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Growth and herb yield of alfalfa as influenced by integrated nutrient management during *kharif* season under central dry zone of Karnataka

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Abstract
The experiment was conducted to study on growth and herb yield of alfalfa as influenced by integrated nutrient management during *kharif* season at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur Taluk, Tumkuru District. The results revealed the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM was recorded the maximum plant height at 30 DAS (40.88 cm), first (83.38 cm), second (90.13 cm), third (91.13 cm), fourth (93.63 cm), fifth (94.13 cm), sixth (92.00 cm) and seventh harvest (89.13 cm) during *kharif* season, and also the same trend was noticed with the maximum number of branches and leaves per plant during *kharif* season at all the harvests. The maximum cumulative fresh (1450.46 q ha^{-1}) and dry herb yield (226.02 q ha^{-1}) during *kharif* season was recorded with the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM.

Keywords: Alfalfa, branches, harvest, height and herb yield

Introduction
Alfalfa (*Medicago sativa* L.) is one of the perennial fodder crop cultivated in an area of one million hectare with annual production of 60 to 130 t/ha green forage in India. It is supplies green fodder continuously for 2-3 years and grown in Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra, Tamil Nadu and Karnataka. It is native of temperate regions of South-West Asia belongs to the family Fabaceae and considered as '*Queen of the fodder crops*'. Alfalfa 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. The use of organic manures and bio-fertilizers along with balanced use of inorganic fertilizers is one of the eco-friendly approaches, which can be incorporated to attain higher crop productivity and sustainability (Singh *et al.*, 2015) [13]. Considering the importance of crop and role of INM, the present investigation was carried out to assess the "Growth and yield of alfalfa as influenced by integrated nutrient management during *kharif* season under central dry zone of Karnataka".

Materials and Method
A field experiment was conducted to study on growth and yield of alfalfa as influenced by integrated nutrient management during *kharif* season under central dry zone of Karnataka at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur Taluk, Tumkuru District under Central dry zone (Zone-4) of Karnataka State during *kharif* seasons from June 2016 to May 2017. The soil status of experiment plot was red sandy loam. There were nine treatments and four replication with randomized complete block design. Alfalfa seeds (variety T-9) were treated with bio-fertilizers *viz.*, *Rhizobium meliloti* and applied PSB) and VAM along with organic manures. The seeds were sown during *kharif* season (1st week of June, 2017) with 30

cm x 15 cm spacing. The tre atment details as mentioned below.

Treatment details

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 growth and herb yield parameters were recorded after harvesting of five tagged plants in each plot. The average of five plants was recorded at first and subsequent harvesting of ratoon crops.

Results and Discussion

I. Effect of INM on plant height during *kharif* season

The data on plant height at 30 DAS, first harvest and subsequent harvesting of ratoon crops during *kharif* season as effected by INM are presented in Table 1. The application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM has resulted maximum plant height at 30 DAS (40.88 cm), first (83.38 cm), second (90.13 cm), third (91.13 cm), fourth (93.63 cm), fifth (94.13 cm), sixth (92.00 cm) and seventh harvest (89.13 cm) during *kharif* season, which was *on par* with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM at 30 DAS and all the harvests. The least plant height was recorded during *kharif* season with the application of 10 t/ha FYM + 100 % N through FYM at 30 DAS and all the harvests.

The increased plant height could be attributed to the application of vermicompost, which has rich source of nutrients, vital plant promoting and humus forming substances, N-fixers and other beneficial micro-organisms helped for building up of cells, thus better growth was observed. The bio-fertilizers have also enhanced the availability of nutrients through atmospheric nitrogen fixation and phosphorous mobilization. The results obtained are in conformity with the findings of Kayina and Reddy (2012) in senna, Sunanda *et al*. (2014) [16] in kasuri methi, Devkota and Jha (2013) [2] in centella and Kalyanasundaram *et al.* (2008) [4] in sweet flag

II. Effect of INM on number of branches and leaves during *kharif* season

The application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM has resulted maximum number of branches and leaves per plant at 30 DAS (11.20 & 89.15), first (19.40 & 218.13), second (25.00 & 297.43), third (25.60 & 297.65), fourth (27.13 & 307.73), fifth (29.50 & 311.38), sixth (28.55 & 307.30) and seventh harvest (27.45 & 296.93) respectively during *kharif* season (Table 2 & 3). The least number of branches and leaves per plant was recorded with the application of 10 t/ha FYM + 100 % N through FYM during *kharif* season at 30 DAS and all the harvests.

