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Effect of Integrated Nutrient Management on Seed Yield, Quality and Economics of Seed Production in Lucerne during *Rabi* Season

Nagappa Desai [a++*], M. S. Anitha [b#], K. R. Shreenivasa [c†] and Roopa B. Patil [d‡]

[a] Agricultural Research Station, UASB, Madenur -573 225, Hassan Taluk, Hassan Dist. Karnataka, India.
[b] College of Agriculture, UASB, Karekere -573 225, Hassan Dist. Karnataka, India.
[c] Agricultural Research Station, UASB, Sri. Rangaswamy Gudda Kaval -572 130, Kunigal Taluk, Tumkuru Dist. Karnataka, India.
[d] College of Agriculture, UAS, GKVK, Bengaluru -560 065, Karnataka, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted to study the effect of integrated nutrient management on seed yield, quality and economics of seed production in Lucerne (*Medicago sativa* L.) at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur taluk of Tumkuru district under southern dry zone of

[++] Senior Farm superintendent and Associate Professor (Horticulture);
[#] Farm superintendent and Assistant Professor (SS & AC);
[†] Senior Farm Superintendent and Associate Professor (Pathology);
[‡] Assistant Professor (Food Science and Nutrition);
**Corresponding author: E-mail: agridesai@gmail.com;*

Karnataka during *rabi* seasons 2017-18. The experiments plots were laid out nine treatments with four replication and Randomized complete block design (RCBD). The results revealed that the maximum fresh herb yield at first harvest of herb (174.07 q/ha), herb yield after harvest of seeds (196.76 q/ha), early flowering (25.52 days), 50% flowering (33.45 days), pod initiation (46.90 days), pod maturation (71.68 days) were recorded during *rabi* seasons with application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM. Whereas, minimum fresh herb yield, delayed flowering, pod initiation, pod maturation were recorded with application of 10 t/ha FYM + 100 % N through FYM.

The plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM was resulted maximum pod set per cent (57.85 %), number of pods per plant (242.45), pod yield per plant (21.10), pod length (6.42 mm), pod weight (90.10 mg), seed set per cent (63.70 %), number of seeds per pod (5.68), test weight (3.36 g), seed yield (231.02 kg/ha) and highest net return per hectare during *rabi* season, while, least pod and seed characters, seed yield and net return per hectare were recorded with application of 10 t/ha FYM + 100 % N through FYM. Therefore, plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM may be recommended for commercial seed production in Lucerne during *rabi* season under southern dry zone of Karnataka.

Keywords: Integrated; harvest; herb; nutrient; season; seed and yield.

1. INTRODUCTION

Lucerne (*Medicago sativa* L.) is one of the most important fodder crops of India called as '*Queen of the fodder crops*' and also known as Alfalfa belongs to the family Fabaceae (Leguminaceae). It can be grown both as annual as well as perennial crops and supply the green fodder continuously for 2-3 years from the same field as perennial crop. It is native of temperate regions of South-West Asia, then introduced into India from North-West in 1900 [1] and cultivated approximately one million hectare of area with production of green forage 60-130 tonnes/ha/year and 186 - 280 kg/ha of seed yield in India. Uttar Pradesh, Punjab, Gujarat, Haryana, Tamil Nadu, Maharashtra and Karnataka are major growing state in the country, it is locally known as 'Kuduremasale' in Karnataka. It yields nutritive and palatable fodder, which contains about 13.3 - 26.6% crude protein,calcium (0.92 – 2.9 %), phosphorus (0.14 – 0.66 %), carotene (9.27 mg/ 100g), fibre (20 - 30 %) and vitamin A and C [2]. It also contain important stachydrine as medicinal alkaloid and used for the purpose of digestive, diuretic, laxative and treating against for blood pressure, hair loss, arthritis, dropsyand acidity.

Among the various cultural practices for cultivation of Lucerne, nutrient management plays an important role in enhancing the herb and seed yield. The soil health and environment are deterioration due to continuous use of high dose of chemical fertilizers. The use of organic manures and bio-fertilizers along with balanced inorganic fertilizers is one of the eco-friendly approaches, which can be enhancing the productivity and sustainability [3]. The ground water contamination and environment pollution are prevented by using the judicious combination of different sources of nutrients, which becomes an important aspect of environmentally, eco-friendly agriculture. Considering the importance of crop and role of integrated nutrient management, the experiment was conducted at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur taluk of Tumkuru district in Karnataka state to study the effect of integrated nutrient management (INM) on seed yield, quality and economics of seed production in Lucerne during *rabi* season.

