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*Full Length Research Paper*

# The effects of different nitrogen doses on herbage and seed yields of annual ryegrass (*Lolium multiflorum* cv. c*aramba*)

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**This study has been carried out during the growing seasons of 2003-2004 and 2004-2005 in Turkey, to determine the effects of different nitrogen doses on the herbage (150, 230, 310, 390, 470, 550, 630 and 710 kg ha$^{-1}$) and seed yields (150, 170, 190, 210, 230, 250, 270 and 290 kg ha$^{-1}$) of and some agricultural characteristics of annual ryegrass cv. "caramba". Two different trials were established separately for the production of herbage and seed in the research. According to the two-year research, applications of different nitrogen doses are observed to be important for all properties of herbage yield and properties except for plant height of seed yield. As a result, the highest forage yield in annual ryegrass with the aim of green herbage is obtained to be of (54834 kg ha$^{-1}$) 470 and (54976 kg ha$^{-1}$) 550 kg ha$^{-1}$ at nitrogen levels, plant height (71.9 cm), crude protein ratio (21.2%) and the yield of crude protein is (1982 kg ha$^{-1}$) 470 kg ha$^{-1}$. It was obtained for the seed production that the highest number of tiller (626 item/m$^2$), fertile tiller number (483 item/m$^2$) and grain yield are (0.54 mg) 210 kg ha$^{-1}$, spikelet number per grain is (32.7 item) 250 kg ha$^{-1}$ and (33.6 item) 270 kg ha$^{-1}$, the highest seed yield is (343 kg ha$^{-1}$) 250 kg ha$^{-1}$ from the nitrogen dose application. In the light of information, the highest values were obtained from total 470 kg ha$^{-1}$ nitrogen application in herbage production and 250 kg ha$^{-1}$ in seed production.**

**Key words:** Crude protein, fodder crops, herbage yield, seed yield, nitrogen doses.

## INTRODUCTION

Annual ryegrass is used as an important fodder crop in a very wide area including North America, Ireland, England, Europe, Mexico, Australia, New Zealand and South Africa (Hannaway et al., 1999). It can easily be used both as a good cover crop and as a preceding crop in rotation in our region as well as in other regions (Saglamtimur et al., 1998). It is also widely used for over-seeding purposes to meet the need for herbage in pasture lands during winter months. It is being grown on a land of about 3 million ha in USA, about 90% of which is used in the form of over-seeding to prolong the grazing or usage period of summer pastures, during the winter season in places where the warm season fodder crops grow more in the pasture lands located southeast of the country.

Cukurova Region located south of Turkey and being one of the leading agricultural regions of Turkey has a great potential for fodder crop growing, because it has a production pattern consisting of rich and diverse products (Saglamtimur et al., 1998). Even though fodder crops are grown for their herbage, they need seed productions for replanting and wide spreading them. It is also hard to make a plant hardly producing seeds widespread no matter how good is the herbage yield and quality. Plants grown for seed production remain longer on the field (Serin, 1999). Seed harvesting should be made in the yellow maturing period and a seed yield of 700-1000 kg ha$^{-1}$ is obtained under normal growing conditions. 1000-grain weight about 2 g (Saglamtimur et al., 1998; Acikgoz, 2001).

The nitrogen content is the greatest individual nutrition factor effecting the growth and development of annual ryegrass (Griffith and Chastain, 1997). A principal limiting factor in ryegrass crops can be water deficit, and among mineral elements, nitrogen impedes the growth and

yields the most (Simic et al., 2009).

When the grasses, especially water and food stuffs are enough, they significantly react positive to the nitrogen fertilization. Especially, nitrogen fertilizer is inevitable to promote the growing in critical periods. However, this positive reaction continues increasing to a certain level and declines. In addition, climatic factors play an important role on the reaction of grasses to the nitrogen. It is possible to have more qualified herbage with the fertilization besides increase the yield. Nitrogen fertilization increases crude protein ratio of herbage especially in grasses.

Nitrogen amount giving into the grass varies based on the aim for cultivation, soil texture, depth and water holding capacity, amount and distribution of precipitation, length of growing season. Absolutely 1000 kg nitrogen per hectare can be found in much fertile soil and precipitation area (Acikgöz, 2001).

In research on annual ryegrass; Alvim and Moojen (1984) applied on annual ryegrass 0, 50, 100 and 150 kg $ha^{-1}$ nitrogen doses. They reported that the dry matter yields are 3370, 4480, 5220, 5500 kg $ha^{-1}$ and the crude protein yields are 620, 880, 1140 and 1200 kg $ha^{-1}$, respectively.

Ozel (1989) has found out that the plant height changed between 110.1 and 176.2 cm, the green herbage yield between 33791 and 89431 kg $ha^{-1}$ and the hay yield 9221 and 18791 kg $ha^{-1}$ in the conserved forage and reported that the leaf ratio ranged from 20 to 32.4% and the stem ratio from 67.6 to 80.1%. For the seed production, he also found out that the plant height is 123.5-231.0 cm, the spikelet number is 448-697 item/$m^2$, the spike length is 35.2-39.7 cm, the spikelet number per spike is 30.2-35.0 item/spike and the seed yield is 980-1640 kg $ha^{-1}$.

