Registration of ‘NF201’ Forage Triticale

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ABSTRACT

‘NF201’ (Reg. No. CV-34, PI 674106) is a forage triticale (×Triticosecale Wittm.) with prolific growth habit and excellent fall-winter forage potential, developed by the Samuel Roberts Noble Foundation, Inc., Ardmore, OK, and released in 2013. NF201 was tested under the experimental designation, NF96210. NF201 was developed from the double cross NF83/’Stan II’/’Roughrider’/’Stan II’ made in 1996. Individual plant selections were performed in early generations followed by head-row and progeny-row schemes. NF201 was selected on the basis of early fall-winter vegetative growth. It has a tall growth habit with an average plant height of 112.5 cm. The leaves are longer and narrower compared with the check cultivars. NF201 was developed mainly for fall-winter forage in the south-central United States. The fall-winter forage yield of NF201 was 9 and 20% more than the check cultivars TAMcale5019 and Thundercale, respectively, at the southern Oklahoma trials. In 2 yr of evaluations at Iowa Park, TX, the fall and winter yield of NF201 was 25 and 21% higher, respectively, than TAMcale5019. At Overton, TX, NF201 was superior to the check cultivars for early season yield. Forage quality of NF201 was similar to the check cultivars. Collectively, in the south-central United States, NF201 had significantly higher yields in the fall-winter period compared with the check cultivars, suggesting that it is the best choice for producers who need forage for early fall-winter grazing.
conditions. In addition, the potential of triticale as a bioenergy feedstock for ethanol production is also more than wheat (Biofuelsdigest, 2011).

The Noble Foundation is the only organization in the southern Great Plains concentrating on the genetic improvement of triticale for direct grazing use. Triticale improvement initiatives at the foundation have been ongoing since the early 1980s. Seasonal distribution of forage yield is as important as total yield. During the period between November and February, farmers in the region do not have choices for grazing their animal. Thus, developing improved cultivars with potential for early fall-winter forage is the primary target of our breeding program. NF201 was selected and developed on the basis of early fall-winter forage vegetative growth potential. It is the first triticale cultivar released from the Noble Foundation breeding program. The justification for release of NF201 triticale is based on its superior fall-winter forage production compared with the check cultivars in the Oklahoma and Texas region.

Methods

NF201 was developed from the double cross NF83/'Stan II'/'Roughrider'/'Stan II'. NF83 is a nonreleased experimental line of the Noble Foundation with potential for early fall forage. Stan II was developed and released by Resource Seeds, Inc., and was well adapted to the growing conditions in the southeastern United States. Roughrider was developed and released by Goertzen Seed Research in 1997 and had a very low ergot (caused by Claviceps purpurea) infection risk (Gibson et al., 2005). The F1, through F6, generations were advanced in space plant nurseries at Ardmore, OK, from 1997 through 2001. NF201 was a single plant selection from F6, space plants based on early fall-winter vegetative growth potential. The plant-row progeny was evaluated in 2002. Subsequent generations were advanced by bulk selfing in the field with roughing of off-type variants each year until 2011.

Performance of NF201 was evaluated in replicated forage variety trials conducted at the Noble Foundation Headquarters Farm at Ardmore (34.1120° N, 97.2889° W; soil type: Alfisols) and the Red River Demonstration and Research Farm at Burneyville (33.9079° N, 97.2889° W; soil type: Mollisols), from 2004–2005 to 2010–2011. Soil samples from both locations were collected before planting, and the fields were fertilized to the recommended levels. Nitrogen, P2O5, and K 2O fertilizers were applied before planting. Additional N fertilizer was top-dressed in four split applications during the active growing seasons. Post-emergence herbicide, Glean (Chlorsulfuron; DuPont), was applied on 9 Nov. 2009 for effective control of winter annual weeds (Nelson, 2011). Leaf rust (Puccinia graminis f. sp. tritici) and powdery mildew (Blumeria graminis) diseases were recorded on a 0-to-9 scale where 0 = no symptom and 9 = dead plants.

Data on different morphological traits and forage yield collected in the southern Oklahoma and north Texas evaluations were analyzed using the general linear models procedures in SAS version 9.2 (SAS Institute, 2010). Means were separated by the least significant difference (LSD) method with P ≤ 0.05.

Characteristics

NF201 is a triticale line with excellent fall-winter forage potential and is best adapted to the southern Great Plains (Fig. 1). Morphological characterization of the NF201 plants revealed that there is no anthocyanin pigmentation in the coleoptile. The juvenile plants have erect growth habit. Leaves are light green and the flag leaf is erect. Leaf surface is smooth and nonwaxy. The leaves are fairly large with an average length of 26 cm and width of 12.4 mm. On average, each stem has four leaves at maturity (Table 1). NF201 is about 7 d earlier in

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heading than ‘Thundercale’ and 1 d later than ‘TAMcale5019’ (Table 1). The plants are about 112.5 cm tall at heading, which is about 11 cm taller than Thundercale and slightly shorter (2.5 cm) than TAMcale5019 (Table 1). Anthocyanin pigmentation and internode hairiness are absent in the stems. The internode is hollow, and each plant has on average more than three nodes at maturity. Stems of NF201 are 4.2 mm in diameter, which is similar to other checks except Thundercale (Table 1). The heads are middense, slightly tapered, erect, and awned at maturity (Fig. 2). Awns of NF201 are 6.2 cm long, which is significantly shorter than TAMcale5019 and similar to Thundercale (Table 1). The seed is oval in shape with rounded cheeks. Seed color is amber and hard-textured. The average seed weight is about 49 (SE = 0.73) g 1000 seed⁻¹.

