Effect of mulching and organic manure on growth and yield performance of wheat

M.A. Al-Amin¹, A.K. Hasan², M.H. Ali³, S. Nessa⁴ and M.N. Islam⁵*

¹Sample Collection Officer, Seed Certification Agency, Kushitia, BANGLADESH
²Associate Professor, Department of Agronomy, Bangladesh Agricultural University, Mymensingh, BANGLADESH
³Scientific Officer, IWMD, Bangladesh Rice Research Institute, Gazipur-1701, BANGLADESH
⁴Lecturer, Department of Zoology, Govt. Edward College, Pabna, BANGLADESH
⁵Scientific Officer, Soil Science Division, Bangladesh Rice Research Institute, Gazipur-1701, BANGLADESH
*Corresponding author’s E-mail: nazrulag@gmail.com

ABSTRACT

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh in Rabi season (dry season) of 2014 to study the effect of mulching and organic manure on growth and yield performance of wheat. Five mulching practices viz. M₁=1 irrigation at 17-21 days after sowing (DAS), M₂=2 irrigations at 17-21 and 55-60 DAS, M₃=3 irrigations at 17-21, 55-60 and 75-80 DAS, M₄=control, M₅=straw mulch (6 t ha⁻¹) and five organic manure managements viz. O₁=recommended chemical fertilizer (NPKS @ 100-23-20-16 kg ha⁻¹), O₂=poultry manure @ 6 t ha⁻¹ (100% PM), O₃=vermicompost @ 8 t ha⁻¹ (100% VC), O₄=50% chemical fertilizer+50% VC and O₅=50% chemical fertilizer+50% PM were used as experimental variables. The experiment was conducted in split-plot design with three replications. The results showed that mulching had significant influence on all attributes. The highest values of all attributes were found in straw mulch treatment. It was observed that organic manure had significant influences on all characters. The highest values of yield and yield attributes were found in O₃ (50% chemical fertilizer+50% PM) treatment. It was observed that effective tillers hill⁻¹, grain yield and straw yield were significantly affected by combined effect of mulching and organic manure. The highest values obtained from mulching and O₃ (50% chemical fertilizer+50% PM) treatment. Therefore, it can be inferred from the results of the study that highest production could be obtained from mulching and O₅ (50% chemical fertilizer+50% PM) treatment.

INTRODUCTION

Both organic and inorganic fertilizers have a potential role on the growth and development of crops. Integrated approach of fertilizer management could minimize leaching losses of nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) to a great extent (Islam, 2009; Islam et al., 2013a, 2013b, 2014 and 2016a). Mineral fertilizers of balanced doses increased the leaf area, photosynthetic productivity and yield of garlic (Borabash and Kochina, 1989). But indiscriminate use of chemical fertilizer changes the physical, chemical and biological properties of soils and may help in boosting up production of crop leaving a healthy environment at the end. Kamal et al. (2012) reported that organic fertilizer is effective in restoring the productivity of degraded soil. Islam et al. (2016b) found that rice straw with IPNS based chemical fertilizer gave better rice yield than rice yield with chemical fertilizer alone. Kumar and Chopra (2013) reported higher yield of wheat due to the effect of seasonal tillage. Kumar (2016) reported the higher agronomical performance of brinjal (Solanum melongena L.) due to the use of integrated nutrients. Moreover, Chopra et al. (2017) reported the significant effect of integrated nutrients on the agronomical growth and crop yield of tomato (Lycopersicon esculentum L.). Water is one of the most important factors that are
necessary for proper growth, balanced development and higher yield of all crops. Water deficiency affects plant
growth and grain yield (Hussain et al., 2004; Wajid et al., 2002). Grain yield was reduced to 65% in the
stressed plants compared to that of irrigated plants (Karim et al., 2000) reported that wheat crop produced
the highest grain yield by applying irrigation at all definable
growth stages. He pointed out that irrigation is an
expensive input therefore; farmer, agronomist, economist
and engineer need to know the response of yield to irri-
gation. Organic mulching is an effective way to increase
water use efficiency, increase crop yield and improve
soil health. Mulching involves putting a barrier between
soil and atmosphere, using different materials such as
crop residue, such as straw, leaves, paper, old carpet,
plastic or gravel. Mulching serves various purposes:
increases soil temperature, reduces water evaporation,
enhances fertilizer efficiency, improves solar light irradi-
tion efficiency, improves soil physical and chemical
properties and improves soil microbial activity (Van Der
Zee et al., 2017).

