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Effect of integrated nutrient management on economics of herb production in lucerne

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Abstract
The experiment was conducted to study the effect of integrated nutrient management on economics of herb production in lucerne (*Medicago sativa* L.) at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur Taluk, Tumkuru District during *kharif* and *rabi* seasons with nine treatments and four replication. The results revealed that the maximum fresh herb yield per hectare at first (193.52 q & 178.70 q), second (207.41 q & 213.89 q), third (209.26 q & 217.13 q), fourth (210.65 q & 218.98 q), fifth (211.11 q & 216.20 q), sixth (210.18 q & 208.33 q) and seventh harvest (208.33 q & 200.00 q) were recorded respectively during *kharif* and *rabi* season and also maximum net return (Rs. 1,38,270 ha^{-1} & Rs. 1,38,675 ha^{-1}) and B:C ratio (2.743 & 2.749) were obtained respectively during *kharif* and *rabi* season with the application 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM.

Keywords: Lucerne, bio-fertilizers, harvest, herb, net return and nutrient

Introduction
Lucerne (*Medicago sativa* L.) is one of the oldest cultivated perennial fodder crop in the world and supplies green fodder continuously for 2-3 years. It belongs to the family Fabaceae and considered as '*Queen of the fodder crops*'. It is native of temperate regions of South-West Asia. In India, lucerne is third most important forage crop cultivated approximately in an area of one million hectare with annual production of 60 to 130 t/ha green forage and seed yield of 186 - 280 kg/ha. It is grown in Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra, Tamil Nadu and Karnataka. Lucerne is relished by all kinds of livestock as it yields nutritious and palatable green fodder, which contains protein (13.3 - 26.6%), phosphorus (0.14 – 0.66 %), calcium (0.92 – 2.9 %), carotene (9.27 mg/ 100g), fibre (20 -30 %) and vitamin A and C (Khalak, 1989). It is important medicinal plant having stachydrine as alkaloid and used as laxative, digestive, diuretic and treating for dropsy, blood pressure, hair loss, acidity and arthritis. It is also used against high cholesterol, asthma, osteo-arthritis, diabetes, stomach problem and a bleeding disorder called thrombocytopenic purpura.
Integrated nutrient management is the use of organic manures and bio-fertilizers along with balanced use of inorganic fertilizers as the eco-friendly approaches, which can be incorporated to attain higher crop productivity and sustainability (Singh *et al.*, 2015) [12]. Considering the importance of crop and role of INM, the present investigation was carried out to assess the "Effect integrated nutrient management on economics of herb production in lucerne"

Materials and Method
The field experiment was conducted at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur Taluk, Tumkuru District situated under Central dry zone (Zone-4) of Karnataka State during *kharif* and *rabi* seasons from June 2016 to July 2017. The soil status of experiment plot was red sandy loam. There were nine treatments and four replication with Randomized complete block design. Lucerne seeds (variety T-9) were treated with bio-fertilizers *viz.*, *Rhizobium meliloti* and applied *Phosporous solubalizing bacteris (PSB) and vascular arabascular mycorhiza (VAM)* along with organic manures. The seeds were sown during *kharif* and *rabi* season with 30 cm x 15 cm spacing.

Treatment details for both the season
T_1 : Rec.Dose of Fertilizer (25:50:25 kg NPK/ha + 10 t/ha FYM)

T_2: 75% RDF + 25% N through FYM
T_3: 75% RDF + 25% N through Vermicompost
T_4: 75% RDF + 25% N through Poultry manure
T_5: 50% RDF + 25% N through FYM + Rhizobium + PSB+VAM
T_6: 50% RDF + 25% N through Vermicompost+ Rhizobium + PSB+VAM
T_7: 50% RDF + 25% N through Poultry manure+ Rhizobium + PSB+VAM
T_8: RDF + *Rhizobium* + PSB+VAM
T_9: 10 t/ha FYM + 100% N through FYM

The first crop was harvested at 60 days after sowing to a height of 5 cm from ground level and ratoon crops were harvested at 30 days interval at flower initiation stage for herbage yield. The observations on fresh weight of plant were recorded after harvesting of five tagged plants in each plot. The average of five plants was recorded as fresh weight of plant at first and subsequent harvesting of ratoon crops. The fresh herbage yield per hectare was calculated by taking weight of leaves and stem after harvesting of plants in each of the respective plot at first and subsequent harvesting of ratoon crops.

