

COMPARATIVE STUDY ON THE GROWTH AND YIELD PERFORMANCE OF *VIGNA UNGUICULATA* IN DIFFERENT DOSES OF NANO UREA TOP DRESSING

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ABSTRACT

Background: Better agronomic techniques, such as optimal nutrient management, contribute to increased fodder legume output and forage quality. The aim of the current study was to determine the effectiveness of different doses with nano urea such as 0ml, 2ml, 4ml and 6ml/liter of water as top dressing on growth and yield of Cowpea. **Methods:** The experiment was laid out with six replication using a Completely Randomized Design. Treatment includes T1 (complete control), T2, T3 and T4 which receives 2 ml/lit., 4ml/lit., 6ml/lit. of nano urea as top dressing respectively at 25 Days After Sowing(DAS). The observations were measured independently at 40DAS and at the time of harvest.

Result: Increased plant height and biomass yield were observed when 2 milliliters of nano urea were applied. When compared to control. Nano urea application at different doses increased the crop yield, while the results were statistically comparable with each other. Applying nano urea at the rate of 2 milliliter per litre of water as top dressing at 24 DAS increased the growth parameters and biomass yield of *Vigna unguiculata* legume fodder and it was comparable with higher doses of nano urea.

KEYWORDS: Biomass yield, *Vigna unguiculata*, Cowpea, Legume fodder, Nano urea.

INTRODUCTION

Total milk production in India is 247.87 million tonnes during 2024-25. The per-capita availability of milk is 485 grams per day (Ministry of Fisheries, Animal Husbandry & Dairying release, 2025). Annual growth rate of milk production has registered as 3.58% in 2024-2025 whereas, it has been decreased from 6.47 % in 2018-19. India owns around 1/4 of the total global population of cattle. But 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 (Suganthi *et al.*, 2019). To feed the present livestock population, the country is facing severe shortage of feed and fodder, (Lalit *et al.*, 2025). Demand of green fodder that too with quality green fodder supply is the prime important factor that limits the productivity of livestock. This might be the reason for steady decrease of annual growth rate of milk production.

Fodder production could be increased by increasing the land area, cultivating improved varieties and following improved agronomic management practices. There is very meagre chance to allocate the land for fodder production, because the food security is a burning issue today as the number of malnourished people estimated to be around one billion (WHO, 2019). Hence, the present condition could be overcome by enhancing high-yielding nutritious fodder crops and by implementing better agronomic management practices (Patil *et al.*, 2018). Efforts should be made to improve the efficiency of feed utilization, feeding of energy and protein rich green fodder. The most cheapest and promising alternative protein source for concentrate feed is our legume fodder.

Cowpea is a quick growing leguminous fodder crop. It is an excellent cover crop, which suppresses weeds and enriches the soil. Cowpea requires warm climate with good atmospheric humidity. It can be grown in *Kharif* as well as in *Zaid* season. Ensuring sufficient nutrient supply is crucial for the maximum growth and yield of cowpea (Raja *et al.*, 2022). Developing smart materials that can consistently release nutrients to particular targeted areas in plants is crucial to address such situations and may help control their deficits in agriculture. Although urea is widely used, only 30–40% of the nitrogen in granular urea is used by plants. The remaining nitrogen is lost through leaching and volatilization, which results in low Nitrogen Use Efficiency, greenhouse gas emissions, and water pollution, necessitating the investigation of alternate solutions (Houlton *et al.*, 2019; Tripathi *et al.*, 2025).

Because of their special qualities, nano fertilizers improve plant performance in terms of ultrahigh absorption, increased production, increased photosynthesis, and notable leaf surface area growth. Additionally, the regulated flow of nutrients helps to keep water resources safe. It is advantageous to replace conventional fertilizer with nano fertilizer since it delivers nutrients into the soil gradually and preventing water pollution.

Because of its desirable particle size about 20-50 nm and more surface area (10,000 times over 1 mm urea prill) and number of particles (55,000 nitrogen particles over 1 mm urea prill) nano urea is bio available too (Rameshaiah *et al.*, 2015). With the use of nanotechnology, it delivers nitrogen more efficiently to the target areas in the plant, reducing losses, and increasing efficiency (Mehta *et al.*, 2024; Yarang *et al.*, 2022). Al-Juthery *et al.* (2018) reported that nano fertilizer application increased the biomass yield of wheat. As a result, nano urea

improves crop nitrogen availability by over 80%, leading to increased nutrient use efficiency. Furthermore, by lowering the loss of nutrients from agricultural areas through leaching and gaseous emissions, nano urea contributes to lessening the environmental impact.

