

Response of grafted glyphosate-resistant and conventional soybean plants to glyphosate

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ABSTRACT

Previous research established that grafting imparts herbicide tolerance from a glyphosate tolerant (RR) soybean rootstock to a conventional (CN) scion. However, no information is available regarding how soybean growth stage, genotype and environment affects the tolerance level expressed in the CN scion. Experiments were conducted in 2013 and 2014 to determine the effect of these variables. Three soybean growth stages (3, 6 and 10-leaf stage), graft combinations of 6 soybean genotypes (3 CN and 3 RR) and 2 temperature conditions were evaluated. Glyphosate rates used were 0.84 and 1.68 kg ae/ha. In every experiment all chimeras of CN/CN died and all RR/RR chimeras were injury free. The mean injury level of 3-leaf and 6-leaf stage chimeras was 72% while for the 10-leaf stage chimeras injury was 63% 24 days after treatment with 0.84 kg ae/ha glyphosate. When the glyphosate concentration was 1.68 kg ae/ha, the injury level of 3-leaf and 6-leaf stage chimeras was 83% and the 10-leaf stage chimera injury level was 74%. Genotype of the CN scion affected the expressed tolerance level of CN/RR chimeras; whereas, genotype of the RR rootstock had less effect. Among CN/RR genotype combinations, 352/9392 and 352/9328 were most tolerant while 5388/9392 was most susceptible. The temperature variation (day/night temperatures were 28/22°C or 24/18°C) showed no significant effect on tolerance of CN/RR, but the tolerance of 352/352 (CN/CN) to glyphosate increased when the temperature was lower.

INTRODUCTION

Grafting is commonly used to combine a hardy rootstock with a desirable scion to prevent soil-borne disease or modify scion characteristics.



Figure 1. Response of CN/CN, CN/RR and RR/RR (24 DAT 1.68 kg ae/ha) (where x/y = scion/rootstock; CN = conventional soybean, RR = glyphosate-resistant soybean) (Jiang et al. 2012) (Figure 1).

Herbicide damage to non target crops is likely to increase due to off-site movement of applications made to new herbicide-resistant crops. We propose that grafting can be used to impart increased tolerance to otherwise-sensitive specialty crops. Jiang et al. (2012) tested this concept using a model system of grafted CN and RR soybean. However, the role of plant size, genotype and temperature on the herbicide resistance level is not known. Our objective is to determine the effect of growth stage, genotype and temperature on the tolerance of grafted soybean CN/RR (conventional scion/glyphosate-resistant rootstock) plants to glyphosate.

MATERIALS AND METHODS

• *Effect of growth stage:* Plants were treated at 3, 6 and 10-leaf stage.

• *Effect of genotype:* 15 combinations were created (Table 1).

Greenhouse conditions for above studies: 27/22°C and 16/8h day/night.

• *Effect of temperature:* 5 combinations (Table 2), 2 temperature regimes (day/night 28/22 °C and 24/18 °C). Irradiance 480 μmol·m⁻²·s⁻¹ photosynthetically active radiation (PAR), 78% humidity and 15/9h photoperiod.

• *Glyphosate treatments:* 1X (0.84 kg ae/ha) and 2X (1.68 kg ae/ha).

• *Plant measurements:* Crop injury and plant shoot dry weight 24 and/or 35 days after treatment (DAT).

• *Data Analysis:* PROC GLM in SAS, LSD (0.05).

Table 1. Genotype combinations in genotype experiment.

CN/CN	CN/RR	RR/RR
352/352, 5388/5388, 5418/5418	352/9392, 5388/9392, 5418/9392, 352/9328, 5388/9328, 5418/9328; 352/9351, 5388/9351, 5418/9351	9392/9392, 9328/9328, 9351/9351

Table 2. Genotype combinations in environment experiment.

