بسم الله الرحمن الرحيم

Sudan University of Science and Technology
College of Graduate Studies

Allelopathic Effects Mesquite (*Prosopis juliflora* Swartz) Aqueous Extracts on Seeds Germination and Seedlings Growth of Alfalfa, Sesame and Sorghum

تأثير التضاد الكيمائي للمستخلصات المائية لأجزاء نبات المسكيت على إنبات البذور ونمو الشتلات للبرسيم، السمسم، الذرة

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الآية

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قال تعالى :

لَا يُكَلِّفُ اللَّهُ نَفْسًا إِلَّا وُسْعَهَا ۚ لَهَا مَا كَسَبَتْ وَعَلَيْهَا مَا اكْتَسَبَتْ ۗ رَبَّنَا لَا تُؤَاخِذْنَا إِنْ نَسِينَا أَوْ أَخْطَأْنَا ۚ رَبَّنَا وَلَا تَحْمِلْ عَلَيْنَا إِصْرًا كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِنْ قَبْلِنَا ۚ رَبَّنَا وَلَا تُحَمِّلْنَا مَا لَا طَاقَةَ لَنَا بِهِ ۖ وَاعْفُ عَنَّا وَاغْفِرْ لَنَا وَارْحَمْنَا ۚ أَنْتَ مَوْلَانَا فَانْصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ (٢٨٦)

صدق الله العظيم

سورة البقرة الآية (286)

Dedication

To my Father

To my Mather

To my Sisters and brothers

To my Supervisor Dr: Ibrahim Saeed

I dedicate this work with sincerer love

Huda

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First of all I renderer my gratitude and praises to The Almighty Allah.

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Abstract

Mesquite plant [*Prosopis juliflora* (Swartz) DC] is an invasive, evergreen and multi-purpose leguminous tree or shrub, native to South America. Unfortunately, due to deliberate distribution within Sudan, the plant became a threat to agriculture and biodiversity. The observed absence of ground vegetation under its canopy suggests that it has some allopathic potential that may be caused by fallen fruits, leaves, roots exudates or plant leachates. The release of these allelochemicals in t0 the soil may inhibit the germination and growth of agricultural crops. This study which was under taken in the laboratory of plant pathology, Department of Plant Protection, College of Agricultural Studies, Sudan University of Science and Technology during January-February, 2016. It was aimed to elucidate the potential of allopathic effects of aqueous extract of different parts of Mesquite plant,- namely fruits, leaves, bark and roots, on germination percentages and early seedlings growth of Alfalfa ,Sesame and Sorghum. The results obtained revealed that the aqueous extracts of different parts of mesquite screened significantly $(\mathbf{P \leq 0.05})$ inhibited the seeds germination of the test crops and reduced the early growth of the seedlings with considerable difference compared to control. These suggest that the inhibitory substance(s) were widely distributed -in Mesquite plant but at varying extents. Moreover, the inhibitory -effect on percentages germination and the reduction in early growth of seedlings given by fruits and leaves extracts was more pronounced and consistent than that in bark and roots. This could be attributed to the assumption that the mesquite fruits and leaves aqueous extracts contain or water-soluble allelochemicals than that of roots and bark and hence the inhibitory effect was more pronounced. Accordingly, they gave 0.0%germination in alfalfa and sesame and 47.6% to 86.7% in sorghum, respectively, compared to control. Whereas

the length of hypocotyl and radical was reduced to 0.0 cm and up to 2.7 cm depending on the efficacy of extract and the response of the test crop. Thus it is recommended to study the nature of inhibitors which should help to determine whether the Allelopathic is the cause behind the exceptional success of Mesquite on the flat plains of agricultural lands in Sudan.

ملخص البحث

نبات المسكيت هو شجرة أو شجيرة مجتاحة تتبع للعائلة البقولية، مخضرة دائما ومتعددة الأغراض موطنها أمريكا الجنوبية. لسوء الحظ ونسبة لانتشارها المتعمد في السودان أصبح نبات المسكيت مهدد للزراعة والتنوع الحيوي.ملاحظة عدم وجود نباتات تحت أشجار المسكيت يقترح انه لديه شيء من التضاد البيوكيميائي وربما تسبب في ذلك تساقط الثمارالأوراق، إفرازات الجذور والمترشح من النبات. إطلاق هذه المضادات البيوكيمائية في التربة ربما يؤدى إلى تثبيط الإنبات ونمو المحاصيل الزراعية.هذه الدراسة والتي نفذت في معمل الإمراض، قسم وقاية النبات، كلية الدراسات الزراعية بجامعة السودان للعلوم والتكنولوجيا خلال يناير وفبراير 2016 , كانت بغرض توضيح إمكانية تأثير التضاد البيوكيميائى في المستخلص المائي للأجزاء المختلفة لنبات المسكيت تحديدا، الثمار،الأوراق،اللحاء والجذور على نسبة الإنبات والنموء المبكر للبادرات متمثلة في الجزير والمنطقة تحت الفلقية للبادرة لدى بعض المحاصيل الحقلية.أظهرت النتائج التي تحصل عليها أن المستخلص المائي للأجزاء المختلفة لنبات المسكيت التي تم فحصها قد ثبطت وبصورة معنوية إنبات بذور المحاصيل التي اختبرت وأنقصت النموء المبكر للبادرات بصورة كبيرة مقارنة بالشاهد.هذا ما يشير إلىأن المادة أو المواد المثبطة منتشرةعلى نحو واسع في نبات المسكيت ولكن بدرجات متفاوتة. أضف إلى ذلك, أن التأثيرالتثبيطي لمستخلصات الثمار والأوراق على نسبة الإنبات وعلى النقص في النموء المبكر للبادرات كان أكثروضوحا وثبوتا مما هو عليه في اللحاء والجذور. ربما يعزى ذلك لإحتواء المستخلص المائي للثمار والأوراق على بيوكيميائيات للتضاد قابله للذوبان في الماء الكثير مما هو عليه في القلف والجذور ولذلك التأثير التثبيطي أكثروضوحا.ولذلك كانت نسبة الإنبات0.0% في البرسيم والسمسم و47.6% إلى86.7% في الذرة على التوالي مقارنة بالشاهد. في حين أن طول نموء البادرات متمثلة في الجزير والمنطقة تحت الفلقية للبادرة انقص إلى0.0 وحتى2.7 سنتيمتر على حسب فعالية المستخلص واستجابت المحصول المختبر.هنالك مقترح بدراسة طبيعة هذه المثبطات والتي قد تساعد في تحديد ما إذا كان التضاد البيوكيميائى هو السبب من وراء النجاح الإستثنائي للمسكيت على السهول المنبسطة للأرضي الزراعية بالسودان.

