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# Herbage Yield and Quality of Ryegrass (*Lolium Multiflorum* Lam) as Influenced by Nitrogen and Phosphorus Management

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## Abstract

A field experiment was carried out at Forage Section Research Farm of CCS Haryana Agricultural University, Hisar (Haryana), India during *Rabi* (winter) season to study the effect of different nitrogen and phosphorus levels on annual ryegrass (*Lolium multiflorum*). Among different N levels, significantly highest green fodder yield (GFY) was recorded at N3 (80 kg N $ha^{-1}$ at sowing + 20 kg N $ha^{-1}$ at three weeks after sowing + 40 kg $ha^{-1}$ N after each cut). The total green fodder and dry matter yield recorded with 220 kg N $ha^{-1}$ were 28.10, 10.40 and 35.51, 8.80 per cent higher over 120 and 170 kg N $ha^{-1}$ respectively. Highest *in-vitro* dry matter digestibility (IVDMD) content (62.34%) was estimated with 220 kg N $ha^{-1}$ which was on a par with 170 kg N $ha^{-1}$. However, maximum digestible dry matter yield (35.91 q $ha^{-1}$) was estimated with 220 kg N $ha^{-1}$ which was significantly higher over the lower nitrogen levels. Among different phosphorus levels, highest GFY was recorded at $P_3$ (50 kg $P_2O_5$ $ha^{-1}$) which was on a par with $P_2$ (40 kg $P_2O_5$ $ha^{-1}$). The green fodder and dry matter yield recorded with 50 kg $P_2O_5$ $ha^{-1}$ were 3.78, 22.79 and 4.72, 35.51 per cent higher over 40 and 30 kg $P_2O_5$ $ha^{-1}$ respectively. Crude protein content and IVDMD content were not affected significantly. However, maximum crude protein yield (5.63 q $ha^{-1}$) digestible dry matter yield (34.90 q $ha^{-1}$) were estimated with 50 kg $P_2O_5$ $ha^{-1}$ which were on a par with 40 kg $P_2O_5$ $ha^{-1}$. To realize the higher forage yield and better nutritive value of ryegrass, application 220 kg N (80 kg N $ha^{-1}$ as basal + 20 kg N $ha^{-1}$ as topdressing at 3 WAS + 40 kg $ha^{-1}$ N just after each cut) and 40 kg $P_2O_5$ $ha^{-1}$ is recommended for soils low in available nitrogen and medium in phosphorus.

**Key words : Fodder yield, nitrogen management, phosphorus levels and ryegrass.**

The Indian land mass has to generate nutritional support to a huge livestock (535.78 million), poultry (851.81 million) (Anonymous, 2020a), human beings (1,352.64 million) (Anonymous, 2019), populations besides an additional vast population of pet and stray canines, wild life and a vast populations of fauna. This raises a relevant, question as to how effective is our land use and how it will sustain such a large population in future. The three main sources of forage supply are crop residues, cultivated fodders and forage from common property resources like forests, permanent pastures and grazing lands which are presently contributing 54, 28 and 18 per cent, respectively. Currently, India faces a challenge to feed its livestock population (Anonymous, 2020b). Feeding the large livestock population of our country with quality fodder uniformly throughout the year is a major challenge for the farmers. Country faces a net deficit of 36% and 11% of green fodder and dry fodder, respectively (IGFRI Vision, 2050). Growth of the grasses is monsoon bound and winter months are considered as the lean period for supply of fodder. Ryegrass (genus *Lolium*) is a genus of about 10 species in the family Poaceae. Perennial ryegrass (*Lolium perenne*) and annual ryegrass (*L. multiflorum*) are important constituents of pasture and lawn-seed mixtures used around the world and particularly in temperate parts of Eurasia (Europe and Asia)

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and Africa (Anonymous, 2020c). *Lolium multiflorum* (Italian ryegrass/annual ryegrass/ westerwold ryegrass) hybridizes freely with *L. perenne* (*L. x hybridum*), *L. rigidum* (*L. x hubbardii*), *L. temulentum* and *L. remotum*. The variability of this species and its tendency to form tetraploids has resulted in the development of a number of tetraploid cultivars which are commercially available as high-yielding pasture grasses (Anonymous, 2020d). Annual ryegrass (*Lolium multiflorum* Lam) is a cool season annual bunchgrass native to Southern Europe. It is genetically diverse and displays a high degree of phenotypic plasticity which means the grass is highly adaptable. Although, this cereal fodder is recently introduced in India but area under this grass is increasing continuously because it is a fast germinating, quick growing and outstanding winter fodder crop with high palatability and nutritive value. The productivity and number of cuttings of annual ryegrass depends on fertilizer dose and proper time of its application. As the grass is highly responsive to nitrogen and phosphorus fertilization, the experiment was undertaken to study its effect on fodder yield and quality of ryegrass.

