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Effect of Tree Species and Environment on the Performance of Wheat-T.aman Rice and Boro Rice-T.aman Rice Cropping Pattern

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Abstract: A study was conducted to evaluate the performance of two multipurpose tree species (*Acacia nilotica* and *Eucalyptus camaldulensis*) were intercropped with wheat followed by Transplant aman rice in rainfed and Boro rice followed by Transplant aman rice in irrigated conditions at East Mollikpur, Dinajpur from November 1998 to November 1999. Results indicate that both the tree species were found compatible with wheat under rainfeed condition. But incase of boro rice grain yield of boro was higher in the open field than that of Agroforestry treatment. Higher T. aman yield received under the canopy of *A. nilotica* (2.53 t ha^{-1}) than *E. camaldulensis* (2.39 t ha^{-1}) in rainfed condition but in irrigated condition there was no significant difference. The overall results considering both tree performance and crop yield underneath the tree canopies indicated that growth of *Acacia nilotica* was not significantly affected in wet land condition and had less negative effect on crop yield than that of *Eucalyptus camaldulensis* as well. Therefore, considering the immediate benefit of crop yield and the long-term value added from timber and plant products, *Acacia nilotica* species might be more compatible with rice-wheat cropping pattern in the study area. Growing trees in cropland may serve as the best option to balance ecosystems.

Key words: Tree species, environment, wheat-t.aman and boro–t.aman

INTRODUCTION

In Bangladesh per capita land area is decreasing at an alarming rate of 0.005 ha/cap/yr[1] due to rapid expansion of population. About 15% of the total land area is classified as forest land that is far below the critical level (25%). The annual rate of deforestation is very high (8,000 ha),[2]. In crop fields, soil fertility maintenance is another problem for resource poor farmers. Fuel shortage led to increasing use of cowdung and agricultural residues, causing loss of soil fertility and crop yield.

To overcome the above problems, Agroforestry practice becomes popular. Inclusion of tree legume in agro forestry helps to add atmospheric nitrogen to the soil through fixation and thereby improve crop productivity. Nitrogen supply to the crops by decaying tree roots and decomposition of pruning materials under agro forestry systems has been well established[3,5]. Farmers grow a considerable number of various tree species in the crop field. There are evidences indicating that several tree species (both indigenous and exotic) grows well in wet and for most of the time in the year, and are found compatible with field crops. A similar system is reported from Madhya pradesh (India), where *Acacia nilotica* is inter-cropped with rice[6]. The farmers of some part of northern Bangladesh have been growing *Acacia nilotica, Eucalyptus camaldulensis, Acacia albida and A. catechu* in association with Boro-T.aman cropping pattern under irrigated condition. But the effects of water logging on the growth and development of the tree species as well as the interactions between the tree and the crops have not yet fully investigated. Therefore, with a view to increasing tree coverage with suitable land use system under irrigated condition, a study was under taken to examine the performance of the crop (rice and wheat) and tree species in wet and dry land condition.

MATERIALS AND METHODS

A field experiment was conducted at East Mollilkpur, Dinajpur from November 1998 to November 1999 utilizing 12 years old multipurpose tree species in the crop fields. Two tree species *Eucalyptus camaldulensis* (Family: Leguminosae) and *Acacia nilotica* (Family: Myrtaceae) have been established during 1987. Data on rainfall and temperature were collected from the secondary source per

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10-day basis. The experiment was laid out in a factorial Randomized Complete Block Design with three replications. The treatments consisted of two tree species and open field (without tree but crop only) under rainfed and irrigated condition. The tree species were intercropped with wheat followed by Transplant aman rice in rainfed and Boro rice followed by Transplant aman rice in irrigated conditions. Trees were spaced 8 m in all direction. Wheat (Var. Kanchan) seeds were broadcast in mid November 1998 at the rate of 120 kg ha^{-1}. About 45 days old seedlings of boro rice (var. Pari) seedlings were transplanted on December 10, 1998 in rows at 25 cm apart. Incase of T. Aman rice (var. Sorna) were transplanted on mid July 1999 in rows at 25 cm apart following 15 cm plant to plant distance. Pruning (root, shoot) of the trees was done 2-3 weeks before the establishment of each crop (eg: wheat, boro and aman rice). The fresh green materials were incorporated into the soil by ploughing. Grain yields of wheat and rice were expressed based on Full alley (area occupied by the crop only) and Field area (total area occupied by the annual crop and tree components) basis. Grain yield of wheat and rice were recorded from one square meter quadrate starting from tree trunk upto 6 meters. Wheat yields were converted to economic yield of boro rice to observed the performance of wheat-T.aman (rainfed) and Boro-T.aman (irrigated) cropping pattern using the prevailing market price of wheat and boro. Tree height was measured by clinometers. Diameter of tree was measured at 0.3 m above the ground level.