CHAPTER ONE

INTRODUCTION

Common mesquite, *Prosopis juliflora* (Swartz) DC of the family Leguminosae is an invasive, ever green and multi-purpose leguminous tree or shrub (Babiker, 2006). The plant which was native to semi-arid areas of the West Indies, Mexico, Central America and northern South America has been introduced to Sudan since 1917’s (Broun and Massey, 1929; Pasiecznik, 2001 and Felker*et al.*, 2003).

The plant is known to be well adapted to harsh environment conditions of many arid zones. At its centre of origin the shrub has played an important social role. In addition to its role in combating desertification and supply of high-value mechanical wood products, firewood and charcoal mesquite provides shelters, animal feed and food for humans in areas where protein intake is very low and under adverse conditions of drought and famines (Ibrahim, 1989).

Unfortunately, in Sudan, where mesquite was introduced in 1917 from South Africa and Egypt (Brown and Massey, 1929), and due to under utilization of the plant, mismanagement and its deliberate distribution within the country, the plant became a threat to agriculture and biodiversity **(**Babiker, 2006).

The ground vegetation under the canopy of the plant indicates that it has some Allelopathic potential which might have been caused either by fallen leaves or plant leachates or root exudates. Consequently, the release of allelochemicalsinto the soil inhibits seed germination and establishment of agricultural crops and vegetation (Rice, 1974). Mesquite plant is an invasive species which widespread in many countries. Shankhla *et al*., (1965) reported the inhibitory effect of *Prosopis juliflora* aqueous extracts on the growth of some plants. Similar results were reported by many workers (Warrag, 1995; Noor *et al*., 1995; Al-Humaid and Warrag, 1997; Nakano *et al*., 2001).

Allelopathy can simply be understood as the ability of plants to inhibit or stimulate growth of other plants in the environment by exuding chemicals. The concept of allelopathy was first introduced by Hans Molisch to describe both the beneficial and the detrimental chemical interactions of plants and microorganisms (Mulisch, 1937). Since then, the term ‘allelopathy’ has undergone several changes and it has been defined as any direct or indirect harmful or beneficial effects of one plant on another through production of chemical compounds that it releases into the environment (Rice, 1979).

The aim of the present study was to elucidate the Allelopathic potential of different parts aqueous extract of *p.juliflora* plant in respect of their *in vitro* effect on germination and growth of some field crops with the following objectives:

- To investigate the effect of the aqueous extracts of different parts of mesquite plant on germination of seeds of some field crops
- To study the inhibitory effect of different mesquite plant parts extracts on early growth of seedlings hypocotyl and radical length.

CHAPTER TWO

LITERATURE REVIEW

Prosopis juliflora (Swartz) DC is a perennial, large shrub native to semi-arid areas of the West Indies, Mexico, Central America and northern South America. The plant has been introduced in Sudan since 1917's from South Africa and Egypt and planted in Khartoum (Broun and Massey, 1929). The species has wide ecological distribution and due to its efficient mode of becomes the dominant species of the area propagation, it competes and soon (Babiker, 2006). Although *P. juliflora* is an aggressive invader, found growing in habitats like coastal marshes, coastal deserts, sand dunes, flat plains, hilly areas, dry stream bed, inland saline flats, degraded and disturbed areas, flat plains with shallow water table appear to be the best suited habitat.

2.1 The mesquite plant

Prosopis SPP.are multi-purpose ever green leguminous trees or shrubs. The -genus comprises 44 species of which 4 0 are natives to the Americas (Pasiecznik, 2001). The plant grows in arrays of environments and is not restricted by soil type, pH, salinity or fertility. In Sudan flowering is year-round (Babiker, 2006). The fruiting period, peaks is in December to June -(coincides with the dry season). Mesquite leaves are unpalatable, while pods, renowned for their high sugar (16%) and protein (12%) contents are which attractive to animals. Self incompatibility promotes hybridization and results in genetic variability, which as noted in similar situations, would confer plasticity and allows colonization of a wide range of habitats (Hierro and Callaway, 2003).

Common mesquite (*P. juliflora*), often multi-stemmed with a spreading crown of pendulous branches hanging down to the ground, is a copious seed producer (Babiker, 2006). The seeds, characterized by coat imposed dormancy, germinate in flushes and establish a huge persistent seed bank. Goats, sheep, cows and feral animals, attracted by the green foliage, eat ripened pods and liberate the seeds. The seeds encapsulated in animal droppings, are spread into new sites over long distances. The pods are also transported by flood waters and run-off (Babiker, 2006).

Following germination mesquite seedlings grow vigorously (Ahmed *et al*., 2009). Tap roots reach deep water tables and extensive lateral roots spread well beyond the crown. The rapidly growing root system and un-palatability of foliage increase seedling survival rate and competitiveness particularly in heavy grazed areas and/or on uncultivated fallows. The high coppicing ability of mesquite ensures recovery of the plant when cut and often results in a multi-stemmed tree. The trees have many competitive advantages over other plants however, the seedlings are somewhat sensitive (Pasiecznik, 1999). They colonize disturbed, eroded, overgrazed or drought-ridden land associated with unsustainable agronomic practices (Pasiecznik, 1999). The trees are believed to deplete groundwater reserves and to smother and suppress, through both Allelopathic and competitive effects, growth of neighboring plants (Ahmed *et al*., 2009). Prosopis pollens are said to be a major cause of allergic reactions and the thorns are poisonous and/or promotive secondary infections on prickling (Takur and Sharma, 1985).