## Materials and Methods

A field experiment was conducted during winter season of 2016-17 at Forage Section Research Farm of CCS Haryana Agricultural University, Hisar (Haryana), India situated at 29°10' N latitude, 75°46' E longitude, and altitude of 215.2 m above mean sea level. The site has semi-arid and sub-tropical climate with hot dry summer and severe cold winter. Average annual rainfall is about 450 mm, 75 per cent of which is received in three months, from July to September during south-west monsoon. Fig. 1 represents the weekly weather parameters i.e. temperature - minimum and maximum (°C), relative humidity of morning and evening (%) and rainfall (mm). The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction (pH 8.0), low in available nitrogen (128.5 kg $ha^{-1}$), medium in available phosphorus (12.0 kg $ha^{-1}$) and potassium (212.0 kg $ha^{-1}$). The experiment was laid out in factorial randomized block design with three replications. The two factor trial comprised of three nitrogen ($N_1$ - 120, $N_2$ - 170 and $N_3$ - 220 kg N $ha^{-1}$) and three phosphorus levels ($P_1$ - 30, $P_2$ - 40 and $P_3$ - 50 kg $P_2O_5$ $ha^{-1}$). The schedule of N application in $N_1$ - 40 kg N $ha^{-1}$ as basal +

**Table 1.** Yield attributes and yield of annual ryegrass at different N and P levels (Total 4 cuts)

| Treatments | No. of tillers $mrl^{-1}$ | Plant height (cm) | Total GFY (q $ha^{-1}$) | Total DMY (q $ha^{-1}$) |
|---|---|---|---|---|
| **N level (kg N $ha^{-1}$)** | | | | |
| $N_1$ - 120 | 239.43 | 47.51 | 313.70 | 42.50 |
| $N_2$ - 170 | 260.09 | 51.05 | 363.98 | 52.93 |
| $N_3$ - 220 | 278.10 | 54.89 | 401.85 | 57.59 |
| SEm± | 1.53 | 0.57 | 5.17 | 0.89 |
| C.D. (P=0.05) | 4.48 | 1.67 | 15.17 | 2.61 |
| **P Levels (kg $P_2O_5$ $ha^{-1}$)** | | | | |
| $P_1$ - 30 | 248.74 | 47.84 | 316.48 | 41.93 |
| $P_2$ - 40 | 262.30 | 52.00 | 374.44 | 54.26 |
| $P_3$ - 50 | 266.58 | 53.60 | 388.61 | 56.82 |
| SEm± | 1.53 | 0.57 | 5.17 | 0.89 |
| C.D. (P=0.05) | 4.48 | 1.67 | 15.17 | 2.61 |
| **N x P** | | | | |
| SEm± | 2.64 | 0.99 | 8.95 | 1.54 |
| C.D. (P=0.05) | 7.76 | NS | NS | NS |

