Azadirachta Indica A. Juss: Wood Ash Affects Seedling Growth of Mung Bean *Vigna Radiata* L.

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***Abstract*—The burning of the wood ash is causing an environmental pollution related issue. The excess concentration of wood ash in the environment normally influenced on plant growth and development. This paper presents the effects of neem wood ash *Azadirachta inidca* A. Juss.) on germination and seedling growth performance of mung bean (*Vigna radiata* L.) crop plants. Overall, the data reveals significant ($p<0.05$) effects of neem wood ash on the different growth variable of mung bean. The treatment of 4-20% neem wood ash significantly ($p<0.05$) affected shoot length of mung bean as compared to control. Neem wood ash treatment at all concentration produced fewer toxic effects on root and leaf growth of mung bean. The neem wood ash treatment at 20% also produced significantly ($p<0.05$) toxic effects on root and leaf dry weight of mung bean. Whereas, neem wood ash treatment at all level did produce any significant effects on shoot dry weight, total plant dry weight and leaf area ratio of mung bean.**

***Index Terms*—Crop, neem, seedling growth, tree, wood ash.**

I. Introduction

Wood ash contain micro and macro nutrient and necessary requirement for plant growth and productivity. The ashes are produced from hardwoods, including oak, maple, ash, hickory, sycamore, walnut, apple and cherry. They also produce several times more ash and contain more nutrients than softwoods like pine and fir [1].

The presence of wood ash in excess concentration in the environment may produce beneficial [2] for harmful effect on plant growth. There are few studies has been carried out on the impact of ash on soil and plant growth. The effects of ash on carrot, canola, maize, rice growth parameters, yield, microbial biomass, soil biota and soil physical and chemical properties were reported [3-17]. The significant effects of wood ash fertilization on soil chemical properties of forest soil in three young Scots pine (*Pinus sylvestris* L.) plantations and a Norway spruce (*Picea abies* (L.) Karst.) plantation with different site fertility in southern Finland was examined [18]. The different behavior of wood ash on sugarcane also examined [19]. Wood ash application generally improved soil properties, which in turn enhanced maize grain, yield [20].

The combustion of wood ash increases the soil pH and provides mineral nutrients likewise calcium, magnesium, potassium and phosphorus [21] to plant growth. However, the addition of wood ash can also produce detrimental impact to agricultural crops and the entire chain of production [22]. The possible harmful components in ash are heavy metal(oid)s including cadmium (Cd), lead (Pb), chromium (Cr), and arsenic (As). Similarly, trace elements, such as nickel (Ni), can be present, and, while these elements fulfill a biological role in small quantities, they can be toxic when present beyond optimal thresholds [23]. The wood has high calorific value as a fuel and most widely used for high grade charcoal [24] it makes a good slow-burning fuel and charcoal [25].The increasingly high cost of mineral fertilizers and a preferred economic disposal of wood ash had necessitated a research in the use of wood ash to reduce the rate of fertilizer application for crop production [26]. In Asian countries, organic wastes, human and livestock excretions, straw, leaf litter, grass, sewage, rice husk charcoal, and wood ash used as a fertilizers and soil conditioners in agriculture to raise the productivity of crops [27]. Positive effects of wood ash fertilization and weed control on the growth of *Scots pine* on former peat-based agricultural land recorded [28].

Neem is multipurpose medicinal tree of family Meliaceae, and found in tropical and subtropical areas of the world [29]. *Azadirachta indica* Adr. Juss commonly known as neem tree, a tree reached up to 15 m tall. It yields good timber and all parts of the plant are medicinal along with many phytochemical properties. Neem tree is ever green and fast-growing cultivating tree in China and Indian subcontinent include Bangladesh, Sri Lanka, Nepal, Maldives and China and throughout the warmer parts of the Pakistan.

The mung bean (*Vigna radiata* (L.) R. Wilczek) is a legume cultivated for its edible seeds and sprouts across Asia [30]. Mung bean crop is cultivating in wide range of ecological conditions of Pakistan and in other Asian countries. Mung bean is utilized in the cereal-based diets and rich in 24% digestible protein [31-32]. Mung bean [*Vigna radiata* (L.) Wilczek], is an indigenous vegetable legume and one of the most important pulse crops in Southeast Asia [33] and is an important pulse in Pakistan [34]. In Pakistan, mung bean is usually grown in rotation with wheat, but AVRDC is broadening opportunities for the crop by intercropping it with sugarcane. Mung bean is an important summer legume grown in Pakistan, accounting for 14% of total pulse production [35]. Mung bean cover an area of 208.5 thousand hectares in Pakistan and 5.5 thousand hectares in Sindh. The average yield in Pakistan as well as in Sindh province has been around 550 kg/ha during the last two decades, which is very low as compared to many other countries. There could be many reasons for the low yield but the prominent one is the low yield potential of the land races and the narrow genetic base [36].

