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Research Article

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# Effect of Mulching Materials on Yield-Attributing Parameters and Bunch Yield of Cavendish Banana (*Musa acuminata* cv. 'Grand Naine')

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## Abstract

A field experiment was conducted at DoAR, Khajura, Banke, Nepal to find the effect of different types of mulching materials on yield and yield-attributing parameters of 'Grand Naine' banana for the two cropping periods, 2020-2021 and 2021-2022. The field was laid out in RCBD having seven treatments replicated three times. Tissue culture plants were planted at 2×2 m spacing in 16 $m^2$ plots, where there were four plants per plot. FYM and chemical fertilizers were applied @ 20 kg and 250:250:350 g NPK per plant per crop cycle along with 0.5% $ZnSO_4$, 0.2% $FeSO_4$, 0.2% $CuSO_4$, and 0.1% Borax was applied as a foliar spray at 3rd, 5th and 7th months after planting. Among the different types of mulches, the bunch length (120.60 cm), distance between first and final hand of bunch (75.50 cm), number of hands (10.00), weight of second hand (3.13 kg), finger length (22.57 cm), girth (13.75 cm), and weight (171.90 g), bunch weight (24.30 kg), and yield (60.76 $tha^{-1}$) were recorded the highest with banana leaves mulch which was closely followed by black plastic mulch. The results of the experiment revealed that as compared to un-mulched plots, mulched plots produced the better yield-attributing parameters and yield of banana. Therefore, banana growers are recommended to use banana leaves as a mulching materials for higher yield. As an alternative, black plastic mulch can used for effective moisture retention and weed control, minimizing soil erosion and higher bunch yield.

**Keywords :** Grand Naine, mulching materials, bunch length, finger length, bunch yield

## Introduction:

Banana (*Musa* spp.) is an ancient fruit crop cultivated by humans and ranks as the fourth most important crop after rice, wheat, and maize in the world. It is cultivated on 5,336,862 ha of land, producing 124,978,578 t of bananas, with a productivity of 23.42 t $ha^{-1}$ (FAO, 2022). In Nepal, banana is mostly cultivated as a tropical fruit crop; however, some plantains are found to be grown in the mid-hill region of the country. In the terai region, Cavendish bananas are predominantly cultivated, although plantains

like the 'Malbhog' banana are also grown in drier areas of the lower altitudes of Nepal. In Nepal, banana is cultivated on 21,413 ha, having a total production of 339,435 t and 15.85 t $ha^{-1}$ yield (MoALD, 2023). The productivity of banana in Nepal is far lower than the global (23.42 t $ha^{-1}$) and India's average (34.53 t $ha^{-1}$) (FAO, 2022). The subordinate productivity in Nepal is associated with several factors, such as inadequate moisture and plant nutrient management, improper sucker management practice, and suboptimal planting date selection. Additionally, poor disease and pest management, lack of quality planting materials, and natural calamities contribute to the lower yield. The absence of a reliable market for banana in Nepal is also a critical factor leading to poor yields.

Soil moisture management is one of the most important issues, accounting for a major part of the investment in banana enterprises. Mulching can significantly reduce production costs by minimizing the need for frequent irrigation, as it conserves moisture (Li et al., 2013; Kader et al., 2017). Mulching also helps prevent soil erosion and maintains moistness in the root zone, which benefits the plant's water access (Dass et al., 2013; Kazemi and Safari, 2018). Mulching materials significantly influence soil temperature management in addition to moisture conservation (Kader et al., 2019). Mulched soil retains water better than bare soil, with materials like wheat straw, grass clippings, and leaf debris increasing moisture levels by about 10% at 5-10 cm depth (McMillen, 2013). Rice straw mulching has been shown to significantly improve the water-holding capacity in banana cultivation (Kumar et al., 2020). Plastic mulches are particularly effective at preventing evaporation and reducing irrigation needs. For example, black plastic mulch raises soil temperatures more effectively than bare soil (Rajablariani et al., 2012), and it transmits absorbed heat to the soil (Steinmetz et al., 2016). White mulches lower soil temperatures, while clear mulches manage temperature by shielding the soil from direct sunlight and reducing evaporation (Bakshi et al., 2015). Organic matter mulching can reduce soil temperatures by over 1°C compared to bare soil (Chalker-Scott, 2007). Transparent photodegradable polyethylene films can increase soil temperature by 2.9-3.3°C (Subrahmaniyan and Zhou, 2008), while colored plastic mulches can raise temperatures by 3-6°C compared to bare soil (Rajablariani et al., 2012). Mulching materials limit weed growth and regulate seedling emergence by covering the soil surface (Khan et al., 2022; Kaur et al., 2024). Polyethylene and straw mulches are particularly effective in reducing weed intensity compared to other mulches and bare plots (Yadav et al., 2018). Iqbal et al. (2020) highlighted that crop cover and mulches help reduce weed seed germination and establishment. Banke is an important district of Nepal for banana production and marketing, therefore, this study was undertaken to assess the effect of different types of mulches on yield and its attributing parameters of banana at the terai region of the Lumbini province of Nepal.