CN/CN	CN/RR	RR/RR
352/352, 5388/5388	352/59392, 5388/59392	9392/9392

RESULTS

Effect of growth stage:

CN/RR plants always showed increased tolerance to glyphosate. The largest plants (treated at 10-leaf stage) showed higher tolerance than those treated at 3-leaf and 6-leaf stages 24 days after treatment (DAT) (Figure 2).

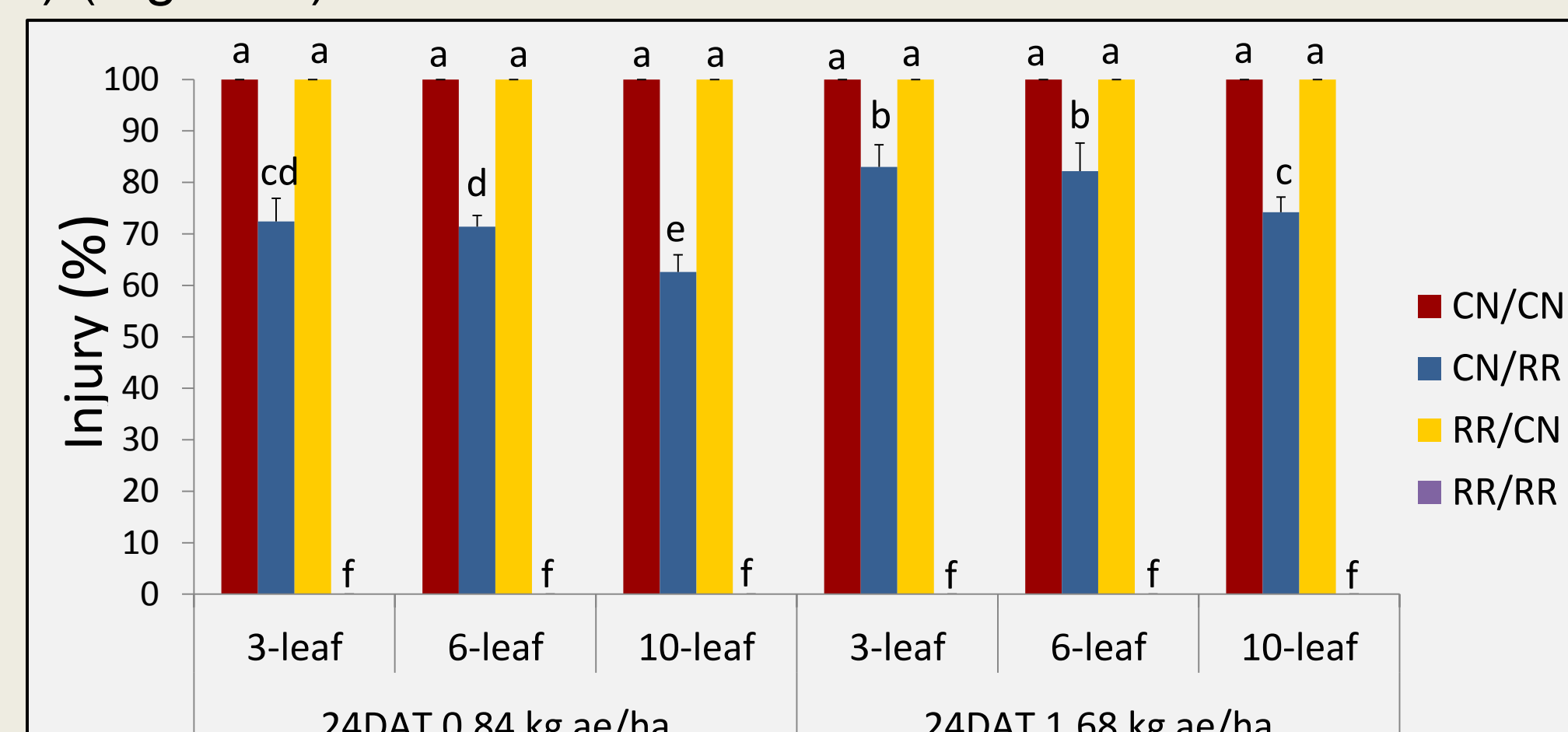
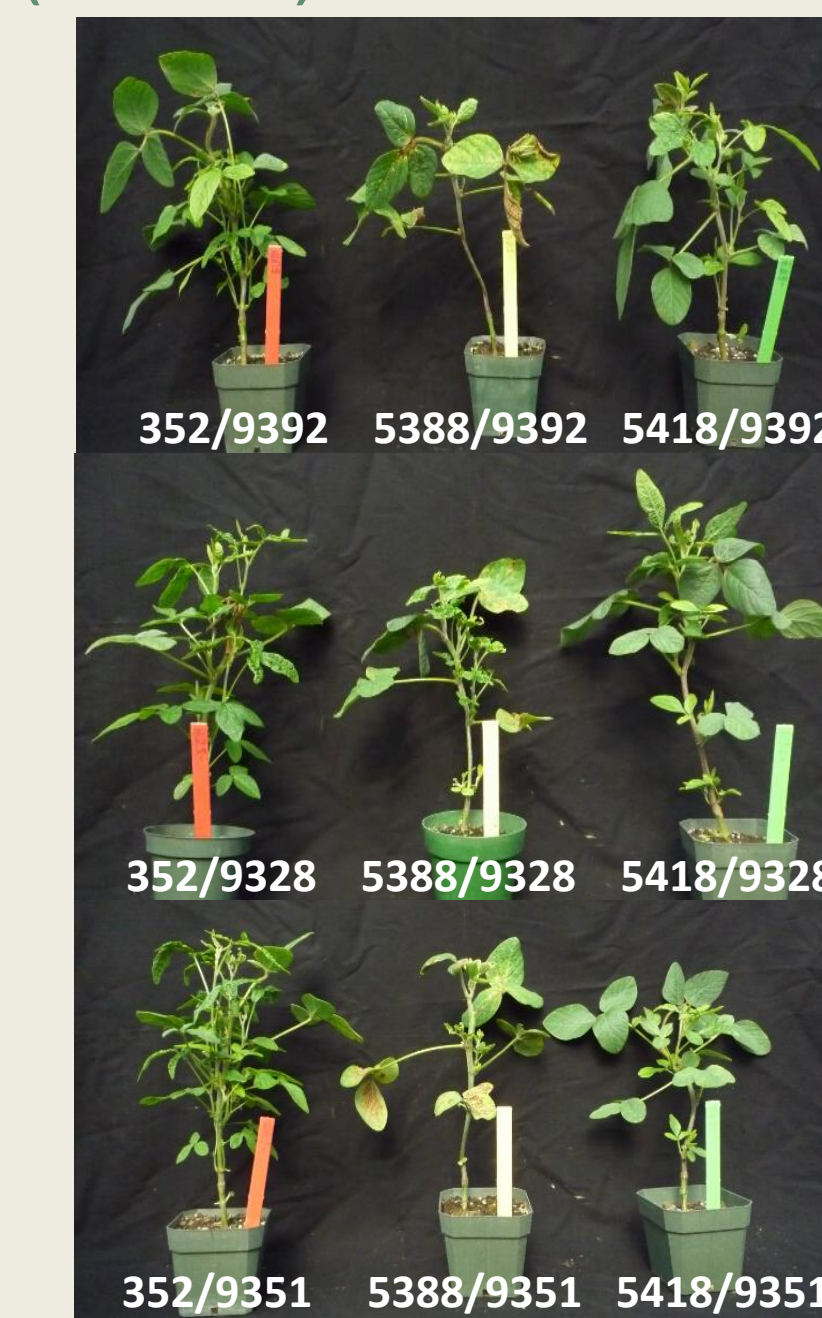


