Journal of Science and Technology 16 (June 2018): 1-9

EFFECT OF CROP RESIDUES ON THE GERMINATION AND GROWTH OF CONTAINERIZED GHORA NEEM (*Melia azedarach* L.) SEEDLINGS

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ABSTRACT

A study was conducted at the Research Field of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Bangladesh during the period of February to August 2016 to find out the effect of crop residue extracts on the germination, root architecture and shoot growth of ghora neem (*Melia azedarach* L.) seedling. There were five treatments including control viz. T_1 (pineapple leaf extract), T_2 (napier grass extract), T_3 (wheat plant extract), T_4 (maize plant extract) and T_5 (only water; Control). The concentration of all crop residues was 1% i.e., 1 g of crop residue extract was mixed with 100 ml of water. There were two experiments. First experiment was to test the germination of Ghora neem seeds and second experiment was to find out the effect of crop residues on the root and shoot growth of transplanted ghora neem seedlings in polybags. Both experiments were laid out in complete randomized design. Germination percentage and number of shoots were positively affected by different crop residues. Ghora neem seeds showed better germination in all the treatments of crop residues compared to control. The highest germination percentage (85%) of ghora neem seeds was calculated in pineapple leaf extract followed by wheat plant extract (75%), napier grass extract (60%) and lowest germination percentage (20%) was recorded in control. Among the root and shoot morphological traits, only number of leaves and root length varied due to crop residue extracts. Other parameters of Ghora neem seedlings like shoot height, root collar diameter, shoot dry biomass, root dry biomass, shoot/root ratio, quality index were found statistically similar. On the other hand, the longest central root length of Ghora neem seedling was found in wheat plant extract and the shortest length was recorded in maize residue extract. Shoot and root dry biomass of ghora neem seedlings did not vary significantly due to crop residues extracts. Root architectural analyses show that although length of first order lateral roots (FOLR) was recorded same after 1 and 3 months but their diameter and number increased after 3 months than that of 1 month. From the study, it can be concluded that pineapple plant extract can be used to break the dormancy and better germination of ghora neem seeds.

Key words: agroforestry, crop residues, ghora neem, germination, root architecture, shoot growth

INTRODUCTION

In agroforestry system, interactions between trees and crops are common phenomena. Crops interact with trees by their residues. On the other hand, trees also interact with crops by their root and shoot systems when both are planted in a same piece of land (Zhang *et al.* 2013; Cao *et al.* 2012; Lin, 2010). Interactions may be positive and/or negative. Interactions may be also

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above ground and below ground for crops and trees (Ong *et al.* 1991). Many researches were done on the allelopathic effect of tree residues on crops (Zhang and Fu 2010; Krishna *et al.* 2010; Sisodia and Siddiqui 2010), but a little research was reported on the crop residual effect on the trees especially on the seedling growth and development (Ferguson *et al.* 2013; Zeng *et al.* 2010).In Bangladesh, Public forest lands account for about 14.9% and the village forests for another 1.8% of the area of the country (FAO 2000). Though we have total 16.9 % forest lands officially, but it is assumed that there is only 7-8% tree coverage. Due to over population and management problems natural forests are decreasing day by day. To meet the high demand of wood, government is encouraging social forestry and agroforestry practices through people's participation (Alam *et al.* 2008; Safa 2004; Nath *et al.* 2000). In this case, choice of species for practicing agroforestry is very much important.

Ghora neem (*Melia azedarach* L.) is a medium sized tall tree with a diameter to 60 cm (Gupta 1993; Doran and Turnbull 1997). It is widely used in agroforestry system of Bangladesh for its deciduous nature and small crown to get maximum benefit. It is usually planted most of the district of Bangladesh as planted roadside avenue trees along highways, railway lines, in parks and gardens (Das and Alam 2001). But it is still unknown about the crop combination with this tree. Therefore, it is necessary to find out the crop-residual effect on this tree to get total higher yield. Both tree and crop species selection depends on their mutual interaction. Growth will be hampered if one component inhibits others. Considering the above facts the present study was undertaken (i) to find out the effect of crop residues on the germination of Ghora neem (*Melia azedarach* L.) seeds, (ii) to determine the effect of crop residues on the shoot development and root architecture of Ghora neem (*Melia azedarach* L.) seedling and (iii) to evaluate the biomass allocation of Ghora neem (*Melia azedarach* L.) seedlings due the effect of crop residues.