Benefit cost ratio (B:C ratio)
The benefit cost ratio was worked out by using the formula;

$$\text{B:C ratio} = \frac{\text{Gross income (Rs. ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs. ha}^{-1}\text{)}}$$

Results and Discussion

I. Effect of integrated nutrient management on fresh weight of plant

The data on fresh weight of plant at first and subsequent harvesting of ratoon crops during *kharif* and *rabi* season as effected by INM are presented in Table 1 & 2. The maximum fresh weight of plant was recorded at first (147.90 g & 152.49 g), second (183.18 g & 191.75 g), third (179.90 g & 195.10 g), fourth (186.05 g & 197.47 g), fifth (191.08 g & 188.85 g), sixth (188.58 g & 183.85 g) and seventh harvest (176.95 g & 174.38 g) during *kharif* and *rabi* season respectively, when plants were supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM, which was *on par* with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM at all the harvests. The lowest fresh weight of plant was recorded with the application of 10 t/ha FYM + 100 % N through FYM in both the season at all the harvests.

The increased fresh weight of plant might be attributed to better availability of nutrients and creation of congenial condition in the vicinity of root zone by bio-fertilizers, with which the plants absorbed more of nutrients and enhanced the synthesis of carbohydrates and utilized for building up of new cell. This agrees with the findings (Rajamanickam *et al*., 2011) [8] in mint, (Ajimoddin *et al*., 2005) [1] in sweet basil, (Shirole *et al*., 2005) [11] in brahmi, (Subodhini *et al*., 2005) [13] in centella, (Kumaravel *et al*., 2003) in sweet worm wood and (Senthil Kumar *et al*., 2003) [10] in marigold.

II. Effect of integrated nutrient management on fresh herb yield per hectare

The maximum fresh herb yield per hectare was recorded at first (193.52 q & 178.70 q), second (207.41 q & 213.89 q), third (209.26 q & 217.13 q), fourth (210.65 q & 218.98 q), fifth (211.11 q & 216.20 q), sixth (210.18 q & 208.33 q), seventh harvest (208.33 q & 200.00 q) and cumulative (1450.46 q & 1453.23 q) during *kharif* and *rabi* season respectively with the application 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM (Table 3 & 4). The application of 10 t/ha FYM + 100 % N through FYM recorded least fresh herb yield per hectare in both the season at all the harvests.

The maximum fresh herb yield may be due to the reason that vermicompost is known to produce favourable effect on physical, chemical and biological factors that determines the productivity and fertility status of soil and supplies nutrients in their available form, increases the microbial population and provides sufficient energy for them to remain active. It also provides the vital macro-nutreint such as N, P, K, Ca, Mg and micro-nutrients. Besides, *Rhizobium* has increased the availability of nitrogen and helped in the synthesis of tryptophan, which is a precursor for the biosynthesis of auxins and hastened the metabolic activities in the plant resulting in maximum plant height, branches and number of leaves, thus maximum herb yield was obtained. The similar reports were found (Vishal *et al*., 2013 and Tiwari, 2012) [14, 15] in kalmegh, (Gupta *et al*., 2011) [4] in black henbane, (Ali *et al*., 2012) [2] in chicory and (Sanjutha *et al*., 2008) [9] in kalmegh.