Celen (1991) obtained 16460 to 39800 kg $ha^{-1}$ of green herbage yield and 470-1060 kg $ha^{-1}$ of crude protein yield in the conserved forage and 340-630 kg $ha^{-1}$ of seed yield in seed production. Saglamtimur et al. (1993) obtained the highest green herbage yield as 61050 kg $ha^{-1}$ and hay yield was 13031 kg $ha^{-1}$. Serin and Gokkus (1993) found that the plant height, spike length, number of spikelet per spike and 1000 grain weight were 130 cm, 17-35 cm, 38 item and 2 g, respectively. Sancak and Manga (1994) determined that the green herbage yield is 5861-11791 kg $ha^{-1}$, the hay yield is 1521-5730 kg $ha^{-1}$ and the crude protein ratio is 4.7-8.5%. Orak and Uygun (1996) reported that, the plant height, and the green herbage yield ranged from 89.7 to 103.7 cm and 9000 to 22330 kg $ha^{-1}$, respectively. The highest green herbage yield value is obtained from sowing rate of 30 kg $ha^{-1}$ and at 30 cm row spacing.

Ozdil (1996) found that the plant height, the green leaf ratio, the green stem ratio, the dry leaf ratio, the dry stem ratio ranged from 104.0 to 146.7 cm, 20.1 to 31.8%, 68.3 to 79.9%, 27.9 to 32.9%, and 67.1 to 72.7%, respectively. In addition, the green herbage yield changed between 23051 and 59491 kg $ha^{-1}$, the hay yield between 5031 and 19311 kg $ha^{-1}$ and the seed yield between 181 and 931 kg $ha^{-1}$. Serin et al. (1996) found that the highest hay yield was 8220 kg $ha^{-1}$, the crude protein yield was 1411 kg $ha^{-1}$ and the crude protein ratio was 17.8%. In addition, Szyszkowska and Sowinski (2001) found that the crude protein ratio was 7.54-23.38%.

Kusvuran and Tansi (2004), working with herbage production found that the plant height, the green herbage yield, the hay yield, the green leaf ratio, the crude protein ratio and the crude protein yield ranged from 65.7 to 68.6 cm, 60145 to 80754 kg $ha^{-1}$, 11871 to 14932 kg $ha^{-1}$, 67.3 to 68.8%, 14.9 to 16.9%, 1893 to 2376 kg $ha^{-1}$, respectively. And that, with seed production, the plant height, the number of tiller, the number of fertile tiller, the spike length, the number of spikelet per spike, 1000-grain weight, the spike weight and the seed yield ranged from 99.5 to 103.1 cm, 469 to 877 item/$m^2$, 299 to 470 item/$m^2$, 29.2 to 32.5 cm, 26.3 to 28.3 item, 2.06 to 2.34 g, 0.36 to 0.39 mg and 208 to 360 kg $ha^{-1}$, respectively.

Kusvuran and Tansi (2005), working with herbage production found that the plant height, the green herbage yield, the hay yield, the green leaf ratio and the dried leaf ratio ranged from 60.4 to 86.0 cm, 27691 to 32441 kg $ha^{-1}$, 6420 to 7301 kg $ha^{-1}$, is from 46.0 to 58.9% and from 43.1 to 50.0%, respectively. And that, with seed production, the found that the plant height, the tiller number, the fertile tiller number, the spike length, the spikelet number per spike, 1000-grain weight, the total yield and the seed yield ranged from 56.6 to 59.9 cm, 366 to 473 item/$m^2$ 85 to109 item/$m^2$, 17.2 to 19.9 cm, 18.4 to 20.0 item, 2.72 to 2.92 g, 3270 to 3500 kg $ha^{-1}$ and 200 to 365 kg $ha^{-1}$, respectively.

Parlak (2005) found that the plant height, the green herbage yield, the hay yield, the nitrogen ratio in hay and the nitrogen yield in hay were 95.6 cm, 45833 kg $ha^{-1}$, 12432.3 kg $ha^{-1}$, 1.27% and 159.2 kg $ha^{-1}$, respectively. Choi et al. (2006), in the Koreanean conditions reported the following crude proteins quantities for the four domestic cultivars: 145, 161, 152 and 132 g $kg^{-1}$. Parlak et al. (2007), working with caramba cv. annual ryegrass, determined that the green herbage yield, and the crude protein yield changed between 6263.4 and 11627.2 kg $ha^{-1}$, and between 237.8 and 798.9 kg $ha^{-1}$.

Gultekin (2008), working with herbage production found that the plant height, the green herbage yield, the hay yield, the green leaf ratio, dry matter yield, crude protein ratio and crude protein yield ranged from 68.45 to 80.2 cm, 28260 to 51140 kg $ha^{-1}$, 7191 to 12100 kg $ha^{-1}$, 35.9 to 40.4%, 2190 to 3680 kg $ha^{-1}$, 6.78 to 7.99%, and 104 to 216 kg $ha^{-1}$, respectively. And that, with seed production, the plant height, the tiller number, the spike number, the spike length, 1000-grain weight and the seed yield ranged from 138.6 to 149.3 cm, 366 to 473 item/$m^2$,

733 to 1387 item/$m^2$, 30.6 to 35.0 cm, from 3.56 to 4.20 g, and 221 to 350 kg $ha^{-1}$, respectively.

