Research Article

FODDER PRODUCTIVITY OF TEOSINTE (*Euchlaena mexicana* Schrad) AT DIFFERENT SOWING DATES IN WESTERN MID-HILLS OF NEPAL

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ABSTRACT

Teosinte is getting popular in recent years as an important summer fodder in Nepal, thus developing its package of cultivation practices is a felt need of farmers. An experiment was conducted to identify the appropriate sowing date of teosinte aiming for western mid hills. The experiment was done using a Randomized Complete Block Design (RCBD) with four treatments of varied sowing dates, each replicated for three times at the experimental site of Goat Research Station, Bandipur, Tanahun, Nepal. Varied sowing dates had significant influences on the growth parameters, such as plant height, number of leaves plant^{-1}, number of tillers hill^{-1} and dried fodder yield. The plants sown at mid-April had higher dried fodder biomass in comparison to the plants sown on 9th May. The change in photoperiods and temperature could have influenced to the fodder yield of teosinte. Adoption of the sowing date of 15th to 23rd April is one of the effective strategies for obtaining higher biomass yield of teosinte in western mid hills that can contribute substantially in mitigating the energy deficit situation to the ruminants.

Key words: Climate, fodder yield, growth parameters

INTRODUCTION

Nepalese ruminant livestock are severely suffering from the feed deficit condition, particularly in the case of energy and protein deficiency during summer season. Low energy content in the feeding strategy affects performance of the animals more than any other nutritional deficiency, and its requirements depend on the stage of production. Adequate amounts of energy are extremely important during late gestation and early lactation for ruminants. Moreover, energy shortages are often complicated by protein or mineral deficiencies (Yami & Merkel, 2008; Rao, 2014). A chronic TDN especially energy shortage is a major limiting factor for livestock production.

Better nutrition through low cost fodders would help farmers in reducing per unit milk production and way out the path towards their ability in adapting harsh condition that may prevail due to alteration in climatic parameters which are associated with feeding management in Nepal. Teosinte (*Euchlaena maxicana* Schard) is one of the most popular summer growing cereal fodder crop rich in energy and fair in crude protein (Upreti and Shrestha, 2006; Devkota et al., 2015), and considered as one of the major summer fodder crop in the elsewhere (Sallam and Ibrahim, 2014). Teosinte shows lower heat injury, sustained chlorophyll content under heat stress (36-45°C) and

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attains high percentage survival of seedlings (at 55°C), also posses the ability of producing large plant biomass yield than other popular non-legume summer fodders, such as; maize in stressed and non stressed conditions (Khan-Niazi, Rauf, da Silva, & Munir, 2015). Teosinte has the advantage of giving very high yields due to profuse tillering capacity, and can give multiple cuts (Devkota et al., 2015). It can withstand heavy monsoon showers or waterlogged conditions for short periods. It grows rather slow at the beginning but comes up fast after establishment (Devkota et al., 2015).

The productivity of the grasses under Poaceae family significantly varies with the sowing dates which is influenced with different climatic variations (Jehangir *et al.*, 2013). In this sense teosinte could be one among promising species provided it grows well under varying sowing scheme that is also related to the change in temperatures and day length. Therefore, this study was conducted to test its ability to grow and produce more herbage mass under varying sowing dates in western mid hills of Nepal.

MATERIALS AND METHODS

The experiment was conducted during April to September 2014 at the experimental site of the Goat Research Station (GRS), Bandipur, Tanahun, Nepal. The experimental site was on the north facing landscape of the hilly station at an altitude of 850 masl and 27° 94' North and 84° 38' East. The soil of the experimental site had 5.8 average pH value and annual rainfall was measured as ~ 2000 mm with an average of 85% relative humidity. The majority of rainfall occurred from June to August. The maximum and minimum temperatures and monthly total rainfall of the area during the study period is presented in Figure (1).

