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# Agronomic performance of RR® soybean cultivars using different pre-sowing desiccation periods and distinct post-emergence herbicides

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**The current study aims to measure the effect of pre-sowing desiccation period and verify the influence of post-emergence herbicide on soybean agronomic traits and grain yield. The experiments were carried out according to a randomized complete block design with three replications during two crop seasons (2012/13 and 2013/14), using split plot design. Five soybean cultivars were used (BRS Favorita RR®, TMG 1179 RR®, TMG 1176 RR®, Anta 82 RR®, NS 7100 RR®). Two desiccation periods were adopted 7 days before sowing and just before sowing. Two types of weed management were tested in post-emergence - using glyphosate (Roundup Ready®) and a soybean selective herbicide (Robust®). During the 2013/2014 crop season, manual weeding was also used. The evaluated traits were plant height, first pod insertion, number of pods per plant and number of seeds per pod, 1,000-grain weight and grain yield. Considering the distinct post-emergence herbicides, there was no significant difference between glyphosate and Robust®. Nevertheless, the desiccation period showed significant differences in plant height, number of pods per plant and grain yield. The soybean grain yield was higher when desiccation was done 7 days before sowing. Therefore, an association between desiccation period and soybean performance was assumed.**

**Key words:** *Glycine Max* (L.) Merril, inhibitors of the 5-enolpyruvylshikimate-3-phosphate synthase enzyme, Roundup Ready®, Robust®.

## INTRODUCTION

After the emergence of biotechnology and the transgenic development of Roundup Ready (RR®) soybean cultivars, there was an alleged gain in easing weed management in this crop. The amount of glyphosate used for weed control was already big before the release of soybean transgenic cultivars (Petter et al., 2007). After the approval of RR® soybean cultivars in Brazil, the intensity of glyphosate consumption became even higher due to the possibility of carrying out post-emergence applications.

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**Table 1.** Soil chemical properties of dystroferric Red Latosol (0-0.20 m). Lavras – MG, in the 2012/2013 and 2013/2014 crop seasons.

| Crop season | pH | $Ca^{2+}$ | $Mg^{2+}$ | $Al^{3+}$ | $H^{+}+Al^{3+}$ | SB | CEC | P | K | OM | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $H_2O$ | cmol$_c$ dm$^{-3}$ | | | | | | mg dm$^{-3}$ | | dag/kg$^{-1}$ | % |
| 2012/13 | 5.9 | 4.7 | 1.3 | 0 | 2.9 | 6.3 | 9.2 | 7.21 | 118 | 2.61 | 68.51 |
| 2013/14 | 6.4 | 5.0 | 1.4 | 0 | 2.9 | 6.7 | 9.6 | 11.46 | 118 | 3.41 | 69.82 |

H + Al: Potential acidity; SB: sumo of basis; CEC: Cation Exchange capacity (pH 7.0); OM: Organic matter content; V: Base saturation

Glyphosate is the most consumed herbicide in Brazil with approximately 250 million liters annually sold (Londres, 2011), thus accounting for 30% or more of the entire amount of active ingredients consumed in the country (AENDA 2011). It confirms the importance of this active ingredient to weed management and, consequently, to the pesticide market.

The glyphosate action mechanism is quite unique, since it is the only herbicide able to specifically inhibit the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPs) enzyme, which catalyzes the condensation of both shikimic acid and pyruvate phosphate, thus preventing the synthesis of three essential amino acids - tryptophan, phenylalanine and tyrosine (Zablotowicz and Reddy, 2004). In other words, the RR® soybean tolerance to glyphosate due to its EPSPs isoform, which is resistant to glyphosate.

However, the immoderate glyphosate use at high doses or the excessive number of applications may cause phytotoxic effects (Santos el al., 2007a) and unbalance the absorption of nutrients, water use and photosynthesis (Zablotowicz and Reddy, 2007; Albrecht et al. 2011; Serra et al., 2011). It may also be harmful to the microbial activity and to the nitrogen-fixing bacteria (Santos et al., 2007b; Zobiole et al., 2010; Serra et al., 2011; Zuffo et al., 2014).