Pulses play a vital role in relieving protein malnutrition in many areas where animal protein cannot afford [37]. The scientific literature on the effects of neem wood ash on mung bean crop is scanty in the country. The main objective of this study was to assess the effects of neem wood ash on seedling growth of an important legume crop mung bean cultivating in larger part of Pakistan.

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II. MATERIALS AND METHODOLOGY

This experimental study 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 32 ºC and relative humidity 65-74 ºC. The plant species commonly known as neem (*Azadirachta indica* (L.) Adelb) and an important legume crop mung bean or green gram (*Vigna radiata* (L.) R. Wilczek was selected. Ashes made by burning the trunk and branches of neem, after burning, the neem wood ashes were collected in jars and the experiments was conducted in pots. The pots were filled up to 2/3 with soil. The concentrations of the neem wood ashes taken in this experiment were 0, 4, 8, 12, 16 and 20%, respectively. The neem wood ash was mixed with 100 g of soil [Table 1].

The growth experiment was conducted in pots filled with soil in August – September when mean temperature was 28 - 32º C and relative humidity was 65-74º C. The healthy seeds of mung bean were obtained from the local seed store, Karachi and were surface sterilized with 0.2% solution of sodium hypochlorite (NaOCl) for one minute to avoid any fungal contamination. The experiment was conducted completely randomized design. Beans used in seedling growth experiments were healthy and of uniform size. Seven replicates for each concentration were taken. After mixing ash with the soil, the seeds of mung bean were imbibed in water for half an hour for the purpose to make any type of seed dormancy. Ten seeds of mung bean were sown in each pot and pots were placed in an open field and watered when required. Without wood ash treatment, plant was used as control. The pots were reshuffled weekly to avoid light, shade or any other climatic factor. The plants were irrigated with tap water. After 40 days, the plants were harvested. The growth of mung bean was observed in neem ash including length of shoot and roots, seedling length and leaf area was noted. For dry weights, the root and shoots were dried at 80º C for 48 hours in oven.

TABLE 1. The composition of neem wood ash in soil sample.

Treatments	Neem bark wood ash	soil
1	0 g wood ash	100 gram of soil
2	4 g wood ash	96 gram of soil
3	8 g wood ash	92 gram of soil
4	12 g wood ash	88 gram of soil
5	16 g wood ash	84 gram of soil
6	20 g wood ash	80 gram of soil

The root shoot ratio, leaf weight ratio, specific leaf area, leaf area ratio was found by following formulas;
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 ($cm^2\ g^{-1}$) = Leaf area / Total plant dry weight

Statistical analyses

Analysis of variance (ANOVA) and DMRT was calculated according to the procedures of Statistical Analysis System using personnel computer having costat

version 3. Least significant differences selected at $P \leqslant 0.05$ were used for multiple means comparison tests.

III. RESULTS AND DISCUSSION

The effects of neem wood ash (*Azadirachta inidca* A. Juss.) on seedling growth and seedling dry weight of

The different concentration of neem wood ash affected seedling length of mung bean as compared to control. An increased in concentration of wood ash at 16% significantly ($p<0.05$) decreased seedling length (29.40 cm) of mung bean as compared to control (39.8 cm). Wood ash may contain heavy metals. Heavy metals in fly ash from a coal fired power station in Poland reported [39]. The uptake of phytotoxic element from the soil might be cause of reduction in seedling growth of mung bean. Similarly, increased in concentration of neem wood ash treatment at 8 – 20% decreased leaf size of mung bean 20.80 sq. cm, 19.30 sq. cm, 14.80 sq. cm, 14.30 sq. cm as compared to control 22.80 sq. cm, respectively. Wood ash has agricultural uses due to its neutralizing power and in addition helps in providing soil nutrients such as Ca, Mg, K, and P. The effect of wood ash on the mobility of heavy metal(oid)s (As, Cd, Cr, Pb, and Ni) in the soil-plant-water system, and the nutritional response (N, P, and K) of ryegrass (*Lolium perenne* L.) under greenhouse in po conditions reported [40]. The application of different concentrations 4, 8, 12, 16 and 20% of neem wood ash produced variable effect on leaf growth of mung bean as compared to without ash treatment. Neem wood ash treatment at all concentration produced different effects on seedling dry weight of mung bean. The neem wood ash treatment at 16-20% significantly ($p<0.05$) affected root and leaf dry weight of mung bean. Whereas, neem wood ash treatment at all level did not produce any significant effects on shoot dry weight, total plant dry weight and leaf area ratio of mung bean. 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 [41]. 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 [42].

