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A Preliminary Study on the Allelopathic Potential of Elephant Grass

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ABSTRACT

Allelopathy is a phenomenon where by one plant affects other plant positively or negatively through special metabolites triggered into the environment. Two experiments were carried out at the Animal Science Laboratory, Faculty of Agriculture Bayero University Kano, Nigeria, to evaluate the allelopathic effects of leaf (LEC) and stem extract concentrations (SEC) of *Pennisetum purpureum* on germination (G) root length (RL), shoot length (SL) and water absorption (WA) of *Stylosanthes hamata* and *Lablab purpureus.* In the first experiment twenty seeds (20) of *Stylosanthes hamata* and *Lablab purpureus* were set on three filter papers that were placed in Petri dishe`s. The filter papers were moistened with distilled water (control treatment) while other treatments filter papers were moistened with LEC ranging from 0, 0.5, 1, 1.5 and 2% (w/v). The same methodology was followed in the second experiment except that SEC of *Pennisetum purpureum* was used instead. The design of the two experiments was a 2 x 5 factorial in a completely randomized design. The factors were two legume seeds species and five leaf/stem extract concentrations (0, 0.5, 1, 1.5 and 2%). The results of the study indicated significant differences between seeds of Stylo and Lablab treated with LEC. Lablab seeds had significantly higher ($P<0.05$) percentage G, RL and SL than Stylo. Concentrations were not significantly different except in the case of WA. G and RL were observed to decline with increase in LEC. In the second experiment, seeds of Stylo and Lablab were significantly different ($P<0.05$) in terms of all parameters measured. Lablab had consistently higher ($P<0.05$) values for G, RL, SL and WA. SEC did not significantly affect G, RL and SL except WA that was found to be the highest at 2% SEC. Overall LEC were observed to have somewhat decreased G and RL while SEC enhanced the two parameters.

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INTRODUCTION

Plants release many bioactive chemicals from their various parts such as leaves, stem, root and sometimes decomposed body through different mechanism into its surrounding environment. These chemicals interact with the surrounding environment and affect plant either positively or negatively (Scavo et al., 2018). Allelopathy is one of the factors affecting pasture development in mixed communities

thereby resulting in sparse growth of pasture and species disappearance. The after effect of this phenomenon is reduced feed availability for animals.

Allelochemicals emancipated as residues, exudates and leaches by many plants from leaves, stem, roots, fruit and seeds have been reported to interfere with growth of other plants (Asgharipour and Armin, 2010). These chemicals products mainly affect plants at seed emergence and seedling levels (Alam and Islam, 2002; Hussain et al., 2007; Naseem et al., 2009). Allelopathy plays an important role in agricultural ecosystems and in a large scale, in the plant covers among the crop-crop, crop-weed and tree-crop covers. These interactions are detrimental and occasionally, are useful and gave attention to allelopathy in natural and agricultural ecosystems. Today, allelopathy is recognized as appropriate potential technology to control weeds using chemicals released from decomposed plant parts of various species (Naseem et al., 2009).

Generally allelochemical plays multiple roles on the physiology of crop plants. It can inhibit plant growth, alter mineral uptake, cause stomatal closure and induce water stress, influence respiration, affect photosynthesis and protein synthesis impair hormone balance and alter enzyme activities. Many researchers have worked on the mechanism of allelochemicals in the legume crops (Mondal et al., 2015).

The ever increasing human population and the need to meet the protein requirement of the growing population necessitates that strategies have to be employed to ensure availability and quality of feed for animals. The phenomenon called allelopathy though not negative in its entirety could pose a serious challenge to forage availability, hence the need to evaluate plant with allelopathic effects for possible screening during the process of forage selection for establishing or better still, to know how best such forages could be established. The study is therefore, aimed at investigating the allelophatic effect of leaf and stem extracts of *Pennisetum purpureum* (Elephant grass) on seed germination, shoot and root length as well as water absortion rate of *Lablab purpureus* (Lablab) and *Stylosanthes hamata* (Stylo).