## Materials and Methods:

### *Experimental site*

The experiment was conducted at the **Directorate of Agricultural Research (DoAR)**, Khajura, Banke, Nepal, situated at an altitude of **133 masl**, with coordinates **28.11° North latitude** and **81.59° East longitude**. The detailed weather data and physicochemical properties of soil are presented in Figure 1and Table 1.

### *Experimental treatments, design, and cultivation practice*

The experiment consisted of seven treatments: no mulch, black plastic mulch (50 µ), clear plastic mulch (50 µ), lentil straw (40 kg), grass straw (40 kg per plot), rice husk (40 kg per plot), and fresh banana leaves (80 kg per plot), organized in a RCBD with three replications. Each experimental unit contained four plants spaced at 2×2 meters and planted in 40 cm deep pits of the same diameter. At planting, 5 kg of farmyard manure (FYM) was applied to each pit after mixing it with the soil from digging. The remaining 15 kg of FYM was applied during the 3rd, 5th, and 7th months after

**Table 1:** The physicochemical properties of soil of the experiment site at Khajura, Banke, Nepal

| Parameters | 0-16 cm depth | 16-56 cm depth | Mean |
|---|---|---|---|
| pH | 6.25 | 6.90 | 6.56 |
| OM (%) | 1.82 | 1.40 | 1.61 |
| N (%) | 0.09 | 0.09 | 0.09 |
| $P_2O_5$ (mg $kg^{1}$) | 18.93 | 7.02 | 12.98 |
| $K_2O$ (mg $kg^{1}$) | 65.66 | 120.40 | 93.03 |
| Ca (mg $kg^{1}$) | 1908.00 | 2058.00 | 1983.00 |
| Mg (mg $kg^{1}$) | 302.00 | 395.60 | 348.80 |
| S (mg $kg^{1}$) | 1.15 | 5.12 | 3.14 |
| B (mg $kg^{1}$) | 0.29 | - | 0.29 |
| Sand (%) | 15.45 | 13.30 | 14.38 |
| Silt (%) | 56.00 | 60.00 | 58.00 |
| Clay (%) | 28.55 | 26.70 | 27.63 |

planting/sucker selection, with 5 kg for each application. NPK fertilizers were applied at a rate of 250:250:350 g per clump in six installments: 30 days, 75 days, 110 days, 150 days, and 180 days after planting/sucker selection, with the final application at the time of shooting. Urea, Diammonium phosphate (DAP), and Muriate of Potash (MoP) were applied in smaller amounts during the early growth stages and slightly increased in later stages. During the shooting phase, 100 g of MoP was applied to each plant. Foliar application of micronutrients, including $ZnSO_4$ (0.5%), $FeSO_4$ (0.2%), $CuSO_4$ (0.2%), and Borax (0.1%), was done at the 3rd, 5th, and 7th months after planting/sucker selection.

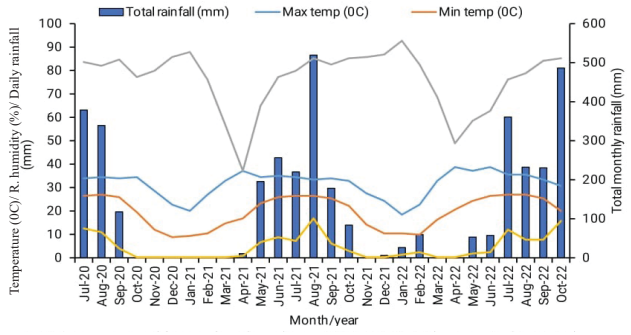


**Figure 1.** Mean monthly weather data during 2020-2022 at Khajura, Banke, Nepal

### Planting materials

The study focused on the Cavendish banana (*Musa acuminata*, 2n=3x=33) cultivar 'Grand Naine,' a variety registered in Nepal, in 2019 (SQCC, 2023). Tissue culture plants, obtained from National Biotechnology Research Center, Khumalar, Lalitpur, Nepal, were used for the experiment, with the first season crop studied as the plant crop (PC) and the second season crop as the first ratoon crop (R1). For the second season crop, sword suckers of similar age were selected.

