CULTIVAR

Registration of ‘N8101’ Small-Seeded Soybean


ABSTRACT

‘N8101’ soybean [Glycine max (L.) Merr.] (Reg. No. CV-498, PI 654355) was cooperatively developed and released by the USDA-ARS and the North Carolina Agricultural Research Service in February 2008 as a small-seeded Maturity Group VIII conventional cultivar. N8101 is the first publicly released small-seeded soybean cultivar in its maturity group and has potential use in the Japanese soyfoods market. It was derived from the cross of small-seeded germplasm NC114 and a small-seeded cultivar N7101. N8101 is adapted to the southeastern United States between 30 and 36° N latitude. In 22 USDA regional trials, N8101 exhibited a 100-seed weight of 7.3 g, 5.4 g less than that of control variety, ‘Prichard RR’. Yield of N8101 was approximately 92% of that produced by Prichard RR (2712 kg ha⁻¹). Over seven additional trials in North Carolina, N8101 had a 100-seed weight of 6.5 g, 1.4 g less than that of small-seeded Maturity Group VII cultivar N7103. Seed protein content was similar to that of Prichard RR, and seed carbohydrate composition was similar to that of N7103. N8101 is resistant to shattering, Soybean mosaic virus, frogeye leaf spot (Cercospora sojina Hara), and bacterial pustule (Xanthomonas campestris pv. glycines (Nakano) Dye). The reduced yield of N8101 compared with commodity-type cultivars limits its use to specialty purposes.

Methods

Parental Selection and Pedigree

N8101 originated from the cross between small-seeded germplasm NC114 and a small-seeded cultivar N7101 (Carter et al., 2003b, 2007). NC114 was a selection from NTCPR90-143 × ‘Pearl’, a small-seeded cultivar (Carter et al., 1995). NTCPR90-143 originated from the cross ‘Gasoy17’ (Baker and Harris, 1979) × ‘Vance’. The pedigree of Vance, co-released by Virginia Polytechnic Institute and State University, USDA-ARS, and North Carolina State University, is uncertain, but it was derived from the cross of ‘Exness’ (Smith and Camper, 1973) either to an unknown wild soybean (G. soja, Sien. and Zucc.) or to a small-seeded soybean plant introduction. The parents of N7101 were the small seeded types Vance and ‘Jizuka’. Jizuka (PI 561386) is a small-seeded Japanese cultivar.

Development of Breeding Line

The cross between NC114 and N7101 was made in the field at the Central Crops Research Station near Clayton, NC, in 1999, and the F₁ plants were grown at the USDA-ARS Tropical Agriculture Research Station, Isabela, PR, the following winter. Approximately 6000 F₂ plants were grown at the Central Crops Research Station in rows spaced 97 cm apart and harvested in bulk in 2000 (approximately 20 kg). The F₃ seed were sieved with a 40-mm (10/64-inch) diameter round-hole screen. Those seed that passed through were kept and inspected for seed appearance. Approximately 300 F₃ seed were retained and grown at Clayton in 2001.

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Abbreviations: CP, coefficient of parentage; HPLC, high-performance liquid chromatography; OVT, Official Variety Testing; RR, Roundup Ready; USB, United Soybean Board.
Individual F$_3$ plants were harvested and rated for 100-seed weight and appearance. Four individual plants were retained and grown in progeny rows in 2002. One of the progeny rows, N8101, was identified as a promising breeding line and tested subsequently under the experimental designation of NTC02AXB-717.

