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RESEARCH PAPER

Effect of nitrogen and phosphorus rates and time of application on growth, fodder yield and quality of hedge lucerne

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Abstract: A field experiment was conducted at the MARS, Dharwad, Karnataka, during the *kharif* season of 2024-25 to study the effect of nitrogen and phosphorus rates and time of application on growth, yield and quality of hedge lucerne.The treatments comprised six nitrogen and phosphorus rates and three time of application. Application of 50 kg N and 60 kg P_2O_5 ha^{-1} significantly enhanced growth parameters like plant height and leaf to stem ratio,total green fodder (26.37 t ha^{-1}), dry fodder yield (5.52 t ha^{-1}), mean crude protein (21.36%) and total ash content (8.13%), total crude protein (1211.41 kg ha^{-1}) and total ash yield (471.0 kg ha^{-1}) as superior to lower levels of nutrient application. Application of nutrients in four splits (25% basal + 25% after 1st cut + 25% after 2nd cut + 25% after 3rd cut) significantly recorded higher growth parameters, total green fodder (23.25 t ha^{-1}), dry fodder yield (4.84 t ha^{-1}), mean crude protein (20.08%) and total ash content (7.76%), total crude protein (1003.5 kg ha^{-1}) and total ash yield (390.4 kg ha^{-1}) as compared three and two splits. Higher green fodder yield and quality of hedge lucerne can be obtained with application of 50 kg N and 60 kg P_2O_5 ha^{-1}in four splits was found optimum.

Key words: Crude protein content, Hedge lucerne, Nitrogen, Phosphorus, Time of application, Total ash content

Introduction

Desmanthus virgatus (L.), commonly known as hedge lucerne, is a perennial, multi-cut legume fodder crop from the *Fabaceae* family. Native to tropical and subtropical America, it adapts well to diverse agro-climatic conditions. It grows from a short herb to a woody shrub (up to 3 m), with deep roots, slender stems and bipinnate leaves. The plant produces white flowers and linear pods. It is highly palatable, non-toxic to ruminants and rich in crude protein (~15.2%). Its rapid regrowth allows for multiple cuttings, yielding up to 39.81 tonnes per acre over six harvests (Radhakrishnan *et al*., 2007). Compared to alfalfa, hedge lucerne is more tolerant to drought, acidic and sodic soils and does not cause bloat due to the presence of condensed tannins (2-3% DM). It is also less affected by pests and diseases and thrives with minimal inputs under rainfall ranging from 250-2000 mm. It is grown as a sole crop, intercrop or in alley cropping systems. Fodder crops need a higher amount of nutrients to support healthy vegetative growth and maintain quality through out their growing period. Nitrogen supports above-ground growth and helps in faster regrowth after cutting, while phosphorus is essential for early root development and is especially important in legumes, which need more phosphorus than cereals (Kumar *et al*., 2012). Proper management of nitrogen and phosphorus is essential for achieving higher yield and better quality in fodder crops. Also, the timing of nutrient application, especially nitrogen, plays a key role in improving its efficiency and crop uptake. Hedge lucerne is a highly palatable perennial fodder crop that grows well in various agro-climatic conditions. However, information on its nutrient management is less. Howevere, the present study was carried out during *kharif* 2024 in the Northern Transition Zone of Karnataka to evaluate the effect of different nitrogen and phosphorus rates and their time of application on the growth, fodder yield and quality of hedge lucerne.

Material and methods

The field experiment was carried out during *kharif* 2024 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka (15°29' N, 74°59' E, 678 m MSL), falling under Zone-8 (Northern Transition Zone). The total rainfall received during cropping period (July to December) was 660 mm well distributed with 42 rainy days. The site had clay soil, neutral pH (7.53), low organic carbon (0.46%) and available nitrogen (256.5 kg ha^{-1}), medium phosphorus (29.3 kg ha^{-1}) and high potassium (352.6 kg ha^{-1}). The experiment was laid out in split plot design with six nitrogen and phosphorus rates [M_1: 25 kg N + 40 kg P_2O_5 ha^{-1}, M_2: 25 kg N + 60 kg P_2O_5 ha^{-1}, M_3: 25 kg N + 80 kg P_2O_5 ha^{-1}, M_4: 50 kg N + 40 kg P_2O_5 ha^{-1}, M_5: 50 kg N + 60 kg P_2O_5 ha^{-1}, M_6: 50 kg N + 80 kg P_2O_5 ha^{-1}] as main plots, and three time of application [S_1:50 % as basal + 50% at 1st cut, S_2:50 % as basal + 25% at 1st cut + 25 % at 2nd cut and S_3: 25 % as basal + 25% at 1st cut + 25% at 2nd cut +25% at 3rd cut] as sub plots in three replication. The crop was sown at 45 cm row spacing with a seed rate of 15 kg ha^{-1}. The first cut was given at 75 days after sowing, leaving 30 cm stubbles, followed by nutrient application as per treatments. Subsequent cuts were taken at 30-day intervals (total 4 cuts). Growth parameters, fodder yield and quality were estimated. The data was analyzed using Fisher's method (ANOVA). Treatment means were compared using Duncan's Multiple Range Test (DMRT) at a 5% level of significance.Critical differences (CD) were calculated where the 'F' test was significant.

