



Seed Yield, Seed Attributes and Economics of Alfalfa Seed Production as Influenced by Integrated Nutrient Management During *kharif* Season under Southern Dry Zone of Karnataka, India

Nagappa Desai ^{a+++*}, B. Mamatha ^{b#}, M. S. Anitha ^{c†}
and Roopa B. Patil ^{d‡}

^a Department of Horticulture, College of Agriculture, UASB, V.C.Farm, Mandya-5714 405, Karnataka, India.

^b Department of Soil science & Agricultural Chemistry, College of Agriculture, UAS, GKVK, Bengaluru -560 065, Karnataka, India.

^c Department of Soil science & Agricultural chemistry, College of Agriculture, UASB, Karekere -573 225, Hassan 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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⁺⁺ Associate Professor (Horticulture);

[#] Assistant Professor (SS & AC);

[†] Farm superintendent and Assistant Professor (SS & AC);

[‡] Assistant Professor (Food science and nutrition);

*Corresponding author: E-mail: agridesai@gmail.com;

ABSTRACT

The field experiment was carried out at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur taluk, Tumkuru, Karnataka during *Kharif* season of 2017-18 to examine the effect of integrated nutrient management on seed yield, seed attributes and net benefit of alfalfa. The experiment was laid out Randomized complete block design (RCBD) comprising nine treatments viz T₁ : RDF (25:50:25 kg NPK/ha + 10 t/ha FYM); T₂ : 75% RDF + 25% N through FYM; T₃ :75% RDF + 25% N through Vermicompost; T₄ :75% RDF + 25% N through Poultry manure; T₅ : 50% RDF + 25% N through FYM + Rhizobium + PSB+VAM ; T₆ :50% RDF + 25% N through Vermicompost+ Rhizobium + PSB+VAM; T₇ :50% RDF + 25% N through Poultry manure+ Rhizobium + PSB+VAM ;T₈ : RDF + *Rhizobium* + PSB+VAM ;T₉ : 10 t/ha FYM + 100% N through FYM and replicated four times. The results of experiments revealed that the plants supplied with of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM shown highest fresh herb yield at first harvest (160.65 q/ha), herb yield after harvest of seeds (187.50q/ha), 50% flowering (35.00 days), pod initiation (48.50days), pod maturation (73.05 days), while, lower fresh herb yield, pod initiation, pod maturation were recorded when 10 t/ha FYM + 100 % N through FYM was applied. The maximum pod (56.78 %), number of pods (228.75/plant), pod yield (19.90/plant), pod length (6.25 mm), pod weight (87.61 mg), seed set (56.50 %), number of seeds (5.50/pod), test weight (3.33g), seed yield per hectare (223.38kg/ha) and highest net return per hectare were recorded with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM. while, poor performance with regard to these parameter were recorded with application of 10 t/ha FYM + 100 % N through FYM. Therefore, application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM may be recommended for commercial seed production in Alfalfa during *kharif* season under southern dry zone of Karnataka.

Keywords: INM; *kharif*; nutrient; PSB; *rhizobium*; seed; yield.

1. INTRODUCTION

Alfalfa (*Medicago sativa* L.) 'Queen of the fodder crops' is an important fodder crops of India, belonging to family Fabaceae and growing extensively as an annual or perennial crops with supply of green fodder continuously for 2-3 years from the same field. It was introduced into India during 1900 from North-West [1] and cultivated in Uttar Pradesh, Punjab, Gujarat, Haryana, Tamil Nadu, Maharashtra and Karnataka in the country. It is growing approximately one million hectare of area and produced 60-130 tonnes of green fodder per hector per year with 186 - 280 kg/ha of seed yield in India. it is locally known as 'Kuduremasale' in Karnataka.

The Nutritive content of palatable fodder 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 stachydrine as medicinal alkaloid and used for digestive, laxative, diuretic

and treating against for blood pressure, arthritis, hair loss, acidity and dropsy. The soil health and environment are deterioration due to continuous use of chemical fertilizers, which can be prevented by using the judicious combination of different sources of nutrients such as use of organic manures and bio-fertilizers along with balanced inorganic fertilizers, one of the eco-friendly approaches, which can be enhancing the productivity and sustainability [3]. By considering the importance of crop and role of integrated nutrient management, the experiment was conducted to study theseed yield, quality and economics of alfalfa seed production as influenced by INM during *kharif*.