Figure 2. Injury level among different grafting combinations (CN/CN, CN/RR, RR/CN and RR/RR), growth stages (3, 6 and 10-leaf stage) and glyphosate treatment concentrations (1X and 2X).



Effect of genotype:

CN/CN died and RR/RR showed no damage after treatment (picture not shown).

CN/RR showed 50-82% injury 35 DAT. Injury level depends on genotype combination (Figure 3).

Both scion and rootstock affect tolerance. But scion has a greater influence on tolerance than rootstock.

Figure 3. Different CN/RR genotype combinations 35 DAT with the 1X concentration glyphosate.

Glyphosate-induced injury was reduced in CN/RR plants with the 352 and 5418 genotype scions relative to plants with the 5388 genotype scion. Plants with 9351 rootstock showed lower tolerance than plants with 9392 and 9328 rootstock. Grafts of 352/9392 and 352/9328 had the least injury, while 5388/9392 had the highest injury 35 DAT with 1X glyphosate (Figure 4 and 5).

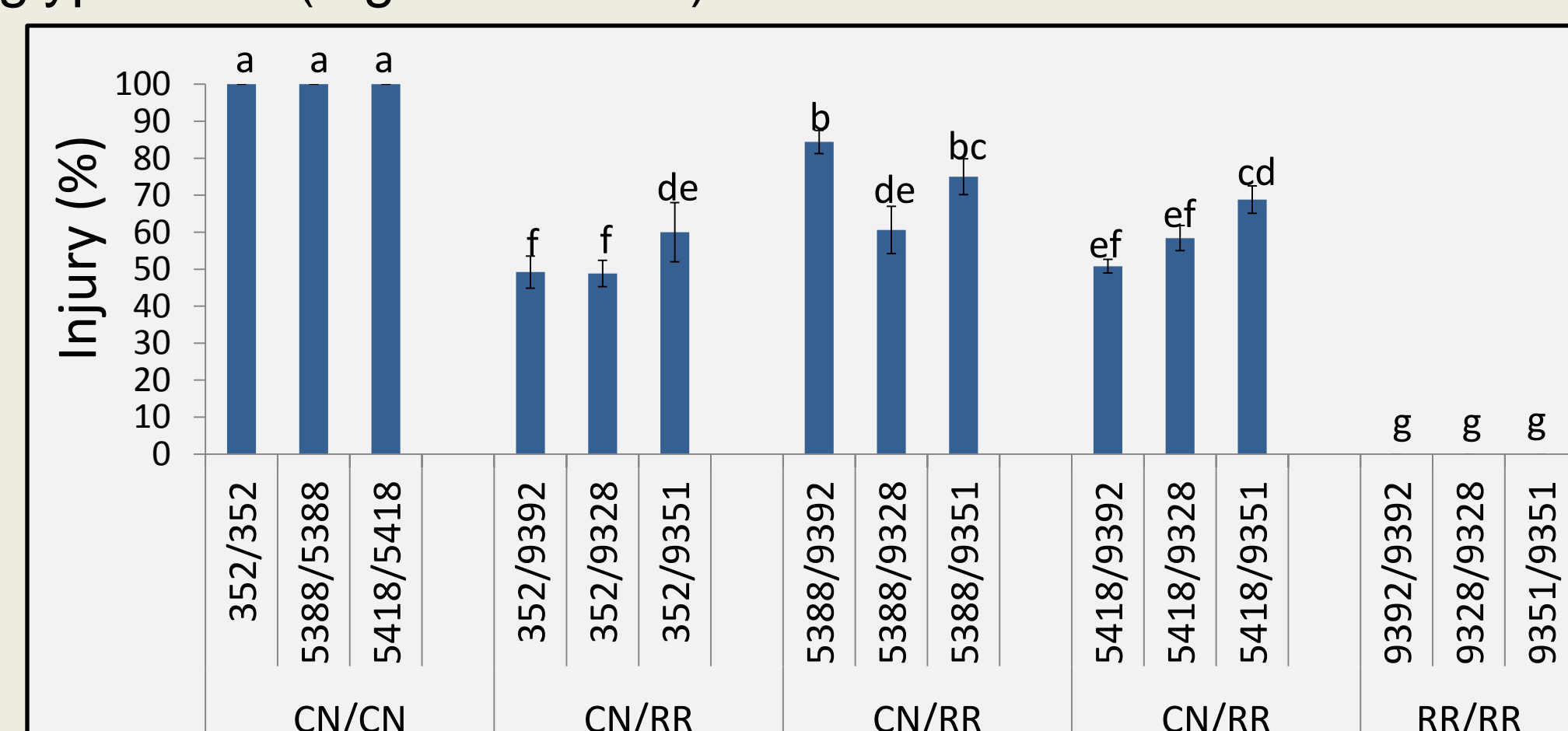


Figure 4. Percent injury of different genotype combinations 35 DAT with 1X concentration glyphosate.

