# Effect of organic and inorganic fertilizer on growth and yield of wheat under Agrisilvicurtural system

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**Abstract:** A field experiment was conducted in an established tree orchard of Sissoo (*Dalbergia sissoo*) and Mahogoni (*Swietania macrophylla)* at the Agroforestry field of the Regional Agricultural Research Station of BARI, Jamalpur during November 2005 to April 2006 to evaluate the performance of growth and yield of wheat with various fertilizers and manure application. Wheat (*Triticum aestivum*) var.Kanchan was grown under the different treatments combinations of this Agrisilvicultural system. The data were collected seven times, first to six times TDM at 15 DAS intervals and finally after harvesting. The results showed that application of organic manures and chemical fertilizer under two species of trees influenced independently and also in combination. The highest 1000-grain weight (42.73 g) was found under Sissoo with poultry manure treatment combinations. Also the highest harvest index (40.00) was obtained under Sissoo with poultry manure and chemical fertilizer treatment combination. The highest yield (1.35 t $ha^{-1}$) was obtained from open area with poultry manure + chemical fertilizer followed by Sissoo (1.15 t $ha^{-1}$) with poultry manure treatment combinations. Therefore, all parameters produced the highest performance in open area compared to tree-wheat association in respect of wheat cultivation. This study indicated that *Dalbergia sissoo* was the species where wheat grown with minimum yield reduction as compares to open area.

**Keywords:** Manure and Fertilizers, Wheat

## Introduction

Wheat (*Triticum aestivum*) is the second most important cereal crop in Bangladesh. Annual wheat consumption is increasing day by day whereas production is decreasing. With the advancement of research in this field, the modern varieties have been evolved along with the improvement of cultural practices; as a result the total wheat production of the country went up. Adverse effects of low light intensity were observed more pronounced on grain yield than on harvest index and dry matter production. Wang and Nakaseko (1986) found that the shading after heading reduced ear, culm and root dry weight and reduced grain yields more than shading before heading. The shading effects would obviously be under lower intensities at early stages of tree growth under taungua system and demands more studies.

Organic manure releases plant nutrients slowly. For this reason, the potentialities of organic sources are very limited to afford higher crop production. Miah (1994) reported that only one fifth to one half of the nutrient supplied from manure is recovered and the remainder is released only by 24 per cent per annum. This may be a concern for soil fertility maintenance but is obviously a barrier for higher plant nutrient uptake. Hence, the possibility of yield increase through these sources alone is minimum. However there are more scopes and better results in these aspects under tree crop association. Although chemical fertilizer application trend has been increased in our country, organic manures like cow dung, poultry litter, farm yard manure utilization also has come to the forefront. To reduce the application of chemical fertilizers, thereby the compactness of soil, poultry litter as a source of organic manure has been chosen to study under wheat production as an under storey crop in

between the open areas of the tree orchard. Integrated plant nutrient system (IPNS) is the newly taken measure which encourages the optimization of all available sources of plant nutrients with objective of improving soil fertility (Sattar, 2002). Cognizant of the above facts, this present research has been designed to evaluate the open spaces of tree orchard for wheat cultivation and to find out a suitable combination of chemical or organic manures for successful wheat production under these agrisilvicultural systems.

## Materials and Methods

The site of the experiment is located at about $24^0 56^/$ North latitude and $89^0 55^/$ East longitude and the plots were at the southern part of the Regional Agril. Res. Station, BARI, Jamalpur, which is under the municipal area of Jamalpur town. Duration of the experiential period was from November 2005 to March 2006 with three replications. Soil of the experimental plot was low in organic matter (1.2%), evolved from the Old Brahmaputra floodplain alluvium and it belongs to the Sonatala soil series. Wheat (*Triticum aestivum* L.) var. Kanchan was used as the test crop. The experiment was laid out following a Randomized Complete Block Design with two factorial arrangements.