### Sampling of plant

In each experimental plot, four plants were planted, and two were selected as sample plants for studying yield-attributing parameters. The selected plants were chosen from opposite corners of the plots to ensure proper representation.

### Bunch length and length between first and final hand

Bunch length was measured from base to the tip of the bunch. The distance between the first and final hand referred specifically to the span between these two hands, excluding the section from the base to the first hand and the tip of the bunch beyond the final hand.

### Number of hands per bunch

It was counted from the bunch of each sample plant and then averaged to determine the mean number of hands.

### Number of fingers per bunch

IT was calculated by summing the fingers on each hand of the bunch. The mean number was then determined by averaging the counts from two sample plants.

### Weight and number of fingers in the second hand

The average weight was obtained from the second hand of the two sampled bunches. Similarly, finger numbers per hand was achieved by counting the fingers of the second hand of the two sample plants.

### Finger girth

The circumference of each finger was measured from 10 fingers in the first row of the second hand and expressed in centimeter.

### Finger length

The length was measured along the stalk on the convex side of the fruit which was obtained from averaging 10 fingers of the upper row of second hand and expressed in centimeter.

### Finger weight

It was recorded from 10 fingers in the first row of the second hand and expressed in grams.

### Bunch weight

The average bunch weight per plant was determined from the four clumps in each experimental plot. The bunch weight included a 30 cm long rachis from the first hand of the bunch. The rachis length was kept consistent for all bunches harvested within the experimental plot.

### Bunch yield

The yield from all four clumps was summed to determine the total production per plot, changed to per hectare and expressed in tons per hectare (t $ha^{-1}$).

### Statistical analysis

Data were compiled in MS Excel and analyzed using the Genstat 18th Edition (VSNI, 2016). To evaluate the significance of the treatments, an analysis of variance was performed (Gomez and Gomez, 1984), and means were differentiated using DMRT at the 5% (Steel et al., 1997).

## Results:

### Bunch length and distance between first and final hand

The effect of different types of mulches on the bunch length of the plant and first ratoon crop was significant. In the plant crop, the longest bunch was observed with banana leaves mulch (120.20 cm), followed by grass straw (117.70 cm), while the shortest in the no-mulch treatment (99.70 cm). For the first ratoon crop, banana leaves mulch again produced the longest bunch (121.00

cm), followed by black plastic mulch (119.80 cm), with the shortest being in the no-mulch treatment (106.00 cm). The combined data for the plant and first ratoon crops indicated that banana leaves mulch resulted in the longest bunch length (120.60 cm), followed by black plastic mulch (117.80 cm), with no mulch producing the shortest length (102.80 cm) (Table 2).

The influence of different types of mulches on the distance between the first and final hand of the bunch was not significant for the plant and first ratoon crops individually but showed significance in the pooled data. The greatest distance between the first and final hand was observed with banana leaves mulch (75.50 cm), followed by black plastic mulch (71.92 cm), lentil straw mulch (70.52 cm), and grass straw mulch (69.00 cm), with the shortest distance occurring in the no-mulch treatment in pooled data (58.58 cm) (Table 2).

**Table 2:** Effect of different types of mulches on mean bunch length and distance between first and final hand of banana cv. 'Grand Naine' during 2020-2022 at Khajura, Banke, Nepal

| Treatments | Bunch length (cm) | | | Distance between first to final hand (cm) | | |
|---|---|---|---|---|---|---|
| | PC | R1 | Pooled | PC | R1 | Pooled |
| No mulch | 99.70$^{b}$ | 106.00$^{c}$ | 102.80$^{c}$ | 55.17 | 62.00 | 58.58$^{c}$ |
| Black plastic | 115.80$^{a}$ | 119.80$^{ab}$ | 117.80$^{ab}$ | 67.17 | 76.67 | 71.92$^{ab}$ |
| Clear plastic | 109.70$^{ab}$ | 112.80$^{bc}$ | 111.30$^{b}$ | 64.83 | 69.83 | 67.33$^{b}$ |
| Lentil straw | 111.50$^{a}$ | 114.20$^{ab}$ | 112.90$^{b}$ | 65.70 | 75.33 | 70.52$^{ab}$ |
| Rice husk | 114.50$^{a}$ | 119.30$^{ab}$ | 116.90$^{ab}$ | 63.83 | 70.17 | 67.00$^{b}$ |
| Grass straw | 117.70$^{a}$ | 112.80$^{bc}$ | 115.30$^{ab}$ | 64.67 | 73.33 | 69.00$^{ab}$ |
| Banana leaves | 120.20$^{a}$ | 121.00$^{a}$ | 120.60$^{a}$ | 69.00 | 82.00 | 75.50$^{a}$ |
| Grand mean | 112.70 | 115.14 | 113.93 | 64.30 | 72.80 | 68.55 |
| CV (%) | 5.50 | 3.40 | 3.20 | 10.70 | 8.90 | 5.80 |
| F-test | 3.55* | 5.56** | 7.54** | 1.22$^{NS}$ | 2.85$^{NS}$ | 5.31** |
| LSD (P≤0.05) | 11.05 | 6.94 | 6.51 | - | - | 7.06 |
| SEm± | 5.07 | 3.18 | 2.99 | 5.64 | 5.28 | 3.24 |