MATERIALS AND METHODS

The experiment was conducted in Agroforestry and Environment Research Field of HSTU. There were five treatment combinations of crop residues including control in both the experiments. These extracts were applied in the Ghora neem seedlings. The CRD design was followed with five replications in each treatment. These were: T_1 = Pineapple leaf extracts, T_2 = Napier grass extracts, T_3 = Wheat plant extracts, T_4 = Maize plant extracts and T_5 = Water (control). Four crop-residue extracts were selected for the study viz. pineapple leaf extract, napier grass extracts, wheat plant and maize plant. For preparing crop extracts, 1 kg fresh crop leaves with twigs were blended in blender machine mixing with two litre water. Then the mixture was boiled for about 1 hour until the extracts reduce to 1 litre. After that the extracts were cooled and filtered. After filtering the extract were preserved in containers for further use.

For germination test, 20 seeds of Ghora neem were taken in each treatment and sown in the germination tray. The trays were then placed in the open condition. After 7 days of seed sowing, four different crop extracts were started to apply. Every week crop extracts were applied up to 9 weeks. Germination data were collected on the germination percentage, germination speed, shoot number and days of germination initiation etc. Germination speed was calculated as under (Chiapusio *et al*. 1997):

$$S= (N_1*1) + (N_2–N_1)*1/2 + (N_3- N_2)*1/3 + \ldots + (Nn- N_{n-1}) *1/n.$$

Where, N_1, N_2, N_3, …… N_{n-1}, N_n refers to the proportion of germinated seeds on the 30^{th}, 33^{rd}, 36^{th} days, …, n-1, n days. The inhibitory / stimulatory effects of extracts on test crops were expressed in percentage (%) of control and were calculated according to T/C, where T is the "treatment" data and C is the "control" data.

For growth trial, naturally grown Ghora neem seedlings were collected under the Ghora neem tree and transplanted in the polybags of the size 9" x 6". The age of the seedlings was 2 months during the time of seedling collection. After transplantation, the polybags were placed in the open field. After one week of transplantation, residue extracts were started to apply in all treatments. There were 12 seedlings for each treatment in the field. Crop residue extracts were applied 15 days interval in all the treatments. The morphology of shoot and roots and their biomass were measured in four times. Above ground parameters that were measured are seedling height (cm), root collar diameter (mm), length of central roots, number of living branches. Above ground parameters that were measured are shoot dry weight (g), root dry weight and total dry biomass.

For biomass measurement, the seedlings were divided into two parts: shoot and root system. The root systems were separated from the soil through gentle wash of water using a bucket and sieve to collect any root fragments detached from the system. Branches and leaves were mixed together to get the shoot weight. Both parts were oven-dried at 80°C (Royo *et al.* 2001; Tsakaldimi *et al.* 2009) for 72 hours until they reached in a constant weight. They were weighed through an electric balance to get shoot dry weight (g), root weight (g). Then total oven dry weight (g) was calculated. The root to shoot ratio was calculated by the root and shoot dry weights (Thompson, 1985). The seedling quality index (QI) was calculated using the equation (Dickson *et al.* 1960): QI=total seedling dry weight (g)/[height (cm)/diameter (mm)+shoot dry weight (g)/root dry weight (g)].

All first-order lateral roots (FOLR) were counted and measured. For this, FOLRs were separated carefully by a sharp knife. For measuring lengths and diameters, each FOLR were numbered serially. Lengths of FOLRs were measured by a measuring tape (made of steel) and diameters of FOLR were measured by a caliper (accuracy 0.1 mm). All statistics were calculated with SPSS software and MS Excel 2007. Distribution was tested for normality by Kolmogorov–Smirnov criterion and the homogeneity of variances was tested by Levene's test.

