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ALLELOPHATIC EFFECT OF PROSOPIS AFRICANA (GUILL AND PER) TAUB POD POWDER ON THE GERMINATION INDICES OF THREE VARIETIES OF ABELMOSCHUS ESCULENTUS (L.) MOENCH

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ABSTRACT
The release of certain chemicals by plants has been found to significantly affect different facets of other plant life cycles, from germination through to reproduction. The study was carried out to investigate the allelopathic effect of *Prosopis Africana* pod powder on the germination, growth and yield attributes of three varieties of *Abelmoschus esculentum*. Germination indices such as germination percentage, germination rate and germination index were evaluated. Growth parameters namely; number of leaves, plant height, stem girth and leaf area were also assessed. The data collected were subjected to analysis of variance using Statistical Package for Social Science (SPSS) 16.0 version. Duncan Multiple Range Test was used to separate mean differences ($P<0.05$). Results revealed that the highest germination percentage, index and rate values were recorded for variety *Yellen* (100%, 3.447 and 0.5), respectively when treated with *Prosopis Africana* pod powder extract. Highest germination index values were recorded in okra varieties *Yellen, Clemson spineless* and *NHAe* when treated with 40, 60 and 40 g of the pod extract (3.447, 3.057 and 3.39) respectively. Least germination percentage, and germination index recorded in okra variety *Clemson spineless* and *NHAe* (7.22% and 0.39) respectively. Administration of 80 and 100 g of the *Prosopis Africana* pod powder extract resulted in a detrimental effect on the three okra varieties, thus concluded allelopathic at these concentrations.

Keywords: Allelopathy, crop, growth, okra, *Prosopis*, yield.

INTRODUCTION

Allelopathy refers to the beneficial or harmful effects of one plant on another plant, both crop and weed species, by the release of chemicals from plant parts by leaching, root exudation, volatilization, residue decomposition and other processes in both natural and agricultural systems (Ferguson *et al*. 2013). Allelopathic compounds are metabolites which released from plants and can be beneficial or detrimental to the growth of receptor plants (Chang-Hung, 1999). The effects of allelochemicals on germination and growth of plants may occur through interference in cell division, energy metabolism, mineral uptake, and biosynthetic processes (Pasiecznik 1999). Ecologically, allelopathic compounds might play an important role in structuring communities.

Allelopathy has been reported to affect many aspects of plant ecology including occurrences, growth and plant succession; the structure of plant communities, dominance, diversity and plant productivity. Commonly cited effects of allelopathy include reduced seed germination and seedling growth (Gulzar & Siddiqui 2014). The detrimental effects of allelochemicals on recipient plants could also be considered to cause biotic stress, called "allelochemical stress" (Folarin *et al*. 2015).

Allelopathy ecology in natural and agricultural ecosystems has received increasing attention because of the significant reduction of important plants growth and yield reduction of crops. It is an ecological interaction primarily based on the ability of certain plant species to produce secondary chemical compounds that exert some sort of biological effects on other organisms, many of which are still unknown (Waller 2003). Hedberg and Edwards (1989) reported that allelopathic compounds could be phenolic in nature. Other researchers (Humaid and Warrag, 1998; Kahi 2003) showed that *Prosopis species* foliage and pods contain autotoxin that can inhibit growth of other plants. However, the influence of the species on tropical food crop like okra under Nigerian condition in particular, has not been studied.

The aim of the study was to investigate the allelopathic effect of *Prosopis Africana* pod on the germination and seedling growth and yield of three varieties of okra. The objectives of the study were to *Prosopis Africana* plant for its capacity to suppress weed; investigate the allelopathic effect of *Prosopis Africana* pod extract on the growth of three varieties of okra; and to evaluate the effect of *Prosopis Africana* pod on yield of three varieties of okra.

MATERIALS AND METHODS

Description of Study Area: The experiment was carried out at the experimental plot (8º44ˈ8ˈˈ and Longitude 4º29ˈ13ˈˈ) of the Department of Plant and Environmental Biology, Kwara State University, Malete, Kwara State Nigeria.

Planting materials: Seeds of okra were obtained from the Ministry of Agriculture, Ilorin, Kwara State, Nigeria. Three varieties of okra namely *Clemson spineless*, *NHAe*, and *Yellen* were used for the research.

Samples of *Prosopis Africana* pod were obtained from Malete, and the shaft in which the pod was removed were cut into small pieces, air dried at room temperature and made into powder using an electric blender.

