# Field Performance of Forty Maturity Group 4 and 5 Soybean Cultivars in a Southern Root-Knot Nematode Infested Field

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## Abstract

The susceptibility of 40 soybean cultivars to the southern root-knot nematode (*Meloidogyne incognita*) was evaluated in 4 field trials. In all trials, the damage threshold was severe, with an average population density of 234 second-stage juveniles(J2)/100 $cm^3$ of soil at harvest. Host susceptibility was based on the percent of root system galled at the R5–R6 growth stage. Cultivars were considered very resistant if the root system galled percentage was between 0.0% to 1.0%, resistant from 1.1% to 4.0%, and moderately resistant from 4.1% to 9.0%. Of the maturity group (MG) 4 Roundup Ready/Xtend® and Enlist® E3 cultivars, Delta Gro DG4940, Progeny P4431E3, Armor EN21E42, Pioneer 46A35, Delta Gro DG46E10, Pioneer P43A42X, Armor EN21E49, and Petrus Seed 49G16GT were moderately resistant. At the same time, Pioneer 45A29L-SA2P was resistant in the Liberty Link® trial. In the maturity group 5 Roundup Ready/Xtend and Enlist E3 trial, Pioneer P52A05X and Syngenta S55-Q3 were resistant, Pioneer P53A74BX, Pioneer P54A54X, Pioneer P55A49X, Progeny P5424XF, Syngenta NKS61-M2X, and Progeny P5554RX were moderately resistant. In contrast, Pioneer P52A43L-SA2P was very resistant in the Liberty Link® trial. The 3 resistant cultivars would be a preferred choice in fields with a high density of southern root-knot nematode; however, the other fourteen moderately resistant cultivars would be useful at lower nematode densities.

## Introduction

The southern root-knot nematode (RKN), *Meloidogyne incognita*, is one of the most important nematodes of soybean in Arkansas (Kirkpatrick et al., 2014).

During the 2019 cropping season, yield losses by RKN were estimated at 5.56 million bushels (Allen et al., 2020). Based on a recent survey, more than 28% of the samples collected in soybean fields in the state were infested with RKN (Kirkpatrick, 2017), which is a dramatic increase over the last survey (Robbins et al., 1987). Factors that contributed to this increase over the past 30 years include an increase in the use of earlier maturing soybean cultivars that are susceptible to RKN and their use in monoculture soybean or soybean-corn cropping systems (Kirkpatrick, 2017).

Management strategies for root-knot nematodes include an integrated approach that utilizes resistant cultivars, crop rotation, and nematicides. Since 2006, the availability of seed-treated nematicides has increased; however, this delivery system is most effective at low nematode population densities or when paired with host plant resistance at higher population densities. Crop rotation can be an effective tool when poor hosts, such as some grain sorghum hybrids or peanuts, are used in a cropping sequence; however, these crops may not fit all production systems. Using resistant soybean cultivars is the most economical and effective strategy for managing RKN (Kirkpatrick et al., 2014). Unfortunately, resistance is limited in the most common maturity groups (MG 4) grown in the state (Emerson et al. 2020) and further limited among new herbicide technology traits for soybean.

Screening soybean cultivars for susceptibility to root-knot nematode is one of the services provided by the University of Arkansas System Division of Agriculture Cooperative Extension Service (CES) and only provides information on those cultivars that are entered into the Official Variety Testing Program (OVT). The objective of this study was to expand on the RKN susceptibility and yield response of a few MG 4 and 5 cultivars that are marketed as resistant or identified as resistant from the OVT.