Results and discussion

Growth parameters

Increase in the application of nitrogen and phosphorus significantly increased the growth of hedge lucerne at all the stages. Significantly higher growth parameters were recorded at 30, 60, 75, 105, 135 and 165 DAS, such as plant height (12, 45.3, 102.9, 85.6, 77.8 and 65.6 cm, respectively) and leaf to stem ratio (0.93, 0.92, 0.88, 0.82 and 0.77, respectively) with application of 50 kg N and 60 kg P_2O_5 ha^{-1}(Table 1 and 2). This was on par with 50 kg N and 80 kg P_2O_5 ha^{-1}. Time of application of nutrients also influenced growth of the hedge lucerne. Similarly, four splits (25% as basal + 25% at 1st cut +25% at 2nd cut + 25% at 3rd cut) significantly recorded in higher plant height (11.4, 44.3, 98.3, 82.2, 73.3 and 61.1cm, respectively) and leaf to stem ratio (0.89, 0.85, 0.75 and 0.70, respectively). This was on par with three splits. Interaction effect of 50 kg N and 60 kg P_2O_5 ha^{-1} in four splits significantly resulted in higher plant height (13, 48.3, 107.4,87.9, 86.5 and 68.6 cm, respectively) and leaf to stem ratio (0.97, 0.95, 0.90, 0.86 and 0.82, respectively) as compared other treatments combinations,this may be due to synergistic effect of nitrogen and phosphorus with timely availability enhanced cellular activity through nutrient uptake.This in turn might have stimulated key physiological processes in the plant.The present findings are in line with those reported by Harikrishna (2005) in fodder maize, Malak (2005) in German grass and Islam (2007) in Napier grass.

Fodder yield

Similarly, application of 50 kg N and 60 kg P_2O_5 ha^{-1} significantly resulted in higher total green fodder (26.37 t ha^{-1}) and dry fodder yield (5.52 tha^{-1}) as compared lower rates. Significantly higher total green fodder (23.25 t ha^{-1}) and dry fodder yield (4.84 t ha^{-1}) were superior under four splits over to three and two splits. Application of 50 kg N and 60 kg P_2O_5 ha^{-1} in four splits significantly resulted in higher total green fodder (30.08 t ha^{-1}) and dry fodder yield (6.26 t ha^{-1}) as compared to other treatment combinations. This may be due to increased growth parameters. This were resulted in higher nutrient uptake

Table1. Plant height of hedge lucerne as influenced by nitrogen and phosphorus levels and their time of application