Darwishi et al. (2009) reported that the highest forage yield and hay yield were 26340 kg $ha^{-1}$ and 9450 kg $ha^{-1}$, respectively. Kunelius and Boswall (2009) stated that for a high herbage yield in the conserved forage a total amount of 235-295 kg $ha^{-1}$ of nitrogen should be given as split applications, such as; 35-50 kg $ha^{-1}$ at seeding, 35-50 kg $ha^{-1}$ at tillering period, 65-80 kg $ha^{-1}$ after first harvest and 50-65 kg $ha^{-1}$ after subsequent harvests. Simic et al. (2009) reported that crude protein and hay yield ranged from 50 to 300 g $kg^{-1}$ and from 3600 to 8250 kg $ha^{-1}$, respectively. Anonymous (2010) also, in herbage production, the crude protein ratio was 15.8% in vegetative period and was 5.8% in maturity period, while it was 15.2% in early vegetative period, was 12.9% in early flowering period and was 6.6% in full flowering period, for hay. Kesiktas (2010) determined that the tiller number per plant, the plant height, the green herbage yield, the hay yield, the crude protein ratio and the crude protein yield ranged from 11.0 to 13.1 numbers, 60.3 to 71.6 cm, 13346 to 18145 kg $ha^{-1}$, 3987 to 5502 kg $ha^{-1}$ 9.5 to 13.6% and 576 to 1070 kg $ha^{-1}$, respectively.

This study is conducted to determine -particularly with the purpose of ensuring that livestock producers and businesses can supply their animals with abundant and delicious feed throughout the winter season both before main crop and second-crop farming- the herbage yield and seed yield and certain agricultural characters in the event of growing of c*aramba*, a species of annual ryegrass, in different nitrogen doses in Cukurova Region which permits two crops a year from the farming field.

## MATERIALS AND METHODS

This study was conducted during the growing seasons of 2003-2004 and 2004-2005, to determine the effect of different nitrogen doses in Cukurova Region (37°57´N and 35°30´E, elevation 24 m) which permits two crops a year from the farming field.

In this study, *Lolium multiflorum* cv. *caramba*, a cultivar of annual ryegrass is used as the material. Cukurova Region, including the city of Adana, has the characteristics of Mediterranean climate. The summer season is warm and dry, and winters are temperate and rainy. In the Cukurova Region, 23 November is the first and 28 February is the last frost date. Average rainfall is 625 mm. An average of 74 days of the year is rainy. Rainfall is 51% during the winter, 26% spring, 18% autumn and 5% summer season. Although, the average relative humidity is 66%, it rises over 90% during the summer season. Average temperature of the last 37 years is 18.7ºC. January is the coldest month, and August is the hottest month. Average temperature in January is 9°C, and average temperature in August is 28ºC (Anonymous, 2007a).

During the 2003-2004 and 2004-2005 growing seasons, whenthe field trials were conducted the average temperature values were parallel to average values for long years with no observation of any value that would negatively affect the plant development. It was found that the rainfall was irregular in consideration of both the averages of the trial years and of long years (Anonymous, 2007b). When needed, crops were irrigated. The average temperature and total precipitation were found to be 16.3°C and 626.3 mm in 2003-2004; 16.5°C and 473.4 mm in 2004-2005; 16.0°C and 621.8 mm in long years, respectively (Table 1). The soils where the study was conducted are entisols brought by Seyhan River, formed of very young alluvial deposits. They are in almost flat and near-flat topographies. The trial area soil properties (texture C, organic matter ratio 0.6-1.1%, soluble salt 0.060-0.065%, total N 0.056-0.0112%, available P 40.8 kg $ha^{-1}$, pH 7.47-7.60, CaCO3 24-27%, silt 27-28%, sand 14-18%, clay 55-58%, cec 370-470 cmol $ha^{-1}$) indicated that there was any limiting factor in terms of soil properties to grow crops for herbage and seed (Anonymous, 2003).

Two different trials were established separately for the production of herbage and seed in the research. In both years and trials, sowings were made based on the calculation of 45 kg $ha^{-1}$ seed and 30 cm row spacing (Kusvuran and Tansi, 2004) during the first week of October. 100 kg 20.20.0 fertilizer was applied to the hectare in plantation. Furthermore, 50 kg N was applied to the hectare in order to make under soil and top soil development of plant in sufficient level and in order to show the development in desired level at the tillering period. N was applied in different doses in order to redevelop of herbage in growing after harvesting, also, in order to obtain better seed in production seed onset of heading. Nitrogen was applied in the form of urea (46% N) by reason of affecting more quickly with regard to other nitrous fertilizer and losing less nitrogen. There is a great need for nitrogen, phosphorus and potassium when high quality annual ryegrass growing is the target. The field trials were arranged in complete randomized block design with three replications. Plot sizes were 3.6 m x 8 m=28.8 $m^2$ and observations were made in the area of 2.4 m x 6.8 m=16.3 $m^2$ after removing 0.6 m in both sides as edge impact. Distance was kept 5 m between blocks and 1 m between plots. In this study, 8 different nitrogen doses were used (Table 2).