**Breeding Line Evaluation**

**Yield Trials**

In 2003, N8101 was tested against commodity genotypes and 14 small-seeded breeding lines (including two from the same breeding population as N8101) at Clayton, NC, and the Sandhills Research Station near Jackson Springs, NC. N8101 had the lowest 100-seed weight of any breeding line ever tested in the USDA breeding program in North Carolina, a yield near the commodity check, and a uniform seed and plant appearance. In 2004, N8101 was submitted to the Maturity Group VIII Preliminary tests of the USDA Southern States Cooperative Uniform Soybean Yield Trials (Paris, 2004), the Southern Diversity Yield Trial Project sponsored by the United Soybean Board (USB), and also restested in North Carolina as a part of the USDA breeding program. Southern Diversity Yield Trial Project tests were grown near Kinston, NC, Jackson Springs, NC, and in Athens and Plains, GA. On the basis of 2004 results, N8101 was moved to the advanced testing stage of the USDA Southern States Cooperative Uniform Soybean Yield Trials in 2005 (Paris and Shelton, 2005), entered into the North Carolina Official Variety Test (OVT) Program (Bowman, 2005), and restested as part of the USDA breeding program. On the basis of the 2005 results, N8101 was restested in all these trials in 2006 and also restested in North Carolina as part of the breeding program in 2007 (Gillen and Shelton, 2006; Bowman 2006). In addition, N8101 was compared to the small-seeded control cultivar N7103 (Carter et al., 2003a) in seven North Carolina environments from 2003 through 2007 as part of the USDA breeding program.

**Plot Technique**

In the USDA Southern States Cooperative Uniform Soybean Yield Trials, field plots consisted of four-row plots in most cases. Rows were end trimmed at maturity, and the two middle rows were harvested for yield determination. Row widths varied among locations from 36 to 102 cm, with the majority planted in 76-cm-wide rows. The length of row harvested varied from 4.6 to 6.5 m. Plant populations were approximately 344,000 ha$^{-1}$. Alleys between plots were approximately 1 m in width. In the USB-sponsored Southern Diversity Yield Trials, plot technique was the same as that used in the USDA Southern States Cooperative Uniform Soybean Yield Trials.

In the North Carolina OVT program, individual plots consisted of eight rows 7.3 m in length and 19 cm between rows. Neither border rows nor end trimming were used, so that harvested plot area was approximately 11.1 m$^2$. Alleys between ranges of plots were 1.8 m in width. Plant populations were approximately 430,000 ha$^{-1}$. Because either a lack of end trimming or absence of border rows causes yield inflation in most soybean field trials (Meis et al., 2002; Heatherly and Tyler, 1998; and Boerma et al., 1976), yield estimates were reduced by 10% on all plots as a correction factor in the standard OVT protocol for data analysis.

For the USDA breeding program in North Carolina, all plots were three rows, 97 cm wide, which were end trimmed at or near maturity. Harvested plot area, the center row, was approximately 4.5 m$^2$. Plant populations were approximately 306,000 ha$^{-1}$. All plots were harvested in boustrophedonic fashion.

**Traits Evaluated**

Agronomic traits evaluated in the yield trials included maturity, lodging, plant height, seed quality, 100-seed weight, and disease reactions. In the USDA Southern States Cooperative Uniform Yield trials, seed protein and seed oil content were analyzed using near-infrared spectroscopy (American Association of Cereal Chemistry, 1999). The near-infrared analyses were performed at the National Center for Agricultural Utilization Research, USDA-ARS, Peoria, IL. In the USDA breeding program in North Carolina, swell ratio was evaluated as the ratio of seed weight after soaking the seed in water for 16 h to initial seed weight, based on a 5-g sample (Cui et al., 2004). Seed carbohydrates were evaluated in the following way. Approximately 5 g of seed were ground in a Retsch ZM 100 mill (Brinkmann Instruments, Westbury, NY) using a 1.0-mm screen and then stored at −20°C. One gram of the milled sample was dried for 36 h in a VirTis Advantage vacuum drier (VirTis, Gardiner, NY). Approximately 100 mg of ground material (the exact weight was recorded) was extracted with 15 mL of extraction buffer with constant agitation for 30 min. The extraction buffer consisted of methanol:chloroform:water (12:5:3) and 53.3 mg L$^{-1}$ lactose and 26.7 mg L$^{-1}$ cellulose as internal standards. The samples were centrifuged at 4100 × g, and the supernatant solution containing the soluble sugars was poured into a new tube. The volume was reduced by keeping uncapped tubes in a fume hood overnight; the extracted sugars were then dried in a vacuum oven (Fisher, Pittsburgh, PA) overnight at 37°C. The sugars were rehydrated in 2 mL of high-performance liquid chromatography (HPLC)–grade water. Fifty microliters of the sample were diluted to 2 mL with water. The dilute sample was passed through a Dionex OnGuard filter (Sunnyvale, CA), and 1 mL was collected in an HPLC autosampler vial. Soluble sugars were analyzed by HPLC as described in Pattee et al. (2000). Carbohydrates were detected with a pulsed amperometric detector.