To increase the efficiency of urea absorption, previously for legume crops were recommended with 2 % urea spray. Foliar fertilizer application has been found to be the most effective method of applying plant nutrients in the form of foliar sprays because nutrients applied through the leaf penetrate the cuticle and stomata of the leaf and reach the cells very quickly, allowing rapid and effective nutrient utilization (Latha and Nadanassabady, 2003). It gives better foliage and pulse yield.

Further, improving the agronomic management techniques to boost biomass and preserve superior fodder quality. Forage quality and yield can be increased by using improved agronomic techniques such as intercropping, optimal nutrient management, timely/sufficient tillage operation, planting at the correct time with an adequate seed rate, timely water management, weed management, and harvesting at the proper stage. (Suganthi *et.al.*, 2025). Therefore, the current study was conducted with the goal of obtaining high-quality cowpea legume fodder using nano urea as top dressing at various dosages to improve nutrient usage efficiency and further to increase cowpea fodder yield and quality.

MATERIALS AND METHODS

In order to compare the effects of applying nano urea on the growth, yield parameters, and nutritive value of *Vigna unguiculata*, the experiment was carried out in degraded wasteland established under the AICRP on Agroforestry Scheme at the Institute of Animal Nutrition, Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam, Tamil Nadu, India, in 2021–2022. The farm is located 52 meters above Mean Sea Level (MSL) at latitude 12.8198°N and longitude 80.0352°E.

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 25.5°C, respectively.

The experiments were conducted in field no.4. Field was prepared by two cross harrowing and planking so as to get a levelled and weed free seed bed for quick germination and faster initial growth. The experimental plot size was 3 * 5 meter. The spacing of the crop was 30 *10 cm. Twenty-five kg (25 kg/ha) seed rate was used for sowing. Gap filling and thinning was done within two weeks of sowing to have two seedlings per hill in order to maintain 100% plant population. Weeding was done 20 days after sowing. The recommended dose of fertilizer is 25:40:20 kg NPK /ha along with 12.5 tonnes/ha of farmyard manure was used. The full amount of farmyard manure that was needed was administered basally. The nutrients were administered as urea single super phosphate and muriate of potash. Full doses of urea, single super phosphate, and muriate of potash were administered basally in accordance with the treatment plan. Twenty-five days after sowing, nano urea was sprayed as a top dressing in various concentrations, such as 0 ml, 2 ml, 4 ml, and 6 ml/liter. At 40 Days After Sowing (DAS) and at harvest, the observations were made. Further other management practices were followed in accordance with the Crop Production Guide (CPG, TNAU).

Experimental details

The objective of the experiment was to assess the efficiency of different doses of nano urea in *Vigna unguiculata*. The treatments were laid out in Completely Randomized Design (CRD). The data was analysed by one way Anova method

Treatments

- T1 - 0 ml/lit of nano urea as top dressing (control)
- T2- 2 ml/lit.of nano urea as top dressing
- T3 - 4 ml/lit.of nano urea as top dressing
- T4 - 6 ml/lit.of nano urea as top dressing

Replication: Six

RESULTS AND DISCUSSION

There is no significant variation ($P>0.05$) observed in-between three doses of nano urea application in growth and yield parameters. Plant height was significantly ($P<0.05$) lower in control and it was higher in all doses (2ml, 4ml and 6ml/liter) of nano urea application and it was statistically on par with each other. The leaf area observed was lower in control and it was 226.7 ± 5.01 cm² at 40 DAS. The leaf area of 2ml, 4ml and 6ml/liter of nano urea was 273.5 ± 4.54 , 273.8 ± 4.61 and 274.8 ± 2.65 cm² respectively. The biomass yield of *Vigna unguiculata* also continued the same trend.