Cutting was made four times in both years. The first year was between on the 17th of January, 2004 and on the 13th of May, 2004; and the second year was between on the 1st of February, 2005 and on the 11th of May, 2005 for the cultivating of herbage. Cutting was made onset of blooming and from height of 5 cm. When cutting at the start of the flowering period, it is a rapidly drying species, with high digestion rate and desirably eaten by livestock (Saglamtimur et al., 1998; Acikgoz, 2001). There were no developments in the plants after May. Cutting was not applied to the plant for the growing of seed, and seed harvest was made when plants were in yellow maturing period, which was on the 14th of June, 2004 for the first year and on the 28th of June, 2005 for the second year.

Data was analyzed according to the randomized complete block design using the MSTAT-C statistical software. Where the difference between the treatments were significant, this difference was compared by Duncan multiple comparison method (Mstat-C, 1991).

## RESULTS

### Herbage yield properties

#### *Plant height, green herbage and hay yield*

The differences between treatments with respect to the plant height, green herbage yield and hay yield values of annual ryegrass were found significant, statistically for each two-year and average of these years (Table 3).

The lowest values (successively: 53.6 cm, 33997 and 6123 kg $ha^{-1}$) in each three properties were obtained in 150 kg $ha^{-1}$ nitrogen dose. Therefore, values increased distinctly with the increasing of nitrogen dose. Change

**Table 1.** Monthly average temperatures and total precipitation at Cukurova-Turkey.

| Months | Temperature (°C) | | | Precipitation (mm) | | |
|---|---|---|---|---|---|---|
| | 2003-2004 | 2004-2005 | Long term | 2003-2004 | 2004-2005 | Long term |
| October | 22.4 | 23.4 | 21.0 | 17.0 | 7.3 | 43.6 |
| November | 15.4 | 15.7 | 15.1 | 22.3 | 141.1 | 67.2 |
| December | 11.0 | 9.6 | 11.1 | 167.2 | 27.0 | 118.1 |
| January | 9.1 | 10.1 | 9.9 | 252.1 | 51.0 | 111.7 |
| February | 9.8 | 10.3 | 10.4 | 117.5 | 75.6 | 92.8 |
| March | 14.7 | 13.9 | 13.1 | 5.6 | 61.1 | 67.9 |
| April | 17.7 | 18.1 | 17.1 | 24.8 | 53.0 | 51.4 |
| May | 21.1 | 22.0 | 21.4 | 19.8 | 41.2 | 46.7 |
| June | 25.6 | 25.7 | 25.2 | 0.0 | 16.1 | 22.4 |
| Average/Total | 16.3 | 16.5 | 16.0 | 626.3 | 473.4 | 621.8 |

**Table 2.** Applications of nitrogen doses for herbage and seed production.

| Herbage Production | | | | | | | Seed Production | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nitrogen doses (kg ha$^{-1}$) | Accompanied by sowing | Onset of tillering | 1st cutting | 2nd cutting | 3rd cutting | 4th cutting | Nitrogen doses (kg ha$^{-1}$) | Accompanied by sowing | Onset of tillering | Onset of heading |
| 150 | 100 | 50 | 0 | 0 | 0 | 0 | 150 | 100 | 50 | 0 |
| 230 | 100 | 50 | 20 | 20 | 20 | 20 | 170 | 100 | 50 | 20 |
| 310 | 100 | 50 | 40 | 40 | 40 | 40 | 190 | 100 | 50 | 40 |
| 390 | 100 | 50 | 60 | 60 | 60 | 60 | 210 | 100 | 50 | 60 |
| 470 | 100 | 50 | 80 | 80 | 80 | 80 | 230 | 100 | 50 | 80 |
| 550 | 100 | 50 | 100 | 100 | 100 | 100 | 250 | 100 | 50 | 100 |
| 630 | 100 | 50 | 120 | 120 | 120 | 120 | 270 | 100 | 50 | 120 |
| 710 | 100 | 50 | 140 | 140 | 140 | 140 | 290 | 100 | 50 | 140 |

continued until 470 kg ha$^{-1}$ and 550 kg ha$^{-1}$ nitrogen dose, after it became stable.

### *Leaf ratio in green herbage, crude protein ratio and crude protein yield*

The differences between treatments with respect to the leaf ratio in green herbage yield, crude protein ratio and crude protein yield values of annual ryegrass were found significant, statistically for each two-year, and average of these years (Table 4).