Soil collection and analysis: Soil Sample was collected from an undisturbed area within the experimental plot of the Department. Digestion of soil sample for trace metal was carried out using Regia

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Method (Gaudino *et al.* 2007). One gram of soil sample was weighed into a clean digestion flask, 9.0 ml of conc. HNO_3 and 9.0 ml of conc. HCl were added into the sample in the digestion flask. The whole sample was heated on an hot plate until all the brownish fumes expelled out (Nitrogenous compounds), which confirmed that the sample is digested and the sample was allowed to cool at room temperature and a few distilled water was added and mixture was filtered into 100 ml standard flask and it was transferred into plastic reagent bottle for analysis with Atomic Absorption Spectrometry (A.A.S.) The analysis for heavy metals with A.A.S. was carried out at University of Ilorin Central Research Laboratory. The treatment comprised of 5 different quantities of powdered pod of *Prosopis Africana* (20, 40, 60, 80 and 100 g); and 3 varieties of okra, laid out in a randomized complete block design.

Germination Indices: The indices computed include germination percentage (G%), germination rate (GR) and germination index (GI).
Germination percentage (G%): The number of germinated seeds as a percentage of the total number of tested seeds given as;

$$G\% = \frac{\text{germinated seeds}}{\text{total tested seeds}} \times 100\% \qquad \text{(Kader 2005).}$$

Germination rate (GR):

$$GR = \frac{1}{t50}$$

Where t_{50} is the time needed to achieve 50% of the final germination percentage (Kader 2005).
Germination index (GI): This was calculated for each treatment according to:

$$GI = \frac{\text{number of germinated seeds}}{\text{days of first count}} + \frac{\text{number of germinated seeds}}{\text{days of second count}} + \frac{\text{number of germinated seeds}}{\text{days of last count}}$$

(Kader 2005).

Growth and yield parameters*:* Data on growth parameters such as number of leaves, plant height, stem girth and leaf area were collected. Yield attributes were collected on number and weight of fruits.

Data analysis: Data collected were subjected to analysis of variance using Statistical Package for Social Science (SPSS) 16.0 version. Duncan Multiple Range Test (DMRT) was used to separate mean differences at P<0.05.

RESULTS

Effects of pod powder of *Prosopis Africana* on germination indices of three varieties of okra

Germination Percentage: Okra variety (*Clemson spineless*) recorded the highest germination percentage (100%) when the okra varieties were treated with 20.0 g of *Prosopis Africana* pod powder extract. However, no significant difference was recorded between the germination percentages of okra varieties *Yellen* and *NHAe*. Least germination percentage in all the okra varieties was observed in okra variety *Clemson spineless* (7.22%), when treated with 80 g of *Prosopis Africana* pod powder extract (Fig. 1)

Germination Index: *Yellen* okra variety grown in pots containing 40 g of *Prosopis Africana* pod powder extract had the highest germination index (3.446). However, there was no significant difference between the germination index values recorded by varieties *Yellen* and *NHAe* (Fig. 2).

Germination Rate: Okra variety *Yellen* seeds sown in pots containing 40g of *Prosopis Africana* pod powder extract had the highest germination rate (0.5), though there was no significant difference between the germination rate values recorded by okra varieties *Yellen* and *NHAe*. Least germination rate (0.11) was recorded by the 3 okra varieties studied at 80 g, and *NHAe* when treated with 100 g of the powder extract (Fig. 3).

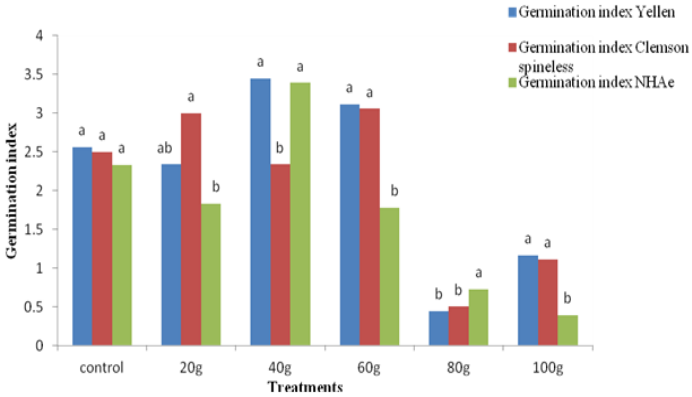

Fig. 1: Effects of *Prosopis Africana* pod powder extract on germination percentage of okra varieties (*Yellen*, *Clemson spineless* and *NHAe*) seeds.

Bars with the same letters are not significantly different from each other at P<0.05.

