Wheat cultivation along with different timber trees as crop land agroforestry system

S.M.E. Islam, M.M. Rahman, M.A. Wadud and G.M.M. Rahman
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh-2202, 1Agriculture Training Institure, Faridpur, E-mail: eazulag91@gmail.com

Abstract: The experiment was conducted at the Field Laboratory of the Department of Agroforestry, Bangladesh Agricultural University (BAU), Mymensingh during December 2014 to March 2015 to observe the performance of wheat in association with six timber yielding tree species viz. kalo koroi (Albizia lebbeck), sissoo (Dalbergia sissoo), jhau (Casuarina equisetifolia), minjiri (Cassia siamea), akashmoni (Acacia auriculiformis), and eucalyptus (Eucalyptus camaldulensis) following Randomized Complete Block Design (RCBD) with three replications for each tree species separately. Different treatments in association with each tree species were T1 = 0-1.5m distance from the tree base, T2 = 0-1.5m distance from the tree base, T3 = 0-1.5m distance from the tree base and T4 = open field condition referred as control (without tree condition). It was found that different morphological parameters viz. plant height (cm), leaf length, leaf per tiller, tiller per plant, spike per plant, spike length (cm), grain per spike, grain per plant, weight of 1000 seeds (g) of wheat varied almost similar pattern in all treatments when grown concomitantly with Kalo koroi, Sissoo, Jhau, Akashmoni, Minjiri and Eucalyptus. Generally, growth of wheat was severely suppressed very near (up to 3.0m) the tree species. As evident from the result it was found that yield of wheat gradually increased with increasing distance from the base of Kalo koroi, Sissoo, Jhau, Akashmoni, Minjiri and Eucalyptus species. It was found that highest yield (2.02 t/ha) of wheat was in control condition which was statistically similar with the yield of treatment T1 of Jhau (1.94 t/ha), Akashmoni (1.91 t/ha), Kalo Koroi (1.99 t/ha), Minjiri (1.97 t/ha) and Sissoo (1.92 t/ha) but in this area yield with eucalyptus tree was 1.81 t/ha which is 11.4% lower compare to control condition. Irrespective of tree species, yield of wheat was 35-55% lower in treatment T1 and 61-78% lower in treatment T2. Overall average yield of wheat with Jhau, Akashmoni, Kalo Koroi, Minjiri, Eucalyptus and Sissoo were 1.27, 1.18, 1.37, 1.35, 1.05 and 1.18 t/ha, respectively which were 37.13, 41.58, 32.18, 33.17, 48.02 and 41.58% lower compare to control condition. Considering the results of this study suitability of wheat cultivation as agroforestry system with studied tree species ranked as Kalo koroi > Minjiri > Jhau > Akashmoni > Sissoo > Eucalyptus.

Key words: Wheat yield, Timber tree species, cropland agroforestry.

Introduction
Bangladesh is situated in the north-eastern part of South Asia. It is a small country with an area of 1,47,570 sq.km. where agriculture contributes 16.33% of the gross domestic product (GDP) of which crop sector contributes 22.81%, livestock 3.34%, fisheries 3.42% and forestry 2.18% (BBS, 2012). Due to huge population we have small amount of arable land and forest cover area. We have only 0.24 and 0.040 acre cultivated and forest lands per capita, respectively (BBS, 2012). Farmers in our country practice monoculture of wheat. But practicing agroforestry system (i.e.cropland agroforestry) with suitable tree crop association which will increase total production than monocultural system. Cropland based Agroforestry (CAF) is a traditional land use system in Bangladesh where tree species like date palm (Phoenix sylvestris), palmyra palm (Borassus flabellifer), babla (Acacia nilotica), mango (Mangifera indica), khoir (Acacia catechu), mahogany (Swietenia spp.), jackfruit (Artocarpus heterophyllus), eucalyptus and sissoo (Dalbergia sissoo) grow naturally or planted on agricultural lands and are purposely retained and maintained by the farmers for different household utilities, products and also for cash income. Farmers in our country practice monoculture of wheat. But practicing agroforestry system with suitable tree crop association, such as wheat association with Kalo koroi, Sissoo, Minjiri, Akashmoni, Jhau and Eucalyptus trees increase total production than monocultural system.

