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The Influence of Buttonwood Ash Application on Growth of Cowpea Seedling

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Authors' contributions

This work was carried out in collaboration among all authors. Author SA performed the study, statistical analyzed the data and drew the graph. Author MZI designed and supervised the study. Author MS managed the literature searches and wrote the first draft of the manuscript. Authors MK and ZURF critically reviewed the manuscript. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Aim: Large quantities of wood ash released in the environment from the different industrial activities such as wood industries, paper industries, power plants, energy generation plant causes pollution or plant, are largely part of environmental pollutants. The objective of the study was to evaluate the efficacy of buttonwood (*Conocarpus erectus*) tree bark wood ash using as different (4, 8, 12, 16 and 20%) applications on seedling growth performance of an important legume crop cowpea (*Vigna unguiculata*) L. Walp. growing in different parts of Pakistan.
Study Design: The effect of buttonwood ash application on seedling growth performance in legume crop cowpea was recorded.
Place and Duration of Study: The experiment was conducted in the green house at the Department of Botany, University of Karachi, Pakistan, during the month of August – September and lasted for forty days.
Methodology: Ash of trunk and branches of buttonwood after burning, the buttonwood ash was collected in jars and the experiments were conducted in pots. The pots were filled up to 2/3 with soil.

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The concentrations of the button wood ashes taken in this experiment were 4, 8, 12, 16 and 20%, respectively. The growth experiment was conducted in pots filled with garden loam soil. The healthy seeds of cowpea were surface sterilized with 0.2% solution of sodium hypochlorite (NaOCl) for one minute to avoid any fungal contamination. In pot, the wood ash was applied in a concentration of 4, 8, 12, 16 and 20%. Ten seeds of cowpea were sown in each pot and pots were placed in an open field and watered when required. Without wood ash treatment, the plant was used as a control. For dry weights, the root and shoots were dried at 80ºC for 48 hours in the oven. The growth of cowpea was recorded in buttonwood ash including their germination percentage, length of shoot and roots, number of leaves and leaf size.

Results: In present studies, the significant ($p<0.05$) impact of button wood ash on shoot length, seedling growth and leaf area of cowpea was observed in pot system. Increase in concentration of buttonwood ash from 4 to 20% decreased root growth. Wood ash treatment at 4% concentration significantly ($p<0.05$) affected shoot dry weight of cowpea. All treatment also affected root, leaf and seedling dry weight of cowpea.

The seedlings of cowpea were tested for tolerance to different (4, 8, 12, 16, 20%) concentrations of buttonwood (*Conocarpus erectus*) ash. The seedlings of cowpea showed the varied response of tolerance to wood ash. The results showed that *V. unguiculata* seedlings showed a high percentage of tolerance at 12% and better at 4 and 16% of buttonwood wood ash treatment. The lowest percentage of tolerance in seedlings of cowpea to wood ash treatment was found at 20% concentration.

Conclusion: The results of the present studies concluded that the treatment of buttonwood ash at all level (4, 8, 12, 16, and 20%) responsible for the variation in seedling growth performances of cowpea. An increase in the concentration of buttonwood ash treatment 4 to 20% produced significant ($p<0.05$) effects on shoot length, seedling length and leaf area of cowpea as compared to control. The button wood ash treatment produced no marked effects on root growth, root dry weight, total plant dry weight and specific leaf area of cowpea as compared to without button wood ash treatment. The treatment of button wood ash decreased the tolerance indices with 8% buttonwood ash treatments. Overall, the results suggest that cowpea has a potential of high cultivation in the presence of buttonwood ash at less than 20% concentration.

Keywords: button wood ash; cowpea; soil analysis; seedling growth; tolerance.