Table.1.Effect on growth parameters and biomass yield (t/ha) of *Vigna unguiculata* in different doses of nano urea application as top dressing (Mean* $\pm$ SE) during first crop

Group	DAS	Plant height (cm) ^S	Number of leaves/plant ^{NS}	Leaf area (cm ²) ^S	Fresh biomass yield (t/ha) ^S
Control	40 Days After Sowing (DAS)	42.37 ^b $\pm$ 0.51	7.17 $\pm$ 0.79	226.70 ^b $\pm$ 5.01	6.30 ^b $\pm$ 0.289
2ml/ litre		54.48 ^a $\pm$ 0.51	10.33 $\pm$ 2.30	273.50 ^a $\pm$ 4.54	8.30 ^a $\pm$ 0.19
4ml/ litre		54.65 ^a $\pm$ 0.53	10.17 $\pm$ 1.82	273.80 ^a $\pm$ 4.61	8.40 ^a $\pm$ 0.34
6ml/ litre		54.92 ^a $\pm$ 0.53	10.67 $\pm$ 1.65	274.80 ^a $\pm$ 2.65	8.60 ^a $\pm$ 0.22
Control	At harvest	85.23 ^b $\pm$ 2.28	12.00 ^b $\pm$ 0.26	284.40 ^b $\pm$ 2.08	11.20 ^b $\pm$ 0.31
2 ml/ litre		95.82 ^a $\pm$ 1.64	14.83 ^a $\pm$ 0.31	318.40 ^a $\pm$ 0.90	12.97 ^a $\pm$ 0.47
4 ml/ litre		96.12 ^a $\pm$ 1.31	15.17 ^a $\pm$ 0.31	319.10 ^a $\pm$ 0.83	13.01 ^a $\pm$ 0.19
6 ml/ litre		96.35 ^a $\pm$ 1.227	15.16 ^a $\pm$ 0.308	319.4 ^a $\pm$ 0.691	13.09 ^a $\pm$ 0.33

*Mean of six replications. S- Significant (P<0.05), NS – Non significant (P>0.05) variation between mean values.

The same trend at 40 DAS was observed at harvest also. Plant height, number of leaves and leaf area was significantly (P<0.05) lower in control. Whereas it was higher in all doses of nano urea application. Application of 6 ml/litre showed the highest leaf area, but it was on par with 4 ml and 2 ml/litre application of nano urea at harvest. There is no significant difference noticed between them. The biomass yield of *Vigna unguiculata* was higher in 6 ml/litre and it was 13.09 $\pm$ 0.33. This was followed by 4 ml and 2 ml/lit. However, there is no significant difference observed between these three doses of nano urea application. The biomass yield of 4 ml and 2 ml/litre was 13.01 $\pm$ 0.19 and 12.97 $\pm$ 0.47 respectively which is onpar with higher doses of nano urea 6ml/lit. In control, biomass yield was significantly (P<0.05) reduced. Besides application of nano urea 2ml/lit is onpar with 4 and 6ml/lit, 2ml/lit is recommended considering the B:C ratio

Table 2. Effect of biomass yield (t/ha) of *Vigna unguiculata* in different doses of nano urea application as top dressing (Mean* $\pm$ SE) during second crop

Group	DAS	Plant height (cm) ^S	Number of leaves/plant ^S	Leaf area (cm ²) ^S	Fresh biomass yield (t/ha) ^S
Control	40 Days After Sowing (DAS)	46.12 ^b $\pm$ 0.49	6.78 ^b $\pm$ 0.69	232.5 ^b $\pm$ 3.92	6.19 ^b $\pm$ 0.19
2ml/ litre		51.34 ^a $\pm$ 0.52	11.02 ^a $\pm$ 0.92	274.21 ^a $\pm$ 3.25	8.42 ^a $\pm$ 0.25
4ml/ litre		52.01 ^a $\pm$ 0.57	11.17 ^a $\pm$ 0.79	275.80 ^a $\pm$ 3.12	8.46 ^a $\pm$ 0.30
6ml/ litre		52.53 ^a $\pm$ 0.48	11.26 ^a $\pm$ 0.58	275.92 ^a $\pm$ 3.10	8.52 ^a $\pm$ 0.34
Control	At harvest	79.24 ^b $\pm$ 1.82	10.45 ^b $\pm$ 0.31	279.51 ^b $\pm$ 1.94	10.78 ^b $\pm$ 0.27
2 ml/ litre		94.85 ^a $\pm$ 2.06	15.01 ^a $\pm$ 0.40	312.50 ^a $\pm$ 0.72	13.05 ^a $\pm$ 0.51
4 ml/ litre		95.20 ^a $\pm$ 1.21	15.32 ^a $\pm$ 0.57	312.90 ^a $\pm$ 0.61	13.16 ^a $\pm$ 0.25
6 ml/ litre		95.32 ^a $\pm$ 1.18	15.44 ^a $\pm$ 0.28	314.30 ^a $\pm$ 0.72	13.26 ^a $\pm$ 0.30