MATERIALS and METHODS

The experiment was conducted at Animal Science Laboratory Bayero University Kano, Nigeria. Kano, Nigeria State lies between latitudes 10°33′ and 12°37′ north and longitudes 7°43′ and 9°25′ east. It occupies a total area of about 20,400 km square. The area has two seasons; a wet season (May – September) and dry season (October – April). The annual rainfall and temperature ranges between 787 and 960 mm and 21°C and 39°C respectively (Nnoli et al., 2006). In terms of soil fertility, the whole state is rated low in terms of nitrogen availability, medium to high for phosphorus and most parts of the state rank medium to high for potassium (Nnoli et al., 2006).

Collection of Seeds, Leaves and Stems Samples

Dried leaves and stems samples of *Pennisetum purpureum* (Elephant grass) were collected from Department of Agronomy Plantation Crops Nursery, Faculty of Agriculture Bayero University, Kano, Nigeria. The samples were separately crushed in to powdered form using mechanical crusher and stored in polythene bag.

Seeds of *Lablab purpureum* and *Stylosanthes hamata* were collected from National Animal Production Research Institute (NAPRI) Shika Zaria, Kaduna, Nigeria. Both seeds were stored in polythene bag inside a freezer before use for experiments.

Experiment I

Preparation of Leaf Extracts Solution and Determination of PH

Ground leaf samples were soaked in distilled water and allowed to stay for a period of 72 hours to arrive at the various *Pennisetum purpureum* leaf extract concentration of 0.5, 1.0, 1.5, 2.0%. Ph of the concentration was measured using Ph meter. Prior to the experiment, the Stylo seeds were treated using hot water at 75° C for 3 minutes and spread on flat surface to dry before usage.

Germination Trial

Germination trial was conducted using seeds of *Lablab purpureus* (Lablab) and Stylosanthes *hamata* (Verano) in petri dishes. Ten (10) seeds were placed on white man's filter paper contained in the petri dishes. The filter papers were moistened with distilled water for the control treatment and extract concentration ranging from 0.5 to 2% for other treatments.

The parameters measured included; rate of germination taken every other day, shoot length, root length and water absorption.

Treatments and Experimental Design

Treatments were leaf extract concentrations; 0, 0.5, 1, and 2% and seeds from two legume species *Lablab purpureus* and *Stylosanthes hamata* combined in a 2x5 factorial in a completely randomized design.

Water Absorption

Dry seeds were initially weighed using electronic balance and then immersed into the various leaf extract concentrations and left for 10 minutes. After ten minutes the seeds were removed blotted with tissue paper and reweighed. The initial and the final weights were determined to know the amount of water absorbed by the seeds.

Percentage Germination, Root and Shoot Length

Number of seeds that germinated every other day was noted for a period of one week and later expressed as percentage of the total number of seeds. At the expiration of one week, root and shoot lengths were measured using meter rule.

Experiment II

Preparation of Stem Extracts Solution and Determination of Ph

Ground stem samples of *Pennisetum purpureum* were soaked in distilled water and allowed to stay for a period of 72 hours to arrive at the various *Pennisetum purpureum* stem extract concentration of 0.5, 1.0, 1.5, 2.0%. Ph of the concentration was measured using Ph meter. Prior to the experiment, the Stylo seeds were treated using hot water at 75^{o}c for 3 minutes and spread on flat surface to dry before usage.

Germination Trial

Germination trial was conducted using seeds of *Lablab purpureus* (Lablab) and *Stylosanthes hamata* (Verano) in petri dishes. Ten (10) seeds were placed on white man's filter paper contained in the petri dishes. The filter papers were moistened with distilled water for the control treatment and extract concentration ranging from 0.5 to 2% for other treatments.

The parameters measured included; rate of germination taken every other day, shoot length, root length and water absorption.