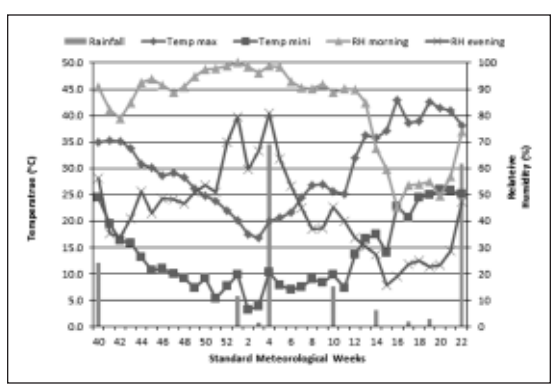


**Fig. 1.** Weekly weather parameters during the crop season (*Rabi* 2016-17)

20 kg N $ha^{-1}$ as topdressing at 3 WAS (weeks after sowing) + 20 kg $ha^{-1}$ N just after each cut, $N_2$ - 60 kg N $ha^{-1}$ as basal + 20 kg N $ha^{-1}$ as topdressing at 3 WAS + 30 kg $ha^{-1}$ N just after each cut and $N_3$ - 80 kg N $ha^{-1}$ as basal + 20 kg N $ha^{-1}$ as topdressing at 3 WAS + 40 kg $ha^{-1}$ N just after each cut. The full dose of phosphorus as per treatment was applied as basal in all treatments. The ryegrass variety used in the trial was Makkhan grass. The sowings was done on November 10, 2016; in rows at 30 cm apart using the seed rate of 15 kg $ha^{-1}$. Total four cuts were taken in all the treatments. First cut was taken 50 days after sowing and rest of the cuts were taken at 25-30 days interval of the previous cut. The harvested green fodder from each plot was weighed in situ and then converted into q $ha^{-1}$. A random sample of 500 g was taken from each plot at the time of green fodder at harvest, chopped well and put into paper bag. These bags were aerated by making small holes all over. The samples were first dried in the sun for 15 days and then transferred in an electric hot air oven for drying at a temperature of 60±5°C till constant weight was achieved. On the basis of dry weight of these samples, the green fodder yield was converted into dry matter yield (q $ha^{-1}$). Crude protein content and in-vitro dry matter digestibility (IVDMD) were estimated in dried and grinded samples (2 mm sieve size), collected at first cut. The crude protein content was calculated by multiplying the nitrogen percentage with 5.83 estimated by conventional micro-Kjeldhal method (AOAC, 1995). IVDMD was determined by method of Barnes *et al*. (1971). Crude protein yield and digestible dry matter yield were calculated by the multiplication of crude protein content (%) and in vitro dry matter digestibility (%) with dry matter yield (q $ha^{-1}$), respectively. The experimental data were analyzed by using OPSTAT software available on CCS Haryana Agricultural University home page (Sheoran *et al*., 1998).

## Results and Discussion

**Nitrogen levels :** Among different nitrogen levels, highest number of tillers $mrl^{-1}$ and plant height (278.10, 54.89 cm, respectively) were recorded with 220 kg N $ha^{-1}$ which were significantly superior over the other two lower levels of nitrogen. Similar trend was observed for green fodder yield and dry matter yield (401.85 and 57.59 q $ha^{-1}$, respectively) being significantly highest with 220 kg N $ha^{-1}$. The total green fodder and dry matter yield recorded with 220 kg N $ha^{-1}$ were 28.10, 10.40 and 35.51, 8.80 per cent higher over 120 and 170 kg N $ha^{-1}$ respectively. The results are in conformity with Sarma *et al*., (2020). Sidhu *et al*., (2020) also reported improvement in fodder yield and quality of ryegrass with increasing levels of nitrogen up to 160 kg N $ha^{-1}$. The cut-wise green fodder and dry matter yield as influenced by different nitrogen levels is shown in Fig. 2 and Fig. 3, respectively. Highest crude protein content (10.15%) was estimated with 220 kg N $ha^{-1}$ which was on a par with 170 kg

**Table 2.** Quality of annual ryegrass as influenced by different N and P levels

| Treatments | Crude protein content (%) | IVDMD (%) | Crude protein yield (q $ha^{-1}$) | Digestible dry matter yield (q $ha^{-1}$) |
|---|---|---|---|---|
| **N level (kg N $ha^{-1}$)** | | | | |
| $N_1$ - 120 | 9.14 | 59.05 | 3.88 | 25.05 |
| $N_2$ - 170 | 10.04 | 62.28 | 5.32 | 33.03 |
| $N_3$ - 220 | 10.15 | 62.34 | 5.85 | 35.91 |
| SEm± | 0.08 | 0.71 | 0.12 | 0.86 |
| C.D. (P=0.05) | 0.23 | 2.10 | 0.36 | 2.60 |
| **P Levels (kg $P_2O_5$ $ha^{-1}$)** | | | | |
| $P_1$ - 30 | 9.69 | 60.65 | 4.09 | 25.5 |
| $P_2$ - 40 | 9.77 | 61.91 | 5.33 | 33.6 |
| $P_3$ - 50 | 9.86 | 61.12 | 5.63 | 34.9 |
| SEm+ | 0.08 | 0.71 | 0.12 | 0.86 |
| C.D. (P=0.05) | NS | NS | 0.36 | 2.60 |
| **N x P** | | | | |
| SEm± | 0.14 | 1.24 | 0.21 | 1.49 |
| C.D. (P=0.05) | NS | NS | NS | NS |