Wheat (Triticum aestivum L.) is one of the major cereal crops of the world ranking first both in acreage and production among the cereal crops. About one third of the total population of the world live on it (Honsan et al., 1982). Nations get more nutrients from wheat than any other cereals crops. From wheat one can get carbohydrates, protein, minerals and vitamins (BARI, 1990) and it is superior to rice for its higher seed protein content. But in agroforestry system, different interactions should take place with respect to how the components of agroforestry utilize and share the resources of the environment and how the growth and development of any of the components will influence the others (Torquabian, 1994). So, it is necessary to examine the performance of different crops with different tree species as agroforestry practices in different ecosystem. Considering the above mentioned facts and potentiality this study was undertaken to observe the morphological behavior and yield performance of wheat with different timber tree species as groforestry system.

Materials and Methods
Experimental site and soil: The experiment was conducted at the Agroforestry Field laboratory, Department of Agroforestry, BAU, Mymensingh during the period from December 2014 to March 2015. Geographically it is located at 24°75’ North latitude and 90°50’ East longitude. It belongs to the Agroecological zone of the Old Brahmaputra Flood Plain. It is characterized by non-calcareous & dark grey flood plain soil having PH value from 6.5 to 6.8. The soil texture is silty loam.

Climate and Weather: The climate condition of the experimental site is sub-tropical and characterized by high temperature and heavy rainfall during Kharif season (April to September) and scanty rainfall associated with moderately low temperature during Rabi season (October to March). The overall relative humidity remains high almost all over the year except winter.

Planting material: A local variety (pradip) of Wheat (Triticum aestivum) was selected as experimental material to cultivate along with six established mature tree species namely Kalo koroi (Albizia lebbeck), Sissoo (Dalbergia sissoo),...
sissoo), Jhau (Casuarina equisetifolia), Minjiri (Cassia siamea), Akashmoni (Acacia auriculiformis), and Eucalyptus (Eucalyptus camaldulensis). Wheat was grown under these trees with maintaining standard spacing. General view of wheat in association with above mentioned tree species is shown in Plate 1.

**Tree establishment and management:** During the period of field present study, the trees of all species were enough mature and well established. Average height and girth of Kalo koroi, sissoo, Jhau, Minjiri, Akashmoni and Eucalyptus trees were 17.70 and 2.31ft., 14.25 and 1.72ft., 31.15 and 2.12ft., 16.13 and 1.60ft., 29.14 and 2.18ft., 41.51 and 3.21ft., respectively. Before starting this study all of the trees were partially pruned disease infected and insect infested leaves and twigs were also removed.

**Experimental design, layout and treatment combination:** Wheat seeds were sown surrounding the six different timber tree species (kalo koroi, sissoo, jhau, akashmoni, eucalyptus and minjiri) following a Randomized Complete Block Design (RCBD) with three replications in each tree species separately. Different distances from the surrounding of each tree base were considered as different treatments of this study. Different distances from surrounding the trees were 0-1.5m, 1.5-3.0m and 3.0-4.5m. Wheat was also grown in without tree condition which was treated as control treatment of this study. Therefore the four different treatments in association with each tree species were as: T1 = 0-1.5m from the tree base, T2 = 1.5m-3.0m from the tree base, T3 = 3.0m-4.5m from the tree base, and T4 = without tree condition (control).