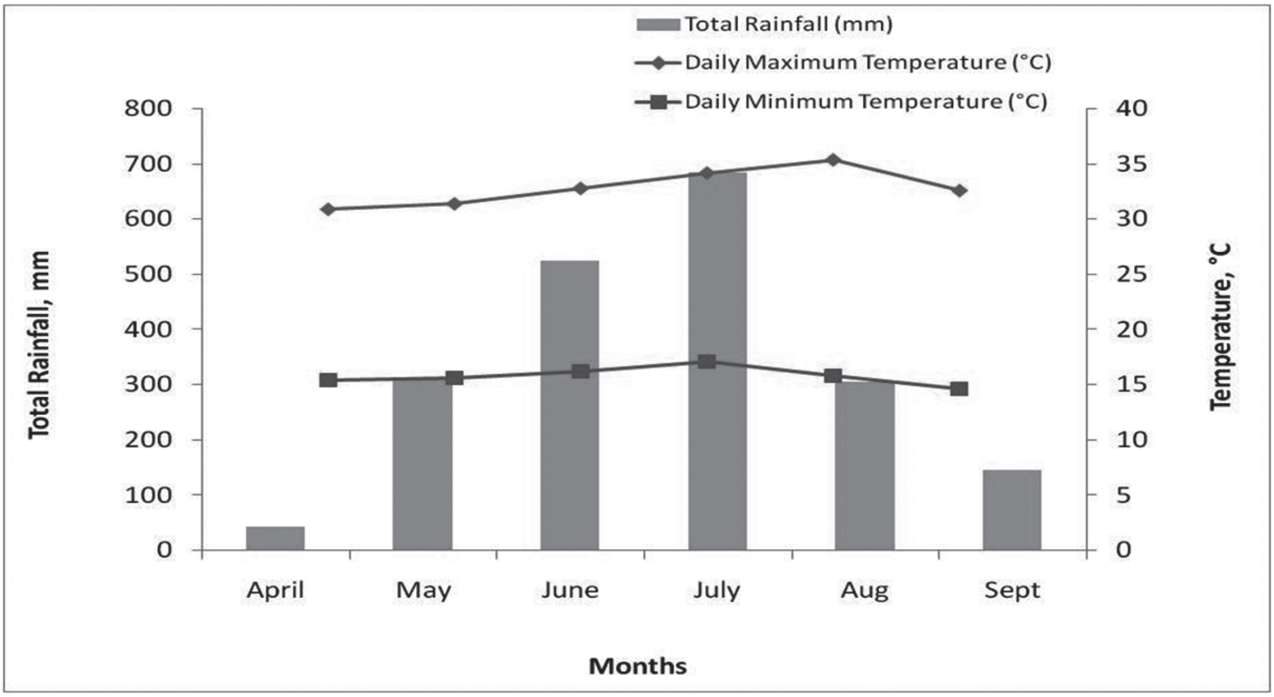


Figure 1. Monthly total rainfall, daily maximum and minimum temperature during the study period at Bandipur, Tanahun, Nepal in 2014

The experiment was conducted by using a Randomized Complete Block Design (RCBD) with four treatments. Different sowing dates (15^{th} April, 23^{rd} April, 1^{st} May and 9^{th} May) were used as treatments, and each treatment was replicated three times. A total of 12 experimental units, each with 4×2 square meter plot size were organized. Local cultivar of teosinte was used in the experiment with the seed rate of 40 kg ha^{-1}. Farm Yard Manure was applied at the rate of 10 t ha^{-1}. Chemical fertilizers Di-ammonium Phosphate (DAP) and Urea were applied for Nitrogen and Phosphorus at the rate of 90:60 kg ha^{-1}. Aggregate DAP and half quantity of urea were applied at the time of sowing as basal dose; and remaining half urea were splitted into three doses and applied as top dressing and after each initial two cuttings. Weeding were done to establish crop and to encourage re-growth after first harvest. Plant geometry was maintained as 40 cm row to row and 10 cm plant to plant distance.

The observation on growth parameters (plant height, number of leaves $plant^{-1}$ and number of tillers $hill^{-1}$) and fodder yield were assessed. Plant height and number of leaves $plant^{-1}$ at every 15 days interval until first harvest, and at the time of every harvest were taken, and number of tillers $hill^{-1}$ were recorded in each harvest. Fresh herbage mass at 50 days after sowing (50 DAS), 85 DAS and 120 DAS were taken. Dry matter contents of the samples were determined by using hot air oven (at 72°C for 24 hours) in the laboratory of Goat Research Station. The data were statistically analyzed by using GenStat Discovery Edition 4 Program (2011). The model included treatments and the blocks as the independent variables.