Treatments and Experimental Design

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Dry seeds were initially weighed using electronic balance and then immersed into the various stem extract concentrations and left for 10 minutes. After ten minutes the seeds were removed blotted with tissue paper and reweighed. The initial and the final weights were determined to know the amount of water absorbed by the seeds.

Percentage Germination, Root and Shoot Length

Number of seeds that germinated every other day was noted for a period of one week and later expressed as percentage of the total number of seeds. At the expiration of one week, root and shoot length was measured using meter rule.

Data Analysis

Data generated were analyzed by Anova using SAS (version 9.2) 2009. Differences among means were generated using (DMRT).

RESULTS

Experiment I

Seeds of legume species were significantly different in terms of the parameters measured (Germination, Root length, Shoot length and Water Absorption). Lablab seeds were significantly the highest ($P<0.05$) in all the parameters mentioned compared to Stylo seeds.

Leaf extract concentration of *Pennisetum purpureum* (Elephant grass) had no significant effect on all the parameters mentioned except water absorption. However, there appeared to be a downward trend in percentage germination with increase in leaf extract concentration similarly for root and shoot length up to 1.0% concentration after which there was an increase at 1.5% concentration followed by a decrease at 2.0% concentration (Table 2).

Water absorption was significantly the highest at 1.5% concentration. In the case of water absorption ditto for shoot and root length though not significant, there appeared to be a significant interaction between legume species and leaf extract concentration on water absorption (Figure 1). Rate of water absorption in Lablab was significantly the highest ($P<0.05$) at all concentration compared to Stylo. Highest rate of water

absorption was recorded at 0.5% leaf extract concentration as shown in the result below.

Table 1. Main and interaction effects of species and leaf extract concentration of *Pennisetum purpureum* on germination, root length, shoot length and water absorption of *Lablab purpureus* and *Stylosanthes hamata*

Specie	Germination (%)	Root Length (mm)	Shoot Length (mm)	Water Absorption (g)
Stylo	14.67[b]	12.58[b]	16.28[b]	0.0006[b]
Lablab	65.33[a]	30.58[a]	46.91[a]	0.0077[a]
P value	0.0001	0.0001	0.0001	0.0001
Concentration (%)				
0	48.33	24.35	31.35	0.0014[e]
0.5	40.83	20.78	30.62	0.0021[b]
1.0	40.53	18.30	31.11	0.0015[d]
1.5	37.50	24.40	34.73	0.0137[a]
2	32.50	20.08	30.15	0.0020[c]
P value	0.49	0.64	0.94	0.0001
Specie*Concentration	NS	NS	NS	**

Means with different superscripts within the same column are significantly different ($P < 0.05$).

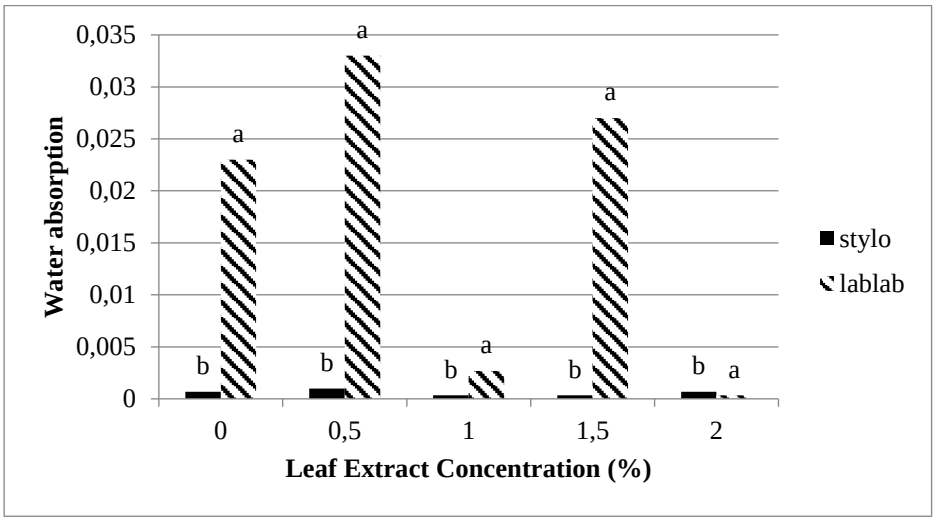

Figure 1. Interaction effect of species and leaf extract concentration on water absorption