As is the case in previous values, the lowest values (successively: 65.6%, 16.0% and 974 kg ha$^{-1}$ were obtained in 150 kg ha$^{-1}$ nitrogen dose. Increase in nitrogen dose increased the values up to the certain level. Optimum values (successively: 74.4%, 21.6% and 1982 kg ha$^{-1}$) were obtained in 470 kg ha$^{-1}$ nitrogen dose in these properties, too; hence, there was not positive effect of increasing nitrogen dose on the values in terms of statistical. Moreover, decreases

**Table 3.** Plant height, green herbage and hay yield average values and groups.

| Nitrogen doses (kg ha$^{-1}$) | Plant height (cm) | | | Green herbage yield (kg ha$^{-1}$) | | | Hay yield (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | Average | 2004 | 2005 | Average | 2004 | 2005 | Average |
| 150 | 55.7 | 51.5 d | 53.6 c | 35388 c | 32606 e | 33997 d | 6341 c | 5904 d | 6123 d |
| 230 | 63.1 | 65.9 bc | 64.5 b | 44018 bc | 40217 d | 42118 c | 8210 bc | 7592 c | 7901 c |
| 310 | 63.9 | 62.8 c | 63.4 b | 49235 ab | 41628 d | 45432 c | 8919 ab | 7712 bc | 8316 bc |
| 390 | 65.0 | 69.2 a-c | 67.1 ab | 49262 ab | 45976 c | 47619 bc | 8514 ab | 8262 a-c | 8389 bc |
| 470 | 69.0 | 74.8 a | 71.9 a | 57160 ab | 52507 a | 54834 a | 9633 ab | 8808 ab | 9220 ab |
| 550 | 63.9 | 72.2 ab | 68.1 ab | 59064 a | 50888 ab | 54976 a | 10264 a | 8841 a | 9553 a |
| 630 | 66.3 | 65.5 bc | 65.9 b | 55658 ab | 52337 a | 53997 ab | 9104 ab | 8782 ab | 8943 a-c |
| 710 | 64.9 | 68.5 a-c | 66.7 ab | 59722 a | 49625 b | 54673 a | 9967 ab | 7807 a-c | 8887 a-c |
| Average | 64.0 | 66.3 | 64.1 | 51188 | 45723 | 48456 | 8869 | 7964 | 8416 |
| * LSD 5% | N.S. | 6.7** | 5.5** | 13560* | 1684** | 6527** | 1898* | 1120** | 1052** |
| C.V. | 8.43 | 5.77 | 7.18 | 11.13 | 8.10 | 11.39 | 12.22 | 8.04 | 10.57 |

*, ** Significance at *P≤ 0.05* and *P≤ 0.01*, respectively; NS, non significant.

**Table 4.** Leaf ratio in green herbage, crude protein ratio and crude protein yield average values and groups.

| Nitrogen doses (kg ha$^{-1}$) | Leaf ratio in green herbage (%) | | | Crude protein ratio (%) | | | Crude protein yield (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | Average | 2004 | 2005 | Average | 2004 | 2005 | Average |
| 150 | 67.8 | 63.4 f | 65.6 e | 16.9 b | 15.1 f | 16.0 d | 1056 c | 891 d | 974 c |
| 230 | 69.5 | 68.1 de | 68.8 cd | 17.8 b | 17.0 e | 17.4 c | 1460 bc | 1286 bc | 1373 b |
| 310 | 74.5 | 70.6 cd | 72.5 ab | 18.0 b | 16.3 e | 17.1 cd | 1615 ab | 1254 c | 1434 b |
| 390 | 74.5 | 75.2 ab | 74.8 a | 17.3 b | 18.3 d | 17.8 c | 1471 bc | 1511 bc | 1491 b |
| 470 | 71.8 | 76.9 a | 74.4 ab | 21.2 a | 22.0 a | 21.6 a | 2031 a | 1935 a | 1982 a |
| 550 | 71.7 | 72.6 bc | 72.2 ab | 19.4 ab | 20.9 b | 20.1 b | 1995 a | 1849 a | 1922 a |
| 630 | 70.0 | 73.4 bc | 71.2 bc | 19.3 ab | 22.1 a | 20.7 ab | 1772 ab | 1946 a | 1859 a |
| 710 | 71.3 | 65.2 ef | 68.3 de | 20.7 a | 19.5 c | 20.1 b | 2065 a | 1522 b | 1794 a |
| Average | 71.4 | 70.1 | 71.0 | 18.8 | 18.9 | 18.9 | 1683 | 1524 | 1604 |
| * LSD 5% | N.S. | 3.0** | 3.1** | 2.7* | 1.0** | 1.4** | 459** | 268** | 254** |
| C.V. | 4.54 | 3.43 | 3.65 | 8.20 | 5.02 | 6.17 | 15.57 | 10.04 | 13.38 |

*, ** Significance at p≤ 0.05 and p≤ 0.01, respectively; NS, non significant.

in values happened from this nitrogen dose.

## Seed yield properties

### *Plant height, number of tiller and number of fertile tiller*

No statistical differences were observed among average plant height values, nearly close values were obtained in different nitrogen doses. However, the differences between treatments with respect to the number of tiller and number of fertile tiller values of annual ryegrass were found significant, statistically for each two-year, and average of these years (Table 5).

The lowest values in the tiller number and the fertile tiller number were obtained in 290 kg ha$^{-1}$ nitrogen dose; however, the highest values were stated in 210 kg ha$^{-1}$ nitrogen dose (626 and 483 item/m$^2$).

Seed yield properties; nitrogen which was given in low dose did not produce an increasing effect to the tiller and the fertile tiller number. Also, nitrogen dose which was applied in 210 kg ha$^{-1}$ did not affect the values positively.