RESULTS AND DISCUSSION

Germination: Germination traits were affected by different crop residue extracts. First germination was recorded after 30 days and last germination was recorded after 48 days of seed sowing. After 48 days highest germination percentage was calculated 85% in T_1 followed by 75% in T_3, 60% in T_2 and lowest germination percentage was recorded 20% in T_5 (Table 1). Crop residue extracts also affected the number of shoots of seeds. The highest percentage of shoots was recorded in T_1 (135%), followed by T_3 (90%), T_2 (70%) and the lowest shoot percentage was recorded in T_5 (20%).

Highest germination speed was found in T_1 (10.4), followed by T_3 (7.5), T_2 (6.4) and lowest in T_5 (1.7) i.e. in Control. This result shows the stimulatory effect of different crop residues on the seed germination of Ghora neem than the control condition (Table 1).
Rietveld (1975) observed that phytotoxic grass residues significantly reduced germination of ponderosa pine seeds, and retarded speed of elongation and mean radicle length. Turk & Tawaha (2003) determined that aqueous crop extracts significantly inhibited germination. Increasing the aqueous extract concentrations significantly inhibited germination, seedling length and weight. They also found that radicle length was more sensitive to crop extract than seed germination. In our experiment, we found that different crop residues significantly increased germination of Ghora neem seeds.

Above ground morphology: Mean shoot height of Ghora neem *(Melia azedarach)* seedlings was found statistically similar among different treatments after transplantation of one month.

Root Collar diameter was not affected by the crop residues. Number of leaves varied differently among the treatments. Highest number of leaves was recorded in T_2 (8.33) and T_4 (8.33) and lowest in T_3 (5.67). Length of central root varied significantly among the treatments. The Longest length of central root was found in T_3 (39.37) and shortest was recorded in other treatments (Table 2).

After transplantation of 3 month, mean shoot height of Ghora neem *(Melia azeadrach* L.) seedlings was found statistically dissimilar among different treatments. The highest value was found in T_3 and T_4 and lowest value in T_1. Root Collar diameter was also similar among different treatments. Number of leaves among different treatments was similar. Length of central root ratios among the treatments after 1 month was statistically similar (Table 3).

Biomass allocation: After 1 month of *Melia azedarach* seedling transplantation shoot and root dry biomass did not vary significantly among different treatments. Total dry biomass was also similar. Quality index was found statistically similar in different treatments (Table 4).

After 3 month of *Melia azedarach* seedling transplantation shoot and root dry biomass were varied significantly similar among different treatments. As a result total dry biomass, shoot/root ratio and quality index were also found statistically similar in different treatments (Table 5).

From the result it is observed that average shoot height increased overtime i.e. after 1 & 3 months of transplantation. But within a period there was no significant differences recorded among the treatments. This result indicates that crop residues of pineapple, napiar grass, wheat & maize did not affect significantly in plant height of Ghora neem at the early stage of their growth. This may be due to the big seedlings of our test tree. Similar result/ different results was (were) recorded by some researchers. Hedge & Miller (1990) found that Plant height and fresh weight per plant of alfalfa and fresh weight per plant of sorghum were lower on alfalfa-soil than on sorghum-soil. As a result, allelopathic compounds in alfalfa-soil were implicated in the growth inhibition of both alfalfa and sorghum.

Architecture of first order lateral roots (FOLR):

Length of FOLR: Figure 1 shows the mean lengths of all FOLR in different treatments after 1 and 3 months of transplantation. At 1- month, lowest mean length of FOLR was 9.1 cm and highest was 14.0 cm of T_1 and T_5 treatments respectively. At 3 month, lowest mean length was 6.0 and highest was 7.5 cm in T_5 and T_3 respectively.