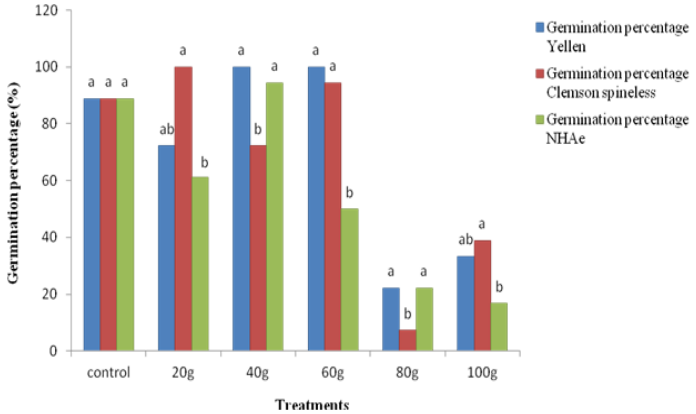

Fig. 1: Effects of *Prosopis Africana* pod powder extract on germination index of okra varieties (*Yellen*, *Clemson spineless* and *NHAe*) seeds.

Bars with the same letters are not significantly different from each other at P<0.05.

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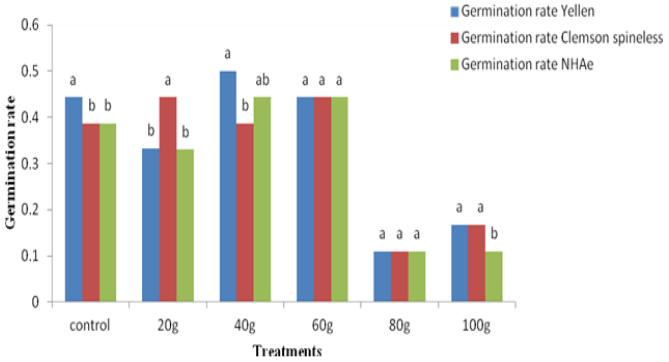

Fig. 2: Effects of *Prosopis Africana* pod powder extract on germination rate of okra varieties (*Yellen*, *Clemson spineless* and *NHAe*) seeds.

Bars with the same letters are not significantly different from each other at P<0.05

Effects of pod powder of *Prosopis Africana* on the growth of okra Variety *Yellen*

Plant Height: Okra seeds sown in pots containing 40 g of *Prosopis Africana* pod powder extract had the highest plant height of 14.63 cm at 4 WAP though there was no significant difference in the heights of those treated with 60 g of the pod extract and control pots. Highest plant heights were observed at 12 WAP. Okra seeds sown in soils containing 80 g of *Prosopis Africana* pod powder had the least plant height from 4WAP to 12WAP (Table 1).

Number of leaves: Plants grown with 80 g of the pod extract had the least number of leaves till 12 WAP.

Leaf Area: The okra plants grown in pots containing 40 g of the pod extract had the highest leaf area at 4 WAP, with no significant difference in the leaf area of those grown in soil treated with 60 g of the pod extract and in control pots, as shown in Table 1.

Stem girth: Okra seeds sown in pots containing 100 g of *Prosopis Africana* pod powder extract had the highest stem girth grown at 12 WAP, though there was no significant difference in the stem girth recorded at 10 and 12 WAP (Table 1).

Effects of pod powder of *Prosopis Africana* on the growth of okra Variety Clemson Spineless

Plant Height: Okra seeds sown in pots containing 40 g of *Prosopis Africana* pod powder extract had the highest plant height of 26.63 cm at 6 WAP though there was no significant difference in the height values of plant grown in soil with 20 g of the pod extract and control pots. Highest plant height was recorded at 12 WAP (Table 2).

Number of leaves: The okra plants grown in pots containing 100 g of *Prosopis Africana* pod powder extract had the highest number of leaves at 12 WAP, though there was no significant difference between the number of leaves of plant grown in 20 and 40 g. Leaf number grown on *Prosopis Africana* has the least number of leaves in control at 12 WAP (Table 2).

Leaf Area: Okra seeds sown in pots containing 40 g of *Prosopis Africana* pod powder extract had the highest leaf area at 8WAP, though there was no significant difference in the leaf area of plant grown in soil containing 80 and 100 g of the pod extract (Table 2).

Stem girth: Plant grown in pots containing 40g of *Prosopis Africana* pod powder extract had the highest stem girth grown at 12WAP though there was no significant difference in the stem girth of plant grown in all weeks of planting. Plant grown on *Prosopis Africana* had the least stem girth at 4WAP.

