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Effect of Nano Urea on the Yield and Proximate Composition of Hedge Lucerne (*Desmanthus virgatus*) - Promising Legume Fodder for Livestock in Tamil Nadu

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ABSTRACT

Background: Improved agronomic practices such as optimum nutrient management, helps to improve forage quality and yield of the legume crop. The present study was conducted to find out the efficacy of nano urea on the yield and proximate nutrient composition of hedge lucerne grown. Comparing nano urea along with urea top dressing.

Methods: The experiment was laid out in randomized block design, replicated six times. At 35 days after sowing, T_1 (control) received 30 kg/ha of urea and treatment T_2 received 4 ml/lit of nano urea as top dressing respectively. Harvested leaf samples were analyzed separately for crude protein (CP), crude fibre (CF), total ash (TA), ether extract (EE) and nitrogen free extract (NFE).

Result: The results showed that Nano urea application 4ml/lit recorded higher plant height, biomass yield in three harvests. Further nano urea application improved the biomass yield of the crop compared to urea top dressing, but it was statistically on par with each other. The study also revealed that there is no significant difference between the nutritive values CP, CF, EE and NFE between the treatment (nano urea) and control. First three harvests in *Desmanthus virgatus* legume crop application of nano urea @ 4ml/lit as top dressing was onpar with that of urea top dressing in increasing the biomass yield.

Key words: Biomass yield, *Desmanthus virgatus*, Hedge lucerne, Legume fodder, Nano urea, Proximate composition.

INTRODUCTION

India is home to 15% of the world's cattle population, with only 2% of the global land area. Even though we own around 1/4 of the total global population of cattle, the fodder production accounts only 4% of the total cultivable land. The severity of the grazing is also extremely high (*i.e.*) 2.6 cattle units per hectare compared to 0.8 cattle units in industrialized nations. India's existing supplies of feed and fodder can barely full fill fewer than half of the 450 million cattle that are needed. The demand of green fodder is to the extent of 60% (Babu *et al.,* 2019). The major feed resources for livestock in our country are grasses, community grazing on common lands and harvested fields, crop residues and agricultural by-products, cultivated fodder, edible weeds, tree leaves from cultivated and uncultivated lands and agro-industrial by-products (Roy *et al*., 2019). There is very meager chance to allocate the land for fodder production, because today the food security is a burning issue as the number of malnourished people estimated to be around one billion (WHO, 2019).

Livestock population, plays a significant role in the economy of the rural people in general and particularly in the arid regions where crop husbandry often failures or pay less remuneration. Productive management of livestock could be only achieved by nutritious green fodder (Mynavathi *et al*., 2017). The country is facing severe shortage of feed and fodder, to feed the present livestock population (Lalit *et al*., 2025). Demand of greenfodder that too with quality green fodder supply is the prime important factor that limits the productivity of animals. It is highly imperative to bridge the gap between the supply and demand of high-quality nutritious dry matter with the declining availability of land. This could be achieved only by improving the productivity of the nutritious green fodder. Hence efforts should be made to improve the efficiency of feed utilization including energy and protein (Mahanta *et al*., 2020). This could be accomplished by enhancing high-yielding nutritious crops and by implementing better agronomic management practices (Patil *et al*., 2018).

Among the fodder crops, legume fodder helps to meet the protein requirement of animals with limited available quantity. *Desmanthus virgatus* is otherwise called as hedge lucerne is primarily used as legume fodder. It is highly palatable to ruminants and may be grazed or fed fresh in cut-and-carry systems (FAOSTAT, 2013). It is one of the legume crop which is most tolerant to grazing and

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withstands regular cutting (US Forest Service, 2010; Cook *et al.,* 2005) helps to control soil erosion, provides green manure and adds Nitrogen to the soil. It is a good quality legume green fodder which contains 20-22 percentage of protein content. Hence this helps to maintain the animal health and further sustain the milk production. This crop is widely used by farmers for its higher crude protein content and resistance to water stress condition.

The quality of the fodder depends upon the nutrient content of the crop and soil productivity. However, its productivity is low compared to other forage crops. This involves the development of agronomic management practices for increasing biomass and maintaining excellent fodder quality. Improved agronomic practices such as optimum nutrient management, intercropping system, timely/adequate tillage operation, planting at right time with adequate seed rate, timely water management, weed management and harvesting at right stage can all help to increase forage quality and yield (Suganthi *et al.,* 2019). Nanotechnology have emerged as promising solutions to enhance agricultural productivity and sustainability (Abhijit *et al*., 2025).