2. MATERIALS AND METHODS

The field experiment was conducted to study the effect of integrated nutrient management (INM) on seed yield, quality and economics of seed production in Lucerne at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur taluk of Tumkuru district under southern dry zone of Karnataka state during *rabi* seasons 2017-18. The experiments plots were laid out nine treatments with four replication and Randomized complete block design (RCBD). Plots were prepared with size of 4.32 sq. m. (2.4 m x 1.8 m) area of red sandy loam soil. Lucerne seeds of T-9 variety were treated with *Rhizobium meliloti* bio-fertilizers, applied recommended dose of fertilizers and organic manures with bio-fertilizers *viz., Phosporous solubalizing bacteris (PSB) and vascular arabascular mycorhiza (VAM)* as per

treatments. The seeds were sown during *rabi* season with 30 cm x 15 cm spacing.

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 observations on herb and seed yield were recorded using five plants per plot. These five plants were randomly selected by avoiding the border plants and were labelled for recording the observations at harvest stage. The first crop was harvested at 60 days after sowing and allowed it for further growth, flowering and to reach physiological maturity stage for obtaining the seeds. The recorded data were analysed suitable statistical analysis as per the procedure outlined by [4]. The results were compared at 5 per cent probability using Fischer's test.

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

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

3. RESULTS AND DISCUSSION

3.1 Effect of INM on Fresh Weight of Plant and Herb Yield of Lucerne

The data on fresh weight of plant, herb yield per plot and per hectare at first harvest and herb yield after harvest of seeds during *rabi* season as influenced by INM are presented in Table 2.

The maximum fresh weight of plant (137.93 g & 128.94 g), fresh herb yield per plot (3.76 kg & 4.25 kg) and fresh herb yield per hectare (174.07 q &196.76 q) at first harvest of herb and herb yield after harvest of seeds respectively during *rabi* season were recorded with the application 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM, which was *at par* with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM. Whereas, the least fresh weight of plant, fresh herb yield per plot and fresh herb yield per hectare was recorded, when plants were supplied with10 t/ha FYM + 100 % N through FYM in during *rabi* season at first harvest of herb and herb yield after harvest of seeds.

The maximum fresh weight of plant and 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 [5]. It also provides the vital macro-nutrient 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, resulting in maximum herb yield was obtained. The similar reports were found in[6-8] and [9] in davana.

3.2 Effect of INM on Flowering Characters in Lucerne

The data on flowering characters such as days taken for flowering, pod initiation, pod maturation and number of flowers per plant during *rabi* season as effected by INM are presented in Table 3. The application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM were resulted in early flowering (25.52 days), 50% flowering (33.45 days), pod initiation (46.90 days), pod maturation (71.68 days) and maximum number of flowers (426.50/plant) were recorded, which was *on par* with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM in pod length. While, the delayed flowering, 50% flowering, pod initiation, pod maturation and minimum number of flowers were recorded with application of 10 t/ha FYM + 100 % N through FYM in during *rabi* season [10].

This might be due to the combined application of organic and inorganic fertilizers along with bio-fertilizers produced bio-active substances showing similar effect as that of growth regulators, which helped in better uptake and utilization of nutrients by the plants resulted in better reproductive growth of the plants. These results are in agreement with the findings [11] in Lucerne, [12] in peppermint, [13] in Kalmegh, [14] and [15] in chamomile.

Table 1. Analysis of Farm yard manure, Vermicompost and Poultry manure for NPK content before conducting the experiment

Organic manures	N content (%)	P_2O_5 content (%)	K_2Ocontent (%)
Farm yard manure	0.95	0.62	0.75
Vermicompost	1.60	0.86	0.98
Poultry manure	2.10	1.35	1.76

Table 2. Effect of integrated nutrient management on fresh weight of plant and herb yield of Lucerne during *rabi* season

