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# Performance of Different Organic Fertilizers on Wheat Yield at Tikapur, Kailali

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**Abstract**

A field experiment was carried out to investigate the effect of different organic materials alone and in combination on the yield of wheat variety Aditya during November 2021- April 2022 in the Agronomy Field of Far Western University, Tikapur, Kailali. The study was carried out with 7 treatments viz. Farmyard manure (FYM), Vermicompost (V), Trichoderma viridae (T), FYM + V (FV), FYM + T(FT), FYM + V + T(FVT) and Control (without any organic matter) and laid out in Randomized Complete Block design with three replications. Chemical fertilizers were not used in the study. The result showed significantly higher number of effective tillers, thousand grain weight and grain yield in the treatment FVT as compared to other organic fertilizers and their combinations. But plant height was found to be the highest in FT followed by FYM. An increase of 16% and 36.29% grain yield was recorded in FVT over FT and the control respectively. Wheat grain yield from FV (2.28 t/ha) and FT (2.08 t/ha) were statistically greater than FYM or Vermicompost when applied alone. Application of Vermicompost and VT had relatively lower influence on yield attributes and yield as compared to FYM and FT. However, all the treatments were superior over the control in terms of all the yield and yield attributing traits.

***Keywords*:** Farmyard manure, trichoderma, vermicompost, growth

## Introduction

Wheat is one of the major food crops after rice and maize occupy a special place in the Nepalese diet as well as in the cropping system of Nepal. This crop contributed 5.67 % to agricultural GDP after rice (13.60 %), vegetable (13.43 %), maize (7.60 %), and potato (6.30 %) in the fiscal year 2021/22 (Ministry of Agriculture and Livestock Development [MoALD], 2023). Despite its contribution, the area under wheat has decreased by 12.7% as compared to the previous census.

Among different Provinces cultivating wheat crops in Nepal, Sudurpaschim Province occupies 20.48 % of the land area under wheat after Madhesh (25.53 %) and Lumbini (22.31 %) (MoALD, 2023). Kailali district considered as a wheat super zone by the Government of Nepal has the highest productivity of 3.58 t/ha among different districts in Sudurpaschim Province. However, the average productivity of wheat in Sudurpaschim province is only 2.56 t/ha which is the lowest among all the provinces cultivating wheat (MoALD, 2023).

Different efforts are being carried out by the Government of Nepal to improve the production and productivity of wheat crops. As a result, 27% of land holdings use improved seeds, 5.9% use hybrid seeds of wheat whereas 28% of the land uses pesticides, and 59% use chemical fertilizers as a source of nutrients for improving the production of wheat in Nepal (National Statistics Office 2023). With the increasing use of modern technologies like improved seed, chemical fertilizers, and pesticides, the production and productivity of wheat have improved slightly but not enough to meet the current demands of the country. Due to limited supply of chemical fertilizers during the growing season and practice of burning crop residues after harvest, most of the farmers do not apply appropriate amount of nutrients in the soil as required. Besides, the application of organic manures is very low in the rice-wheat cropping system, as evidenced in digital soil map, which shows 1.6-2.2 % organic matter in the soil of the Kailali district. Gairhe et al. (2021) have also reported that almost 60% of soil in Nepal has low organic matter content. This indicates that current practices of nutrient management especially the application of organic manures and fertilizers are not sufficient to maintain soil productivity for sustainable food production in Nepal.

To improve soil fertility and sustain the long-term productivity of the rice-wheat cropping system, it is essential for farmers to work strategically towards integrated and efficient nutrient management. This includes continuous use of high quantities of organic manures along with bio-fertilizers and appropriate amount of chemical fertilizers. A study report revealed an increase in grain yield of both wheat and maize due to increased soil carbon content and soil microbial activities when farmyard manures were applied along with chemical fertilizers in the long run (Kaur et al., 2008). Among the various sources of organic manures viz. animal wastes, Vermicompost, compost, green manures, crop residues, bone meal, fish meals, humic acid, and bio-fertilizers used in Nepal (Acharya et al., 2020), FYM and poultry manures are commonly applied in the wheat crop at Kailali district. Nowadays, bio-fertilizers are being used as a cheaper input requiring less cost for transportation and application for improving yields of major food crops in the world. The use of Trichoderma for increasing resistance to fungal diseases, releasing growth-promoting