2.2 Propagation of mesquite

Prosopis juliflora is propagated through seeds. The dispersal unit consists of a pod with a high content of viscous, sugary material. The pods are eaten by animals and the seeds, after necessary acid scarification, are excreted through droppings. During the rainfall a large number of seeds germinate in animal droppings. The seedlings develop deep roots to tap underground water.

The ecological significance of phytotoxins in old field succession and in other natural communities has attracted the attention of many workers (; Mizutani, 1989; May & Ash, 1990; Choesin &Boerner, 1991).

Among the allelochemicals which take part in such interactions are phenols, terpenes, glucosides, alkaloids, amino acids and sugars (Harborne, 1989). *P. juliflora*, during the last few years, has invaded all kinds of communities in the flat plains of Sudan (Babiker, 2006) and has now become dominant especially in Eastern Sudan by completely eliminating the natural vegetation. This exceptional success of *P. juliflora* could be attributed to allelopathy.

2.3 Uses of mesquite

Mesquite, at its centre of origin, the arid areas in South America, has played an important social role. In addition to its role in combating desertification and supply of high-value mechanical wood products, firewood and charcoal mesquite provides shelters, animal feed and food for humans in areas where protein intake is very low and under adverse conditions of drought and famines (Ibrahim, 1989). The plant is important for fencing stalks, and as bee forage for honey production. Mesquite pods are a source of good quality flour and syrup (Felker*et al*., 2003). Flour and syrup from mesquite are used in making foodstuffs at household levels (Pasiecznik, 2001, Felker*et al*., 2003). Mesquite species exude a water soluble gum that has been used as a substitute for gum Arabic during periods of restricted trading or international market shortages (Vilela and Ravtta, 2005). Mesquite species have ameliorating effects on soil under canopy. The tree fixes nitrogen and the leaf litter, when incorporated, improves soil physical and chemical properties. In Peru, leaves of mesquite are valued as compost (Pasiencznik, 2001). Foliage of mesquite contains several chemicals which are effective against several weeds; insects, fungi and some are of medical and/or industrial value (Pasiecznik, 1999).

Moreover, mesquite, when properly managed, is a suitable tree for agro-forestry in low-input low-rainfall areas (Luukkanen*et al*., 1983).

In Sudan the success attained in establishment and the ability of mesquite to tolerate drought, fix sand dunes and capacity to furnish shade, fuel, timber, fodder and edible pods provided the impetus for repeated introductions of the tree into various agro ecologies with emphasis on dry areas (Babiker, 2006). In the period 1978-1981 the tree was planted as shelterbelts on premises of Portsudan, Tokar and Kassala towns (Elsidig, *etal* 1998) and along the Nile.

2.4 Invasive nature of mesquite

In most of the countries, where it was introduced, mesquite has spread outside where it was originally planted and has become a serious weed (ElHouri, 1986). Ease of spread of mesquite is consistent with its invasive nature, ease of adaptations to novel environments, lack of natural enemies and underutilization and mismanagements (Ali and Labrada, 2006; Babiker, 2006; Kathiresan, 2006). It is noteworthy that exploitation of mesquite in Argentina between 1500 and 1975 reduced the natural coverage of Prosopis to between 25 and 50% (Choge and Chikamai, 2004). Utilization of wood and non-wood products of mesquite in Sayun and Tarim in Yemen, in addition to the benefits realized by the community, curtailed spread of the tree and lessened its importance as a weed (Ali and Labrada, 2006).

In fact, the deliberate distribution of mesquite within the country, prevailing drought, livestock and feral animal's movement coupled with decreased land-use, land tenure, under utilization of the plant, mismanagement and over exploitation of natural vegetation in Sudan have led to spread of mesquite into various locations where it has become a national pest (Elhouri, 1986) specially in eastern Sudan where the bulk of mesquite infestation (>90%) is there.However, the plant constitutes a threat to agriculture, biodiversity and may lead to deterioration of natural vegetation and pastures and, thus, jeopardize the livelihood of a large proportion of the populace, particularly, where livestock keeping and subsistent farming are the main avenues for income generation.

2.5 Allelopathic activity of mesquite

The phenomenon of plants influencing neighboring plants through the release of chemicals in the environment has been known as early as 370 BC. Greeks and Romans have used this knowledge in agriculture since c. 64 AD (Fraenkel, 1959). From this, he cautiously speculated that chemicals of plant origin (allelochemicals) have potential for bringing about population level change by affecting the growth of neighboring plants.

Actually, allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms. Allelochemicals are a subset of secondary metabolites which are not required for metabolism (i.e. growth, development and reproduction) of the allelopathic organism. Allelochemicals with negative allelopathic effects are an important part of plant defense against herbivory (Stamp and Nancy, 2003).

The P. juliflora is an invasive and widespread species in many countries. Shankhlaet al., (1965) reported the inhibitory effect of aqueous extracts on the growth of some plants. Similar results were reported by many workers (Warrag, 1995; Noor et al., 1995; Al-Humaid and Warrag, 1997; Nakano et al., 2001).

The major allelochemicals reported were the phenolics. The plant parts which fall to the ground are not totally degraded quickly by the microbes due to the high phenol content. Nakano *et al*., (2002, 2003) isolated L-Tryptophan from the freeze-dried leaves of *P. juliflora* which inhibited the radical growth. And, Nakano *et al*., (2002) also isolated syringing lariciresinol. Syringin inhibited the root and shoot growth of lettuce seedlings and Barnyard grass. Lariciresinol inhibited root and shoot growth of lettuce seedling and Barnyard grass seedling .The effect of growth inhibiting substance becomes more evident at higher concentrations and the promoting influence become more prominent with higher dilutions of the aqueous extracts (Sen and Chawan, 1970).

It was also reported elsewhere (El-Keblawy and Al-Rawai, 2007), that the effect of *P. juliflora* on the associated flora significantly depended on the density and size of canopy; wherein larger individuals and greater densities have significantly greater negative impacts on associated plants.

2.2 Alfalfa (*Medicago sativa*)

Alfalfa is a clover-like legume, perennial plant that belongs to Fabaceae (Teuber, *et al.,* 1987). In Sudan the plant is of economical importance as fodder for local consumption and for export.