Comparing nano urea and urea granules in an area of nutrient management practice has been taken. Nano urea is a liquid urea which contains 4 per cent nitrogen as encapsulated analogues embedded on an organic matrix. It has a small size of 20 to 50 nm with more surface area (Rameshaiah *et al*., 2015). More surface area aids in dispersing nitrogen throughout the entire leaf, increasing absorption (Subbarao *et al.,* 2013). Therefore, the goal of the current study is to increase biomass yield through nutrient management strategies without sacrificing fodder quality.

MATERIALS AND METHODS

The experiment was conducted in degraded wasteland established under AICRP on Agroforestry Scheme at the Institute of Animal Nutrition, Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam, Tamil Nadu, India during 2021-22 to compare the effect of nano urea application with conventional urea application on the growth, yield parameters and nutritive value of *Desmanthus virgatus*. The farm is situated at 12.8198°N latitude and 80.0352°E longitude with an altitude of 52 M above mean sea level (MSL). The soil of the experimental site was calcareous in nature and having a pH of 6.2. The soil of the experimental field was low in nitrogen, medium in phosphorus and high in potassium. Annual rainfall of the region during the experimental period was 1911 mm and more than 80 per cent was received between August to December. Mean annual maximum and minimum temperature were 30.1°C and 25.54°C, respectively.

The crop was established with the spacing of 50×0 cm (solid row spacing). The experimental field was uniformly applied with FYM @ 25 t/ha and 25:40:20 kg NPK /ha was applied as basal as per the recommendation of crop production guide. The treatment and control plot was applied with nano urea @ 4 ml/lit and 30 kg nitrogen/ha as top dressing respectively. Nano urea particles were purchased from the SPIC commercial product and the recommended dose for all cereal crops are 4 ml/liter of water. However, in fodder crops research was not yet conducted seperately. Nano urea application was done by replacing urea top dressing of the crop. Other cultivation practices such as irrigation, weed management and were followed as per the Crop Production Guide (CPG, TNAU). Harvesting was carried out 90 days after sowing of the crop in control and treatment plots. The research plot size is 4×3 meter and the treatments are replicated six. The design of the experiment was mean comparison to find out the significance of the treatment and control. The observed values were analysed by SPSS mean comparison method.

T_1 - Control (30 Kg/ha of nitrogen as urea granules for top dressing).

T_2 - Recommended dose of 4 ml/nano urea per liter of water as top dressing.

RESULTS AND DISCUSSION

No significant variation (P>0.05) was observed in plant height, number of leaves, on 35th DAS (Day After Spraying) of nano urea in comparison with urea granules applied. The same trend continued during the later stages of crop growth such as at harvest also. The plant height and number of leaves are the best yield attributing characters. Number of leaves (Numbers) of control and treatment were 19.3±3.46 and 25.7±2.64, respectively (Table 1). Likewise the biomass Yield (t/ha) of *Desmanthus virgatus* was 13.94±0.35 and 14.19±0.70 tonnes per hectare in the first harvest. But there is no significant difference between the two groups of control and treatment at harvest also.

Table 1: Effect of nano urea in comparison with urea granules on *Desmanthus virgatus* fodder at first harvest (Mean ± SE).

Group	DAS (cm)^{NS}	Plant height (cm)^{NS}	Number of leaves	Stem girth	Fresh biomass yield (t/ha/harvest)^{NS}
T_1 - Control	35	67.5±2.87	16.7^a±3.43	1.08±0.03	6.43±0.17
T_2 - Treatment		73.8±5.06	23.5^b ±2.98	0.92±0.12	6.58±0.34
T_1 - Control	At harvest	111.3±6.80	19.3±3.46	1.08±0.03	13.94±0.35
T_2 - Treatment	(85 days)	114.2±0.35	25.7±2.64	0.92±0.12	14.19±0.70

*Mean of six replications. Mean bearing different superscripts within column differ significantly (P<0.05). NS- Non significant (P>0.05) variation between mean values.

The biomass yield of *Desmanthus virgatus* is higher in treatment when compared with control, whereas there is no significant difference among the treatments.

Plant height, number of leaves, on 35th DAS (Day After Spraying) of nano urea in comparison with urea granules was observed in second harvest also. There was no significant variation (P>0.05) was observed in these yield attributing characters. The plant height (cm) at harvest was 119.33±1.23 and 113.00±1.83 in control and treatment, respectively (Table 2) The same trend continued during the later stages of crop growth such as at harvest also. Number of leaves (Numbers) of control and treatment were 14.83±0.71 and 17.50±0.76, respectively. Likewise, the biomass yield (t/ha/harvest) of *Desmanthus virgatus* was 14.26±0.11 and 14.79±0.17 tonnes per hectare per harvest.