hormones (Pandey et al., 2019), and stimulating the growth of roots to favor during drought episodes in cereal crops has been recognized (Modrzewska et al., 2022), which can contribute greatly to the yield of wheat. Similarly, with the encouragement to manufacture organic fertilizers by the Government of Nepal (Ministry of Agriculture Development [MoAD], 2015), vermicompost is being promoted in many districts of Nepal by the local government as one of the best alternatives to amend soil. To improve the yields of wheat through cheaper and easily available organic fertilizers, this study aims to find the effect of different organic fertilizers and their combinations on wheat yield.

## Methods and Procedures

### Experimental Site

The study was carried out in the Agronomy Farm, Department of Agriculture, Far Western University, Tikapur, Kailali, Nepal during the month of November 2021 to April 2022. Geographically, it is located at an elevation of 161 meters above mean sea level on the latitude of 28°32'26" N and longitude of 81°7'26" E. Kailali district lies in Sudurpaschim Province of Nepal.

### Soil and Weather

The experiment site had fluvial non-calcareous soil with the pH value of 7.32. The soil was sandy loam with 40.4% sand and 14.98% clay. The organic matter content in the soil was very low with the value of 1.85%. The soil had 0.09% nitrogen with 75.67 kg/ha and 181.54 kg/ha phosphorous and potassium respectively (NARC, 2023). During the experiment period, the temperature ranged from 10.73$^0$C to 29.37$^0$C with the lowest during the month of January. The average temperature during the crop-standing period was 17.91$^0$C whereas relative humidity ranged from 23.44% to 88.75% with the highest on February and the lowest during April. Site received a total precipitation of 154.22 mm with an average of 0.85 mm during the field experiment. Likewise, the crop received rainfall of 26.46 mm on February 4$^{th}$, which was the highest during the growth period (NASA, 2023).

### Experimental Setup

The experiment was carried out in Randomized Complete Block Design (RCBD) with seven treatments consisting of organic fertilizers and their combination on yield and yield attributes of wheat crop as shown in Table 1.

**Table 1**

*Treatment Details*

| Treatments | Formulation |
|---|---|
| Farmyard manure (FYM) | 6 ton/ha |

| | |
|---|---|
| Vermicompost (V) | 2.47 ton/ha |
| Farmyard manure + Vermicompost (FV) | 6 ton/ha + 2.47 ton/ha |
| Farmyard manure + Trichoderma (FT) | 6 ton/ha + 2ml per kg FYM |
| Vermicompost + Trichoderma (VT) | 2.47 ton/ha + 2ml per kg Vermicompost |
| Farmyard+Vermicompost+Trichoderma (FVT) | 6 ton/ha + 2.47 ton/ha + 2ml per kg FYM |
| Control | Without any organic fertilizers |

Each treatment was replicated thrice. For this, the field was laid out in 247 square meter (19 m × 13 m) area. Altogether there were 21 plots, each plot receiving a treatment was $6m^2$. The distance between each replication was 1 meter whereas that between each treatment was 50cm. For this, the field was irrigated and ploughed with power tiller. The field was laid out one day before to sowing and harrowing was done on 27th November. For making up the treatments, locally available FYM commonly used by the farmers was collected from nearby farm and applied @6ton/ha, as recommended by Government of Nepal, whereas Vermicompost collected from campus farm was applied @2.47 t/ha. Similarly, Trichoderma viridae from Agricare Nepal Pvt. Ltd., Chitwan, Nepal with $10^9$ cfu/ml conidial suspensions was used @2ml/kg of organic manures (FYM or Vermicompost). After mixing Trichoderma for the treatments FT, VT and FVT, they were left in shade for 48 hours to facilitate mycelial growth in corresponding organic manure. The treatments were incorporated in the relevant plots as per the treatments before sowing wheat on 28 November.

**Seed and Sowing**

The variety of wheat crop used in this research was Aaditya. Seed was sown on 28th November, 2021. Continuous line sowing was done in rows made 25 cm apart. Thinning was done to maintain 10cm distance between each plant.

**Cultural Practices**

Weeding was done 25 and 50 days after sowing manually and was irrigated twice immediately after weeding. Chemical fertilizers, insecticides, fungicides, herbicides were not used, keeping in line with the organic title of the experiment. Wheat was harvested on April 4, 2022 i.e., 127 days after sowing.