2.3 Sesame (*Sesamum indicum* L.)

Sesame is a flowering plant in the genus Sesamum and considered as the oldest oilseed crop known to humanity. Most wild species of the genus *Sesamum* are native to sub-Saharan Africa. Sesame is widely naturalizedin tropical regions around the world and is cultivated for its edible seeds, which grow in pods. It is a drought-tolerant crop that able to grow where other crops fail (Raghav Ram, *et al.,* 1990). Sesame has one of the highest oil contents of any seed with a rich nutty flavor. It is a common ingredient in cuisines across the world (Ray Hansen, 2011). Like other nuts and foods, it can trigger allergic reactions in some people.

2.4 *Sorghum bicolor* L. (Moench):

According to ICRISAT (1993), Sorghum is one of the major cereal crop and staple food for millions of the poorest and most food insecure people in the Semi-Arid Tropics of Africa and Asia. The greatest diversity in both cultivated and wild types of Sorghum is found in north-eastern tropical Africa. The crop may have been domesticated in that region, possibly Ethiopia.

In the Sudan sorghum is produced mainly in rain-fed agriculture. The cereal harvest for the Republic of the Sudan is estimated at 5.707 million MT, comprising 4.606 million MT of sorghum FAO/WHO (2011). Sorghum is used in Sudan as food for human beings and feed for animals. Industrial uses include extraction of many products such as starch, oil, alcohol, sugar, and sugary juices (Khatab *et al*., 2000).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experimental site

The experiments were conducted in the laboratory of Plant Pathology, Department of Plant Protection, College of Agricultural Studies, Sudan University of Science and Technology during January-February 2016.

3.2 Collection of mesquite plant and crop seeds samples

Different parts of Mesquite (fruits, leaves, barks and roots) were collected from trees growing in the premises of the College of Agricultural Studies, Shambat. The parts collected were cleaned from dust and strange material by hand, washed with distilled water, surface sterilized with 1% Sodium hypo Chloride, thoroughly washed in sterilized water and dried under shade at ambient temperature(25-30c) . ground and powdered separately to obtain fine powder for extraction and kept till use.

Healthy uniform grains of sorghum, sesame and alfalfa were obtained from the central grain market. Before germination test the grains were surface sterilized with 1% sodium hypochloride for 20 minutes, then rinsed with the distilled water for several times to remove excess of chemical.

3.3 Preparation of aqueous extract of different plant parts

Aqueous extracts of each of the plant parts were prepared as recommended by Okigbo (2006). The obtained fine powder form different parts of mesquite was weighted (500 gm) and added to it 1000 ml sterilized distilled water and then placed in a shaker for 24 hrs. The extracts were filtered using Whatman No. 1 filter paper and the filtrate was kept in the refrigerator to serve as stock solutions.

3.4 Bioassay

The seed samples were alfalfa, sesame, sorghum germinated by being platted on filter papers (dia. 9.0 cm) placed in 9.0 cm sterilized plastic Petri-dishes and then moistened with the respective test extract (four test extracts). Twenty five seeds were plated from each sample. A total of four seed samples per crop, with three replications, were used. Treatments were arranged in a completely randomized design with three replications and kept in dark place for seeds germination. Distilled water was used as a control. Five ml of the respective test extract was then added to each Petri-dish every other day till the end of the experiment after four days.

3.5 Measurement and statistical analysis

The seeds of each crop were examined for germination and early growth of seedlings upon emergence of radical and hypocotyls after 4 days. Seeds were considered germinated upon radical emergence. Germination was determined by counting the number of germinated seeds in each treatment and expressed as percentage of the total number of treated seeds. Seedlings were then retrieved, and radicle and hypocotyls length were measured using millimeter ruler and recorded. The seeds germination percentages and seedlings growth were employed as measures for Allelopathic activity.

The data were subjected to statistical analysis by analysis of variance using Mstat software. Means were separated for significance using Duncan's Multiple Range Test (DMRT) $(P \leq 0.05)$.

CHAPTER FOUR

RESULTS

4.1 Effect of Mesquite plant aqueous extracts on the germination percentages.

The results of the effect of aqueous extracts from different parts of *P.juliflora* on the final germination percentages of seeds of various test crops after four days from sawing are presented in Table 1 and Figure 1. Generally the results showed that aqueous extracts of different parts of mesquite screened,invariably and significantly inhibited the seeds germination of the test crops compared to control (100%) The inhibitory effect resulted in germination percentages ranged from 0.0% to 93.3%.

Among different parts of mesquite extracts that of fruits and leaves reduced significantly (0.05) and consistently the seeds germination of all seeds of test crops. They gave 0.0% germination in Alfalfa and Sesame fruits extracts and 46.7% and 70.7% in Sorghum; respectively; followed in descending order by bark extract which gave 46.7%, 86.7% and 64.0% and roots extract 80.0%, 93.3% and 86.7% germination in seeds of Alfalfa, Sesame and sorghum; respectively. In fact, the roots extract exhibited the lowest inhibitory effect on the germination of seeds of all crops. Moreover, the suppressing effect of fruits extract was more pronounced on seeds of all crops than other parts of mesquite. However, among crops, the germination of seeds of sorghum was the least affected by the different extracts.