Weed management in soybean fields has been done in three ways: just before sowing, 7 to 10 days before sowing or earlier (Oliveira Jr. et al. 2006). Reports indicate that the desiccation performed just before sowing, known as "Apply and Sow", is the most popular method among farmers, since it allows saving time and maximizing machinery use.

The current study aims to measure the effect of different pre-sowing desiccation periods using glyphosate and to verify how post-emergence herbicides affect soybean agronomic traits and grain yield.

## MATERIAL AND METHODS

The experiments were conducted during 2012/2013 and 2013/2014 crop seasons at the Federal University of Lavras, in the Center for Scientific and Technological Development in Agriculture – “Muquém” Experimental Farm (located at 21°12 ’S, 45°58 ’W and 918 m altitude), in Lavras County, Minas Gerais State, in a clayey-texture soil classified as dystroferric Red Latosol – LVdf, with the following textural values: Clay: 640 g kg$^{-1}$; Silt: 200 g kg$^{-1}$; Sand: 160 g kg$^{-1}$. The chemical composition of the soil from the experimental area is presented in Table 1.

According to Koppen classification, the local climate conditions can be classified as Cwa, with mean annual temperature of 19.3°C and normal annual rainfall of 1,530 mm (Dantas et al., 2007). Climatic data were collected at the weather station of National Institute of Meteorology (INMET) located at Federal University of Lavras-UFLA and they are shown in Figure 1. In the previous season, the experimental area was cultivated with corn. After harvesting, the area was fallowed. The area had high weed infestation before the experiment setup. Among them, *Bidens subalternans* DC., *Ipomoe anil* (L.) Roth., *Brachiaria decumbens*.

The experiments were conducted in a split plot design with three replications. The experimental plot consisted of four 5 m-long rows, the two central rows were considered to be the effective area. Two plots were taken under consideration in order to evaluate the effect from the desiccation period – the first plot, which was subjected to desiccation 7 days before sowing, and the second one, in which desiccation was performed just before sowing. The subplots were five RR® soybean cultivars (BRS Favorita RR®, TMG 1179 RR®, TMG 1176 RR®, Anta 82 RR®, NS 7100 RR®).

The effect of two post-emergence herbicides was evaluated in distinct plots: Glyphosate (1.080 g a. i. ha$^{-1}$) and Robust® (Fluazifop-P-Butil 250 g a. i. ha$^{-1}$ and Fomesafen 200 g a. i. ha$^{-1}$). The subplots were five RR® soybean cultivars. During the 2013/2014 crop season, plots under manual weeding were used as control. The crop management either before or after sowing was that recommended for our conditions, according to the crop demand.

By the time plants were ready to be harvested, plant height and first pod insertion were measured using metric ruler. In addition, 5 plants per plot were collected to determine the number of pods per plant, and the number of seeds per pod by manual counting. The 1000-grain weight was determined according to the methodology described by Brasil (1992). Seed moisture was standardized at 13% and grain yield was estimated in Kg/ha.

The results were subjected to variance analysis (ANOVA), and the means were grouped by Scott-Knott test (1974), at 5% probability. Statistical analysis was performed using the SISVAR® statistical package (Ferreira, 2011). The statistical model and analysis procedure were similar to those presented by Ramalho et al. (2012).

## RESULTS AND DISCUSSION

The results from the desiccation periods indicated that the number of pods per plant, number of seeds per pod and the 1.000-grain weight presented significant differences ($p \leq 0.01$) regarding the crop season effect (Table 2).

All the evaluated traits were significantly ($p \leq 0.01$) influenced by the cultivars (Table 2). It was expected,

