85 %	65%	45 %	65%
<i>Triticum durum</i>	98%	80%	45%	35%	53.33%
<i>Triticum dicoccum</i>	70%	50 %	30%	15%	31..67%
<i>Triticum polonicum</i>	96%	75%	45%	20%	48.33%
<i>Triticum turgidum</i>	100%	95%	80%	65%	80%
Means = 92.80 %		77%,	53%	36%	55.33%



Fig. 1 Control (*Triticum dicoccum* seeds treated with distilled water)



Fig.2 *Triticum dicoccum* seeds treated with 10% level of *Eucalyptus globulus* leaf extract



Fig.3 *Triticum dicoccum* seeds treated with 15% level of *Eucalyptus globulus* leaf extract



Fig.4 *Triticum dicoccum* seeds treated with 20% level of *Eucalyptus globulus* leaf extract

It can be summarized from the results that the leaf extract having any concentration of allelochemical will reduce the wheat seed germination. The variation in germination of different wheat species might be due to the variation of genetics of these five species.

Figures (below) show the height of seedlings of *Triticum turgidum* when treated with different levels of *Eucalyptus globulus* leaf extract.



Fig.5 Control==(Triticum aestivum seedlings treated with distilled water)



Fig. 6 Seedlings treated with **10%** level of *Eucalyptus globulus* leaf extract



Fig. 7 Seedlings treated with **15%** level of *Eucalyptus globulus* leaf extract



Fig. 8 Seedlings treated with **20%** level of *Eucalyptus globulus* leaf extract

5.3 Fresh weight of Seedlings

Three weeks old seedlings were uprooted and data were recorded and analyzed. The results are presented in Tables 5.

Table.5. Allelopathetic effects of *Eucalyptus globulus* leaf extract on fresh weight of seedlings of five wheat species.

Wheat species	0% (Control)	Fresh weight (in gram) of seedlings on different levels of <i>Eucalyptus globulus</i> leaf extract			5 species means
		10%	15%	20%	
<i>Triticum aestivum</i>	90.00 g	63.00g	45.00g	32.00g	46.67
<i>Triticum durum</i>	85.00g	55.00g	39.00g	25.33g	39.78
<i>Triticum dicoccum</i>	67.00g	47.00g	38.00g	19.00g	34.67
<i>Triticum polonicum</i>	88.00g	58.00g	48.00g	29.00g	45
<i>Triticum turgidum</i>	95.00g	66.00g	49.00g	35.00g	50
Means =85g		57.80g	43.80g	28.00g	43.22

Different levels of *Eucalyptus globulus* leaf extract have significant impact on wheat fresh weight at 95% confidence interval (One –way ANOVA, $p < 0.05$).

The Eucalyptus extract had decreased the fresh weight of wheat seedlings. Some wheat species were more adversely affected than all other species.

The extract level of 10%, 15% and 20% decreased the fresh weight of all wheat species. Some proved to be the more fresh weight producing species as compared to other species at 20% level of *Eucalyptus globulus* leaf extract. At lower level (10%), comparatively less reduction in their fresh weights was observed.

This indicates that when wheat seedlings are treated with Eucalyptus leaf extract can tolerate the stress up to some extent, but as concentration increases, significant reduction in fresh weight and growth of seedling occurs in all wheat species. Aqueous *Eucalyptus globulus* leaf extract of various levels inhibited the germination of five wheat species and also negatively affected their fresh weights.

5.4 Dry weight of seedlings

Table 6. Allelopathetic effects of *Eucalyptus globulus* leaf extract on dry weight of seedlings of five wheat species.

Varieties (wheat)	Dry weight (in gram) of seedlings on different level of <i>Eucalyptus globulus</i> leaf extract				5 species means
	0% (Control)	10%	15%	20%	
<i>Triticum aestivum</i>	4.00 g	2.30g	1.18 g	0.99g	1.49g
<i>Triticum durum</i>	2.00g	1.21g	0.57g	0.41g	0.73g
<i>Triticum dicoccum</i>	0.90.g	0.3g	0.17g	0.10g	0.29g
<i>Triticum polonicum</i>	1.50g	0.99g	0.21g	0.15g	0.45g
<i>Triticum turgidum</i>	6.00g	2.17g	1.45g	1.02g	2.21g
	Means==2.88g	1.00g	0.71g	0.534g	1.00g

Different levels of *Eucalyptus globulus* leaf extract has significant impact on wheat dry weight at 95% confidence interval (One –way ANOVA, $p < 0.05$).