Table 1: Effects of pod powder of *Prosopis Africana* on growth of okra variety *Yellen*

	4WAP	6WAP	8WAP	10WAP	12WAP
			Plant height (cm)		
Control	13.46^{a} ± 2.03	16.76^{a} ± 1.94	18.60^{ab} ± 2.91	18.83^{ab} ± 3.19	19.20^{ab} ± 2.85
20g	12.70^{a} ± 2.45	18.23^{a} ± 3.23	20.47^{ab} ± 0.67	20.57^{ab} ± 0.78	21.10^{ab}± 0.89
40g	14.63^{a} ± 1.16	19.23^{a} ± 4.03	22.83^{a} ± 1.34	23.30^{a} ± 1.67	23.50^{a} ± 1.60
60g	13.60^{a} ± 1.30	18.83^{a} ± 1.48	20.90^{ab} ± 1.22	20.77^{ab} ± 1.14	20.67^{ab} ± 1.50
80g	3.57^{b} ± 6.18	4.40^{b} ± 7.62	5.53^{c} ± 9.58	5.50^{c} ± 9.53	5.53^{c} ± 9.58
100g	3.22^{b} ± 0.78	11.97^{b} ± 4.97	13.40^{bc} ± 4.30	14.03^{b} ± 4.20	14.37^{b} ± 3.51
			Number of leaves		
Control	4.0^{ab} ± 0	4.67^{a} ± 1.53	4.67^{ab} ± 1.53	4.67^{ab} ± 1.53	5.0^{a} ± 1.00
20g	5.33^{a} ± 0.58	4.67^{a} ± 1.58	2.33^{b} ± 1.53	1.67^{b} ± 1.15	6.67^{a} ± 3.06
40g	5.0^{a} ± 1.00	3.67^{a} ± 2.08	2.67^{b} ± 0.58	2.33^{b} ± 0.58	5.33^{a} ± 4.04
60g	6.0^{a} ± 0	4.33^{a} ± 0.58	2.33^{b} ± 0.58	2.67^{b} ± 0.58	4.67^{a} ± 1.53
80g	1.67^{b} ± 2.89	2.0^{a} ± 3.46	1.67^{b} ± 2.89	1.67^{b} ± 2.89	2.0^{a} ± 3..46
100g	4.33^{a} ± 1.53	6.0^{a} ± 2.65	6.33^{a} ± 1.53	6.67^{a} ± 1.53	7.33^{a} ± 3.21
			Leaf area (cm^2)		
Control	9.37^{abc} ± 1.12	15.77^{a} ± 1.40	13.07^{a} ± 4.33	13.99^{a} ± 4.18	10.28^{a} ± 2.57
20g	16.87^{ab} ± 4.32	22.47^{a} ± 5.81	22.42^{a} ± 9.59	33.18^{a} ± 28.41	27.08^{a} ± 22.62
40g	19.30^{a} ± 9.15	17.33^{a}±13.00	18.78^{a} ± 14.58	12.72^{a} ± 3.61	19.79^{a} ± 8.95
60g	11.59^{abc} ± 6.22	18.0^{a} ± 5.89	25.52^{a} ± 5.15	16.77^{a} ± 0.85	18.77^{a} ± 4.48
80g	4.44^{c} ± 7.69	8.63^{a} ± 14.95	14.04^{a} ± 24.32	10.74^{a} ± 18.59	7.83^{a} ± 13.57
100g	5.91^{bc} ± 4.74	13.21^{a} ± 8.66	32.46^{a} ± 18.21	29.47^{a} ± 11.53	30.71^{a} ± 16.25
			Stem girth		
Control	0.72^{b} ± 0.08	1.20^{a} ± 0	1.43^{a} ± 0.25	1.40^{a} ± 0.20	1.57^{a} ± 0.25
20g	1.20^{a} ± 0.10	1.30^{a} ± 0.10	1.57^{a} ± 0.23	1.67^{a} ± 0.32	1.87^{a} ± 0.38
40g	1.15^{ab} ± 0.22	1.37^{a} ± 0.12	1.53^{a} ± 0.12	1.63^{a} ± 0.06	1.57^{a} ± 0.15
60g	0.93^{ab} ± 0.15	1.27^{a} ± 0.12	1.40^{a} ± 0.17	1.47^{a} ± 0.12	1.67^{a} ± 0.06
80g	0.20^{c} ± 0.35	0.30^{b} ± 0.52	0.47^{b} ± 0.81	0.50^{b} ± 0.87	0.53^{b} ± 0.92
100g	1.03^{ab} ± 0.38	1.33^{a} ± 0.32	1.63^{a} ± 0.40	2.00^{a} ± 0.36	2.13^{a} ± 0.15