*Mean of six replications. S- Significant (P<0.05), NS – Non significant (P>0.05) variation between mean values

In second crop also there is no significant variation (P>0.05) was observed in-between three doses of nano urea application in growth and yield parameters. Plant height was significantly (P<0.05) lower in control and it was higher in all doses (2ml, 4ml and 6ml/litre) of nano urea application. The three doses of nano urea application it was statistically on par with each other. The leaf area observed was lower in control and it was 232.5 $\pm$ 3.92 cm² at 40 DAS. The leaf area of 2ml, 4ml and 6ml/litre of nano urea was 274.21 $\pm$ 3.25, 275.8 $\pm$ 3.12 and 275.92 $\pm$ 3.10 cm² respectively. The biomass yield of *Vigna unguiculata* also continued the same trend at 40 days after sowing of the crop.

At harvest the same trend as that of 40 DAS was observed. Plant height, number of leaves and leaf area was significantly (P<0.05) lower in control. Whereas it was higher in all doses of nano urea application.

Application of 6 ml/liter showed the highest leaf area, but it was on par with 4 ml and 2 ml/litre of nano urea application. The biomass yield of *Vigna unguiculata* was higher in 6 ml/liter and it was 13.26 ± 0.30 t/ha. This was followed by 4 ml and 2 ml/lit. The biomass yield of 4 ml and 2 ml/liter was 13.16 ± 0.25 and 13.05 ± 0.51 respectively. In control, yield was significantly ($P < 0.05$) lower, whereas in treatments like 2 ml, 4 ml and 6 ml/litre of nano urea application, the biomass yield was significantly ($P < 0.05$) higher, and they are on par with each other. This might be due to Nitrogen supports rapid cell division and expansion, increasing leaf and stem biomass. These physiological effects promote a more robust plant structure with increased biomass accumulation in vegetative parts leads to increase in the fodder yield. Similar results are in confirmation with Singh *et.al.* (2023) and Balachandrakumar *et.al.* (2024)

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 in soil as urea and hence application of urea as 2% spray is recommended in *Vigna unguiculata*. 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). The new technique of application of 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 a significant difference observed between nano urea application and control group at all stages of crop growth (Table 1 and 2). 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 increased the productivity of the crop. These findings were corroborate the earlier reports of De Rosa *et.al.* (2010).

The biomass yield was higher in *Vigna unguiculata* at harvest stage of the crops in nano urea application treatments might be due to increased nitrogen use efficiency and the same results were 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 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). This might be due to 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, Subbarao *et.al.*, 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). The biomass yield of *Vigna unguiculata* in T2 was 13.05t/ha compared to treatment of 10.78 t/ha (Table 2). The same results were obtained in *Vigna radiata* in which the yield was increased by foliar spray (Pratihari and Banerjee, 2023; Islam *et.al.*, 2023). The result is also in confirmation with Sachin *et.al.* (2024). He inferred that foliar-applied Nano DAP improved photosynthesis and nutrient uptake, ultimately enhancing yield and marketable output.

CONCLUSION

From the aforementioned study it is evident that using nano urea has the potential to improve agricultural yields, nitrogen uptake, and environmental support by reducing greenhouse gas emissions. To lessen the financial strain on both governments, the Government of India (GoI) recommends that we either increase the effectiveness of urea or investigate other innovative fertilizers. Even though farmers had to pay more for the spraying of nano-urea, this expense may be reduced by hiring drones on a custom basis. The study concluded that the legume fodder crop responded well to the spraying of nano urea as top dressing. In *Vigna unguiculata*, the application of 2 ml/liter of nano urea enhanced crop development and yield-attributing characteristics like plant height, number of leaves/plant and biomass yield. This is statistically equivalent to applying 4 and 6 milliliters of nano urea per liter of water. In addition to providing the necessary nutrients for plants, it also balances the costs and environmental benefits on both sides.

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Conflict of interest

The authors declare no conflicts of interest.

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