III. Effect of integrated nutrient management on economics of herb production

The maximum net return per hectare (Rs. 1,38,270 ha^{-1} & Rs. 1,38,675 ha^{-1}) and maximum benefit per rupee invested as B:C ratio (2.743 & 2.749) was obtained during *kharif* and *rabi* season with the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM, which was followed by the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM (Table 5). The minimum net return (Rs. 1, 22, 118 ha^{-1} during *kharif* and Rs. 1, 24, 608 ha^{-1} during *rabi* season) and B:C ratio (2.59 during *kharif* and 2.62 during *rabi* season) were obtained with the application of 10 t/ha FYM + 100 % N through FYM.

The maximum net return and B:C ratio may be attributed to the enhanced herb yield due to optimum level of nutrients supplied with vermicompost and bio-fertilizers to meet the required demand of the crop. Similar results were reported (Kulmi and Tiwari, 2006) [6] in Ashwagandh. The minimum net return and B:C ratio were obtained with the application of 10 t/ha FYM + 100 % N through FYM during *Kharif* and *rabi* season. The lowest net return and B:C ratio may be due to lesser yield obtained due to insufficient supply of nutrients. Similar results were obtained (Aliezera *et al*., 2012) [3] in sweet basil, (Tiwari, 2012) [14] in kalmegh.

Table 1: Effect of integrated nutrient management on fresh weight of plant in lucerne *kharif* season

	Fresh weight of plant (g)						
Treatment	**I Harvest**	**II Harvest**	**III Harvest**	**IV Harvest**	**V Harvest**	**VI Harvest**	**VII Harvest**
T_1	128.85	159.40	161.48	163.85	169.71	168.15	155.88
T_2	114.85	144.50	144.38	149.33	152.48	155.63	142.68
T_3	124.60	155.28	153.10	159.00	163.93	163.93	152.00
T_4	122.40	149.18	150.70	154.75	158.65	158.50	146.38
T_5	138.40	168.55	170.98	175.23	179.93	179.30	167.03
T_6	147.90	183.18	179.90	186.05	191.08	188.58	176.95
T_7	143.78	178.33	173.93	180.55	184.75	183.68	171.83
T_8	133.20	163.18	166.63	169.38	175.15	174.93	161.60
T_9	110.03	139.60	141.03	144.93	148.43	151.90	138.85
F- test	*	*	*	*	*	*	*
S.Em±	2.91	3.53	2.85	3.36	3.35	3.12	3.22
CD at 5 %	8.50	10.31	8.31	9.82	9.78	9.13	9.41

Table 2: Effect of integrated nutrient management on fresh weight of plant in lucerne during *rabi* season

	Fresh weight of plant (g)						
Treatment	**I Harvest**	**II Harvest**	**III Harvest**	**IV Harvest**	**V Harvest**	**VI Harvest**	**VII Harvest**
T_1	137.88	179.12	181.55	184.34	175.27	167.64	159.50
T_2	127.74	169.55	171.86	173.97	165.75	157.73	149.14
T_3	133.04	174.14	176.18	178.15	169.96	164.13	154.70
T_4	131.78	174.16	175.94	178.20	169.93	161.70	154.64
T_5	146.58	185.49	189.68	191.62	183.46	176.92	167.76
T_6	152.49	191.75	195.10	197.47	188.85	183.85	174.38
T_7	150.96	190.16	192.87	194.39	187.16	180.18	171.75
T_8	142.57	182.83	185.66	188.11	179.08	172.60	164.21
T_9	124.87	166.00	167.37	169.95	162.30	155.73	145.68
F- test	*	*	*	*	*	*	*
S.Em±	1.76	1.75	1.37	6.21	1.74	2.09	2.16
CD at 5 %	5.15	5.11	4.01	2.12	5.10	6.11	6.31

Table 3: Effect of integrated nutrient management on fresh herb yield per hectare in lucerne during *kharif* season