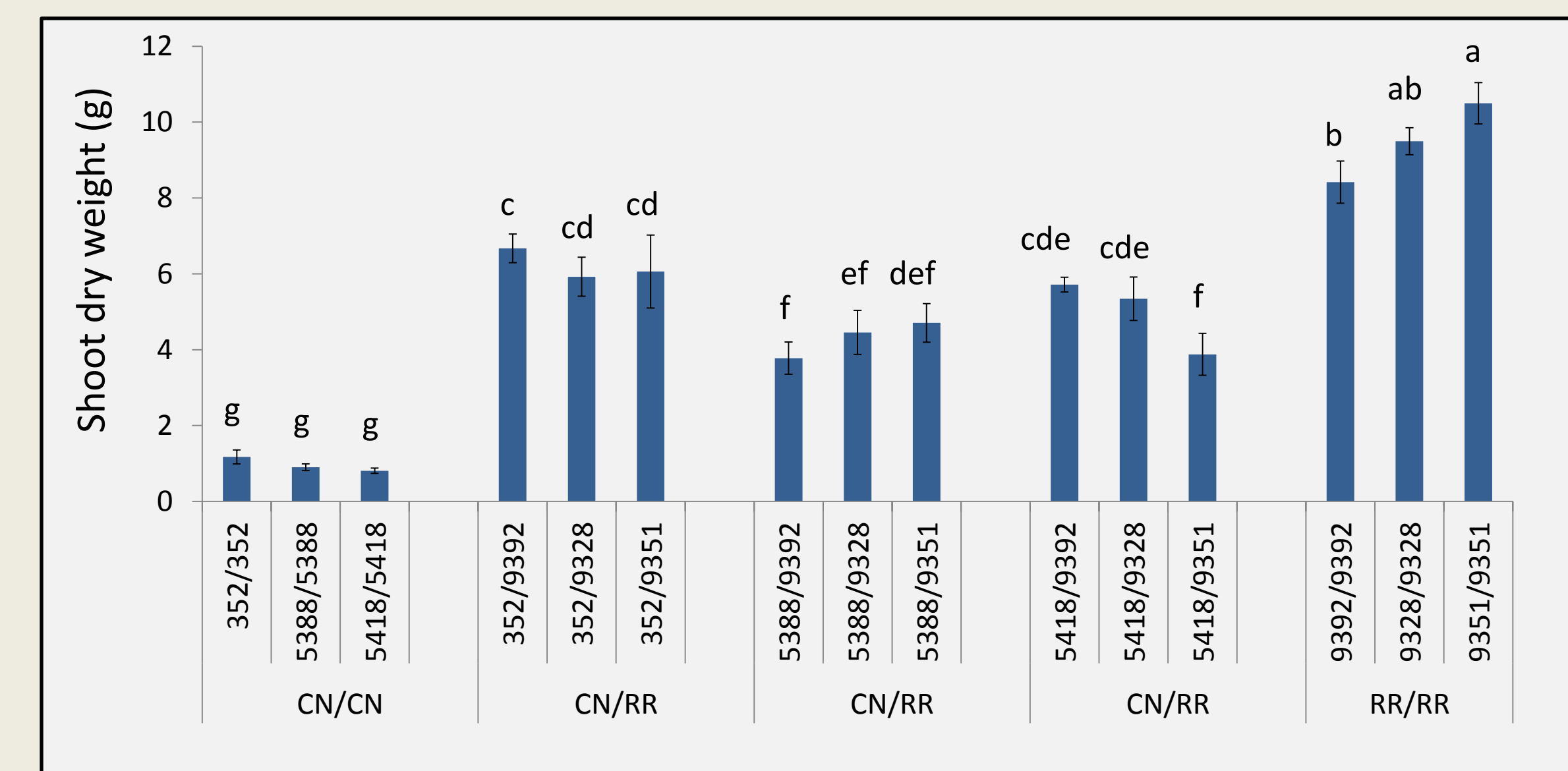


Figure 5. Shoot dry weight of different genotype combinations 35 DAT with 1X concentration of glyphosate.

Effect of temperature:

Temperature did not affect the response of 352/9392 and 5388/9392 (CN/RR) to glyphosate; whereas 352/352 (CN/CN) showed lower injury under lower temperature regime (Figure 6 and 7).