Treatments	30DAS (cm)	60DAS (cm)	75DAS (cm)	105DAS (cm)	135DAS (cm)	165DAS (cm)
Main plot- Nitrogen and phosphorus levels						
M_1	9.3^{b}	37.3^{b}	84.0^{b}	72.9^{b}	63.9^{c}	54.4^{c}
M_2	9.5^{b}	39.0^{ab}	90.1^{ab}	74.6^{b}	65.3^{c}	55.5^{c}
M_3	9.7^{b}	41.8^{ab}	93.5^{ab}	77.8^{ab}	66.8^{c}	57.5^{bc}
M_4	10.7^{ab}	42.3^{ab}	94.4^{ab}	80.5^{ab}	69.8^{bc}	58.7^{bc}
M_5	12.0^{a}	45.3^{a}	102.9^{a}	85.6^{a}	77.8^{a}	65.6^{a}
M_6	11.1^{ab}	44.5^{ab}	99.6^{a}	83.8^{a}	74.2^{ab}	62.1^{ab}
S.Em±	0.31	1.29	2.54	2.16	2.11	1.66
Sub plots-Time of application						
S_1	9.5^{b}	39.6^{b}	89.9^{a}	76.6^{b}	66.9^{b}	56.8^{b}
S_2	10.3^{ab}	41.2^{b}	94.5^{ab}	78.8^{ab}	68.8^{ab}	58.9^{ab}
S_3	11.4^{a}	44.3^{a}	98.3^{a}	82.2^{a}	73.3^{a}	61.1^{a}
S.Em±	0.24	0.79	1.83	1.44	1.41	0.97
Interaction						
M_1S_1	8.8^{fg}	32.8^{f}	74.3^{d}	70.8^{e}	62.2^{f}	52.8^{i}
M_1S_2	8.9^{fg}	38.7^{c-f}	87.9^{cd}	72.2^{de}	63.6^{f}	54.2^{hi}
M_1S_3	10.1^{b-g}	40.2^{b-e}	89.9^{bc}	75.6^{b-e}	66.0^{d-f}	56.1^{f-i}
M_2S_1	8.8^{fg}	38.2^{def}	88.7^{cd}	72.4^{de}	63.9^{f}	53.9^{hi}
M_2S_2	9.3^{e-g}	36.1^{ef}	89.9^{bc}	74.7^{c-e}	65.1^{ef}	55.1^{f-i}
M_2S_3	10.4^{b-g}	42.8^{a-d}	92.1^{bc}	76.8^{b-e}	67.0^{d-f}	57.4^{e-h}
M_3S_1	8.6^{g}	41.7^{b-e}	89.7^{b-d}	74.54^{c-e}	63.9^{f}	54.7^{g-i}
M_3S_2	9.8^{d-g}	39.8^{b-e}	92.5^{a-c}	76.4^{b-e}	65.6^{d-f}	57.9^{e-g}
M_3S_3	10.8^{b-f}	43.8^{a-d}	98.4^{abc}	82.4^{a-d}	70.9^{b-d}	59.8^{de}
M_4S_1	9.7^{e-g}	39.1^{c-f}	89.9^{bc}	77.4^{b-e}	66.3^{d-f}	57.4^{e-h}
M_4S_2	10.7^{b-f}	42.7^{a-d}	95.7^{a-c}	79.7^{a-e}	69.8^{c-e}	58.4^{ef}
M_4S_3	11.8^{a-d}	45.1^{a-c}	97.7^{a-c}	84.6^{a-c}	73.5^{bc}	60.3^{de}
M_5S_1	11.1^{a-e}	42.7^{a-d}	98.7^{a-c}	83.3^{a-c}	72.6^{bc}	62.0^{cd}
M_5S_2	12.0^{a-c}	44.9^{a-c}	102.7^{a-c}	85.5^{ab}	74.4^{bc}	66.1^{ab}
M_5S_3	13.0^{a}	48.3^{a}	107.4^{a}	87.9^{a}	86.5^{a}	68.6^{a}
M_6S_1	10.1^{c-g}	42.8^{a-d}	96.7^{a-c}	81.5^{a-d}	72.9^{bc}	60.1^{de}
M_6S_2	11.1^{a-e}	44.9^{a-c}	98.0^{a-c}	84.1^{a-c}	74.1^{bc}	62.1^{cd}
M_6S_3	12.1^{ab}	45.7^{ab}	104.20^{ab}	85.8^{ab}	75.6^{b}	64.0^{bc}
S.Em±	0.58	1.94	4.49	3.53	3.46	2.39

Note: DAS – Days after sowing, Means followed by the same lower case letter/s in a column do not differ significantly by DMRT (P=0.05)

Table 2. Leaf to stem ratio of hedge lucerne as influenced by nitrogen and phosphorus rates and time of application