Mean diameter of FOLR: Mean diameter of FOLR varied due to crop residues among the Ghora neem (*Melia azedarach* L.) seedlings (Figure 2). Diameter of FOLR increased over time. After 1-month of transplantation, lowest mean diameter of FOLR plant was recorded 0.8 mm in T_1 and highest was found 1.52 in T_3.

Number of FOLR: Number of FOLR of Ghora neem (*Melia azedarach* L.) seedlings after 1 and 3 months of transplantation is presented in Figure 3. After 1 month, the highest number of FOLR was found in T_1 and the lowest number of FOLR was in T_5. After 3 month, the highest number of FOLR was recorded in T_3 and the lowest number of FOLR was in T_5.

Table 1. Effect of crop residues on the germination traits of Ghora neem seeds

Germination traits	Treatments				
	T_1	T_2	T_3	T_4	T_5
Seed germination %	85	60	75	50	20
Number of shoot per 100 seed	135	70	90	65	20
Germination speed	10.4	6.4	7.5	4.7	1.7
Treatment/Control (T/C)	612.9	375.1	443.3	279.3	100.0

Note: T_1=Pineapple leaf extract, T_2=Napier grass extract, T_3= Wheat straw extract, T_4= Maize straw extract and T_5= only water (Control)

Table 2. Effect of crop residues on the morphological characteristics of shoot and root of *Melia azedarach* seedlings in different treatments after 1 month of transplantation

Treatments	Shoot height (cm):H	Root Collar diameter (mm): D	Number of leaves	Central Root (cm)
T_1	44.47a ±3.30	3.69a±0.32	6.33ab±0.33	26.53b±1.58
T_2	32.43a ±5.97	3.12a±0.74	8.33a±0.88	21.43b±1.16
T_3	43.80a ±5.81	3.54a±0.46	5.67b±0.33	39.37a±4.83
T_4	37.27a ±5.05	3.55a±0.33	8.33a±1.20	27.40b±3.08
T_5	36.33a ±3.69	3.48a±0.32	8.00ab±0.58	28.63b±3.66

Note: T_1=Pineapple leaf extract, T_2=Napier grass extract, T_3= Wheat straw extract, T_4= Maize straw extract and T_5= only water (Control). In a column figures having similar letter(s) do not differ significantly and figure bearing different letters differ significantly by Duncan Multiple Range Test at $P \leq 0.05$

Table 3. Morphological characteristics of shoot and root of *Melia azedarach* seedlings in different treatments after 3 months of transplantation

Treatments	Shoot height (cm)	Root Collar diameter (mm)	Number of leaves	Central Root (cm)
T_1	64.63b±1.74	7.04a±0.22	11.67a±1.86	44.13a±0.67
T_2	82.97ab±0.73	7.44a±0.23	14.00a±1.53	43.00a±1.09
T_3	94.20a±1.21	8.00a±0.35	11.33a±1.76	44.07a±1.26
T_4	102.00a±3.17	8.74a±0.14	12.33a±1.20	46.87a±1.32
T_5	81.00ab±1.60	8.75a±0.42	11.67a±1.00	44.83a±1.88

In a column figures having similar letter(s) do not differ significantly and figure bearing different letters differ significantly by Duncan Multiple Range Test at $P \leq 0.05$

Table 4. Biomass allocation and quality index of *Melia azedarach* seedlings at different treatments after 1 month of transplantation

Treatments	Shoot dry biomass (g)	Root dry biomass (g)	Total dry biomass (g)	Quality index
T_1	2.19a±0.25	1.20a±0.21	3.39a±0.39	0.25a±0.05
T_2	1.73a±0.12	1.13a±0.12	2.87a±0.24	0.24a±0.03
T_3	1.87a±0.28	1.30a±0.20	3.17a±0.48	0.23a±0.03
T_4	2.10a±0.23	1.20a±0.21	3.30a±0.40	0.28a±0.05
T_5	1.90a±0.31	0.77a±0.07	2.67a±0.29	0.21a±0.02