Factor: A = Tree species

i) Open Area (Control): OA

*ii) Dalbergia sissoo*: DS

*iii) Swietania macrophylla*: SM

Factor: B= Fertilization procedure

i) Poultry litter @ 10 t $ha^{-1}$: P

ii) Chemical fertilizer @ 120-16-35-20-2-1 kg N-P-K-S-Zn-B $ha^{-1}$: C

iii) 50% poultry litter + chemical fertilizer (50%): P+C

Total number of experimental plot was 27. Eighteen plots were laid under tree species and the size of each unit plot was 5.5m x 3.5m = 19.25$m^2$. Data on growth parameters and dry matter production $plant^{-1}$ was recorded at every 15 days. Yield data were collected from $2/3^{rd}$ portion (wheat plants) of each plot as $1/3^{rd}$ portion was used to collected data on growth parameters. Data on yield contributing parameters such as Dry matter weight $plant^{-1}$ 6 dates (15 days interval), Plant height at harvest (cm), Length of spike (cm), No of spikelets $spike^{-1}$, No of grain $spike^{-1}$, Weight of 1000 seed (g), Weight grain yield (t $ha^{-1}$), Weight of straw (t $ha^{-1}$) were recorded and statistically analyzed using the "Analysis of variance" (ANOVA) technique with the help of computer package program (MSTAT). The mean differences were done following new Duncan's Multiple Range Test (Gomez and Gomez, 1984).

## Results and Discussion

**Plant Height:** The tallest plants (86.82 cm) were observed under Sissoo tree, which might be due to shading effect that led the plant to become tall. The dwarf plants (75.02 cm) were observed under SM due to lack of moisture in the soil surface. Plant height of Indian spinach was affected by tree shade which was reported by Wadud (1999). This may attributed due to the stimulation of the cellular expansion and cell division under shaded condition, which resulted higher plant height under reduced light condition reported by Islam (1995) in mungbean and Murshed (1996) in chickpea. The highest plant height (83.39 cm) observed by P + C (Table 2). On the other hand, two treatments were statistically similar but the lowest one (80.9 cm) was observed with the poultry manure treatment. This result again supports the finding of Singh and Agrawal (1983). This result was also agreed with the findings of Wadud (1999), who reported that an increased plant height was found when tree biomass was added with manures and fertilizers. In case of interaction effect between various shading condition and fertilizer and manure application, the highest plant height (88.00 cm) was recorded from DS with P+C

treatment combinations. The lowest (72.63 cm) was observed in SM with C.

**Spike length:** The highest spike length (8.84 cm) was observed under DS. The shortest spike length (7.64 cm) was observed in open area (Table 1). The influence on spike length due to various fertilizer and manure application were statistically similar (Table 2). The highest spike length (8.57 cm) recorded with the poultry manure application and the lowest (7.61 cm) was observed with C. Singh and Agarwal (1983) reported that application of manures (cowdung, poultry manures) and fertilizers (NPKS) increased the spike length which was significantly higher applied with tree biomass. Interaction effect between various shading condition and various fertilizer and manure application were significantly varied in spike length. The highest spike length (9.53 cm) was observed in the treatment combinations of DS with P and the lowest spike length (6.93 cm) was recorded in treatment combinations of OA with chemical fertilizer.

**Spikelets Spike$^{-1}$:** The highest spikelets spike$^{-1}$ (13.56) was observed for the OA due to high light intensity (Table 1). The shortest spike length (13.07) was observed in DS. Chaturvedi and Ingram (1989) have reported that shading decreased the production of spikelets number on the secondary rachis branches and in the lower part of the panicle. Influence of various fertilizer and manure application were highly significant (Table 2). The highest spikelets spike$^{-1}$ (13.37 cm) was recorded from the chemical fertilizer and P+C. The lowest (13.20) was observed from the poultry manure applied plots. In case of interaction between various shading condition and fertilizer and manure application, the highest spikelets spike$^{-1}$ (13.90) was found under OA with chemical fertilizer treatments and the lowest spikelets spike$^{-1}$ (12.80) was observed in treatment combinations of DS with chemical fertilizer application.

**Grain Spike$^{-1}$:** The highest grain spike$^{-1}$ (28.93) was observed in OA. The lowest grain spike$^{-1}$ (23.42) was observed under SM (Table 1). Influence of various fertilizer and manure application were varied significantly (Table 2). The highest grain spike$^{-1}$ (27.36) was observed from in Poultry manure. The lowest (25.18) was observed in chemical fertilizer. Considering the interaction effect between various shading condition and various fertilizer and manure application, the highest grain spike$^{-1}$ (29.40) was observed in open area with P+C treatment combinations. And the lowest grain spike$^{-1}$ (22.27) was observed in SM with chemical fertilizer treatment combinations.