## Procedures

Forty soybean cultivars were evaluated in a field naturally infested with Meloidogyne incognita near Kerr, Ark. The cultivars were among what each company considered to be resistant in the most common MG 4 and 5s grown in the state (Tables 1–4). The experiments were divided between MG and herbicide technologies [glyphosate-tolerant (Roundup Ready® 2 Yield), glufosinate-tolerant (Liberty Link®), dicamba-tolerant (Xtend®), and 2,4-D-tolerant (Enlist® E3)]. Fertility, irrigation, and weed management followed recommendations by the CES. Plots consisted of 4 rows, 30 ft long, spaced 30 in. apart, separated by a 5-ft fallow alley. Plots were furrow irrigated. Seeds were planted using a Kincaid Precision Voltra Vacuum plot planter (Kincaid Equipment Manufacturing, Haven, Kan.) on 27 May 2021 at a seeding rate of 150,000 seeds/ac. The experimental design was a randomized complete block with 4 replications per cultivar. The population density of RKN at planting averaged 66 second-stage juveniles (J2)/100 $cm^3$ of soil, with a final population

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density of 234 J2/100 $cm^3$ of soil. Nematode infection was based on root galling using a 0-100 percent scale (0–1.0 = very resistant, 1.1–4.0 = resistant 4.1–9.0 = moderately resistant, 9.1–20.0 = moderately susceptible, 20.1–40.0 = susceptible, 40.1–100.0 = very susceptible) from 8 arbitrarily sampled roots/plot at R5–R6 growth stage. The 2 center rows of each plot were harvested on 19 Oct 2021 using an SPC-40 Almaco combine equipped with a Harvest Master weigh system (Harvest Master, Logan, Utah).

Data were subject to analysis of variance (ANOVA) using ARM 2021.7 (Gylling Data Management, Inc., Brookings, S.D.). When appropriate, mean separations were performed using Tukey's honestly significant difference test at $P = 0.05$.

## Results and Discussion

Of the maturity group 4 Roundup Ready/Xtend and Enlist E3 cultivars, there was a wide range in susceptibility, with 2.3% to 72.5% of the root system being galled. One cultivar was resistant to the southern root-knot nematode, Pioneer 43A42X, and had a lower ($P = 0.05$) gall rating than Delta Grow DG4880, the susceptible control (Table 1); however, this cultivar had a slightly higher gall rating and was moderately resistant in the other maturity group 4 trial (Table 2). These gall ratings show there is variability in nematode populations across field trials. In addition, this resistant cultivar had an average grain yield of 61 bu./ac, which was 26 bu./ac greater than the average yield (35 bu./ac) of the susceptible cultivars. In both trials, there was a negative correlation between root system galling and yield.

Of the maturity group 5, Roundup Ready/Xtend and Enlist E3 cultivars, 2 were resistant. Susceptibility ranged from 2.6% to 59.9% of the root system being galled. Pioneer P52A05X and Syngenta S55-Q3 were resistant, and all had a lower ($P = 0.05$) gall rating than Delta Grow DG5170, the susceptible control cultivar (Table 3). These resistant cultivars' grain yield average was 69 bu./ac, which was 32 bu./ac greater than the average yield (37 bu./ac) of the susceptible cultivars. There was a significant negative correlation ($r = -0.81$, $P = 0.0001$) between galling and yield.

In the maturity group 4 and 5, Liberty Link cultivars, one was very resistant, and one was resistant. Susceptibility ranged from 0.1% to 34.7% of the root system being galled. Pioneer P52A43L was very resistant, and Pioneer P45A29L was resistant, and both had a lower ($P = 0.05$) gall rating than Delta Grow DG47E80, the susceptible control (Table 5).

The resistant cultivar grain yield average was 70 bu./ac, which was 24 bu./ac greater than the average yield (35 bu./ac) of the susceptible cultivars. There was a significant negative correlation ($r = -0.91$, $P = 0.0001$) between galling and yield. With the decrease in the availability of cultivars, this will be the last year we will have a sole Liberty Link cultivar screen.

## Practical Applications

The southern root-knot nematode is an important yield-limiting pathogen affecting soybean production worldwide. These data provide information on cultivars' susceptibility to the southern root-knot nematode and its impact on susceptible soybean cultivars. Cultivar selection should be based on at least two years of screening as there is variation in galling and yield between seasons.