Treatment	**Fresh herb yield per hectare (q)**							
	I Harvest	**II Harvest**	**III Harvest**	**IV Harvest**	**V Harvest**	**VI Harvest**	**VII Harvest**	**Cumulative**
T_1	184.26	196.76	198.61	199.54	200.93	200.46	197.68	1378.24
T_2	180.56	192.59	191.67	194.91	196.30	195.37	193.98	1345.38
T_3	184.26	196.30	199.07	199.54	200.00	200.46	197.22	1376.85
T_4	182.87	195.83	197.68	198.15	199.54	200.00	195.83	1369.90
T_5	189.35	203.24	203.24	206.48	207.87	207.41	204.17	1421.76
T_6	193.52	207.41	209.26	210.65	211.11	210.18	208.33	1450.46
T_7	190.74	204.63	203.24	207.41	208.33	208.33	206.02	1428.70
T_8	187.04	199.07	200.46	202.78	204.17	204.63	200.93	1399.08
T_9	178.70	187.96	189.35	192.59	193.52	193.06	190.28	1325.46
F- test	*	*	*	*	*	*	*	*
S.Em±	1.38	1.37	2.24	1.40	1.03	0.74	1.31	9.55
CD at 5 %	4.05	4.01	6.55	4.10	3.01	2.15	3.84	27.90

Table 4: Effect of integrated nutrient management on fresh herb yield per hectare in lucerne during *rabi* season

Treatment	**Fresh herb yield per hectare (q)**							
	I Harvest	**II Harvest**	**III Harvest**	**IV Harvest**	**V Harvest**	**VI Harvest**	**VII Harvest**	**Cumulative**
T_1	172.22	206.48	208.33	210.65	209.26	202.31	193.05	1402.30
T_2	166.2	201.85	201.85	204.63	202.31	196.30	188.89	1362.03
T_3	169.91	204.17	206.02	208.33	206.48	200.46	191.67	1387.04
T_4	168.52	203.24	204.17	206.48	205.09	199.07	191.20	1377.77
T_5	175.46	211.11	213.42	216.67	213.89	205.55	197.22	1433.32
T_6	178.70	213.89	217.13	218.98	216.20	208.33	200.00	1453.23
T_7	177.78	212.50	215.28	218.52	215.28	207.41	199.07	1445.84
T_8	174.07	208.79	211.11	213.89	211.57	203.70	194.91	1399.52
T_9	162.04	199.07	199.54	201.39	200.46	193.52	186.11	1342.13
F- test	*	*	*	*	*	*	*	*
S.Em±	1.06	0.86	1.32	0.72	0.79	0.94	0.94	6.50
CD at 5 %	3.10	2.50	3.85	2.11	2.05	2.73	2.76	19.10

Table 5: Influence of integrated nutrient management on economics of herb production in lucerne

Treatment	Economics of herb during *kharif* season (Rs. ha^{-1})				Economics of herb during *rabi* season (Rs. ha^{-1})			
	Gross return	Cost of cultivation	Net return	B:C ratio	Gross return	Cost of cultivation	Net return	B:C ratio
T_1	206730	77649	129081	2.660	210345	77649	132696	2.710
T_2	201810	77513	124297	2.600	204300	77513	126787	2.640
T_3	206520	78810	127710	2.620	208050	78810	129240	2.640
T_4	205485	77437	128048	2.650	206670	77437	129233	2.670
T_5	213270	78008	135262	2.730	214995	78308	136987	2.740
T_6	217575	79305	138270	2.743	217980	79305	138675	2.749
T_7	214305	78432	135873	2.732	216870	78932	137938	2.747
T_8	209865	78937	130928	2.680	209925	78937	130988	2.660
T_9	198825	76707	122118	2.590	201315	76707	124608	2.620

Conclusion

The study on the effect of integrated nutrient management on economics of herb production in lucerne revealed that, the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM has recorded maximum herb yield and also maximum profit during *kharif* and *rabi* season. Therefore, 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM may be recommended for commercial cultivation of lucerne under central dry zone of Karnataka.

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