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Review on Interaction among Boundary Planted Eucalyptus Globules with Soil and Crop

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Abstract

In recent year single rows of *E. globules* tree planted along field boards have become a dominant feature of central highlands of Ethiopia. Different journals showed that different extracts of *E. globulus* leaf had varying degrees of inhibition on germination and seedling growth of *S. nigrum* weed and more inhibition was seen with higher concentrations. In present study, methanol and ethyl acetate extracts had the strongest inhibitory effects. Therefore, it is possible to use these two extracts as a component for production of bio-herbicides. Eucalyptus species caused drawbacks rather than improving the performance of the undergrowth vegetation unlike the mentioned multipurpose trees. Plant secondary metabolites (PSMs) offer plants chemical defences against herbivores and are known to influence intake and diet choice in both insect and mammalian herbivores. That is why eucalyptus leaf palatability to sheep and goat is reduced.

Keywords: Allelopathic; Component interaction; Eucalyptus globulus; Undergrowth vegetation

Abbreviations: Ca: Calcium; CEC: Cation Exchange Capacity; ETB: Ethiopian Birr; ha: Hectare; Mg: Magnesium; K: Potassium; P: Phosphorus;

Introduction

Eucalyptus is one of the most widely used genera in global commercial plantation timber industries [1]. These plantations are generally nonspecific and have been managed successfully and sustainably for many years. Nevertheless, concerns have been raised about the costs of fertilizers, reduced biodiversity, and productivity losses from pests and disease [2,3]. Mixed-species plantations containing a eucalypt and a nitrogen (N_2) fixing species have the potential to address some of these concerns and improve nutrient cycling [4], soil fertility [5], biomass production [6,7] and carbon sequestration [8-10] while providing other benefits through a diversification of [5,11,12], improved risk management and protection from pests and diseases [3,5,13].

Mixtures can also be used as a silivcultural system for growing high quality timber [11,13-15]. The design and silviculture of a mixture depends on the specific objectives. For example, the admixed N_2-fixing species may be used to produce a wood product or simply to increase N availability, and the aim of the admixture may be to maximize biomass, volume, or structural diversity, or to improve tree form and wood quality.

Approaches used scope and limitation

Scope of this term paper includes impacts of Eucalyptus globules on crop, animal, weed, economy and soil properties of different journals. Eucalyptus globules in soil, crop, weed and animal interaction is an iterative process that can be refined through repeated experimentation, monitoring, and readjustments. A single approach by a researcher will not lead immediately to a satisfactory solution for the interaction. The function of the researcher is to provide technical expertise and help the concerned stakeholders in the identification of their problems, the analysis of information, facilitation and monitoring of changes. To this end, a review of different journals approach is employed in this term paper to develop scientifically tested information on their interaction. Research works for greenhouse and field test on chemical characterization allopathic extracts as well as the economic interaction of this tree species is limited.

Summary of the outcome

Nutrient losses in *Eucalyptus globules* plantations on soil nutrient status depend on the intensity of biomass removal at harvest. Hydrophobicity can affect soil microorganisms, plant growth, soil hydrology and soil erosion processes at centimeter to catchment scale as confirmed partly by Florenzano (1956) who found that the nitrifying bacteria were very low under the litter of Eucalyptus plantation. Soil under eucalyptus plantation in central highlands of Ethiopia is highly acidic. this is due to leaching of cations deep into the soil since the soil is red and rainfall is high

(1560mm) and due to incorporation of maize stalk that increase humic and fulvic acids in the soil (Dou et al. 2008).

Eucalyptus globules reduce the amount of soil moisture content, organic matter content and base saturation of soil. Soil microorganism is negatively influenced by Eucalyptus. Other than exchangeable calcium and magnesium *Eucalyptus globules* has low impact on soil potassium content. As Telashwork chane and others said sowing of Maize, Vica faba, barely and Tomato under canopy of eucalyptus have significant impact on yield. Chemicals like methanol and ethyl acetate produced from leaves of eucalyptus retard the of *Solinum nigrum* weed growth. Study shows that leaf of *Eucalyptus globules* is unpalatable to goat, sheep and chattels. However, in dry area its shade protects animals from impact of incoming solar radiation.

Types of Interaction

General description

Eucalyptus (Myrtaceae family) is native to Australia and has been widely introduced into countries throughout the world, including Saudi Arabia, to produce cellulose, wood for fuel, essential oils or to sequester carbon [16].