Means values with the same superscript letters within a column in a section are not significantly different at P < 0.05

Table 2: Effects of pod powder of Prosopis Africana on growth of okra variety *Clemson spineless*

	4WAP	6WAP	8WAP	10WAP	12WAP
			Plant height (cm)		
Control	19.65^{a} ± 0.43	24.40^{a} ± 0.10	25.53^{ab} ± 0.97	25.93^{a} ± 0.47	26.73^{a} ± 1.10
20g	18.70^{ab} ± 2.42	24.47^{a} ± 4.68	26.83^{ab} ± 4.08	26.83^{a} ± 4.14	27.07^{a} ± 4.28
40g	16.30^{ab} ± 1.65	26.63^{a} ± 1.77	28.33^{a} ± 0.60	28.37^{a} ± 2.00	29.00^{a} ± 0.61
60g	17.87^{ab} ± 1.29	26.43^{a} ± 1.52	27.10^{ab} ± 2.31	28.00^{a} ± 2.01	27.77^{a} ± 1.76
80g	6.70^{c} ± 5.80	10.57^{b} ± 9.56	13.10^{a} ± 11.39	13.60^{a} ± 11.78	18.20^{a} ±16.29
100g	10.40^{bc} ± 9.23	15.0^{ab} ±13.01	15.63^{ab} ±13.74	16.57^{a} ±14.45	16.73^{a} ±14.57
			Number of leaves		
Control	4.33^{a} ± 0.58	3.67^{a} ± 0.58	2.33^{a} ± 0.58	1.33^{a} ± 1.15	1.67^{a} ± 1.53
20g	5.00^{a} ± 1.00	3.33^{a} ± 0.58	3.0^{a} ± 1.00	3.33^{a} ± 1.53	4.00^{a} ± 1.73
40g	5.67^{a} ± 0.58	3.67^{a} ± 1.53	3.67^{a} ± 2.08	3.00^{a} ± 2.65	4.00^{a} ± 2.65
60g	5.33^{a} ± 0.58	4.33^{a} ± 2.52	4.33^{a} ± 3.21	3.67^{a} ± 3.06	3.67^{a} ± 4.04
80g	2.67^{a} ± 2.52	4.33^{a} ± 3.79	2.0^{a} ± 2.65	3.0^{a} ± 2.65	3.67^{a} ± 3.21
100g	3.0^{a} ± 2.65	3.67^{a} ± 3.51	3.00^{a} ± 3.61	3.67^{a} ± 4.72	7.33^{a} ± 5.69
			Leaf area (cm^2)		
Control	11.73^{ab} ± 4.24	13.43^{a} ± 6.49	15.39^{b} ± 7.53	11.32^{a} ± 10.38	6.58^{b} ± 6.64
20g	16.10^{ab} ± 4.59	15.10^{a} ± 5.55	13.89^{b} ± 2.34	17.80^{a} ± 4.15	14.51^{ab} ± 1.63
40g	19.27^{a} ± 9.99	21.66^{a} ± 16.88	47.88^{a} ±19.59	28.54^{a} ± 14.87	27.15^{a} ± 7.17
60g	11.93^{ab} ±3.29	17.97^{a} ± 6.25	16.39^{b} ± 5.12	22.68^{a} ± 6.51	14.20^{ab}± 13.19
80g	1.27^{c} ± 1.18	7.17^{b} ± 8.53	9.67^{b} ± 16.74	10.72^{a} ± 16.52	12.18^{ab}± 13.67
100g	6.03^{bc} ± 5.23	27.47^{a} ± 40.03	10.87^{b} ±12.22	11.46^{a} ± 13.48	13.65^{a} ± 13.01
			Stem girth		
Control	1.17^{a} ± 0.12	1.33^{a} ± 0.25	1.37^{a} ± 0.40	1.53^{a} ± 0.42	1.80^{a} ± 0.53
20g	1.10^{a} ± 0.26	1.43^{a} ± 0.47	1.43^{a} ± 0.25	1.53^{a} ± 0.12	1.70^{a} ± 0.10
40g	1.03^{a} ± 0.06	1.37^{a}± 0.21	1.63^{a} ± 0.38	1.70^{a} ± 0.17	1.90^{a} ± 0.26
60g	1.03^{a} ± 0.32	1.13^{a} ± 0.25	1.27^{a} ± 0.12	1.43^{a} ± 0.23	1.57^{a} ± 0.06
80g	0.53^{a} ± 0.46	0.70^{a} ± 0.61	0.83^{a} ± 0.72	1.00^{a} ± 0.87	1.03^{a} ± 0.89
100g	0.67^{a} ± 0.61	1.07^{a} ± 0.92	1.27^{a} ± 1.10	1.23^{a} ± 1.07	1.43^{a} ± 1.24

Means values with the same superscript letters within a column in a section are not significantly different at P < 0.05.

