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Effect of Natural Farming on Soil Health, Growth, Yield and Quality of Sorghum-Oat Fodder Production System

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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

The field experiment was conducted on fodder sorghum (*Sorghum bicolor* L.) and fodder oat (*Avena sativa* L.) during the *kharif* and *rabi* season in 2022-23 at GPB Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P). The experiment was laid out in randomized block design (RBD). Results revealed that the growth parameters of *kharif* sorghum and *rabi* oat *viz*., plant population (20.96 m^{-1} and 71.83 m^{-1}), plant height (190.00 cm and 112.42 cm), Leaf: stem ratio (0.74 and 0.38), green fodder yield (274.46 q ha^{-1} and 263.9 q ha^{-1}),

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dry fodder yield (68.61 q ha^{-1} and 65.97 q ha^{-1}) and quality parameters *viz*., crude protein content (8.83 % and 7.84 %), crude protein yield (6.06 q ha^{-1} and 5.17 q ha^{-1}), ADF (40.22 % and 44.31 %) and NDF (65.59 % and 73.61%) at harvest was improved by different organic treatments over control, being highest under FYM @ 5 t ha^{-1} + Natural farming with mulch followed by FYM @ 5 t ha^{-1} + Natural farming without mulch.

Keywords: Natural farming; FYM; compost tea; yield; quality; fodder production; crude protein.

1. INTRODUCTION

Sorghum (*Sorghum bicolor* L.) belonging to the family *poaceae*, is an important *kharif* season dual purpose crop and the world's fifth most important cereal, in terms of both production and area planted. In India, Maharashtra is the top-state in terms of area and production with a productivity of 2150 kg ha^{-1}. Uttar Pradesh ranks lower due to their smaller planted area (0.20 m ha) and lower production (0.28 m t). Sorghum (*Sorghum bicolor* L.) is a C4 cereal fodder crop with excellent photosynthetic productivity. Its fodder contains more than 50% digestible nutrients which consist of 8% protein, 2.5% fat and 45% nitrogen-free-extract (NFE). Its feeding value has been reported as equal to that of corn and due to its palatability and succulence nature, it is relished well by animals [1].

Oat (*Avena sativa* L.) belonging to the family *poaceae,* is amongst the major winter cereal forages cultivated throughout the country. It is a fast growing, palatable, succulent and nutritive fodder [2,3]. It ranks sixth in the world cereal production statistics following wheat, maize, rice, barley and sorghum. It is a dual- purpose crop of tropical and subtropical. In India, oat is exclusively grown for fodder in western Uttar Pradesh, Haryana and Punjab. It is also grown on limited scale in some parts of Maharashtra, Madhya Pradesh, Gujarat, Orissa, Bihar and West Bengal [4]. Oats have a high content of fat and are rich in oleic and linoleic acids. It contains B1, B2, B6 and A, K & E vitamins.

Further [4] include valuable minerals, micronutrients, antioxidants and sterols compared to barley or maize, oats have 1% – 3% more crude protein. Also, when compared to the other cereals, oats have a balanced amino acid composition and a higher concentration of essential amino acids, such as lysine, making it one of the most preferred feed ingredients by livestock farmers

Being exhaustive crops, these crops require higher dose of nutrients for production in particular, nitrogen. This requirement is fulfilled by applying inorganic fertilizers to the soil. Due to continuous use of inorganic fertilizers to fulfil the nutritional demand of these crops, the ill-effects of these high analysis fertilizers have been reported on the soil productivity and sustainability [5].

Natural Farming is a term used to describe an ecological farming approach to produce organic based food crops. It is a natural agriculture alternative which promotes lower production cost and at the same time is able to achieve product of high quality and yield with lower or without the usage of inorganic fertilizers and pesticides [6]. This system of agriculture aims to meet the requirements of crops at the farm itself with the use of locally available materials. As claimed, this concept helps to maintain ecological balance and also satisfying the conditions of the law of biological diversity.

2. MATERIALS AND METHODS

The experiment was conducted during the *kharif 2022* and *rabi* season 2022-23 at GPB Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) Geographically, the experimental site falls under humid, sub-tropical climate and is located at 26.47^0 N latitude and 82.12^0 E longitude on an elevation of about 113 meter above mean sea level in the Indo-Gangetic alluvial soil belt of eastern Uttar Pradesh. The soil of field was slightly alkaline in reaction, low in organic carbon and available nitrogen, while medium in phosphorus and rich in potassium. Plant population counted from each plot area at the time of harvesting and was considered for recording the plant population. The height of five randomly selected plants were measured at harvest stage by the meter scale. The average plant height was calculated by taking the mean of height of 5 selected plants and expressed in cm. Ten plant samples were collected in each treatment outside the net plot area leaving the extreme border row and fresh weights of the samples were taken separately for leaves and

stems and leaf to stem ratio was computed at harvest stage by using the following formula:

Leaf: stem ratio = $Freshweightofleave$ (g) / Fresh weight of stems (g)

Acid detergent fiber percentage was measured by boiling of forage in an acid detergent solution, then measuring the residue remaining. In the same way NDF was measured by boiling the forage in a neutral detergent solution, then measuring the soluble residue. Nitrogen content of plant samples was estimated by modified Micro kjeldahl method [7] and the crude protein content was estimated by using the following formula which was expressed in percentage.