Experiment II

Significant difference were observed among species in terms of germination, root length, shoot length and water absorption. Percentage germination in Lablab (75%) treated with stem extract concentration of *Pennisetum purpureum* was significantly higher ($P<0.05$) than that of stylo (17.33%).

Similarly stem extract concentration of *Pennisetum purpureum* (Elephant grass) had no significant effect on all the parameters mentioned except water absorption where the rate of water absorption was found to somewhat increased with increase in stem extract concentration of *Pennisetum purpureum* from 0.00165 at 0% concentration with a slump at 1 and 1.5% followed by an increase at 2%. Water absorption rate was significantly ($P<0.05$) highest at 2% stem extract concentration (Table 2).

Significant interaction was observed between species and concentration on water absorption, *Lablab purpureus* had significantly ($P<0.05$) the highest water absorption rate across all concentration. Water absorption rate was observed to increase from 0 - 0.5 % with a slump at 1 and 1.5% followed by an increase at 2% (Figure 2).

Table 2. Main and interaction effects of species and concentration on germination, root length, shoot length as well as water absorption, as affected by stem extract concentration of *Pennisetum purpureum*

Specie	Germination (%)	Root Length (mm)	Shoot Length (mm)	Water Absorption (g)
Stylo	17.33[b]	19.60[b]	18.85[b]	0.00060[b]
Lablab	75.00[a]	31.33[a]	48.28[a]	0.01134[a]
P value	0.0001	0.0004	0.0001	0.0001
Concentration (%)		`		
0	40.83	23.98	31.23	0.00165[d]
0.5	42.50	24.45	36.18	0.00885[b]
1.0	53.33	27.88	29.47	0.00369[c]
1.5	47.50	29.95	35.91	0.00369[c]
2	46.67	21.08	35.05	0.01199[a]
P value	0.33	0.29	0.29	0.0001
Specie*Concentration	NS	NS	NS	**

Means with different superscripts within the same column are significantly different (P < 0.05).