RESULTS

Plant height and number of leaves

The plant height and the number of leaves $plant^{-1}$ of teosinte under different sowing dates are presented in Table (1). The fodder teosinte sown on 9th May had attained more height (p>0.001) than the plant sown on other dates (P>0.001), at 15 DAS. Likewise, on the 30th day of the experiment, the teosinte sown on 23rd April and 1st May had attained taller plants (P>0.001). The similar result was obtained at the time of first harvest (50 DAS); the plants shown on 23rd April and 1stMay had shown higher plant heights (p>0.001). At the time of second harvest (85 DAS), the treatments of 23rd April and 1st May sown plants had attained taller plant height (p>0.001), but at the time of third harvest (120 DAS), earlier sown teosinte had significantly taller (p>0.001) plants than the plants shown in later dates.

Table 1. Plant height and numbers of leaves of the Teosinte under different sowing date at Bandipur, Tanahun, 2014

Date of sowing	Plant height, cm					No of leaves, $plant^{-1}$				
	15 DAS	30 DAS	50 DAS	85 DAS	120 DAS	15 DAS	30 DAS	50 DAS	85 DAS	120 DAS
15th April	26.12^d	87.62^c	136.00^b	174.89^b	160.62^a	5.37^a	7.50^a	7.86^a	7.75^a	9.17^a
23rd April	30.37^c	104.61^a	155.92^a	191.84^a	144.92^b	4.48^c	6.68^b	7.43^b	7.73^a	8.52^b
1stMay	38.88^b	107.28^a	167.26^a	198.02^a	140.68^b	4.90^b	5.95^c	6.57^c	6.88^b	6.93^c
9thMay	47.77^a	96.83^b	135.00^b	174.62^b	143.70^b	4.52^c	5.26^d	5.87^d	5.57^c	5.67^d
SEM	1.32	2.23	2.92	3.08	1.93	0.10	0.11	0.13	0.15	0.13
F-probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

The means with different alphabets are statistically different, SEM= Standard Error of Mean, DAS= Days after sowing

The more numbers of leaves plant^{-1} were obtained for the early shown treatments of teosinte. On the 15 days after sowing, number of leaves plant^{-1} were found significantly higher ($p>0.001$) for the plants sown on 15th April. Likely, the treatments of teosinte sown on 15th April had shown significantly higher ($p>0.001$) number of leaves plant^{-1} on 30 DAS, 50 DAS (at time of first cut), 85 DAS (at the time of second cut) and 120 DAS (at the time of third cut).

Number of tillers

The numbers of tillers hill^{-1} of teosinte was influenced by different sowing dates (Table 2). At the time of first harvest (50 DAS), more profuse tillering was found in the plants sown on 1st May in comparison to 9th May. The plants sown on earlier dates (15th April, 23rd April and 1st May) had statistically similar ($p>0.05$) number of tillers hill^{-1}. Likewise, the number of tillers hill^{-1} was significantly higher ($p<0.01$) for the plants sown on 15th April compared to the plants sown on 23rd April and 9th May, which is statistically similar with 1st May at the time of second harvest (85 DAS). The results obtained on the third harvest (120 DAS) were such that the number of tillers hill^{-1} was unremittingly reduced with the subsequent sowings. In this experiment, significantly higher ($p<0.001$) number of tillers were obtained for the plant sown on 15th April in comparison to the plants shown on 9th May in every harvest.