Treatments	30 DAS	60 DAS	75 DAS	105 DAS	135 DAS	165 DAS
Nitrogen and phosphorus levels						
M_1	1.48^{a}	0.8^{b}	0.78^{c}	0.74^{b}	0.57^{c}	0.56^{d}
M_2	1.67^{a}	0.83^{ab}	0.78^{c}	0.76^{b}	0.62^{c}	0.60^{cd}
M_3	1.72^{a}	0.88^{ab}	0.84^{bc}	0.80^{ab}	0.67^{bc}	0.64^{cd}
M_4	1.59^{a}	0.91^{ab}	0.87^{ab}	0.81^{ab}	0.75^{ab}	0.67^{bc}
M_5	1.73^{a}	0.93^{a}	0.92^{a}	0.88^{a}	0.82^{a}	0.77^{a}
M_6	1.74^{a}	0.93^{a}	0.88^{ab}	0.84^{ab}	0.76^{ab}	0.73^{ab}
S.Em±	0.19	0.02	0.02	0.03	0.02	0.02
Time of application						
S_1	1.58^{a}	0.85^{a}	0.81^{b}	0.77^{b}	0.66^{b}	0.64^{b}
S_2	1.56^{a}	0.88^{a}	0.83^{b}	0.8^{ab}	0.69^{b}	0.65^{ab}
S_3	1.82^{a}	0.91^{a}	0.89^{a}	0.85^{a}	0.75^{a}	0.7^{a}
S.Em±	0.1	0.02	0.02	0.03	0.02	0.01
Interaction						
M_1S_1	1.26^{a}	0.8^{b}	0.72^{h}	0.71^{ab}	0.54^{f}	0.51^{i}
M_1S_2	1.31^{a}	0.79^{b}	0.74^{gh}	0.72^{ab}	0.58^{f}	0.56^{hi}
M_1S_3	1.87^{a}	0.82^{b}	0.88^{b-d}	0.8^{ab}	0.6^{f}	0.61^{fgh}
M_2S_1	1.73^{a}	0.78^{b}	0.78^{f-h}	0.69^{b}	0.6^{f}	0.56^{hi}
M_2S_2	1.6^{a}	0.81^{b}	0.76^{gh}	0.75^{ab}	0.56^{f}	0.59^{gh}
M_2S_3	1.67^{a}	0.9^{a}	0.82^{d-f}	0.85^{ab}	0.71^{de}	0.66^{def}
M_3S_1	1.38^{a}	0.8^{b}	0.79^{e-g}	0.79^{ab}	0.67^{e}	0.61^{fgh}
M_3S_2	1.8^{a}	0.92^{a}	0.84^{c-e}	0.81^{ab}	0.68^{e}	0.64^{efg}
M_3S_3	1.97^{a}	0.91^{a}	0.89^{bc}	0.81^{ab}	0.67^{e}	0.68^{cde}
M_4S_1	1.38^{a}	0.91^{a}	0.84^{c-e}	0.77^{ab}	0.71^{de}	0.72^{bc}
M_4S_2	1.49^{a}	0.89^{a}	0.86^{b-d}	0.83^{ab}	0.75^{cd}	0.62^{fg}
M_4S_3	1.91^{a}	0.95^{a}	0.92^{ab}	0.84^{ab}	0.79^{bc}	0.68^{cde}
M_5S_1	1.98^{a}	0.91^{a}	0.87^{b-d}	0.86^{ab}	0.77^{c}	0.73^{bc}
M_5S_2	1.5^{a}	0.95^{a}	0.91^{b}	0.87^{ab}	0.83^{ab}	0.77^{ab}
M_5S_3	1.7^{a}	0.94^{a}	0.97^{a}	0.9^{a}	0.86^{a}	0.82^{a}
M_6S_1	1.77^{a}	0.92^{a}	0.86^{b-d}	0.83^{ab}	0.69^{e}	0.7^{cd}
M_6S_2	1.67^{a}	0.93^{a}	0.87^{b-d}	0.83^{ab}	0.75^{cd}	0.72^{bc}
M_6S_3	1.8^{a}	0.93^{a}	0.89^{bc}	0.88^{ab}	0.85^{a}	0.76^{b}
S.Em±	0.24	0.04	0.06	0.1	0.04	0.03

Note: DAS – Days after sowing, Means followed by the same lower case letter/s in a column do not differ significantly by DMRT (P=0.05)

Table 3. Fodder yield and quality of hedge lucerne as influenced by nitrogen and phosphorus rates and time of application