The increased number of branches and leaves might be due to supply of nutrients through organic, inorganic and bio-fertilizers, which has enhanced the metabolic activity of plant by increasing cell division and cell elongation as results in maximum plant height with more number of branches and leaves. These findings are in line with Patil *et al.* (2014) [8], Gudade (2013) [3] in kalmegh and Nadukeri (2010) [17] in ashwagandha

III. Effect of INM on fresh and dry weight of plant

The maximum fresh and dry weight of plant was recorded at first (147.90 g & 23.37 g), second (183.18 g & 28.17 g), third (179.90 g & 28.67 g), fourth (186.05 g & 29.04 g), fifth (191.08 g & 29.43 g), sixth (188.58 g & 29.84 g) and seventh harvest (176.95 g & 28.13 g) respectively during *kharif* season, when plants were supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM (Table 4). The lowest fresh and dry weight of plant was recorded with the application of 10 t/ha FYM + 100 % N through FYM during *kharif* season at all the harvests. The increased fresh and dry 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. These findings are in line with Rajamanickam *et al.* (2011) [9] in mint, Ajimoddin *et al.* (2005) [1] in sweet basil, Shirole *et al.* (2005) [12] in brahmi and Subodhini *et al.* (2005) [15] in centella.

IV. Effect of INM on fresh and dry herb yield per hectare

The maximum fresh and dry herb yield per hectare was recorded at first (193.52 q 30.23 q), second (207.41 q & 31.76 q), third (209.26 q & 32.68 q), fourth (210.65 q & 32.82 q), fifth (211.11 q & 33.06 q), sixth (210.18 q & 32.82 q) and seventh harvest (208.33 q & 32.55 q) respectively during *kharif* season with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM (Table 5). The same trend was noticed with cumulative fresh and dry herb yield. The application of 10 t/ha FYM + 100 % N through FYM recorded least fresh and dry herb yield per hectare during *kharif* season at all the harvests.

The maximum fresh and dry 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 with Vijay *et al*. (2015), Vishal and Duhan (2013) [17], Ravirajashetty *et al.* (2014) [11] in davana, Raju *et al*. (2014) [10] and Sivakumar *et al.* (2011) [14] in ashwagandha.

Table 1: Effect of integrated nutrient management on plant height of alfalfa during *kharif* season

Treatment	Plant height (cm)							
	30 DAS	I Harvest	II Harvest	III Harvest	IV Harvest	V Harvest	VI Harvest	VII Harvest
T_1	36.38	76.63	80.63	82.38	83.63	86.13	85.13	82.63
T_2	34.63	73.75	77.13	77.63	74.63	82.75	82.88	77.88
T_3	36.23	76.60	80.61	82.38	83.75	86.50	85.15	82.00
T_4	35.93	75.00	79.13	80.63	81.75	84.00	84.88	79.63
T_5	38.25	81.13	86.63	87.63	88.63	91.75	90.13	87.13
T_6	40.88	83.38	90.13	91.13	93.63	94.13	92.00	89.13
T_7	39.25	82.88	88.63	89.63	91.63	93.75	91.48	88.68
T_8	37.13	79.83	83.63	85.63	86.00	89.88	88.13	84.00
T_9	33.75	71.88	76.13	76.63	80.75	81.63	81.00	79.63
F- test	*	*	*	*	*	*	*	*
S.Em±	0.56	0.36	0.90	0.87	0.85	0.54	0.52	0.60
CD at 5 %	1.65	1.04	2.62	2.53	2.50	1.60	1.53	1.76

DAS: Days after sowing

Table 2: Influence of integrated nutrient management on number of branches in alfalfa during *kharif* season

Treatment	Number of branches per plant							
	30 DAS	I Harvest	II Harvest	III Harvest	IV Harvest	V Harvest	VI Harvest	VII Harvest
T_1	9.93	17.88	22.80	22.88	24.78	25.55	25.20	23.48
T_2	9.30	16.78	20.58	21.28	22.65	23.55	23.25	21.53
T_3	9.92	17.88	22.75	22.80	24.90	25.56	25.30	23.48
T_4	9.63	17.28	21.58	21.80	23.28	24.50	24.50	22.80
T_5	10.60	18.25	24.50	23.95	26.28	28.05	27.50	25.53
T_6	11.20	19.40	25.00	25.60	27.13	29.50	28.55	27.45
T_7	11.05	18.73	24.80	24.55	26.80	28.56	27.58	26.60
T_8	10.35	17.93	23.60	23.78	25.55	26.50	26.55	24.58
T_9	9.10	15.53	19.98	20.55	22.55	22.65	22.60	20.55
F- test	*	*	*	*	*	*	*	*
S.Em±	0.14	0.22	0.14	0.53	0.24	0.42	0.27	0.62
CD at 5 %	0.41	0.66	0.43	1.56	0.72	1.23	0.81	1.80

DAS: Days after sowing

Table 3: Number of leaves in alfalfa as influenced by integrated nutrient management during *kharif* season

Treatment	Number of leaves per plant							
	30 DAS	I Harvest	II Harvest	III Harvest	IV Harvest	V Harvest	VI Harvest	VII Harvest
T_1	81.80	196.20	277.90	280.45	283.05	294.00	286.45	273.18
T_2	76.08	180.13	272.00	272.85	274.20	287.80	277.68	263.08
T_3	81.68	188.18	276.58	281.60	282.45	294.45	286.98	272.70
T_4	78.35	184.38	268.23	279.30	279.85	291.93	281.40	268.15
T_5	86.93	200.10	287.95	287.98	295.60	299.40	295.53	282.55
T_6	89.15	218.13	297.43	297.65	307.73	311.38	307.30	296.93
T_7	88.30	204.45	292.98	293.18	301.15	302.83	300.90	291.10
T_8	84.90	196.15	282.60	283.23	288.90	296.93	289.08	279.15
T_9	75.20	176.28	271.93	267.80	266.80	280.18	269.08	259.20
F- test	*	*	*	*	*	*	*	*
S.Em±	0.72	5.89	2.23	2.70	2.57	3.24	3.65	3.81
CD at 5 %	2.10	17.20	6.23	7.90	7.50	9.45	10.65	11.14