**Table 3.** Nutrient content and uptake of annual ryegrass as influenced by different N and P levels

| Treatments | N content (%) | P content (%) | N uptake (kg ha$^{-1}$) | P uptake (kg ha$^{-1}$) |
|---|---|---|---|---|
| **N level (kg N ha$^{-1}$)** | | | | |
| $N_1$ - 120 | 1.57 | 0.44 | 66.85 | 18.96 |
| $N_2$ - 170 | 1.72 | 0.45 | 93.26 | 24.08 |
| $N_3$ - 220 | 1.74 | 0.47 | 102.63 | 26.93 |
| SEm± | 0.02 | 0.004 | 2.38 | 0.57 |
| C.D. (P=0.05) | 0.06 | 0.01 | 7.19 | 1.73 |
| **P Levels (kg $P_2O_5$ ha$^{-1}$)** | | | | |
| $P_1$ - 30 | 1.66 | 0.42 | 70.69 | 17.70 |
| $P_2$ - 40 | 1.68 | 0.46 | 94.46 | 25.01 |
| $P_3$ - 50 | 1.69 | 0.48 | 97.60 | 27.26 |
| SEm± | 0.02 | 0.004 | 2.38 | 0.57 |
| C.D. (P=0.05) | NS | 0.01 | 7.19 | 1.73 |
| **N x P** | | | | |
| SEm± | 0.03 | 0.01 | 4.12 | 0.99 |
| C.D. (P=0.05) | NS | NS | NS | NS |

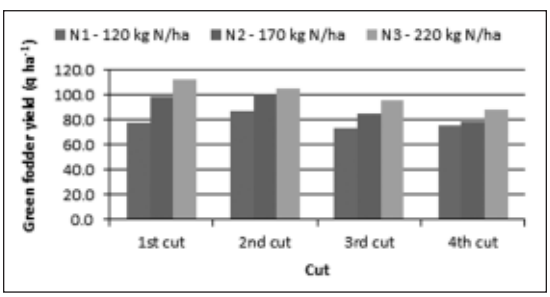


**Fig. 2.** Cut wise green fodder yield of ryegrass at different nitrogen levels

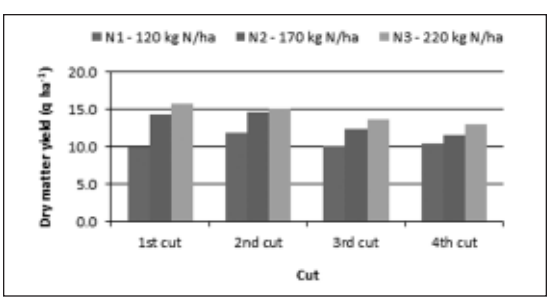


**Fig. 3.** Cut wise dry matter yield of ryegrass at different nitrogen levels

N ha$^{-1}$. Crude protein content is the function of per cent nitrogen content. There was better assimilation of N in the presence of higher nitrogen levels resulting on increased protein synthesis (Bora *et al.*, 2020). However, maximum crude protein yield (5.85 q ha$^{-1}$) was estimated with 220 kg N ha$^{-1}$ which was significantly higher over the lower nitrogen levels. Crude protein yield depends on crude protein content and dry matter yield and further the higher dry matter at 220 kg N ha$^{-1}$ increased the crude protein yield significantly. Among different nitrogen levels, highest IVDMD content (62.34%) was estimated with 220 kg N ha$^{-1}$ which was on a par with 170 kg N ha$^{-1}$. However, maximum digestible dry matter yield (35.91 q ha$^{-1}$) was estimated with 220 kg N ha$^{-1}$ which was significantly higher over the lower nitrogen levels. Maximum N and P content (1.74 and 0.47%) was estimated with 220 kg N ha$^{-1}$ which was significantly higher over the lower N levels for N content but for P content on a par with 170 kg N ha$^{-1}$. Highest N and P uptake (102.63 and 26.93 kg ha$^{-1}$, respectively) was also estimated with 220 kg N ha$^{-1}$ which was significantly higher over the lower N levels for N and P uptake.

**Phosphorus levels :** Among different phosphorus levels, highest number of tillers/mrl (266.58) and plant height (53.6 cm) were recorded with 50 kg $P_2O_5$ ha$^{-1}$ which were on a par with 40 kg $P_2O_5$ ha$^{-1}$ but significantly superior over 30 kg $P_2O_5$ ha$^{-1}$. Similar trend was observed for green fodder yield and dry matter yield (388.61 and 56.82 q ha$^{-1}$, respectively) being significantly highest with 50 kg $P_2O_5$ ha$^{-1}$ and being on a par with 40 kg $P_2O_5$ ha$^{-1}$. The green fodder and dry matter yield recorded with 50 kg $P_2O_5$ ha$^{-1}$ were 3.78, 22.79 and 4.72, 35.51 per cent higher over 40 and 30 kg $P_2O_5$ ha$^{-1}$ respectively. The cut wise green fodder and dry matter yield as influenced by different phosphorus levels is shown in Fig. 4 and Fig. 5, respectively. Crude protein content

