# EFFECT OF DIFFERENT LEVELS OF NITROGEN ON THE YIELD, TOTAL NITROGEN CONTENT AND NITROGEN UPTAKE OF FOUR ORCHARDGRASS VARIETIES GROWN UNDER CONTROLLED CONDITIONS

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The effect of different levels of nitrogen on the forage yield, total nitrogen content and nitrogen recovery of four orchardgrass varieties was determined. The varieties used in this study were Potomac, Pennlate, Commercial and Iowa No. 6. The nitrogen fertilizer used was ammonium nitrate at the rates of 0, 160, 320 and 640 pounds of nitrogen per acre (2 X 10⁶ lb. soil). The varieties were seeded in pots and grown in a growth chamber where the diurnal temperatures, day length and moisture factors were controlled. The study was limited to two harvests and shows that whereas the forage yield and total nitrogen content increased with the increasing nitrogen rates, nitrogen uptake efficiency decreased with the increased nitrogen applications in all the varieties.

## INTRODUCTION

Orchardgrass (*Dactylis glomerata* L.) is one of the major grasses grown either alone or in mixtures for hay and pasture purposes on many irrigated areas of Colorado. The increasing use of Nitrogen fertilizers in grassland agriculture today makes it imperative to pay more attention to the reaction of different orchardgrass varieties in order to aid in recommending specific varieties under given nitrogen levels.

Several workers (Cummings and Teel, 1965; Drake *et al.*, 1963; Griffith and Teel, 1965; Gordon *et al.*, 1962; Jones *et al.*, 1947; Kresge and Younts, 1963; Lewis and Lang, 1957; MacLeod, 1965; Mortensen *et al.*, 1964) have studied the effect of nitrogen fertilization to orchardgrass but, most of these studies are either on a single variety or comparisons are made with other grass species under different environmental conditions which may not have much applicability under the soil and climatic conditions obtaining in the plain regions of northern Colorado. However, the work of Dotzenko (1961) and Dotzenko and Henderson (1964) pertinent to the aforesaid region indicated that forage yields were closely associated with the amount of nitrogen applied, with most varieties showing increased yields at the higher rates of nitrogen. The

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magnitude of increase varied with varieties as well as with the rates of nitrogen applied. Nitrogen fertilizer although increased the per cent total nitrogen, but per cent nitrogen recovery was inversely related to the amount of fertilizer applied. However, their work was done in the field where environmental changes were quite variable during the period of their study, while the objective of this study was to evaluate the effect of different nitrogen levels on the yield, total nitrogen content and percentage nitrogen recovery of four orchardgrass varieties grown under the controlled conditions in a growth chamber.

## MATERIAL AND METHODS

The varieties of orchardgrass used in this study were Potomac, Pennlate, Commercial and Iowa No. 6. Approximately two kilograms of Fort Collins silt loam soil were placed in each of the waxed 1/2 gallon paper cartons (5 inch diameter—6 inch depth) lined with polyethylene bags. On March 19, 1961, all pots were seeded with different varieties in the greenhouse. On April 14, when the seedlings had formed three or more leaves they were thinned to seven plants per pot, and on April 19, to five plants. The pots were then transferred to the growth chamber on April 21. The day and night temperatures in the chamber were set at 72°F. and 64°F., respectively, with a day length of 16 hours to eliminate variability that generally exists in the greenhouse. The pots were irrigated by using a solution balance and adding sufficient water to bring the soil to field capacity. The plants were clipped uniformly on April 29. Nitrogen was added at 0, 160, 320 and 640 pounds per acre ($2\times10^6$ lb. soil) or 0, 0.48, 0.96 and 1.92 grams of ammonium nitrate per pot, respectively. The 640-pound nitrogen rate was split into two equal applications with a week's interval between. Thus, with the exception of varieties and levels of nitrogen which were laid out in a split plot design with three replications, all other growth factors like soil, moisture, temperature and light were kept constant.