Recorded data were analyzed using IRRISTAT microcomputer programme. Graphs were drawn in micro-soft 98 excel programme.

RESULTS AND DISCUSSIONS

Plant environment: The agro meteorological data (temperature and rainfall) per 10 days during the study period (November 1998 to November 1999) are shown in Fig. 1. There was a distinct dry season from November to April, and a wet season from May to October. In spite of the sharp dry season, tree growth did not suffer much probably due to their deep rooting systems.

Wheat experienced only 18 mm rainfall, which was not favorable for its production. The optimum well distributed rainfall required for wheat production is 400 to 1100 mm. Since rice was grown in the wet season, it experienced a well-distributed rainfall through the growing season (total 1858.2 mm).

The performance of rice and wheat grown under different tree species and hydrologic environment (rainfed and irrigated) is presented and discussed separately for each crop.

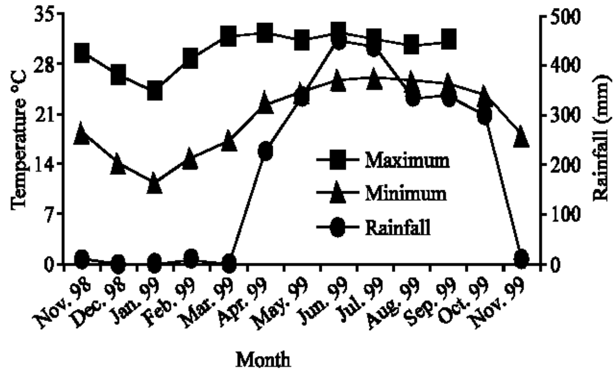

Fig. 1: Monthly meteorological data during the experimental period (November 1998 to November 1999) at Dinajpur, Bangladesh

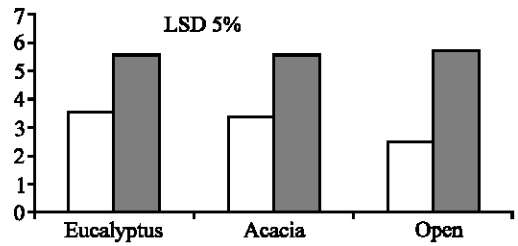

Fig. 2: Effect of tree species and environment on the grain yield of Wheat (rainfed) and Boro (irrigated) (full alley basis)

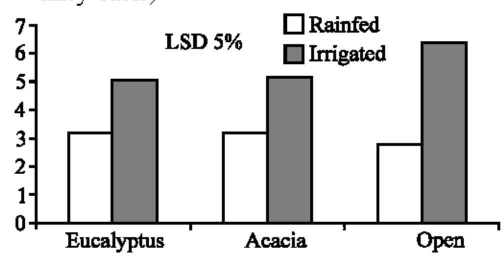

Fig. 3: Effect of tree species and environment on the grain yield of Wheat (rainfed) and Boro (irrigated) (field area basis)

Wheat: Both tree species and hydrologic condition (Fig. 2 and 3) significantly influenced grain yield of wheat. On full alley basis, significantly the highest yield of the wheat (2.43 t ha^{-1} equivalent to grain yield of boro rice 3.53 t ha^{-1}) (Fig. 2) was obtained from underneath the *E. camaldulensis* tree species followed by the wheat yield 2.30 t ha^{-1} equivalent to grain yield of boro rice 3.35 t ha^{-1} under *A. nilotica* tree species. The lowest grain yield of wheat (1.71 t ha^{-1} equivalent to grain yield of boro rice 2.48 t ha^{-1}) was obtained from the open field (no tree but wheat only). On field area basis, approximately the equal amount of wheat yield under the canopy of *Eucalyptus* (1.95 t ha^{-1} equivalent to grain yield of boro rice 2.83 t ha^{-1}) and the canopy of *Acacia* (1.93 t ha^{-1} equivalent