**Crop establishment and management:** Wheat seeds were directly sown in the experimental plot on the 1st week of November 2014. The seeds were sown by broadcasting method. After emergence, wheat was thinned out to maintaining approx. 4-5 cm distance from plant to plant. Intercultural operations were done in order to ensure and maintain the normal growth of the wheat. Care was taken to avoid bird damage of seeds during and soon after germination. Manual weeding was done two times in each plot on 21 and 40- days after sowing (DAS). The field was irrigated just after weeding.

**Sampling and Data collection:** Different morphological data viz., plant height (cm), tiller/plant, spike/plant, spike length (cm), grain/spike, grain/plant, and weight of 1000 seeds(gm) were recorded after harvesting. Yield of wheat estimated as t/ha from recorded yield attributes. Yield reduction of wheat also estimated in different treatments in association with all studied tree species.

**Statistical analysis:** The recorded data were compiled and analyzed by RCBD design to find out the statistical significance of experimental results. The means for all recorded data were calculated and analyzed statistically by using wasp2 software package to find out the statistical significance of the experimental results for all the characters were performed. The mean differences were evaluated by Duncan’s Multiple Range Test (DMRT) (Gomez and Gomez, 1984) at 5% level of significance and also by Least Significance Difference (LSD) test.

**Results and Discussion**

Morphological parameters: Morphological parameters of wheat in association with jhau, akashmoni, kalo koroi, eucalyptus, minjiri and sissoo trees were recorded during harvesting period. Generally, it was found that values of all morphogenical parameters of wheat was gradually decreased towards the base of all studied timber tree species. Average values of all morphological parameters of wheat was significantly varied compared to control condition (Table 1). Effect of different tree species on different morphological parameters of wheat are presented separately as:

**Plant height:** Plant height of wheat was significantly influenced by different tree species (Table 1). It was found that tallest (95.75cm) plant of wheat was produced in control condition and second highest plant height of wheat was produced with kalo koroi (66.24cm) and minjiri (64.50cm) tree which were statistically similar. Third highest plant height of wheat was produced in association with jhau tree (59.30cm) followed by sissoo tree (55.52 cm), akashmoni (53.29cm) and shortest plant was produced with eucalyptus (48.95 cm) tree. Kalo koroi and minjiri are legumious tree whose leaves added nitrogen to the soil as a result growth parameters of wheat may be better with these tree species. Pervin et al., (2015) observed better growth of mustard in association with kalokoroi tree. Eucalyptus tree have superficial root network in surface area (Laclau et al., 1999) which indicate more competition for moisture and nutrient with what roots as a result wheat was much shorter in association with this tree.

**Tiller plant**\(^1\): Tiller plant\(^1\) of wheat wheat was also significantly affected by different tree species (Table 1). Highest number tiller of wheat plant was found in control condition i.e., without tree combination (5.07). Second highest number of tiller plant\(^1\) of wheat was produced with kalo koroi (3.50) and minjiri (3.46) tree which were statistically similar. Third highest number of tiller plant\(^1\) of wheat was produced in association with jhau tree (3.15)

---

Plate 1. Wheat cultivation in association with (a) Jhau, (b) Akashmoni, (c) Kalo koroi, (d) Eucalyptus, (e) Minjiri, and (f) Sissoo trees
followed by sissoo tree (2.95), akashmoni (2.94) and less number of tiller plant$^{-1}$ was produced with eucalyptus (2.60) tree. Alam et al., (2012) recorded less number tiller plant$^{-1}$ was produced with eucalyptus (2.60) tree. Alam et al., (2012) recorded less number tiller plant$^{-1}$ in kangkong and indian spinach with eucalyptus tree due to its superficial root network in surface area.

