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Allelopathic effects of Ficusarnottiana Miq. bark extracts on plant germination

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Abstract : Allelopathy is a biological process in which plants influence the growth and germination of other species in their environment. The aim of present study was to examineallelopathic effect ofextractsof bark of FicusarnottianaMiq. on seed germination inVignaradiata L., Glycine max, and Arachishypogaea L.as the experiment plant. The allelopathic effects of bark aqueous extracts at 20%, 40%, 60%, 80% and 100% concentrations was studied and compared with control on growth of all three species. Findings indicated that bark extracts of Ficusarnottiana Miq.exhibits greater stimulatory effect not just on the germination percentage, its mean germination time or spread but also on the root length and shoot length germination. Overall, our finding revealed that Ficusarnottiana Miq. could be used as a natural plant growth stimulator. Modern molecular biology techniques should be done for phytochemical examination of Ficusarnottiana Miq. for growth regulatory properties.

Keywords: Moraceae;FicusarnottianaMiq.; Germination; Allelopathic effects;

Introduction

Allelopathy is a biological phenomenon in which plants influences the germination and growth of other plants by releasing allelochemicals in their environment. Allelochemicals can have both beneficial (positive allelopathy) and harmful (negative allelopathy) effects on target plant or another plant present in surroundings (Molisch, 1937).International allelopathy society has defined the "allelopathy as, any process which involves growth of bioactive molecules by plants, microbes, algae, fungi or viruses that influence the growth and development of agricultural, natural and biomedical applications.system".Weed management, crop cultivation, and crop re-establishment are all examples of how allelopathy is employed in agriculture. Allelochemicals are a subset of secondary metabolites whichcan be used as bio-fertilizer and bio-herbicides,which is present in leaf, flowers, stalks, twigs, fruits, seeds, buds, pollen, and roots and almost all plant tissues (Williams et al 1989).In the soil, a broad variety of substances are released during the enzymatic breakdown and microbial decomposition of plant materialsand a lot of them have vital biological activities such as seed germination, plant growth and also increases crop yield. Several allelochemicals produced by a variety of crops like purple medic (Medicago sativa), barley (Hordeumvulgare), oats (Avena sativa), rice (Oryza sativa), rye (Secalecereale), sorghums (Sorghum spp.), sunflower (Helianthusannuus), sweet potato (Ipomoea batatas) and wheat (Triticumaestivum), gaveinhibitory effect on seed germination in weed species. In comparison to synthetic pesticides, many allelochemicals generated by crops are regarded environmentally harmless and give distinct molecular targets. Studies indicate that being rich source of secondary metabolites, medicinal plants can also be used as source of allelochemical.

The FicusarnottianaMiq.belongs to Moraceae family, commonly known as Paraspipal and Kodiarasu(Warrieretal 1994). It is a significantplant of traditional medicinal system and is distributed throughout India, mostly in rocky hills at heights of 1,350 m elevations (Joy et al 1993). The fruits, leaves and stem of the plant contain many secondary metabolites like sterols, alkaloids, carbohydrates,flavanoids, tannins, and phenols etc (Ahmedull and Nayar 1999). The leaves of plants are used treat infertility. Barks of the plant are used as astringent, aphrodisiac, demulcent, depurative and emollient. It is also used to

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treat inflammation, diarrhoea, diabetes, burning, ulcers, scabies, wounds, and skin problems (Mazumdaret al 2009).

Despite their stimulatory effect and inhibitory impact on invading alien species (IAS) allelochemicals may be employed as natural herbicides against other IAS, as an alternative to the routinely used synthetic herbicides that pollute the environment and pose health hazards to consumers.The purpose of this study to wasinvestigate the allelopathic effects of extracts bark ofFicusarnottianaMiq.on the germination of Vignaradiata L., Glycine max, and Arachishypogae. Vignaradiata L. Glycine max, and ArachishypogaeaL. are one of the most important legumes in the world especially in developing countries. These are leading source of food protein.

Materials And Methods:

Plant collection

The healthy barksof FicusarnottianaMiq.were collected from the forest of Balawala, Dehradun (Uttrakhand, India) during the month of April and May . The plants were identifiedandauthenticated byDr. PradeepTiwari at the Department of Botany, Dr H. S. Gour University, Sagar (A central university). Herbarium voucher specimen (No.BOT/H/08/21/01/02) has been deposited in the departmental herbarium. Due to easy replication, rapid growth and observable traits in germination and growth, Vignaradiata L., Glycine max, Arachis hypogaea L.was chosen as test plant. Seeds of Vignaradiata L.(mungbean), Glycine max(soyabean), Arachis hypogaea L.(groundnut)were obtained from local markets and screened for seed quality. Damaged seeds were then discarded upon ocular examination.

