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GROWTH, YIELD AND QUALITY OF HEDGE LUCERNE (*DESMANTHUS VIRGATUS* (L.) WILLD.) AS INFLUENCED BY DIFFERENT AGRO-TECHNIQUES IN SOUTHERN DRY ZONE OF KARNATAKA

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SUMMARY

A filed experiment was carried out at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, Karnataka during 2020-21 and 2021-22 to identify the planting geometry, nutrients requirement and its application in hedge lucerne for higher green forage yield and quality under irrigated condition. The experiment consisted 18 treatment combinations *viz.,* two planting geometry as main plots, three nutrient levels as sub plots and three time of nutrient ($N:P_2O_5:K_2O$ kg/ha) application as sub-sub plots and laid out in split-split plot design with three replication. The pooled data revealed that, 45 cm row spacing recorded significantly higher green fodder, dry matter, crude protein and total digestible crude protein yield (844.7, 167.2 33.4 and 31.7 q/ha/year, respectively). Among nutrient levels, application of 50:100:50 :: $N:P_2O_5:K_2O$ kg/ha registered higher green fodder, dry matter, crude protein and total digestible crude protein yield (853.7, 169.1, 34.0 and 32.3 q/ha/year, respectively) and found on par with application of 37.5:75:37.5 :: $N:P_2O_5:K_2O$ kg/ha. The nutrient application in four splits recorded significantly higher green fodder, dry matter, crude protein and total digestible crude protein yield (840.8, 166.3, 33.3 and 31.6 q/ha/year, respectively) which was at par with three split applications on pooled basis.

Key words : Hedge lucerne, agro-techniques, growth and yield of fodder, fodder quality

India being home to world's largest livestock population, animal husbandry plays a significant role in the economy of the people in general and more particularly in the regions where crop husbandry offers less remuneration. High yielding and nutritious green fodder are essential for effective management of livestock (Mynavathi *et al.,* 2017). Among the factors limiting the productivity of livestock, inadequate availability of quality fodder is the most important one. There exists a shortage of green fodder to the extent of 30 per cent (Shekara *et al.,* 2019). Considering the huge gap between the demand and supply of green nutritious fodder and quality dry matter yield, it is essential to bridge this gap through exploration of new perennial fodder legume crop.

The perennial legume fodder, *Desmanthus virgatus* (L.) Willd., commonly known as hedge lucerne is highly tolerant to regular cutting and grazing by ruminants hence, is highly suitable as a leguminous fodder crop in varied agro-climatic conditions. After cutting to certain height, it regrows rapidly producing numerous fine stems. The biomass yield of hedge lucerne per acre for six cuttings was reported as 39.81 Mg and the mean crude protein content was 15.20 per cent, respectively (Radhakrishnan *et al.,* 2007). The different agronomic practices will significantly influence the growth, yield and quality of fodder. Hedge lucerne is a highly palatable forage legume, but appropriate management practices are needed to ensure both quantity and suitable quality as fodder. Pursuing of literature revealed scanty information on the yield of hedge lucerne. With this background, the present study was undertaken to find out the optimum planting geometry, amount of macro-nutrients required and time of nutrient application on growth parameters, yield and quality of hedge lucerne.