The present paper also identifies the influence of neem wood ash on the seedling dry weight of mung bean. The dry matter contents of seedlings of mung bean can be related to the decrease in shoot and seedling growth. Application of neem wood ash significantly affected leaf (0.115 g) and root dry matter (0.03 g) of mung bean as compared to the control. Wood ash treatment at 20% increased leaf weight ratio (0.51) as compared to the control (0.39). The effect of rubber wood biochar at 1 and 2% amendment showed a significant positive effect on aboveground dry matter accumulation of root stock, seedling growth and nutritional status of *Hevea* nursery plants was determined [43].

TABLE 2. The effects of neem wood ash (*Azadirachta inidca* A. Juss.) on seedling growth and seedling dry weight of mung bean *(Vigna radiata* L).

	Wood ash concentration (%)					
Growth parameter	**0**	**4**	**8**	**12**	**16**	**20**
Shoot length (cm)	28.0c ±0.71	25.12a ±0.75	23.12c d ± 0.5	21.6bc ± 1.34	19.4ab ± 0.89	16.9a ±1.60
Root length (cm)	11.7a ±1.50	14.2a ±0.85	12.5a ± 1.20	13.2a ±1.80	15.1a ± 3.70	12.5a ± 0.84
Seedling length (cm)	39.8b ± 1.8	39.3b ±1.12	35.6ab ± 1.78	34.8ab ±2.51	34.5ab ± 4.59	29.4a ±2.28
Leaf area (sq.cm)	22.8a ±4.98	23.1a ± 6.39	20.8a ± 2.97	19.3ab ±1.17	14.8a ±1.48	14.3a ±4.08
Root dry weight (g)	0.0775a b±0.02	0.155b ±0.55	0.040a ±0.01	0.0750ab ±0.22	0.112ab ±0.01	0.030a ±0.001
Shoot dry weight (g)	0.195a ±0.035	0.132b ±0.16	0.212a ±0.061	0.0155a ±0.023	0.182a ±0.025	0.100a ±0.033
Leaf dry weight (g)	0.180ab ±0.021	0.122a ±0.02	0.220b ±0.043	0.145ab ±0.16	0.145ab ±0.02	0.115a ±0.014
Total plant dry weight (g)	0.452a ±0.046	0.410a ±0.09	0.472a ±0.012	0.375a ±0.53	0.440a ±0.063	0.245a ±0.043
Root / shoot ratio	0.465a ± 1.16	1.09b ± 0.29	0.234a ± 0.08	0.472a ± 0.077	0.629a ± 0.07	0.309a ± 0.03
Leaf weight ratio	0.398ab ± 0.03	0.308a ± 0.2	0.475a ± 0.02	0.395a ± 0.29	0.325a ± 0.01	0.511a ± 0.09
Specific leaf area (cm^2g^{-1})	121.6ab ±13.84	187.0b ±29.4	97.88a ±6.85	137.2ab ±14.18	111.4ab ±21.1	135.9ab ±50.5
Leaf area ratio	48.92a ±7.04	55.58a ±4.9	46.94a ±5.40	54.28a ±6.84	35.77a ±6.09	58.29a ±10.10
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.						

IV. Conclusion

The results conclude that variable changes in seedling growth of mung bean including root, shoot, seedling length, leaf size and seedling dry weight were related to increase in concentration of neem wood ash from 4 – 20% as compared to control (without ash) in soil. The treatment of neem wood ash at 20% significantly ($p<0.05$) affected shoot and seedling length, seedling dry weight of mung bean (*Vigna radiata*) as compared to control treatment.

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