Crude protein (%) = N (%) × 6.25.

The crude protein yield (q ha^{-1}) was estimated by the following formula:

Crude protein yield (q ha^{-1}) = ($\boldsymbol{Crude\ protein}$ (%) / 100) × Dry fodder yield

Green fodder yield of each net plot was obtained by weighing of green fodder and finally converting into quintal per hectare (q ha^{-1}). After the harvesting of green fodder yield from each net plot, the plant samples were air dried in the sun and then in the oven at 70 ^{0}C till they attained a constant weight. The dry fodder yield for each treatment was computed to quintal per hectare.

3. RESULTS AND DISCUSSION

The perusal of the data (Table 1) showed significant variation in plant population at harvest due to the effect of different treatments. Highest plant population (20.96 m^{-1} and 71.83 m^{-1}) was recorded under FYM @ 5 t ha^{-1} + Natural farming with mulch, which was *at par* with FYM @ 5 t ha^{-1} + Natural farming without mulch, while significantly higher than rest of the treatments. This might be because of organic fertilizers which contain growth promoters like indole acetic acid and gibberellic acid known to have positive effect on the germination of seed and growth of crop**.** The minimum plant population (m^{-1}) in *kharif* sorghum and *rabi* oat was recorded under control treatment. The results are in close conformity with that of Sreenivasa *et al*., 2009. The highest plant height (190.00 cm and 112.42 cm) at the time of harvest was recorded under FYM @ 5 t ha^{-1} + Natural farming with mulch being on par with FYM @ 5 t ha^{-1} + Natural farming without mulch and FYM @ 10 t ha^{-1} while significantly higher over rest other treatments; whereas minimum plant height (cm) in *kharif* sorghum and *rabi* oat was recorded under control. Organic treatments like Beejamrit, Jeevamrit and Mulch which increase microbial activity in the soil and ultimately ensures the better availability of nutrients to the crops might have contributed to increased plant growth and subsequently greater plant height. These findings align with the research conducted by Palekar, [8] and Bhagat et al. [9]

Further, the data revealed that leaf: stem ratio at harvest have not varied significantly in *kharif* sorghum while significant variation was observed in *rabi* oat under the influence of different treatments. Highest leaf: stem ratio in *kharif* sorghum at harvest (0.74) was recorded under the effect of FYM @ 5 t ha^{-1} + Natural farming with mulch whereas highest leaf: stem ratio in *rabi* oat at harvest (0.38) was recorded under the influence of FYM @ 5 t ha^{-1} + Natural farming with mulch, being on par with FYM @ 5 t ha^{-1} + Natural farming without mulch, but significantly higher than rest of the treatments. However minimum leaf: stem ratio in *kharif* sorghum and *rabi* oat was recorded under control treatment. Organic sources of nutrients, resulted in a greater number of shoots of crops per unit area, which might have reduced the stem girth due to more inter specific competition hence resulted in better leaf stem ratio. These results are in accordance with the findings of Brar [10].

The highest green fodder yield (274.46 q ha^{-1} and 263.9 q ha^{-1}) and dry fodder yield (68.61 q ha^{-1} and 65.97 q ha^{-1}) was recorded under FYM @ 5 t ha^{-1} + Natural farming with mulch, which was *at par* with FYM @ 5 t ha^{-1} + Natural farming without mulch while significantly higher over other treatments in both *kharif* sorghum and *rabi* oat, whereas minimum green and dry fodder yield (q ha^{-1}) was recorded under control. Organic sources of nutrients might have improved physio-chemical and biological properties of the soil and further better availability of nutrients to the plant, improved the growth and yield attributes which ultimately resulted into higher green and dry fodder yield of the crop. These results corroborate the findings of Patil et al, [11].