PC = Plant crop, R1 = First ratoon crop

### *Number of hands and fingers per bunch*

The effect of different types of mulches on the number of hands per bunch was significant. In the plant crop, the highest number of hands was observed with black plastic mulch (9.50), while the lowest with the no-mulch treatment (7.33). On the first ratoon crop, rice husk mulch produced the highest number of hands (11.33), and the lowest was again observed with the no-mulch treatment (6.77). The pooled data indicated that banana leaves mulch resulted in the highest number of hands (10.00), while no mulch produced the lowest (7.05) (Table 3).

Similarly, the effect of different kinds of mulches on the number of fingers per bunch in both the plant crop and first ratoon crop was significant. In the plant crop, the highest number of fingers was recorded with black plastic mulch (158.80), followed by rice husk mulch (152.20), while the lowest with no mulch (124.00). For the first ratoon crop, banana leaves mulch had the highest number of fingers (220.00), followed closely by rice husk (219.20), and the lowest with no mulch (132.30). The pooled data revealed that rice husk mulch resulted in the highest number of fingers (185.70), followed by banana leaves mulch (182.30), with the lowest number in no mulch (128.20) (Table 3).

### *Weight and number of fingers per hand*

The effect of different types of mulches on the second-hand weight of the plant crop was non-significant, but it became significant in the first ratoon crop and the pooled data. In the first ratoon crop, the highest second-hand weight was recorded with banana leaves mulch (3.06 kg), followed by grass straw mulch (2.82 kg) and black plastic mulch (2.78 kg), with the lowest weight observed in the no-mulch treatment (1.89 kg). The pooled data

**Table 3:** Effect of different types of mulches on mean number of hands and fingers per bunch of banana cv. 'Grand Naine' during 2020-2022 at Khajura, Banke, Nepal

| Treatments | Number of hands per bunch | | | Number of fingers per bunch | | |
|---|---|---|---|---|---|---|
| | PC | R1 | Pooled | PC | R1 | Pooled |
| No mulch | 7.33$^{c}$ | 6.77$^{c}$ | 7.05$^{c}$ | 124.00$^{b}$ | 132.30$^{b}$ | 128.20$^{c}$ |
| Black plastic | 9.50$^{a}$ | 10.33$^{ab}$ | 9.92$^{a}$ | 158.80$^{a}$ | 190.30$^{ab}$ | 174.60$^{ab}$ |
| Clear plastic | 8.67$^{ab}$ | 8.17$^{bc}$ | 8.42$^{b}$ | 148.70$^{a}$ | 150.20$^{b}$ | 149.40$^{bc}$ |
| Lentil straw | 8.83$^{ab}$ | 8.67$^{abc}$ | 8.75$^{ab}$ | 151.20$^{a}$ | 168.70$^{ab}$ | 159.90$^{abc}$ |
| Rice husk | 8.50$^{b}$ | 11.33$^{a}$ | 9.92$^{a}$ | 152.20$^{a}$ | 219.20$^{a}$ | 185.70$^{a}$ |
| Grass straw | 8.67$^{ab}$ | 10.50$^{ab}$ | 9.58$^{ab}$ | 143.30$^{a}$ | 191.50$^{ab}$ | 167.40$^{ab}$ |
| Banana leaves | 8.83$^{ab}$ | 11.17$^{a}$ | 10.00$^{a}$ | 144.70$^{a}$ | 220.00$^{a}$ | 182.30$^{ab}$ |
| Grand mean | 8.62 | 9.56 | 9.09 | 146.10 | 181.70 | 163.90 |
| CV (%) | 5.40 | 15.60 | 7.90 | 6.30 | 18.20 | 11.00 |
| F-test | 5.87** | 3.97* | 6.93** | 4.31* | 3.04* | 3.79* |
| LSD (P≤0.05) | 0.83 | 2.66 | 1.28 | 16.36 | 58.80 | 31.96 |
| SEm± | 0.38 | 1.22 | 0.59 | 7.51 | 26.99 | 14.67 |