In a column figures having similar letter(s) do not differ significantly and figure bearing different letters differ significantly by Duncan Multiple Range Test at P≤0.05

Table 5. Biomass allocation and quality index of *Melia azedarach* seedlings at different treatments after 3 month of transplantation

Treatments	Shoot dry biomass (g)	Root dry biomass (g)	Total dry biomass (g)	Quality index
T_1	3.10a± 0.06	2.80a± 0.07	5.90a± 0.09	0.57a± 0.02
T_2	4.00a±0.09	3.57a±0.12	7.57a± 0.03	0.62a± 0.03
T_3	5.23a± 0.07	3.27a±0.09	8.50a± 0.12	0.64a± 0.03
T_4	5.80a±0.12	3.63a±0.12	9.43a± 0.12	0.71a± 0.12
T_5	4.67a±0.12	3.53a±0.09	8.20a± 0.19	0.77a± 0.02

In a column figures having similar letter(s) do not differ significantly and figure bearing different letters differ significantly by Duncan Multiple Range Test at P≤0.05

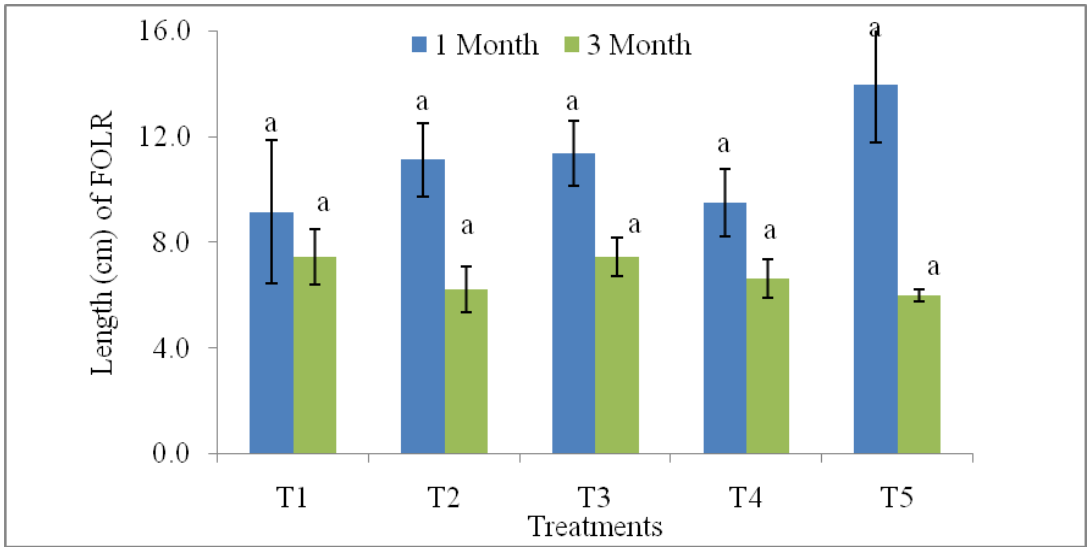

Figure 1. Mean length of FOLR of *Melia azedarach* in different time period

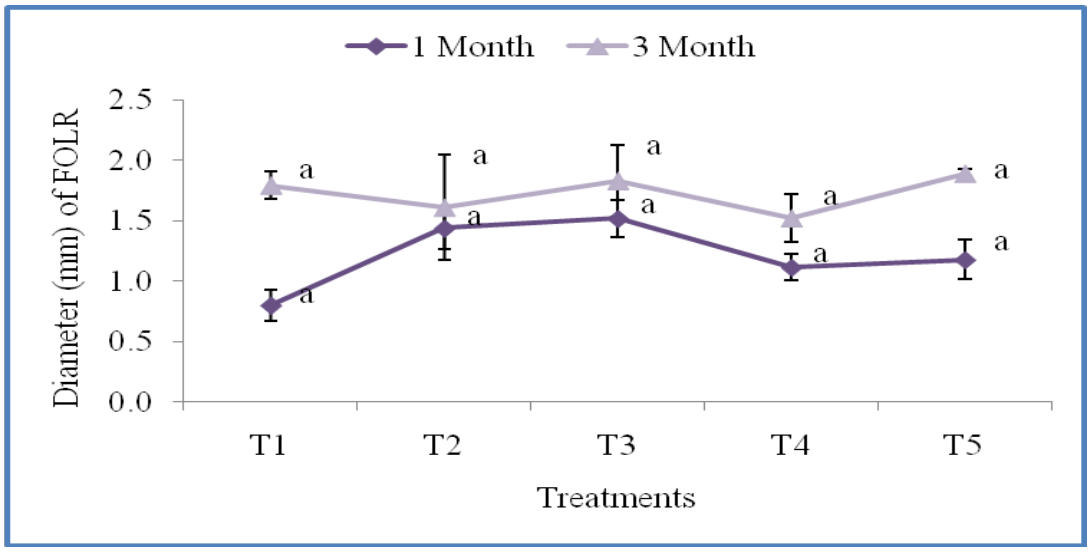