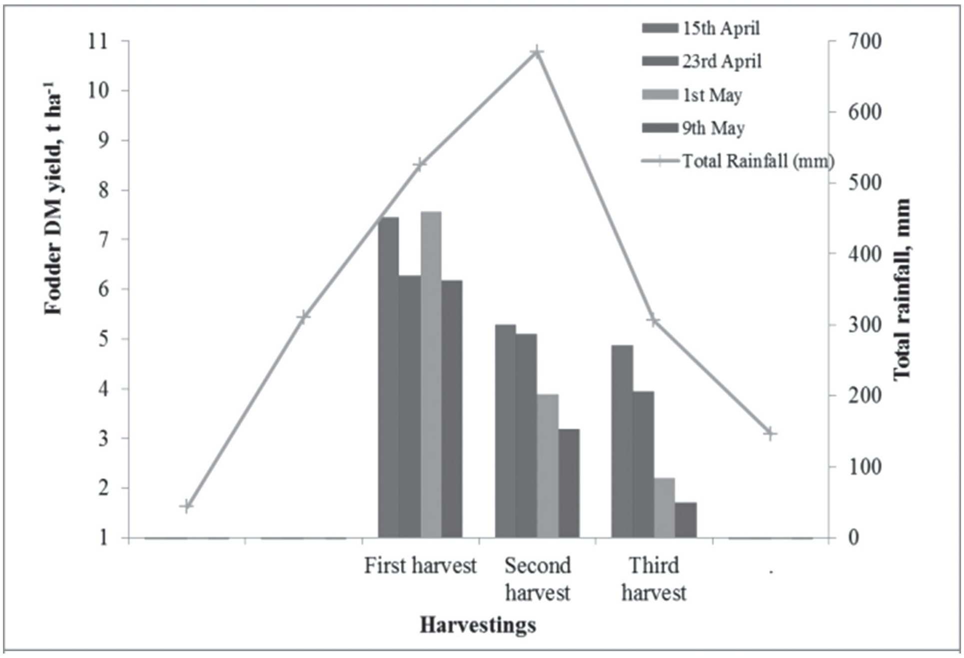
Table 2. Number of tillers hill^{-1} of teosinte under different sowing dates at Bandipur, Tanahun, 2014

Date of sowing	No of tillers hill^{-1}		
	First harvest (50 DAS)	Second harvest (85 DAS)	Third harvest (120 DAS)
15th April	5.22^{ab}	7.22^{a}	8.11^{a}
23rd April	5.00^{ab}	5.56^{b}	7.56^{a}
1st May	5.89^{a}	6.22^{ab}	6.78^{ab}
9th May	4.33^{b}	5.00^{b}	5.89^{b}
SEM	0.39	0.53	0.59
F-probability	<0.05	<0.01	<0.01

The means with different alphabets are statistically different, DAS= Days after sowing

Fodder yield

The results of the fodder dry matter yield of teosinte on different harvestings under different sowing dates along with the temperatures and rainfall in the study period are presented in Figure (1 and 2); on which the treatment means in each harvesting for dried fodder yield is compared. The dried biomass yield of teosinte sown on different dates were statistically similar ($p>0.05$) at the time of first harvest (50 DAS) where as the mean yields were within the range of 6.18 to 7.57 t ha^{-1}. But, at the second harvest (80 DAS), the fodder sown on initial two dates (15th April and 23rd April) had significantly higher ($p<0.05$) dried fodder biomass yield compared to later two dates (1st May and 9th May). The similar results were obtained for the third harvest as well.



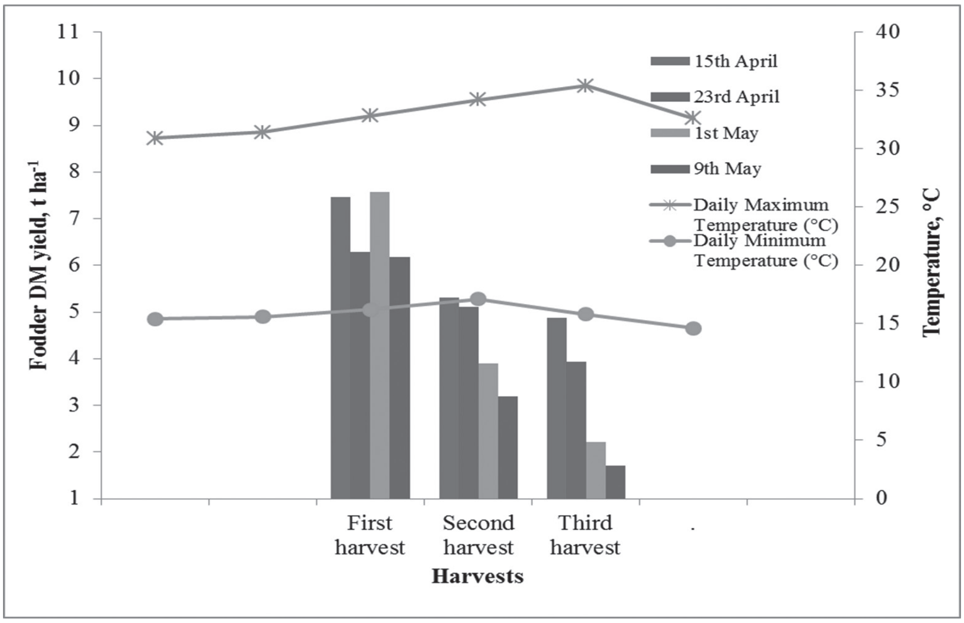


Figure 2. Monthly total rainfall, average daily minimum and maximum temperatures in the experimental period and mean fodder dry matter yield of three subsequent harvests of teosinte sown on different dates in 2014

The difference in the treatments means are non-significantly different ($p>0.05$) for first harvest, and significantly different for Second ($p<0.05$) and Third ($p<0.01$) harvests.