PC = Plant crop, R1 = First ratoon crop

**Table 4:** Effect of different types of mulches on mean weight and number of fingers per hand of banana cv. 'Grand Naine' during 2020-2022 at Khajura, Banke, Nepal

| Treatments | Weight of second hand (kg) | | | Number of fingers in second hand | | |
|---|---|---|---|---|---|---|
| | PC | R1 | Pooled | PC | R1 | Pooled |
| No mulch | 2.12 | 1.89c | 2.01$^{c}$ | 14.00$^{c}$ | 15.50$^{c}$ | 14.75$^{b}$ |
| Black plastic | 3.23 | 2.78$^{ab}$ | 3.01$^{a}$ | 21.17$^{a}$ | 19.67$^{ab}$ | 20.42$^{a}$ |
| Clear plastic | 2.43 | 2.37$^{bc}$ | 2.40$^{bc}$ | 15.83$^{bc}$ | 17.17$^{bc}$ | 16.50$^{b}$ |
| Lentil straw | 2.99 | 2.27$^{bc}$ | 2.63$^{ab}$ | 19.00$^{ab}$ | 19.83$^{ab}$ | 19.42$^{a}$ |
| Rice husk | 3.20 | 2.33$^{bc}$ | 2.76$^{ab}$ | 18.00$^{abc}$ | 22.50$^{a}$ | 20.25$^{a}$ |
| Grass straw | 3.31 | 2.82$^{ab}$ | 3.07$^{a}$ | 21.67$^{a}$ | 21.17$^{a}$ | 21.42$^{a}$ |
| Banana leaves | 3.20 | 3.06$^{a}$ | 3.13$^{a}$ | 20.17$^{ab}$ | 21.83$^{a}$ | 21.00$^{a}$ |
| Grand mean | 2.92 | 2.502 | 2.713 | 18.55 | 19.67 | 19.11 |
| CV (%) | 16.80 | 11.80 | 10.30 | 13.60 | 9.10 | 5.70 |
| F-test | 2.66$^{NS}$ | 5.53** | 6.37** | 3.75* | 6.00** | 15.88*** |
| LSD (P≤0.05) | - | 0.53 | 0.49 | 4.49 | 3.19 | 1.94 |
| SEm± | 0.40 | 0.24 | 0.23 | 2.06 | 1.46 | 0.89 |

PC = Plant crop, R1 = First ratoon crop

of plant crop and first ratoon crop indicated that banana leaves mulch produced the highest hand weight (3.13 kg), followed by grass straw (3.07 kg) and black plastic mulch (3.01 kg), while no mulch produced the lowest hand weight (2.01 kg) (Table 4).

The effect of mulching materials on the number of fingers per hand of the plant crop was significantly the highest with grass straw mulch (21.67), which was statistically similar to black plastic mulch (21.17), lentil straw (19.00), rice husk (18.00), and banana leaves mulch (20.17), with the lowest number with no mulch (14.00). Similarly, in the first ratoon crop, finger number per hand was the highest with rice husk mulch (22.50), which was statistically at par with banana leaves (21.83), grass straw (21.17), lentil straw (19.83), and black plastic mulch (19.67), while the lowest was again recorded with no mulch (15.50). The pooled data showed that grass straw mulch produced the highest number of fingers per hand (21.42), followed by banana leaves (21.00), and the minimum with no mulch (14.75) (Table 4).

### *Finger length*

The effect of different types of mulches on finger length in the plant crop was significantly the longest with black plastic mulch (23.95 cm), It was statistically comparable to rice husk (23.87 cm), banana leaves (23.07 cm), grass straw (23.03 cm), and lentil straw (22.38 cm) mulched plants. The shortest finger length was observed with the no-mulch treatment (20.08 cm) (Table 5).

### *Finger girth and weight*

The effect of different types of mulches on finger girth in the plant crop, first ratoon crop, and pooled data were significant(Table 6). In the plant crop, the greatest girth was observed with banana leaves mulch (14.00 cm), which was statistically comparable to black plastic (13.81 cm), rice husk (13.48 cm), and grass straw (13.63 cm) mulched treatments. The lowest finger girth was recorded with no mulch (12.26 cm). In the first ratoon crop, the maximum girth was also recorded with banana leaves mulch (13.50 cm), followed closely by black plastic mulch (13.49 cm), while the lowest again with no mulch (11.19 cm). The combined data from both crops indicated that the highest girth was found with banana leaves mulch (13.75 cm), followed by black plastic mulch (13.65 cm), while no mulch had the lowest girth (11.73 cm) (Table 6).