1. INTRODUCTION

Large quantities of wood ash released from the wood industries and power plants affect plant growth and environment. Over a few decades, a number of wood ashes are used in the agricultural field. The impact of ash released from the wood industry and power plants on soil properties, on the availability of nutrient elements and on the growth and chemical composition of crops and trees, root growth, as well as on the environment reported [1-2]. Biological effects of wood ash on plant growth, pine stand, willow plantation, and aquatic ecosystem were examined [3-6]. Wood ash is generally applied as a potassium fertilizer, but the effects of simultaneous incorporation of wood ash and crop straw on the turnover of soil organic carbon (SOC) and soil inorganic recast to carbon (SIC) were investigated [7]. In recent years, there has been a growing interest in the tropical world in using crop residues for improving soil productivity in order to reduce the use of external inputs of inorganic fertilizers [8-10]. The application of palm bunch ash significantly increased maize grain yield of 4530 and 6120 kg at the rate of 2 tons for the major and minor rainy seasons, respectively [11]. Khalid et al. [8] considered that the oil palm residues during replanting contributed a significant amount of nutrients and considered that could be recycled in the plantation (Malaysia). The management of oil palm residues affected the release of nutrients and hence their uptake and the growth of young palms. The effect of sawdust and wood ash applications on soil chemical properties, N and P nutrient content and growth of cocoa seedlings in the nursery was investigated [9]. Adekayode and Olojugba [10] suggested that the increasingly high cost of mineral fertilizers and preferred economic disposal of wood ash had necessitated research in the use of wood ash to reduce the rate of fertilizer application for maize production. The rice husk ash increased the soil pH, in agreement with the results obtained by [12-14].

In Asian countries, organic wastes, human and livestock excretions, straw, leaf litter, grass, sewage, rice husk charcoal, and wood ash used as fertilizers and soil conditioners in agriculture to raise the productivity of crops [15]. Positive effects of wood ash fertilization and weed control on the growth of *Scots pine* on former peat-based agricultural land recorded [16].

The present investigation aims to evaluate wood ash treatment produced varied effects on seedling growth of cowpea. The documentation on button wood ash impact on crop growth is scanty in Pakistan. The objective of the study was to evaluate the efficacy of buttonwood (*Conocarpus erectus*) tree bark wood ash using five different (4, 8, 12, 16 and 20%) on seedling growth performance of an important legume crop cowpea (*Vigna unguiculata*) L. Walp. growing in different parts of Pakistan.

2. MATERIALS AND METHODS

The experiment was conducted in the green house at the Department of Botany, University of Karachi, Pakistan, during the month of August - September. The mean temperature was 28 to 32ºC and relative humidity 65-74%. The plant species are commonly known as buttonwood (*Conocarpus erectus*) and an important legume crop cowpea (*Vigna unguiculata*) L. Walp was selected. Ash of trunk and branches of buttonwood after burning, the button wood ash was collected in jars and the experiments were conducted in pots. The pots were filled up to 2/3 with soil. The concentrations of the button wood ashes taken in this experiment were 4, 8, 12, 16 and 20%, respectively. The treatments were prepared as follows.

0%, 0 gram of ash mixed with 100 gram of soil

4%, 4 gram of ash mixed with 96 gram of soil

8%, 8 gram of ash mixed with 92 gram of soil

12%, 12 gram of ash mixed with 88 gram of soil

16%, 16 gram of ash mixed with 84 gram of soil

20%, 20 gram of ash mixed with 80 gram of soil

The experiment was conducted in pots filled with garden loam soil. The healthy seeds of cowpea (*Vigna unguiculata* L.) Walp. were obtained from the local market and were surface sterilized with 0.2% solution of sodium hypochlorite (NaOCl) for one minute to avoid any fungal contamination. Beans used in seedling growth experiments were healthy and of uniform size. Seven replicates for each concentration were taken. In a pot, the wood ash was applied in a concentration of 4, 8, 12, 16 and 20%. After mixing ash with the soil, the seeds of cowpea were imbibed in water for half an hour for the purpose to break any type of seed dormancy. Ten seeds of cowpea were sown in each pot and pots were placed in an open field and watered when required. Without wood ash treatment, the plant was used as a control. The pots were reshuffled weekly to avoid light, shade or any other climatic factor. The plants were irrigated with tap water and after 40 days, the plants were harvested. For dry weights, the root and shoots were dried at 80º C for 48 hours in the oven. The growth of cowpea was recorded in buttonwood ash including their germination percentage, length of shoot and roots, number of leaves, leaf size. The root shoot ratio, leaf weight ratio, specific leaf area, leaf area ratio was found by following formulae;

