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# Influence of Seed Rate and Nitrogen Levels on Yield, Major Nutrients Content In Forage Oat Crop (*Avena sativa* L.) and Available NPK Status of Soil After Harvest

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**ABSTRACT**
*A field experiment was conducted during two consecutive winter (rabi) seasons of 2014-15 and 2015-16 to study the "Productivity and quality of forage oat (Avena sativa L.) under varying seed rate and nitrogen levels in irrigated conditions of western plain zone of Uttar Pradesh. The treatment consist of two factors seed rate and nitrogen levels. The factor seed rate has three rates viz. 60, 90, 120 kg per hectare while factor nitrogen has six levels i.e. 0, 40, 80, 120, 160 and 200 kg nitrogen per hectare. Pooled results revealed that the total dry matter yield, NPK content in plant at first cut and available NPK in soil after each cut maximum with seed rate 90 kg/ha. At second cut was maximum NPK content found with seed rate 120 kg per hectare y. Among nitrogen levels application of 200 kg nitrogen found to have maximum total dry matter yield, NPK content in plant. Thus, sowing of oat with 90 kg seed rate per hectare along with application of 160 kg nitrogen found to be better for high total dry matter yield, NPK content in plant and available NPK in soil after each cut.*
*Keywords: NPK, Oat Crop, Seed Rate*

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## INTRODUCTION
India secures first position in livestock population globally, being 512.05 million heads with Madhya Pradesh as highest population (10.27%) followed by Uttar Pradesh (10.24%) . Livestock production is the backbone of Indian agriculture contributing nearly 25.6% and 4.11% in agriculture and total GDP, respectively and proved to be source of employment and ultimate livelihood for most part of population [1]. Indian agriculture is oriented towards mixed farming in which livestock rearing forms an integral part of rural living. Livestock productivity directly depends upon the nutritious, balanced and adequate feeding. Some of major feed resources are the herbages from cultivated forages, grazing materials from grasslands and crop residues/by products i.e., straw, stover etc.
In India the area under fodder cultivation is estimated to be about 4% of the gross cropped area which has remained static for the last four decades because of preferential need of human food accounting 8.6 m ha. At present, the demand is about 222 million tonnes green and 416 million tonnes of dry fodder but availability is only about 143 and 253 million tonnes, respectively [2]. To meet the fodder shortage the growing area should ideally be around 20 m ha by 2020 A.D. which appears to be rather difficult to achieve [7]. Since area under cultivated forages cannot be increased much however, the possibilities exist for improved land productivity through appropriate management practices [10, 15].
Among cultivated forage crops, oat (*Avena sativa* L.), due to its quick growing, high forage yielding ability and energy rich nutritional forage, is a valuable winter forage crop of India. Moreover, it produces very high green fodder per unit area and per unit time with minimum irrigation. Its fodder and grains are highly nutritious, rich in fat, protein, vitamin-B, phosphorus, iron, etc. Due to high forage yield, palatability and nutritive value, it has become a very popular *rabi* forage crops in areas having limited irrigation facilities in the country

The production of oat is not being fully exploited because of the lack of proper information on its optimum fertilizer requirements. It has been recognized that the careful use of fertilizer can improve yield of crops [16]**.** Nitrogen element is major plant nutrient that most frequently limits yield and plays an important role in quality of forage crops [20]. The importance of nitrogen fertilization to maintain higher production potential of oat is well recognized. Among the major nutrient elements, nitrogen has special significance in increasing green biomass yield and its quality. Nitrogen fertilization has been reported to improve not only the yield but also the crude protein content of multicut forage oat. It is thus, the basic constituent of plant life. It tends to encourage vegetative growth and governs to considerable degree of the utilization of other nutrients. The increase in nitrogen doses with increase in growth resulted in plant height, number of shoot and leaves [19]. increasing leaf area per plant. All growth attributes that directly or indirectly affected forage yield and quality are affected by cultural practices as well as agricultural inputs. The addition of nitrogen fertilizer increased plant height. Increase in plant height resulted in an increase in leaf number per plant as reported by Akintoye [23]. Gasim [24] indicated that the increase in plant height with nitrogen fertilizer

The selection of optimum seed rate is another important cultural practice and is mainly controlled by seed size, vigor, germination percentage, sowing methods and required plant population of the crop. Seed rate is defined as the amount of seed sown per unit area. It is an important factor for forage production, since it affect plant density and consequently affect the yield of forage. Higher seed rates usually results in higher plant density, which increases forage yield. Therefore the optimum seed rate for forage production is higher than that for grain production [12]. Nutritive value of fodder maize was reported to vary with plant population. Nitrogen , phosphorus and potassium content in forage decreased with increasing seed rate of maize [14] as well as in sorghum [6].