DAS: Days after sowing

Table 4: Fresh and dry weight of plant in alfalfa as influenced by integrated nutrient management during *kharif* season

Treatment	Fresh and dry weight of plant (g/plant)													
	I Harvest		II Harvest		III Harvest		IV Harvest		V Harvest		VI Harvest		VII Harvest	
	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
T_1	128.85	21.51	159.40	24.34	161.48	25.03	163.85	26.03	169.71	27.17	168.15	27.18	155.88	24.67
T_2	114.85	18.33	144.50	22.11	144.38	22.92	149.33	24.80	152.48	24.94	155.63	24.66	142.68	22.79
T_3	124.60	19.73	155.28	25.00	153.10	25.55	159.00	25.30	163.93	26.34	163.93	26.00	152.00	24.32
T_4	122.40	19.39	149.18	22.99	150.70	23.84	154.75	24.66	158.65	25.49	158.50	25.22	146.38	23.23
T_5	138.40	22.16	168.55	25.84	170.98	27.21	175.23	27.84	179.93	28.94	179.30	28.50	167.03	26.33
T_6	147.90	23.37	183.18	28.17	179.90	28.67	186.05	29.04	191.08	29.43	188.58	29.84	176.95	28.13
T_7	143.78	22.84	178.33	27.47	173.93	27.73	180.55	28.67	184.75	29.07	183.68	29.17	171.83	27.24

T_8	133.20	21.14	163.18	25.00	166.63	26.43	169.38	27.34	175.15	27.78	174.93	27.59	161.60	25.67
T_9	110.03	17.63	139.60	21.14	141.03	22.50	144.93	24.00	148.43	23.90	151.90	24.29	138.85	22.30
F- test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
S.Em±	2.91	0.35	3.53	0.72	2.85	0.44	3.36	0.35	3.35	0.17	3.12	0.43	3.22	0.52
CD at 5 %	8.50	1.05	10.31	2.10	8.31	1.29	9.82	1.02	9.78	0.50	9.13	1.43	9.41	1.52

Table 5: Effect of integrated nutrient management on fresh and dry herb yield in alfalfa during *kharif* season

Treatment	Fresh and dry herb yield per hectare (q)															
	I Harvest		II Harvest		III Harvest		IV Harvest		V Harvest		VI Harvest		VII Harvest		Cumulative	
	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
T_1	184.26	28.75	196.76	30.37	198.61	31.11	199.54	31.16	200.93	31.39	200.46	31.20	197.68	30.93	1378.24	214.91
T_2	180.56	28.06	192.59	29.58	191.67	29.91	194.91	30.46	196.30	30.69	195.37	30.60	193.98	30.09	1345.38	209.39
T_3	184.26	28.61	196.30	30.00	199.07	30.79	199.54	31.11	200.00	31.20	200.46	31.25	197.22	30.97	1376.85	213.93
T_4	182.87	28.38	195.83	29.81	197.68	30.32	198.15	30.83	199.54	30.97	200.00	30.79	195.83	30.51	1369.90	211.61
T_5	189.35	29.58	203.24	31.16	203.24	31.99	206.48	32.04	207.87	32.41	207.41	32.04	204.17	31.67	1421.76	220.89
T_6	193.52	30.23	207.41	31.76	209.26	32.68	210.65	32.82	211.11	33.06	210.18	32.82	208.33	32.55	1450.46	226.02
T_7	190.74	29.91	204.63	31.48	203.24	32.31	207.41	32.45	208.33	32.78	208.33	32.45	206.02	32.04	1428.70	223.42
T_8	187.04	29.17	199.07	30.83	200.46	31.85	202.78	31.71	204.17	31.81	204.63	31.48	200.93	31.25	1399.08	218.10
T_9	178.70	27.68	187.96	29.35	189.35	29.58	192.59	30.09	193.52	30.32	193.06	30.23	190.28	29.68	1325.46	206.93
F- test	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
S.Em±	1.38	0.20	1.37	0.20	2.24	0.20	1.40	0.27	1.03	0.19	0.74	0.25	1.31	0.27	9.55	1.75
CD at 5 %	4.05	0.60	4.01	0.58	6.55	0.59	4.10	0.81	3.01	0.55	2.15	0.72	3.84	0.80	27.90	5.10

Conclusion

The study on growth and herb yield of alfalfa as influenced by integrated nutrient management during *kharif* season under central dry zone of Karnataka revealed that, the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM has recorded maximum growth and herb yield of alfalfa during *kharif* season. Therefore, 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM may be recommended for commercial cultivation of alfalfa under central dry zone of Karnataka.

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