2. MATERIALS AND METHODS

The field experiment was carried out at the farm field of Krishi Vigyan Kendra, Konehalli, Tiptur taluk, Tumkuru district under southern dry zone of Karnataka during *Kharif* season 2017-18 on seed yield, quality and economics of alfalfa seed

production as influenced by integrated nutrient management. The nine treatments and four replication were laid out with Randomized complete block design (RCBD). Plots were prepared with size of 4.32sq.m (2.4 m x 1.8 m) area of red sandy loam soil. Alfalfa 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 *kharif* season with 30 cm x 15 cm spacing.

Treatment details:

- T₁ : RDF (25:50:25 kg NPK/ha)+ 10 t/ha FYM
- T₂: 75% RDF + 25% N through FYM
- T₃: 75% RDF + 25% N through Vermicompost
- T₄:75% RDF + 25% N through Poultry manure
- T₅: 50% RDF + 25% N through FYM + Rhizobium + PSB+VAM
- T₆ :50% RDF + 25% N through Vermicompost+ Rhizobium + PSB+VAM
- T₇ :50% RDF + 25% N through Poultry manure+ Rhizobium + PSB+VAM
- T₈ : RDF + *Rhizobium* + PSB+VAM
- T₉ : 10 t/ha FYM + 100% N through FYM

Table 1. NPK content of Poultry manure, Vermi-compost and Farm yard manure for NPK content before conducting the experiment

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

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 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 labelled for recording the observations at harvest stage. The recorded data were analysed by 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 calculated by using the below mentioned formula:

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

3. RESULTS AND DISCUSSION

3.1 Fresh Weight of Plants and Herb Yield of Alfalfa Affected by INM During *kharif* Season

The fresh weight of plant, herb yield/plot and herb yield/ha were recorded during *kharif* season at first harvest and herb yield after harvest of seeds are presented in Table 2. The plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM during *kharif* season was recorded maximum fresh weight (133.11g/plant & 121.49 g/plant), fresh herb yield (3.47kg/plot & 4.05kg/plot) and fresh herb yield (160.65q/ha & 187.50q/ha) at first harvest of herb and herb yield after harvest of seeds respectively, which was *at par* with the plants supplied with 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM. Whereas application of 10 t/ha FYM + 100 % N through FYM during *kharif* season were recorded least fresh weight/plant, fresh herb yield/plot and fresh herb yield/ha at first harvest of herb and herb yield after harvest of seeds.

The highest fresh weight of plant and fresh herb yield might be due to that, vermin-compost is known to produce favorable effect on chemical, biological and physical factors in soil, that determines productivity and fertility status of soil and supply the nutrients in their available form, enhance the microbial population and provides sufficient energy for them to remain active [5]. It also provides both the vital macro-nutrient and micro-nutrients such as N, P, K, Ca, Mg, besides, *Rhizobium* has been increased the availability of N and helped in the synthesis of tryptophan as resulted in obtained maximum herb yield. These results are in agreement with [6] in alfalfa, [7,8,9] in ashwagandha and [7] in davana.

3.2 Effect of Flowering Characters by INM in Alfalfa During *kharif* Season

Flowering characters such as days taken for flowering, pod initiation, pod maturation and number of flowers/plant were recorded during *kharif* season are presented in Table 3. The plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM during *kharif* season was recorded in early flowering (27 days), 50% flowering (35 days), pod initiation (48.5 days), pod maturation (73.05days) and highest number of flowers per plant (405) were

recorded, which was *on par* with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB + VAM in pod length. Whereas, application of 10 t/ha FYM + 100 % N through FYM during *kharif* season were recorded in delayed flowering, 50% flowering, pod initiation, pod maturation and least number of flowers.

This might be due to the integrated application of inorganic fertilizers and organic manure along with biofertilizers showing similar effect of growth regulators and provide in better uptake of nutrients by the plants as a result in better reproductive growth of the plants. The similar reports were found with [10] in Alfalfa, [11] in peppermint, [12] in Kalmegh, [13,14] in chamomile.