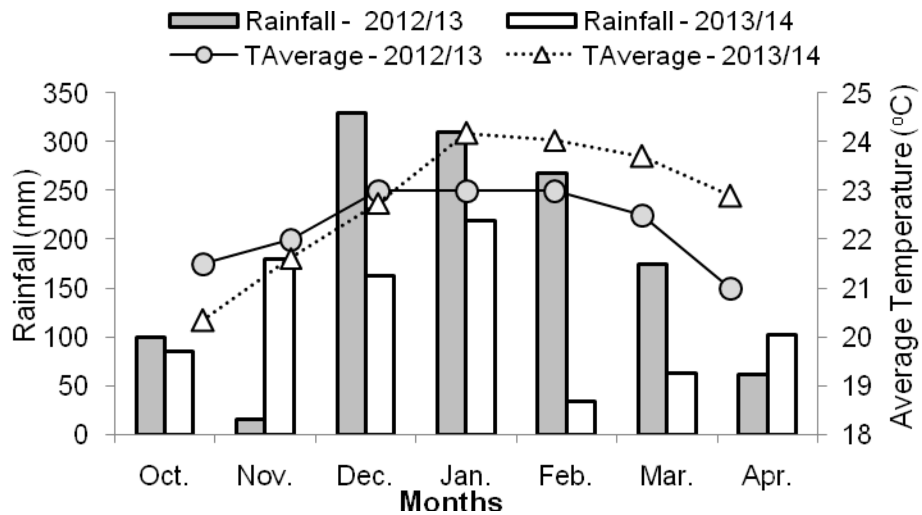


**Figure 1.** Monthly mean rainfall and mean temperature in Lavras– MG, during the 2012/2013 and 2013/2014crop seasons. Source: National Institute of Meteorology (INMET).

because cultivars have distinct genetic backgrounds, growth habits, maturity groups and other features that lead to such variation. These results corroborate those by Stulp et al. (2009) who also found differences in cultivar performances in different crop seasons.

Regarding the desiccation period, these results indicated that plant height, number of pods per plant and grain yield were significantly influenced by the desiccation method (Table 2). These results were also reported by Oliveira Jr. et al. (2006), who described the influence of glyphosate desiccation timing on soybean plant height and yield, thus reinforcing results found in the current study.

Except for the number of seeds per pod, the other agronomic traits and grain yield presented significant difference ($p \leq 0.01$) in the season x cultivar interaction (Table 2). Regarding the season x desiccation period interaction, only plant height and number of pods per plant presented significant differences ($p \leq 0.05$). As for the cultivar x desiccation period interaction, no significant difference was found in the evaluated parameters. The season x cultivars x desiccation period interaction showed significant difference in seed number per pod and grain yield; it shows that the cultivars have unequal performances regarding distinct desiccation methods and different crop seasons.

The differences in the pattern of production components among crop seasons did not affect grain yield (Table 2). The number of pods per plant was higher in the 2013/2014 crop season, and. the number of seeds per pod and the 1,000-grain weight were lower.

This fact may be attributed to the higher mean temperature observed during soybean pod formation in January and February (Figure 1). According to Castro et al. (2008), the soybean plant reaches better development in temperatures between 20 and 30°C, and the optimal temperature is approximately 30ºC. Increase in the number of pods per plant led to decrease in the amount of photoassimilates available for each pod, and consequently, to a smaller number of seeds per pod and 1,000-grain weight value.

By comparing the desiccation periods, the current study results indicated that the "Apply and Sow" method led to 10.56, 12.34 and 7.61% reduction in plant height, number of pods per plant and grain yield, respectively (Table 2). Oliveira Júnior et al. (2006) and Santos et al. (2007b) also described the negative effect caused by the "Apply and Sow" method on soybean yield. Data provided by these studies corroborated the results found in the current study.

The differences among management systems have been taken under consideration due to the shading effect caused by the weed population, which affects the growth of soybean seedlings. Therefore, Constantin et al. (2007) reported that the "Apply and Sow" system leads to grain yield decrease due to the shading effect. Thus, the current study assumes that the significant difference between desiccation periods probably due to the largest weed population found in the "Apply and Sow" method. This largest population accounts for the stronger shading effect at earlier soybean growth stages.

According to the economic point of view, grain yield is the most important production component. Therefore, a difference of 301.0 $Kg.ha^{-1}$ among yield averages was observed, thus suggesting the reductive effect of "Apply and Sow" method on the soybean yield.