MATERIAL AND METHODS

The field experiment was conducted during 2020-21 and 2021-22 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, University of Agricultural Sciences, Bengaluru, which is situated in Southern Dry Zone (ACZ-VI) of Karnataka between 12°45 and 13°57 North latitude and 76°45 and 78°24′ East longitude at an altitude of 695 m above mean sea level. The soil of the experimental site is neutral in reaction (7.47) with electrical conductivity of 0.37 dS/m, medium in organic carbon (0.55%), low in available nitrogen (269.7 kg/ha), medium in available phosphorous (48.5 kg/ha) and potassium (174.7 kg/ha). The experiment was laid out in split-split plot design with eighteen treatment combinations comprising of two planting geometry (P_1: 30 cm and P_2: 45 cm row spacing with continuous sowing) as main plots, three nutrient levels (N_1: 25:50:25, N_2: 37.5:75:37.5 and N_3: 50:100:50 $N:P_2O_5:K_2O$ kg/ha, respectively) as sub plots and three time of nutrient ($N:P_2O_5:K_2O$ kg/ha) application (T_1: Entire dose of as basal, T_2: 50 % as basal + 25% at 3rd cut +25 % at 6th cut and T_3: 25 % as basal + 25% at 2nd cut + 25% at 4th cut +25 % at 6th cut) as sub-sub plots and replicated thrice. The crop was sown at a planting geometry of 30 cm and 45 cm row spacing with continuous sowing as per the treatment and 25 per cent of the RDF of lucerne crop (6.25:12.5:6.25 $N:P_2O_5:K_2O$ kg/ha) was taken as a base of nutrients for better establishment of hedge lucerne crop and uniformly applied for all the treatments at the time of sowing. After complete establishment of the crop, uniform cut was given at 75 days after sowing by leaving stubbles of 30 cm height and thereafter, the amount and time of nutrients application was followed as per the treatments. While the subsequent cut was given at 40 days interval. Total of 7 cuts in the first year and 9 cuts in the second year was taken. At the time of harvesting plant height and green fodder yield was recorded and known quantity of sample was taken, separated into leaf and stem and oven-dried at 70 ± 2°C temperature for leaf stem ratio and dry matter estimation. Later samples were powdered for crude protein estimation. The data of two years were statistically analyzed and discussed on pooled basis.

RESULTS AND DISCUSSION

Plant height

The plant height of hedge lucerne didn't differ significantly at different planting geometry. However, the numerically higher plant height was recorded with 30 cm row spacing (93.3 cm) followed by 45 cm row spacing (90.0 cm) on pooled basis (Table 1). This might be due to less interception of solar radiation in closer spacing which resulting in more auxin concentration that may led to increased plant height

TABLE 1

Plant height and leaf stem ratio of hedge lucerne as influenced by planting geometry, nutrient levels and time of nutrient application

Treatments	Plant height (cm)			Leaf stem ratio		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Planting geometry (P)						
P_1: 30 cm between rows x continues sowing	94.7	91.9	93.3	0.81	0.78	0.79
P_2: 45 cm between rows x continues sowing	91.2	88.7	90.0	0.89	0.86	0.87
S.Em ±	1.28	1.30	1.27	0.01	0.01	0.01
C.D. (p=0.05)	NS	NS	NS	0.07	0.07	0.07
Nutrient levels (N)						
N_1: 25:50:25 kg $N:P_2O_5:K_2O$/ha	88.8	85.9	87.4	0.78	0.74	0.76
N_2: 37.5:75:37.5 kg $N:P_2O_5:K_2O$/ha	94.3	91.8	93.0	0.87	0.85	0.86
N_3: 50:100:50 kg $N:P_2O_5:K_2O$/ha	95.7	93.4	94.5	0.90	0.87	0.88
S.Em ±	1.30	1.35	1.35	0.01	0.01	0.01
C.D. (p=0.05)	4.24	4.39	4.39	0.04	0.04	0.04
Time of nutrient ($N:P_2O_5:K_2O$ kg/ha) application (T)						
T_1: Entire dose of as basal	90.4	87.4	88.9	0.80	0.77	0.79
T_2: 50% as basal + 25% at 3rd cut +25% at 6th cut	93.7	91.3	92.5	0.86	0.83	0.85
T_3: 25% as basal + 25% at 2nd cut + 25% at 4th cut+25% at 6th cut	94.9	92.5	93.7	0.88	0.86	0.87
S.Em ±	1.14	1.13	1.12	0.01	0.01	0.01
C.D. (p=0.05)	3.32	3.31	3.27	0.03	0.03	0.03
Interaction						
P × N	NS	NS	NS	NS	NS	NS
P × T	NS	NS	NS	NS	NS	NS
N × T	NS	NS	NS	NS	NS	NS
P × N × T	NS	NS	NS	NS	NS	NS