Data presented in Table 2 indicated that different treatments could not influenced the crude protein content (%), ADF (%) and NDF (%) significantly in *kharif* sorghum and *rabi* oat, however numerically maximum crude protein (8.83 %

Table 1. Effect of different organic nutrients on the Plant population (m-1), Plant height (cm), Leaf: stem ratio, Green and Dry fodderyield (q ha-1) at harvest in *kharif* sorghum and *rabi* oat

Treatments	Plant population		Plant height		Leaf: stem ratio		Green fodder yield		Dry fodder yield	
	Sorghum	Oat	Sorghum	Oat	Sorghum	Oat	Sorghum	Oat	Sorghum	Oat
T_1 - FYM @10 t/ha	17.86	59.61	185.87	105.79	0.73	0.33	245.7	225.99	61.42	56.49
T_2-Natural Farming with Mulch	17.21	58.17	183.11	102.92	0.71	0.30	229.22	214.73	57.3	53.68
T_3-Natural Farming without Mulch	16.84	57.45	181.78	100.80	0.71	0.31	210.35	211.46	52.58	52.86
T_4 - FYM @ 5 t/ha+ Natural Farming with Mulch	20.96	71.83	190.00	112.42	0.74	0.38	274.46	263.9	68.61	65.97
T_5- FYM @ 5 t/ha+ Natural Farming without Mulch	19.52	68.52	189.82	108.98	0.73	0.37	251.01	240.7	67.2	63.17
T_6-FYM@5 t/ha+ Compost Tea	16.53	55.89	178.39	97.61	0.69	0.31	204.92	204.69	51.23	51.17
T_7 – Control	16.16	52.47	175.04	92.86	0.67	0.25	170.36	171.72	42.59	42.93
Sem (±)	0.60	2.04	1.66	3.05	0.02	0.01	7.68	7.42	1.91	1.92
CD	**1.87**	**6.36**	**5.18**	**9.40**	**NS**	**0.05**	**23.93**	**23.13**	**5.88**	**6.00**

Table 2. Effect of different organic nutrients on the ADF (%), NDF (%), Crude protein content (%) and crude protein yield (q ha-1) atharvest in *kharif* sorghum and *rabi* oat

Treatments	Acid detergent fiber		Neutral detergent fiber		Crude protein content		Crude protein yield	
	Sorghum	Oat	Sorghum	Oat	Sorghum	Oat	Sorghum	Oat
T_1 - FYM @10 t/ha	38.61	43.81	61.38	69.30	8.26	7.46	5.07	4.21
T_2-Natural Farming withMulch	37.34	43.36	60.37	67.20	8.1	7.33	4.64	3.93
T_3-Natural Farming withoutMulch	36.77	42.23	60.14	66.13	8.04	7.25	4.23	3.83
T_4 - FYM @ 5 t/ha+ NaturalFarming with Mulch	40.22	44.31	65.59	73.61	8.83	7.84	6.06	5.17
T_5- FYM @ 5 t/ha+ NaturalFarming without Mulch	39.64	44.10	62.37	72.61	8.4	7.67	5.64	4.85
T_6-FYM@5 t/ha+ CompostTea	36.47	41.78	59.70	64.19	7.89	7.01	4.04	3.59
T_7 – Control	35.52	38.72	59.46	64.13	7.42	6.96	3.16	2.99
Sem (±)	3.22	1.40	5.29	2.25	0.27	0.24	0.15	0.14
CD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.47**	**0.43**

and 7.84 %), ADF (40.22 % and 44.31 %) and NDF (65.59 % and 73.61%) was recorded under FYM @ 5 t ha^{-1} + Natural farming with mulch in *kharif* sorghum and *rabi* oat. Data further reveals that application of different treatments had significant effect on crude protein yield (q ha^{-1}) of *kharif* sorghum and *rabi* oat. Maximum crude protein yield was recorded under FYM @ 5 t ha^{-1} + Natural farming with mulch (6.06 q ha^{-1} and 5.17 q ha^{-1}) in *kharif* sorghum and *rabi* oat respectively, which was *at par* with FYM @ 5 t ha^{-1} + Natural farming without mulch. The minimum crude protein content (%), crude protein yield (q ha^{-1}), ADF (%) and NDF (%) was recorded under control. Organic nutrients might have helped in enhancing the quality of crop. These results are in agreement with the findings of Kumbar and Devakumar, [12,13].

4. CONCLUSION

The fodder production in the country is not sufficient to meet the requirements of the growing livestock population and also the forages offered to animals are mostly of poor quality. Thus, the need of the hour is not only to enhance the production of good quality fodder, but also to make the fodder accessible round the year to dairy animals, so Natural farming is a way to get maximum yield and quality without using toxic chemical fertilizers. The result of the present study showed that by the application of FYM @ 5 t ha^{-1} + Natural farming with mulch helped in achieving better growth parameters, better fodder quality and maximum fodder yield round the year in *kharif* sorghum and *rabi* oat cropping system.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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