Treatments	Total green fodder yield (t ha^{-1})	Total dry fodder yield (t ha^{-1})	Mean crude protein content (%)	Total crude protein yield kg ha^{-1}	Mean total ash content (%)	Total ash yield (kg ha^{-1})
Nitrogen and phosphorus levels						
M_1	15.74^{e}	3.23^{c}	17.93^{c}	591.31^{d}	6.53^{c}	213.9^{d}
M_2	17.10^{e}	3.53^{c}	18.37^{bc}	650.32^{cd}	7.00^{bc}	249.1^{d}
M_3	18.73^{d}	3.86^{c}	19.03^{bc}	752.94^{c}	7.16^{bc}	282.9^{cd}
M_4	21.02^{c}	4.57^{b}	19.41^{bc}	912.53^{b}	7.5^{ab}	347.8^{bc}
M_5	26.37^{a}	5.52^{a}	21.36^{a}	1211.41^{a}	8.13^{a}	471.0^{a}
M_6	23.18^{b}	4.78^{b}	20.03^{ab}	989.86^{b}	7.73^{ab}	369.7^{b}
S.Em.±	0.31	0.11	0.52	22.08	0.18	14.9
Time of application						
S_1	18.34^{c}	3.79^{b}	18.58^{c}	732.51^{b}	6.97^{a}	270.5^{b}
S_2	19.87^{b}	4.11^{b}	19.40^{b}	818.14^{b}	7.3^{a}	306.2^{b}
S_3	23.25^{a}	4.84^{a}	20.08^{a}	1003.54^{a}	7.76^{a}	390.4^{a}
S.Em.±	0.32	0.10	0.32	20.37	0.14	6.4
Interaction						
M_1S_1	13.82^{j}	2.83^{g}	17.16^{g}	502.85^{h}	6.43^{e}	188.8^{i}
M_1S_2	14.65^{j}	3.00^{g}	18.01^{fg}	549.36^{gh}	6.46^{e}	193.8^{i}
M_1S_3	18.75^{gh}	3.86^{d-f}	18.63^{c-g}	721.71^{f}	6.7^{e}	259.0^{gh}
M_2S_1	15.14^{j}	3.10^{fg}	17.77^{fg}	545.36^{gh}	6.85^{de}	209.9^{hi}
M_2S_2	17.08^{i}	3.52^{e-g}	18.11^{fg}	636.84^{fgh}	6.98^{c-e}	255.3^{gh}
M_2S_3	19.09^{g}	3.98^{de}	19.22^{c-f}	768.74^{ef}	7.17^{c-e}	282.3^{fg}
M_3S_1	16.88^{i}	3.45^{e-g}	18.57^{d-g}	667.97^{f-h}	6.91^{c-e}	242.2^{g-i}
M_3S_2	17.61^{hi}	3.65^{e-g}	19.27^{c-f}	701.58^{fg}	7.16^{c-e}	260.7^{gh}
M_3S_3	21.70^{ef}	4.48^{cd}	19.24^{c-f}	889.26^{de}	7.41^{b-e}	346.0^{de}
M_4S_1	19.10^{g}	4.03^{de}	18.43^{e-g}	765.09^{ef}	7.05^{c-e}	286.7^{fg}
M_4S_2	21.84^{ef}	4.56^{cd}	19.37^{c-f}	905.19^{de}	7.52^{b-e}	335.7^{d-f}
M_4S_3	24.40^{bc}	5.11^{bc}	20.43^{b-d}	1067.31^{bc}	7.92^{a-d}	420.9^{bc}
M_5S_1	23.70^{cd}	4.93^{bc}	20.34^{b-e}	1032.28^{b-d}	7.41^{b-e}	381.1^{cd}
M_5S_2	25.34^{b}	5.35^{b}	21.34^{ab}	1166.91^{b}	8.12^{a-c}	440.5^{b}
M_5S_3	30.08^{a}	6.26^{a}	22.39^{a}	1435.05^{a}	8.87^{a}	591.5^{a}
M_6S_1	21.37^{f}	4.42^{cd}	19.24^{c-f}	881.49^{de}	7.17^{c-e}	314.6^{ef}
M_6S_2	22.68^{de}	4.57^{cd}	20.27^{b-e}	948.95^{cd}	7.56^{b-e}	351.5^{de}
M_6S_3	25.49^{b}	5.35^{b}	20.58^{bc}	1139.16^{b}	8.45^{ab}	442.9^{b}
S.Em.±	0.78	0.24	0.79	49.88	0.36	15.6

Note: DAS – Days after sowing, Means followed by the same lower case letter/s in a column do not differ significantly by DMRT (P=0.05)

by the crop and in turn increase in the fodder yield. These results were similar to the reports of Chaudhary *et al*. (2020) where the increased application of nitrogen and phosphorus to pearl millet resulted in higher growth and fodder yield. Conversely, green fodder yields (Fig 1 and 2) of hedge lucerne were decreased from the first to the fourth cut, which could be attributed to reduction in per-day productivity from second cut onwards and a gradual decrease in dry matter production per plant at later harvest stages. Green fodder yield exhibited a strong correlation with dry matter production and the reduction

