



## Integrated Nutrient Management on Fodder Dual Purpose Oat (*Avena sativa* L.)

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### *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

**Aim:** To study the effect of integrated nutrient management (INM) on growth, yield and quality of dual purpose fodder oat.

**Study Design:** Randomized Block Design.

**Place and Duration of Study:** Anand Agricultural University, Anand during Rabi 2019-2021.

**Methodology:** The experiment was laid out in randomized block design with four replications. The experimental treatments were consisted of ten INM treatments viz., T<sub>1</sub> (100% recommendation dose of fertilizer; RDF' 80-40-00 kg NPK/ha), T<sub>2</sub> (10 t FYM/ha + 100% RDF), T<sub>3</sub> (castor cake/ha + 100% RDF), T<sub>4</sub> (poultry manure/ha + 100% RDF), T<sub>5</sub> (neem cake/ha + 100% RDF), T<sub>6</sub> (5 t FYM + 25% RDN from FYM + 75% RDF + biofertilizer), T<sub>7</sub> (5 t FYM + 25% RDN from castor cake + 75% RDF + biofertilizer), T<sub>8</sub> (5 t FYM + 25% RDN from poultry manure + 75% RDF + biofertilizer), T<sub>9</sub> (5 t FYM + 25% RDN from neem cake + 75% RDF + biofertilizer) and T<sub>10</sub> (50% RDN from FYM + 50% RDN from castor cake + biofertilizer). Amount of castor cake, poultry manure and neem cake were applied based on 10 t FYM/ha equivalent N, i.e., respectively 1.45, 3.23 and 3.27 t/ha.

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**Results:** The results revealed that quality parameters of fodder oat such as dry matter, dry matter yield, crude protein, ADF, NDF, crude fiber contents as well as ash content of green fodder and straw were found significant superior with application of T<sub>6</sub> and T<sub>10</sub> treatments. Similarly, NPK content and their uptake into the seed and straw were also found significantly higher with the same treatments. The physicochemical and biological properties of experimental field soil at harvest of oat crop were also considerably improved due to application of INM treatment as compared to initial soil nutrient status.

**Keywords:** INM (Integrated Nutrient Management); Fodder oat; FYM (farmyard manure); castor cake; neem cake; poultry manure; biofertilizer.

## 1. INTRODUCTION

The forage crops are the mainstay of animal production, and are the plant species that are cultivated and harvested for feeding the animals in the form of green forage, silage, hay or other forms. Livestock is an important component of Indian rural and urban economies. Livestock sector has been making rapid strides and spectacular growth in recent time with positive impact on the lives of rural people mainly small farmers, marginal farmers and agricultural landless labourers by raising their living standards considerably. Briefly, livestock contributes about 4.5% to total GDP and 25.8% to the agriculture GDP [1]. Feed and fodder have been identified as one of the major components in achieving the desired level of livestock production, hence the productivity and availability of good quality feed and fodder is of prime importance for the development of livestock sector. Although India has the largest livestock population, ~15% of the world, but country has only 4.4% of its cultivated area covered under fodder crops with an annual total forage production of 866 MT (i.e., 400 MT green fodder and 466 MT dry fodder production). However, the annual forage requirement is 1706 MT (1097 MT green and 609 MT dry fodder production) to support the existing livestock population [2]. As a result, livestock suffers with malnutrition for round the year, resulting in their production capacity at sub-optimum level and half of the total losses in livestock productivity are due to inadequacy in supply of feed and fodder. Fodder and crop residues of cereals are major source of forage but the nutritive value of these fodder is not adequate to achieve higher milk production. Availability of quality green fodder is the key to success of dairy enterprises as it is difficult to maintain health and production of the livestock without supply of quality green fodder.