**Data Collection**

The data on plant height (cm), spike bearing tillers, grains per spike, thousand grain weight, straw yield, grain yield were recorded at the time of harvest. The data were taken from randomly selected 10 plants for plant height, spike bearing

tillers and grains per spike whereas grain yield and straw yield were recorded from the whole plot. The data collected was tabulated and averaged for each parameter in excel sheet. Analysis of variance table was prepared for each parameters and treatments were compared using least significant difference test at 5% level of significance using the software R-studio version 4.2.1.

## Results and Discussion

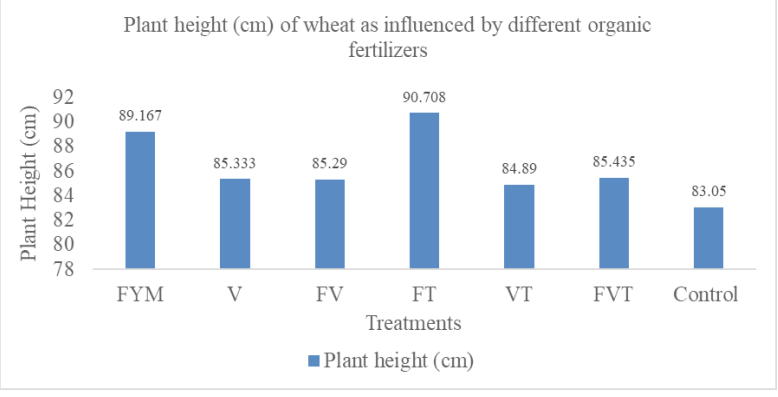
Results obtained after analysis for different parameters viz. plant height, effective tiller number, grains per spike, thousand grain weight, straw yield and grain yield under different treatments are described below.

### Plant Height

Average plant height ranged from 83.05cm to 90.71cm with the tallest obtained from the treatment (FT) while plant heights of all the treatments were greater than the un amended control which stands the lowest. Significant differences in plant height was observed among different organic materials and their combinations, as shown in figure 1. The plant height was found to be the highest in the treatment FT which was 90.71cm followed by FYM with the value 89.17cm. This increase in plant height in treatment FT was 8.44% over control, which is in line with a research study on Trichoderma (Mahato et al., 2018). After FT, plant height was also good Ramin plots treated with FYM with an increase of 6.86% in height over control which is in line with a study which also revealed that application of FYM increased the growth parameters like dry matter production, leaf area index, leaf area duration, net assimilation rate and relative growth rate of wheat (Ram et al., 2011). The treatments FTV, V and FV showed slight difference in plant height,

**Figure 1**

*Plant Height of Wheat under Different Organic Fertilizers*



numerically but were statistically at par in expressing plant height. It implies that vermicompost supported in increasing plant height. This aligns with a study which showed 13.29% increase in plant height in vermicompost applied plots over un amended control (Cirka et al., 2022). Among these, VT had a slight increase in plant height by 2.167% over control. The plant height was significantly the smallest i.e., 83.05cm in the treatment control at 5% level of significance.

**Effective Tiller Count**

Number of effective tillers was significant ($p<0.05$) with 101.33 $m^{-2}$ in FV, which was also the highest among the treatments and showed a 20.33% increase over control, as observed in table 1. This increase was slightly higher than FYM (16.64%) which valued to 97.167 $m^{-2}$. The observed increase in number of effective tillers due to FYM was in line with the study on wheat which showed that application of FYM significantly increased effective tillers $plant^{-1}$ of wheat (Ram et al., 2011). This was also supported by another study which stated as organic sources offer more balanced nutrition to the plants, especially micro nutrients which could positively affect number of tiller in plants (Mitnala, 2018). Interestingly, the treatment containing Trichoderma could not perform better in increasing tiller number as compared to farmyard manure. The treatments V, FT and VT were statistically at par in yielding the number of effective tillers $m^{-2}$ but were significantly greater than control. Although Vermicompost significantly stimulates the growth of cereals like paddy (Bhattacharjee et al., 2001) but addition of relatively less amount of Vermicompost might have failed to release nutrients sufficient enough to generate large number of effective tillers. The combination of Trichoderma with organic manures performed quite satisfactorily with increase over control which is in line with the findings from a research which revealed that FYM when combined with Trichoderma has promoted the tiller number over control (Mahato et al., 2018). The treatment control yielded the lowest number of effective tillers i.e., only 81 tillers $m^{-2}$.