## MATERIALS AND METHODS

The field experiment was conducted during rabi season 2014-15 and 2015-16 at Sardar Vallabhbhai Patel University of Agriculture and Technology Meerut (Uttar Pradesh) situated $29^0$ 04, N latitude and $77^0$ 42 'E longitude at an altitude of 237 meters above the mean sea level. The soil was sandy loam in texture (60.20 % sand, 18.63 % silt and 21.18% clay having 7.95pH,0.47 % organic carbon , low in available nitrogen (238.94 kg/ha) and medium in phosphorus(15.35 kg/ha) and potassium(222.07 kg/ha).The treatments comprised three seed rates of oat [$S_{60}$-60 kg/ha ; $S_{90}$-90 kg/ha; $S_{120}$-120 kg/ha] and six N levels (0, 40, 80, 120, 160 and 200 kg/ha).The experiment was laid out in factorial randomized block design with four replications. The crop was fertilized with 60 kg P/ha, 40 kg K/ha as common dose and N as per treatments. Oat 'Kent' variety was sown in rows 30 cm apart on 14/11/2014 and 28/11/2015. Half the quantity of nitrogen and full dose of P were applied as basal dressing in each plot. The remaining half dose of N was top dressed just after first cut (55 DAS). The first irrigation was given 20 DAS , second 55 DAS and last at 95 DAS. Thus, a total of three irrigations were given to meet the water requirement of crops. To keep the experimental plots weed free, two hand weeding was done at 28 and 60 DAS. Rainfall during the crop period was 160.10 and 21.20 mm in 2014-15 and 2015-16 respectively. The two cuttings were taken with first cutting at 55 DAS and second at 115 DAS. Fresh sample (500g) at each cut from each plot was taken and dried in oven at 70 °**C** for 48 hours to determine the dry matter content. The nitrogen ,phosphorus and potassium content in plant was estimated by chemical analysis as described below.

### Chemical Analysis

### Plant analysis

Nitrogen, phosphorus and potassium contents were analysed in plant sample at the harvest of the crop by adopting modified micro-kjeldhal method for nitrogen, vanado-molybdate yellow color method for phosphorus and flame photometer method for potassium as described by Jackson [8].

### Nitrogen

In plant total nitrogen was determined by kjeldhals method. In a digestion tube 0.5 gm finally powdered plant samples was taken and added 10 ml of concentrated $H_2SO_4$ + 1gm digestion mixture ($K_2SO_4$ + $CuS0_4.5H_2O$), and kept for overnight, then heating was done in digestion chamber till the clear colourless solution appears. Cooled digest was shifted to distillation unit. The content was distilled for 10 minutes using 40% NaOH and distillate was collected in a conical flask containing 4% Boric acid mixture. The distillate was finally titrated against standardized $H_2SO_4$, once the colour change from bluish green to permanent pale pink colour note the burette reading.

### Digestion for P and K sample

0.5 gm dried powdered plant samples were taken in a digestion tube and 10ml of di-acid mixture (9:4 $HNO_3$:$HClO_4$) was added and kept for overnight. It was then digested on a black digester till the colour less solution was obtained. The flask was cooled and 25ml of distilled water added into solution after then the solution was filtrated into a 50ml of volumetric flask and make up volume by distilled water.

**Colour develop for P**

5 ml of aliquot was taken into 50ml volumetric flask and 10ml of vandate-molybdate solution were added and diluted to 50ml mixed well and read the intensity of yellow colour on spectrophotometer by using blue filter at 420 nm wavelength a blank reading was also run without sample simultaneously [8].

**Potassium**

For determination of K, digested extract was used directly with flame-photometer. The potassium content in digested sample is determined by Flame-photometer.

## RESULT AND DISCUSSION

**Effect on total dry matter yield**

The data presented in Table 1. Indicated that the dry matter yield was in general higher during 2015-16 as compared to 2014-15. The non significant difference due to seed rate for total dry matter was recorded during both year. However, maximum total dry matter yield obtained with 90 kg per hectare seed rate ($S_{90}$) during both years. The minimum dry matter yield for first, second cut and total were recorded with 60 kg per hectare seed rate ($S_{60}$). The increased biomass production with 120 and 90 kg seed rate per hectare could be attributed to the higher number of shoot per metre linear row length and taller plant at first and second cut which might have increased the photosynthetic area leading to higher biomass production. These findings are in line with Younie [22], Singh *et al.* [17], Khan *et al.* [11], Jan and Jan [9] and Singh *et al.* [19].

