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Soil properties and available nutrient affected by seed rates and nitrogen levels in makkhan grass (*Lolium multiflorum* L) in Western U.P.

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Abstract
A field experiment was conducted in the *Rabi* season 2021-22 and 2022-23 in factorial randomized design with fifteen treatments having two factors *viz* – seed rate and nitrogen levels and each treatment was replicated four times. The experiment was laid with the hypothesis that seed rates and nitrogen levels have significant effect on soil properties. The result opts for the rejection of null hypothesis that seed rate per hectare @ 20 kg and nitrogen level @ 125 kg ha^{-1} is the suit parameter to snitches the soil properties towards neutral range however; it was non-significant over the two years of experiment. Additionally, the author feels that, when same experiment is conducted for long time, the null hypothesis can be further accepted.

Keywords: Makkhan grass, soil properties, seed rate and N levels

1. Introduction
Makkhan grass (*Lolium multiflorum* Lam.) is a winter season annual forage, short duration, poaceae family, high palatability and digestibility. The grass is mostly adapted to cool moist climate and grow best in a temperature range of 22 to 25 °C in acid to alkalis soil reaction. The amount of seed rate and nitrogen management are most important aspects for consideration in order to achieve higher forage yields (Fessehazion *et al*., 2011) [1]. All the physiological processes in plants depend on temperature modifications in environment which is altered by plant population. This further gives an opportunity to the crop to get optimum temperature for germination and at subsequent crop growth to maximize the forage production. A principal limiting factor in makkhan grass crops can be water deficit, and among mineral elements, nitrogen impedes the growth and yields the most. Adequate nitrogen supply in forage crops helps to improve herbage growth rate, tiller density, plant height and ultimately total herbage production. The nitrogen content is the greatest individual nutritional factor affecting the growth and development of annual ryegrass (Griffith *et al*., 1997) [2]. Therefore, the proper information on seed rates and optimum nutrients requirement, especially of nitrogen could be of great use in getting higher forage productivity of makkhan grass under.

1.1 Objective of the study
1. To study the effect of levels of nitrogen and seed rate on soil properties.
2. To get the effect of levels of nitrogen and seed rate on nutrient availability.

2. Materials and Methods
The two repeated experiment was conducted in 2021-22 and 2022-23 cropping years at research farm of SVPUA&T, Meerut, Uttar Pradesh. The experiment was sown on 1st October 2021-22 and 18 October 2022-23 respectively in first and second years experiment. Sowing was done manually in four replication with three Seed rate levels (10, 15, 20 kg ha^{-1}) and five nitrogen levels (0, 50, 75,100, and 125 kg ha^{-1}) and 15 treatment combinations. The plot was irrigated 10 days after sowing and thereafter after the every cutting by tub well in separate

plots with the help of irrigation channels. Application of nitrogen one fourth of the total nitrogen applied as basal does and rest of nitrogen was applied top dressed in three splits does at the after cutting of makkhan grass. First split after the 1st cut, 2nd split after 2nd cut and 3rd split after 3rd cut of the green forage. Soil treated with seed rate and nitrogen levels were randomly sampled from the cores of the soil in each plot (10 × 10 cm, 5–10 cm soil layer) during the sampling of the makkhan grass field in February 2022 and 2023 respectively first and second experiment. Blank soils (control treatment) were also sampled at the same time with the same method, and control was the blank soil before the trial. Partial soil samples were sieved to < 2 mm, air-dried, and then analysed in the laboratory (15 treatments combination × 4 replicates). Soil available nitrogen was determined by (Subbiah and Asija 1956) [8], available phosphorus (Olsen *et al.*, 1956) [6] and available potassium was determined using the (Hanwey and Heidal, 1952) [3] method. Soil physical properties viz., partical density and bulk density was determined with pycnometer and core sampler method respectively (Black *et al*., 1965) [11] and organic carbon are estimated with (Walkley & Black, 1934) [10].

3. Results and Discussion

3.1 Soil physico-chemical properties

3.1.1 Soil pH

The seed rate levels did not cause significant effect on soil pH at initial value to final cuttings during both years. In general, the soil pH was decrease with the increase amount of seed rate. After the final cutting of makkhan grass, soil pH ranged from 7.79 to 7.78 and 7.24 to 7.03 during 2021-22 and 2022-23, respectively, being higher with application of 10 kg seed rate per hectare while the lowest value of soil pH (7.78 and 7.03, 2022 and 2023, respectively) was recorded with 20 kg seed rate ha^{-1}. Similarly, different nitrogen levels did not cause significant difference in soil pH during both the years. However, it varied from 7.75 to 7.82 and 7.10 to 7.22, being maximum with no application of nitrogen while minimum with the application of 125 kg nitrogen per hectare during 2021-22 and 2022-23, respectively.