Table 3: Effects of pod powder of Prosopis Africana on growth of okra variety *NHAe*

	4WAP	6WAP	8WAP	10WAP	12WAP
			Plant height (cm)		
Control	16.83^{a} ± 3.19	20.83^{ab} ± 2.19	21.57^{ab} ± 3.26	22.20^{ab} ± 3.47	22.30^{ab} ± 3.03
20g	17.33^{a} ± 4.36	25.40^{a} ± 5.50	26.80^{a} ± 6.58	27.53^{a} ± 6.05	27.40^{a}± 5.97
40g	14.75^{ab} ± 1.65	19.77^{ab} ± 0.91	20.73^{abc} ± 0.95	20.63^{abc} ± 0.40	20.87^{ab} ± 0.49
60g	8.17^{bc} ± 7.09	10.07^{bc} ± 8.73	10.70^{bcd} ± 9.27	10.70^{bcd} ± 9.27	10.97^{bc} ± 9.49
80g	2.41^{c} ± 4.19	4.03^{c} ± 6.99	4.20^{d} ± 7.27	4.57^{d} ± 7.91	4.57^{c} ± 7.91
100g	2.98^{c} ± 5.17	7.10^{bc} ± 12.29	7.07^{cd} ± 12.23	7.37^{cd} ± 12.76	7.53^{bc} ± 13.05
			Number of leaves		
Control	4.67^{abc} ± 0.58	3.67^{a} ± 0.58	2.00^{a} ± 1.00	2.00^{a} ± 1.00	3.67^{a} ± 1.15
20g	6.67^{a} ± 0.58	3.67^{a} ± 1.53	3.00^{a} ± 0	1.67^{a} ± 1.15	3.33^{a} ± 2.52
40g	5.33^{ab} ± 0.58	4.33^{a} ± 0.58	2.33^{a} ± 0.58	1.67^{a} ± 1.53	1.0^{a} ± 1.00
60g	3.00^{bc} ± 2.65	3.33^{a} ± 3.06	3.33^{a} ± 2.89	2.33^{a} ± 2.52	2.67^{a} ± 3.06
80g	1.33^{c} ± 2.31	1.67^{a} ± 2.89	2.00^{a} ± 3.46	2.33^{a} ± 4.04	2.33^{a} ± 4.04
100g	1.67^{c} ± 2.89	2.67^{a} ± 4.62	1.67^{a} ±2.89	1.67^{a} ± 2.89	2.33^{a} ± 4.04
			Leaf area (cm^{2})		
Control	14.78^{b} ± 2.19	15.90± 0	14.12 ± 0	9.68 ± 0	9.03± 0
20g	32.94^{a} ± 16.67	15.90± 0	14.12 ± 0	9.68 ± 0	9.03± 0
40g	12.14^{b} ± 2.28	15.90± 0	14.12 ± 0	9.68 ± 0	9.03± 0
60g	7.55^{b} ± 6.93	15.90± 0	14.12 ± 0	9.68 ± 0	9.03± 0
80g	1.04^{b} ± 1.79	15.90± 0	14.12 ± 0	9.68 ± 0	9.03± 0
100g	4.13^{b} ± 7.15	15.90± 0	14.12 ± 0	9.68 ± 0	9.03± 0
			Stem girth		
Control	1.20^{ab} ± 0.20	1.27^{ab} ± 0.09	1.40^{a} ± 0.17	1.50^{ab} ± 0.17	1.50^{ab} ± 0.20
20g	1.43^{a} ± 0.47	1.77^{a} ± 0.15	1.87^{a} ± 0.25	1.97^{a} ± 0.35	2.10^{a} ± 0.26
40g	0.97^{abc} ± 0.25	1.23^{ab}± 0.06	1.37^{a} ± 0.06	1.50^{ab} ± 0.10	1.60^{ab} ± 0
60g	0.47^{bc} ± 0.42	0.90^{ab} ± 0.78	1.0^{a} ± 0.87	1.0^{ab} ± 0.87	1.00^{ab} ± 0.87
80g	0.20^{c} ± 0.35	0.33^{b} ± 0.58	0.53^{a} ± 0.92	0.47^{b} ± 0.80	0.50^{b} ± 0.87
100g	0.37^{c} ± 0.64	0.53^{b}± 0.92	0.63^{a} ± 1.09	0.70^{ab} ± 1.21	0.67^{b} ± 1.15

Means values with the same superscript letters within a column in a section are not significantly different at P < 0.05.