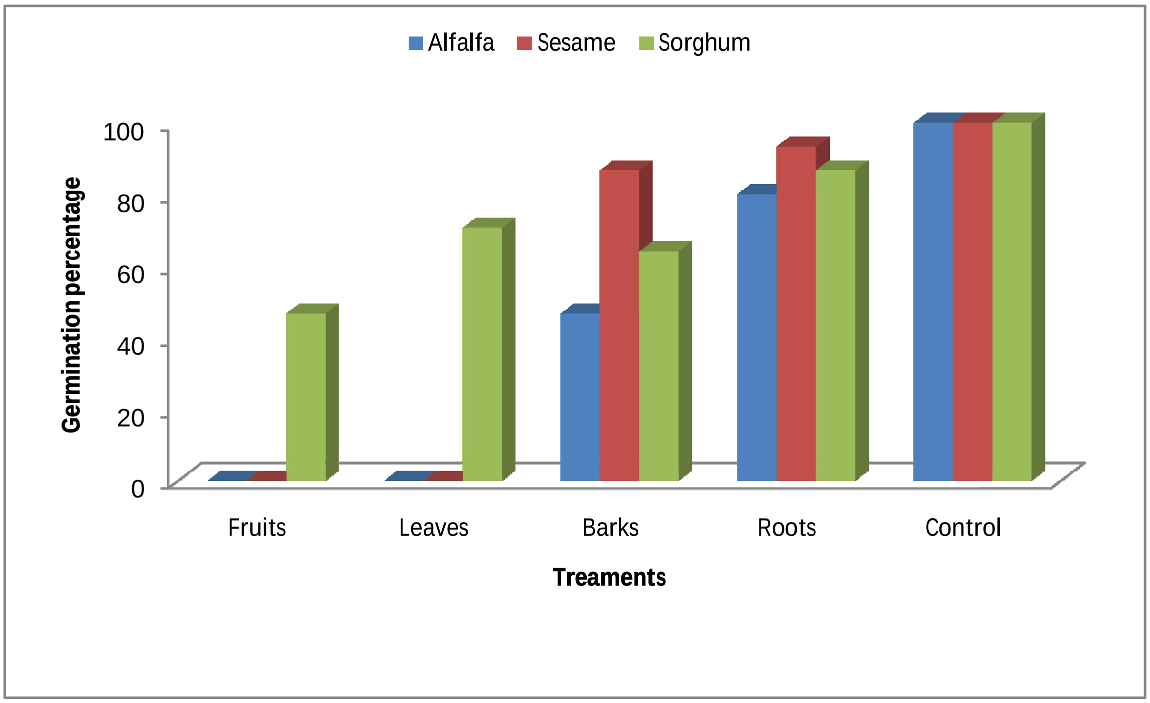

Figure 1. Effect of aqueous extracts from different parts of *mesquite plant* on the germination of seeds of various crops.

4.2 Effect of aqueous extracts of Mesquite plant on the growth of hypocotyl and radical of Alfalfa

The effect of aqueous extracts from different parts of *P.juliflora* on the growth of hypocotyl and radical of test crops, four days after sawing, is-presented in Tables 2, 3, 4 and Figures 2, 3 and 4. The data revealed that the extracts of different parts of mesquite plant screened, exhibited considerable differences in their inhibitory effect on the early growth of hypocotyl and radicle of seedlings of the test crops compared to control. The inhibitory effect ranged from 0.0% cm to 2.7cm length.

Among different parts of mesquite extracts that of fruits and leaves expressed similar consistency in reducing significantly $(P \leq 0.05)$ the growth of hypocotyl and radical of seedlings of the test crops compared to control. In fact, the length of the hypocotyl and radical was reduced to 0.0% cm in Alfalfa and Sesame ranged from 0.10% cm for radical to 1.033 cm in hypocotyls of Sorghum. The reduction effect given by bark and roots extracts on both parameters of growth was less in all seedlings of the test crops. In fact, the roots extract exhibited the lowest inhibitory effect on the growth of hypocotyl and radicle of test crops. Moreover, the suppressing effect of fruits extract was more pronounced on the seedlings growth of all crops. However, among crops, the growth of the sorghum seedlings was the least affected by the different extracts.

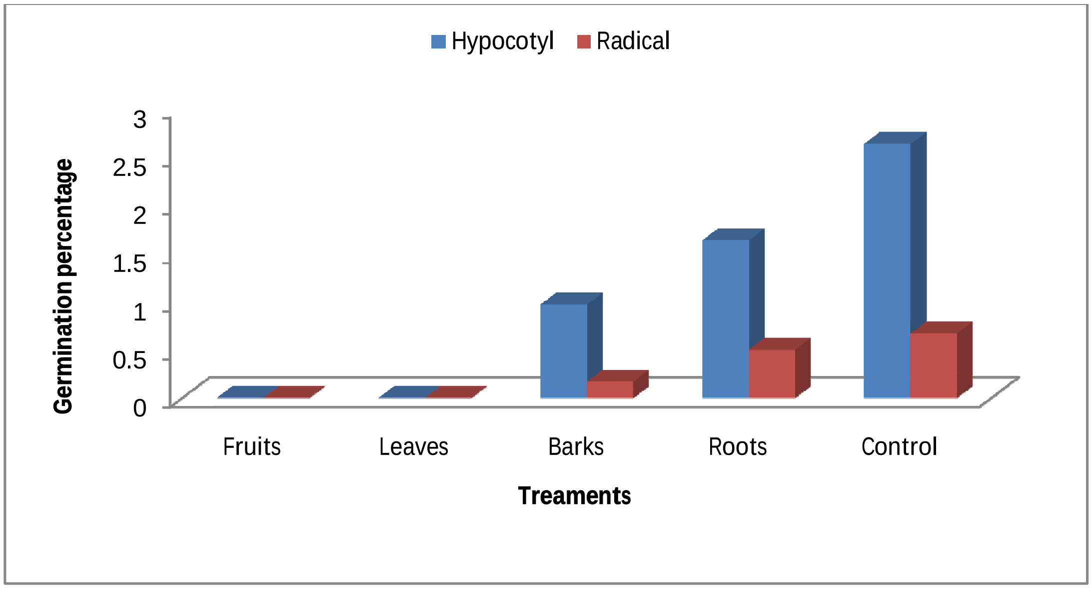

Figure 2.Effect of aqueous extracts from different parts of Mesquite plant on the mean seedlings hypocotyl and radicle length (cm) of Alfalfa.