Boundary tree plantation is one of the Agroforestry practices which include trees, birds on the tree as hest and crop. This technology is widely practices in northern part of Ethiopia. *Eucalyptus globules* is the popular tree species planted in the boarder of road and farm. Traditional Agroforestry practices in Ethiopia involve planting tree in various spatial patterns to meet the wood, fuel and fodder requirement of farmers. In recent year, however, single rows of *E.globules* tree planted along field boards have become a dominant feature of central highlands of landscape.

Tree growing on farm boundaries is a very common practice, but it requires agreement between the neighbours' involved avoiding conflicts. There are different ways of sharing trees planted on a boundary. Sometimes two rows of trees are planted, one on each side of the boundary, and then each farmer grows and manages their own trees. Genotoxicity is defined as variable types of DNA damage and mutations, ranging from gene to structural or numerical chromosome changes. The occurrence of mitotic abnormalities and induction of micronuclei in inter phase cells are main criteria of genotoxic effect. Mitotic activity retardation and disturbances of mitotic phases are reported as indicators of cytotoxic effect (e.g. Delay in seed germination of any species). Several phenolic compounds such as caffeic, coumaric, gallic, hydroxybenzoic, syringic and vanillic acids have been identified as allelochemicals in leaf extracts of Eucalyptus [17].

Soil interaction (soil fertility, chemical, physical, biological)

Nutrient losses in Eucalyptus globules plantations on soil nutrient status depend on the intensity of biomass removal at harvest. The whole tree harvesting represents an output of N, P, K, Ca and Mg corresponding to 24.7, 3.6, 25.9, 69.5 and 11.6kg ha^{-1} $year^{-1}$, which is not compensated by the natural, inputs (Cortez, 1996). In contrast, the harvest of stem wood only may decrease such depletion to 5.8, 2.0, 10.8, 10.5 and 4.3kg ha^{-1}. The proportions of these amounts supplied by annual inputs from the atmosphere were, respectively, 72.6%, 6.3%, 9.4%, 31.1% and 32.0%. Therefore, the amounts of N, P, K Ca and Mg, needed to compensate the export through stem wood only removal were, respectively, 1.60, 1.89, 9.79, 7.22 and 2.93kg ha^{-1} $year^{-1}$. The amounts with respect to Ca, K and Mg may be supplied in high proportion by weathering [18,19] (Table 1).

Table 1: The impact of E. globules in soil physical, chemical and biological property.

Properties	List of Characters	Amount /Impact	Authors
Chemical	Base saturation	Slow	Madeira [20], Alexander [21]
	PH value	Low	Madeira [20], Janice L et al. 2016, Tilashework chane 2009
	Extractable Aluminum	High	Madeira [20]
	Organic matter as compare with crop land	Low	Birru Y et al. 2011
	Total Nitrogen content compare with crop land	High	Birru Y et al. 2011
	P>K>Ca>Mg		Fernndo P et al. 2011
	CEC	increase	Alexander [21]
Physical	Soil moisture content	Low	Tilashework chane 2009
	Hydrophobicity	High	Abelho and Graca (1996), Tilashework chane 2009
	Soil degradation	increase	Alexander [21]
Biological	Soil microorganism	Negatively affect	Watson (2000)

The exchangeable calcium and potassium are all in the high range (Ilaco,1985). Dedecek et al. (2007) reported that Eucalyptus had a small effect on K level.

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Effect on crop and microclimate

Table 2: Effects of E. globules on crop and Microclimate.

List of Characters	Amount	Authors
Biomass and grain yield from woodlot	15m(Decreased)	Tilashework chane 2009
Plant height of maize	18.5_171cm reduced	EI-Khawas & Shahata 2005
Biomass of maize	11.8_33.3 ton/ha reduced	EI-Khawas & Shahata 2005
Grain yield of maize	4.9_13.5ton/ha reduced	EI-Khawas & Shahata 2005
Coffee shade	Reduce yield	
Broad bean (Vica faba) &maize	Reduced yield due to phenolic compound produced	S.M. El-Darier [22]
Barely production	Reduced due to Water soluble phytotoxic,cytotoxic and genotoxic chemical produced by eucalyptus	Maissa M et al. [23]
Tomato	Inhibition increase with increase concentration	Fikreyesus et al. [24]

Generally, Eucalyptus reduces the crop yield when it is planted near to them.