NF201 is a forage triticale with prolific growth habit, and it has excellent fall-winter forage potential (Fig. 1). It is well adapted to the southern Great Plains under rainfed conditions. During 7 yr (2004–2005 to 2010–2011) of testing at two Oklahoma locations (Ardmore and Burneyville), the forage fall-winter yield of NF201 was numerically higher in the heavy-textured clay soil at Ardmore than in the light-textured sandy soil at Burneyville (Table 2). Fall-winter forage yield of NF201 was significantly higher than the check cultivars at Burneyville. At Ardmore, fall-winter forage yield of NF201 was 25.2% higher than the late check cultivar Thundercale, but it was only 6.2% higher than the early check cultivar TAMcale5019 (Table 2). Spring yield of Thundercale was appreciably higher than either cultivar (Table 2). Spring forage yield of NF201 and TAMcale5019 was similar across locations (Table 2). As a result, the total forage yield of all three cultivars was very similar at both Oklahoma locations (Table 2). Therefore, across 7 yr of evaluations at the two Oklahoma locations, the main advantage of NF201 was observed for its fall-winter forage which was the target trait for breeding this cultivar. The fall-winter forage yield of NF201 in these southern Oklahoma locations was 3300 kg ha⁻¹ but was only 3035 kg ha⁻¹ (−9%) for TAMcale5019 and 2746 kg ha⁻¹ (−20%) for Thundercale. In all the evaluation trials, the total forage yield of NF201 varied from 2432 to 9001 kg ha⁻¹. Total forage yield of TAMcale5019 ranged from 1959 to 8494 kg ha⁻¹, and that of Thundercale ranged from 2461 to 8193 kg ha⁻¹.

In 2 yr of evaluations at Iowa Park, TX, NF201 produced more fall, winter and total forage than the other entries (Table 3). Like the two southern Oklahoma test locations, the main yield advantage in Iowa Park was observed for fall and winter growth. The fall and winter yield of NF201 was 25 and 21% higher than TAMcale5019, respectively. NF201 had 816 kg ha⁻¹ fall-winter yield advantage over TAMcale5019. Fall-winter yield of NF201 was 657 kg ha⁻¹ higher than NF96213, an experimental line developed in our breeding program. Although TAMcale5019 showed better spring forage production, its total yield was 3.5% less than NF201. For fall-winter forage, NF201 was superior to its peers.

During the 2009–2010 growing season at Overton, NF201 was superior to the check cultivars for early season yield (Table 4). Yield of NF201 in later harvests was similar to all other

Table 1. Morphological characteristics of NF201 compared with other triticale lines and cultivars in southern Oklahoma during the 2008–2009 and 2009–2010 growing seasons.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Leaf length cm</th>
<th>Leaf width mm</th>
<th>Leaf number cm</th>
<th>Plant height cm</th>
<th>Stem diameter cm</th>
<th>Number of nodes</th>
<th>Spike length cm</th>
<th>Spike width mm</th>
<th>Awn length mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF201</td>
<td>25.95ab†</td>
<td>12.36b</td>
<td>4.42c</td>
<td>112.50b</td>
<td>4.21a</td>
<td>3.55bc</td>
<td>11.63ab</td>
<td>8.12a</td>
<td>61.70b</td>
</tr>
<tr>
<td>NF96213</td>
<td>25.24bc</td>
<td>13.65a</td>
<td>4.33c</td>
<td>114.41a</td>
<td>4.24a</td>
<td>3.47c</td>
<td>12.02a</td>
<td>8.18a</td>
<td>61.52b</td>
</tr>
<tr>
<td>TAMcale5019</td>
<td>27.03a</td>
<td>13.53a</td>
<td>4.63b</td>
<td>115.00a</td>
<td>4.23a</td>
<td>3.68ab</td>
<td>11.65ab</td>
<td>7.42b</td>
<td>90.28a</td>
</tr>
<tr>
<td>Thundercale</td>
<td>24.37c</td>
<td>13.12a</td>
<td>4.83a</td>
<td>101.47c</td>
<td>3.92b</td>
<td>3.75a</td>
<td>11.25b</td>
<td>7.65b</td>
<td>74.10ab</td>
</tr>
</tbody>
</table>

† Means within a column followed by a same letter do not differ significantly at P ≤ 0.05.
entries. Total yield of NF201 during the 2009–2010 growing season and three season’s average was statistically similar but numerically higher than the two check cultivars (Table 4). Across all evaluations, NF201 had significantly higher fall-winter yields compared with the check cultivars, suggesting that it is the best choice for producers desiring early fall-winter grazing in the east Texas region (Table 4).