**Statistical Analysis**

Seed yield and other agronomic traits were evaluated in the field with a randomized complete block experimental design. For yield, replication number within an individual test was two in 2004 and three thereafter for USDA regional trials, five for the North Carolina OVT Program, four for the Southern Diversity Yield Trial Project, and three or four for the USDA breeding program in North Carolina, depending on year and location. For the USDA regional trials, agronomic data other than yield were usually taken on only one replication within individual trials. For the other trials, data were collected on all replications.
Analysis of variance was completed using SAS (SAS Institute, 2007). Within any individual year, location and replication were considered random effects and genotypes fixed. Fischer’s protected LSD was used for comparisons of genotypes over locations using the genotype x location mean square as the error estimate. Assessment of N8101 across years was more difficult because entries changed from year to year in all regional, state, and local yield trials. We identified entries (e.g., control cultivars and promising new breeding lines) that were common over years in yield trials and performed an analysis of variance on this subset of the original data. Genotypic means from each individual test were used in the analysis. The LSD was constructed from the genotype x environment error term and employed only when the overall F-test genotypic effects was significant (p < 0.05).

The analysis over years described here is commonly used in breeding programs and registration manuscripts. However, Piepho and Mohring (2006) pointed out the dangers in pooling test data across years when the test population is truncated annually based on yield results. When only the selected genotypes (i.e., winners) from each year are included in the following year of yield trials, random positive errors may accumulate in data and impact the analysis, simply because positive errors contribute to the likelihood that a genotype will be selected. Despite this concern, their empirical analysis of yield-trial data sets indicated that this effect may not be great. In the case of N8101, the genotype was selected early in the breeding process for small seed with the expectation that it would be lower yielding than commodity-type cultivars. Subsequent regional yield trials were used to describe the agronomic qualities of the genotype rather than choosing among many types to identify the best. Thus, the main concerns raised by Piepho and Mohring (2006) may not apply in the present case. Further, when the number of test locations and years is large, as with the present study, we speculate that the bias effect should be small.

**Seed Purification and Increase**

Seed purification of N8101 began in 2004 and continued through 2007. Plants and seed from 2003 (F3:6) test plots were rogued to remove visible contamination and then planted in an increase block consisting of six rows of 30.4 m length and 96.5 cm row spacing at Jackson Springs, NC. The increase block was rogued at flowering and maturity to eliminate off-type plants. Outside rows served as borders and were not harvested for seed increase. Before harvest, the plot combine was cleaned with a gas-powered leaf blower to eliminate extraneous seed. In addition, the first 3 kg of seed harvested from the increase were discarded in an effort to further reduce the possibility of contamination from hidden seed within the combine. This practice was followed each year as part of the standard protocol for increase of promising lines in the breeding program.

**Plant Characteristics**

**Agronomic and Botanical Description**

N8101 matures approximately 1 d before ‘Prichard RR’, 4 d later than ‘Cook’, and 5 d later than ‘N8001’ (Boerma et al., 1992; Carter et al., 2008). Prichard RR is a backcrossed derivative of the cultivar Prichard that carries resistance to glyphosate (Boerma et al., 2001). Although N8101 is an F3-derived cultivar, it has been very uniform phenotypically in tests for all traits, including 100-seed weight. N8101 has yellow seed with shiny luster and clear hilum, purple flowers, gray pubescence, determinate growth habit, tan pod wall, and narrow leaves. In USDA regional trials, N8101 was slightly more lodging resistant (p < 0.05) than Prichard RR and similar to Cook (Paris, 2004; Paris and Shelton, 2005; Gillen and Shelton, 2006), exhibiting an average lodging score of 2.1, compared with an average score of 2.5 for Prichard RR (Table 1) (1 = all plants are erect; 5 = all plants prostrate). The plant height of N8101 (81 cm) was significantly (p < 0.05) shorter than that of Cook (91 cm) or Prichard RR (97 cm) in these same trials. On the basis of observations in North Carolina, N8101 is resistant to pod dehiscence (shattering) after maturation, even when harvest is delayed extensively.