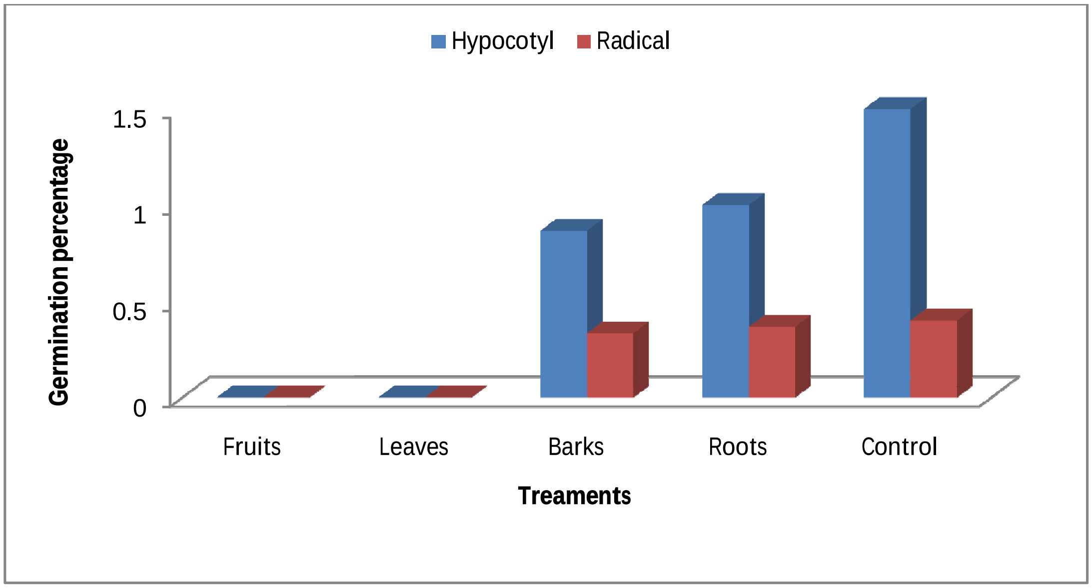

Figure 3.Effect of aqueous extracts of different of Mesquite plant parts on the mean seedlings hypocotyl and roots radical length (cm) of Sesame.

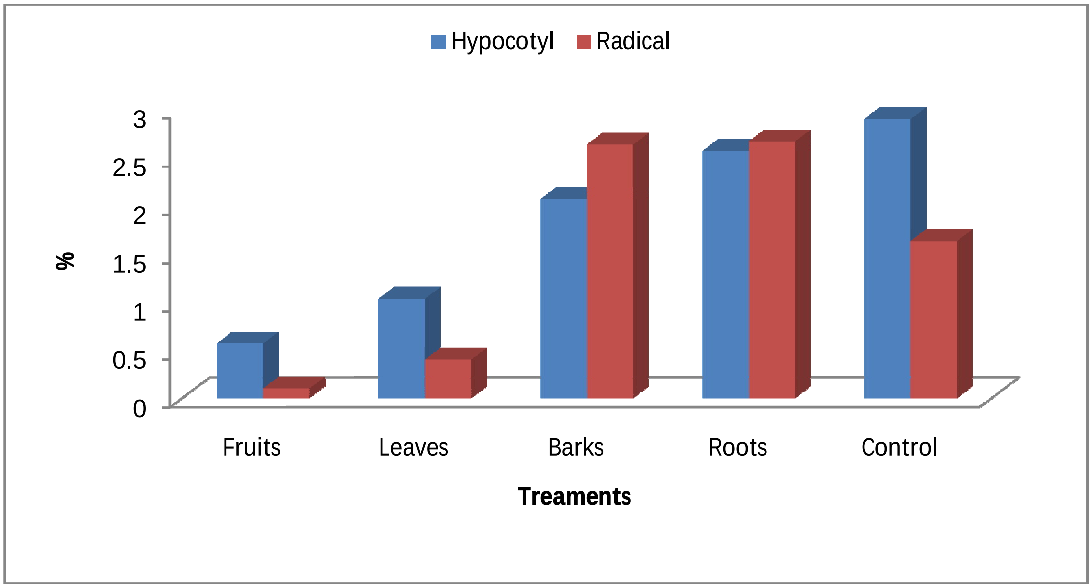

Figure 4. Effect of aqueous extracts of different of Mesquite plant parts on the mean seedlings hypocoty) and radical length (cm) of Sorghum crop

CHAPTER FIVE

DISCUSSION

The phenomenon of the presence of biochemical inhibitors associated with some weeds, shrubs or trees parts is widespread in the plant kingdom (Khan, 1982; Hedge & Miller, 1990). Many woody species are reported to have phytotoxins (Akram*et al*., 1990; May & Ash, 1990; Chou & Lee, 1991; Ferguson, 1991 ;)Kil& Yun (1992). Chou & Yang (1982) showed that leachates of the bamboo, *Phyllostachysedulis* (Carr.), contain significant amounts of allelopathic compounds that can suppress the growth of undergrowth weeds. However, the water-soluble allelopathic substances released by the woody plants and take part in such interactions have been identified as phenolic compounds, flavonoids and alkaloids which are distributed in woody species (Chou, 1989 and Harborne, 1989).

However, the ecological significance of phytotoxins in old field succession and in other natural communities has attracted the attention of many workers (Mizutani, 1989; May & Ash, 1990; Choesin&Boerner, 1991).

In this study, the effect of aqueous extracts from different parts of *P.juliflora* on the final germination percentages of seeds and early growth of seedling of various test crops was investigated. The data revealed that extracts of different parts of mesquite plant screened significantly inhibited the seeds germination of the test crops compared to control with considerable differences among crops.

Moreover, the effect of fruits and leaves extracts were found to be more pronounced than that of bark and roots. This highly significant inhibitory effect of fruits and leaves extracts could be attributed to that the mesquite fruits and leaves aqueous extracts contain water-soluble allelochemicals than that of roots and bark and hence the inhibitory effect was more. These results confirm that of Sazada*et al*., (2009) who reported similar results on seeds of wheat and Chellamuthu*et al*., (1977) who reported that the *P. juliflora* significantly reduced thegermination percentage of gram and sorghum.

In this regard, Chou (1989) reported that the Allelopathic metabolites leached out from woody plants often suppress the growth of undergrowth species sharing the same habitat. The results obtained in this study is also in line with Akram*et al*., (1990) and Kil& Yun (1992) who reported that the Allelopathic effects generally produce an inhibition of germination and early growth of seedlings. Moreover, Macias *et al*., (1992) reported that although the specific mode of action of allelochemicals was not investigated, many other studies demonstrated inhibition occurring through limiting cell division, respiration, photosynthesis or by disrupting membrane regulation. Accordingly, the presence of allelochemicals activity in some parts of Mesquite explains the possibility of a role of allelopathy in the phenomenal success of *P. juliflora* as an invader. These results also suggested that the inhibitory substance(s) were widely distributed in mesquite plant but to varying extents.