Oats (*Avena sativa* L.) is an important winter forage crop having wider adaptability in India

particularly in northern, western and central states. It is widely grown for green fodder because of its luxuriant growth habit, succulent, good palatability and highly nutritious nature. The genus *Avena* comprises of about seventy species. The *Avena sativa* and *Avena 81yzantine* are the main oats grown for fodder and grain. The nutrient requirement of oat is comparatively higher over other *rabi* forage crops. To meet out these demand, higher doses of inorganic fertilizers are required which is uneconomical for fodder production. Moreover, continuous use of chemical fertilizers may have adverse impact on soil health. To this, the integrated nutrient management (INM) holds great potential not only for securing high productivity but also sustaining the soil health [3].

## 2. MATERIALS AND METHODS

A field experiment was conducted during the *rabi* season 2019-20 at Main Forage Research Station, Anand Agricultural University, Anand (Gujarat). The experimental soil was low in organic carbon (0.28%) and available nitrogen (232.87 kg/ha), medium in available phosphorus (35.12 kg/ha), and high in potassium (280.20 kg/ha). The experiment was laid out in the randomized block design with ten treatments with four replications. Half of the recommended dose of nitrogen (i.e., 80 kg N/ha; through urea) and entire recommended dose of phosphorus (i.e., 40 kg P/ha; through SSP) was applied as basal and the remaining half a dose of nitrogen was given in two equal splits i.e., at 40 DAS and 55 DAS. The entire quantity of farmyard manure, castor cake, poultry manure and neem cake were incorporated before 10 days of sowing and biofertilizer (NPK consortia; 1 L/ha) was spray on soil surface at time of sowing. The recorded data of various parameters were statistically analyzed reported at  $\alpha=0.05$  significance level. All the soil chemical analysis done by as the standard analytical procedures.

## 2.1 Dry matter Content (%) and Dry Matter Yield (q/ha)

A fresh sample of 500 g green fodder oat harvest from each net plot, was subsequently chopped into small pieces and air dried for three to four days. This air-dried samples were then dried in the oven at 100°C till attainment of constant weight. The dry matter content (%) was calculated by using given formula.

$$\text{Dry matter content (\%)} = \frac{\text{Oven dried fodder weight (g)}}{\text{Fresh fodder weight (g)}} \times 100$$

The dry matter yield was calculated by multiplying dry matter content (%) with green fodder yield using following formula and expressed in q/ha.

$$\text{Dry matter content (q/ha)} = \frac{\text{Dry matter content (\%)} \times \text{Green fodder yield (q/ha)}}{100}$$

## 2.2 Crude Protein Content (%) and Crude Protein Yield (q/ha)

The total nitrogen content (%) was estimated as per the Kjeldahl method (Jackson, 1973). Subsequently, crude protein content (%) was calculated by multiplying the percentage of total nitrogen content with a factor of 6.25. The crude protein yield was estimated by multiplying crude protein (%) with dry matter yield and expressed in q/ha.

$$\text{Crude protein yield (q/ha)} = \frac{\text{Dry matter content (\%)} \times \text{Crude protein content (\%)}}{100}$$

## 2.3 Acid Detergent Fibre (%), Neutral Detergent Fibre (%) and Ash Content (%)

Estimation of acid detergent fibre (ADF) and neutral detergent fibre (NDF) contents was estimated following the method described by the Goering and Vansoest (1975). For the ash content, known weight of sample was ashed in muffle furnace at 550 C temperature and the ash content was estimated using following formula

$$\text{Ash (\%)} = \frac{\text{Weight of ash} \times 100}{\text{Weight of sample}}$$

## 2.4 Nutrient Uptake (kg/ha)

Nutrient uptake by seed and straw was calculated by multiply nutrient content with yield parameter, by following formula.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{Yield (kg/ha)}}{100}$$