There is no significant variation (P>0.05) was observed in treatment and control group in plant height, number of leaves, on 35th DAS (Day After Spraying) and at harvest in comparison with urea granules applied. The same trend continued during the later stages of crop growth such as at harvest also. The plant height and number of leaves are the best yield attributing characters. Number of leaves (Numbers) of control and treatment were 25.67±0.558 and 26.17±0.792 respectively. Likewise the biomass yield (t/ha/harvest) of *Desmanthus virgatus* was 15.56±0.35 and 15.68±0.189 tonnes per hectare per harvest in third harvest (Table 3). But there is no significant difference between the two groups of control and treatment at harvest also. The biomass yield of *Desmanthus virgatus* is slightly higher in treatment when compared with control, whereas there is no significant difference among the treatment and control.

Harvested leaf samples were analyzed separately for crude protein (CP), crude fber (CF), total ash (TA), ether extract (EE) and nitrogen free extract (NFE). There is no significant variation (P>0.05) was observed in treatment and control group in proximate composition. The crude protein (%) content of urea and nano urea applied plots was 20.20±0.28 and 20.29±0.17. The value of crude protein was slightly higher in nano urea application whereas it is onpar with control.

Fertilizers play an important role especially nano fertilizers with their efficiency and environment friendly nature. Nitrogen use efficiency of the crop is poor when it is applied as urea and hence application of urea is comparable with that of nano urea. 40-60 per cent of nitrogen 80-90 percentage of phosphorus and 50-90 per cent of potassium are lost in the environment which causes considerable economic losses (Trenkel 2010; Saigusa 2000; Solanki *et al*., 2015). Nano fertilizers increased the availability of nitrogen by increasing the surface area of absorption (Yogendra *et al.,* 2021; Jeyani *et al*., 2025). Hence even in the very low quantity it gives better and comparable results with that of urea. There was no significant difference between the urea application (control) and nano urea application (treatment) group at all stages of crop growth including harvest stage also (Fig 1, Table 4). This might be due to regulation of release of nitrogen and deliver the correct quantity of nutrients required by the crops in suitable proportion and hence it promoted the productivity of the crop (De Rosa *et al*., 2010).

The biomass yield increase in *Desmanthus virgatus* was noticed at the harvest stage of all crops in nano urea application might be due to increased nitrogen use efficiency and the same results obtained by Rahale (2010). She reported that nano fertilizer increased the NUE up to 45% over control. She also reported that the release of nitrate from nano urea with zeolite continued even after 1176 hrs. Long term availability of nitrogen fertilizer in the plants helps to increase the biomass yield of the crop. Yogendra *et al.* (2021) also reported that slow and steady release of nitrogen from nano zeolite is for more than 45 days with

Table 2: Effect of nano urea in comparison with urea granules on *Desmanthus virgatus* fodder during second harvest (Mean*±SE).

Group	DAS	Plant height (cm)^{NS}	Number of leaves ^{NS}	Stem girth (cm)	Fresh biomass yield (t/ha/harvest)^{NS}
T_1- Control	35	90.0±4.35	14.83±0.95	1.67±0.04	5.86±0.17
T_2 - Treatment		98.3±3.67	15.50±0.76	1.18±0.03	6.05±0.11
T_1- Control	At harvest	119.33±1.23	14.83±0.71	1.38^{a}±0.06	14.26±0.11
T_2 - Treatment	(85 days)	113.00±1.83	17.50±0.76	1.57^{b}±0.10	14.79±0.17

*Mean of six replications. Mean bearing different superscripts within column differ significantly (P<0.05). NS - Non significant (P>0.05) variation between mean values.

Table 3: Effect of nano urea in comparison with urea granules on *Desmanthus virgatus* fodder at third harvest (Mean ± SE).

Group	DAS	Plant height (cm)^{NS}	Number of leaves ^{NS}	Stem girth (cm)^{NS}	Fresh biomass yield (t/ha/harvest)^{NS}
T_1- Control	35	93.7±0.29	16.5±0.34	1.4±0.07	6.01±0.09
T_2 - Treatment		95.0±1.09	18.0±0.37	1.5±0.11	6.16±0.13
T_1- Control	At harvest	112.8±0.94	25.7±0.56	1.5±0.06	15.60±0.27
T_2 - Treatment	(85 days)	112.5±1.18	26.2±0.79	1.5±0.09	15.68±0.19

*Mean of six replications. Mean bearing different superscripts within column differ significantly (P<0.05). NS - Non significant (P>0.05) variation between mean values.

