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Effect of nitrogen levels and cutting management on available nitrogen, phosphorus and potassium of soil in fodder oat *(Avena sativa* L.) cultivation

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Abstract
The field experiment, conducted to evaluate the Effect of nitrogen levels and cutting management on growth, yield and quality of fodder oat *(Avena sativa* L.). A field experiment was conducted during *Rabi* season 2015-16 at Crop Research Centre (Chirauri) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to evaluate the effect of nitrogen levels and cutting management on performance of fodder oat and chemical properties of soil. The area lie at a latitude of 29º 40' North and longitude of 77º 42' East with an elevation of 237 meters above mean sea level. The soil of the experimental field was well drained, sandy loam in texture and slightly alkaline in reaction. It was medium in available nitrogen and phosphorus but high in available potassium with an electrical conductivity (1:2, soil: water suspension) of 1.6 dS/m. The treatments comprised 5 nitrogen levels (0, 40, 80, 120 and 160 kg ha^{-1}) and 2 cutting management (single at 50% flowering and double at 60 DAS and 50% flowering), replicated 4 times in a factorial randomized block design. The data on growth, physiology, green forage yield and quality and its contributing traits were calculated on net plot area basis (16 m^2), whereas content and uptake in straw along with soil available nutrients and production economic, were recorded as per the standard procedure. The results indicated that leaf area index at all the stages of oat was significantly superior at 160 kg nitrogen ha^{-1}. Likewise, single cut resulted into higher value of above mentioned parameter than their respective counterparts like double cutting (60 DAS and 50 % flowering).

Keywords: Nitrogen, Cutting management**,** phosphorus and potassium

1. Introduction
Livestock population is the largest in India comprising 182.50 million cattle, among these, 61.30 million buffaloes, 76.65 million goats, 41.30 million sheep, 10.0 million pigs and 3.04 million other animals. (Jat *et al*., 2014) [6]. India is having the largest livestock population, 15% of the world's livestock population (Neelar, 2011) [9]. Livestock contributing 7% to national GDP and source of employment and ultimate livelihood for 70% population in rural areas. Deficiency in feed and fodder has been identified as one of the major components in achieving the desired level of livestock production. At present, the country faces a net deficit of 63% green fodder, 24% dry crop residues and 64% feeds (Kumar *et al.*, 2012) [8]. The productivity of our livestock often remains low due to inadequate and nutritionally unbalanced supply of feed and fodder. Half of the total losses in livestock productivity are attributed to the inadequacy in supply of feed and fodder.
Deficiency of green fodder will be about 64.9% and for dry fodders up to 24.9% in 2025 A.D. Under such circumstances the only way to bridge the gap between demand and supply of the fodder is to ameliorate the forage resources. Among forages, oat *(Avena sativa* L.) is an important winter feed and forage crop. Owing to its excellent growth habit, better regeneration capacity and good quality forage, it is a promising forage crop. Oat being rich in carbohydrates, vitamins, minerals and total digestible nutrients, is widely used as supplement, hay and silage.
Oat (*Avena sativa* L.) is the important cereal (*Gramineae*) and forage crop, grown during *rabi* season and is next to berseem in nutritive value. It is also rich in energy, protein, vitamin B, phosphorous and iron (Tiwana *et al.*, 2008) [13]. It is cultivated in an area of 1021 million ha with an annual production of 233 million tons in the world (Anonymous, 2009) [1]. The total area covered under oat cultivation in India is about 1.0 million ha with 350-500 q ha^{-1} green

fodder productivity (IGFRI, 2011) [5]. In India, it is grown in Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal. The crop occupies maximum area in Uttar Pradesh (34%) followed by Punjab (20%), Bihar (16%), Haryana (9%) and Madhya Pradesh (6%).

It is important winter crop in many parts of the world and is grown as multipurpose crop for grain, pasture, forage or as a rotation crop. Oat plant has excellent growth habit, quick recovery after cutting and good quality herbage. It is a palatable, succulent and nutritious crop. The protein quality of oat is excellent. Oat requires a long cool season for its growth; therefore, it is successfully grown in the northern plains and hilly areas of the country. Oat is mostly fed as green but surplus is converted into silage or hay to use during fodder deficit periods. Oat as a forage crop, has the advantage of being winter hardy and serves as catch crop.

