Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

European Journal of Experimental Biology, 2014, 4(1):349-352

ISSN: 2248 –9215
CODEN (USA): EJEBAU

Phenotypic variation of coffee plant seed germination and seedling growth intercropping with agro-forestry tree species

Brhanu Hunde, Yohannes Petros and Manikandan Muthuswamy*

Department of Biology, Faculty of Natural and Computational Sciences, Haramaya University, Haramaya, Dire Dawa, Ethiopia

---

ABSTRACT

Plant may be directly or indirectly affected their phenotypic characters, when it is growing in intercropping system. The phenotypic changes caused by one of the factor releasing the allelochemicals from different plants species. It was observed that when the arabica coffee were growing with agro-forestry plants. The seeding phenotypic characters especially their height was reduced. Therefore, the research was initiated to find out the factors which affect the seedling phenotypic characters of arabica coffee variety when is growing with selected agro-forestry tree species. It was noted that aqueous extracts at a concentration of 5, 10 and 20% had an inhibitory effect on arabica coffee germination and effect was found higher than control and treatments. The extracts brought about considerable inhibitions in the germination of coffee seed and in the phenotypic variation in growth of radicle and plumule. In all extracts, the degree of inhibition increased with the increase in the concentrations of the extracts thus suggesting that the effects of the extracts were concentration dependent. However, the results obtained also tend to suggest that the degree of retardation in seed germination and seedling phenotypic variations were more in the extracts derived from the E. globulus leaf than those from the Albizia gummifera and Cordia africana. Therefore, an arabica coffee seedling phenotypic character was highly affected by Eucalyptus globules leaf extract.

Keywords: *Eucalyptus globulus, Albizia gummifera, Cordia africana* leaf extract, germination, *arabica coffee,* plant development, allelochemicals*)*

INTRODUCTION

Plant phenotypic characters are also depended up on the nearby growth of the plants. Many of the phototoxic substance suspected of causing germination and growth inhibition has been identified from plant tissues and soils. These substances are termed allelochemicals [1]. The nearby plant is controlled by releasing the allele-chemicals. Allelochemicals are present in all plants tissues including leaves, stems, flowers and roots, seeds and buds. These allelochemicals are usually called secondary plant products of the main metabolic pathways in plants [2]. They may be water-soluble substances that are released into the environment through leaching, root exudation, volatilization or decomposition of plant residues. [3] and [4, 5] have reported that the allelochemicals may released by seeds into the soil.

In agro-forestry system, the inhibitory effect of tree species on germination and growth of understory crops has been attributed to the phytotoxic chemicals released from the tree leaf litter and root. However, it influence varies with tree crop combination; such an inhibitory effects on the understory vegetation have been exhibited in pines [6, 7, 8] have studied the inhibitory effect of *Eucalyptus*, Bamboo, Teak and *Acacia* on the germination and seedling growth of certain food crops.

In some part of Ethiopia people are cultivating coffee with agro-forestry tree species (*Eucalyptus globulus, Albizia gummifera, Cordia africana)*. Although agro-forestry system has a potential to increase yield, it has to compete with food crops. Therefore detailed studies on the effect of tree allelochemicals on seed germination, growth and metabolism of crop plants needs to be conducted prior to recommending any tree species for agro-forestry system. In this context, a study was undertaken to elucidate the effects of four commonly grown farm trees species *Eucalyptus globulus, Albizia gummifera, Cordia africana* on germination behavior and phenotypic variation in root and shoot growth of *arabica* coffee seed.

MATERIALS AND METHODS

Mature fresh leaves of *Eucalyptus globulus, Albizia gummifera, Cordia africana leaf* extract were collected and dried in an oven at $60^{o}C \pm 20^{o}C$ for two days, powdered (40 mesh) and used for bioassay with *arabica coffee* variety.

The dried leaves were ground to a fine powder in Wiley Mill (40 mesh). Using this powder aqueous extracts were prepared by the method of Heisey [9]. The aqueous extract was diluted with water to get 5, 10 and 20% concentrations. The dilutions corresponded to 0.05, 0.1 and 0.2 % of water extractable materials. The seeds of *arabica coffee* were surface sterilized with 0.1% mercuric chloride for 1 min. to remove the fungal spores on the seeds. Then the seeds were washed with distilled water for several times to remove the mercuric chloride.

Bioassay studies were carried out following the method of Heisey [9]. The experimental design was a randomized complete block with five replicates for each treatment and control. Germination percentage, plumule and radicle length were measured after 15 days.

RESULTS AND DISCUSSION

The leaf leachates of *E. globulus* inhibited the seed germination of *arabica* coffee seeds (Table1). In the present study, maximum inhibition was observed in 20%, followed by 10 and 5%. The inhibition effect in *arabica coffee* seed was 71% at 20% concentration. [10] Found that the use of aqueous extracts of *E. golobuse* leaves inhibited seed germination of maize and kidney-bean. Under field condition, the *Eucalyptus* trees reduced the wheat crop germination [11]. The forestry plantation residue of *Eucalyptus* (leaf and branch) suppressed seed germination and early seedling growth of the dicotyledonous species. A large number of studies confirmed that *Eucalyptus* sp. leachates contained phenolic compounds such as coumaric, gallic, gentisic, catechol, hydroxybenzoic syringic and vanillic acid. Germination of cereals depends on α-amylase activity that regulates starch break down, necessary for supplying substrates to respiratory metabolism. Eucalyptus *(Eucalyptus globulus)* leaf leachates decreased α-amylase activity in seeds of finger milet (*Eleusine coracanta)*, resulting in inhibition of germination [12].