The first cutting was taken before bloom stage on June 7, and the second harvest on June 30. The fresh harvests of the first and second cuttings from each treatment were placed in a forced draft oven having a temperature of 70°C. The material was dried for a period of 72 hours. Dry weights under each treatment were recorded for yield data and the samples were ground in a Wiley mill to pass a 40-mesh screen. Analysis for total nitrogen were made on duplicate one-gram samples of ground plant material from the replicates of each treatment, using the Kjeldahl method as modified by Gunning (A.O.A.C., 1955). The percentage recovery of fertilizer nitrogen was calculated by the following formula :

$$\frac{\text{total nitrogen in fertilized crop} - \text{total nitrogen content in check}}{\text{total nitrogen applied}} \times 100$$

## RESULTS AND DISCUSSION

The average yield data of the first cutting, second cutting and the total forage yield on dry weight basis are given in Table I.

Varietal differences were not significant in the individual cuttings as well as the total yield. This similarity in response of the varieties could be attributed to the constant conditions of moisture, temperature and day length in the growth chamber. In the field, these factors usually vary considerably during the growth period, as a consequence may produce significant varietal differences, depending upon the different inherent varietal reactions to such varying environmental conditions. This contention is supported by the work of Dotzenko and Henderson, 1964. They obtained varietal differences in a similar experiment in the field.

TABLE I. *Forage yield grams per pot (dry weight).*

| Variety. | N added lbs./acre | Mean Yield | | |
|---|---|---|---|---|
| | | First cutting | Second cutting | Total Yield |
| Potomac | Control | 4.25 | 1.53 | 5.78 |
| | 160 | 5.27 | 3.43 | 8.70 |
| | 320 | 5.52 | 3.63 | 9.15 |
| | 640 | 5.80 | 4.20 | 10.00 |
| Pennlate | Control | 4.58 | 2.77 | 7.32 |
| | 160 | 5.25 | 3.40 | 8.65 |
| | 320 | 5.60 | 3.73 | 9.33 |
| | 640 | 5.97 | 4.20 | 10.17 |
| Commercial | Control | 5.10 | 2.55 | 7.65 |
| | 160 | 5.33 | 3.10 | 8.43 |
| | 320 | 5.66 | 3.90 | 9.57 |
| | 640 | 6.10 | 4.13 | 10.23 |
| Iowa No. 6 | Control | 4.70 | 2.60 | 7.30 |
| | 160 | 5.03 | 3.27 | 8.30 |
| | 320 | 5.10 | 3.87 | 8.97 |
| | 640 | 5.20 | 4.30 | 9.50 |
| Varieties | | N.S. | N.S. | N.S. |
| Nitrogen levels | | 0.35* | 0.23** | 0.42* |
| Nitrogen × varieties | | N.S. | ** | * |

*Significant at 5% level. **Significant at 1% level.

All the nitrogen levels increased the forage yield over the control. Although yield differences between nitrogen levels in the first cuttings were not as large as in the second cutting and in the total yield, maximum forage production was obtained at the 640 pound level followed by 320 and 160 pound levels, respectively in all the harvests. This indicates that the yield of orchardgrass may also increase with the increased nitrogen applications. The limited nitrogen response in the first cutting may be due to early blooming characteristic of these orchardgrass varieties. This view is supported by (Dotzenko, 1961; Dotzenko and Henderson, 1964; Lewis and Lang, 1957) who reported that the earliest maturing species showed the least nitrogen fertilizer response. Large yield differences between the nitrogen levels in the second cutting indicate that nitrogen was markedly consumed by the aftermath, *i.e.*, second cutting and this may explain why there is a significant residual fertilizer effect on the yield of second cutting.

The interactions between the nitrogen levels and varieties were not significant in the first cutting but were significant in the second cutting and in the total yield. The significant effect of the interactions in the second cutting was large enough to offset the non-significant influence of the interactions in the first cutting. This is the main reason for the significant differences found in the comparison of the interactions between the varieties and the nitrogen levels in the analysis of total forage yield.

The data presented in Table 2 show the percentage total nitrogen content of the various grass varieties under different nitrogen fertilizer levels in the first cutting, second cutting and the total forage yield.

Excepting the Iowa No. 6 variety which had higher nitrogen content only in the first cutting, no other significant varietal differences were found. Thus, in general, no variety under this study appears to be superior to another with respect to the total nitrogen content. This may be due to their similarity of reaction to the very uniform environmental conditions under which they were grown.

The total nitrogen content of the forage under all the fertilizer treatments was higher than that of the control in all the harvests. Within fertilizer treatments, the higher the nitrogen applications, the greater was the influence on the total nitrogen content of the forage. However, the first increment of 160 pounds of nitrogen increased the total nitrogen content to a greater extent than did the additional increments. Significant differences were found in nitrogen by varietal interactions. In general, these observations are in agreement with the findings of Dotzenko (1961), Dotzenko and Henderson (1964), and Wagner (1954).