## 3. RESULTS AND DISCUSSION

### 3.1 Dry Matter Content and Dry Matter Yield

It is evident from data (Table 1) that the incorporation of 5 t FYM + 25% N from FYM + 75% RDF + biofertilizer (i.e., T<sub>6</sub>) significantly produced higher dry matter yields of 71.71 and 15.50 q/ha with dry matter contents of 13.06% and 19.38%, respectively at 55 DAS and at harvest. However, with respect to the dry matter yield, treatment T<sub>6</sub> was statistically at par with T<sub>5</sub>, T<sub>7</sub>, and T<sub>8</sub> at 55 DAS and with T<sub>2</sub>, T<sub>3</sub>, T<sub>5</sub>, T<sub>7</sub>, and T<sub>8</sub> at harvest. Improvement in the dry matter yield in the said treatments could be due to integrated use of organic and inorganic fertilizers, which are known to improve soil physicochemical properties, and further the application of biofertilizer may also increases the availability plant nutrients. This ultimately resulted into profuse vegetative growth and tillering. These results correspond with the findings reported by [4,5].

### 3.2 Crude Protein Content and Crude Protein Yield

Significantly higher crude protein of 12.07% at 55 DAS was obtained with the incorporation of 5 t FYM + 25% N from poultry manure + 75% RDF + biofertilizer (i.e., T<sub>8</sub>), was statistically at par with treatment T<sub>4</sub>, T<sub>5</sub>, T<sub>6</sub>, and T<sub>10</sub>. Whereas, at harvest, the significantly higher crude protein (11.93%) was observed with treatment T<sub>6</sub>, was statistically followed by treatment T<sub>2</sub>, T<sub>4</sub>, and T<sub>5</sub>. Correspondingly, significantly maximum crude protein yield at 55 DAS and at harvest (8.14 and 1.84 q/ha, respectively) were observed due to treatment T<sub>6</sub>. Increases in the crude protein content in fodder oat is apparently due to incorporation of organic and inorganic fertilizer and biofertilizer, which supplied readily available nitrogen to the plant roots. This is an obvious finding and correspond with published works [6,7].

**Table 1. Effect of integrated nutrient management on fodder quality of dual purposed oat**

Treatments	First cut at 55 DAS						At harvest					
	DM (%)	DMY (q/ha)	CP (%)	CPY (q/ha)	ADF (%)	NDF (%)	DM (%)	DMY (q/ha)	CP (%)	CPY (q/ha)	ADF (%)	NDF (%)
T <sub>1</sub> : 100% RDF (80-40-0 NPK kg/ha)	11.08	53.52	10.00	5.76	60.50	80.00	12.79	8.79	9.43	0.83	65.75	63.25
T <sub>2</sub> : 10t FYM + 100% RDF	11.64	58.52	10.70	6.10	58.50	72.25	17.50	12.64	11.37	1.43	59.50	54.50
T <sub>3</sub> : Castor cake + 100% RDF	11.12	53.64	10.60	5.67	58.75	75.75	16.50	12.71	10.53	1.34	56.50	55.25
T <sub>4</sub> : Poultry manure + 100% RDF	11.10	59.21	11.82	7.06	53.50	73.50	17.00	11.92	11.32	1.34	56.50	53.25
T <sub>5</sub> : Neem Cake + 100% RDF	11.55	61.11	10.82	6.60	57.75	76.76	18.25	13.89	10.74	1.49	56.00	55.50
T <sub>6</sub> : 5 t FYM + 25% N from FYM + 75% RDF + Biofertilizer	13.06	71.71	11.42	8.14	51.25	65.25	19.38	15.50	11.93	1.84	52.50	48.25
T <sub>7</sub> : 5 t FYM + 25% N from Castor cake + 75% RDF + Biofertilizer	12.27	62.63	10.00	6.24	54.75	76.00	17.50	12.54	10.39	1.28	59.75	54.75
T <sub>8</sub> : 5 t FYM + 25% N from Poultry manure + 75% RDF + Biofertilizer	12.67	61.76	12.07	7.47	52.50	74.25	19.12	13.14	10.04	1.31	53.00	52.00
T <sub>9</sub> : 5 t FYM + 25% N from Neem Cake + 75% RDF + Biofertilizer	11.67	56.79	10.62	6.02	55.75	67.25	17.12	10.94	9.99	1.09	53.00	57.50
T <sub>10</sub> : 50% N from FYM + 50% N from Castor cake + Biofertilizer	10.12	41.04	11.47	4.72	54.00	73.50	16.37	8.40	11.37	0.97	57.50	53.00
S.Em. ±	0.55	3.74	0.45	0.45	1.97	2.74	1.18	1.23	0.42	0.13	2.42	2.57
CD 5 %	1.60	10.85	1.31	1.29	5.71	7.96	3.42	3.57	1.21	0.37	7.01	7.45
CV (%)	9.48	12.90	8.28	13.98	7.06	7.47	13.76	20.42	7.81	19.89	8.48	9.38