Effect on weed

Table 3: Effect of E.globules on weed.

Parts	Effect	Authors
Leaves	Unpalatable & allopathic to pasture growth	Anderson [25]
Candidia albicans (infection) concentration in liver and kidney homogenates rate	Reduces /Helps to reduce diabetic infection	Bokaeian et al. [26]
		Alison M [27]
		Alireza Nakhaee et al. [28]

Interaction with animal

Table 4, As stated in the table above eucalyptus improves Candidia infection in normal and diabetic rats that in some ways validates the traditional use of this plant in treatment of diabetic patients. Eucalyptus administration significantly improved the hyperglycemia, polydipsia, polyphagia, and it also compensated weight loss of diabetic rats. Moreover, eucalyptus caused a significant reduction in *C. albicans* concentration in liver and kidney homogenates.

Table 4: The effect of Eucalyptus globules on Animal.

Parts	Effect	Authors
Leaves	Unpalatable & allopathic to pasture growth	Anderson [25]
Candidia albicans (infection) concentration in liver and kidney homogenates rate	Reduces /Helps to reduce diabetic infection	Bokaeian et al. [26]
		Alison M [27]
		Alireza Nakhaee et al. [28]; Pass DM et al. [29]

Economic interaction (cited by Biruk Ketsela [30])

Farmers are uses Eucalyptus for feulwood and charcoal production. In tropic and subtropical countries, they plant eucalyptus due to its economic advantages. Compared to other exotic species eucalyptus grow fast and generate income to satisfy their daily expenses. The extra income generated from eucalyptus can contribute to food security. Eucalyptus can start to provide income from age 3-4 in Ethiopian highlands excluding in-between benefits.

Small scale farmers use eucalyptus for fuel wood, fence and construction of houses or to generate income by selling parts or the whole tree (Cefeka, Mager, Weraj, Quwami, and fuel wood). Each of the above activities has different market value including leaves of eucalyptus (Table 5) in different areas. For instance, the price for one sack of leaves (used for baking of Injera) weighing about 25- 30kg is ETB 10-15, one bundle of Cefeka (20- 25 single tree) is ETB 40-45, and Mager (one single tree) is ETB 10-12 in Sendafa town. In Addis Ababa the price for the leaves and the Chefeka is 80-100% more and for a single tree about 40% higher. Small scale farmers sell their product at small towns like Sendafa (farmers get somewhat small profit in contrast with the value sold in the big cities).

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Table 5: Market chain for different assortments of eucalyptus in central Ethiopia.

Different Assortment of Eucalyptus m		length	Diameter	Quantity		Years after		Price different Location/Markets (ETB)				
		cm	stem	kg/m^3	Planting	Coppicing						
Amharic Names								Sendafa	Addis Ababa	Debrezeyit	Gimbichu	ELPA
Cefeka	Thin wood used for between poles	2_4	≤2.8	20-25	.	2_3	2	40_45	80_85	50	70_75	.
Mager	used to connect both construction poles and roofs	2_4	45	1	.	3_5	2_4	10_12	14_17	18	10_15	.
Quami, seregela & weraji	construction pole:connect top of wall &roof	4_8	7.2	1	.	4_8	3_6	35_40	45_50	40	20_40	.
Transmission pole		>18	15.4	1	.	>8	>7	40_50	80_100	80_85	.	72
Gindla	tree truck used for fuel,	.	.	.	1m3	>12	>10	400	430_550	.	300_500	.
	barks,branches in bundles	.	.	.	25_45	.	.	13_16	.	.	.	.
Qitel	leaves in sack		.	.	25_30	.	.	10_15	20_25	.	.	.

Source: Surevy 2011.

Estimation what the farmers and retailers say.

The average benefit per single stem is around 4 ETB and the average benefits per ha per year was about 15,105 ETB. Farmers can get more befits from small wood lots compared to large; the price per stem decrease to about half if a hectare is added to the woodlot (i.e. from the 0.44 ha which is the average of the sample). To increase the rotation with an extra year (beyond the sample average of 7.7 years) will add about 16% to the benefit obtained per stem. For every 1,000 extra seedlings planted per ha (from the sample average of 10,843 seedlings per ha) the benefit per stem will decrease only with 3.25% giving a total gain in benefit per ha up to about 20,000 seedlings per ha (if decrease is constant and planting cost is not considered) Table 5 [31-42].

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