Effects of pod powder of *Prosopis Africana* on the growth of okra Variety *NHAe*

Plant Height: Okra plant grown in pots containing 20 g of *Prosopis Africana* pod powder extract had the highest plant height of 27.40 cm at 12 WAP, though there was no significant difference between the heights of plant grown in 40 g of the pod extract and control pots. Highest plant heights were observed at 12WAP (Table 3).

Number of leaves: Okra seeds sown in pots containing 40 g of *Prosopis Africana* pod powder extract had the highest leaf number grown at 4 WAP, though there was no significant difference between the number of leaves of okra plant in soil with 80 and 100 g of the pod extract. Leaf number grown on *Prosopis Africana* had the least number of at 12WAP (Table 3).

Leaf Area: Okra plant grown in pots containing 20 g of *Prosopis Africana* pod powder extract had the highest leaf area at 4 WAP. However, there was no significant difference in the leaf area of okra in all the treatments except those in soil treated with 20 g of the pod extract (Table 3).

Stem girth: Plants in pots containing 20 g of *Prosopis Africana* pod powder extract had the highest stem girth at 12 WAP, though there was no significant difference between the stem girth values of okra grown in soil 80 and 100 g of the pod extract as shown in Table 3.

Effects of pod powder of *Prosopis Africana* on number and weight of fruit of okra variety *Yellen*

Okra fruit grown in pots containing 40g and 60g of *Prosopis Africana* pod powder extract had the highest fruit number and highest weight of most edible fruit is at 20g though there was no significant difference in the number of fruit at 80g and 100g and most edible fruit is at 60g and 20g of plant grown in *Yellen* (Table 4).

Effects of pod powder of *Prosopis Africana* on number and weight of fruit of okra variety *Clemson spineless*

Fruits collected from okra grown in pots containing 20 g of *Prosopis Africana* pod powder extract had the highest fruit number and weight at 40 g, though there was no significant difference in the number of fruit values at 40 g of the pod extract and control (Table 4).

Table 4: Effects of pod powder of *Prosopis Africana* on yield attributes of three varieties of okra

Varieties	*Yellen*		*Clemson spineless*		*NHAe*	
	Number of fruits	Weight of edible fruits	Number of fruits	Weight of edible fruits	Number of fruits	Weight of edible fruits
Control	3.33^{b}	3.47^{ab}	3.67^{ab}	3.03^{ab}	5.0^{a}	14.03^{ab}
20g	3.67^{b}	6.57^{a}	5.67^{a}	5.03^{ab}	3.67^{ab}	20.33^{a}
40g	5.67^{a}	5.03^{ab}	3.33^{ab}	6.93^{a}	5.67^{a}	19.83^{ab}
60g	5.67^{a}	5.77^{a}	6.0^{a}	5.53^{ab}	2.33^{bc}	11.07^{abc}
80g	0.33^{c}	1.07^{b}	0	0	0	0
100g	1.00^{c}	2.87^{ab}	2.0^{bc}	5.03^{ab}	1.0^{c}	6.63^{bc}

Means values with the same superscript letters within a column are not significantly different at P < 0.05

Effects of pod powder of *Prosopis Africana* on number and weight of fruit of okra variety *NHAe*

Okra fruit grown in pots containing 40 g of *Prosopis Africana* pod powder extract had the highest fruit number and highest weight of fruit when treated with pod extract of 20 g, though there was no significant difference in the number of fruit when treated with soil containing 40 g of the pod extract and control pots of okra grown in *NHAe* (Table 4).

DISCUSSION

Okra seeds planted started to germinate after four days. Germination involves several stages that begin with water uptake by dry seed and end with the elongation of the embryonic axis. Nonetheless, even under favorable conditions, water absorption is prevented in seeds of many species characterized with hard impermeable seed coat causing physical dormancy. The decrease in germination indices recorded in this study could be as a result of the negative effects the pod powder has on the seeds, especially at higher concentrations. This observation is in accordance with an earlier research by Getahun & Ali (2017) who studied the allelopathic effect of *Prosopis juliflora* aqueous extract on tropical crops. They concluded from their findings that the extract from the *Prosopis spp.* are capable of effecting inhibitory effects on the germination and growth of the tropical crops investigated. They opined that the extract of the *Prosopis* sp. is capable of reducing germination and significantly inhibiting seedling growth of the crops. Similarly, Siddiqui *et al.* (2009), who also studied the allelopathic effect of different concentration of extract of *P. juliflora* on seed germination and radicle length of wheat, and reported proportional inhibitory effect of aqueous extracts of *Prosopis juliflora* on seeds germination and seedling growth of wheat.