In general, increasing level of nitrogen increased total dry matter yield as well as dry matter yield at each cut. At first and second cut increasing the levels of nitrogen increased dry matter yield significantly and highest yield (21.82 and 84.47 q $ha^{-1}$) and (24.46 and 87.23 q $ha^{-1}$) was recorded at the level of 200 kg nitrogen per hectare, which was higher (161.94 and 116.65) and (97.74 and 142.64) percent than control during 2014-15 and 2015-16, respectively. Minimum dry matter yield (8.33 and 38.99 q $ha^{-1}$) and (12.37 and 35.95) during 2014-15 and 2015-16, respectively was obtained under no nitrogen application. Similarly increasing the doses of nitrogen increased total dry forage yield significantly which reached from (47.32 and 48.35 q $ha^{-1}$) at control to 106.29 and 111.69 q $ha^{-1}$ at 200 kg nitrogen per hectare ($N_{200}$). The increase in nitrogen rates from 40 -160 kg per hectare also increased significantly dry matter yield at both cuts and total dry matter yield. The increase in total dry matter yield were 26.71, 72.19, 102.58, 117.84, 124.62 and 28.65, 84.14, 106.74, 123.66, 131.00 percent at 40, 80, 120, 160 and 200 kg nitrogen per hectare, respectively compare to control. Sharma and Dixit [16], who reported positive correlation between dry matter and yield contributing characteristics i.e. plant height, number of shoots leaves per meter row length and leaf area index. Mahale *et al.* [13] reported that dry matter yield of oat increased with increasing nitrogen levels from 0-120 kg per hectare which significantly increased the dry matter yield at first and second cut as well as total dry forage yield of oat.

**Effect on NPK content in plant**

Data presented in Table 1 indicated that the nitrogen content in plant progressively decreased with advancement of crop age upto second cut during both years. Among seed rate non-significant difference at first cut was observed for N and K content during both years. However, P content at first cut was significantly higher with 90 kg per hectare seed rate ($S_{90}$) than 60 ($S_{60}$) and 120 kg ($S_{120}$) per hectare seed rate during both the years, while at second cut, phosphorus and potassium content both found significantly higher with 120 kg per hectare seed rate ($S_{120}$) followed by 60 ($S_{60}$) and 90( $S_{90}$) kg per hectare seed rate. Verma and Joshi [21] reported significant increase in nitrogen content of teosinte with increase in seed rate which might have been due to species variation.

The effect of nitrogen levels on nitrogen, phosphorus and potassium content in plant tissue declined with the increased age of plant and reached to its minimum levels at second cut (115 days after sowing). However, with increasing the levels of nitrogen application increase in nitrogen, phosphorus and potassium content in plant at all the stages during both years. At 55 days after sowing (first cut ), with increase in the levels of nitrogen from 0-200 kg nitrogen per hectare significantly increased nitrogen, phosphorus and potassium content. The application of 200 kg nitrogen per hectare recorded maximum nitrogen, phosphorus and potassium content (3.13, 0.33, 3.99 and 3.37,0.35, 4.15) in plant during 2014-15 and 2015-16, respectively  and minimum values of nitrogen, phosphorus, potassium content 1.77, 0.17, 3.74 and 1.92, 0.20, 3.91 % during 2014-15 and 2015-16, respectively at 0 kg nitrogen per hectare. At 115 days after sowing (second cut ) with increasing the application of nitrogen, increased the nitrogen, phosphorus and potassium content in plant significantly with maximum values of  2.16, 0.19, 2.05 and 2.10, 0.19, 2.14 % respectively at 0 kg nitrogen per hectare. The result are in conformity by Bloom *et al.* [4] opined that high nitrogen content of crop at early stages was due to luxury absorption of nitrogen. The young actively growing roots absorb nitrogen voracious beyond the capacity of the plant to assimilate. This excessively absorbed nitrate is accumulated in vacuoles and made available for assimilation when external source is depleted. At later stages, however, it disappeared perhaps because of depiction of plant reserve, nitrogen supply from soil simultaneously. On the other hand the content of phosphorus and potassium in plant also increased with increasing levels of nitrogen which made rapidly availability of nitrogen and phosphorus in plant tissue at both cuts during both years. The results were also reported by Bhilare *et al.* [3].