The desiccation 7 days before sowing led to increase in plant height and in the number of pods per plant, in

**Table 2.** Variance and mean value analyses of plant height (PH), first pod insertion (FPI), number of pods per plant (NPP), seeds per pod (SPP), 1,000-grain weight (TGW) and grain yield (GY), by taking under consideration the study on different desiccation periods in RR® soybean cultivars during the 2012/13 and 2013/14 crop seasons, Lavras – MG.

| Source of variation | DF | ANOVA (Mean squares - MS)[1] | | | | | |
|---|---|---|---|---|---|---|---|
| | | PH | FPI | NPP | SPP | TGW | GY |
| | | cm | | unit | | g | Kg ha$^{-1}$ |
| Blocks | 2 | 437.60 | 0.074 | 12.82 | 0.029 | 0.82 | 1818849.03 |
| Seasons (A) | 1 | 55.29$^{ns}$ | 0.032$^{ns}$ | 11768.40** | 0.23** | 328.30** | 34879.93$^{ns}$ |
| Cultivars (C) | 4 | 253.37* | 141.64** | 3214.15** | 0.26** | 65.34** | 2678304.52* |
| Desiccation (D) | 1 | 1332.93* | 17.28$^{ns}$ | 1644.31* | 0.007$^{ns}$ | 0.65$^{ns}$ | 1359481.59* |
| A x C | 4 | 301.25** | 40.57** | 2026.39** | 0.17$^{ns}$ | 8.23* | 1188135.99** |
| A x D | 1 | 209.06* | 2.32$^{ns}$ | 2.68* | 0.005$^{ns}$ | 0.80$^{ns}$ | 581435.86$^{ns}$ |
| C x D | 4 | 29.09$^{ns}$ | 4.16$^{ns}$ | 413.99$^{ns}$ | 0.009$^{ns}$ | 3.06$^{ns}$ | 1199762.62$^{ns}$ |
| A x C X D | 4 | 18.77$^{ns}$ | 12.81$^{ns}$ | 711.39$^{ns}$ | 0.04* | 0.69$^{ns}$ | 1393195.62** |
| Error 1 | 2 | 122.16 | 3.53 | 68.04 | 0.01 | 10.82 | 254365.61 |
| Error 2 | 8 | 57.62 | 4.61 | 222.50 | 0.02 | 9.83 | 365315.12 |
| Error 3 | 28 | 47.12 | 10.67 | 472.50 | 0.01 | 9.68 | 270150.09 |
| Mean | | 85.3 | 13.8 | 79.5 | 2.2 | 15.0 | 3728.1 |
| CV 1 (%) | | 12.96 | 13.61 | 10.37 | 6.02 | 10.82 | 13.53 |
| CV 2 (%) | | 8.90 | 15.55 | 18.75 | 6.89 | 9.83 | 16.21 |
| CV 3 (%) | | 8.05 | 23.65 | 27.32 | 5.30 | 9.68 | 13.94 |
| Factors | | Mean values[2] | | | | | |
| **Crop season** | | | | | | | |
| 2012/13 | | 84.3$^{a}$ | 13.8$^{a}$ | 65.5$^{b}$ | 2.3$^{a}$ | 173.8$^{a}$ | 3704.0$^{a}$ |
| 2013/14 | | 86.2$^{a}$ | 13.7$^{a}$ | 93.5$^{a}$ | 2.2$^{b}$ | 127.0$^{b}$ | 3752.2$^{a}$ |
| **Herbicides** | | | | | | | |
| "Apply and Sow" | | 80.5$^{b}$ | 13.2$^{a}$ | 74.3$^{b}$ | 2.2$^{a}$ | 149.3$^{a}$ | 3577.5$^{b}$ |
| 7 days | | 90.0$^{a}$ | 14.3$^{a}$ | 84.7$^{a}$ | 2.3$^{a}$ | 151.4$^{a}$ | 3878.6$^{a}$ |
| **Cultivars** | | | | | | | |
| BRS Favorita RR® | | 80.5$^{b}$ | 14.6$^{b}$ | 99.0$^{a}$ | 2.2$^{a}$ | 184.3$^{a}$ | 3888.7$^{a}$ |
| Anta 82 RR® | | 90.6$^{a}$ | 14.0$^{b}$ | 65.2$^{b}$ | 2.2$^{a}$ | 151.4$^{b}$ | 3657.2$^{a}$ |
| NS 7100 RR® | | 81.6$^{b}$ | 10.2$^{c}$ | 63.9$^{b}$ | 2.0$^{b}$ | 147.1$^{b}$ | 2943.0$^{b}$ |
| TMG 1179 RR® | | 84.0$^{b}$ | 11.2$^{c}$ | 94.5$^{a}$ | 2.4$^{a}$ | 118.5$^{c}$ | 4031.9$^{a}$ |
| TMG 1176 RR® | | 89.6$^{a}$ | 19.0$^{a}$ | 75.1$^{b}$ | 2.3$^{a}$ | 150.5$^{b}$ | 4119.5$^{a}$ |