There are several factors, which affect the productivity and quality of forage oat. Nitrogen is a one of the major component to influence the forage growth, yield and quality. Nitrogen play the vital role in the growth of fodder through the impact on cell elongation, cell division and inter-nodal expansion, it also play a major role in early establishment of the crop. Nitrogen is useful for the improvement of the leaf area by synthesis of enzymes and chlorophyll and also improves the leaf weight. Nitrogen improves the fodder yield through enhancement of growth parameters like plant height, number of tillers, leaf area index, number of leaves, leaf:stem ratio and dry matter accumulation. It is an essential part of protein and is a constituent of physiologically important compounds like nucleotides, vitamins, enzymes and hormones that promotes growth and development in crop plants (Kumar *et al*., 2001) [7] and also improve the meristematic activity, it is useful for absorbing of nutrients from the soil efficiently and enhance the protein content of the crop through improvement in synthesis of carbohydrates. Forage oat especially multi-cut oat cultivars are heavy feeder of nutrients and remove large amount of nutrients from the soil. Nitrogen availability to the plant directly influence the forage yield, it is the reason to provide the nitrogen with the split applications. Split application of nitrogen improves the availability of the nutrient to the crop and improves the nitrogen use efficiency. In general farmers use the nitrogen 120 kg ha^{-1} with improper doses in oat crop but nitrogen @160 kg ha^{-1} with split applications gave the higher yields than farmer practices (Chouhan *et al*., 2014) [2].

Cutting management is the one of the important factor to influence the fodder crop growth, yield and quality. In general cutting management may fallowed in fodder crops for higher yields. Cutting exhibits the effect on nutrient and natural resource utilization by the crop. As compared to single cut multi cut crops absorb more nutrients, which directly influence the nitrogen content, protein content and other quality parameters of the crop. Cutting is one of the main factor to influence the green and dry forage yield (Patel *et al*., 2013) [10], because it plays major role in biomass synthesis. In oat crop commonly gave two cuttings are at different stages, but 1st cut at 60 DAS and 2nd cut at 50% flowering gave the better growth and yield (Sharma *et al*., 2001) [11].

Materials and Methods

The field experiment was conducted at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during *rabi* season 2015-16. The climate of this region is sub-tropical and semi-arid and climate characterized with summers and extremely cold winters. The mean maximum temperature of this region is about 43 ^{0}C to 45 ^{0}C is not uncommon during summer while very low temperature (1-2 ^{0}C) accompanied by frost may be experienced in December-January. The winters are cool; frost generally occurs towards the end of December and may continue till the end of January. The monsoon generally begins during the third week of June and desists by the end of September. The total precipitation and its distribution in this region various largely about 75 to 85% of it's received during July to September and few showers are also a common feature during the month of December to January and in late spring season. Mean weekly meteorological data for the season during experimentation period (2015-2016) based on observations collected at meteorological observatory of SVPUA&T, Modipuram, Meerut. Total precipitation of 211.30 mm was received during the experimentation period. The maximum temperature being 32.71 ^{0}C was recorded in 13th standard week. While, the minimum temperature was 8.57 ^{0}C in 51th standard week and the Relative Humidity ranged from 45.4 to 66.2 % recorded, respectively in the morning. Ten treatment combinations comprising of five levels of nitrogen viz., 0 kg ha-1 N(N0), 40 kg ha-1 N (N1), 80 kg ha-1 N (N2), 120 kg ha-1 N (N3) and 160 kg ha-1 and two cuttings, single cut at 50% flowering stage and first cut at 60 DAS and second cut at 50% flowering. Oat seed were drilled by adopting a spacing of 25 cm. Kent cultivar was used in the study. Soil samples were collected from 0-15 cm depth from each plot. These samples were processed and analysed for various physico-chemical properties in the laboratory of department of Agronomy, in Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. Available nitrogen in soil was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956). Available phosphorus in the soil was extracted by 0.5 M sodium bicarbonate ($NaHCO_3$) adjusted to pH 8.5 and P in the aliquot was determined by Ascorbic acid method (Olsen *et al.,* 1954). Available K in the soil was determined by 1 N NH_4OAc extraction method (Hanway and Heidal, 1952).