Wheat is one of the world’s most widely adapted food
grain crops, which supplies more than 50% of the calorie
need and nearly similar requirement of the protein need
of one third of world population. Though wheat is an
important cereal crop in Bangladesh, its average yield is
low compared to that of the advanced countries of the
world. The low yield of wheat in Bangladesh is attributa-
table to a number of reasons such as poor field manage-
ment, unavailability of quality seed, climatic hazards,
intensive cropping, imbalance fertilizer use, improper
water management and inadequate knowledge of using
proper plant densities. Considering the above facts, an
experiment was undertaken to study the effect of differ-
et types of organic manure and mulching on growth and
yield performance of wheat (BARI GOM-26).

MATERIALS AND METHODS

Experimental sites and seasons: The experimental site
was located at the 24.75°N latitude and 90.50°E longitude
at elevation of 18m above the mean sea level. The soil
belongs to the non-calcareous dark grey floodplain under
the Agro-ecological region of the Old Brahmaputra Flood-
plain, AEZ-9 (UNDP and FAO, 1998). The soil of experi-
mental plot was a medium high land with silty clay loam
having pH 6.80. Physical and chemical properties of the
soil at 0-15cm depth have been presented in Table 1. The
experimental site belongs to the subtropical area character-
ized by heavy rainfall during Kharif season (April to
September) and scanty in the Rabi season (October to
March) associated with moderately low temperature and
plenty of sunshine. The present study was carried out in
Rabi season.

Experimental design and treatments: The following
treatments were assigned in a split-plot design with three
replications.

Main plot: Mulching

- \( M_1 \) = 1 irrigation at 17-21 days after sowing (DAS)
- \( M_2 \) = 2 irrigations at 17-21 and 55-60 DAS
- \( M_3 \) = 3 irrigations at 17-21, 55-60 and 75-80 DAS
- \( M_4 \) = Control

Sub-plot: organic manure

- \( O_1 \) = recommended chemical fertilizer (NPKS @ 100-23-
16 kg ha\(^{-1}\))
- \( O_2 \) = poultry manure @ 6 t ha\(^{-1}\) (100% PM)
- \( O_3 \) = vermicompost @ 8 t ha\(^{-1}\) (100% VC)
- \( O_4 \) = 50% chemical fertilizer + 50% VC
- \( O_5 \) = 50% chemical fertilizer + 50% PM

The unit plot size was 2.5m×2m. Replication to replication
and plot to plot distance was 1.0m and 0.50m, respectively.
BARI Gom-26 (variety of wheat) was used as tested crop.
Seeds of BARI Gom-26 were sown in the well prepared
plots on 19 November 2014. Prior to sowing seeds, the
whole experimental area was divided into unit plots
maintaining the desired spacing. The unit plot was spaded
one day before planting for loosening the soils and incor-
porating the basal dose of fertilizers. The bunds around
individual plots were made firm enough to control water
movement between plots. Nitrogen, P, K and S were
applied as triple superphosphate (TSP), muriate of potash
(MoP) and gypsum, respectively. Full dose of TSP, MoP,
gypsum, organic manures and one third of urea were
applied in each plot at the time of final land preparation
and fertilizers and manures were mixed with soil thorough-
ly by spading. The rest urea were top dressed in two equal
splits, one at crown root initiation stage (20 days after
sowing) and the other at booting stage (45 days after
sowing).