Figure 2. Mean diameter of FOLR of *Melia azedarach* in different time period

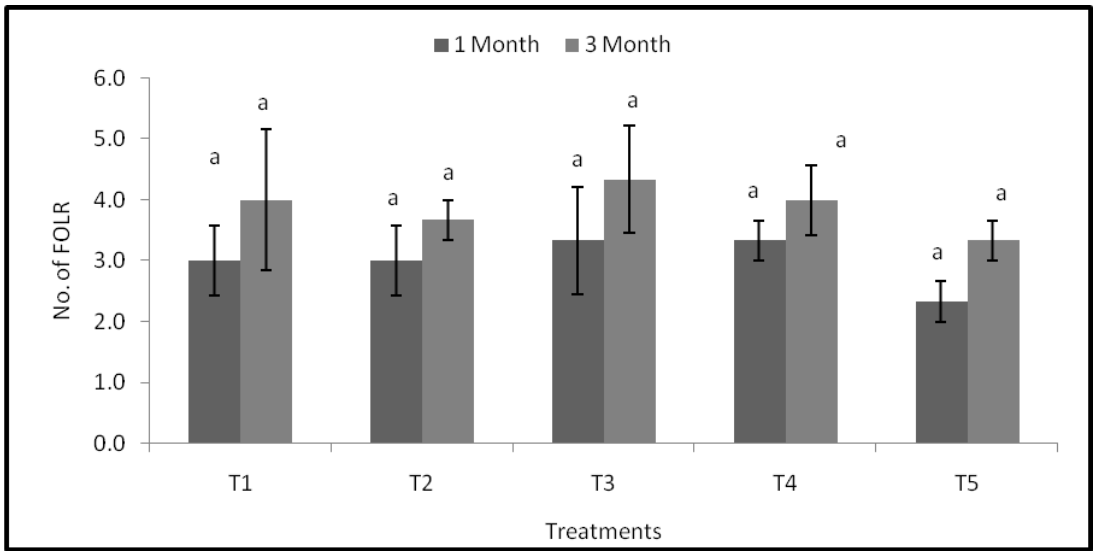

Figure 3. Effect of crop residues on number of FOLR of *Melia azedarach* in different time period among different treatments

CONCLUSIONS

From the present study it may be concluded that germination of Ghora neem seeds was positively affected by different crop residues especially by the pineapple plant extract. Therefore, pineapple plant extract can be used to break the dormancy and better germination of Ghora neem seeds. Beside this, residue extracts increased lateral root number and diameter which insert positive effect on the early development of Ghora neem seedlings. However there was no significant variation of shoot and root morphological traits except lateral roots of Ghora neem seedlings due to low concentration residue extracts. So, pineapple, napier grass, wheat and maize can be grown in association with Ghora neem tree in respect of tree-crop interaction.

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