### 1000-Grain weight, spike length and number of spikelet per spike

The differences between treatments with respect to the 1000-grain weight, spike length and number of spikelet per spike values of annual ryegrass were found significant, statistically for each two-year, and average of these years (Table 6).

The lowest values in the number of spikelet per spike were obtained in 150 kg ha$^{-1}$ (26.3 items) nitrogen dose,

**Table 5.** Plant height, number of tiller and fertile tiller average values and groups.

| Nitrogen doses (kg ha$^{-1}$) | Plant height (cm) | | | Number of tiller (item/m$^2$) | | | Number of fertile tiller (item/m$^2$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | Average | 2004 | 2005 | Average | 2004 | 2005 | Average |
| 150 | 131.8 ab | 140.5 ab | 136.2 | 544 de | 572 e | 558 f | 431 bc | 454 d | 442 cd |
| 170 | 135.9 a | 128.6 c | 132.3 | 570 b-d | 596 cd | 583 de | 444 ab | 473 bc | 459 b |
| 190 | 117.5 c | 137.5 b | 127.5 | 588 ab | 625 b | 607 bc | 446 ab | 162 cd | 454 bc |
| 210 | 118.1 c | 144.4 ab | 131.3 | 607 a | 646 a | 626 a | 464 a | 502 a | 483 a |
| 230 | 125.0 bc | 140.7 ab | 132.8 | 581 ab | 656 a | 618 ab | 449 ab | 511 a | 480 a |
| 250 | 127.3 a-c | 148.9 a | 138.1 | 572 bc | 623 b | 598 cd | 136 a-c | 482 b | 459 b |
| 270 | 126.3 a-c | 142.1 ab | 134.2 | 549 c-e | 606 bc | 578 e | 434 bc | 474 bc | 454 bc |
| 290 | 124.8 bc | 137.9 b | 131.4 | 523 e | 584 de | 553 f | 409 c | 452 d | 431 d |
| Average | 125.9 | 140.1 | 133.0 | 567 | 613 | 590 | 439 | 476 | 458 |
| * LSD 5% | 10.2* | 8.6** | N.S. | 28** | 19.7** | 16.2** | 29* | 14.1** | 15.4** |
| C.V.. | 4.61 | 3.50 | 4.04 | 2.77 | 2.83 | 2.31 | 3.77 | 3.69 | 3.84 |

*, ** Significance at p≤ 0.05 and p≤ 0.01, respectively; NS, non significant.

while the highest values (2.54 mg) were obtained in 1000-grain weight in the same dose. However, the highest value (34.4 mm) in length of spike was obtained in 230 kg ha$^{-1}$ nitrogen dose, and the lowest value (31.2 mm) was obtained in 290 kg ha$^{-1}$ nitrogen dose. However, obtained values in applied nitrogen doses were close to each other and they took place in the same group statistical. The highest value (33.6 items) in the number of spikelet per spike was obtained in 270 kg ha$^{-1}$ nitrogen dose. However, the lowest value (26.3 items) was stated in 150 kg ha$^{-1}$ nitrogen dose.

## Spike weight and seed yield

The differences between treatments with respect to the spike weight and seed yield values of annual ryegrass were found significant, statistically for each two-year, and average of these years (Table 7).

It was seen that different nitrogen doses, which were applied in spike weight and seed weight, had different affects. The highest value (0.54 mg) in weight of spike was obtained in 210 kg ha$^{-1}$ nitrogen dose, while the highest seed yield (343 kg ha$^{-1}$) was obtained in 250 kg ha$^{-1}$ nitrogen dose.

## DISCUSSION

Herbage yield properties; plant height values were indication of re-growing up of annual grass after cutting. With the increasing of nitrogen dose, height of plant increases until definite level. Later, plant height has a tendency of decrease on account of nutritional element competition.

Plant height values obtained from the study are similar to the values found by Kusvuran and Tansi (2004), Kusvuran and Tansi (2005), Gultekin (2008), and Kesiktas (2010). While values obtained from the study were higher than ones of Ozel (1989), Serin and Gokkus (1993), Orak and Uygun (1996), Ozdil (1996), and Parlak (2005).

Green herbage (54834 kg ha$^{-1}$) and hay yields (9220 kg ha$^{-1}$) were important in terms of yield in animal breeding. 470 kg ha$^{-1}$ nitrogen dose was considered the most suitable dose. Hence, the amount of extra fertilizer applied, means cost, and the difference in terms of increasing of green herbage and hay yields was not economic sufficiency. Griffith and Chastain (1997) started that high nitrogen dose causes a decreased of annual grass yield by reason of over competition. However, Simic et al. (2009) started that low nitrogen dose causes an increase in grass yield. As a result of the research, it is possible to say that obtained green herbage and hay yields were in sufficient level in terms of animal breeding. Green herbage yield values obtained from the study were similar to the values found by Ozdil (1996), Parlak (2005), and Gultekin (2008). While the values found by Celen (1991), Sancak and Manga (1994), Orak and Uygun (1996), Kusvuran and Tansi (2005), Parlak et al. (2007), Darwishi et al. (2009), Kunelius and Boswall (2009), and Kesiktas (2010) are lower than the study findings, the other values were higher than the studies of Ozel (1989), Saglamtimur et al. (1993), and Kusvuran and Tansi (2004).