Sampling and data collection: At maturity, the experi-
mental crops (wheat) were harvested plot-wise on 6 March
2015. The harvested crop of each plot was bundled sepa-
rately tagged properly and brought to the clean threshing
floor. The bundles were dried to open sunshine, threshed
and then grains were cleaned. The grain and straw yields
were taken plot-wise and converted into t ha\(^{-1}\). The grain
and straw yields were recorded after sun drying to the con-
stant weight. Plant height was measured from ground level
to the tip of the upper most spikes and was expressed in
cm. Tillers which had at least one leaf visible were count-
ed. It included both productive and non-bearing tillers. The
spikes which had at least one grain were considered as
effective tillers. The tillers which had no spikes were
regarded as non-effective tillers. Presence of any food
materials in the spikelet was considered as grain and total
number of grains presented in each spikelet was counted.
Number of grains spike\(^{-1}\) was counted taking ten spikes
from the five selected plants of each plot and the average
number was recorded. One thousand clean dried grain
(14% moisture content) were randomly counted from the
seeds obtained from the sample plants and weighted by as
electrical balance and was expressed in gram. The grain
was measured from 1 m\(^2\) area in each plot (14% moisture
content) and was converted into ton hectare\(^{-1}\). The
sun-dried straw was weighed from the same sample area
harvested for grain yield and converted into ton hectare\(^{-1}\).
Harvest index is the ratio of economic yield to biological
yield and was calculated with the following formula.
Statistical analysis: The collected data were statistically analyzed using analysis of variance technique with the help of computer package programmed MSTAT and significance of mean difference was adjudged by Duncan’s Multiple Range test (DMRT) as laid by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of mulching on chlorophyll content of wheat: The Chlorophyll content of wheat was significantly affected by mulching (Figure 1) at 35 and 55 DAT. At 35 DAT, the highest chlorophyll content (35.11) was observed in treatment M1, which was statistically identical to treatment M3 (32.33) and M2 (31.25) and the lowest chlorophyll content (29.23) was obtained from M4 treatment. At 55 DAT, the highest chlorophyll content (42.05) was observed in treatment M3 which was statistically identical to treatment M1 (40.53) and M2 (39.19) and the lowest chlorophyll content (36.23) was obtained from M4 treatment.

Effect of organic manure on chlorophyll content of wheat: The Chlorophyll content of wheat was significantly affected by of organic manure (Figure 2) at 35 and 55 DAT. At 35 DAT, the highest chlorophyll content (33.02) was observed in treatment O2, which was statistically identical to treatment O3 (32.45) and O1 (31.78) and the lowest chlorophyll content (30.01) was obtained from O3 treatment. At 55 DAT, the highest chlorophyll content (41.21) was observed in treatment O3, which was statistically identical to treatment O1 (40.29) and O2 (39.32) and the lowest chlorophyll content (37.69) was obtained from O3 treatment.

Combined effect of mulching and organic manure on chlorophyll content of wheat: The chlorophyll content of wheat was not significantly affected by combined effect of mulching and organic manure.

Effect of mulching on effective tillers hill⁻¹: Effective tillers hill⁻¹ was significantly influenced by mulching (Table 2). The highest (3.85) effective tillers hill⁻¹ were recorded in M4 treatment followed by M1 (3.14), M2 (3.11) and M3 (3.10) treatment and the lowest (2.47) effective tillers hill⁻¹ were recorded in M4 treatment.

Effect of organic manure on effective tillers hill⁻¹: Effective tillers hill⁻¹ was significantly influenced by organic manure (Table 3). The highest numbers (3.45) of effective tillers hill⁻¹ were recorded in O2 treatment followed by O1 treatment and the lowest (2.89) effective tillers hill⁻¹ was recorded in O3 treatment, which was statistically similar to O2 (3.02).

Combined effect of mulching and organic manure on effective tillers hill⁻¹: Mulching and organic manure significantly affected effective tillers hill⁻¹ (Table 4). The highest effective tillers hill⁻¹ (4.56) was observed in treatment M2O1, while the lowest effective tillers hill⁻¹ (2.00) was obtained from M4O2 treatment, which was identical to M2O2 treatment.

Effect of mulching on number of grains spike⁻¹: Number of grains spike⁻¹ was significantly influenced by mulching (Table 2). The highest number of grains spike⁻¹ (37.64) were recorded in M1 treatment, while the lowest (27.37) number of grains spike⁻¹ were recorded in M4 treatment.