[1] ** and *, significant at 1 and 5% probability by F test, respectively. $^{ns}$, Non-significant; DF, degrees of freedom; CV, coefficient of variation. [2] Means followed by the same letter in columns belong to the same group by Scott Knott test (1974), at 5% probability.

comparison to the "Apply and Sow" method. Such differences appear to be related to root dry weight decrease or to nodule dry weight decrease in soybean plants when the "Apply and Sow" method is adopted, as reported by Santos et al. (2007b) who described the low development of soybean plants resulting from weakened root systems.

There was high variation range between the mean yields, from 2943 to 4120 Kg.ha$^{-1}$ in the NS 7100 RR® and TMG 1176 RR® cultivars, respectively (Table 2). However, all cultivars showed satisfactory performances, and the yield values above the average presented by this crop in the state of Minas Gerais were obtained in the 2013/2014 crop season - 2687 Kg.ha$^{-1}$ (CONAB, 2014). Generally speaking, Anta 82 RR® and NS 7100 RR® cultivars reached higher yields in the "Apply and Sow" method (Figure 2). The other cultivars and crop seasons showed a distinct pattern. Nevertheless, no significant difference was found in grain yield. This fact is probably correlated to the individual features of each cultivar and to the genotype x environment interaction. Santos et al. (2007b) recommend that the pre-sowing desiccation in soybean fields should be done at least 7 days before sowing. Thereby, the current study assumes that Anta 82 RR® and NS 7100 RR® cultivars are not affected by glyphosate application just before sowing. Except for