The effect of different types of mulches on finger weight was significant across the plant crop, first ratoon crop, and pooled data. In the plant crop, the highest finger weight was recorded with rice husk (194.30 g), followed by banana leaves mulch (187.40 g), while the lowest was noted with the no mulch treatment (135.70 g). In the first ratoon crop, black plastic mulch produced the heaviest finger weight (161.70 g), followed by banana leaves (156.30 g), and again, the lowest was seen with no mulch (120.60 g). The combined data showed that finger weight was the highest with banana leaves (171.90 g), followed closely by black plastic mulch (170.40 g), while no mulch had the lowest weight (128.20 g) (Table 6).

**Table 5:** Effect of different types of mulches on mean finger length and curvature of banana cv. 'Grand Naine' during 2020-2022 at Khajura, Banke, Nepal

| Treatments | Finger length (cm) | | |
|---|---|---|---|
| | PC | R1 | Pooled |
| No mulch | 20.08$^{c}$ | 18.77 | 19.43 |
| Black plastic | 23.95$^{a}$ | 21.17 | 22.56 |
| Clear plastic | 21.86$^{bc}$ | 22.31 | 22.08 |
| Lentil straw | 22.38$^{ab}$ | 21.39 | 21.89 |
| Rice husk | 23.87$^{a}$ | 20.13 | 22.00 |
| Grass straw | 23.03$^{ab}$ | 20.95 | 21.99 |
| Banana leaves | 23.07$^{ab}$ | 22.08 | 22.57 |
| Grand mean | 22.61 | 20.97 | 21.79 |
| CV (%) | 4.50 | 9.00 | 5.00 |
| F-test | 5.13** | 1.24$^{NS}$ | 2.96$^{NS}$ |
| LSD (P≤0.05) | 1.82 | - | - |
| SEm± | 0.84 | 1.54 | 0.89 |

PC = Plant crop, R1 = First ratoon crop

**Table 6:** Effect of different kinds of mulches on mean finger girth and weight of banana cv. 'Grand Naine' during 2020-2022 at Khajura, Banke, Nepal

| Treatments | Finger girth (cm) | | | Finger weight (g) | | |
|---|---|---|---|---|---|---|
| | PC | R1 | Pooled | PC | R1 | Pooled |
| No mulch | 12.26$^{d}$ | 11.19$^{b}$ | 11.73$^{c}$ | 135.70$^{d}$ | 120.60$^{b}$ | 128.20$^{c}$ |
| Black plastic | 13.81$^{ab}$ | 13.49$^{a}$ | 13.65$^{a}$ | 179.00$^{ab}$ | 161.70$^{a}$ | 170.40$^{a}$ |
| Clear plastic | 12.88$^{c}$ | 13.09$^{a}$ | 12.99$^{b}$ | 149.30$^{cd}$ | 146.80$^{a}$ | 148.10$^{b}$ |
| Lentil straw | 13.40$^{b}$ | 12.88$^{a}$ | 13.14$^{b}$ | 163.40$^{bc}$ | 146.90$^{a}$ | 155.10$^{ab}$ |
| Rice husk | 13.48$^{ab}$ | 12.92$^{a}$ | 13.20$^{b}$ | 194.30$^{a}$ | 139.20$^{ab}$ | 166.80$^{a}$ |
| Grass straw | 13.63$^{ab}$ | 13.03$^{a}$ | 13.33$^{ab}$ | 180.70$^{ab}$ | 144.80$^{a}$ | 162.80$^{ab}$ |
| Banana leaves | 14.00$^{a}$ | 13.50$^{a}$ | 13.75$^{a}$ | 187.40$^{a}$ | 156.30$^{a}$ | 171.90$^{a}$ |
| Grand mean | 13.35 | 12.87 | 13.11 | 170.00 | 145.20 | 157.60 |
| CV (%) | 2.10 | 2.80 | 1.80 | 6.60 | 8.40 | 5.60 |
| F-test | 14.01*** | 14.58*** | 23.33*** | 10.96*** | 3.46* | 9.21*** |
| LSD (P≤0.05) | 0.49 | 0.63 | 0.43 | 19.88 | 21.82 | 15.74 |
| SEm± | 0.23 | 0.29 | 0.19 | 9.12 | 10.02 | 7.22 |