**1000-grain Weight:** The highest 1000-grain weight (41.39 g) was observed in DS and the lowest (39.83 g) was observed in SM (Table 1). Influence of various fertilizer and manure application were insignificant (Table 2). The highest 1000-grain weight (41.23 g) was observed from Poultry manure application while the lowest (40.12 g) was observed from the chemical fertilizer application plots. In case of interaction between various shading condition and fertilizer and manure application the highest 1000-grain weight (42.73 g) was observed under DS with poultry manure treatment combinations. The lowest 1000-grain weight (39.33 g) was observed from the treatment combination of SM with poultry manure.

**Grain Yield:** Effects of different shade conditions on yield of wheat were statistically significant (Table 1). The highest grain yield (1.28 t ha$^{-1}$) was observed from open area (OA), which was differed from the yield of shading areas. The lowest grain yield (1.06 t ha$^{-1}$) was observed under SM. Similar types of result was found by Alam *et al.,* (2000), where they reported that rice yield significantly varied with the yield of shading plots under silviagricultral system The variety (*cv* Kanchan) was highly sensitive variety showed a rapid declining growth rate after 20 DAS. This results

agreed with those of Bhatta *et al.,* (1994), who reported a high temperature stress condition at grain filling period resulting lower grain yield, similar statements were also made by Wiegand and Cuellar (1981), Asana and Williams (1965), Begga and Rawsan (1977) and Jhala and Jadon (1989). Reduced dry matter production under low light causing poor yield has been shown by Nayak and Murty (1980). In case of fertilization treatments, the highest grain yield weight (1.17 t $ha^{-1}$) was observed in Poultry manure + Chemical fertilizer. The lowest (1.12 t $ha^{-1}$) was observed only in chemical fertilizer (Table 2). Similar observation was made by Yaduvanshi, (2003). The application of NPK and its combination with green manuring and FYM increased yield of wheat where higher profit was obtained. Similar result was also reported by Zia *et al.* (2002). Interaction effect between various shading condition and various fertilizer and manure application were significant in grain yield. The highest grain yield (1.35 t $ha^{-1}$) was observed in open area with poultry manure + chemical fertilizer treatment combinations. And the lowest grain yield (1.06 t $ha^{-1}$) was observed in SM with poultry treatment combination. A similar type of result was found by Muneshwar, (2001). The use of FYM and green manure increased K availability in soil, N sustainability that indicated increasing productivity of wheat.

**Straw Yield:** The highest straw yield (2.04 t $ha^{-1}$) was observed in open area. The lowest straw yield weight (1.77 t $ha^{-1}$) was observed in SM. Similar result was obtained by Satish *et al.* (2003). Photosynthetic rate and specific leaf weight of wheat also decreased significantly with the increase in shade duration. In case of fertilization effect, the highest straw yield (1.84 t $ha^{-1}$) was observed in Poultry manure + Chemical fertilizer (Table 2). The lowest (1.76 t $ha^{-1}$) was observed in chemical fertilizer. Such a positive effect of the combined use of organic manures and chemical fertilizers on straw yield was also cited by Rajput and Warsi (1992) and Boron *et al.,* (1995). Interaction between various shading condition and various fertilizer and manure application were significant variation in grain yield; the highest grain yield (2.17 t $ha^{-1}$) was observed under open area with poultry manure + chemical fertilizer treatments combinations. And the lowest grain yield (1.59 t $ha^{-1}$) was observed in SM with poultry manure + chemical fertilizer treatment combinations.

**Biological Yield:** The biological yield was calculated by the combination of grain and straw yield. The data reveals that the effect of trees significantly affected biological yield (Table 1). The highest yield (3.31 t $ha^{-1}$) was obtained from the open area and the lowest yield (2.64 t $ha^{-1}$) was obtained from the SM which was statistically different. Similar result was observed by Kirem (2001). Grain yield and biological yield decreased bellow *Dalbergia sissoo* tree canopies and ranged from 69.24 to 79.86% of the control, respectively. Biological yield had no such significant variation between poultry manure and chemical fertilizer but variation in poultry manure + chemical fertilizer which was the highest yield production (3.01 t $ha^{-1}$) and the lowest (2.89 t $ha^{-1}$) was observed from chemical fertilizer (Table 2). N supply positively affected resulting in lighter grain weight per spike. In case of interaction effect, the highest biological yield (3.5 t $ha^{-1}$) was recorded from the treatment combination of open area with poultry manure + chemical fertilizer. The lowest biological yield (2.63 t $ha^{-1}$) was produced by the treatment combination SM with poultry manure + chemical fertilizer.