**Table 1: Effect of seed rate and nitrogen levels on total dry matter yield and NPK content in oat plant (%) during 2014-15 and 2015-16**

| Treatments | 2014-15 | 2015-16 | 2014-15 | | | | | | 2015-16 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total dry matter yield | | N content | | P content | | K content | | N content | | P content | | K content | |
| | | | I cut | II cut | I cut | II cut | I cut | II cut | I cut | II cut | I cut | II cut | I cut | II cut |
| **Seed Rate (kg ha$^{-1}$)** | | | | | | | | | | | | | | |
| $S_{60}$ | 80.18 | 83.45 | 2.57 | 1.73 | 0.26 | 0.15 | 3.86 | 1.93 | 2.75 | 1.67 | 0.29 | 0.16 | 4.03 | 2.04 |
| $S_{90}$ | 84.25 | 87.95 | 2.60 | 1.69 | 0.30 | 0.14 | 3.96 | 1.89 | 2.78 | 1.64 | 0.32 | 0.14 | 4.11 | 1.97 |
| $S_{120}$ | 82.57 | 86.14 | 2.52 | 1.76 | 0.23 | 0.17 | 3.82 | 2.00 | 2.71 | 1.69 | 0.27 | 0.19 | 4.00 | 2.11 |
| S.Em.± | 1.17 | 1.29 | 0.02 | 0.10 | 0.01 | 0.002 | 0.04 | 0.02 | 0.04 | 0.07 | 0.003 | 0.002 | 0.04 | 0.02 |
| C.D. at 5% | N.S. | N.S. | NS | NS | 0.02 | 0.005 | N.S. | 0.06 | N.S. | N.S. | 0.008 | 0.007 | N.S | 0.06 |
| **N levels (kg ha$^{-1}$)** | | | | | | | | | | | | | | |
| $N_0$ | 47.32 | 48.35 | 1.77 | 1.25 | 0.17 | 0.11 | 3.74 | 1.79 | 1.92 | 1.16 | 0.20 | 0.12 | 3.91 | 1.91 |
| $N_{40}$ | 59.96 | 62.20 | 2.21 | 1.52 | 0.22 | 0.13 | 3.81 | 1.86 | 2.39 | 1.45 | 0.25 | 0.14 | 3.97 | 1.96 |
| $N_{80}$ | 81.48 | 84.74 | 2.51 | 1.72 | 0.26 | 0.15 | 3.86 | 1.92 | 2.67 | 1.61 | 0.29 | 0.16 | 4.03 | 2.03 |
| $N_{120}$ | 95.86 | 99.96 | 2.73 | 1.80 | 0.29 | 0.16 | 3.92 | 1.98 | 2.92 | 1.77 | 0.32 | 0.17 | 4.09 | 2.08 |
| $N_{160}$ | 103.08 | 108.14 | 3.04 | 1.93 | 0.32 | 0.18 | 3.96 | 2.03 | 3.23 | 1.90 | 0.34 | 0.18 | 4.12 | 2.12 |
| $N_{200}$ | 106.29 | 111.69 | 3.13 | 2.16 | 0.33 | 0.19 | 3.99 | 2.05 | 3.37 | 2.10 | 0.35 | 0.19 | 4.15 | 2.14 |
| S.Em.± | 1.65 | 1.82 | 0.03 | 0.14 | 0.01 | 0.002 | 0.06 | 0.03 | 0.05 | 0.10 | 0.004 | 0.003 | 0.06 | 0.03 |
| C.D. at 5% | 4.69 | 5.16 | 0.10 | 0.40 | 0.02 | 0.007 | 0.17 | 0.08 | 0.15 | 0.29 | 0.011 | 0.009 | 0.16 | 0.09 |

**Table 2. Effect of seed rate and nitrogen levels on available NPK in soil (kg/ha) after each cut during 2014-15 and 2015-16**