through enhanced cell division and cell elongation. On the other hand, the stem length of crops gets reduced under wider spacing due to more sunlight availability to the crop leading to less competition between the plants (Buxton, 2001). Similar results were reported by Molosiwa *et al.* (2022) who observed slight decrease in plant height with widening distance between the rows. Among nutrient levels, application of 50:100:50 N:P_2O_5:K_2O kg/ha recorded significantly higher plant height (94.5 cm) and found on par with 37.5:75:37.5 N:P_2O_5:K_2O kg/ha (93.0 cm). The significantly lower plant height was observed with application of 25:50:25 N:P_2O_5:K_2O kg/ha (87.4 cm) on pooled basis. This might be due to better absorption of nutrients, improved vegetative growth and increased plant metabolic activities with higher levels of nutrients. Similar findings were also observed by Satpal *et al.* (2020) and Kumar *et al.* (2021). Further, application of nutrients in four splits (T_3) recorded significantly higher plant height (93.7 cm) which was on par with application of nutrient in three splits (T_2) (92.5 cm) and significantly superior over application of entire dose of nutrients as a basal (88.9 cm) on pooled basis. The increase in plant height might be due to availability of nutrients to the crop throughout the crop growth period with more number of split application of nutrients. Further, soil of the experimental site is sandy loam in nature. The application of entire dose as a basal may led to various losses of nutrients *viz.,* leaching losses and fixation of phosphorus which resulted in non availability to the crop and thereby reduced the plant height. These results are in line with the findings of Ullah *et al.* (2015) in fodder maize and Naveena *et al.* (2021) in fodder oats. Interaction between planting geometry, nutrient levels and time of nutrient application were found non-significant with respect to plant height. The similar trend was observed during both the years of study.

Leaf stem ratio

Leaf stem ratio is an important factor determining the selection of diet, quality and forage intake of livestock. The mean leaf stem ratio of hedge lucerne was significantly higher with the crop sown at a wider spacing of 45 cm row spacing (0.87) than 30 cm row spacing (0.79) on pooled basis (Table 1). The more availability of light, water and nutrients

TABLE 2

Green fodder and dry matter yield of hedge lucerne as influenced by planting geometry, nutrient levels and time of nutrient application

Treatments	Green fodder yield (q/ha/year)			Dry matter yield (q/ha/year)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Planting geometry (P)						
P_1: 30 cm between rows x continues sowing	710.7	834.1	772.4	140.1	163.9	152.0
P_2: 45 cm between rows x continues sowing	777.0	912.5	844.7	154.1	180.3	167.2
S.Em ±	10.1	12.2	10.9	2.1	2.5	2.2
C.D. (p=0.05)	61.6	74.5	66.4	12.5	15.1	13.6
Nutrient levels (N)						
N_1: 25:50:25 kg N:P_2O_5:K_2O/ha	680.7	800.4	740.6	133.9	156.7	145.3
N_2: 37.5:75:37.5 kg N:P_2O_5:K_2O/ha	765.2	897.8	831.5	151.5	177.3	164.4
N_3: 50:100:50 kg N:P_2O_5:K_2O/ha	785.6	921.8	853.7	155.8	182.3	169.1
S.Em ±	10.4	13.0	11.9	2.2	2.7	2.4
C.D. (p=0.05)	34.0	42.3	38.8	7.3	8.8	8.0
Time of nutrient (N:P_2O_5:K_2O kg/ha) application (T)						
T_1: Entire dose of as basal	704.5	826.1	765.3	138.9	162.2	150.6
T_2: 50% as basal + 25% at 3rd cut +25% at 6th cut	756.5	888.7	822.6	149.8	175.3	162.5
T_3: 25% as basal + 25% at 2nd cut + 25% at 4th cut +25 % at 6th cut	773.5	908.2	840.8	153.2	179.4	166.3
S.Em ±	9.1	10.9	9.8	1.7	2.0	1.9
C.D. (p=0.05)	26.4	31.7	28.7	5.0	6.0	5.4
Interaction						
P × N	NS	NS	NS	NS	NS	NS
P × T	NS	NS	NS	NS	NS	NS
N × T	NS	NS	NS	NS	NS	NS
P × N × T	NS	NS	NS	NS	NS	NS