Forage quality of NF201 was comparable to the check cultivar TAMcale5019 (data not shown). Early season forages of both NF201 and TAMcale5019 had similar crude protein (252.0 vs. 253.6 g kg$^{-1}$), acid detergent fiber (223.4 vs. 196.2 g kg$^{-1}$), neutral detergent fiber (399.3 vs. 370.9 g kg$^{-1}$), total digestible nutrient (704.1 vs. 726.2 g kg$^{-1}$) and in vitro dry matter digestibility (931.4 vs. 948.0 g kg$^{-1}$).

During 7 yr of evaluations in southern Oklahoma and north and east Texas, NF201 was found highly resistant to powdery mildew and also possessed high levels of resistance to leaf rust (data not shown). It also has high levels of field cold tolerance. Growth of NF201 slowed down during winter months but recovered completely during the spring in southern Oklahoma.

Seed yield of all small grains in our experiments was calculated from plots that were not clipped after the plants reached the jointing stage. During 3 yr of evaluations at two Oklahoma locations, average seed yield of NF201 was estimated 2.43 t ha$^{-1}$ (SE = 0.19). Similar seed yield was estimated in TAMcale5019 (2.54 t ha$^{-1}$; SE = 0.17) and Thundercale (2.23 t ha$^{-1}$; SE = 0.23) in the same studies.

### Availability

Seed samples of NF201 have been placed in the National Plant Germplasm System (NPGS). NF201 is a protected germplasm and will available for distribution to scientists according to policies of the NPGS and will not be distributed without approval until the protection expires (20 yr). Oklahoma Genetics Inc., Stillwater, OK 74076, is the commercial distributor and primarily responsible for producing and marketing seed of NF201. We maintain a small seed inventory of NF201 at the Noble Foundation; minor seed requests should be forwarded to the corresponding author. Requests may be granted subject to terms of a material transfer agreement.

### Acknowledgments

We extend our sincere appreciation to Dr. Lloyd Nelson, Texas Agricultural Experiment Station, for his collaboration in performance data collection. We are thankful to Dr. Jagadeesh Mosali, Agricultural Division, Noble Foundation, for his continuous support and evaluation of the experimentals. We are very thankful to Hem Bhandari, Shawn Norton, Roger Hartwell, Julie Barrick, Brian Motes, Jennifer Black, and Lynn Jacob for their help. Our sincere appreciation also goes to Dennis Walker for conducting all forage analyses.

### Tables

#### Table 2. Forage yield of NF201 and two check triticale cultivars at Noble Foundation farms at two southern Oklahoma locations averaged across seven growing seasons from 2004–2005 to 2010–2011.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Headquarters Farm, Ardmore</th>
<th>Red River Farm, Burneyville</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall-winter</td>
<td>Spring</td>
</tr>
<tr>
<td>NF201</td>
<td>3884a†</td>
<td>1983b</td>
</tr>
<tr>
<td>TAMcale5019</td>
<td>3658a</td>
<td>2034b</td>
</tr>
<tr>
<td>Thundercale</td>
<td>3103b</td>
<td>2597a</td>
</tr>
</tbody>
</table>

† Means within a column followed by the same letter do not differ at $P \leq 0.05$.

#### Table 3. Two-year average yield of triticale cultivars/line at Iowa Park, TX.

<table>
<thead>
<tr>
<th>Cultivar/line</th>
<th>Forage yield</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg ha$^{-1}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NF201</td>
<td>2124a†</td>
<td>226a</td>
<td>5188b</td>
<td>9576a</td>
<td></td>
</tr>
<tr>
<td>NF96213</td>
<td>1746b</td>
<td>1985ab</td>
<td>5148b</td>
<td>8879b</td>
<td></td>
</tr>
<tr>
<td>TAMcale5019</td>
<td>1695b</td>
<td>1878b</td>
<td>5688a</td>
<td>9261ab</td>
<td></td>
</tr>
</tbody>
</table>

† Means within a column followed by the same letter do not differ at $P \leq 0.05$.

#### Table 4. Forage yield of triticale entries in evaluation trials at Overton, TX, during the 2009–2010 growing season, as well as the average of three seasons of production (data obtained from Nelson, 2011).

<table>
<thead>
<tr>
<th>Entry</th>
<th>Harvest dates</th>
<th>Forage yield</th>
<th>Total</th>
<th>Three-season avg. total yield†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>kg ha$^{-1}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NF201</td>
<td>1118a‡</td>
<td>2653a</td>
<td>3070a</td>
<td>6841a</td>
</tr>
<tr>
<td>TAMcale5019</td>
<td>195b</td>
<td>2874a</td>
<td>3433a</td>
<td>6502a</td>
</tr>
<tr>
<td>TAMcale6331</td>
<td>507b</td>
<td>2246a</td>
<td>3171a</td>
<td>5949a</td>
</tr>
</tbody>
</table>


‡ Means within a column followed by the same letter do not differ at $P \leq 0.05$.
References