Hay yield values obtained from the study are similar to

**Table 6.** 1000 grain weight, spike length, and number of spikelet per spike average values and groups.

| Nitrogen doses (kg ha$^{-1}$) | 1000-Grain weight (mg) | | | Spike length (cm) | | | Number of spikelet per spike (item) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | Average | 2004 | 2005 | Average | 2004 | 2005 | Average |
| 150 | 2.57 | 2.52 a | 2.54 a | 29.9 e | 33.0 b | 31.5 b | 25.9 c | 26.6 e | 26.3 c |
| 170 | 2.35 | 2.48 a | 2.41 bc | 30.5 de | 33.0 b | 31.8 b | 29.8 b | 30.0 cd | 29.9 b |
| 190 | 2.47 | 2.39 b | 2.43 ab | 30.9 c-e | 32.9 b | 31.9 b | 30.1 ab | 25.5 e | 27.8 c |
| 210 | 2.25 | 2.18 d | 2.22 e | 32.5 b-d | 35.9 a | 34.2 a | 31.4 ab | 29.5 d | 30.5 b |
| 230 | 2.34 | 2.46 ab | 2.40 b-d | 33.2 a-c | 35.6 a | 34.4 a | 28.8 bc | 31.7 bc | 30.2 b |
| 250 | 2.46 | 2.51 a | 2.49 ab | 35.1 a | 32.3 b | 33.7 a | 31.8 ab | 33.5 ab | 32.7 a |
| 270 | 2.32 | 2.30 c | 2.31 c-e | 33.8 ab | 29.4 c | 31.6 b | 33.0 a | 34.1 a | 33.6 a |
| 290 | 2.28 | 2.13 c | 2.30 de | 32.5 b-d | 29.9 c | 31.2 b | 28.8 bc | 32.6 ab | 30.7 b |
| Average | 2.38 | 2.39 | 2.39 | 32.3 | 32.8 | 32.5 | 30.0 | 30.5 | 30.2 |
| *LSD 5% | N.S. | 0.08** | 0.11** | 2.4** | 1.4** | 1.3** | 3.1** | 2.1** | 1.8** |
| C.V. | 5.34 | 4.00 | 4.03 | 4.30 | 4.42 | 3.48 | 5.94 | 4.93 | 5.02 |

*, ** Significance at p≤ 0.05 and p≤ 0.01, respectively; NS, non significant.

**Table 7.** Spike weight and seed yield average values and groups.

| Nitrogen doses (kg ha$^{-1}$) | Spike weight (mg) | | | Seed yield (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | 2004 | 2005 | Average | 2004 | 2005 | Average |
| 150 | 0.39 bc | 0.36 h | 0.38 e | 311 | 345 bc | 329 ab |
| 170 | 0.36 c | 0.37 g | 0.37 e | 280 | 324 c | 302 c |
| 190 | 0.38 bc | 0.43 e | 0.40 de | 296 | 363 ab | 330 ab |
| 210 | 0.55 a | 0.52 b | 0.54 a | 268 | 336 c | 302 c |
| 230 | 0.47 ab | 0.53 a | 0.50 ab | 266 | 364 ab | 315 bc |
| 250 | 0.47 ab | 0.49 c | 0.48 bc | 312 | 375 a | 343 a |
| 270 | 0.42 bc | 0.46 d | 0.44 cd | 271 | 329 c | 300 c |
| 290 | 0.36 c | 0.43 f | 0.40 e | 266 | 325 c | 295 c |
| Average | 0.43 | 0.45 | 0.44 | 284 | 345 | 315 |
| * LSD %5 | 0.10** | 0.002** | 0.04** | N.S. | 21** | 24** |
| C.V. | 7.70 | 7.00 | 8.84 | 8.02 | 7.48 | 6.36 |

*, ** Significance at *P≤ 0.05* and *P≤ 0.01*, respectively; NS, non significant.

the values found by Serin et al. (1996), Kusvuran and Tansi (2005), Darwishi et al. (2009), and Simic et al. (2009). While the values found by Alvim and Moojen (1984), Sancak and Manga (1994), and Kesiktas (2010) are lower than the study findings, the other values were higher than the studies of Ozel (1989), Saglamtimur et al. (1993), Ozdil (1996), Kusvuran and Tansi (2004), Parlak (2005), and Gultekin (2008). It was preferred that leaf ratio should be high, in other words, stem ratio should be low level in order to obtain nutritive and pleasure herbage in grasses. Because assembled lignin and cellulose in stems cause to decrease not only in nutritional value, but also in pleasure of plants with the increasing and thickening of stems. When the plants were onset of flowering, cutting was made in each two-year. So, leaf ratios of plants were in high level.