Extract preparation

FicusarnottianaMiq. barkobtained from the plant was washed with running tap water, cut into tiny piecesand shade dried at room temperature for 30 days. Dried barks were grounded into a fine powder with an electrical blender, which was then kept until required. In a soxhlet apparatus, 100g of powdered bark was extracted with water for 8 hours. The plant material was then condensed, using a rotary evaporator under reduced pressure and stored in vials at 4°C till further examination (Herborne 1998).The extract was then filtered with the help ofWhatman no.1 filter paper and collected in a conical flask labelled ₹stock solution₹ or ₹100% extract.₹ Using the extract as stock solution 20%, 40%, 60%, 80%and 100% concentrations were prepared by dilution, and their allelopathic impact was assessed using a seed germination bioassay (Singh et al 2013).

Pot study

Eighteen pots were prepared for the allelopathy activity of aqueous extract ofF.arnottianaMiq. barks. Each pot was filledwith agriculture soil and added 15 seeds of Vignaradiata L., Glycine max, Arachishypogaea L. respectively each six potsconstitutedand the succeeding received extract 20%, 40%, 60%, 80% and 100% concentrations. Each treatment was replicated thrice. For the first day, 5 ml of each concentration was added to each pot. For the next 14 days, the seeds were kept moist by applying roughly 1 ml of each extract daily. Germinated seeds were counted after two weeks of observation based on the presence of radicle and also measured using a foot ruler.When the radicle of a seed protruded at least 1 mm, it was considered germinated.

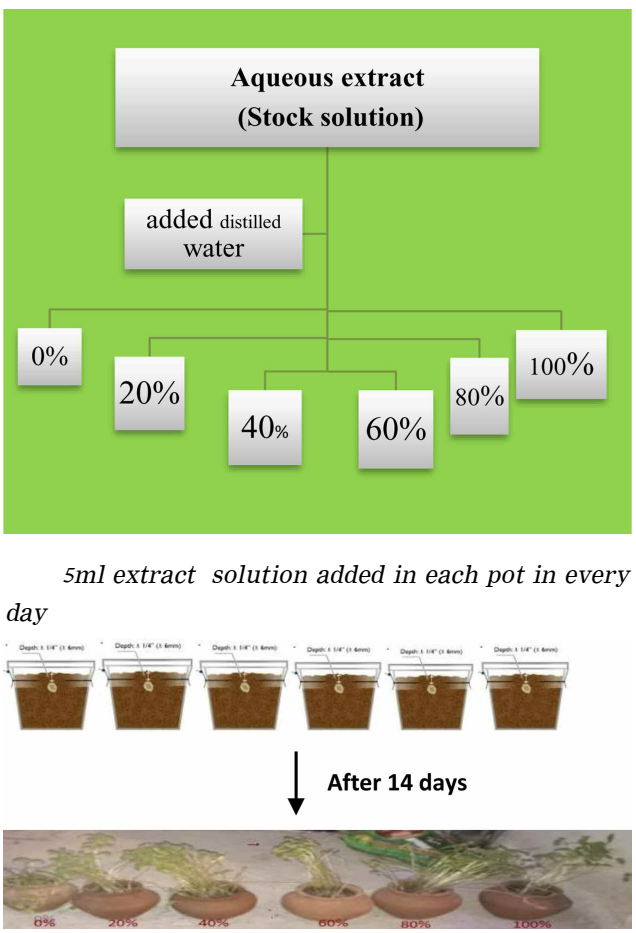


Fig 1: Schematic presentation of seed germination by pot method

Following ISTA guidelines, all parameters of seed germination such as root and shoot length were observed in each pot after 14 days displaying, as well as the quantity of aberrant and dead seeds.Following

Oyun (2006), the mean germination time (MGT)andgermination percentage were calculated.

$$\text{Germination \%} = \frac{\text{No.of germinated seeds x 100}}{\text{total seeds}}$$

$$\text{MGT} = \frac{\sum(N * d)}{\sum N}$$

Where N = Number of seeds germinated

d = Number of days since the start of the germination tests.

Effect of aqueous extracts of barks of F.arnottianaMiq. on seed germination

The effect of F.arnottianaMiq. aqueous extracts on seed germinationVigna radiata L., Glycine max, and Arachis hypogaeaL. with respect to different concentration was investigated in a second experiment. Fifteen consistently germinated seeds each of Vigna radiata L., Glycine max, and Arachis hypogaea L. were placed in separate pots and then treated with 5 ml of each F.arnottianaMiq. aqueous extract (stock solution) or control water.The coated seeds were kept in controlled chamber with temperature of 25°C and a 12/6-hour light–dark photoperiod. Various measurements were taken for 14 days old plantlets for root length, shoot length (were estimated using a rulerin cm), shoot dry weight, and root dry weight (in mg) were calculated after drying all components in a hot air oven at 70°C for 48 hours. Dried biomass was weigh using a digital balance.

