conditions (Tarara, 2000; Yimer, 2020). Therefore, this study was undertaken to evaluate the effect of different mulching materials on the growth and yield of onion under the agro-climatic conditions of Nepal's Terai region.

This study was therefore designed to: (i) evaluate the effects of four mulching materials and an unmulched control on growth dynamics across four developmental stages; (ii) assess their influence on bulb yield components and total fresh yield; and (iii) identify the most suitable mulching strategy for onion production in Bardiya District, Nepal.

2 Materials and Methods

2.1 Experimental site

The experiment was conducted at Shree Janata Secondary School, Bansgadhi Municipality, Bardiya District, Lumbini Province, Nepal (28.26° N, 81.52° E; approximately 150 m above sea level) during the rabi season from November 2024 to April 2025. The site has a subtropical monsoon climate with an average annual rainfall of approximately 1,600-1,900 mm, most of which occurs between June and September. During the crop-growing period, the mean monthly temperature ranged from approximately 11 °C in December to 35 °C in April.

The experimental field consisted of sandy loam soil with good drainage and a slightly acidic to neutral reaction (pH 6.0-7.2), which is considered suitable for onion cultivation. Based on the regional soil characteristics of Bansgadhi, Bardiya, the cultivated soils generally contain 1.5%-3.0% soil organic matter, 150-300 kg/ha available nitrogen, 15-35 kg/ha available phosphorus, 180-350 kg/ha available potassium, and have a bulk density of 1.3-1.6 g/cm^3. These soil properties indicate moderate fertility suitable for vegetable production. The experimental field had previously been cultivated with seasonal cereal crops and had not received any mulch treatment before the establishment of the experiment.

2.2 Experimental design and treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments and three replications, resulting in fifteen experimental plots, each measuring 5.0 m^2.

The treatments were as follows: T_1: Control (no mulch); T_2: Black polyethylene mulch (25 µm thickness); T_3: Rice straw mulch (5 cm thick); T_4: Banana leaf mulch (5 cm thick); T_5: Sawdust mulch (5 cm thick).

The organic mulching materials were collected locally and applied immediately after transplanting to maintain a uniform layer over the soil surface. Black polyethylene mulch was perforated at the designated planting positions before transplanting.

Forty-five-day-old seedlings of the locally grown onion cultivar 'Nasik Red' were transplanted on 20 November 2024 at a spacing of 15 cm × 10 cm (between rows × within rows). An inter-plot spacing of 0.5 m and an inter-block spacing of 1.0 m were maintained throughout the experiment.

2.3 Crop management

The field was ploughed twice to a depth of approximately 20 cm, followed by harrowing and leveling seven days before transplanting. Fertilizers were applied at the recommended rate of 80:60:60 kg N:P_2O_5:K_2O/ha using urea, diammonium phosphate (DAP), and muriate of potash (MOP). The full doses of phosphorus and potassium and 50% of the nitrogen were applied as basal fertilizer at transplanting, while the remaining nitrogen was top-dressed in two equal splits at three and six weeks after transplanting (WAT).

Flood irrigation was used throughout the experiment. All plots received the same amount of irrigation water at five-day intervals to ensure uniform water availability among treatments. Soil moisture was not monitored using soil moisture sensors, tensiometers, or the gravimetric method; therefore, the effects of mulching on soil moisture were inferred from crop growth and yield responses rather than direct soil moisture measurements.

Manual weeding was carried out at three and six weeks after transplanting in the control plots, whereas no additional weeding was required in the mulched plots because the mulch effectively suppressed weed growth.