While leaf ratio in green herbage values were considerably higher than ones found by Ozel (1989), Ozdil (1996), Gultekin (2008), and slightly higher than Kusvuran and Tansi (2005), they were similar to ones found by Kusvuran and Tansi (2004). Simic et al. (2009) informed that nitrogen dose should be applied in high

dose in order to increase crude protein ratio of grass. As it is known, forage grasses are rich in carbohydrate, and forage legumes are rich in protein. While the protein ratio rises to the level of 30-35% in legumes, this ratio is at lower levels (10-15%) in grasses. The protein ratio obtained from the annual ryegrass in the current study is higher than the 12% threshold value approved for livestock raising. Depending on harvest frequency, it is possible that the leaf ratio increasing because of shortening of the period between the harvests contributes to this.

Crude protein ratio values obtained from the study were higher than the values found by Sancak and Manga (1994), Kusvuran and Tansi (2004), Parlak (2005), Gultekin (2008), Anonymous (2010), and Kesiktas (2010). The values were similar to ones by Serin et al. (1996), and Szyszkowska and Sowinski (2001). Crude protein yield values obtained from the study are similar to the values found by Serin et al. (1996), While the values found by Alvim and Moojen (1984), Celen (1991), Parlak (2005), Parlak et al. (2007), and Kesiktas (2010) are lower than the study findings, the other values were higher than ones of Kusvuran and Tansi (2004), Choi et al. (2006), Gultekin (2008), and Simic et al. (2009).

Plant height applied from plants, which were grown in an effort to seed production, was higher in comparison with herbage production. Because, there was not any cutting process to the plant, seed production was aimed at directly. Furthermore, nitrous fertilizer produced an increasing effect to the tiller and the fertile tiller number. But, this positive effect continued until certain level. Later, it affected in a negative way, because plants were in competition with nutritional element of in high nitrogen dose. It is possible to say that there was decreasing in the tiller and the fertile tiller number because of the competition.

Plant heights before harvest for seed yield were found to be lower than ones by Ozel (1989), and Gultekin (2008), while they were higher than ones Kusvuran and Tansi (2004; 2005), and Parlak (2005). The values were similar to ones by Serin and Gokkus (1993), Ozdil (1996). While the numbers of tiller study findings were higher than values found by Kusvuran and Tansi (2005), and Gultekin (2008), they were partly similar to the values found by Kusvuran and Tansi (2004). The numbers of fertile tiller study findings were higher than values found by Kusvuran and Tansi (2004, 2005), while they were lower than to the values found by Gultekin (2008).

While 1000-grain weight study findings affect negatively on values spike length and spikelet number per spike values were high until certain level (between 210-270 kg $ha^{-1}$), the values except these were low. It is possible to say that there was no certain consistency in different nitrogen doses when each of three qualities was analyzed. 1000-grain weight values obtained from the study are similar to the values found by Kusvuran and Tansi (2004). While the values found by Serin and Gokkus (1993) are lower than the study findings, the other values were higher than ones Kusvuran and Tansi (2005), and Gultekin (2008).

Spike length values obtained from the study are similar to the values found by Serin and Gokkus (1993), Kusvuran and Tansi (2004), and Gultekin (2008). While the values found by Ozel (1989) are lower than the study findings, the other values were higher than ones Kusvuran and Tansi (2005). Spikelet number per spike values obtained from the study is partly similar to the values found by Ozel (1989), and Kusvuran and Tansi (2004). While the values found by Kusvuran and Tansi (2005) are lower than the study findings, the other values were higher than ones in the study of Serin and Gokkus (1993).

Applied nitrogen doses produce variable effect on values. Namely, the highest value in nitrogen dose was obtained in 250 kg $ha^{-1}$ at seed yield. The lowest (295 kg $ha^{-1}$) value was obtained in 290 kg $ha^{-1}$ dose. Thus, when 210 kg $ha^{-1}$ nitrogen was given, the highest tiller and fertile tiller number was obtained. Obtained 1000-grain weight in this dose was the lowest level. Spike weight ones obtained from the study was higher than the values found by Kusvuran and Tansi (2004). The seed yield from the current study were lower than the values found by Ozel (1989), Celen (1991), and Ozdil (1996), and were similar to the values found by Kusvuran and Tansi (2004, 2005), and Gultekin (2008).

## Conclusion

In this study, the annual ryegrass (*Lolium multiflorum* Lam.) cultivar, caramba, which are potential fodder species, was studied to determine the herbage and seed yield, and certain agricultural characters in different nitrogen doses for livestock. It can be used as grazing, if not, as cutting throughout the winter season.

According to the two-year research, applications of different nitrogen doses are observed to be important for all properties of herbage yield and properties except for plant height of seed yield.

Consequently, it is stated that yield is taken in satisfactory level and plant gave positive reaction to the nitrogen which was applied after cutting and it gave high quality feed. In addition, it is stated that the most suitable dose was in total 470 kg $ha^{-1}$ (80 kg $ha^{-1}$ after each cutting).

In seed production, annual ryegrass gave positive reaction to the nitrogen and it is stated that the highest seed production was obtained in 250 kg $ha^{-1}$ (onset of heading 100 kg $ha^{-1}$).

On the other hand, it is notable that seed yield is taken

(329 kg $ha^{-1}$) in satisfactory level although there is not any nitrogen application namely onset of heading in 150 kg $ha^{-1}$ nitrogen dose application. Nitrogen which was applied onset of heading increased the seed yield about 4% and this nitrogen means cost.

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