offered by wider spacing resulted in higher synthesis of photosynthates (CHO) and increased activity of hormonal growth regulators resulted in more number of leaves and leaf area which led to higher leaf stem ratio (Naim *et al.,* 2011). Application of higher doses of nutrients (50:100:50 $N:P_2O_5:K_2O$ kg/ha) recorded significantly higher leaf stem ratio (0.88) which is at par with 37.5:75:37.5 $N:P_2O_5:K_2O$ kg/ha (0.86) over lower nutrient levels (25:50:25 $N:P_2O_5:K_2O$ kg/ha) (0.76) on pooled basis. This might be due to more light use efficiency of above ground part which in turn attributed to an improved photosynthetic rate which improves leaf density, mesophyll cell surface area, specific leaf thickness and leaf weight (Chabot and Chabot, 2004). Similar findings were also reported by Mubeena *et al.* (2020) and Kumar *et al.* (2021). Among time of nutrient application, significantly higher leaf stem ratio was recorded with the application of nutrients in four splits (0.87) and found on par with three split applications (0.85) and superior over application of entire dose of nutrients as a basal (0.79). The trend was similar during both the years of study. Adequate nutrition throughout crop growth period and minimum various losses of nutrients might have resulted in more leaf area and number of leaves per stem which in turn increased the leaf stem ratio (Arshad *et al.,* 2016; Singh and Dutta, 2021). Whereas, Leaf stem ratio didn't differ significantly due to interaction among planting geometry, nutrient levels and time of nutrient application.

Green fodder yield

The significant difference in green fodder yield was observed among planting geometry. The crop sown at a row spacing of 45 cm recorded significantly higher green fodder yield (844.7 q/ha/year) as compared to 30 cm row spacing (772.4 q/ha/year) on pooled basis (Table 2). The increase in green fodder yield might be due to better utilization of available resources *viz.,* space, water and nutrients with optimum plant population which might have enhanced the growth parameter mainly number of branches, leaf stem ratio and dry matter accumulation per unit area may led to higher green fodder yield under wider spacing (Bode *et al.*, 2018; Anon., 2022). Among nutrient levels, application of 50:100:50 kg $N:P_2O_5:K_2O$/ha recorded significantly higher green fodder yield (853.7 q/ha/year) and found on par with 37.5:75:37.5 $N:P_2O_5:K_2O$ kg/ha (831.5 q/ha/year) and superior over nutrient level of 25:50:25 $N:P_2O_5:K_2O$ kg/ha (740.6 q /ha/year). The above results are in line with findings of Tufenkci *et al.* (2006), Singh *et al.* (2020) and Kumar *et al.* (2021). However, application of nutrients in four splits recorded significantly higher green fodder yield (840.8 q/ha/year) and it was on par with three splits (822.6 q/ha/year) and superior over application of entire dose of nutrients as a basal (765.3 q/ha/year) on pooled basis. Similar trend was noticed during both the years of study. The increase in green fodder yield with incremental level and split application of nutrients might be due to better absorption of nutrients, more vegetative growth, increased plant metabolic activities, better carbohydrates assimilation and thereby improved the growth parameters *viz.,* plant height, leaf stem ratio, number of branches per unit area and thereby increased the green fodder yield. It is further evidenced by strong positive correlation between green fodder yield and number of branches per square meter (r^2 = 0.97) (Fig. 1). Similar kind of results were also obtained by Alka *et al.* (2014) in fodder oats and Singh and Dutta (2021) in fodder teosinte. Whereas, interaction among planting geometry, nutrient levels and time of nutrient application found non-significant with respect to green fodder yield.