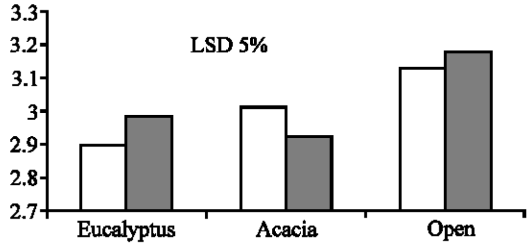

Fig. 4: Effect of tree species and environment on the grain yield of Wheat (rainfed) and Boro (irrigated) (full alley basis)

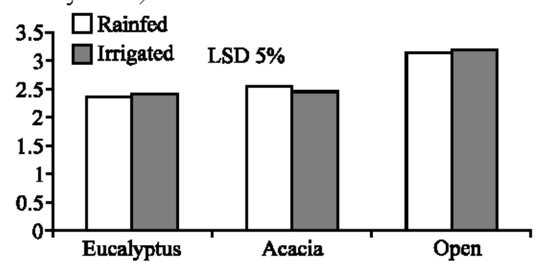

Fig. 5: Effect of tree species and environment on the grain yield of Wheat (rainfed) and Boro (irrigated) (field area basis)

to grain yield of boro rice 2.81 t ha^{-1}) was obtained (Fig. 3). But significantly the lowest yield (1.71 t ha^{-1} equivalent to grain yield of boro rice 2.48 t ha^{-1}) was received from the open field than that of the agroforestry treatments. These results indicate a significant yield improvement in agroforestry system under rainfed situation. This yield improvement may be attributed by the prunings of roots and shoots reduce the competition for moisture and nutrients as well as to the application of pruning biomass into the soil as green manures. A substantial improvement was reported where tree pruning were used as mulch[7].

Rice: Grain yields of irrigated boro rice were significantly affected by tree species and hydrologic environment (Fig. 2 and 3). On the full alley basis, significantly the highest grain yield of boro (5.72 t ha^{-1}) was obtained from the open field treatment than that of agroforestry treatment (Fig. 2). There was significant the lowest yield of boro rice (5.50 t ha^{-1}) was recorded under *A. nilotica*, which was statistically identical to the yield of the same crop (5.56 t ha^{-1}) under *E. camaldulensis*. This dominance of *E. camaldulensis* over *A. nilotica* during boro rice may be attributed to the closure of *A. nilotica* canopy compared to the porous and errectophyll nature of *E. camaldulensis* canopy giving less shading. It may also be attributed to the decrease in competition of *E. camaldulensis*, being exhaustive species, for water because of irrigation. Lal,[8] concluded that shading was responsible for suppression of yield. Basri *et al.*,[9] also reported the similar results. Jadhav,[10] reported that partial shading (45-50% of normal light) at 15 days after transplanting reduced the grain yield by 73% in 25 rice cultivators because of reduction in number of panicles/plant (51.5%) and in number of unfilled spikelet (42%).

On field area basis, boro grain yield was significantly affected by the tree species (Fig. 3) where the highest grain yield (5.12 t ha^{-1}) was obtained from open field compared to the yield of same crop under *A. nilotica* (4.66 t ha^{-1}) and *E. camaldulensis* (4.46 t ha^{-1}). Regardless of tree species and open treatment, the hydrologic environment significantly affected grain yield where higher yield was received from the irrigated condition.