3.3 Effect of Pod Quality by INM in Alfalfa During *kharif* Season

The pod quality such as pod set per cent, number of pods/plant, number of filled pods, number of seeds/pod, pod yield, pod weight and pod length were recorded during *kharif* season are presented in Table 4. The application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM during *kharif* season were recorded maximum pod set per cent (56.78%), number of pods (228.75/plant), number of filled pods (129.25/plant), pod yield (19.90/plant), pod weight (87.61mg) and pod length (6.25mm). Whereas, application of 10 t/ha FYM + 100 % N through FYM during *kharif* season were recorded with minimum pod set per cent, number of pods/plant, number of filled pods/plant, pod yield/plant, pod weight and pod

length. The good pod quality could be due to application of *Rhizobium*, PSB and VAM enhances vegetative growth, better of photosynthetic and metabolites as resulted in early flowering, pod initiation and which improved the pod characters. The results are similar with the works of [15] in Ambrette.

3.4 Effect of Seed Characters and Seed Yield by INM in Alfalfa During *kharif* Season

The Effect of seed characters and seed yield by INM during *kharif* season are presented in Table 5. The plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM during *kharif* season was recorded maximum seed set per cent (56.50%), number of seeds (5.50/pod), test weight (3.33g) and seed yield (2.07g/plant, 48.25g/plot & 223.38kg/ha). Whereas, application of 10 t/ha FYM + 100 % N through FYM during *kharif* season was recorded minimum seed set per cent, number of seeds/pod, test weight, seed yield. This might be due to adequate availability of nutrients sources at different growth stages through the integrated application of inorganic, organic and bio-fertilizers and sequential metamorphosis from source to sink. The similar results are findings with [16] in isabgol and also increased uptake of nitrogen by *rhizobium* fixation of atmospheric nitrogen. Besides, the optimum supply of nutrient could have helped in increased plant metabolic activity and source to sink relationship, thus, higher the yield by more number of seeds. Similar results were found with [17] in Ashwagandha.

Table 2. Fresh weight of plants and herb yield of Alfalfa affected by INM during *kharif* season

Treatment	Fresh plant weight (g)		Fresh herb yield / plot (kg)		Fresh herb yield / hectare (g)		
	1 st Harvest of herb	Herb weight after harvest of seeds	1 st Harvest of herb	Herb yield after harvest of seeds	1 st Harvest of herb	Herb yield after harvest of seeds	Cumulative herb yield
T ₁	115.96	106.08	3.34	3.93	154.63	181.94	336.57
T ₂	103.37	96.58	3.23	3.81	149.54	176.39	325.93
T ₃	112.15	102.85	3.30	3.89	152.78	180.09	332.87
T ₄	110.15	100.06	3.27	3.87	151.39	179.17	330.56
T ₅	124.56	113.50	3.41	3.99	157.87	184.72	342.59
T ₆	133.11	121.49	3.47	4.05	160.65	187.50	348.15
T ₇	129.40	116.97	3.45	4.03	159.72	186.57	346.29
T ₈	119.87	109.68	3.38	3.60	156.48	166.67	323.15
T ₉	99.02	93.79	3.15	3.76	145.83	174.07	319.90
F- test	*	*	*	*	*	*	*
S.Em±	3.10	2.61	0.017	0.012	1.01	0.81	2.00
CD at 5 %	9.05	7.64	0.05	0.035	2.95	2.36	5.83

Table 3. Effect of flowering characters by INM in Alfalfa during *kharif* season

Treatment	No. of days for flowering	No. of days for 50% flowering	No. of flowers/plant	No. of days for pod initiation	No. of days for pod maturation
T ₁	28.55	36.10	386.50	50.13	75.30
T ₂	29.13	37.85	379.25	52.25	77.63
T ₃	28.60	36.10	385.75	50.13	75.35
T ₄	29.00	37.20	382.50	51.75	76.03
T ₅	27.55	35.60	396.63	49.10	74.28
T ₆	27.00	35.00	405.00	48.50	73.05
T ₇	27.10	35.50	399.25	48.75	73.75
T ₈	27.75	35.80	389.63	49.38	74.38
T ₉	29.38	38.00	376.00	53.25	78.25
F- test	*	*	*	*	*
S.Em±	0.15	0.18	2.78	0.12	0.38
CD at 5 %	0.44	0.54	8.14	0.34	1.12