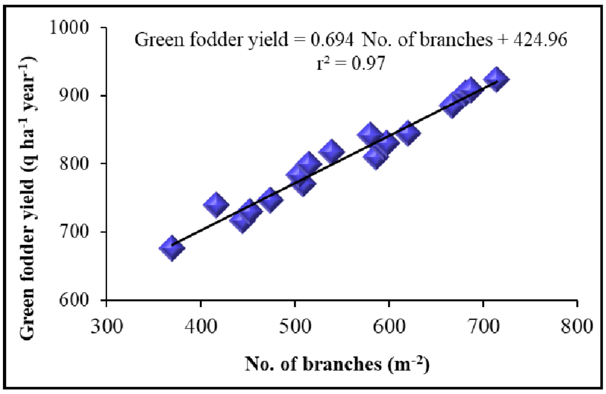

Fig. 1. Relationship between green fodder yield and number of branches of hedge lucerne.

Dry matter yield

The crop sown at 45 cm row spacing recorded significantly higher dry matter yield (167.2 q/ha/year) over 30 cm row spacing (152.0 q/ha/year) on pooled basis (Table 2). These results are in conformity with the findings of Panda *et al.* (2019) and Anon. (2022). However, significantly higher dry matter yield (169.1 q/ha/year) was recorded with application of 50:100:50 $N:P_2O_5:K_2O$ kg ha^{-1} of nutrients and it is on par with nutrient level of 37.5:75:37.5 $N:P_2O_5:K_2O$ kg/ha (164.4 q

Field view of the Trial

/ha/year) as compared to lower doses of nutrients (25:50:25 N:P_2O_5:K_2O kg/ha) (145.3 q/ha/year) on pooled basis. Similar findings were also reported by Tufenkci *et al.* (2006), Arshad *et al.* (2016) and Kumar *et al.* (2021). Whereas, significantly higher dry matter yield was recorded with the application of nutrients in four splits (166.3 q/ha/year) and found on par with three split applications (162.5 q/ha/year) and significantly superior than application of entire dose of nutrients as a basal (150.6 q/ha/year) on pooled basis. The same trend was noticed during both the years of experimentation. Dry matter yield is a function of green fodder yield and dry matter content. Hence, significantly higher dry matter yield might be due to better partitioning of photosynthates, higher green fodder yield with slight increase in dry matter content. These results are in line with the findings of Balabanli *et al.* (2010) and Singh and Dutta (2021). Further, the dry matter yield didn't differ significantly due to interaction among planting geometry, nutrient levels and time of nutrient application.

TABLE 3

Crude protein and total digestible crude protein yield of hedge lucerne as influenced by planting geometry, nutrient levels and time of nutrient application

Treatments	Crude protein yield (q/ha/year)			Total digestible crude protein yield (q/ha/year)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Planting geometry (P)						
P_1: 30 cm between rows x continues sowing	28.5	32.0	30.3	27.0	30.4	28.7
P_2: 45 cm between rows x continues sowing	31.4	35.4	33.4	29.8	33.6	31.7
S.Em ±	0.46	0.52	0.47	0.44	0.50	0.46
C.D. (p=0.05)	2.77	3.14	2.87	2.69	3.04	2.81
Nutrient levels (N)						
N_1: 25:50:25 kg N:P_2O_5:K_2O/ha	26.9	30.3	28.6	25.4	28.7	27.1
N_2: 37.5:75:37.5 kg N:P_2O_5:K_2O/ha	31.0	34.8	32.9	29.4	33.1	31.2
N_3: 50:100:50 kg N:P_2O_5:K_2O/ha	32.0	35.9	34.0	30.4	34.2	32.3
S.Em ±	0.52	0.58	0.55	0.51	0.57	0.53
C.D. (p=0.05)	1.70	1.90	1.79	1.65	1.85	1.72
Time of nutrient (N:P_2O_5:K_2O kg/ha) application (T)						
T_1: Entire dose of as basal	28.1	31.6	29.8	26.6	30.0	28.3
T_2: 50% as basal + 25% at 3rd cut +25% at 6th cut	30.6	34.3	32.4	29.0	32.6	30.8
T_3: 25% as basal + 25% at 2nd cut + 25% at 4th cut +25% at 6th cut	31.4	35.3	33.3	29.8	33.5	31.6
S.Em ±	0.38	0.45	0.41	0.37	0.43	0.40
C.D. (p=0.05)	1.12	1.30	1.20	1.08	1.26	1.17
Interaction						
P × N	NS	NS	NS	NS	NS	NS
P × T	NS	NS	NS	NS	NS	NS
N × T	NS	NS	NS	NS	NS	NS
P × N × T	NS	NS	NS	NS	NS	NS