Phytochemical analysis

The crude aqueous extract of F.arnottianaMiq. was qualitatively tested using Molisch, Fehling, Alkaline Reagent, Lead Acetate, Mayer, Wagner, Ferric Chloride, Borntrager, Liebermann–Buchard, and Salkowski tests to find out the occurrence of various allelochemicals (Table 1).

Table1:Methods for the phytochemical analysisofmain group of compounds.

Phytochemicals tested	Chemical Test method
Alkaloids	Dragendorff's, Mayer's and Wagner'sreagent
Flavonoids	Shinoda test
Tannins	Ferric chloride and potassium dichromatesolutions
Steroids	Salkowaski test
Carbohydrate	Molish,Fehlingand Barfoed's test
Amino acids	Ninhydrine test and Tyrosine test
Terpenoids	Liebermann-Buchard, and Salkowski tests

Data analysis

The magnitude of stimulatory effect on Vigna radiata L., Glycine max and Arachis hypogaeaL. seedlings was determined using mean germination time, shoot, and root length. Seedling measurements done by one–way analysis of variance (ANOVA), followed by calculation of Duncan multiple range and were compared with least significant difference at 5%, using SPSS version 23.

Results

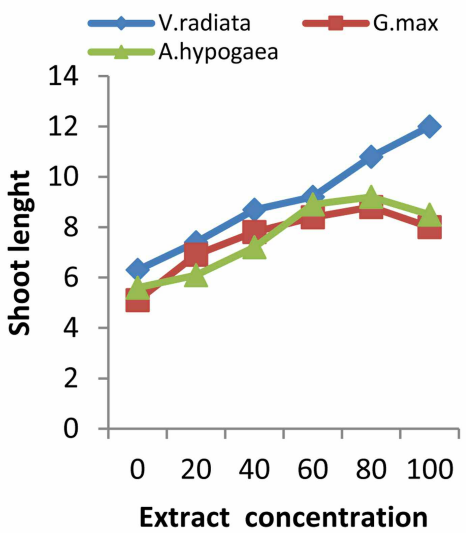
Allelopathic effect is exhibited when there is a positive influence in seedling growth and germination when compared to seedlings under control. The results shows that aqueous extracts of barks F.arnottiana Miq. had stimulatory effect on growth of seedlings in Vigna radiata L., Glycine max, and Arachis hypogaea L as evidenced by seedling growth and germination. These beneficial impacts revealed that V. radiata seedling growth is concentration dependent and species specific (Table 2 and Table 3).Mean germination time and germination percentage of Vigna radiata L., Glycine max, and Arachis hypogaea L. was significantly increased specially 80 and 100% concentration F. arnottiana Miq. barks extracts. respectively, in comparison with the control. While the growth in lower concentrations was not noticeable. However, MGT increased gradually and significantly with respect to the increasing concentration. Bark extract increased MGT of V.radiata 2.4, 2.5, 2.9, 3.0, 4.2 and 4.6 at the concentrations of 20, 40, 60, 80 and 100 respectively as compared to control. Phytochemical results showed presence of allelochemicals, such as flavonoids, alkaloids, tannins, saponins, carbohydrate, amino acid and terpenoids.

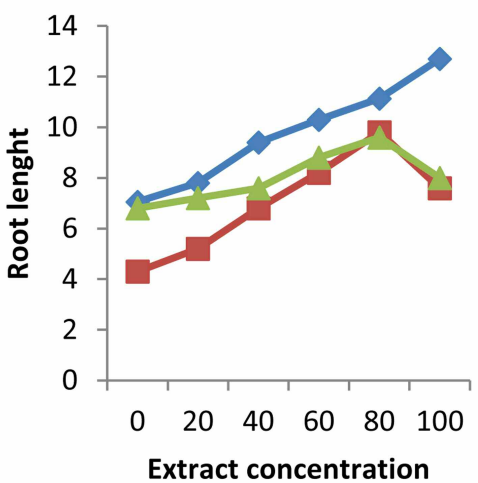
Table2: Effect of varying concentrations of aqueous extracts of barks of F. arnottiana Miq. on shoot length and root length in Vigna radiata L., Glycine max, and Arachishypogaea L.