3.1.2 Electrical conductivity

The seed rate levels caused significant differences in electrical conductivity of soil after final cuttings during 2021-22 years and non-significant during 2022-23. In general, electrical conductivity decreased with increase in the amount of seed rate. After the final cutting of makkhan grass, soil electrical conductivity ranged from 0.216 to 0.236 and 0.215 to 0.221 during 2021-22 and 2022-23, respectively, being higher with 10 kg seed rate per hectare. While lowest value of electrical conductivity 0.215 and 0.216 were recorded with 20 kg seed rate ha^{-1} during 2021-22 and 2022-23, respectively.

The data revealed that there was significant difference in electrical conductivity due to varying levels of nitrogen during both the years. The values of electrical conductivity varied from 0.230 to 0.237 and 0.208 to 0.211, during 2021-22 and 2022-23, respectively. The maximum value of electrical conductivity was associated with no application while minimum with the application of 125 kg nitrogen per hectare during both years of experiment.

3.1.3 Organic carbon (%)

The levels of seed rate significantly influenced the organic carbon after final cutting of makkhan grass during both the years. In general, organic carbon was increased with the increase in amount of seed rate of makkhan grass.

Soil organic carbon ranged from 0.45 to 0.52 and 0.46 to 0.54 during 2021-22 and 20202-23, respectively, being higher with application of 20 kg seed rate per hectare while lowest value (0.45 and 0.46) was recorded with 10 kg ha^{-1} seed rate during 2021-22 and 2022-23 respectively. There was a non-significant difference in organic carbon content due to the varying levels of nitrogen during both the year of experiment. The value of soil organic carbon varied from 0.47 to 0.50 and 0.48 to 0.51 during 2021-22 and 2022-23, respectively. The maximum value of organic carbon recorded with application of 125 kg nitrogen per hectare while minimum value of organic carbon associated with no application of nitrogen. This might be due to addition of relatively greater amount of forage root residue compare to other lower doses of seed rate.

3.1.4 Bulk density

The bulk density was not significantly influenced by seed rates after final cuttings during both years. In general, bulk density was decrease with the increase in amount of seed rate. The value of soil bulk density varied from 1.43 to 1.48 and 1.36 to 1.40 during 2021-22 and 2022-23 cropping years, respectively, being higher with application of 10 kg seed rate per hectare. While the lowest value of bulk density was recorded at 20 kg ha^{-1} seed rate per hectare during both the years.

Similarly, the bulk density was not significantly influenced by varying levels of nitrogen during both the years. However, it varied from 1.42 to 1.48 and 1.35 to 1.41, during 2021-22 and 2022-23, respectively. The maximum bulk density recorded with no application of nitrogen while minimum with application of 125 kg nitrogen per hectare during both years.

3.1.5 Particle density

The particle density was not significantly influenced by seed rates after final cuttings during both years. In general, particle density was decrease with the increase in amount of seed rate. The value of soil particle density varied from 2.54 to 2.55 and 2.51 to 2.54 during 2021-22 and 2022-23, respectively, being higher with application of 10 kg seed rate per hectare. While the lowest value of particle density was recorded 20 kg ha^{-1} seed rate per hectare during both the years.

Similarly, the particle density was not significantly influenced by varying levels of nitrogen during both the years. However, it varied from 2.48 to 2.63 and 2.46 to 2.59, during 2021-22 and 2022-23, respectively. The maximum particle density recorded with no application of nitrogen while minimum with application of 125 kg nitrogen per hectare during both years.

Table 1: Effect of seed rate and N levels on properties of soil after the completion of experiments during 2021-22 & 2022-23

Treatments	Soil properties									
	Bulk density (gm/cc)		Particle density (gm/cc)		Soil pH		EC (dSm^{-1})		Organic Carbon (%)	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Seed Rate (kg ha^{-1})										
10	1.43	1.40	2.55	2.54	7.79	7.24	0.236	0.221	0.45	0.46
15	1.41	1.38	2.55	2.52	7.79	7.20	0.221	0.218	0.48	0.51
20	1.38	1.36	2.54	2.51	7.78	7.03	0.216	0.215	0.52	0.54
SEm(±)	0.02	0.01	0.06	0.03	0.09	0.07	0.003	0.002	0.00	0.00
CD (p=0.05)	NS	NS	NS	NS	NS	NS	0.011	NS	0.01	0.01
Nitrogen levels (kg ha^{-1})										
0	1.42	1.41	2.63	2.59	7.82	7.22	0.237	0.230	0.47	0.49
50	1.42	1.40	2.57	2.58	7.80	7.17	0.230	0.225	0.48	0.50
75	1.41	1.38	2.54	2.51	7.77	7.15	0.225	0.220	0.48	0.51
100	1.39	1.36	2.52	2.49	7.76	7.14	0.217	0.205	0.49	0.51
125	1.38	1.35	2.48	2.46	7.75	7.10	0.211	0.208	0.50	0.51
SEm(±)	0.02	0.02	0.079	0.03	0.12	0.09	0.003	0.003	0.05	0.02
CD (p=0.05)	NS	NS	NS	NS	NS	NS	0.008	0.009	NS	NS
Initial value	1.43	1.42	2.58	2.56	7.89	7.48	0.237	0.233	0.48	0.51

3.2 Available nutrients

3.2.1 Nitrogen

The available soil nitrogen after final cutting of makkhan grass was decrease from the initial status irrespective of the treatments. Available soil nitrogen after cutting of makkhan grass was significantly influenced by seed rate and nitrogen levels during both the years.