The data (in Table-5) revealed that aqueous extracts of different levels of *Eucalyptus globulus* leaf extract significantly reduced the dry weight of wheat seedlings over control. The adverse effect gradually increased resulted in the decrease of dry weight of the seedlings. The reason could be the decrease in fresh weight of seedling.

Another probable reason could be the inhibitory effect of allelochemicals in uptake of water by seedling and reduction in other physiological processes of wheat species. Similar findings have been reported by Patel *et al.*, (2002) who reported that Eucalyptus trees reduced germination, seedling growth and yield of wheat crop. This harmful effect of different aqueous extract pointed out that allelochemicals in any concentration present in soil could decrease the dry weight and yield of any wheat genotype. Several studies have reported that many secondary metabolites are released into the environment, either as exudation from living plant tissues or by decomposition of plant material under certain conditions (Einhelling, 1995).

These chemicals like phenolics, terpenoids and alkaloids and their derivatives are potential inhibitors of germination, seedling growth, fresh weight and dry weights. Herro and Callaway (2003) observed that aqueous Eucalyptus extract was effective in general to cause growth inhibition. But all plants of the same species were not equally susceptible to aqueous extracts of Eucalyptus.

CHAPTER SIX

Discussion

The foregoing results clearly indicated the suppressive effect of *Eucalyptus globulus* leaf extract on germination and seedling growth of bioassay species. Seed germination is considered to be the most critical stage especially under stress conditions. During germination, biochemical changes take place, which provide the basic framework for subsequent growth and development. The initial metabolic changes that occur immediately after the imbibition of water are the increase in the hydrolytic enzymes such as alpha-amylase and protease.

Alpha amylase is an important starch degrading enzyme in the endosperm of cereal grains. The reaction products provide substrate and an energy source for the embryo during germination. Inhibition of seed germination of crop plants is also due to disturbance in the activities of peroxidase, alpha-amylase and acid phosphates (Alam and Islam, 2002).

All levels of leaf extract had inhibitory effect on the germination of all wheat species as compared to the control treatment. It can be seen from the data in Table 4 that only wheat species, *Triticum turgidum* produced maximum number of germinated seeds (80%) over all other species. This indicates that this species had some tolerance to the adverse influence of allelochemicals contained in the leaf extract. But some species were found to be most sensitive towards leaf extract application.

It is very clear from these results that wheat crop sown near or under the Eucalyptus trees will be adversely affected and its germination is reduced up to about 50%. The interaction also showed that each level of extract had injurious effect on all wheat species than control treatment. The interaction among various levels of *Eucalyptus globulus* leaf extract and wheat species depicted that *Eucalyptus globulus* leaf extract at lower level (10%) has lower inhibitory effect as compared to higher level (20%) in all wheat species. This gradual decrease in germination was due to allelopathic effects of *Eucalyptus globulus* leaf extract from lower level (10%) to higher level (20%) as compared to control.

Several researchers such as Bowman and Kirkpatrick (1986), Igboanugo (1986, 1987), Lovett (1989) have also reported similar effect of Eucalyptus species. Hillis and Brown, (1988) pointed out that various Eucalyptus species could yield allelopathic chemicals that may be effective in suppressing understory vegetation. All species of Eucalyptus have foliar oil glands that are rich in essential oils, principally terpenoids; typically 1 to 5 percent of the fresh weight is essential oils (Barker RT, Smith 1920; Guenther 1950).

The leaves contain diverse phenolic compounds (Hillis 1967; Hillis and Brown, 1988). It has long been recognized that many Eucalyptus leaf extracts have strong antibiotic properties (Bowman and Kirkpatrick 1986). Swami and Reddy, (1984) also found the inhibitory effect of Eucalyptus leaf extracts on germination of certain food crops.

May and Ash, (1990) pointed out that various *Eucalyptus* species could yield allelopathic chemicals that may be effective in suppressing understory vegetation. Singh *et al.*, (1992) have studied the impact of *Eucalyptus* shelter belts on some crops in India. They concluded that the poor performance of crops in the *Eucalyptus* shelter belts area was related to an allelopathic effect of *Eucalyptus*.

Cremer (1990) reported that *Eucalyptus* may exert a negative effect on the grazing yield of pasture in Western Australia. The presence of terpenes in eucalypt soils also has been reported by Lovett *et al.*; (1985). Dense stands of *Eucalyptus* could conceivably cast shade as deep as to prohibit herb growth. However, figure 9 (below) illustrates that total inhibition of annuals occurs in well-lighted situations. Light interception by *Eucalyptus* is not great, even in young dense stands. The unshaded sides of most stands fail to support the herb flora. All these facts suggest that light is not limiting to herbs in this area. Comparative light readings confirmed that *Eucalyptus* did not create unfavorable light conditions.