**Harvest Index:** The highest harvest index (39.99 t $ha^{-1}$) was calculated from the DS and the lowest

**Table 3.** Effect of tree shading conditions on different periodical dry matter weight (g) $plant^{-1}$

| Treatment | Periodical dry matter weight (g plnat$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|
| | 1st (15 DAS) 22/12/05 | 2nd (30 DAS) 06/01/06 | 3rd (45 DAS) 21/01/06 | 4th (60 DAS) 05/02/06 | 5th (75 DAS) 20/02/06 | 6th (90 DAS) 07/03/06 |
| **OA** | 0.10 a | 0.302 a | 4.36 | 3.87 | 4.84 | 5.44 |
| **DS** | 0.13 a | 0.364 a | 5.95 | 2.44 | 4.96 | 4.31 |
| **SM** | 0.11 a | 0.304 a | 2.24 | 1.04 | 3.93 | 4.46 |

**Table 4.** Effect of manure and fertilizer application on different periodical dry matter weight (g) plant$^{-1}$

| Treatment | Periodical dry matter weight (g plnat$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|
| | 1st (15 DAS) 22/12/05 | 2nd (30 DAS) 06/01/06 | 3rd (45 DAS) 21/01/06 | 4th (60 DAS) 05/02/06 | 5th (75 DAS) 20/02/06 | 6th (90 DAS) 07/03/06 |
| **Poultry (P)** | 0.11 a | 0.47 a | 5.43 a | 2.77 a | 5.23 a | 5.00 b |
| **Chemical (C)** | 0.12 a | 0.23 c | 3.24 c | 1.99 b | 3.90 c | 3.84 c |
| **P + C** | 0.11 a | 0.28 b | 3.89 b | 2.59 a | 4.59 b | 5.32 a |
| **CV%** | 35.9 | 10.99 | 5.50 | 8.34 | 5.92 | 0.23 |
| **LSD at (0.05)** | 0.05 | 0.03 | 0.24 | 0.21 | 0.28 | 5.01 |

DAS = Days after sowing, P = Poultry manure, C = Chemical fertilizer

OA = Open area, DS = *Dalbergia sissoo*, SM = *Swietania macrophylla*, P = Poultry manure, C = Chemical fertilizer

In a column, values with same latter do not differ significantly at 5% level as per DMRT

(38.55 t ha$^{-1}$) was observed from SM (Table 1). On the other hand, the highest harvest index (39.34 t ha$^{-1}$) was observed from the poultry manure and the lowest (38.97 t ha$^{-1}$) was calculated from the P +C (Table 2). Similarly the application of organic manures improved yield attributes and grain, straw and biological yields of wheat observed by Ranwa (1999). The interaction between trees and fertilizer and manure application the highest harvest index (40.00) was obtained from DS with poultry manure and chemical fertilizer treatment combinations. The lowest (38.46) was calculated in treatment combination both Open area and SM with chemical fertilizer, chemical fertilizer + poultry manure. The same result was got by Song-Youg Lin, *et al.* (2001). The application of fertilizer NPK combined with OM had better yield increase effect the application of fertilizer NPK alone, especially combined with farm yard manure at a higher dose.

**Dry Matter accumulation:** Dry matter (DM) accumulation plant$^{-1}$ at periodical interval at different days were very negligees differences between various shading effects were observed under growing conditions at different DAS. Similarly interaction affect of various shading condition and different fertilizer and manure application on the dry matter (DM) accumulation plant$^{-1}$ at different DAS have been presented with Table 3 & 4. The highest DM (0.13 g plant$^{-1}$) was obtained in *Dalbergia sissoo* (DS) and the lowest (0.1 g plant$^{-1}$) in open area (OA) at 15 DAS. Similarly type of results was obtained from different DAS under Tree species. These results agree with the findings of other previous researchers Jadhav (1987) reported that reduction of vegetative characters of rice under different tree-rice association as well as orientations observed in the present investigation might be due to shading (lack of appropriate light intensity).