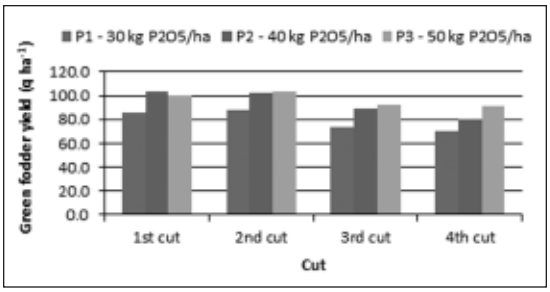


**Fig. 4.** Cut wise green fodder yield of ryegrass at different phosphorus levels

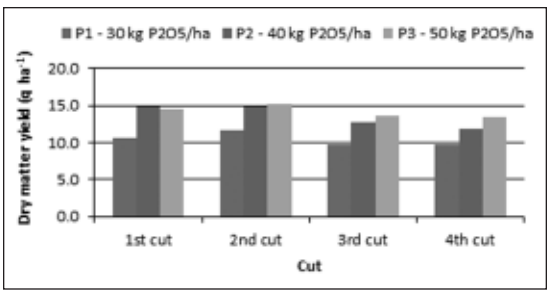


**Fig. 5.** Cut wise dry matter yield of ryegrass at different phosphorus levels

and IVDMD content were not affected significantly. However, maximum crude protein yield (5.63 q $ha^{-1}$) digestible dry matter yield (34.90 q $ha^{-1}$) were estimated with 50 kg $P_2O_5$ $ha^{-1}$ which were on a par with 40 kg $P_2O_5$ $ha^{-1}$. The crude protein and digestible dry matter yields recorded with 50 kg $P_2O_5$ $ha^{-1}$ were 5.63 & 37.65 and 3.87 and 36.86 per cent higher over 40 and 30 kg $P_2O_5$ $ha^{-1}$, respectively. CPY and DDMY are influenced by the dry matter yield directly. The estimated N content at different P levels was not affected significantly. However, maximum P content (0.48%) was estimated with 50 kg $P_2O_5$ $ha^{-1}$ which was significantly higher over the lower P levels. Highest N and P uptake (97.60 and 27.26 kg $ha^{-1}$, respectively) was also estimated with 50 kg $P_2O_5$ $ha^{-1}$ which was significantly higher over the lower N levels for N and P uptake.

## Conclusion

Based on the results, it can be concluded that the soils of semi-arid ecosystem (low in available nitrogen and medium in available phosphorus) responded well to the applied nitrogen and phosphorus in annual ryegrass crop. The application of the 80 kg Nitrogen+40 kg $P_2O_5$ as basal dose followed by 20 kg N $ha^{-1}$ as topdressing at three Weeks after sowing and 40 kg N $ha^{-1}$ just after each cut per hectare may be recommended to realize higher fodder yield of ryegrass.

## References

Anonymous. 2019 : "World Population prospects – Population division". population.un.org. United Nations Department of Economic and Social Affairs, Population Division. Retrieved on November 9, 2019.

Anonymous. 2020a : 20th Livestock Census – 2019, All India Report. Department of Fisheries, Animal Husbandry and Dairying, Department of Animal Husbandry and Dairying, Statistics Division, Krishi Bhawan, New Delhi.

Anonymous, 2020b : Efficient Land Use Integrated Livestock Development – A Road Map, TAAS publication. file:///D:/Article%2012.9.19/Efficient%20Land%20Use-A%20Road%20Map_15-2-2020.pdf

Anonymous. 2020c : https://www.britannica.com/plant/ryegrass accessed on 24.4.20

Anonymous. 2020d : https://www.cabi.org/isc/datasheet/31165 accessed on 24.4.20

AOAC. 1995 : Official Methods of Analysis, 16th edn. Association of Official Analytical Chemists, Arlington, U. S. A, ID No. 984.13.

Barnes, R. F., Muller, L. D., Bauman, L. F. and Colenbrande, V. F. 1971 : In-vitro dry matter disappearance of brown midrib nutrients of Zea mays L. J. Anim. Sci., 33 : 881-884.

Bora, S. S., Sharma, K. K., Borah, K., Saud, R. K. and Borgohain, L. 2020 : Effect of nitrogen levels and seed rate on quality of ryegrass (*Lolium multiflorum*) in Assam. Forage Res., 46(1): 54-57.

IGFRI Vision. 2050 : Indian Grassland and Fodder Research Institute, Jhansi (UP).

Sarma, A., Saud, R. K., Thakuria, K., Sharma, K. K. and Bora, S. S. 2020 : Nitrogen management in ryegrass (*Lolium multiflorum*). Forage Res., 45(4): 295-297.

Sheoran, O. P., Tonk, D. S., Kaushik, L. S. Hasija, R. C. and Pannu, R. S. 1998 : Statistical Software Package