**Yield Performance**

Over 25 environments in the regional USDA Cooperative Uniform Soybean Yield Trials, N8101 yielded 8% less than the standard control cultivar Prichard RR and 14% less than Cook in a wide range of row widths under full

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Table 1. Means of agronomic traits for ‘N8101’ and soybean control cultivars in the USDA-ARS Southern Regional Uniform Soybean Test, averaged over 2004 (5 environments), 2005 (11 environments), and 2006 (9 environments). Tests were grown in two replications per environment in 2004 and three replications per environment thereafter. The LSD value was calculated using trait means from each environment, treating each environment as a replication in an RCB analysis. No glyphosate was applied to this test.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield (kg ha⁻¹)</th>
<th>Protein (g kg⁻¹)</th>
<th>Oil (%)</th>
<th>Maturity (Oct. 1 = 1)</th>
<th>Lodging</th>
<th>Height (cm)</th>
<th>Seed quality</th>
<th>Seed size (g 100 seed⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cook</td>
<td>2898</td>
<td>419</td>
<td>191</td>
<td>26</td>
<td>2.1</td>
<td>91</td>
<td>2.1</td>
<td>15.2</td>
</tr>
<tr>
<td>Prichard RR</td>
<td>2712</td>
<td>430</td>
<td>190</td>
<td>31</td>
<td>2.5</td>
<td>97</td>
<td>1.8</td>
<td>12.7</td>
</tr>
<tr>
<td>N8101</td>
<td>2482</td>
<td>433</td>
<td>171</td>
<td>30</td>
<td>2.1</td>
<td>81</td>
<td>1.5</td>
<td>7.3</td>
</tr>
<tr>
<td>LSD₀.₀₅</td>
<td>176</td>
<td>6</td>
<td>3</td>
<td>1.4</td>
<td>0.2</td>
<td>3</td>
<td>0.26</td>
<td>1.0</td>
</tr>
<tr>
<td>Environments, no.</td>
<td>25</td>
<td>19</td>
<td>19</td>
<td>16</td>
<td>22</td>
<td>25</td>
<td>14</td>
<td>22</td>
</tr>
</tbody>
</table>

¹A score of 1 indicates no lodging; 5 indicates a prostrate plant.

²Seed quality is rated on a 1 to 5 scale, where 1 is very good and 5 is very poor.
season conditions in the Southeast (Table 1). In five environments in the North Carolina OVT Program (Bowman, 2005, 2006), N8101 produced significantly lower \((p < 0.05)\) yields than did standard cultivars NC Raleigh (Burton et al., 2006) (34% less) and Cook (23% less) in narrow (19 cm) row spacings (Table 2). In four testing environments of the Southern Diversity Yield Trial Project, N8101 (2479 kg ha\(^{-1}\)) yielded significantly less \((p < 0.05)\) than Prichard RR (17% less), Cook (22% less), and N8001 (23% less) (Table 3). In seven North Carolina environments, N8101 yielded 8% less than the small seeded cultivar N7103, although the difference was not significant \((p > 0.05)\) (Table 4).

### 100-Seed Weight, Seed Composition, Seed Quality and Swell Ratio

#### 100 Seed Weight and Protein and Oil Content

N8101 exhibited very small seed in USDA regional trials, with an average 100-seed weight of 7.3 g which was significantly less \((p < 0.05)\) than that of Cook or Prichard RR (15.2 and 12.7 g, respectively) (Table 1). In seven North Carolina environments (Table 4), 100-seed weight of N8101 (6.5 g) was significantly less \((p < 0.05)\) than that of small-seeded cultivar N7103 (7.9 g). Average seed protein concentration was significantly higher and oil concentration lower \((p < 0.05)\) for N8101 (433 and 171 g kg\(^{-1}\)) compared with that of Cook (419 and 190 g kg\(^{-1}\)) on a zero percent moisture basis.

#### Table 2. Agronomic comparison of ‘N8101’ and control soybean cultivars in the North Carolina State University Official Variety Trials in 2005 and 2006, grown in narrow-row trials (19 cm between rows). Five replications were grown in each environment.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield (kg ha(^{-1}))</th>
<th>Maturity</th>
<th>Lodging</th>
<th>Height (cm)</th>
<th>Seed size (g 100 seed(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC Raleigh</td>
<td>3427</td>
<td>1.5</td>
<td>91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N7002</td>
<td>3239</td>
<td>1.3</td>
<td>98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook</td>
<td>2943</td>
<td>1.5</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N8001</td>
<td>2943</td>
<td>1.1</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N8101</td>
<td>2271</td>
<td>1.7</td>
<td>93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD(_{0.05})</td>
<td>454</td>
<td>0.7</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environments, no.</td>
<td>5</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\) A score of 1 indicates no lodging; 5 indicates a prostrate plant.