PC = Plant crop, R1 = First ratoon crop

**Table 7:** Effect of different types of mulches on mean bunch weight and yield of banana cv. 'Grand Naine' during 2020-2022 at Khajura, Banke, Nepal

| Treatments | Bunch weight (kg) | | | Bunch yield (t ha$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | PC | R1 | Pooled | PC | R1 | Pooled |
| No mulch | 18.25$^{d}$ | 16.38$^{c}$ | 17.31$^{d}$ | 45.62$^{d}$ | 40.94$^{c}$ | 43.28$^{d}$ |
| Black plastic | 23.67a$^{b}$ | 24.79$^{a}$ | 24.23$^{a}$ | 59.17$^{ab}$ | 61.97$^{a}$ | 60.57$^{a}$ |
| Clear plastic | 20.19$^{cd}$ | 19.85$^{bc}$ | 20.02$^{c}$ | 50.47$^{cd}$ | 49.62$^{bc}$ | 50.05$^{c}$ |
| Lentil straw | 20.63$^{cd}$ | 21.09$^{ab}$ | 20.86$^{bc}$ | 51.57$^{cd}$ | 52.73$^{ab}$ | 52.15$^{bc}$ |
| Rice husk | 21.51$^{bc}$ | 23.02$^{ab}$ | 22.26$^{ab}$ | 53.77$^{bc}$ | 57.54$^{ab}$ | 55.66$^{ab}$ |
| Grass straw | 24.45$^{a}$ | 23.50a$^{b}$ | 23.97$^{a}$ | 61.12$^{a}$ | 58.74$^{ab}$ | 59.93$^{a}$ |
| Banana leaves | 24.75$^{a}$ | 23.85$^{a}$ | 24.30$^{a}$ | 61.89$^{a}$ | 59.64$^{a}$ | 60.76$^{a}$ |
| Grand mean | 21.92 | 21.78 | 21.85 | 54.80 | 54.50 | 54.63 |
| CV (%) | 7.20 | 9.20 | 5.20 | 7.20 | 9.20 | 5.20 |
| F-test | 7.24** | 6.41** | 16.08*** | 7.24** | 6.41** | 16.08*** |
| LSD (P≤0.05) | 2.77 | 3.56 | 2.02 | 6.99 | 8.89 | 5.04 |
| SEm± | 1.24 | 1.63 | 0.93 | 3.21 | 4.08 | 2.31 |

PC = Plant crop, R1 = First ratoon crop

### *Bunch yield*

The influence of different types of mulches on individual bunch weight in the plant crop was significantly the highest with banana leaves mulching (24.75 kg), followed closely by grass straw (24.45 kg) and black plastic mulching (23.67 kg), while the minimum weight was recorded in the no-mulch treatment (18.25 kg) (Table 7). In the first ratoon crop, the highest bunch weight was observed with black plastic mulch (24.79 kg), followed by banana leaves mulch (23.85 kg), whereas the lowest with no mulch (16.38 kg). The pooled data from both plant and first ratoon crops indicated that banana leaves mulch produced the highest bunch weight (24.30 kg), followed closely by black plastic mulch (24.23 kg), while the lowest was with the no-mulch treatment (17.31 kg) (Table 7).

Regarding bunch yield in the plant crop, banana leaves showed the greatest bunch yield (61.89 t $ha^{-1}$), which was statistically similar to grass straw (61.12 t $ha^{-1}$) and black plastic mulch (59.17 t $ha^{-1}$), whereas the no-mulch treatment yielded the least (45.62 t $ha^{-1}$). In the first ratoon crop, black plastic mulch produced the highest yield (61.97 t $ha^{-1}$), followed by banana leaves (59.64 t $ha^{-1}$), with the lowest yield with no mulch (40.94 t $ha^{-1}$). The combined data for both plant and first ratoon crops revealed that banana leaves mulching gave the maximum yield (60.76 t $ha^{-1}$), followed closely by black plastic mulch (60.57 t $ha^{-1}$), while the lowest yield was recorded with the no-mulch treatment (43.28 t $ha^{-1}$) (Table 7).