Root/ shoot ratio = root dry weight / shoot dry weight

Leaf weight ratio = leaf dry weight / total plant dry weight

Specific leaf area (cm^2 g^{-1}) = Leaf area / leaf dry weight

Leaf area ratio = Leaf area / Total plant dry weight

The wood ash tolerance indices was determined by the following formula:

Tolerance index **=** (Mean root length in wood ash treatment / Mean root length in control treatment) X 100

2.1 Statistical Analysis

Statistical significance was carried out by Analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT), according to the procedures of the Statistical Analysis System using personnel computer software packages SPSS version 14.0. Least significant differences selected at $P \leq 0.05$ were used for multiple means comparison tests. Determinations were means of triplicate analyses.

3. RESULTS AND DISCUSSION

In this study, root, shoot, seedling length, seedling dry weight, and tolerance index performance of cowpea (*Vigna unguiculata*) was recorded against different concentrations (0, 4, 8, 12, 16 and 20%) of button wood ash (Table 1,

Fig. 1). The effects of buttonwood ash treatments on seedling growth and seedling dry weight were found differently for cowpea. In non-treated control treatment, the mean root length (19.00 cm), shoot length (31.62 cm), seedling length (50.62 cm) and seedling dry weight (0.785 g) for cowpea were recorded. The treatment of buttonwood ash treatment at 4% significantly ($p<0.05$) affected shoot length (29.88 cm) of cowpea. The changes in shoot growth of cowpea might be due to the release of toxic element from wood ash treatment available in the substrate. Wood ash residue also contains heavy metals and can produce useful and harmful effects on plant growth. There are few studies have assessed the effects of metal accumulation in plants due to wood ash [17]. In present studies, the significant ($p<0.05$) impact of button wood ash on seedling growth and leaf area of cowpea was recorded. Increase in concentration of buttonwood ash from 4 to 20% was responsible for decreasing in root growth of cowpea as compared to control treatment (Table 1). The wood ashes are using in the agricultural field for better production of crop. Root growth plays an important role in the development of a plant in obtaining the nutrient from the soil. The results showed that cowpea seedlings showed no significant effects on root growth of buttonwood wood ash treatment at all levels. Increase in concentration of button wood ash highly decreased leaf area of cowpea as compared to control treatment. Wood industries and power plants generate enormous quantities of wood ash and influence on soil properties and nutrient uptake [1]. The results showed that wood ash treatment also affected root, leaf and seedling dry weight of cowpea. The varied response of different (4, 8, 12, 16, 20%) concentrations of buttonwood (*Conocarpus erectus*) ash on the root, shoot, leaf and total plant dry weight of cow was observed. Our findings are in agreement with Movin-Jesu [2] who found the effect of wood ash upon root development, ash content, and pod yield and nutrient status of okra. In another study, the treatment of 0.0, 1.25, 2.50, 3.75, 5.00 t/ha oil palm bunch ash affected the number, length, diameter and dry root yield and N, P, K contents of bitter and sweet cassava (*Manihot esculenta* crantz) at 12 months after planting [18]. Similarly, The effect of sawdust and wood ash applications on soil chemical properties, N and P nutrient content and growth of cocoa seedlings with the treatments 0, 4, 8, 12 and 16 t ha^{-1} of sawdust ash and wood ash was investigated [9].

Table 1. Effects of different concentration (0, 4, 8, 12, 16 and 20%) of buttonwood ash on seed germination and seedling growth of cowpea (*Vigna unguiculata* L. Walp.)