Treatment	Fresh weight of plant (g)		Fresh herb yield per plot (kg)		Fresh herb yield per hectare (q)		
	1st Harvest of herb	Herb weight after harvest of seeds	1st Harvest of herb	Herb yield after harvest of seeds	1st Harvest of herb	Herb yield after harvest of seeds	Cumulative herb yield
T_1	124.09	119.45	3.58	4.09	165.74	189.35	355.09
T_2	114.98	112.79	3.51	3.97	162.50	183.80	346.30
T_3	119.73	115.48	3.58	4.05	165.74	187.50	353.24
T_4	118.60	115.50	3.55	4.01	164.35	185.65	350.00
T_5	131.92	124.17	3.68	4.21	170.37	194.91	365.28
T_6	137.93	128.94	3.76	4.25	174.07	196.76	370.83
T_7	135.56	125.94	3.70	4.24	171.30	196.30	367.60
T_8	128.31	121.93	3.63	4.15	168.05	192.13	360.18
T_9	112.37	110.31	3.47	3.91	160.65	181.02	341.67
F- test	*	*	*	*	*	*	*
S.Em±	2.06	1.32	0.024	0.016	1.21	0.29	1.96
CD at 5 %	6.03	3.88	0.071	0.048	3.55	0.85	5.72

Table 3. Effect of integrated nutrient management on flowering characters in Lucerne during *rabi* season

Treatment	Number of days taken for flowering	No. of days taken for 50% flowering	Number of flowers per plant	No. of days taken for pod initiation	No. of days taken for pod maturation
T_1	26.80	34.56	404.72	48.66	73.78
T_2	27.82	35.50	390.40	50.49	74.82
T_3	27.22	34.92	398.21	49.25	74.10
T_4	27.34	34.92	395.80	49.56	74.45
T_5	26.10	33.82	416.20	47.50	72.80
T_6	25.52	33.45	426.50	46.90	71.68
T_7	25.60	33.50	421.45	47.10	72.15
T_8	26.40	34.14	409.84	48.12	73.25
T_9	28.25	35.95	381.74	51.45	75.30
F- test	*	*	*	*	*
S.Em±	0.12	0.12	3.27	0.19	0.42
CD at 5 %	0.35	0.34	9.54	0.56	1.23

3.3 Effect of Integrated Nutrient Management on Pod Quality in Lucerne

The data on pod quality such as pod set per cent, number of pods per plant, number of filled pods, number of seeds per pod, pod yield, pod length and pod weight during *rabi* season as influenced by INM are presented in Table 4. The maximum pod set per cent (57.85 %), number of pods per plant (242.45), number of filled pods per plant (154.45), number of seeds per pod (5.68), pod yield per plant (21.10), pod length (6.42 mm) and pod weight (90.10 mg) were recorded during *rabi* season, when plants were supplied with of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM. Whereas, minimum pod set per cent, number of pods per plant, number of filled pods per plant, number of seeds per pod, pod yield per plant, pod length and pod weight were recordedwith application of 10 t/ha FYM + 100 % N through FYM in during *rabi* season. The good quality pods might be attributed to the role of *Rhizobium*, PSB and VAMin increased vegetative growth, production of greater amount of photosynthates and better synthesis of metabolites resulted in early flowering, pod initiation and which in turn resulted to profused and improved the pod characters. The results are in conformity with the works of [16] in ambrette.

3.4 Effect of INM on Seed Characters and Yield in Lucerne

The data on seed characters and yield during *rabi* season as affected by INM are presented in Table 5. The application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM was recorded maximum seed set per cent (63.70 %), number of seeds per pod (5.68), test weight (3.36 g), seed yield per plant (2.10 g), seed yield per plot (49.90 g) and seed yield per hectare (231.02 kg/ha) during *rabi* season. While, minimum seed set per cent, number of seeds per pod, test weight, seed yield per plant, seed yield per plot and seed yield per hectare were recorded with application of 10 t/ha FYM + 100 % N through FYM during *rabi* season. This could be attributed to sequential metamorphosis from source to sink and adequate availability of nutrients at different growth stages through the combination of organic, inorganic and bio-fertilizers sources. These results are in accordance with the findings of [17] in isabgol and also attributed to maximum fixation of atmospheric nitrogen with *rhizobium* helped in increased uptake of nitrogen to the plant. Besides, the optimum supply of nutrient might have helped in enhanced plant metabolic activity and source to sink relationship, thus yield more seeds. Similar findings were also made by[18]in ashwagandha.