## Discussion:

Present findings indicate that mulched plots significantly outperformed un-mulched plots across various yield attributes, including bunch length, hand and fingers number per bunch, weight and number of fingers per hand, finger length, girth, and individual finger weight (Table 2- 7). Among the different mulching materials used, banana leaves and black plastic mulch exhibited superior performance in terms of yield and associated attributes. For the pooled data from both the plant and first ratoon crops, banana leaves achieved the maximum weight of bunch (24.30 kg per bunch) and yield (60.76 t $ha^{-1}$), closely tracked by black plastic mulch with a bunch weight of 24.23 kg and a productivity of 60.57 t $ha^{-1}$. In contrast, the un-mulched plots recorded the lowest bunch weight (17.31 kg per bunch) and yield (43.28 t $ha^{-1}$). The application of banana leaves and black plastic as a mulching materials resulted in a remarkable yield increase of 40.39% and 39.95%, respectively, compared to the un-mulched plots. This enhanced yield in mulched plots is attributed to several factors, including reduced weed competition, improved soil moisture retention, and enhanced nutrient availability and conservation, particularly with plastic mulches, leading to better plant growth.

There is a strong positive correlation between yield and various vegetative growth parameters (Tak et al., 2015). Mulching creates the favorable environmental conditions for optimum growth of banana. These insights suggest that enhancing vegetative growth through mulching could significantly improve banana yield. Water availability plays a crucial role in the growth and development of banana plants. Mulching emerges as a key practice in this context, as highlighted by McMillen (2013), who noted that mulched soil retains water more effectively than bare soil. This water retention not only supports the plant's immediate needs but also contributes to the long-term health of the banana crop by maintaining optimal moisture levels. Furthermore, the benefits of mulching extend beyond moisture retention. According to Kader et al. (2019), mulching helps regulate soil temperature, which is vital for maintaining ideal growth conditions. The slow movement of water facilitated by mulch also aids in nutrient retention within the root zone, making essential nutrients more accessible to the plants (Qiu et al., 2020). This aspect underscores the synergistic effects of mulching practices on soil health and plant nutrition. Additionally, the use of different types of mulches, such as polyethylene and straw, has been shown to effectively reduce weed intensity (Yadav et al., 2018). Furthermore, the benefits of mulching extend to supporting beneficial soil microorganisms, which are vital for nutrient recycling and uptake (De Biman et al, 2021). The presence of these microorganisms enhances soil health and fertility, thereby contributing to improved plant growth and yield. In summary, our study confirms the vital role of vegetative growth parameters in determining banana yield, and it underscores the significance of water management and mulching techniques in enhancing these parameters. Future research should continue to explore the interplay between these factors to develop comprehensive strategies for improving banana production systems.

From the mulching experiments, Kumar et al. (2020) reported a bunch weight of 23.00 kg, an average of 12.71 hands per bunch, 154.58 fingers per bunch, and a finger weight of 142.79 g when using rice straw mulching in 'Grand Naine' banana which is very close to the present findings. Wankhade et al. (2023) observed a bunch weight of 25.89 kg, 151.48 fingers per bunch, a finger weight of 170.75 g, and a 19.72% yield increase with black plastic mulching in 'Grand Naine' bananas. Additionally, Santosh and Tiwari (2017) recorded a bunch weight of 22.82 kg, an average of 8.67 hands per bunch, and a finger length of 18.71 cm in 'Grand Naine' banana. Salau et al. (1992) found that plantains mulched with elephant grass and plastic mulch achieved a bunch weight of 11.63 kg, 7.70 hands per bunch, and a 50.32% yield rise when compared to un-mulched plots. Gold et al. (2006) also reported the highest bunch weight (8.90 kg) in fully mulched plots (using maize stovers and grasses) for African highland cooking bananas (AAA). Variations in results across these studies can be attributed to differences in climatic

conditions, varieties, and the specific mulching materials utilized.

## Conclusion:

The study obviously demonstrates that the use of different mulching materials significantly enhances various banana yield attributes. Specifically, mulched plots exhibited superior performance compared to un-mulched plots, with banana leaves and black plastic mulch producing the superior results in terms of bunch weight, number of hands and fingers per bunch, finger length, girth, and individual finger weight. The combined data from first and second season crops confirmed that banana leaves mulching produced the highest bunch weight (24.30 kg) and bunch yield (60.76 t $ha^{-1}$), closely followed by black plastic mulch (24.23 kg and 60.57 t $ha^{-1}$). Therefore, banana growers are recommended to use banana leaves as a mulching material for the optimum production of bunch. Alternatively, black plastic mulch can be used attaining the similar yield.

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## Declaration of conflict of interest and ethical approval:

Basant Chalise was the principal investigator, managing the field experiments, data collection, literature review, and manuscript preparation. Arjun Kumar Shrestha, Arvind Srivastava, and Kalyani Mishra Tripathi contributed in planning, directing, and guiding the research. All authors reviewed and approved the final manuscript. The authors announce there is no conflict of interest.

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