Extract Conc. (%, w/v)	Shoot Length (in cm)			Root Length (in cm)		
	V.radiata	*G. max*	*A.hypogaea*	*V.radiata*	*G. max*	*A.hypogaea*
Control	6.3	5.1	5.6	7.06	4.3	6.5
20	7.4	6.9	6.1	7.8	5.2	7.2
40	8.7	7.8	7.2	9.4	6.8	7.6
60	9.2	8.4	8.9	10.3	8.2	8.8
80	10.0	8.2	9.2	11.14	9.8	9.6
100	10.8	8.0	6.8	12.7	7.6	8.0

Table 3: Effect of varying concentrations of F. arnottiana Miq. aqueous extracts on shoot dry weight and root dry weight in Vigna radiata L., Glycine max, and Arachis hypogaea L.seeds

Extract Conc. (%, w/v)	Shoot Dry Weight (in mg)			Root Dry Weight (in mg)		
	V.radiata	*G. max*	*A.hypogaea*	*V.radiata*	*G. max*	*A.hypogaea*
Control	12	5.1	5.6	7.06	4.3	6.5
20	20	6.9	6.1	7.8	5.2	7.2
40	27	7.8	7.2	9.4	6.8	7.6
60	32	8.4	8.9	10.3	8.2	8.8
80	36	8.2	9.2	11.14	9.8	9.6
100	47	8.0	6.8	12.7	7.6	8.0





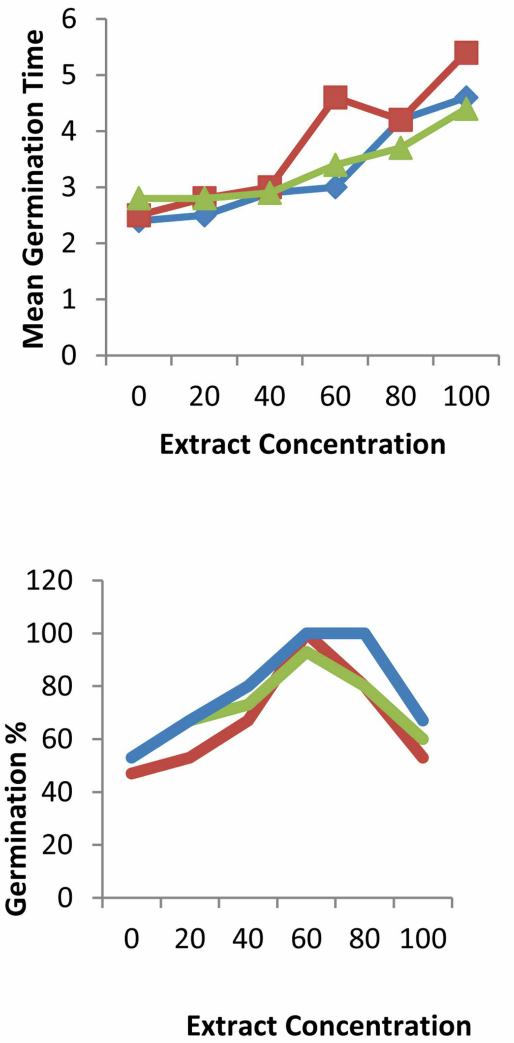


Fig. 2 : Effect of various concentrations of Ficus arnottiana Miq. aqueous extracts on Shoot length, Root length, GP and MGT of V..radiata, G.max, and A.hypogaea.

The responses of all horticultural crops varied depends upon the concentration of F. arnottiana Miq. plant parts utilized for aqueous extraction, as demonstrated by our findings. Bark extracts of F. arnottiana Miq. were beneficial to crop germination due to the presence of allelochemicals at low concentrations in bark.

Conclusion

Allelochemicals are found in essentially every plant parts in a heterocyclic form.Allelochemicals are synthesised and released by plants and other organisms in response to various stimuli.Thermal decomposition, foliage leaching, root secretion, decaying of plant waste and component absorption into soils all contribute to the release of various

allelocehicals and other mineral nutrients in the soil.

The results of our experiments support the hypothesis that aqueous extracts obtained from the barks F.arnottianaMiq. interfere with seedling growth and germination rate of V.radiata, G.max, and A.hypogaea possibly through producing flavonoid chemicals that are water soluble (Babu et al 2017).The potential of F.arnottianaMiq. allelochemicals to stimulate germination and seedling growth in all horticultural crops increased with the increase in concentration, and the allelopathic effect are species-dependent, with each of the three test plants responded in a different way. However, more research into the ecological significance of F.arnottianaMiq. in herbicide application in various field scenarios is required.Moreover, quantitative analysis, and combination of laboratory results are suggested to efficiently investigate the allelopathic effect of this plant and their potential application as natural herbicides.

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