3.5 Effect of INM on Economics of Seed Production in Lucerne

The data on economics of seed production in Lucerne as influenced by INM during *rabi* season are presented in Table 6. The maximum net return per hectare (Rs.71,461/ha) was obtained during *rabi* season with the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM. Similarly, the maximumbenefit cost ratio (2.23) was obtained with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM during *rabi* season. Whereas, the minimum net return (Rs.57,633/ha) and B:C ratio (2.02)

Table 4. Effect of integrated nutrient management on pod quality in Lucerne during *rabi* season

Treatment	Pod set per cent	No. of pods/plant	No. of filled pods/plant	Pod yield/plant (g)	Pod length (mm)	Pod weight (mg)
T_1	55.29	223.78	126.16	20.05	6.18	87.40
T_2	54.52	212.85	114.81	19.05	5.98	85.70
T_3	54.87	218.50	120.90	19.64	6.05	86.45
T_4	54.49	215.65	118.51	19.56	6.02	86.40
T_5	56.57	235.45	138.33	20.75	6.31	89.14
T_6	57.85	242.45	154.45	21.10	6.42	90.10
T_7	57.07	238.50	150.94	21.00	6.35	89.48
T_8	56.03	229.65	132.65	20.34	6.26	88.24
T_9	54.16	210.58	112.08	18.50	5.94	85.24
F- test	*	*	*	*	*	*
S.Em±	0.34	2.22	1.23	0.08	0.04	0.32
CD at 5 %	0.99	6.47	3.60	0.23	0.11	0.94

Table 5. Effect of integrated nutrient management on seed characters and yield in Lucerne during *rabi* season

Treatment	Seed set (%)	Number of seeds/pod	Test weight (g)	Seed yield/plant (g/plant)	Seed yield/plot (g/plot)	Seed yield/ha (kg/ha)
T_1	56.37	5.34	3.23	2.03	46.50	215.28
T_2	53.94	4.98	3.18	1.98	44.48	205.93
T_3	55.33	5.22	3.21	2.01	45.84	212.22
T_4	55.27	5.10	3.20	2.00	45.80	212.04
T_5	58.75	5.51	3.28	2.07	48.80	225.93
T_6	63.70	5.68	3.36	2.10	49.90	231.02
T_7	63.29	5.60	3.30	2.09	49.56	229.44
T_8	57.76	5.40	3.25	2.05	47.65	220.60
T_9	53.22	4.78	3.16	1.95	43.10	199.54
F- test	*	*	*	*	*	*
S.Em±	0.14	0.04	0.027	0.01	0.32	1.75
CD at 5 %	0.43	0.13	NS	0.03	0.93	5.12

Table 6. Effect of integrated nutrient management on economics of seed production in Lucerne during *rabi* season

Treatment	Economics of seed production during *rabi* season (Rs./ha)			
	Gross return	Cost of cultivation	Net return	B:C ratio
T_1	121737	57199	64538	2.130
T_2	117043	57063	59980	2.050
T_3	120360	58360	62000	2.060
T_4	120070	56987	63083	2.110
T_5	127224	57558	69666	2.200
T_6	130069	58855	71214	2.210
T_7	128943	57782	71161	2.230
T_8	124477	58487	65990	2.128
T_9	113890	56257	57633	2.020

Fig 1 : General view of Lucerne experiment during *Rabi season*

Fig 2 : Lucerne crop after I harvest

was obtained with the application of 10 t/ha FYM + 100 % N through FYM. The maximum net return and B:C ratio through seed production might be attributed to enhanced growth and development by optimum level of nutrients supplied by the organic manure and bio-fertilizers *viz.*, *Rhizobium*, PSB and VAM to meet the required demand of the crop till physiological maturity, which intern resulted in increased seed yield. Similar reports were found by [19, 20] in alfalfa.

Fig 3 : Flowering initiation stage

Plate 1 : Harvesting stage and analysis

4. CONCLUSION

The experiment concluded that effect of integrated nutrient management on seed yield, quality and economics of seed production in Lucerne during *rabi* season under southern dry zone of Karnataka revealed that, the maximum seed yield, good quality and highest profit in seed production were recorded with application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM during *rabi* season. Therefore, plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAMmay be recommended for commercial seed productionin Lucerne during *rabi* season under southern dry zone of Karnataka.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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