Results and Discussion

Soil available nitrogen

Soil available nitrogen differs significantly by the nitrogen levels and cutting management. Initial N was (227.00 kg ha^{-1}) which decline to 156.7 kg ha^{-1} in the non-fertilized plot. Available soil nitrogen improved by improving of nitrogen doses, Highest available soil N with 160 kg nitrogen ha^{-1} (245.5 kg ha^{-1}) was higher than control plot (156.7 kg ha^{-1}). Availability of soil nitrogen increased with successive increment in nitrogen levels. Among the cutting management, available soil nitrogen in single cut (203.0 kg ha^{-1}) was significantly higher than double cutting practices (191.0 kg ha^{-1}).

Soil available phosphorus

Available soil Phosphorus differs significantly with nitrogen levels and cutting management. The initial available phosphorus (16.25 kg ha^{-1}) decline to 14.2 kg ha^{-1} in non-fertilized plot. Available soil P was improved significantly by improving of nitrogen doses. Higher available of soil P with 160 kg nitrogen ha^{-1} (16.2 kg ha^{-1}) was higher than control plot (14.2 kg ha^{-1}). Among the cutting management, available soil Phosphorus in single cut (15.3 kg ha^{-1}) was significantly higher than double cutting practices (15.1 kg ha^{-1}).

Soil available potassium

Available soil potassium varied significantly with nitrogen levels and cutting management. The initial soil available potassium was (225.76 kg ha^{-1}) decline to 212.6 kg ha^{-1} in control plot. Available soil K was improved significantly by improving of nitrogen doses. Available of soil potassium with the application of 160 kg nitrogen ha^{-1} (224.7 kg ha^{-1}) higher than control plot (212.6 kg ha^{-1}). Moreover, all other treatments, potassium availability increased with successive increment in nitrogen level. Among the cutting management, available soil potassium in single cut (219.4 kg ha^{-1}) was significantly higher than double cutting practices (217.8 kg ha^{-1}).

Effect of nitrogen levels and cutting management on available nitrogen, phosphorus and potassium in soil (kg ha^{-1})

Available soil nutrients status (kg ha^{-1})			
Treatment	N	P	K
Nitrogen levels (kg ha^{-1})			
N - 0	156.7	14.2	212.6
N - 40	168.8	14.6	216
N - 80	188.8	15.3	218.1
N - 120	226.7	15.7	221.6
N - 160	245.5	16.2	224.7
S.Em (±)	1.57	0.04	0.72
CD at 5%	4.58	0.13	2.09
Cutting management			
50% flowering	203.0	15.3	219.4
At 60 DAS and 50% flowering	191.0	15.1	217.8
S.Em (±)	0.99	0.03	0.45
CD at 5%	2.89	0.08	1.32

Initial values: N-227.75, P- 16.25 and K- 225.76 (kg ha^{-1})

After harvesting the soil available nutrients (available nitrogen, phosphorus and potassium) decline from their initial value. Available soil nutrients *viz*., available nitrogen, phosphorus and potassium were lower under the double cutting system. Moreover, among the different cutting management single cut noticed maximum available nitrogen, phosphorus and potassium than cutting at 60 DAS. Although the statistical difference was significant in nitrogen levels as well as cutting management. Increasing in nitrogen dose increases the nutrient status in soil (N, P and K). Higher soil available nutrient was probably due to better growth parameters which will leave more root residue in soil. The findings were also supported by Dwivedi *et al*. (2015) [3].

Conclusion

Available nutrient status of soil including N, P and K increased with the increasing in the nitrogen level. In the case of N, P, and K 160 kg N ha^{-1} gave the high availability. Cutting management also showed the significant effect on nutrient availability. N, P and K were more available in the single cutting system compare than double cutting.

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