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ALFALFA FORAGE YIELD AND WEED CONTROL IN RESPONSE TO PLASTIC FILM MULCH IN TEMPERATE ENVIROMENT

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ABSTRACT: Alfalfa or Lucerne (*Medicago sativa*) is an important forage legume having a potential to improve the dairy feeding system in the country. However, this legume crop is susceptible to weed infestation and farmers are facing difficulty in controlling weeds as it involves intensive labor for weed management. Therefore, a field trial was conducted to evaluate the effect of plastic film mulch on morphological traits and weed control in Lucerne fodder crop from March to September, 2020. The experiment was laid out in randomized complete block design with three treatments and four replications. The treatment consisted of black plastic mulch and two non-mulch treatments (Line sowing and broadcast). The variables evaluated were plant height, forage biomass, dry matter yield, forage quality and weed control. The results showed that the Lucerne plants that were mulched using plastic film produced significantly higher forage biomass, dry mater yield and required minimum weeding than those without plastic mulch. Since the plastic film mulching technology has positive effect on forage yield and weed control, it has the potential to be promoted for Lucerne production especially for processing Lucerne meal (dried crumbs and powder) as protein source for dairy feed production in the country.

Keywords: Lucerne; forage biomass; dry matter yield; plastic film mulch; weed control.

1. INTRODUCTION

Adequate forage production and year-round availability of fodder are the critical requirements to sustain profitability of dairy farming. The livestock, particularly dairy cow needs to consume sufficient amount of dry matter constituting forage and concentrate for maintaining optimum body condition score and milk production. In any commercial dairy farming, feed is the main driving force for successful venture and account for major chunk of production cost (Makkar 2016). Pasture based feeding is the best and cheapest for sustainable dairy farming. The National Research and Development Center for Animal Nutrition, Bumthang under Department of Livestock has been supporting Dzongkhag Livestock sectors to upscale improved forage production in Bhutan. Annually, the center supplies around 23 MT of fodder seeds and 180 MT of oat and fodder maize seeds for improved pasture and winter fodder development in the country (NRDCAN 2021). Recently, the up-scaling of legume fodder production has been initiated in potential dairy farming areas to improve pasture composition and forage-based feeding system. One of the prolific legumes suitable for feeding dairy cow is Alfalfa or Lucerne (Wang et al. 2014). Lucerne (*Medicago sativa*) is a temperate perennial legume having potential to produce high quality forage all year-round and contains sufficient concentration of nutrients for all class of livestock (Shashikala et al. 2017). Further, processing Lucerne into leaf meals (dried crumbs and powder) as protein source in dairy feed had been initiated and was found promising to reduce import of oil cakes for animal feed production. However, the Lucerne legume crop is susceptible to weed infestation and farmers are facing difficulties in controlling the weeds as it involves intensive labor for weed management. Accordingly, there is need to come up with appropriate strategy and technology to address these challenges faced by the dairy farmers. One of the viable technologies to control weed and maintain soil moisture is the mulching technology. Mulching is a technique in which soil surface is covered with crop residues or plastic sheet to minimize the water loss through evaporation and control weed (Zribi et al. 2915). Mulching can have an imperative role in increasing crop productivity and water retention capacity. Among mulching materials, plastic film mulching is more effective in rising soil temperature (Pandey et al. 2016) and maintaining ambient soil environment. Therefore, the field trial was undertaken to determine the effect of applying black plastic film mulch on forage yield and weed control in Lucerne (Alfalfa) fodder crop.

2. MATERIALS AND METHOD

2.1 Experimental site

The field experiment was conducted from March to November, 2020 at the National Research and Development Center for Animal Nutrition, Bumthang. The center is located at an altitude of 2650 meters above sea level with geographical location between 27.54 º North latitude and 90.75 º East longitude. The area falls under temperate climate characterized by cool wet summer and cold dry winter.

2.2 Experimental design and treatment

The experiment was laid out in a randomized complete block design with three treatments and four replications. Line sowing of Alfalfa seeds was carried out in the treatment plots which were plastic mulched while the seeds were broadcasted in the control plots which were not plastic mulched. The individual plot measured 12.5 m^2 (5 m x 2.5 m). In total, there were twelve experimental plots with spacing of 0.5m between plots and 1 m between replications.