In aman rice season, on full alley basis, significantly the highest grain yield both in rainfed (3.14 t ha^{-1}) and irrigated (3.19 t ha^{-1}) condition were received from the open field (Fig 4) compared to that from *E. camaldulensis* (2.90 t ha^{-1} in rainfed and 2.99 t ha^{-1} in irrigated conditions) and *A. nilotica* (3.02 t ha^{-1}) in rainfed and (2.93 t ha^{-1}) in irrigated conditions. There was no significant difference between grain yield of aman rice under the canopy of *E. camaldulensis and A. nilotica* both in rainfed and irrigated conditions. On field area basis, significantly higher aman grain yield (2.53 t ha^{-1}) was obtained under the canopy of *A. nilotica* while lower yield (2.35 t ha^{-1}) was received under the canopy of *E. camanldulensis* in rainfed situation (Fig. 5). But significantly the highest aman grain yield (3.14 t ha^{-1}) was obtained from the open field treatment than that of agroforestry treatments. In irrigated condition, there was no significant different in grain yields of aman rice obtained underneath the *A. nilotica* (2.46 t ha^{-1}) and the *E. camaldulensis* (2.39 t ha^{-1}) treatments. But significantly the highest aman grain yield (3.19 t ha^{-1}) was also obtained from the open field treatment than that of agroforestry treatment. In agroforestry treatments, the reduction of crop yield compared to the open field was due to the cumulative effect of land area reduction by the occupancy of trees as well as the competition between tree and crop. It is noted that 16% land area was reduced by the occupancy of *A. nilotica* tree while 20% area reduced by that of *E. camaldulensis* trees. Decrease in yield under trees may be due to the lateral expansion of roots and shading effect.

Tree height: The increase in tree height over 1 year was significantly affected by species and environment (rainfed and irrigated condition). *E. camaldulensis* showed significantly a lower increase in tree height in irrigated condition (0.37 m) compared to that in rainfed situation (0.45 m) shown in Table 1. There was no significant

Table 1: Effect of cropping pattern on the growth and dry matter of pruned biomass of tree species

Parameters	Tree species	Cropping pattern Wheat-T.aman (Rainfed)	Boro-T.aman (Irrigated)
Tree height increase (m)	*Eucalyptus camaldulensis*	0.45Aa	0.37 Ba
	Acacia nilotica	0.14Ab	0.12 Ab
Base diameter (cm)	*Eucalyptus camaldulensis*	2.89Aa	2.55 Aa
	Acacia nilotica	2.31Ab	1.78 Bb
Total dry matter of pruned biomass (kg plant^{-1})	*Eucalyptus camaldulensis*	11.11Aa	9.85Ba
	Acacia nilotica	3.52Ab	3.30 Ab

In a column, means followed by a common letter are not significantly different at the 5% level by DMRT. Capital letters are assigned for comparing 2 means under water management and small letters for means of the species in each water management

difference in increase in height of *A. nilotica* between rainfed (0.14 m) and irrigated situation (0.12 m). Increase in height of *E. camaldulensis* was however higher than that of *A. nilotica* both in rainfed and irrigated conditions.

Base diameter: No significant difference was observed in increase in base diameter of the *E. camaldulensis* tree due to irrigation (2.89 cm in rainfed and 2.55 cm in irrigated condition) shown in Table 1. There was significantly a lower increase in base diameter of *A. nilotica* under irrigated condition (1.78 cm) compared to that in rainfed situation (2.31 cm). However, *E. camaldulensis* showed significantly the higher value of diameter increase both in rainfed (2.89 cm) and irrigated (2.55 cm) conditions compared to *A. nilotica* (2.31 cm in rainfed and 1.78 cm in irrigated condition).

Total pruning dry mater: Total pruning dry matter of roots, stems, twigs and branches was significantly affected by tree species and water management (Table 1). *E. camaldulensis* produced significantly the higher total dry matter (9.85-11.11 kg plant^{-1}) than *A. nilotica* (3.30-3.52 kg plant^{-1}). The total dry matter of *Eucalyptus* under irrigated condition was significantly lower (9.85 kg) than that in rainfed condition (11.11 kg). There was no significant variation in total dry matter of *A. nilotica* between rainfed (3.52 kg) and irrigated (3.30 kg) condition.

The overall results imply that *E. camaldulensis* and *A. nilotica* were more compatible with wheat under rainfed condition than under irrigated `condition. While *Acacia* may have lesser negative effective on crop yield in irrigated condition compared to that of *E. camaldulensis* considering the area lost due to occupancy of trees in the field.

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