Significantly highest available nitrogen (193.3 and 194.9 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with 10 kg seed rate per hectare, while lowest available nitrogen (185.0 and 186.5 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with 20 kg seed per hectare during both years of experiment.

Among nitrogen levels, the significant maximum available nitrogen (196.7 and 197.5 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with the application of 125 kg nitrogen per hectare which was statically at par with 100 kg nitrogen per hectare during both the years. While lowest available nitrogen (180. and 181.5 kg N ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with control treatment during both years of experiment. The increase in soil available nitrogen with the increase in nitrogen levels might be due to the added nitrogen as per each treatment to some extent and better growth of annual makkhan grass with nitrogen application might have added more organic matter to the soil, hence better soil nitrogen status with increasing nitrogen levels (Devi *et al.*, 2010)

3.2.2 Available phosphorus

The available soil phosphorus after final cutting of makkhan grass was decrease from the initial status irrespective of treatments. Available phosphorus after cutting of makkhan grass was significantly influenced by seed rate and nitrogen levels during both the years

Significant highest available soil phosphorus (20.0 and 19.3 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with 10 kg ha^{-1} while lowest available phosphorus (16.7 and 15.2 kg ha^{1} during 2021-22 and 2022-23 respectively) was recorded with 20 kg seed per hectare during both years of experiment.

The nitrogen levels caused significant variation in available soil phosphorus. The maximum values of available soil phosphorus (19.2 and 18.3 kg ha^{-1} during 2021-22 and 2022-23, respectively) was noticed with application of 125 kg nitrogen per hectare while lowest available soil phosphorus (17.3 and 17.1 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with control treatment during both years of experiment. This may be due to vigorous vegetative as well as profuse root growth, which might have led to better absorption of nutrients from soil and resulted in better crop growth, forage yield and improvement in nutrient contents due to increased availability (Jehangir *et al.*, 2013; Ukai *et al.*, 2016) [5, 9]

3.2.3 Available potassium

The available soil potassium after final cutting of crop was decrease from the initial status irrespective of treatments. Available soil potassium after cutting of makkhan grass was significantly influenced by seed rate and nitrogen levels during both the years.

The highest values of available potassium (136.3 and 134.9 kg ha^{-1} during 2021-22 and 2022-23, respectively) were recorded with 10 kg seed rate ha^{-1}, followed by 15 kg seed rate per hectare while lowest available potassium (130.9 and 129.4 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with 20 kg seed rate per hectare during both years of experiment.

The nitrogen levels did not cause significant effect on available soil potassium but the maximum available soil potassium (134.8 and 133.4 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with application of 125 kg nitrogen per hectare while lowest available soil potassium (133.0 and 131.4 kg ha^{-1} during 2021-22 and 2022-23, respectively) was recorded with control treatment during both year of experiment.

Table 2: Effect of seed rate and nitrogen levels on available of N, P_2O_5 and K_2O of after the completion of experiments during 2021-22 & 2022-23

Treatments	Available nutrients (kg ha^{-1})					
	Available N		Available P		Available K	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Seed Rate (kg ha^{-1})						
10	193.3	194.9	20.0	19.3	136.3	134.9
15	190.1	191.0	17.9	17.6	134.6	133.3
20	185.0	186.5	16.7	15.2	130.9	129.4
SEm(±)	1.8	0.98	0.17	0.21	1.4	1.58
CD (p=0.05)	5.1	2.8	0.49	0.62	4.0	NS
Nitrogen levels (kg ha^{-1})						
0	180.5	181.5	17.3	17.1	133.0	131.7
50	186.4	186.5	17.3	17.5	133.8	132.4
75	190.5	191.0	17.7	17.8	133.8	132.4
100	193.2	196.7	18.2	18.5	134.4	132.9
125	196.7	197.5	18.9	19.2	134.8	133.4
SEm(±)	2.3	1.27	0.22	0.28	1.8	2.0
CD (p=0.05)	6.67	3.6	0.63	0.80	NS	NS
Initial value	197.8	198.6	19.5	18.1	137.6	135.1

4. Conclusion

It is clearly evidenced from the results that the evaluated soil properties *viz.*, pH, electrical conductivity, bulk density, particle density, and organic carbon doesn't have any significant remarkable changes on the seed rates and nitrogen levels on Makkhan grass during both years. Increasing trend with the application led towards normalization in the soil conducting indices however, the effect was non-significant. Thus, there is need for the long term experiment.

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