Crude protein yield

The 45 cm row spacing recorded significantly higher crude protein yield (33.4 q/ha/year) over 30 cm row spacing (30.3 q/ha/year) on pooled basis (Table 3). Among levels of nutrients, application of 50:100:50 N:P_2O_5:K_2O kg/ha recorded significantly higher crude protein yield (34.0 q/ha/year) which was at par with application of 37.5:75:37.5 N:P_2O_5:K_2O kg ha^{-1} (32.9 q/ha/year) of nutrients than lower doses of nutrients (25:50:25 N:P_2O_5:K_2O kg/ha) (28.6 q/ha/year) on pooled basis. However, application of nutrients in four splits recorded significantly higher crude protein yield (33.3 q/ha/year) and found on par with three split applications (32.4 q/ha/year) but superior over application of entire nutrients as a basal (29.8 q/ha/year) on pooled basis. The similar trend was followed during both the years of study. The higher crude protein yield might be due to significantly higher dry matter yield with considerable increment in crude protein content. Because, crude protein yield is a function of dry matter yield and crude protein content (Anon., 2022). Similar findings were also reported by Shekara *et al.* (2012), Shekara *et al.* (2020) and Sheta *et al.* (2021). On the other hand, crude protein yield didn't show any significant difference due to interaction between planting geometry, nutrient levels and time of nutrient application.

Total digestible crude protein yield

The planting geometry of 45 cm row spacing recorded significantly higher total digestible crude protein yield (31.7 q/ha/year) than 30 cm row spacing (28.7 q/ha/year) on pooled basis (Table 3). Among levels of nutrients, application of 50:100:50 N:P_2O_5:K_2O kg ha^{-1} recorded significantly total digestible crude protein yield (32.2 q/ha/year) and found on par with application of 37.5:75:37.5 N:P_2O_5:K_2O kg/ha (31.2 q/ha/year) but significantly superior over application of 25:50:25 N:P_2O_5:K_2O/kg/ha (27.1 q/ha/year). Further, application of nutrients in four splits (T_3) recorded significantly higher total digestible crude protein yield (31.6 q/ha/year) which was at par with nutrient application in three splits (T_2) (30.8 q/ha/year) than application of entire dose as a basal (T_1) (28.3 q/ha/year). The similar trend was observed during both the years of study. The increase in total digestible crude protein yield was due to higher crude protein yield and crude protein content since they are positively related with one another (Bilal *et al.*, 2016).

Based on the experimental results it can be inferred that the planting geometry of 45 cm row spacing with continuous sowing recorded higher leaf stem ratio, green fodder, dry matter and crude protein and total digestible crude protein yield. Among levels of nutrients, application of 37.5:75:37.5 N:P_2O_5:K_2O kg/ha and application of nitrogen, phosphorus and potassium in three splits (50 % as basal + 25% at 3rd cut + 25 % at 6th cut) among time of nutrient application were found better with respect to growth parameters, green and dry biomass, crude protein and total digestible crude protein yield of hedge lucerne.

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