Effect of organic manure on number of grains spike⁻¹: Significant variation was observed due to variations in organic manure in terms of number of grains spike⁻¹ (Table 3). It was evident that the highest number of grains spike⁻¹ (34.50) was given by the treatment O3, which was statistically similar to O4 (33.51). The lowest number of grains spike⁻¹ (29.53) was given by the treatment O2.

Combined effect of mulching and organic manure on number of grains spike⁻¹: No significant variation was observed due to the interaction between mulching and organic manure in terms of grains spike⁻¹ (Table 4).

Effect of mulching on 1000-grain weight: 1000-grain weight was significantly influenced by mulching (Table 2). The highest 1000-grain weight (46.17 g) was recorded in M3 treatment, while the lowest 1000-grain weight (38.81 g) was recorded in M4 treatment. This may occur due to the different water management among the plants.

Effect of organic manure on 1000-grain weight: 1000-grain weight was significantly influenced by organic manure (Table 3). The highest 1000-grain weight (43.32 g) was recorded in O3 treatment, which was identical to O4 (42.84 g) and O1 (42.38 g) treatment and the lowest (39.38 g) 1000-grain weight was recorded in O2 treatment. Other treatments gave the identical result. This may occur due to the different nutrient management among the plants. Similar result was obtained by Channabasanagowda et al. (2007) who reported that vermicompost @ 3.8 t per ha + poultry manure @ 2.45 t per ha recorded significantly higher plant height (86.30 cm), number of leaves (40.50) and higher number of tillers (94.60) at 90 DAS and it also recorded higher number of ear heads per meter square (160.10), 1000 seed weight (42.73 g) and seed yield (3043 kg/ha), vigour index (3223), seedling dry weight (311.27 mg) and protein content (13.41%) of wheat compared to other treatments.

Combined effect of mulching and organic manure on 1000-grain weight: There was no significant interaction effect between mulching and organic manure on the weight of 1000-grains (Table 4).

Effect of mulching on grain yield: Grain yield was significantly influenced by mulching (Table 2). The highest (4.13 t ha⁻¹) grain yield was recorded in M1 treatment, which was identical to M3 (4.10 t ha⁻¹), while the lowest (3.60 t ha⁻¹) grain yield was recorded in M4 treatment. This may occur due to the different environmental factors and cultural management practices. Same result was obtained by Huang et al. (2005) who reported that straw mulch increased wheat (Triticum aestivum L.) yields significantly during both dry (1997) and wet (1998) years. It increased biomass and grain yield of spring wheat by 37 and 52%, respectively, in 1997, and by 20 and 26%, respectively, in 1998. Straw mulch also significantly decreased evapotranspiration (P < 0.05), soil water depletion (P < 0.01), and increased water-use efficiency (P < 0.001).

Effect of organic manure on grain yield: Grain yield was...
significantly influenced by mulch (Table 3). The highest (4.21 t ha\(^{-1}\)) grain yield was recorded in O\(_2\) treatment, while the lowest (3.60 t ha\(^{-1}\)) grain yield was recorded in O\(_3\) treatment. Similar result was found by Hammad et al. (2011) who observed that the combination of green manure (GM), farm yard manure (FYM), poultry litter (PL), press mud (PM) and sewage sludge (SS) each @ of 10 t ha\(^{-1}\) gave maximum economic yield (3.65 t ha\(^{-1}\)), which was 137% more from control. PL and SS each @ 10 t ha\(^{-1}\) followed by green manuring should be used as organic manure in wheat crop. Amanullah Jan et al. (2011) also reported that the plant height, productive tillers m\(^{-2}\), grains spike\(^{-1}\), grain yield, straw yield, and harvest index of wheat were significantly higher in plots which received 30 Mg FYM ha\(^{-1}\).