Fig.10. Eucalypt stands devoid of water and other biodiversity

Penfold and Willis (1961) documented the presence of many terpenes in Eucalyptus. Guenther (1950) indicated that the terpenes p-cymene, α -phellandrene, cuminal, phellandral, cineole, α -pinene, B-pinene, and geranial are present in *E. camaldulensis*. Several of these, particularly cineole, possess considerable phytotoxicity (Muller and Muller 1964). Phenolic compounds are important in the leaves and bark of Eucalyptus. Chlorogenic acid has been shown by Sondeheimer (1964) to inhibit several metabolic processes. Bende (1956) showed that gallic acid leached from litter of *Acer platanoides* was toxic to germination and growth of test plants. Griummer (1961) showed that several cinnamic acid derivatives were toxic to seedlings in water culture. Yardeni and Evenari (1952) found that leachates of dried *E. camnaldulensis* leaves were toxic to grasses.

Terpenes influence the annual grassland flora only after becoming adsorbed to soil particles.

Their atmospheric concentration is never high and concentration by adsorption is essential to the effectiveness of these toxins. Adsorbed terpenes are transferred to germinating seedlings through cuticular waxes and eventually reach sites of inhibition (Muller 1965). There is an annual periodicity in their concentration in the soil. Terpenes accumulate in dry soil throughout the summer and reach a peak just before the onset of winter rains. At this time, germinating seedlings are most severely affected. The level of toxicity diminishes as the season progresses, due perhaps to microbial degradation. The degree of inhibition possible is directly related to the amount of colloidal material present in the soil. Phenolic acids act more directly. Litter accumulates through the summer and reaches a peak when winter rains commence. These rains leach phenolics from litter into the soil. In soil suitable to their concentration, these toxins directly influence the growth of herbs. Well-drained, light soils do not concentrate these toxins and their favorable aeration permits rapid toxin degradation. Allelopathic effects are strong over a considerable range of soil moisture conditions. On the xeric end of a moisture gradient, competition for water combines with the allelopathic influences of terpenes and phenolics to produce extensive bare zones. Increased soil moisture availability lessens the likelihood that inhibited plants will succumb to drought stress. Prolonged moist conditions favor the degradation of allelopathic substances. Heavier rains tend to wash toxins deep into the soil and dilute them.

These mechanisms may explain partially why allelopathic phenomena are less easily recognized in humid regions than in arid or semi-arid regions.

Soil texture affects the concentration of toxins, soil moisture, and the microflora. Sandy soils do not concentrate toxins to significant levels since they lack sufficient colloidal material. In heavy soils, toxins are concentrated near the surface by differential adsorption. Where heavy loam soil is underlain by a clay pan, the free movement of water is further restricted, so that water-soluble toxins are concentrated in the upper soil layers still more effectively. During the critical portion of the growing season, heavy soils are partially anaerobic, whereas sandy soils are aerobic; thus degradation of toxins is inhibited in a heavy soil as compared to a sandy soil. The soil moisture regime in sandy soils is more favorable to herb growth due to the reduced capillarity of this soil and subsequent lower surface evaporation. Loam allows neither rapid infiltration nor deep penetration. The high degree of capillary in loam leads to large evaporation losses, an effect magnified by the presence of a clay pan. In sand, Eucalyptus roots are plentiful near the surface, but they penetrate much more deeply and are not nearly so concentrated at the upper levels.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

7.1 CONCLUSION

The present investigation revealed that aqueous leaf extract of *Eucalyptus globulus* at various levels (doses) inhibited seed germination and reduced fresh weights and dry weights of wheat seedlings. Its effectiveness on seed germination and seedling growth suggests that leaves of Eucalyptus may act as a source of allelochemicals after being released into soil or after decomposition. The presence of allelochemicals negatively affects the neighboring or successional plants.

7.2 RECOMMENDATION

There is therefore urgent need to restore indigenous trees, shrubs, herbs and grasses. Clearly, just as these resources are essential for saving us from the swords of desertification, they are also critical for 'pumping' up macro- and micronutrients to the surface of the soil. Although several studies were made in other countries, the present work is the start point on our local wheat species. Therefore, there is a need to provide information to farmers about plantation of Eucalyptus trees and their allelopathic effects. Further studies are suggested to clarify the possible physiological mechanisms related to allelopathic effects of Eucalyptus spp. on crop plants.

CHAPTER EIGHT

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