DM=dry matter; DMY=dry matter yield; CP=crude protein; CPY=crude protein yield

**Table 2. Effect of integrated nutrient management on content, uptake of fodder and post-harvest nutrient status of soil**

Treatments	Seed						Straw						Soil properties						
	Content (%)			Uptake (kg/ha)			Content (%)			Uptake (kg/ha)			pH	EC (dS/m)	Org. Carbo (%)	Total N (kg/ha)	Avail. P <sub>2</sub> O <sub>5</sub> (kg/ha)	Avail. K <sub>2</sub> O (kg/ha)	TBC (cfu/g × 10 <sup>6</sup> )
	N	P	K	N	P	K	N	P	K	N	P	K							
T <sub>1</sub>	2.17	0.25	1.67	42.44	4.94	32.38	1.52	0.21	1.72	104.28	14.87	119.45	7.46	0.21	0.27	223	32	264	6.25
T <sub>2</sub>	2.31	0.27	1.75	38.13	4.44	28.68	1.82	0.24	1.85	131.34	17.65	134.11	7.47	0.22	0.29	246	40	288	13.00
T <sub>3</sub>	2.09	0.28	1.65	39.39	5.30	31.13	1.67	0.26	1.70	130.76	20.04	131.73	7.46	0.21	0.28	232	41	278	11.50
T <sub>4</sub>	2.20	0.28	1.45	39.66	5.02	26.27	1.82	0.25	1.70	128.88	17.66	119.79	7.45	0.21	0.28	245	36	281	13.00
T <sub>5</sub>	2.19	0.27	1.67	36.80	4.52	28.63	1.72	0.25	1.82	130.49	18.91	138.65	7.47	0.22	0.28	233	37	279	12.25
T <sub>6</sub>	2.26	0.32	1.70	57.21	8.59	43.00	1.90	0.29	1.95	153.91	23.41	156.83	7.47	0.21	0.29	261	41	308	15.75
T <sub>7</sub>	2.16	0.26	1.67	48.04	5.91	37.59	1.65	0.27	1.85	115.82	19.11	130.90	7.47	0.21	0.28	231	36	285	14.25
T <sub>8</sub>	1.97	0.32	1.80	41.96	6.88	38.36	1.60	0.25	1.85	110.51	17.39	127.26	7.46	0.22	0.28	259	38	292	13.00
T <sub>9</sub>	2.12	0.26	1.60	45.69	5.67	33.99	1.60	0.25	1.92	101.02	16.19	122.97	7.46	0.22	0.29	232	37	280	14.50
T <sub>10</sub>	2.03	0.27	1.75	36.39	4.81	31.06	1.82	0.25	1.85	93.56	13.02	94.20	7.46	0.21	0.29	257	40	292	16.00
S.Em. ±	0.07	0.02	0.12	3.17	0.45	3.61	0.07	0.01	0.06	9.45	1.56	10.89	0.28	0.01	0.01	9.00	1.00	8.00	0.89
CD 5 %	0.19	NS	NS	9.21	1.30	NS	0.21	0.02	NS	27.42	4.52	NS	NS	NS	NS	26.00	4.00	22.00	2.59
CV (%)	6.31	12.02	14.59	14.91	16.04	21.78	8.50	6.23	6.66	15.74	17.46	17.08	7.37	8.12	5.71	7.43	7.17	5.43	13.76