2.3 Mulching and sowing

The experimental field was properly ploughed and harrowed before one week prior to sowing. The land was divided into blocks and each block consisted of required number of plots. The thin black plastic film mulch was spread over the plot with mulch treatment. Line and broadcast sowing were done on no mulch treatment plots. Seed sowing in plastic mulch was done through holes in thin plastic sheet. No irrigation was done as it was sown as summer fodder crop when the rains were frequent.

2.4 Weeding

The periodic weeding was carried for plots with no mulch treatments (Broadcast and line sowing) but weeding was not done for plots with mulch treatment.

2.5 Data collection

The data was collected at 90 days after sowing and subsequent cuts were done at 60 days interval. The data were recorded on plant height, fresh forage and dry matter yield. The plant height was measured in centimeters from based to tip of the plant by randomly selecting eight plants from each replicate. To measure the fresh forage biomass, the entire plot was harvested and fresh plant materials were weighed with weighing scale.

2.6 Laboratory analysis

The plant materials were systematically mixed and a representative sample weighing 250 gm was collected from each plot after harvest. The samples were collected to estimate dry matter and nutrient content. The laboratory test for nutrient content was conducted at the Animal Nutrition Laboratory, NRDCAN, Bumthang. The dry matter was calculated based on following formula.

$$\%\,DM = \frac{W3 - W1}{W2 - W1} X100$$

where W_1 is the weight of the pan, W_2 is weight of the pan + weight of the fresh sample and W_3 is weight of the pan + weight of the dry sample. The proximate analysis was performed to determine crude protein, crude fat, crude fiber and total ash content.

2.7 Data analysis

The data for forage biomass and dry matter yield from three cuts were added and converted to acreage to obtain total yield. For the morphological trait, data was averaged from numbers of cuts obtained.

The data was entered on Microsoft Excel and exported to IBM SPSS version 26 for statistical analysis. The data sets were checked for outliers, followed by Shapiro Wilk's and Leven's test for normality and homogeneity of variance respectively. The data were analyzed for descriptive statistics such as mean and standard deviation. The statistical inference test was performed through General Linear Model with Multivariate ANOVA. The Post Hoc test was done to compare the means of different treatments on forage yield and nutrient composition. Differences in means were considered significant when p value was less than 0.05.

3. RESULTS AND DISCUSSIONS

3.1 Plant height

The data for the plant height, fresh forage biomass and dry matter yield are presented in Table 1. The maximum plant height (55.82 cm) was recorded for T3 (Plastic mulch) followed by T1 (Line sowing) and T2(Broadcast) with 50.69 and 40.23 cm respectively. There was significant deference (p< 0.05) in plant height between T2 and T3. The observation in this study is in conformity with findings of Das et al. (2018) who reported similar result in forage crop. According to Ansah et al. (2010), the plant height is a major factor contributing towards yield towards different grasses. Plastic mulches showed superior performance in plant height than no mulch treatment and increased plant height in mulch plants was due to better soil moisture and optimum soil temperature provided by the mulches (Ashrafuzzaman et al. 2011). Harvesting stage of the plant also affects plant physiology in terms of plant height (Shoaib et al. 2013). Asmare (2016) mentioned that plant height increased with advancement of harvest time of the plant. In current study, lucerne plants were harvested at 90 days in first cut and 60 days cutting interval was maintained for subsequent cuts.

3.2 Weed control

Weeds are a major challenge in forage legume production where the use of synthetic herbicides and chemicals are not advised in weed management. Weed growth in T1 and T 2 (without mulch) was observed prominent. The lowest weed infestation was observed in T3 (Mulch). Minimum weeding requirement throughout the growing period for T1 & T2 (without mulch) was three times in present study. Weeding was not required for mulch treatment (T3). Similar result was reported by Sun et al. (2015) on weed control from plastic mulching. The black plastic mulch may inhibit the weed growth and control weed population through preventing light entry (Bond and Grundy 2001).