Table 1. Morphological parameters (av. of all treatments) of wheat in association with different tree species

<table>
<thead>
<tr>
<th>Treatments/Tree species</th>
<th>Plant height (cm)</th>
<th>Tiller/plant</th>
<th>Spike/plant</th>
<th>Spike length (cm)</th>
<th>Grain/spike</th>
<th>Grain/plant</th>
<th>Weight of 1000 seeds (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibaru</td>
<td>59.76</td>
<td>3.154</td>
<td>2.404</td>
<td>9.474</td>
<td>38.684</td>
<td>597.674</td>
<td>79.86d</td>
</tr>
<tr>
<td>Akashmoni</td>
<td>53.29d</td>
<td>2.94e</td>
<td>2.33e</td>
<td>8.82e</td>
<td>36.06e</td>
<td>552.40e</td>
<td>27.83e</td>
</tr>
<tr>
<td>Kalo koroi</td>
<td>66.24h</td>
<td>3.51b</td>
<td>2.78b</td>
<td>10.54b</td>
<td>43.05b</td>
<td>659.52b</td>
<td>33.23b</td>
</tr>
<tr>
<td>Minjiri</td>
<td>64.50b</td>
<td>3.46bc</td>
<td>2.66c</td>
<td>10.08c</td>
<td>41.88bc</td>
<td>640.85bc</td>
<td>32.49bc</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>48.95e</td>
<td>2.60f</td>
<td>2.06f</td>
<td>7.80f</td>
<td>31.87f</td>
<td>488.29f</td>
<td>24.60f</td>
</tr>
<tr>
<td>Sissoo</td>
<td>55.52d</td>
<td>2.95e</td>
<td>2.33e</td>
<td>8.86e</td>
<td>36.20e</td>
<td>554.57e</td>
<td>28.94de</td>
</tr>
<tr>
<td>Control</td>
<td>95.75a</td>
<td>5.07a</td>
<td>4.02a</td>
<td>15.23a</td>
<td>62.72a</td>
<td>953.28a</td>
<td>48.03a</td>
</tr>
</tbody>
</table>

Mean in column followed by the different letter are significantly different by DMRT at p=0.05 and p=0.01, T1=0-1.5m distance, T2=1.5-3.0m distance, T3=3.00-4.5m distance and T4=Control (Without tree)

Spike plant$^{-1}$: Spike plant$^{-1}$ of wheat was significantly influenced by different tree species (Table 1). Highest number of spike plant$^{-1}$ of wheat was found in control treatment i.e., without tree combination (4.02). Second highest number of spike plant$^{-1}$ of wheat was produced with kalo koroi (2.78) followed by minjiri (2.66), jhau (2.66), sissoo tree (2.49), akashmoni (2.33) and less number of spike plant$^{-1}$ was recorded with eucalyptus (2.06) tree. Relatively reduced number penicle plant-1 was recorded in rice with akashmoni tree by Singha et al., (2015).

Spike length: Different timber tree species was significantly influenced the spike length of wheat during combined production as agroforestry system (Table 1). Lonest spike of wheat plant was found in control condition i.e., without tree combination (15.23cm). Second highest spike of wheat was obtained with kalo koroi (10.54cm) followed by minjiri (10.48cm), jhau (9.47cm), sissoo tree (8.86cm), akashmoni (8.82cm) and less number of spike plant$^{-1}$ was recorde with eucalyptus (7.80cm) tree. Smaller sized chilli fruit was reported by Rahman et al. (2013) in association with akashmoni tree in a char based farming system.

Grain spike$^{-1}$ and plant$^{-1}$: Grain spike$^{-1}$ and plant$^{-1}$of wheat was significantly influenced by different tree species (Table 1). It was found that maximum number grain spike$^{-1}$ and plant$^{-1}$ (62.22 and 953.28) of wheat was produced in control condition and second highest number grain spike$^{-1}$ and plant$^{-1}$ of wheat was produced with kalo koroi (43.05 and 659.52) and minjiri (41.88 and 640.85) tree which were statistically similar. Third highest number grain spike$^{-1}$ and plant$^{-1}$ of wheat was produced in association with jhau tree (38.68 and 592.62) followed by sissoo tree (36.20 and 554.57), akashmoni (36.06 and 552.40) and less number grain spike$^{-1}$ and plant$^{-1}$ was produced with eucalyptus (31.87 and 488.29) tree. Pervin et al., (2015) reported higher number of grain pod$^{-1}$ and plant$^{-1}$ in mustard with kalo koroi tree.