Table 4. Effect of pod quality by INM in Alfalfa during *kharif* season

Treatment	Pod set (%)	No. of pods per plant	No. of filled pods per plant	Pod yield per plant (g)	Pod length (mm)	Pod weight (mg)
T ₁	54.98	212.50	111.50	18.02	5.90	85.38
T ₂	53.92	204.50	101.50	16.95	5.63	84.35
T ₃	55.02	211.95	111.50	18.00	5.85	85.40
T ₄	54.58	208.75	106.55	17.56	5.80	85.25
T ₅	56.16	222.25	121.75	19.10	6.00	86.15
T ₆	56.78	228.75	129.25	19.90	6.25	87.61
T ₇	56.43	225.50	127.50	19.50	6.15	86.03
T ₈	56.14	220.00	119.25	18.54	5.98	85.95
T ₉	53.66	201.75	98.00	16.58	5.58	83.75
F- test	*	*	*	*	*	*
S.Em±	0.22	2.12	2.10	0.25	0.07	0.41
CD at 5 %	0.64	6.21	6.13	0.73	0.22	1.25

Table 5. Effect of seed characters and seed yield by INM in Alfalfa during *kharif* season

Treatment	Seed set per cent	No. of seeds per pod	Test weight (g)	Seed yield per plant (g/pl)	Seed yield per plot (g/plot)	Seed yield per hectore (kg/ha)
T ₁	52.47	4.70	3.16	1.95	43.63	201.99
T ₂	49.63	4.45	3.10	1.92	42.10	194.06
T ₃	52.61	4.71	3.14	1.95	43.53	201.34
T ₄	51.04	4.65	3.11	1.94	42.38	196.20
T ₅	54.78	5.20	3.20	2.00	46.25	214.12
T ₆	56.50	5.50	3.33	2.07	48.25	223.38
T ₇	56.04	5.38	3.24	2.03	47.00	217.59
T ₈	54.20	4.98	3.18	1.97	45.75	211.80
T ₉	48.57	4.35	3.09	1.91	41.38	191.57
F- test	*	*	*	*	*	*
S.Em±	0.24	0.10	0.42	0.02	0.64	2.75
CD at 5 %	0.70	0.29	NS	0.06	1.87	8.03

3.5 Effect of Integrated Nutrient Management on Economics of Seed Production in Alfalfa During *kharif* Season

The economics of seed production in Alfalfa during *kharif* season are presented in Table 6.

The plants supplied with 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM during *kharif* season was obtained highest net return (Rs. 65,763/ha) and obtained the maximum cost benefit ratio (2.12) during *kharif* season with the application of 50 % RDF + 25 % N through poultry manure + *Rhizobium* + PSB +

VAM. Whereas, the lowest net return (Rs.51,824/ha) and B:C ratio (1.92) was obtained with the application of 10 t/ha FYM + 100 % N through FYM during *kharif* season. The highest net return and B:C ratio in seed production could be due to

enhancement of growth and development by supplying of integrated nutrients to meet the required demand of the crop till physiological maturity resulted in increased seed yield. Similar reports were found by [18,19] in alfalfa [20].

Table 6. Effect of INM on economics of seed production in Alfalfa during *kharif* season

Treatment	Economics of seed production during <i>kharif</i> season			
	Gross Return (Rs./ha)	Cost of Cultivation (Rs./ha)	Net return (Rs./ha)	B:C ratio
T ₁	114090	57199	56891	1.990
T ₂	109759	57063	52696	1.930
T ₃	113520	58360	55160	1.940
T ₄	110998	56987	54011	1.950
T ₅	120034	57558	62476	2.080
T ₆	124618	58855	65763	2.117
T ₇	121873	57482	64391	2.120
T ₈	118782	58487	60295	2.030
T ₉	108081	56257	51824	1.920



Fig. 1. Alfalfa crop after I harvest



Fig. 2. General view of Alfalfa experiment during *kharif* season



Fig. 3. Harvesting of alfalfa



Fig. 4. Plot treatment



Fig. 5. Plot treatment



Fig. 6. Flowering stage



Fig. 7. Leaf and stem weight of all treatment



Fig. 8. Harvesting stage of seeds

4. CONCLUSION

From the experiment findings of present investigation, it can be concluded that, the application of 50 % RDF + 25 % N through vermicompost + *Rhizobium* + PSB + VAM has recorded the maximum seed yield, good quality and highest profit in seed production. which may be recommended for commercial seed production in of Alfalfa during *kharif* season under southern dry zone of Karnataka.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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