Glyphosate has greater toxicity under higher temperature. Thus, higher aromatic amino acid or glyphosate translocation rate between root and scion or higher regrowth rate may be the reason that CN/RR showed similar injury level under both temperature regimes.

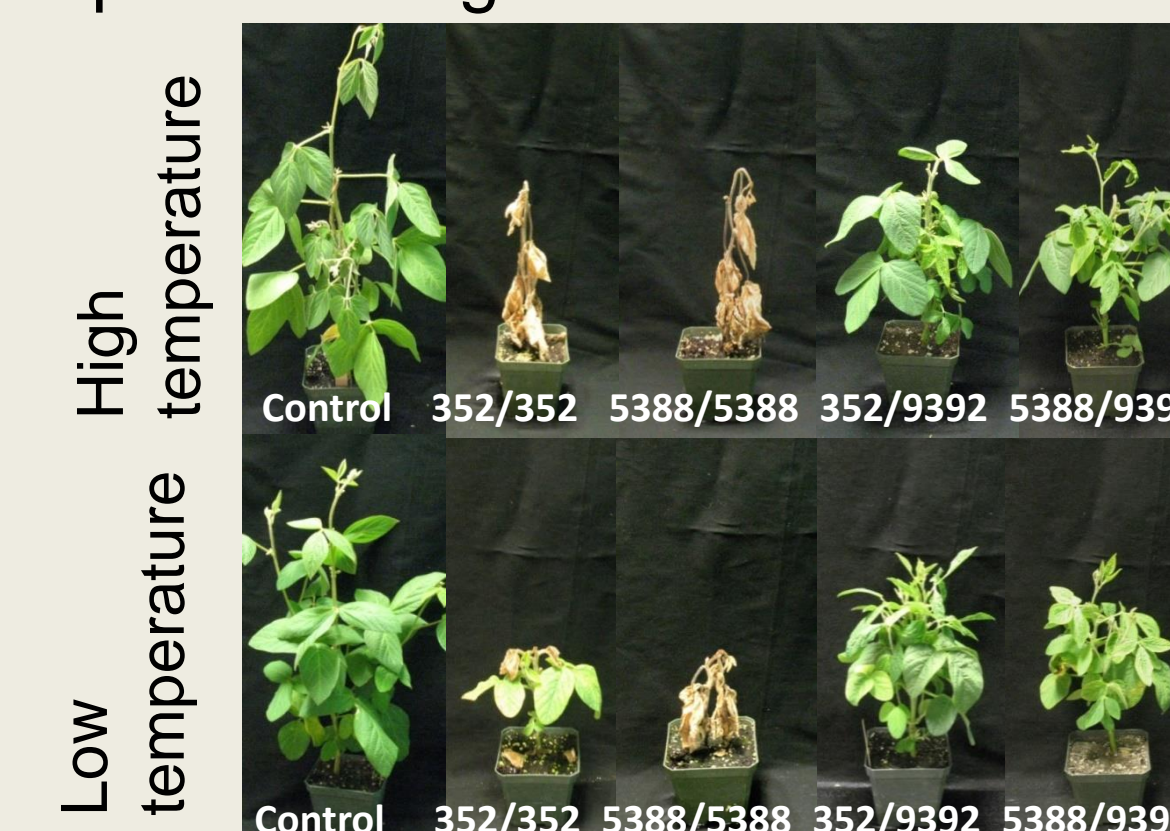


Figure 6. The response of CN/CN and CN/RR grafts to 1X glyphosate 24 DAT.