The data also demonstrated that the extracts of different parts of mesquite plant screened inhibited the early growth of seedlings as measured by hypocotyl and radical length with considerable differences among crops. However, the inhibitory effect of roots extract on growth parameters was found to be the least. This could be attributed to the continuous release and leaching of active allelochemicals during the crop growth. However, this mere presence of suppressing effect does not prove that allelopathy does occur under natural conditions. Similar results was reported by Mehar *et al*., (1995) who demonstrated that the roots extract of Mesquite has the least reducing effect on germination and early seedlings growth of various cultivars of Zea mays and *Triticum aesitvum*.

Conclusions

- This present study proved categorically that the different parts of mesquite plant extracts screened, invariably reduced significantly seeds germination and early growth of seedlings of all test seeds crops which indicates the presence of Allelopathic potential in *P. juliflora*.
- There are considerable differences in the inhibitory effect of the mesquite parts screened.
- Likewise, the seeds crops tested responded differently to the suppressing effect of mesquite parts extracts.

Recommendations

The study revealed that the inhibitory effect of the roots extracts were the least. This mere presence of Allelopathic effect does not prove that allelopathy does occur under natural conditions.

Accordingly the following investigations were recommended:-

- To study the movement of allelochemicals to the soil;
- To investigate the maintenance of allelochemicals potential while present in the soil;
- To study the change in inhibitor concentrations after various periods of drying under natural conditions;
- To characterize the nature of inhibitors which should help to determine whether the allelopathy is the cause of the exceptional success of *P. juliflora* on the flat plains of agricultural lands in Sudan?

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Appendices

Appendix (1). Mesquite tree (*Prosopis juliflora*)

Table 1.Effect of aqueous extracts from different parts of *Prosopis juliflora* on the germination of seeds crops.

Treatments	**Crops**		
	Alfalfa	**Sesame**	**Sorghum**
Fruits	0.00^{d}	0.00^{d}	46.70^{d}
Leaves	0.00^{d}	0.00^{d}	70.7^{c}
Barks	46.67^{c}	86.70^{c}	64.00^{c}
Roots	80.00^{b}	93.3^{b}	86.67^{b}
Control	100.00^{a}	100.0^{a}	100.00^{a}
P-value	0.0^{**}	0.0^{**}	0.0^{**}
C.V%	6.03	4.12	8.06
$Lsd_{0.05}$	4.971	4.201	10.79

Value(s) bearing different superscript(s) are significantly different $(P \leq 0.05)$ according toDMRT.

Table 2.Effect of aqueous extracts of different parts of Mesquite plant parts on the seedlings hypocotyl and radicle length (cm) of Alfalfa.

Treatments	Hypocotyl	Radicle
Fruits	0.00^{e}	0.00^{e}
Leaves	0.00^{e}	0.00^{e}
Barks	0.96^{c}	0.17^{e}
Roots	1.63^{b}	0.50^{d}
Control	2.63^{a}	0.67^{d}
P-value	0.0^{**}	
C.V%	14.87	
$Lsd_{0.05}$	0.2799	

Value(s) bearing different superscript(s) are significantly different ($P \leq 0.05$) according to DMRT.

Table 3. Effect of aqueous extracts of different of Mesquite plant parts on the seedlings hypocotyl and radicle length (cm) of Sesame

Treatment	Hypocotyl	Radicle
Fruits	0.00^{d}	0.00^{d}
Leaves	0.00^{d}	0.00^{d}
Barks	0.87^{b}	0.33^{c}
Roots	1.00^{b}	0.37^{c}
Control	1.50^{a}	0.40^{c}
P-value	0.0^{**}	
C.V%	29.19	
$Lsd_{0.05}$	0.2221	

Value(s) bearing different superscript(s) are significantly different ($P \leq 0.05$) according to DMRT.

Table 4. Effect of aqueous extracts of different of Mesquite plant parts on the seedlings hypocotyl and radicle length (cm) of Sorghum crop

Treatments	Hypocotyl	Radicle
Fruits	0.567^{ef}	0.1000^{f}
Leaves	1.033^{de}	0.400^{ef}
Barks	2.067^{bc}	2.633^{ab}
Roots	2.567^{ab}	2.667^{ab}
Control	2.900^{a}	1.633^{cd}
P-value	0.0059^{**}	
C.V%	23.25	
$Lsd_{0.05}$	0.6552	

Value(s) bearing different superscript(s) are significantly different ($P \leq 0.05$) according to DMRT.

.

Appendix (9)

Germination

Function: One way ANOVA

(Alfa Alfa)

A N A L Y S I S O F V A R I A N C E T A B L E

S. of Var.	df	SS	MS	F-cal	P-value
Between	4	24906.667	6226.667	833.929	0.0000
Within	10	74.667	7.467		
Total	14	24981.333			

Coefficient of Variation = 6.03%

1	Number	Sum	Average	SD	SE
1	3.00	0.000	0.000	0.00	1.58
2	3.00	0.000	0.000	0.00	1.58
3	3.00	140.000	46.667	6.11	1.58
4	3.00	240.000	80.000	0.00	1.58
5	3.00	300.000	100.000	0.00	1.58
Total	15.00	680.000	45.333	42.24	10.91
Within				2.73	

Duncan's Multiple Range Test

LSD value = 4.971

SE = 1.578 at alpha = 0.050

Original Order			Ranked Order		
Mean 1 =	0.0000	D	Mean 5 =	100.0	A
Mean 2 =	0.0000	D	Mean 4 =	80.00	B
Mean 3 =	46.67	C	Mean 3 =	46.67	C
Mean 4 =	80.00	B	Mean 2 =	0.0000	D
Mean 5 =	100.0	A	Mean 1 =	0.0000	D

(Sesame)

A N A L Y S I S O F V A R I A N C E T A B L E

S. of Var.	df	SS	MS	F-cal	P-value
Between	4	31626.667	7906.667	1482.500	0.0000
Within	10	53.333	5.333		
Total	14	31680.000			