**Combined effect of mulching and organic manure on grain yield:** Mulching and organic manure significantly affected Grain yield (Table 4). The highest grain yield (4.46 t ha\(^{-1}\)) was observed in treatment M\(_1\)O\(_4\), which was statistically identical to treatment M\(_2\)O\(_3\) (4.30 t ha\(^{-1}\)), M\(_3\)O\(_2\) (4.30 t ha\(^{-1}\)) and M\(_4\)O\(_1\) (4.40 t ha\(^{-1}\)). The lowest grain yield (3.20 t ha\(^{-1}\)) was obtained from M\(_4\)O\(_1\) treatment combination.

**Effect of mulching on straw yield:** Like the grain yield, straw yield of wheat was also significantly influenced by mulching (Table 2). The highest (8.10 t ha\(^{-1}\)) straw yield was recorded in M\(_1\) treatment, while the lowest (5.47 t ha\(^{-1}\)) straw yield was recorded in M\(_4\) treatment. Other treatments (M\(_1\), M\(_2\) and M\(_3\)) hold the statistically second highest position. This may occur due to the different environmental factors and cultural management practices.

**Effect of organic manure on straw yield:** Straw yield was significantly influenced by organic manure (Table 3). The highest (7.35 t ha\(^{-1}\)) straw yield was recorded in O\(_3\) treatment and the lowest (6.66 t ha\(^{-1}\)) straw yield was observed in O\(_1\) treatment.

**Combined effect of mulching and organic manure on straw yield:** Mulching and organic manure significantly affected straw yield (Table 4). The highest straw yield (8.43 t ha\(^{-1}\)) was observed in treatment combination of M\(_1\)O\(_4\), which was statistically identical to treatments M\(_2\)O\(_3\) (8.34 t ha\(^{-1}\)) and M\(_3\)O\(_2\) (8.31 t ha\(^{-1}\)). The lowest straw yield (5.26 t ha\(^{-1}\)) was obtained from M\(_4\)O\(_1\) and M\(_3\)O\(_2\) treatment combination, which was similar to M\(_4\)O\(_1\) and M\(_2\)O\(_3\) treatment combinations.

**Effect of mulching on harvest index:** Different levels of mulching practices exerted significance influence on harvest index (Table 2). The highest harvest index (39.69%) was recorded in M\(_4\) treatment. On the other hand, the lowest value (33.76%) was found in M\(_3\) treatment, which was identical to M\(_1\) (33.95%).

**Effect of organic manure on harvest index:** Harvest index was significantly influenced by organic manure (Table 3). The highest (36.42%) harvest index was recorded in O\(_3\) treatment, which was statistically similar to O\(_4\) (36.09%) and O\(_1\) (35.72%) treatment and the lowest (35.09%) harvest index was recorded in O\(_1\) treatment, which was statistically similar to O\(_3\) and O\(_4\).

**Combined effect of mulching and organic manure on harvest index:** There was no significant interaction effect between mulching and organic manure on the harvest index (Table 4). Davari et al. (2012) applied the farmyard manure (FYM), vermicompost (VC), FYM + rice residue (RR), VC + RR, FYM + RR + biofertilisers (B), and VC + RR + B. FYM and VC on nitrogen basis (60 kg ha\(^{-1}\)), whereas RR was applied at 6 t ha\(^{-1}\). The combinations of FYM + RR + B and VC + RR + B resulted in the highest increased growth and yield attributing characters of wheat and increased grain yield of wheat over the control by 81% and 89% in two successive years.

**Table 1.** Physical and chemical properties of initial soil (at 0-15cm depth) used for the cultivation of wheat.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Physical properties</td>
<td>Silty loam</td>
</tr>
<tr>
<td>Textural class</td>
<td>Silty loam</td>
</tr>
<tr>
<td>Sand (%)</td>
<td>15.46</td>
</tr>
<tr>
<td>Silt (%)</td>
<td>57.72</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>24.85</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>4.08</td>
</tr>
<tr>
<td>Field capacity (%)</td>
<td>27.90</td>
</tr>
<tr>
<td>Water holding capacity (%)</td>
<td>57.2</td>
</tr>
<tr>
<td>Bulk density (g cm(^{-3}))</td>
<td>1.47</td>
</tr>
<tr>
<td>Partial density (g cm(^{-3}))</td>
<td>2.71</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>45.76</td>
</tr>
<tr>
<td>Hydraulic conductivity (cm hr(^{-1}))</td>
<td>0.68</td>
</tr>
<tr>
<td>B. Chemical properties</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>6.8</td>
</tr>
<tr>
<td>Total N (%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Organic carbon</td>
<td>0.68</td>
</tr>
<tr>
<td>Available P (mg kg(^{-1}))</td>
<td>16.72</td>
</tr>
<tr>
<td>Available K (cmol kg(^{-1}))</td>
<td>0.12</td>
</tr>
</tbody>
</table>
### Table 2. Effect of mulching on yield and yield contributing characters of wheat.