The result of this study revealed that the growth parameters of the okra decreased with increasing concentration of *Prosopis Africana* pod powder extract. Consequently, the results indicated that the pod powder of *Prosopis Africana* possesses allelopathic effect,

which significantly inhibited the growth and yield of the okra varieties. Poor growth recorded when treated with higher concentration of the pod powder, in terms of number of leaves, plant height and leaf area, further indicated the deleterious effect of the powder on the parameters. This finding is in harmony with an earlier study by Amare (2012) who worked on the allelopathic effect of *Eucalyptus globules* on seed germination and early growth of some monocot crop. They reported that allelopathic effect of the aqueous botanical extract used resulted in reduction of germination rate, and lengths of radicles and plumules of the test plants. The trend observed in this study is also in line with a report of Jadhar & Gayanar (1992) who found that the percentage of germination, plumule and radicle length of rice and cowpea decreased with increasing concentration of *Acacia auriculiformis* leaf leachates.

Several reports addressed the importance of allelopathic effect of various trees; *E. camaldulensis*, *Prosopis julifera* and *Acacia nilotica*, which significantly affected seed germination and seedling growth of specific crops and weed species (Khan *et al*. 2004). Gulzar & Siddiqui (2014) reported that the allelopathic effect from aqueous extracts of *E. alba* showed an inhibitory effect on seed germination and seedling growth of weed (*Cassia tora* L. and *Cassia sophera* L.) and crop plants (*P. aureus* L. and *Oryza sativa* L). Foliar leachates have been regarded to be most phytotoxic in nature (Xuan *et al.* 2004; Ferguson *et al*. 2013). This is applicable also to *V. paradoxa* leaves, which may have contributed to the inhibitory effect on the studied vegetables. In similar experiments, researchers concluded that allelopathy and stress interact under natural condition. Romeo & Weidenhamer (1998) reported that under laboratory condition, which is less typically and therefore less stressful than field condition, the allelopathic effect might be reduced. Phenolic acids have been shown to be toxic to germination and plant growth processes (Einhelling 1995). *V. paradoxa* contains palmitic, oleic, linoleic, arachidic, stearic and phenolic. From its composition, phenolic compounds present might be responsible for the inhibitory effect on the studied vegetables (Xuan *et al.* 2004; Ferguson *et al*. 2013). Nevertheless, in this research, biotic stress might be partially responsible for the increases of the allelopathic effect of *Prosopis Africana* pod powder extract, since the experiment was carried out in planting polythene pots

The plant height was observed to be higher in 20 to 60 g of the pod extract treatments in the three varieties of okra (*Yellen, Clemson spineless, NHAe*) and heights were significantly higher than the control, 80 and 100 g, for all the plant heights studied, at different intervals. The highest values of plant height were observed in *Clemson spineless* which is 29.00 cm in 40 g at 12 WAP and the lowest plant height was observed in *NHAe* which is 4.57 cm in 80 g at 12 WAP. At the end of the experiment, plants grown in 20 to 60 g of *Prosopis Africana* pod powder had higher growth than 80 to 100 g treatments which implies that lower concentrations of the pod powder support the growth of the plant. The higher the concentration of *Prosopis Africana* the lower values of the evaluated parameters of the okra plant. With respect to stem girth and leaf area of the three varieties of okra; *Yellen, Clemson spineless, NHAe* response of the treatment are not significantly different from each other. Among the three varieties (*Yellen, Clemson spineless* and *NHAe*), *Clemson spineless* had the highest leaf area of 47.88 cm^2 in grown in soil containing 40 g of the pod extract at 8 WAP, and *Yellen* also had the highest stem girth of 2.13 mm in 100 gpod extract treatment at 12 WAP. The numbers of leaves of the three varieties (*Yellen*, *Clemson spineless* and *NHAe*) are similar. The numbers of leaves were not significantly different at $P< 0.05$. The leaf number of the plant reduced due to falling of leaves after the first fruit harvest.

The highest number of fruits was obtained from *Clemson spineless* in 60 g of *Prosopis Africana* pod powder which was followed by values obtained from varieties *Yellen* and *NHAe*. Significantly highest fruit size was observed in *NHAe* when compared to those of *Yellen* and *Clemson spineless* varieties. There was no significant difference in fruit number between the three varieties. Apart from the number of fruit per plant, individual fruit weight also plays a key role in determining yield per plant

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