TABLE II. *Total nitrogen percentage*

| Variety | N added lbs./acre | Mean | | |
|---|---|---|---|---|
| | | First cutting | Second cutting | Total Yield |
| Potomac | Control | 2.37 | 1.83 | 4.20 |
| | 160 | 3.22 | 3.19 | 6.41 |
| | 320 | 3.34 | 3.26 | 6.59 |
| | 640 | 3.43 | 3.45 | 6.88 |
| Pennlate | Control | 2.84 | 2.04 | 4.88 |
| | 160 | 2.90 | 2.87 | 5.77 |
| | 320 | 3.11 | 3.08 | 6.19 |
| | 640 | 3.17 | 3.32 | 6.48 |
| Commercial | Control | 2.59 | 1.68 | 4.27 |
| | 160 | 3.04 | 3.72 | 5.76 |
| | 320 | 3.27 | 3.29 | 6.56 |
| | 640 | 3.29 | 3.39 | 6.68 |
| Iowa No. 6 | Control | 3.11 | 1.83 | 4.93 |
| | 160 | 3.26 | 3.06 | 6.32 |
| | 320 | 3.59 | 3.31 | 6.91 |
| | 640 | 3.62 | 3.36 | 6.98 |
| Varieties .. | .. | 0.16* | N.S. | N.S. |
| Nitrogen levels .. | .. | 0.09* | 0.11* | 0.13* |
| Nitrogen x varieties .. | .. | * | * | * |

*Significant at 5% level.

Table 3 compares the percentage nitrogen recovery in the first, second and the combined harvests.

Under the conditions of this experiment, Potomac in general recovered more nitrogen than the other three varieties in all harvests. However, the percentage nitrogen recovered by all varieties under study was not large enough to cause any significant varietal differences in total nitrogen content as well as forage yields.

Maximum nitrogen recovery percentages occurred at the 160 pound rate followed by the 320 and 640 pound rates, respectively. This indicates that the nitrogen recovery efficiency decreased with the increased nitrogen fertilizer rate. Fertilizer by variety interactions were significant when both the harvests were taken together. In general, the varieties with lower nitrogen levels showed higher nitrogen recovery.

The percentage recovery of fertilizer nitrogen under various treatments was low in all the harvests. This may have been due to the conditions under which the plants were grown in the growth chamber, where the blooming habits of the grass received further stimulation by the increased day length as well as the maintenance of optimum temperature and availability of adequate moisture. Because of the rapid growth, the first harvest was obtained five weeks after the fertilizer application and the second harvest three weeks thereafter. This left comparatively little time for the plants to recover the applied nitrogen as efficiently as they would have under natural conditions in the field, where a longer growing period would have been available. This view is supported by Dotzenko (1961), Dotzenko and Henderson (1964), Lewis and Lang (1957), who contend that early blooming is a factor that limits nitrogen response.

TABLE III. *Percentage nitrogen recovery.*

| Variety | N added lbs./acre | Mean | | |
|---|---|---|---|---|
| | | First cutting | Second cutting | Total |
| Potomac | 160 | 14.31 | 16.97 | 31.29 |
| | 320 | 8.72 | 9.35 | 18.07 |
| | 640 | 5.15 | 6.09 | 11.24 |
| Pennlate | 160 | 4.62 | 8.62 | 13.23 |
| | 320 | 4.58 | 6.08 | 10.63 |
| | 640 | 3.08 | 4.30 | 7.78 |
| Commercial | 160 | 6.34 | 8.68 | 15.02 |
| | 320 | 5.67 | 8.90 | 14.57 |
| | 640 | 3.63 | 5.05 | 8.68 |
| Iowa No. 6 | 160 | 5.93 | 10.93 | 16.86 |
| | 320 | 4.94 | 8.61 | 13.55 |
| | 640 | 2.72 | 5.06 | 7.78 |
| Variety | | 3.46* | 1.19* | 3.56* |
| Nitrogen levels | | 1.82* | 1.44* | 2.71* |
| Nitrogen X varieties | | N.S. | N.S. | N.S. |

*Significant at 5% level.

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