EC=electrical conductivity; TBC=total microbial count

### 3.3 ADF and NDF

The acid detergent fiber (ADF) value relates to the cellulose and lignin cell wall components of the forage. These values are significant because they relate to an animal's capacity to digest forage. The capacity to digest or the digestibility of the feed diminishes as ADF increases. While the entire cell wall, which includes the ADF fraction plus hemicellulose, is represented by the neutral detergent fiber (NDF) value. The NDF levels are significant since they indicate how much forage the animal can ingest. Dry matter intake usually decreases as the NDF percentage rises. Results of present study revealed that incorporation of treatment T<sub>6</sub> produced fodder with significantly lower ADF and NDF contents of 51.25% and 65.25% at 55 DAS; 52.50% and 48.25% at harvest, respectively. This could be due to succulence vegetative growth and slender stem and early growing stage of crop. The ADF and NDF values usually increases with growth and development of plant and at each fodder cut, obviously due to greater synthesis of carbohydrates, cellulose and accumulation of fibrous components [7,8].

### 3.4 Macronutrient (NPK) Content and their Uptake in Seed

The data present in Table 2 shows that nitrogen (N) content of oat seed was significantly influenced due to INM treatments, while phosphorus (P) and potassium (K) contents were observed non-significant. Significantly higher N content (2.31%) was observed with treatment T<sub>2</sub> (10 t FYM + 100% RDF), which was statistically at par with treatment T<sub>2</sub>, T<sub>4</sub>, T<sub>5</sub>, T<sub>6</sub> and T<sub>7</sub>. Increases in the N content in seed apparently due to greater bioavailability of nitrogen from the applied integrated nutrient sources and subsequent efficient absorption of N by plant root. The findings are corresponding with the published results [9,10].

Correspondingly, the studied sets of INM treatment had influenced N and P uptake into the seed, and were found significantly higher (57.21 and 8.59 kg/ha) due to treatment T<sub>6</sub> respectively). This could be evidently due to the correspondingly higher seed yield and nutrient content [11].

### 3.5 NPK Content and Uptake in Straw

Similarly, studied INM treatments had also influenced N and P contents in straw, and were found significantly higher (1.90% and 0.29%,

respectively) due to treatment T<sub>6</sub> respectively). Correspondingly, their uptake into the straw also found statistically higher (153.91 and 23.41 kg/ha, respectively) with treatment T<sub>6</sub>. Application of organic and inorganic fertilizer together with biofertilizer facilitates the bioavailability of N and P, and thereby greater content and uptake of N and P into the straw [9,10,11].

### 3.6 Soil Properties

Data on soil properties e.g., pH, EC, Total N, available P<sub>2</sub>O<sub>5</sub>, available K<sub>2</sub>O, and total microbial counts (TBC) are present in Table 2. The soil available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as well as TBC after harvest of the crop was evidently influenced by the INM treatments. The soil available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O NPK were significantly higher (261, 41, 380 kg/ha, respectively) treatment T<sub>6</sub>; whereas statistically maximum microbial count of 16 × 10<sup>6</sup> cfu/g was observed with treatment T<sub>10</sub>, statistically followed by treatment T<sub>6</sub>. The soil NPK status and TBC at harvest, as compared to initial and 100% RDF was found increased with integrated nutrient management. The results might be due to addition of nutrients in soil by combine application of organic and inorganic fertilizer with biofertilizer. The continued availability of nutrient from organic manure and mineralization of native soil nutrients, lead to build up the soil concentration.

## 4. CONCLUSION

In view of the results obtained from the present examination, it is concluded that dual purposed fodder oat (cv. Kent) should be fertilized with 5 t FYM + 25% RDN from FYM (i.e., 20 kg N/ha) + 75% RDF (i.e., 60 kg N/ha + 30 kg P<sub>2</sub>O<sub>5</sub>) + biofertilizer (soil application at 1 L/ha) for producing the quality green fodder, seed yield and for sustaining the soil nutrient and biological properties.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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