Total cumulative yield of the dried fodder was obtained higher for the treatments of earlier sowing dates. The dried fodder yield of teosinte sown on 15th April (17.56 t ha^{-1}) was significantly higher ($p<0.01$) than the yield of plants sown on 1st May and 9th May (13.67 and 11.08 t ha^{-1}, respectively). Likewise, the teosinte fodder sown on 23rd April had yielded higher dried fodder yield compared to the fodder sown on 9th May. Poorer dried fodder biomass yield was shown by the treatments of later sowing dates compared to the treatments of earlier sowing.

Table 3. Cumulative fodder dry matter yield of teosinte under different sowing dates at Bandipur, Tanahun, 2014

Date of sowing	Cumulative fodder DM Yield (t ha^{-1})
15th April	17.65^{a}
23rd April	15.33^{ab}
1st May	13.67^{bc}
9th May	11.08^{c}
SEM	1.31
F-probability	<0.01

The means with different alphabets are statistically different

The scatter plot of the means of the dried fodder yield of each harvest for the different treatments are presented in the Figure (3). Higher treatment means from the earlier sown treatments were obtained above the trend line and it was decrease by delaying the sowing dates. The line had a slope of -0.8858 with the constant value of 16.021.

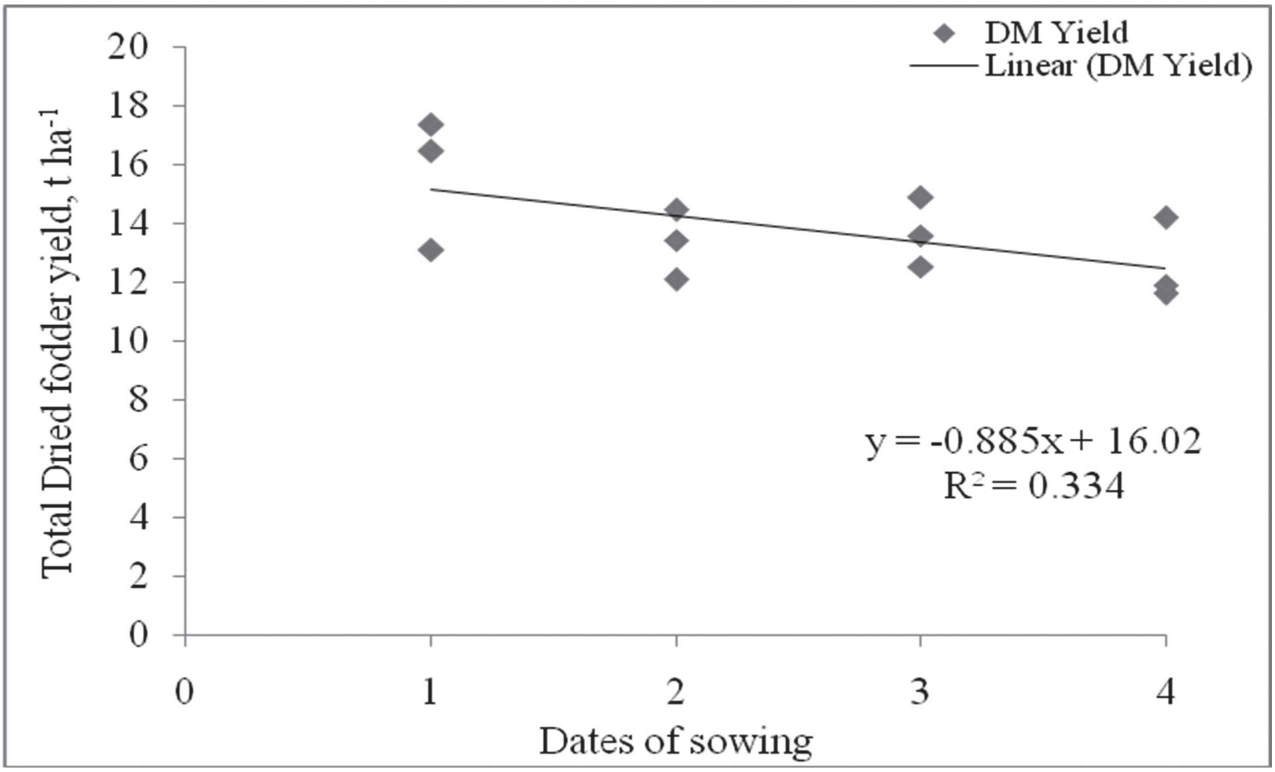


Figure 3. Relationships between mean dried fodder yield and sowing dates in 2014

The correlation matrix of the plant height, number of leaves plant^{-1}, number of tillers hill^{-1} and dry matter yield had shown that the correlation coefficients between fodder dry matter yield and other yield attributing characters, such as plant height, number of leaves, number of tillers were highly significant ($p<0.001$).

DISCUSSION

The results of the study revealed that growth parameters, such as plant height, number of leaves, number of tillers; and fodder biomass were significantly affected by the sowing date of teosinte (Table 1, Table 2 and Table 3). The reduction in number of leaves plant^{-1}, number of tillers hill^{-1} and fodder dry matter yield were more pronounced for later sowing dates. These findings are in close conformity with Abd El-Lattief (2011) as the author reported that date of sowing had significant effect for growth parameters and fodder yield of pearl millet (*Pennisetum glaucum*) with June planting having lower yields than earlier plantings in Egypt.

The dried fodder biomass yield was similar ($p>0.05$) in the first harvest for different sowing dates. But the treatments with later sowing dates had considerably reduced fodder biomass yield in successive harvestings, especially in the third harvest. It might be due to the extensive vegetative growing period on the summer climate for first and second harvests. The precipitation and temperatures were raised during the second harvest in comparison to first harvest (Figure 2). In the third harvest, the yields from later two sowing