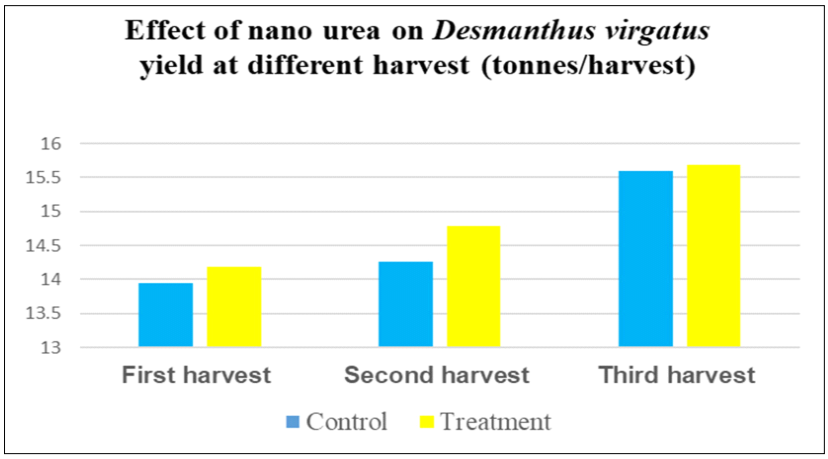


Fig 1: Comparing the yield of *Desmanthus virgatus* in nano urea applied plot with control at different harvest.

Table 4: Effect of nano urea on Proximate composition (%) in comparison with urea granules on *Desmanthus virgatus* fodder at third harvest (Mean±SE).

Proximate	*Desmanthus virgatus*	
Composition (%)	Control	Treatment
Crude protein	20.20±0.28	20.39±0.17
Crude fiber	5.32±0.07	5.18±0.09
Ether extract	4.54±0.09	4.72±0.05
Total ash	11.72±0.10	11.32±0.02
NFE	58.22±0.17	58.39±0.17

conventional fertilizer does of only 8 days. Subramanian and Rahale (2009) reported that release of nitrogen from nano fertilizer followed a sequence of a two-step process: An initial burst and a subsequent slow release up to 60 days. The use of nano fertilizer not only causes increased use efficiency of the elements but also reduces the toxicity generated due to over-application in the soil as well as reduces the split application of fertilizers (Naderi and Danesh-Shahraki 2013). Further it indicates that uptake mechanism is also triggered by the application of nano-urea as foliar spray. Similar finding was also reported by Babu *et al.* (2022). Nano-urea discharges nutrients in 40-50 days and it is applied on the leaves instead of soil; whereas conventional urea is applied in soil and discharges nutrients in 2-7 days (Manikandan and Subramaniam, 2018).

The biomass yield of *Desmanthus virgatus* was 15.60 kg/ha/cutting compared to treatment of 15.68 t/ha/cutting. The biomass yield of legume fodder is slightly higher in treatment compared to control. The same results were obtained in *Vigna mungo* (Black gram) crop where the yield was increased from 983.33 kg per hectare in control to 1587.33 Kg/ha in treatment reported by Islam *et al.* (2023). Kumar *et al.* (2021) reported that apart from increasing the yield of the crop it also increased the B:C ratio.

The crude protein content of urea and nano urea applied plots was 20.20±0.28 and 20.39±0.17. The value was slightly higher in nano urea application as mentioned earlier, where as it was statistically on par with urea and nano urea top dressing. The might be due to better absorption of nutrients in long term. Similarly the crude fibre is slightly lower in treatment compare to control whereas it is statistically on par with each other. This might be also due to better absorption of nutrient and water which creates more juiciness. Better absorption of nutrient improved the fat percentage which is evident from the higher value of ether extract which was 4.54±0.09 in treatment and 4.72±0.05 in control respectively.

CONCLUSION

From the above study it could be clearly expressed that nano urea application has potential to enhance crop yields, nutrient uptake and supporting the environment by way of lowering GHG emissions. Regarding the price of urea, the Government of India (GoI) is providing substantial subsidies. This suggests that we should either improve the efficiency of urea usage or explore alternative novel fertilizers to reduce the financial burden on both the government and farmers. Although, the spraying cost of nano-urea incurred additional burden on farmers but it can be minimized using drone on custom hiring basis.

Based on the findings of the study, it is possible to infer that the legume fodder crop reacted effectively to spray-applied nano urea top treatment. The application of nano urea 4 ml/lit. improved crop development and yield attributing parameters such as plant height, number of tillers and biomass yield over three harvests in *Desmanthus virgatus.* This is statistically comparable to the application of nitrogen in the form of urea as top dressing. It also balancing the cost and environment on both sides to benefit besides meeting out the requirement of plant nutrients.

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Conflict of interest

The authors declare no conflicts of interest.

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