<table>
<thead>
<tr>
<th>Mulching</th>
<th>Effective tillers hill$^{-1}$</th>
<th>No. of grains spike$^{-1}$</th>
<th>1000-grain weight (g)</th>
<th>Grain yield (t ha$^{-1}$)</th>
<th>Straw yield (t ha$^{-1}$)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M₁</td>
<td>3.10b</td>
<td>30.84c</td>
<td>42.29b</td>
<td>3.68c</td>
<td>7.16b</td>
<td>33.95c</td>
</tr>
<tr>
<td>M₂</td>
<td>3.11b</td>
<td>32.85b</td>
<td>41.41b</td>
<td>4.02b</td>
<td>7.17b</td>
<td>35.92b</td>
</tr>
<tr>
<td>M₃</td>
<td>3.15b</td>
<td>32.69b</td>
<td>41.47b</td>
<td>4.10a</td>
<td>7.25b</td>
<td>36.12b</td>
</tr>
<tr>
<td>M₄</td>
<td>2.47c</td>
<td>27.37d</td>
<td>38.81c</td>
<td>3.60d</td>
<td>5.47c</td>
<td>39.69a</td>
</tr>
<tr>
<td>M₅</td>
<td>3.85a</td>
<td>37.64a</td>
<td>46.17a</td>
<td>4.13a</td>
<td>8.10a</td>
<td>33.76c</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.48</td>
<td>8.90</td>
<td>4.86</td>
<td>2.48</td>
<td>2.06</td>
<td>3.82</td>
</tr>
</tbody>
</table>

Mean values in a column having the similar letter do not differ significantly whereas mean values in having the dissimilar letter differ significantly as per DMRT; M₁ = 1 Irrigation at 17-21 days after sowing (DAS); M₂ = 2 irrigations at 17-21 and 55-60 DAS; M₃ = 3 irrigations at 17-21, 55-60 and 75-80 DAS; M₄ = Control; M₅ = Straw mulch @ 6 t ha$^{-1}$.

### Table 3. Effect of organic manure on yield and yield contributing characters of wheat.

<table>
<thead>
<tr>
<th>Organic manure</th>
<th>Effective tillers hill$^{-1}$</th>
<th>No. of grains spike$^{-1}$</th>
<th>1000-grain weight (g)</th>
<th>Grain yield (t ha$^{-1}$)</th>
<th>Straw yield (t ha$^{-1}$)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₁</td>
<td>3.06c</td>
<td>32.53bc</td>
<td>42.38b</td>
<td>3.94c</td>
<td>7.09b</td>
<td>35.72ab</td>
</tr>
<tr>
<td>O₂</td>
<td>3.02cd</td>
<td>31.31c</td>
<td>41.63b</td>
<td>3.72d</td>
<td>6.85c</td>
<td>35.19b</td>
</tr>
<tr>
<td>O₃</td>
<td>2.89d</td>
<td>29.53d</td>
<td>39.98c</td>
<td>3.60c</td>
<td>6.66d</td>
<td>35.09b</td>
</tr>
<tr>
<td>O₄</td>
<td>3.25b</td>
<td>33.51ab</td>
<td>42.84ab</td>
<td>4.06b</td>
<td>7.19b</td>
<td>36.09ab</td>
</tr>
<tr>
<td>O₅</td>
<td>3.45a</td>
<td>34.50a</td>
<td>43.32a</td>
<td>4.21a</td>
<td>7.35a</td>
<td>36.42a</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.48</td>
<td>8.90</td>
<td>4.86</td>
<td>2.48</td>
<td>2.06</td>
<td>3.82</td>
</tr>
</tbody>
</table>