The study indicated that *Dalbergia sissoo* was the species where wheat grown with minimum reduction as compares to open area. There was an ample scope to grow wheat in the plantation areas, then a substantial quantity of area to be brought under wheat cultivation in the country. On the other hand, a lot of production of poultry litter from the poultry farms of the country

could be used as organic manure to meet the nutrient requirement of the crops, because utilization of organic manure is more environmental friendly than chemical fertilizer application. Integrated use of chemical fertilizer with organic manures can help to sustain soils low in organic matter. Poultry manure (PM) from expanding poultry industry may be a good source of organic manure. The yield of wheat increased significantly due to addition of either PM. Residual effect of organic manures was more when applied in dry land wheat crop. Direct effect of use of organic manures produced higher crop yields than any residual effect of organic manures. We have studied the residual effect of different organic materials on the succeeding wheat. Organic manure releases plant nutrients slowly. For this reason, the potentialities of organic sources are very limited to afford higher crop production. This may be a concern for soil fertility maintenance at the initial stage but is obviously a positive of yield increase through these sources with chemical fertilizer is great as evident from our study also. The combined use of organic manure with inorganic fertilizer performed better than sole use of organic fertilizers. PM could be used to get higher yields and to better sustain soil nutrient availability. Therefore, it may be concluded that yield decrease near the tree due to shade and competition; still combine production system with sissoo may become beneficial for the farmers from sustainable view point.

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**Table 1.** Yield contributing characters of wheat as influenced by various shading conditions under two tree species.

| **Treatment** | **Yield contributing characters of wheat (var. Kanchan)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Plant** | **Spike** | **Spikelets** | **Grain** | **1000-** | **Grain** | **Straw** | **Biological** | **Harvest** |

| | height (cm) | length (cm) | spike$^{-1}$ | spike$^{-1}$ | grain weight (g) | yield (t ha$^{-1}$) | yield (t ha$^{-1}$) | yield (t ha$^{-1}$) | Index (%) |
|---|---|---|---|---|---|---|---|---|---|
| **OA** | 83.60 b | 7.64 b | 13.56 a | 28.93 a | 40.80 a | 1.28 a | 2.04 a | 3.31 a | 38.74 b |
| **DS** | 86.82 a | 8.84 a | 13.07 b | 26.33 b | 41.9 a | 1.11 b | 1.77 b | 2.88 b | 39.99 a |
| **SM** | 75.02 c | 7.83 b | 13.31 a | 23.421 c | 39.83 a | 1.06 c | 1.89 c | 2.64 c | 38.55 b |
| **CV%** | 2.71 | 2.76 | 1.26 | 2.98 | 2.89 | 3.90 | 2.50 | 2.10 | 1.0 |
| **LSD at (0.05)** | 2.90 | 0.29 | 0.22 | 1.02 | 1.54 | 0.06 | 0.06 | 0.08 | 0.47 |

DAS = Days after sowing, OA = Open area, DS = *Dalbergia sissoo,* SM = *Swietania macrophylla*

**Table 2.** Yield contributing characters of wheat as influenced by various manure and fertilizer application under two tree species.

| Treatment | Yield contributing characters of wheat (var. Kanchan) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | Spike length (cm) | Spike let spike$^{-1}$ | Grain spike$^{-1}$ | 1000-grain weight (g) | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) | Biological yield (t ha$^{-1}$) | Harvest Index (%) |
| **Poultry (P)** | 80.9 b | 8.57 a | 13.20 a | 27.36 a | 41.23 a | 1.15 ab | 1.80 b | 2.94 b | 39.34 a |
| **Chemical (C)** | 81.14 b | 7.61 c | 13.37 a | 25.18 c | 40.12 a | 1.12 b | 1.76 b | 2.89 b | 38.98 b |
| **P + C** | 83.39 a | 8.144 b | 13.37 a | 26.16 b | 40.67 a | 1.17 a | 1.84 a | 3.01 a | 38.97 b |
| **CV%** | 2.17 | 2.49 | 0.67 | 3.19 | 2.46 | 2.4 | 2.37 | 2.30 | 0.80 |
| **LSD at (0.05)** | 1.82 | 0.21 | 0.09 | 0.86 | 1.03 | 0.03 | 0.05 | 0.13 | 0.31 |

DAS = Days after sowing, P = Poultry manure, C = Chemical fertilizer

In a column, values with same latter do not differ significantly at 5% level as per DMRT