dates were severely affected by the aplenty decreased precipitation and by the lower maximum and minimum temperatures. The reason may be that the fodder yield was much affected by the shortened day length with altered temperature and precipitation. The temperature and precipitations changes the rate of the growth (Yoshida, 1981). The higher temperatures available to the early sown crop resulted in the better growth of crop in terms of plant height and tiller production thereby producing more tonnage of fodder (Jehangir *et al.*, 2013).

The dried fodder yield was continuously decreased in the later harvests for each treatment in this experiment. The poor persistency of teosinte to the more numbers of successive cuttings could be one of the reasons for this results. Teosinte responses to the photoperiods associated with different latitudes and time of sowing. Teosinte is a short day plant like other tropical plants in which no day neutral or long day properties have been found. This response to photoperiod seizures the vegetative stage of teosinte into reproductive stage after September when short day of less than 13 hours photoperiod begins. In order to achieve good reproductive performance, the seed of teosinte should be sown in the field in the spring and the plants made to blossom and mature 96 to 135 days when exposed to 10 hour photoperiods for 20 days (Mulhes and Ahrens, 1959). In addition, prevailing temperature is one of the determining factors in photoperiodic response. In the sense, photoperiod and temperature are the primary factors which influence time of retarding vegetative growth and development of its reproductive stage (Rogers, 1950).

The dried fodder yield was reduced significantly in the second and subsequent harvest for delayed showing dates. The decreased dry fodder yield could be due to the restricted supply of nutrients, perhaps due to disruption of vascular connection and utilization in various physiological and metabolic processes. Maas *et al.* (2007) reported that growth of pearl millet tend to decline from April through June planting and then significantly decreased when plantings were done in July or August under rain-fed conditions.

CONCLUSION

The findings of this study revealed that sowing teosinte on 15th and 23rd April had contributed substantially higher fodder yield in mid hills of western region of Nepal. It infer that managing planting date influences crop growth and development parameters such as plant height, number of leaves plant^{-1} , numbers of tillers hill^{-1}, and fodder yield of teosinte. Adjustment of the sowing date of teosinte from mid-April to third week of April can increase fodder productivity in the western mid hills, which could substantially contribute to mitigate the energy deficit situation of the Nepalese ruminant livestock in the summer season.

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