<table>
<thead>
<tr>
<th>Entry</th>
<th>Yield (kg ha(^{-1}))</th>
<th>Maturity (Oct. 1 = 1)</th>
<th>Seed size (g 100 seed(^{-1}))</th>
<th>Lodging</th>
<th>Height (cm)</th>
<th>Seed quality (^{b})</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7002</td>
<td>3407</td>
<td>36</td>
<td>13.2</td>
<td>2.3</td>
<td>86</td>
<td>2.2</td>
</tr>
<tr>
<td>N8001</td>
<td>3171</td>
<td>36</td>
<td>14.7</td>
<td>1.9</td>
<td>89</td>
<td>2.2</td>
</tr>
<tr>
<td>Cook</td>
<td>3165</td>
<td>36</td>
<td>15.5</td>
<td>2.1</td>
<td>96</td>
<td>2.6</td>
</tr>
<tr>
<td>Prichard</td>
<td>3003</td>
<td>39</td>
<td>13.3</td>
<td>2.3</td>
<td>94</td>
<td>2.2</td>
</tr>
<tr>
<td>N8101</td>
<td>2479</td>
<td>41</td>
<td>6.2</td>
<td>2.4</td>
<td>89</td>
<td>1.8</td>
</tr>
<tr>
<td>LSD(_{0.05})</td>
<td>323</td>
<td>6</td>
<td>3.1</td>
<td>1.2</td>
<td>13</td>
<td>1.6</td>
</tr>
</tbody>
</table>

\(^{a}\) A score of 1 indicates no lodging while 5 indicates a prostrate plant.

\(^{b}\) Seed quality is rated on a 1–5 scale where 1 is very good and 5 is very poor.

#### Table 4. Agronomic comparison of ‘N8101’ and ‘N7103’ soybean cultivars in seven North Carolina environments, averaged over 2003 (2 environments), 2004 (1 environment), 2005 (2 environments), 2006 (1 environment), and 2007 (1 environment). N7103 is the highest-yielding small-seed late-maturity cultivar adapted to North Carolina.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Yield (kg ha(^{-1}))</th>
<th>Maturity (Oct. 1 = 1)</th>
<th>Lodging</th>
<th>Seed size (g 100 seed(^{-1}))</th>
<th>Swell ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>N7103</td>
<td>2892</td>
<td>29</td>
<td>1.7</td>
<td>79</td>
<td>2.23</td>
</tr>
<tr>
<td>N8101</td>
<td>2657</td>
<td>34</td>
<td>2.7</td>
<td>6.5</td>
<td>2.25</td>
</tr>
<tr>
<td>LSD(_{0.05})</td>
<td>422</td>
<td>7</td>
<td>0.4</td>
<td>0.9</td>
<td>0.03</td>
</tr>
<tr>
<td>Environments, no.</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

\(^{a}\) A score of 1 indicates no lodging; 5 indicates a prostrate plant.

\(^{b}\) Swell ratio is defined as the ratio of seed weight after soaking the seed in water for 16 h to the weight of dry seed before soaking.

#### Table 1. Agronomic comparison of ‘N8101’ and ‘N7103’ soybean cultivars in seven North Carolina environments, averaged over 2003 (2 environments), 2004 (1 environment), 2005 (2 environments), 2006 (1 environment), and 2007 (1 environment). N7103 is the highest-yielding small-seed late-maturity cultivar adapted to North Carolina.

#### Sugar Content

The levels of six sugars were determined because they are potentially important to the soyfood industry. Sugars were measured in seed from increase blocks and replicated yield plots of N8101 and N7103 in 2006 and 2007 (Table 5). Sucrose levels were slightly lower in N8101 relative to N7103 and are consistent with reports that sucrose levels are positively correlated with seed size (Cicek et al., 2006). The level of inositol was slightly elevated in N8101 relative to N7103. The remaining sugars, including the antinutritional raffinose and stachyose carbohydrates, were comparable between the two small-seeded types.