	Wood ash concentration (%)					
Growth parameter	0	4	8	12	16	20
Shoot length (cm)	31.62dc ±1.72	29.88cd±1.9	22.65ab± 1.5	23.75b±1.11	25.62ab±1.8	18.38a ±1.45
Root length (cm)	19.00a±4.45	15.88a ±2.1	11.5a±1.96	16.88a±1.66	15.25a±1.27	11.12a±1.34
Seedling length (cm)	50.62b±5.86	45.75b±1.45	34.15a±3.27	40.62ab±2.09	40.88ab±1.73	29.5a ±2.52
Leaf area (sq.cm)	37.45b ±6.9	26.54a±4.25	13.14a±2.09	33.76b±3.73	38.53b±1.69	19.73a ±5.79
Root dry weight (g)	0.080a±0.01	0.327a±0.19	0.385a±0.17	0.130a±0.017	0.190a±0.050	0.105a±0.032
Shoot dry weight (g)	0.202ab±0.028	0.250b±0.05	0.250b±0.024	0.182ab±0.021	0.212ab±0.04	0.120a±0.030
Leaf dry weight (g)	0.502a±0.011	0.347a±0.10	0.217a±0.082	0.342a±0.041	0.432a±0.118	0.200a±0.076
Total plant dry weight (g)	0.785a ± 0.116	0.925a±0.19	0.852a ±0.26	0.655a±0.477	0.835a ±0.14	0.425a ±0.09
Root / shoot ratio	0.435a±0.11	1.189a±0.06	1.485a±0.617	0.712a±0.03	0.840a±0.09	0.845a±0.048
Leaf weight ratio	0.616a±0.63	0.406ab±0.1	0.247a±0.042	0.521ab±0.047	0.509ab±0.11	0.425ab±0.12
Specific leaf area (cm^2g^{-1})	85.32a±25.22	92.12a±19.1	81.19a±20.55	103.2a±18.96	115.58a±32.7	106.99a±11.7
Leaf area ratio	48.70a±9.56	31.65ab±6.7	19.46a±6.06	53.20b±8.91	49.66b±6.73	42.62ab±9.54

Symbol used. ± = Standard Error. Values followed by the same letters in the same row are not significantly different ($p<0.05$) according to Duncan's Multiple Range Test.

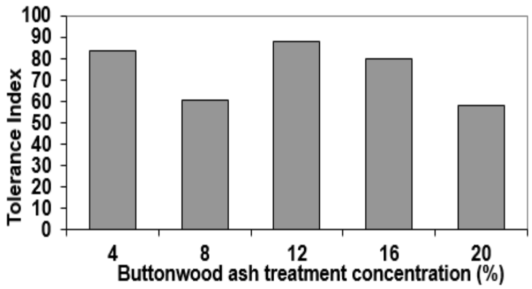

Fig. 1. Percentage of tolerance in cowpea seedlings using different concentration (4, 8, 12, 16 and 20%) of buttonwood ash

Ashes from the burning of wood and other plant-derived materials have been used as soil amendments for centuries [19]. The application of wood ash is beneficial but it can also serve as damaging to plant growth because the soil chemical and biochemical functions can be affected by the higher rate of wood ash addition. The results showed that the wood ash at low concentration less affected seedling growth and seedling dry weight performance of cowpea. Ojeniyi et al. [20] recorded the influence of oil palm bunch as on root growth and NPK status of cassava.

The seedlings growth performance of cowpea was tested for percentage of tolerance to different (4, 8, 12, 16, 20%) concentrations of buttonwood ash (Fig. 1). The results showed that cowpea seedlings showed a high percentage of tolerance at 12% of buttonwood ash treatment. Cowpea seedlings showed the better percentage of tolerance at 4 and 12% of buttonwood wood ash treatment. The lowest percentage of tolerance in seedlings of cowpea to wood ash treatment at 20%.

4. CONCLUSION

It can be correlated that with the treatment of button wood ash at all levels (4, 8, 12, 16, and 20%) responsible for the variation in seedling growth performances of cowpea. It was concluded that the increase in the concentration of buttonwood ash treatment 4 to 20% produced significant ($p<0.05$) effects on shoot length, seedling length and leaf area of cowpea as compared to control. The buttonwood ash treatment produced no marked effects on root growth, root dry weight, total plant dry weight and specific leaf area of cowpea in compared to without button wood ash treatment. The treatment of button wood ash decreased the tolerance indices with 8% buttonwood ash treatment. Overall results suggest that cowpea has a potential of high cultivation in the presence of buttonwood ash at less than 20% concentration.

COMPETING INTERESTS

The authors declare that the research work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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