Table 1: Bioassay studies of aqueous leaf extract of *E. globulus* on seed germination and seedling growth of *arabica* coffee seed

	E.globulus leaf extract		
Concentration%	Germination %	Plumule length(cm)	Radile length(cm)
Control	70	5.7	4.7
5	33	4.5	3.8
10	23	4.1	3.5
20	20	3.3	2.9

Therefore, effects of allelochemicals on seed germination appear to be mediated through a disruption of normal cellular metabolism rather than through damage of organelles. Reserve mobilization, a process which usually takes place rapidly during early stages of seed germination seems to be delayed or decreased under allelopathy stress conditions [13]. The leachates of *E. globulus* also caused reduction in seedlings growth of *arabica coffee* seed (Table 1). The inhibition of shoot and radicle length is concentration dependent. The magnitude of inhibition from

leachates followed the order: 20>10>5%. The maximum of 40 % and 38% reduction in plumule and radical was recorded at 20% leaf extracts respectively

The aqueous leaf extracts of, *A.gummifera* was inhibitory to the seed germination, plumule and radical length of *arabica coffee* seeds. The maximum inhibitory effect was observed at the highest concentration (Table 3). The reduction in seed germination by the treatment of leaf aqueous extracts treatment with a maximum reduction of 48% was recorded at 20% leaf aqueous extract of *A.gummifera.* At the highest concentration the leaf extract of *A.gummifera* showed 32% reduction in plumule length. The reduction in radical length was 36% at 20% concentration of leaf aqueous extract of *A.gummifera*.

Table 2: Bioassay studies of aqueous leaf extract of *A. gummifera* on seed germination and seedling growth of *arabica coffee* seed

	A. gummifera leaf extract		
Concentration%	Germination %	Plumule length(cm)	Radile length(cm)
Control	70	5.7	4.7
5	46	5.0	3.9
10	43	4.5	3.7
20	36	3.8	2.9

In bioassay studies of *C. africana* on *arabica coffee* the germination of plumule and radicle length was decreased in all concentrations. As shown in table 3: In the highest concentration n the maximum inhibitory effect was observed. The inhibitory effect on the seed germination by leaf aqueous extracts was gradual decreased with increasing the concentrations of *C.africana*.

Table 3: Bioassay studies of aqueous leaf extract of *C.africana* on seed germination and seedling growth of a*rabica coffee* seed

	C.africana leaf extract		
Concentration%	Germination %	Plumule length(cm)	Radile length(cm)
Control	70	5.7	4.7
5	63	5.0	4.6
10	60	4.8	4.5
20	53	3.9	3.4

A maximum 24% reduction in germination was observed at 20% leaf extract of *C.africana*. The redaction in plumule lengthy by aqueous leaf extracts of *C. africana* showed gradual decreases in plumule length of *arabica coffee* seed. The maximum of 31% reduction in plumule length was recorded at 20% C. *africana* aqueous leaf extracts. A similar pattern of decrease was observed in radicle length of *arabica coffee* seeds treated with aqueous leaf extracts a maximum of 27% was noticed at 20% concentration of *C. africana* leaf extract.

CONCLUSION

The present investigation revealed that aqueous leaf extract of *E.globulus, Albizia gummifera, Cordia africana* at various concentration levels inhibited the phenotypic variation in terms of germination, plumule and radical length of *arabica coffee* seedlings. The inhibitory effect was more in *E. globules* when compared with *Albizia gummifer* and *Cordia Africa*n treated seeds of *arbica* coffee seeds. Therefore, it was suggested that these agro forestry trees species are not suitable for the growth of *arabica* coffee seeds

REFERENCES

[1] Whittaker RH, *Feeney* PP, *Science*, **1971**, 171, 75.
[2] Swain T, *Annu. Rev. Plant Physiology*, **1977**, 28, 479-501.
[3] Elemore CD, *Weed Science*, **1980**, 28, 658-660.
[4] Friedman J, Rushkin E,. Waller G, *J Chem Ecol*, **1982**, 8, 55-645.
[5] Rice E L, Botanical *Reviews*, **1974**, 45, 15-109.
[6] Eyini M, Joy M, Asokumar P, *Tropical Ecology*, **1989**, 30, 138-141.
[7] Bansal GL, Nayyer H, Bedi YS, *Journal Agricultural Sciences*, **1992**, 62 , 771-772.
[8] Bora IP, Singh J, Borthakur R, Bora E, *Annals of Forestry* , **1999**, 7, 143-146.
[9] Heisey RM, *American Journal of Botany*, **1990**, **77**, 662-670.
[10] El-Khawas SA,, *Plants. Biotechnology*, **2005**, 4, 23–34.

[11] Patil TM, Hedge, *Current Science*, **1988**, 42, 1178-1181.
[12] Pandey DLP, Kauraw V, Bhan M, *Chem. Ecol*, **1993**, 19, 2651-2662.
[13] Gniazdowska A, Bogatek R, *Acta Physiologiae Plantarum*, **2005**, 27, 395–407.