**Table 1**

*Yield and Yield Attributing Traits of Wheat under Different Organic Fertilizers*

| Treatment | Effective tiller (no.) | Grains per spike (no.) | 1000 grain weight | Straw yield (t/ha) | Grain Yield (t/ha) |
|---|---|---|---|---|---|
| Farmyard manure (FYM) | 97.17a | 51.00b | 54.00abc | 3.01a | 2.03bc |
| Vermicompost (V) | 82.67bc | 50.66b | 53.67bc | 2.61ab | 2.01bc |

| | | | | | |
|---|---|---|---|---|---|
| Farmyard+Vermicompost (FV) | 101.33a | 51.33b | 58.67ab | 3.06a | 2.28ab |
| Farmyard+Trichoderma (FT) | 85.00bc | 49.00b | 60.33a | 2.82a | 2.08ab |
| Vermicompost+Trichoderma (VT) | 84.33bc | 47.00b | 58.67ab | 2.48ab | 1.97bc |
| Farmyard+Vermicompost+Trichoderma (FVT) | 92.67ab | 59.66a | 60.00a | 3.12a | 2.48a |
| Control | 81.00c | 45.33b | 50.67c | 2.17b | 1.58c |
| F-value | * | * | * | * | * |
| C.V. | 7.09 | 7.82 | 6.37 | 13.12 | 12.25 |
| $LSD_{0.05}$ | 11.24 | 7.04 | 6.41 | 0.64 | 0.45 |

* significant at 5% level of significance, treatment means followed by the same letter (s) within column are non–significantly different among each other at 5% level of significance. CV= Coefficient of variation

**Grains Per Spike**

The number of grains spike$^{-1}$ ranged from 45 to 59.66 with the lowest in control and the highest in the treatment FVT. Significantly highest number of grains per spike i.e. 59.66 was observed when all organic materials were combined together i.e., FVT at 5% level of significance. It valued 59.66 in the plots treated with FVT followed by FYM and FV which might be due to increase in all other growth parameters contributing the number of grains. All the treatments FV, F, V, FT, VT and control were statistically at par with control in yielding number of grains spike$^{-1}$ though numerically it ranged from 51.33 to 45.33 in FV and control respectively. FVT treated plot showed 24% increase followed by 11.6% in FV, 11% in F and 7 % in FT over control respectively. The result revealed only 10.5% increase in Vermicompost over the control in yielding number of grains per spike This result is in line with the findings by Devi et al. (2011), who reported 29.57% and 36.76% increase in wheat grains per spike in Vermicompost and (Vermicompost + PSB) over the control. In contradictory to this findings, an increase in 31.8% grains per spike was reported when FYM was applied over the control (Aatif et al., 2017).

**Thousand Grain Weight**

The treatments FT and FVT were statistically at par in yielding thousand grain weight, which were also the highest among the treatments recorded. The treatment FYM+Trichoderma showed an increase of 13.25% over control, slightly higher to FYM+Vermicompost+Trichoderma that is 12.77%. The treatments

FYM+Vermicompost and Vermicompost+Trichoderma didn't have much significant difference which were 11.04% and 10.79% increase over control respectively. FYM treated with Trichoderma showed the highest thousand-grain weight than FYM treated with vermicompost or Vermicompost treated with Trichoderma. FYM+Vermicompost had yielded quite good thousand-grain weight which is in conformity with a study (Ali et al., 2020). Similarly, Vermicompost when combined with Trichoderma performed significantly better than when applied alone. Positive effect of Trichoderma on size and grain yield has also been reported by (Mahato et al., 2018). 21% increase in 1000 grain weight by Trichoderma harzianum over control has been reported by Hasan et al. (2012) due to increase in vegetative growth of wheat. Similarly, FV and VT were statistically at par in yielding 1000 grain weight. It implies that performance of farmyard manure and Trichoderma were almost similar in increasing the weight of wheat grains, when combined with Vermicompost. In line with our finding, a study also reported significant increase in all the growth parameters and yield attributes except test weight when Vermicompost was applied in wheat in the first year (Davari et al., 2012).