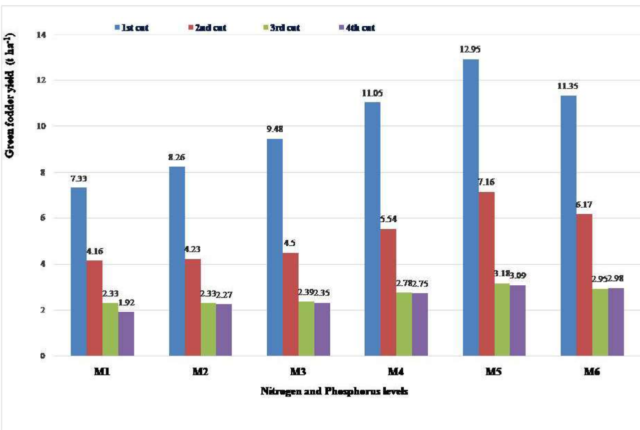

Fig 1.Green fodder yield of hedge lucerna at 75, 105, 135 and 165 DAS as influenced by nitrogen and phosphorus levels

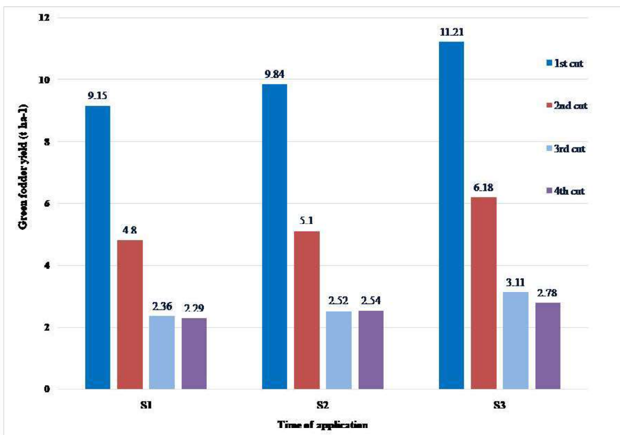

Fig 2.Green fodder yield of hedge lucerna at 75, 105, 135 and 165 DAS as influenced by application of nitrogen and phosphorus levels

in yields at successive cuts may also be linked to cooler weather conditions during those periods. A similar trend was observed in Hybrid Napier by Ishrath *et al*., (2018). Green fodder yield of berseem was declined with successive cuts under varying fertilizer levels under Dharwad condition (Vidyashree *et al*., 2023) and Mynavathi *et al*. (2021) in hedge lucerne.

Quality parameters

Application of 50 kg N and 60 kg P_2O_5 ha^{-1}significantly obtained higher mean crude protein (21.36%) and total ash content (8.13%), total crude protein (1211.41 kg ha^{-1}) and total ash yield (471.0 kg ha^{-1}) as compared to lower levels. In case time of application, significantly higher mean crude protein (20.08%) and total ash content (7.76%), total crude protein (1003.5 kg ha^{-1}) and total ash yield (390.4 kg ha^{-1}) was obtained under the four splits as compared three and two splits. Combined effect of 50 kg N and 60 kg P_2O_5 ha^{-1} in four splits significantly resulted in higher mean crude protein (22.39%) and total ash content (8.87%), total crude protein (1435.1 kg ha^{-1}) and total ash yield (591.5 kg ha^{-1}) over other treatments. Higher quality parameters mainly depends on the nitrogen concentration in the plant which influenced the protein synthesis, as nitrogen is the chief component of amino acids and also higher crude protein and total ashyield as well as dry fodder yield resulted from the higher nutrients supplied at right time. Similar results were also observed by Wangchuk *et al*. (2015) in Hybrid Napier.These observations corroborate earlier reports by Sheta *et al*. (2010) in fodder oat and Muttappanavar and Shekara (2023) in hedge lucerne.

Conclusion

On the basis of data obtained from the present investigation, it can be concluded that application of 50 kg N and 60 kg P_2O_5 ha^{-1}in four splits (25% as basal + 25% at 1st cut + 25% at 2nd cut + 25% at 3rd cut) was better for higher green fodder yield and quality of hedge lucerne.

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