Mean values in a column having the similar letter do not differ significantly whereas mean values in having the dissimilar letter differ significantly as per DMRT; O₁ = recommended chemical fertilizer (NPKS @ 100-23-20-16 kg ha$^{-1}$); O₂ = poultry manure @ 6 t ha$^{-1}$ (100% PM); O₃ = vermicompost @ 8 t ha$^{-1}$ (100% VC); O₄ = 50% chemical fertilizer + 50% VC; O₅ = 50% chemical fertilizer + 50% PM.

### Table 4. Combined effect of mulching and organic manure on yield and yield contributing characters of wheat.

<table>
<thead>
<tr>
<th>Mulching × Organic manure</th>
<th>Effective tillers hill$^{-1}$</th>
<th>No. of grains spike$^{-1}$</th>
<th>1000-grain weight (g)</th>
<th>Grain yield (t ha$^{-1}$)</th>
<th>Straw yield (t ha$^{-1}$)</th>
<th>Harvest index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₁</td>
<td>3.00efg</td>
<td>30.53</td>
<td>42.63</td>
<td>3.80fg</td>
<td>7.30defg</td>
<td>34.22</td>
</tr>
<tr>
<td>O₂</td>
<td>3.00efg</td>
<td>29.97</td>
<td>41.30</td>
<td>3.50h</td>
<td>6.90hi</td>
<td>33.66</td>
</tr>
<tr>
<td>M₁</td>
<td>3.00efg</td>
<td>28.84</td>
<td>40.43</td>
<td>3.40hi</td>
<td>6.67i</td>
<td>33.75</td>
</tr>
<tr>
<td>O₁</td>
<td>3.16de</td>
<td>31.77</td>
<td>43.37</td>
<td>3.80fg</td>
<td>7.40cdef</td>
<td>33.93</td>
</tr>
<tr>
<td>O₂</td>
<td>3.33cde</td>
<td>33.10</td>
<td>43.73</td>
<td>3.90ef</td>
<td>7.50cd</td>
<td>34.20</td>
</tr>
<tr>
<td>O₃</td>
<td>3.13def</td>
<td>33.87</td>
<td>41.97</td>
<td>4.00de</td>
<td>7.11fg</td>
<td>36.58</td>
</tr>
<tr>
<td>O₄</td>
<td>3.00efg</td>
<td>30.60</td>
<td>41.90</td>
<td>3.80fg</td>
<td>7.09gh</td>
<td>36.06</td>
</tr>
<tr>
<td>M₂</td>
<td>3.27fg</td>
<td>30.47</td>
<td>38.49</td>
<td>3.80fg</td>
<td>6.90hi</td>
<td>35.50</td>
</tr>
<tr>
<td>O₁</td>
<td>3.17de</td>
<td>34.37</td>
<td>42.17</td>
<td>4.20bc</td>
<td>7.34defg</td>
<td>36.38</td>
</tr>
<tr>
<td>O₂</td>
<td>3.47cd</td>
<td>34.97</td>
<td>42.52</td>
<td>4.30ab</td>
<td>7.37cddef</td>
<td>36.83</td>
</tr>
<tr>
<td>O₃</td>
<td>3.16de</td>
<td>32.67</td>
<td>42.10</td>
<td>4.10cd</td>
<td>7.28deg</td>
<td>36.01</td>
</tr>
<tr>
<td>O₄</td>
<td>3.16de</td>
<td>32.00</td>
<td>40.67</td>
<td>4.00de</td>
<td>7.17ef</td>
<td>35.79</td>
</tr>
<tr>
<td>M₃</td>
<td>3.00efg</td>
<td>31.20</td>
<td>39.12</td>
<td>3.70g</td>
<td>6.86hi</td>
<td>36.23</td>
</tr>
<tr>
<td>O₁</td>
<td>3.16de</td>
<td>33.43</td>
<td>42.40</td>
<td>4.30ab</td>
<td>7.39cde</td>
<td>36.78</td>
</tr>
<tr>
<td>O₂</td>
<td>3.23de</td>
<td>34.17</td>
<td>42.84</td>
<td>4.40a</td>
<td>7.53cd</td>
<td>37.90</td>
</tr>
<tr>
<td>O₃</td>
<td>2.67gh</td>
<td>28.43</td>
<td>39.07</td>
<td>3.70g</td>
<td>5.44k</td>
<td>33.45</td>
</tr>
<tr>
<td>O₄</td>
<td>2.33hi</td>
<td>27.37</td>
<td>38.83</td>
<td>3.30ij</td>
<td>5.26k</td>
<td>34.52</td>
</tr>
<tr>
<td>M₄</td>
<td>2.00i</td>
<td>23.20</td>
<td>37.50</td>
<td>3.20j</td>
<td>5.26k</td>
<td>32.85</td>
</tr>
<tr>
<td>O₁</td>
<td>2.66gh</td>
<td>28.50</td>
<td>39.10</td>
<td>3.80fg</td>
<td>5.48k</td>
<td>33.96</td>
</tr>
<tr>
<td>O₂</td>
<td>2.66gh</td>
<td>29.37</td>
<td>39.57</td>
<td>4.00de</td>
<td>5.89j</td>
<td>33.42</td>
</tr>
<tr>
<td>O₃</td>
<td>3.33cde</td>
<td>37.23</td>
<td>45.93</td>
<td>4.10cd</td>
<td>8.31a</td>
<td>37.50</td>
</tr>
<tr>
<td>O₄</td>
<td>3.60e</td>
<td>36.63</td>
<td>45.47</td>
<td>4.00de</td>
<td>7.83b</td>
<td>36.68</td>
</tr>
<tr>
<td>M₅</td>
<td>3.66e</td>
<td>33.93</td>
<td>44.36</td>
<td>3.90ef</td>
<td>7.59bc</td>
<td>36.77</td>
</tr>
<tr>
<td>O₁</td>
<td>4.10b</td>
<td>39.50</td>
<td>47.17</td>
<td>4.20bc</td>
<td>8.34a</td>
<td>39.49</td>
</tr>
<tr>
<td>O₂</td>
<td>4.56a</td>
<td>40.90</td>
<td>47.93</td>
<td>4.46a</td>
<td>8.43a</td>
<td>40.59</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.48</td>
<td>8.90</td>
<td>4.86</td>
<td>2.48</td>
<td>2.06</td>
<td>3.82</td>
</tr>
</tbody>
</table>