Coefficient of Variation = 4.12%

1	Number	Sum	Average	SD	SE
1	3.00	0.000	0.000	0.00	1.33

2	3.00	0.000	0.000	0.00	1.33
3	3.00	260.000	86.667	2.31	1.33
4	3.00	280.000	93.333	4.62	1.33
5	3.00	300.000	100.000	0.00	1.33
Total	15.00	840.000	56.000	47.57	12.28
Within			2.31		

Duncan's Multiple Range Test
LSD value = 4.201
SE = 1.333 at alpha = 0.050

Original Order			Ranked Order		
Mean 1 =	0.0000	D	Mean 5 =	100.0	A
Mean 2 =	0.0000	D	Mean 4 =	93.33	B
Mean 3 =	86.67	C	Mean 3 =	86.67	C
Mean 4 =	93.33	B	Mean 2 =	0.0000	D
Mean 5 =	100.0	A	Mean 1 =	0.0000	D

(Sorghum)

A N A L Y S I S O F V A R I A N C E T A B L E

S. of Var.	df	SS	MS	F-cal	P-value
Between	4	5081.600	1270.400	36.091	0.0000
Within	10	352.000	35.200		
Total	14	5433.600			

Coefficient of Variation = 8.06%

1	Number	Sum	Average	SD	SE
1	3.00	140.000	46.667	6.11	3.43
2	3.00	212.000	70.667	6.11	3.43
3	3.00	192.000	64.000	8.00	3.43
4	3.00	260.000	86.667	6.11	3.43
5	3.00	300.000	100.000	0.00	3.43
Total	15.00	1104.000	73.600	19.70	5.09
Within			5.93		

Duncan's Multiple Range Test
LSD value = 10.79
SE = 3.425 at alpha = 0.050

Original Order			Ranked Order		
Mean 1 =	46.67	D	Mean 5 =	100.0	A
Mean 2 =	70.67	C	Mean 4 =	86.67	B
Mean 3 =	64.00	C	Mean 2 =	70.67	C
Mean 4 =	86.67	B	Mean 3 =	64.00	C

Mean 5 =	100.0 A	Mean 1 =	46.67 D

Experiment Model: Two Factor Completely Randomized Design; where Factor A = H/R and Factor B = Cultivar

Alfa Alfa

A N A L Y S I S O F V A R I A N C E T A B L E

S. of Var.	df	SS	MS	F-cal	P-value
Factor A	1	4.563	4.563	171.1125	0.0000
Factor B	4	12.152	3.038	113.9250	0.0000
AB	4	4.125	1.031	38.6750	0.0000
Error	20	0.533	0.027		
Total	29	21.374			

Coefficient of Variation: 14.87%

Duncan's Multiple Range Test

LSD value = 0.2799

SE = 0.09487 at alpha = 0.050

Original Order			Ranked Order		
Mean 1 =	0.0000	E	Mean 5 =	2.633	A
Mean 2 =	0.0000	E	Mean 4 =	1.633	B
Mean 3 =	0.9667	C	Mean 3 =	0.9667	C
Mean 4 =	1.633	B	Mean 10 =	0.6667	D
Mean 5 =	2.633	A	Mean 9 =	0.5000	D
Mean 6 =	0.0000	E	Mean 8 =	0.1667	E
Mean 7 =	0.0000	E	Mean 1 =	0.0000	E
Mean 8 =	0.1667	E	Mean 2 =	0.0000	E
Mean 9 =	0.5000	D	Mean 7 =	0.0000	E
Mean 10 =	0.6667	D	Mean 6 =	0.0000	E

Sesame

A N A L Y S I S O F V A R I A N C E T A B L E

S. of Var.	df	SS	MS	F-cal	P-value
Factor A	1	1.541	1.541	90.6667	0.0000
Factor B	4	4.391	1.098	64.5784	0.0000
AB	4	1.302	0.325	19.1471	0.0000
Error	20	0.340	0.017		
Total	29	7.575			

Coefficient of Variation: 29.19%

Duncan's Multiple Range Test

LSD value = 0.2221

SE = 0.07528 at alpha = 0.050

Original Order			Ranked Order		
Mean 1 =	0.0000	D	Mean 5 =	1.500	A
Mean 2 =	0.0000	D	Mean 4 =	1.000	B
Mean 3 =	0.8667	B	Mean 3 =	0.8667	B
Mean 4 =	1.000	B	Mean 10 =	0.4000	C
Mean 5 =	1.500	A	Mean 9 =	0.3667	C
Mean 6 =	0.0000	D	Mean 8 =	0.3333	C
Mean 7 =	0.0000	D	Mean 1 =	0.0000	D
Mean 8 =	0.3333	C	Mean 2 =	0.0000	D
Mean 9 =	0.3667	C	Mean 7 =	0.0000	D
Mean 10 =	0.4000	C	Mean 6 =	0.0000	D

Sorghum

A N A L Y S I S O F V A R I A N C E T A B L E

K Value	Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob
	Factor A	1	0.867	0.867	5.8449	0.0253
	Factor B	4	26.455	6.614	44.5876	0.0000
	AB	4	2.965	0.741	4.9966	0.0059
	Error	20	2.967	0.148		
	Total	29	33.254			

Coefficient of Variation: 23.25%

Duncan's Multiple Range Test

LSD value = 0.6552

SE = 0.2221 at alpha = 0.050

Original Order			Ranked Order		
Mean 1 =	0.5667	EF	Mean 5 =	2.900	A
Mean 2 =	1.033	DE	Mean 9 =	2.667	AB
Mean 3 =	2.067	BC	Mean 8 =	2.633	AB
Mean 4 =	2.567	AB	Mean 4 =	2.567	AB
Mean 5 =	2.900	A	Mean 3 =	2.067	BC
Mean 6 =	0.1000	F	Mean 10 =	1.633	CD
Mean 7 =	0.4000	EF	Mean 2 =	1.033	DE
Mean 8 =	2.633	AB	Mean 1 =	0.5667	EF
Mean 9 =	2.667	AB	Mean 7 =	0.4000	EF
Mean 10 =	1.633	CD	Mean 6 =	0.1000	F