**Straw Yield**

Significant differences in straw yield were observed in the plots applied with different organic materials over the control. The straw yield ranged from 3.12 to 2.17 t ha-1 with the highest from treatment FVT and the lowest from the control. Straw yield from most of the treatments viz. FYM, FV, FT, FVT were statistically at par but was greater than VT and V. Straw yield from FV showed an increase of 30.44% over control followed by FYM and FT with 27.9%, 23.04% increase over control respectively. In line with our findings, an increase in 30.4% straw yield from FYM over control was reported in a study (Shah & Ahmad, 2006). Straw obtained from V and VT were almost equal with an increase of 16% and 12.5% than control but was the lowest among all other organic fertilizers and their combinations. But in contradictory to our findings, a significant increase in wheat green mass compared to control was reported in a study where vermi-extract was used singly or in combination with Trichoderma (Bubina & Tereshchenko, 2011). All the treatments containing FYM yielded greater amount of straw than without it.

**Grain Yield (t/ha)**

Significantly highest grain yield was observed in the treatment FVT which was 36.29% increase over the control and 8% more than FV and 16 % more than FT. The highest grain yield (t/ha) in these treatments is due to the highest number of grains per spike, bold grains (as evidenced from 1000 grain weight) and the biomass. Combination of organic matter in soil may have supported for soil micro

environment leading to increased foliage, biomass, root growth leading to increased grain yield (Yang et al., 2020). Similar improvement in grain yield due to increased organic manures was reported in a study (Wahid et., al 1998) and 29-36% increase in wheat grain yield due to use of Trichoderma harzanium were reported in Jaipur and Kota (Sharma et al., 2012). An increase in 22.16 % grain yield was observed in the plots applied with FYM over the control. Similar finding was reported by Singh and Patra (2017) who also reported an increase of wheat yield by 19% in FYM as compared to control, though non-significant. Grain yield obtained from FV and FT were statistically at par with the values of 2.28 tha-1 and 2.08 tha-1 respectively. These results revealed that increase in grain yield could be obtained when FYM is supplemented with other organic fertilizers, whether it be Trichoderma or Vermicompost or the combination of both. Our results corroborate with the findings by Davari et al. (2012) who found that the combination of FYM + Rice residue + biofertilisers increased the rice yield by more than 80% as compared to control. Among different organic materials used in this experiment VT and V provided significantly lower grain yield but performed better than control, which might be due to lesser number of effective tillers and thousand grain weight. Our finding is in line with the findings by Roberts et al. (2007) who also reported non-significant increase in wheat yield when Vermicompost was applied as compared to other organic manures. The treatments V and VT yielded 18.95% and 19.7% more grains than control, revealing that organic matter content supports in increasing the yield of grains. Application of Trichoderma viridae yielded relatively higher when combined with FYM or Vermicompost as compared to when applied single. Similar finding has been reported in rice where increase in grain yield was observed when FYM or Vermicompost were accompanied by biofertilisers and wheat residue (Davari & Sharma, 2010). In contradictory to our findings, a 10-fold increase in yield for tomato plants was observed when water-extractable fraction of Vermicomposts enriched with T. virens was applied when compared to the control (Dos Santos Pereira et al., 2021).

## Conclusion

Combination of one or more organic materials increased the yield of wheat significantly, under organic condition, but is not sufficient enough to achieve the potential yield of the variety. FVT proved to be superior in most of the yield attributes and yield among all the organic fertilizer and their combination. However, wheat yields were comparable with FV and FT but reduced grain yields were obtained from the treatments FYM, Vermicompost, and VT, indicating that 'FYM' if supplemented with other organic fertilizers though at small amount could statistically improve the grain yield. Similarly, Trichoderma when combined with FYM showed

significantly better effect in terms of yield attributing traits and yield as compared to its combination with vermicompost or when Vermicompost applied alone. So, application of Trichoderma with different organic manures could be one of the best alternatives to improve grain yield to some extent in wheat at different locations in far western region. At the same time, this study suggests similar field experiments at different locations but with recommended dose of chemical fertilizers for broader applicability of this research.

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