3.3 Forage yield parameter

Fodder yield is the important trait and ultimate product of forage crop which reveals the total biomass attained by the plants during its life cycle. As shown in Table 1, T3 (Mulch treatment) produced significantly (p < 0.05) higher fresh forage biomass and dry matter yield than no mulch treatments (T1& T2). This result is in an agreement with the finding of Das et al. (2017) who reported the similar result in forage crops. Anwar et al. (2012) mentioned that variation in sequence of fresh and dry biomass of grasses in due to different in

Table 1: Plant height, fresh forage biomass and dry matter yield (MT) across three treatments

Parameters	Treatments			Significance
	T1 (Line sowing)	T2 (Broadcast)	T3 (Plastic mulching)	
Plant height (cm)	50.69 ±7.53	40.23 ± 12.31	55.82 ± 8.25	*
Fresh biomass yield (MT)	2.26 ± 1.02	1.22 ± 1.10	5.06 ± 2.63	*
Dry matter yield (MT)	0.59 ± 0.27	0.35 ±0.32	1.92 ± 1.21	*

***** *p<0.05; ns: non-significant*

Table 2: Nutrient composition across three treatments

Nutrient composition (%)	Treatments			Significance
	T1 (Line sowing)	T2 (Broadcast)	T3 (Plastic mulching)	
Crude Protein	20.01	17.48	21.41	ns
Crude fat	3.50	2.75	5.50	*
Crude fiber	18.25	18.75	15.25	ns
Total Ash	8.59	8.80	9.28	

***** *p<0.05; ns: non-significant*

water content in biomass. According to Javed et al. (2019), the plastic mulch plot produced higher crop yield. Increased in yield from the plants of mulch plots could be associated with conservation of moisture, reduction in evaporation and improved microclimate (Jabran et al. 2015). Sunlight directly falls on the soil without mulch and convert water from liquid to gaseous phase, which is then directly lost to the atmosphere. Therefore, mulch helps provide more water to plants through retaining soil moisture content. Soil microbial environment and fertility are directly related to increased yield in response to plastic film mulching that also improves soil water content and soil temperature regime (Qin et al. 2015). Plastic mulching through soil improvement condition also increased plant available nutrients particularly inorganic nitrogen content in the soil (Lee et al. 2021). In addition, mulching soil using plastic film strengthened the organic nitrogen retention and which contributed to reduce nitrogen leaching loss (Ruidisch et al. 2013).

3.3 Forage quality parameter

Crude protein is one of the vital factors affecting quality of fodder and represents important criteria for evaluating forage quality. Result of the nutrient composition across three treatments are depicted in Table 3. The crude protein content obtained in T1, T2, T3 were 20.01, 17.48 and 21.41 percent respectively. The crude protein content in T3 was found higher than T1 and T2 but there was no significant ($p > 0.05$) difference observed across three treatments. The T3 with mulching treatment contained significantly ($p < 0.05$) higher crude fat content than T1 and T2 although there were no significant ($p > 0.05$) differences among three treatments in respect of crude fiber and total ash content. The plastic mulching prevents nutrient leaching from the soil and facilitates decomposition of organic residues under it thereby increases the bioavailability of micro nutrients (Lalitha et al. 2010). According to Ribeiro et al. (2014), Nutrient content of the plant depends on stage of maturity and as the plant ages, nutrient content decreases due to increase in percentage of cellulose and hemicellulose. At present study cutting intervals were uniformly maintained across three treatments.

4. CONCLUSIONS & RECOMMENDATION

Based on the current experimental result, it could be concluded that plastic mulches had positive effect on forage biomass and dry matter yield in Lucerne forage crop. The mulching significantly increased the forage yield compared to non-mulch practice. The black plastic mulch also suppressed weed growth and hence reduced the labor requirement and use of herbicides for weed control. The plastic mulching technology is immensely promoted in enhancing vegetable production due to low cost and associated advantages. Under plastic film mulch, soil properties like soil temperature, moisture content, bulk density, aggregate stability and nutrient availability were improved. Considering an increased in forage yield, effective weed control and water use efficiency, this technology could be adopted by livestock farmers in the country to increase forage legume production. More importantly, this technology can be adopted for processing Lucerne meal (dried crumbs and powder) as protein sources for dairy feed production.

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