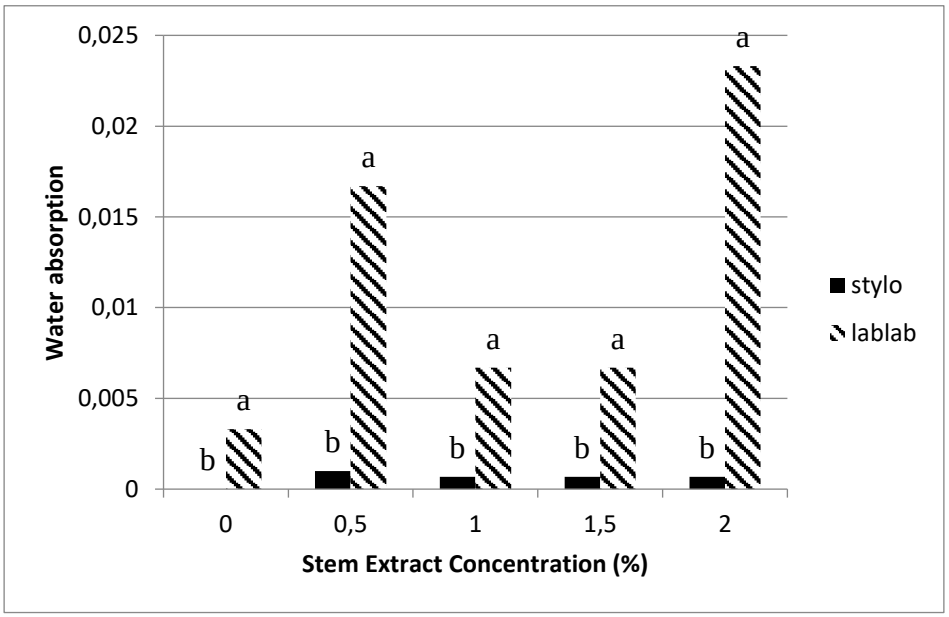

Figure 2. Interaction effect of species and leaf extract concentration on water absorption

DISCUSSION

The results from experiment I showed a decrease in germination rate as leaf extract concentration *Pennisetum purpureum* increased. This agrees with the report of Singh

and Chaudhary (2011) who reported that that the effect of allelochemicals include inhibition or retardation of germination rate. The result also showed that the root length of both test species was reduced by aqueous leaf extracts of *Pennisetum purpureum*. The results obtained suggest that the reduction in root length might be attributed to allelochemicals present in leaf extract of *Pennisetum purpureum.* The results agrees with the report of Hussain and Reigosa (2011) who found the inhibitory effect of allelochemicals (phenolic compounds) on root length of *Dactylis glomerata*, *Lolium perenne* and *Rumex acetosa*. Similarly, Arowosegbe et al. (2012) reported that the increase in concentrations of leaf and root extracts of *A. ferox* also increased inhibitory effect on root elongation of beetroot and carrot. This inhibitory effects on root elongation of tested species in this investigation might have been also contributed by reduction in cell division (Gholami et al., 2011), due to damage of cell membrane caused by allelochemicals (Rice, 1984). However, the shoot length of tested legume species was found to somewhat increase with increase in leaf extract concentration of *Pennisetum purpureum* which contrast with of the report Hussain and Reigosa (2011) who found the inhibitory effect of allelochemicals (phenolic compounds) on shoot length of *Dactylis glomerata*, *Lolium perenne* and *Rumex acetosa*. Results from experiment II showed more positive effect with increase in stem extract concentrations of *Pennisetum purpureum* on germination rate, root and shoot length of the tested legume species. This is in contrast with the study conducted by Ashrafi et al. (2008) that the allelopathicity on germination and growth of wild barley (*Hordeum spontaneum*) increased with the increasing concentrations of sunflower extracts. The retarded germination and root length observed in this study might be influenced by damage of root cells due to interference of nutrient uptakes and other growth processes caused by allelochemicals found in leaf extract of *Pennisetum purpureum*. Moreover, these results showed more inhibitory effects on root than shoot length. This might be due to direct contact of root with the extracts containing inhibitory chemicals. Similar

findings were reported by Quasem (1995) who investigated the allelopathic effect of three *Amaranthus* spp. (Pigweeds) on wheat (*Triticum durum*). However, among the parameters measured water absorption rate was found to somewhat increased with increase in leaf and stem extracts concentrations of *Pennisetum purpureum.* This might be attributed to stimulatory effect of allelochemicals on water absorption and enzyme activities.

The observed significant differences between *Stylosanthes hamata* and *Lablab purpureus* in terms of germination rate, root length, shoot length and water absorption observed may probably be due to seed size as larger seed size connote higher carbohydrate reservoir.

CONCLUSION and RECOMMENDATION

It can be concluded that both leaf and stem extracts of *Pennisetum purpureum* have negative and positive allelopathic effects respectively. The negative effect was more clearly observed in leaf extract concentration on water absorption where it appeared to decrease with increase in leaf extract concentration of*Pennisetum purpureum* even though a definite trend was not observed. However, a positive allelopathic effect of stem extract concentration of *Pennisetum purpureum* was observed on water absorption.

Field studies should be conducted to further define the limit of the allelopathic effect of *Pennisetum purpureum*.

Conflict of Interest

The authors have declared that there are no competing interests.

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