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**Table 1. Root gall ratings and yield from 11 Roundup Ready/Xtend® and Enlist® E3 maturity group 4 soybean cultivars grown in a southern root-knot nematode (*Meloidogyne incognita*) infested field near Kerr, Ark.**

| Cultivar | Root system galled[†] | Susceptibility[‡] | Yield[§] |
|---|---|---|---|
| | % | | bu./ac |
| Pioneer P43A42X | 2.3 d[¶] | R | 59.2 a |
| Agri Gold G4881E3 | 12.9 a-d | MS | 57.2 a |
| Armor EN21E49 | 8.7 bcd | MR | 54.4 a |
| Petrus Seed 4916GT | 6.3 cd | MR | 52.8 a |
| Progeny P4444RKS | 14.6 a-d | MS | 50.8 ab |
| Dyna Gro S48X40 | 18.3 abc | MS | 50.2 ab |
| Syngenta NKS44-2E3 | 20.3 abc | S | 49.1 ab |
| Delta Grow DG48E28 | 21.0 abc | S | 48.2 ab |
| Syngenta NKS45-J3X | 42.2 a | VS | 47.2 ab |
| Syngenta S46-E3S | 20.1 abc | S | 45.1 ab |
| Delta Grow DG47E80 | 41.7 a | VS | 36.5 bc |
| Armor EX4121X | 35.8 ab | S | 28.6 c |
| Delta Grow DG4880 (Susceptible Check) | 44.7 a | VS | 28.2 c |

[†] Root gall rating severity was based on a percent scale where 0 = no galling and 100 = 100% of root system galled.

[‡] Susceptibility based on percent of root system galled where 0–1.0 = very resistant (VR); 1.1–4.0 = resistant (R); 4.1–9.0 = moderately resistant (MR); 9.1–20.0 = moderately susceptible (MS); 20.1–40.0 = susceptible (S); 40.1%–100.0 = very susceptible (VS).

[§] Adjusted to 13% moisture.

[¶] Numbers within the same column followed by the same letter are not significantly different ($P$ = 0.05) according to Tukey's honestly significant difference test.

**Table 2. Root gall ratings and yield from 10 Roundup Ready/Xtend® and Enlist® E3 maturity group 4 soybean cultivars grown in a southern root-knot nematode (*Meloidogyne incognita*) infested field near Kerr, Ark.**

| Cultivar | Root system galled[†] | Susceptibility[‡] | Yield[§] |
|---|---|---|---|
| | % | | bu./ac |
| Pioneer P43A42X | 5.9 d | MR | 53.7 a |
| Delta Grow DG4940 | 4.6 d[¶] | MR | 63.2 a |
| Progeny P4431E3 | 5.0 d | MR | 63.2 a |
| Armor EN21E42 | 6.1 d | MR | 60.1 ab |
| Pioneer P46A35X | 5.4 d | MR | 60.0 ab |
| Delta Grow DG46E10 | 5.4 d | MR | 59.9 ab |
| Delta Grow DG49E90 | 13.5 cd | MS | 59.0 ab |
| Local Seed LS 4506XS | 28.1 bc | S | 50.3 b |
| Northup King NKS48-2E3S | 43.3 ab | VS | 27.2 c |
| Delta Grow DG4880 (Susceptible Check) | 56.8 ab | VS | 21.8 c |
| Armor EX4821X | 72.5 a | VS | 21.7 c |
| Armor EN4221X | 63.8 a | VS | 19.1 c |

[†] Root gall rating severity was based on a percent scale where 0 = no galling and 100 = 100% of root system galled.

[‡] Susceptibility based on percent of root system galled where 0–1.0 = very resistant (VR); 1.1–4.0 = resistant (R); 4.1–9.0 = moderately resistant (MR); 9.1–20.0 = moderately susceptible (MS); 20.1–40.0 = susceptible (S); 40.1%–100.0 = very susceptible (VS).