| Treatments | 2014-15 | | | | | | 2015-16 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Available N | | Available P | | Available K | | Available N | | Available P | | Available K | |
| | I cut | II cut | I cut | II cut | I cut | II cut | I cut | II cut | I cut | II cut | I cut | II cut |
| **Seed Rate (kg ha$^{-1}$)** | | | | | | | | | | | | |
| $S_{60}$ | 244.67 | 231.17 | 15.95 | 15.15 | 190.15 | 177.18 | 244.30 | 230.61 | 15.42 | 14.61 | 189.59 | 177.07 |
| $S_{90}$ | 245.42 | 232.32 | 16.39 | 15.28 | 190.69 | 178.03 | 244.83 | 231.73 | 15.83 | 14.76 | 190.13 | 177.47 |
| $S_{120}$ | 244.80 | 231.44 | 16.07 | 15.25 | 190.30 | 177.39 | 244.41 | 230.85 | 15.53 | 14.69 | 189.74 | 177.16 |
| S.Em.± | 2.48 | 2.36 | 0.18 | 0.16 | 2.13 | 1.93 | 2.47 | 2.35 | 0.17 | 0.16 | 2.12 | 1.92 |
| C.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| **N levels (kg ha$^{-1}$)** | | | | | | | | | | | | |
| $N_0$ | 219.38 | 210.51 | 18.13 | 16.10 | 214.35 | 188.46 | 218.90 | 209.92 | 17.59 | 15.54 | 213.80 | 187.89 |
| $N_{40}$ | 232.45 | 221.32 | 17.24 | 16.08 | 208.63 | 185.29 | 232.19 | 220.76 | 16.70 | 15.48 | 208.07 | 184.89 |
| $N_{80}$ | 242.40 | 230.01 | 16.34 | 15.47 | 195.90 | 180.74 | 242.02 | 229.45 | 15.79 | 14.91 | 195.36 | 181.32 |
| $N_{120}$ | 251.26 | 237.77 | 15.86 | 14.83 | 180.59 | 176.32 | 250.72 | 237.18 | 15.29 | 14.40 | 180.00 | 175.84 |
| $N_{160}$ | 259.40 | 243.11 | 15.06 | 14.59 | 173.85 | 169.52 | 258.95 | 242.52 | 14.51 | 14.03 | 173.28 | 168.93 |
| $N_{200}$ | 264.88 | 247.14 | 14.21 | 14.28 | 168.96 | 164.88 | 264.30 | 246.55 | 13.67 | 13.74 | 168.41 | 164.52 |
| S.Em.± | 3.50 | 3.33 | 0.25 | 0.23 | 3.01 | 2.72 | 3.50 | 3.32 | 0.25 | 0.22 | 3.00 | 2.72 |
| C.D. at 5% | 9.95 | 9.46 | 0.72 | 0.66 | 8.55 | 7.73 | 9.93 | 9.44 | 0.70 | 0.64 | 8.53 | 7.72 |

## Effect on Available NPK in soil

The data presented in Table 2 revealed that non significant difference among seed rate for available nitrogen, phosphorus and potassium in soil after first and second cut was found during both years. However, after first and second cut field sown with 90 kg per hectare seed rate ($S_{90}$) recorded higher available NPK in soil than 120 and 60 kg per hectare seed rate during both years. The minimum available NPK was recorded with 60 kg per hectare seed rate ($S_{60}$) after each cut during both years.

The effect of nitrogen on availability of NPK in soil after first cut was found significant with increase in level of nitrogen from $N_0$ to $N_{200}$. It was observed that application of nitrogen at higher doses increased the availability of nitrogen significantly and it varied from 219.38 to 264.88 kg per hectare and 218.90 to 264.30 kg per hectare during 2014-15 and 2015-16, respectively and after second cut also similar trend was observed and availability of nitrogen in soil varies from 210.51 to 247.14 kg per hectare and 209.92 to 246.55 kg per hectare and phosphorus, potassium in soil varies 16.10 to 14.28, 188.46 to 164.88 and

 

15.54 to 13.74, 187.89 to 164.52 kg per hectare during 2014-15 and 2015-16, respectively. However, after first and second cut available NPK in soil recorded significantly higher with application of 200 kg nitrogen per hectare followed by 160, 120, 80, 40 and 0 kg nitrogen per hectare. The minimum available N in soil after each cut recorded with no nitrogen application during both years. The application of increasing levels of nitrogen from 0 – 200 kg per hectare significantly increased the availability of nitrogen in soil after first and second cuts of oat both the year. But in the case of phosphorus and potassium in soil, the values were decreased with increased of nitrogen doses. This was probably due to the fact that with the addition of nitrogen at higher doses there was more uptake of phosphorus and potassium by plants and hence residual phosphrous and potassium in soil was low that reported by Chakraborty *et al.* [5].

## CONCLUSION

The total dry matter yield, NPK content in plant at first cut and available NPK in soil after each cut maximum with seed rate 90 kg/ha. At second cut was maximum NPK content found with seed rate 120 kg per hectare y. Among nitrogen levels application of 200 kg nitrogen found to have maximum total dry matter yield, NPK content in plant. Thus sowing with 90 kg seed rate per hectare along with application of 160 kg nitrogen found to be better for high total dry matter yield, NPK content in plant and available NPK in soil after each cut.

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