#### Seed Quality

Seed quality ratings were significantly \((p < 0.05)\) better for N8101 than for Prichard RR or Cook in USDA regional trials (Table 1) and numerically superior in USB-sponsored Southern Collaborative Soybean diversity tests (Table 3). Seed quality was rated on a 1 to 5 scale, where 1 is very good and 5 is very poor.

#### Swell Ratio

The ability of the seed to imbibe water, the first step in production of natto soyfoods, was measured using the swell ratio assay (Cui et al., 2004). A larger swell ratio generally results in a softer final product, which is generally preferred by natto manufacturers. In North Carolina from 2005 to 2007 (a total of four environments), N8101 had an average swell ratio of 2.25, similar to the swell...
ratio of small-seeded cultivar N7103 (2.23) (Table 4). Thus, the swell ratio of N8101 appears acceptable for use in the Japanese natto market, although there is no uniform standard for Japanese manufacturers.

**Disease Resistance**

Results from the USDA Southern States Cooperative Uniform Soybean Yield Trials indicate that N8101 is resistant to Soybean mosaic virus but susceptible to root knot (Meloidogyne) species of nematode as well as races 2, 3, and 14 of soybean cyst (Heterodera glycines Ichinohe) nematode (Paris and Shelton, 2005; Gillen and Shelton, 2006). Although not confirmed by independent tests, N8101 appears resistant to both frogeye leaf spot (Cercospora sojina Hara), and bacterial pustule [Xanthomonas campesstris pv. glycines (Nakano) Dye]; it has never shown any symptoms for these diseases in test plots in North Carolina, even when the diseases were clearly present in the field on other genotypes (data not shown). Visual inspection of seed after harvest in North Carolina indicates that N8101 may exhibit small amounts of mottling (bleeding hilum) in some environments.

**Relation to Other Small-Seeded USDA-ARS Releases of Southern Maturity**

Several USDA-ARS small-seeded cultivars and germplasm have been released in recent years, including cultivars Vance, Pearl, N7101, N7102 (Carter et al., 1995; Carter et al. (2003b,c), and N7103, and germplasm NC114 and NC115 (Carter et al., 2007). N8101, the current release, is related to all these materials, and they are all interrelated, because the small-seeded trait originated from the cultivar Vance. Vance constitutes at least half the ancestry of each release above. Vance was developed by Glenn Buss at Virginia Polytechnic Institute and State University and then cotested and coreleased with USDA-ARS and North Carolina Agricultural Research Service in 1986. The name Vance is derived from the states involved in the release, Virginia and North Carolina. Because N8101 is likely to be a parent in further breeding efforts and is related to these releases, we calculated its coefficient of parentage (CP) with the others to better quantify breeding relationships. For breeding purposes, CP may be defined as an estimate of the proportion of the genome for which two cultivars share alleles that are identical by descent (Carter et al., 2004). The CP relation of N8101 with Vance, Pearl, N7101, N7102, N7103, NC114, and NC115 is 0.54, 0.50, 0.64, 0.39, 0.50, 0.64, and 0.46, respectively. The CP of NC114 and N7101, the parents of N8101, is 0.28. These two have a relatively low CP value between them because Jizuka appears in the pedigree of N7101 but not NC114.

Manjarrez-Sandoval et al. (1997) found reduced genetic variance for yield in populations derived from parents whose CP was about 0.25 or greater, suggesting that one can expect reduced breeding progress from mating half-sibs (which have a CP relation of 0.25) or more closely related relatives. Thus, it is unlikely that mating N8101 with its previously released relatives will lead to increased yield. If improved yield of small-seeded types is a breeding objective, a good strategy might be to mate N8101 or its relatives above to breeding stock that are less related to Vance.

**Availability**

Breeder seed of N8101 will be maintained by the Soybean and Nitrogen Fixation Unit, USDA-ARS, 3127 Ligon St., Raleigh, NC 27607. Small quantities can be obtained by request from the corresponding author. Seed of this release will be deposited in the National Plant Germplasm System, where it will be available for research purposes and for use as parental stock in the development and commercialization of new cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new breeding line or cultivar.

**Acknowledgments**

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**References**