[§] Adjusted to 13% moisture.

[¶] Numbers within the same column followed by the same letter are not significantly different ($P$ = 0.05) according to Tukey's honestly significant difference test.

**Table 3. Root gall ratings and yield from 11 Roundup Ready/Xtend® and Enlist® E3 maturity group 5 soybean cultivars grown in a southern root-knot nematode (*Meloidogyne incognita*) infested field near Kerr, Ark.**

| Cultivar | Root system galled [†] | Susceptibility[‡] | Yield[§] |
|---|---|---|---|
| | % | | bu./ac |
| Pioneer P53A74BX | 5.7 cd[¶] | MR | 74.8 a |
| Pioneer P52A05X | 2.6 d | R | 72.1 ab |
| Pioneer P54A54X | 6.7 cd | MR | 69.3 abc |
| Pioneer P55A49X | 8.6 cd | MR | 65.8 a-d |
| Progeny P5424XF | 7.0 cd | MR | 65.4 a-d |
| Syngenta S55-Q3 | 3.4 d | R | 65.0 a-d |
| Syngenta NKS61-M2X | 8.0 cd | MR | 63.7 a-d |
| Progeny P5604XF | 9.8 cd | MS | 62.7 a-d |
| Progeny P5554RX | 5.8 d | MR | 61.6 a-d |
| Local Seed LS 5418XFS | 13.8 bcd | MS | 59.4 bcd |
| Delta Grow DG50E10 | 10.3 cd | MS | 56.6 cd |
| Stine 50EA22 | 10.8 cd | MS | 56.6 cd |
| Syngenta S51-E3 | 21.6 abc | S | 54.6 d |
| Delta Grow 5170 (Susceptible Check) | 59.9 a | VS | 29.7 e |
| Delta Grow 5170 (Susceptible Check) | 52.7 ab | VS | 27.3 e |

[†] Root gall rating severity was based on a percent scale where 0 = no galling and 100 = 100% of root system galled.

[‡] Susceptibility based on percent of root system galled where 0–1.0 = very resistant (VR); 1.1–4.0 = resistant (R); 4.1–9.0 = moderately resistant (MR); 9.1–20.0 = moderately susceptible (MS); 20.1–40.0 = susceptible (S); 40.1%–100.0 = very susceptible (VS).

[§] Adjusted to 13% moisture.

[¶] Numbers within the same column followed by the same letter are not significantly different (*P* = 0.05) according to Tukey's honestly significant difference test.

**Table 4. Root gall ratings and yield from 3 maturity group 4 and 5 Liberty Link® and Enlist® E3 soybean cultivars grown in a southern root-knot nematode (*Meloidogyne incognita*) infested field near Kerr, Ark.**

| Cultivar | Root system galled[†] | Susceptibility[‡] | Yield[§] |
|---|---|---|---|
| | % | | bu./ac |
| Pioneer P52A43L | 0.1 b[¶] | VR | 74.1 a |
| Pioneer P45A29L | 2.8 ab | R | 65.9 a |
| Delta Grow DG47E80 (Susceptible Check) | 34.7 a | S | 46.4 b |

[†] Root gall rating severity was based on a percent scale where 0 = no galling and 100 = 100% of root system galled.

[‡] Susceptibility based on percent of root system galled where 0–1.0 = very resistant (VR); 1.1–4.0 = resistant (R); 4.1–9.0 = moderately resistant (MR); 9.1–20.0 = moderately susceptible (MS); 20.1–40.0 = susceptible (S); 40.1%–100.0 = very susceptible (VS).

[§] Adjusted to 13% moisture.

[¶] Numbers within the same column followed by the same letter are not significantly different (*P* = 0.05) according to Tukey's honestly significant difference test.