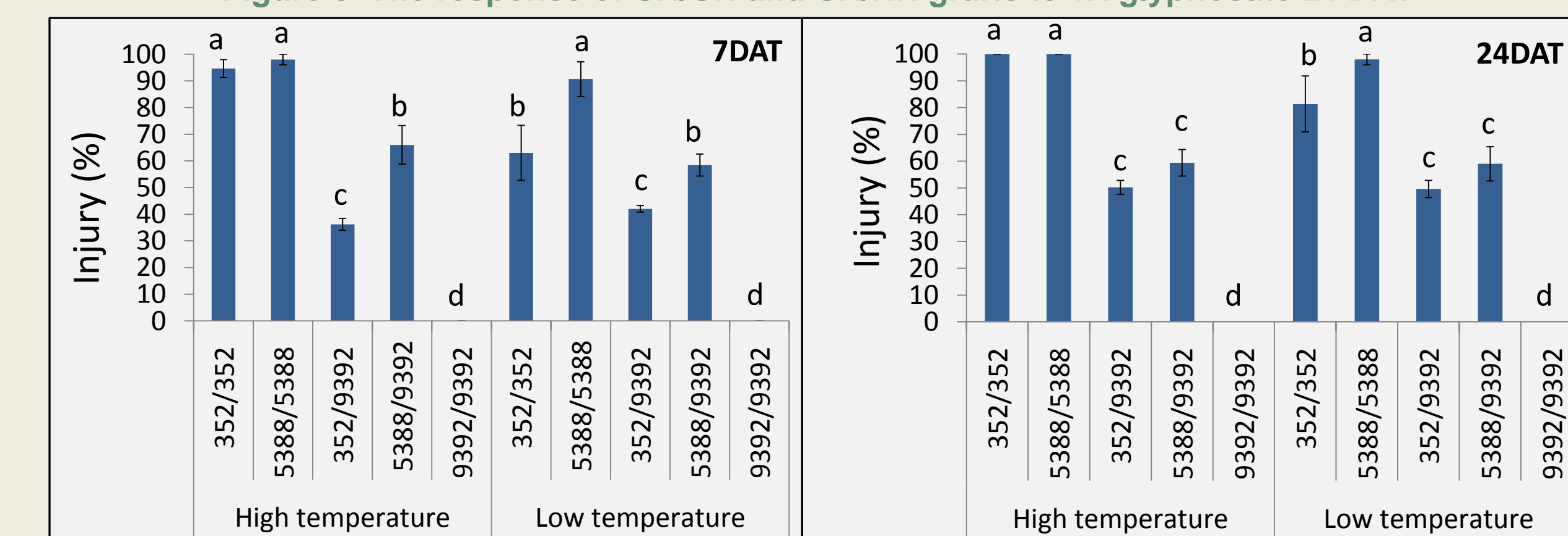


Figure 7. Response of CN/CN, CN/RR and RR/RR grafted plants 7 and 24 DAT with a 1X concentration of glyphosate.

CONCLUSIONS AND DISCUSSION

Tolerance was higher when plants were treated at the 10-leaf stage compared to 3- and 6-leaf stages.

Genotype affected CN/RR tolerance. 352/9392 and 352/9328 grafts were most tolerant, while 5388/9392 grafts were least tolerant.

Temperature did not affect the tolerance level of CN/RR combinations.

REFERENCE

Jiang, L, X Xu, Z Li, D Doohan, 2012. Grafting Imparts Glyphosate Resistance in Soybean. Weed Technology 27(2): 412-416.

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