Mean values in a column having the similar letter do not differ significantly whereas mean values in having the dissimilar letter differ significantly as per DMRT; M₁ = 1 Irrigation at 17-21 days after sowing (DAS); M₂ = 2 irrigations at 17-21 and 55-60 DAS; M₃ = 3 irrigations at 17-21, 55-60 and 75-80 DAS; M₄ = Control; M₅ = Straw mulch @ 6 t ha$^{-1}$; O₁ = recommended chemical fertilizer (NPKS @ 100-23-20-16 kg ha$^{-1}$); O₂ = poultry manure @ 6 t ha$^{-1}$ (100% PM); O₃ = vermicompost @ 8 t ha$^{-1}$ (100% VC); O₄ = 50% chemical fertilizer + 50% VC; O₅ = 50% chemical fertilizer + 50% PM.
Conclusions

Considering the findings it may be concluded that significant variation existed due to the effects of mulching practices and different organic manure management levels in respect to chlorophyll content, effective tillers hill\(^{-1}\), number of grains spike\(^{-1}\), 1000-grain weight, grain yield, straw yield and harvest index; those were higher in mulching treatment (M\(_4\)), whereas those parameters gradually declined with the decrease in moisture level. Poultry manure with chemical fertilizers (O\(_2\)) in combination of mulching (M\(_4\)) produced the highest grain and straw yield of wheat and it took superior position in all other parameters studied including yield components. Therefore, it may be concluded that poultry manure with chemical fertilizers in combination with mulching be used successfully in an integrated way for the successful cultivation of wheat.

Open Access: This is open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and the source are credited.

REFERENCES