1000 grain weight: 1000 grain weight of wheat was significantly influenced by different tree species (Table 1). It was found that maximum weight of 1000 grain (40.03g) of wheat was produced in control condition and second highest value of weight of 1000 grain of wheat was recorded in kalo koroi (33.23g) and minjiri (32.49g) tree which were statistically similar. Third highest value of weight of 1000 grain wheat was produced in association with jhau tree (29.86g) followed by sissoo tree (28.94g), akashmoni (27.83g) and less value of weight of 1000 grain was recorded eucalyptus (24.60g) tree. Singha et al., (2015) reported lower value of weight of 1000 grain of rice in association with akashmoni tree.

Yield: Yield of wheat significantly influenced by studied tree species. i.e. the kalo koroi, minjiri, jhau, akashmoni, sissoo and eucalyptus when grown as agroforestry system. It was found that in considering with all of these tree species yield of wheat gradually decreased towards the base of tree (Fig. 1).

Though the yield variation is similar but numerically yield variation is not same. Highest yield (2.02 t/ha) of wheat was found in control condition. i.e.without tree condition. Along with these tree species highest yield was found in the treatment T$_3$. i.e.3.0-4.5m distance areas from tree base, where highest yield was obtain in combination with Kalo koroi (1.37 t/ha) which was statistically similar in combination with Minjiri (1.35 t/ha) followed by Jhau (1.27 t/ha). Akashmoni and sissoo (1.18 t/ha) and lowest yield was obtained in considering with Eucalyptus (1.05 t/ha) (Fig. 2). In case of treatment T$_2$. i.e. 1.5-3.0m distance from tree base yield of wheat was much moro reduced with similar treatment like treatment T$_3$. Where 35-55% yield was reduced compare to control condition.
Generally, in agroforestry system components yield reduce 48% lower yield compared to open field condition. Produced 42% lower and along with eucalyptus produced with jhau 37% lower, along with akashmoni and sissoo is 32-34% lower compare to open field condition, along with kalo koroi and minjiri produced highest yield which reduce in different rate along with different trees. Along condition and in the tree-crop association, wheat yield (Fig. 4).

These yield reduction of wheat in closer distance from Jhau, akhmoni, kalo koroi, minjiri, eucalyptus and sissoo trees were might be due to severe competition for different nutrients elements and moisture between the root system of these tree and crop species. Kundu et al. (2014) and Habib et al. (2012) found lower yield of soybean and okra when cultivate very near the base of 5 and 3 years old Xylia dolabriformis trees. Overall average yield of wheat with Jhau, Akashmoni, Kalo Koroi, Minjiri, Eucalyptus and Sissoo were 1.27, 1.17, 1.37, 1.35, 1.05 and 1.18 t/ha (Fig. 2), respectively which were 37.13, 42.08, 32.18, 33.17, 48.02 and 41.58% lower compare to control condition (Fig. 3). Yield of wheat was higher in open field condition and in the tree-crop association, wheat yield reduce in different rate along with different trees. Along with kalo koroi and minjiri produced highest yield which is 32-34% lower compare to open field condition, along with jhau 37% lower, along with akashmoni and sissoo produced 42% lower and along with eucalyptus produced 48% lower yield compare to open field condition. Generally, in agroforestry system components yield reduce due to resource competition (Rao, et al. 1998). In association with eucalyptus highest (48%) yield reduction may due to its superficial root network in surface area (Laclau et al. 1999), adverse effect on soil (Kidanu et al. 2005), creating water stress (Gindaba et al. 2004), nutrient depletion and exudates allelochemicals to the soil (EI-Khawas and Shehata, 2005).

References