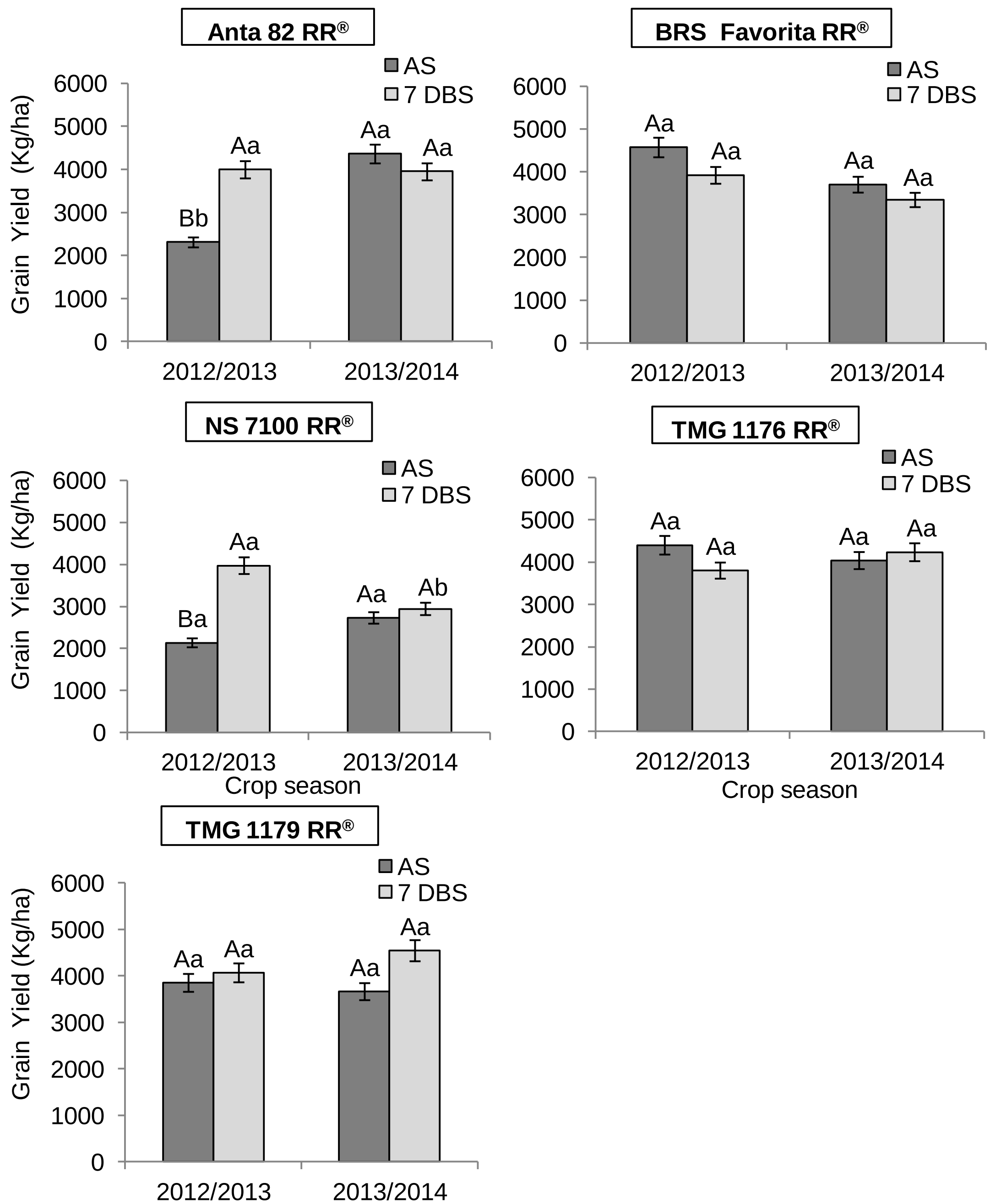


**Figure 2.** Grain yield (Kg/ha) in RR® soybean cultivars in different desiccation periods (AS, "Apply and Sow"; 7 DBS, 7 days before sowing), during the 2012/2013 and 2013/2014 crop seasons, in Lavras, MG, Brazil. Averages followed by the same capital letter in the same crop season and lower case in the same desiccation period belong to the same group according to the Scott-Knott test (1974) at 5% probability.

plant height and grain yield, the other variables were significantly ($p \leq 0.01$) influenced by crop seasons (Table 3). Regarding the different weed management systems, a significant difference was found among cultivars ($p \leq 0.01$) in all the evaluated traits, which is consistent with the genetic diversity among cultivars.

However, the different types of post-emergence weed control did not present significant differences in the evaluated traits, as well as season x herbicide interaction, cultivar x herbicide interaction and season x cultivars x herbicide interaction.

As for the season x cultivar interaction, there was

**Table 3.** Variance and mean value analyses of plant height (PH), first pod insertion (FPI), number of pods per plant (NPP), seeds per pod (SPP), 1,000-grain weight (TGW) and grain yield (GY) by taking under consideration the study on different herbicides in RR® soybean cultivars, during the 2012/13 and 2013/14 crop seasons in Lavras – MG.

| Source of Variation | DF | ANOVA (Mean Squares - MS)¹ | | | | | |
|---|---|---|---|---|---|---|---|
| | | PH | FPI | NPP | SPP | TGW | GY |
| | | cm | | unidade | | g | Kg $ha^{-1}$ |
| Blocks | 2 | 580.14 | 17.04 | 989.01 | 0.04 | 1.02 | 576326.77 |
| Seasons (A) | 1 | $91.26^{ns}$ | 76.61** | 11043.26** | 0.18* | 280.41** | $762913.86^{ns}$ |
| Cultivars (C) | 4 | 464.04** | 93.75** | 6130.34** | 0.32** | 73.93** | 5057549.21** |
| Herbicides (H) | 1 | $25.61^{ns}$ | $9.44^{ns}$ | $989.01^{ns}$ | $0.87^{ns}$ | $3.19^{ns}$ | $24485.22^{ns}$ |
| A x C | 4 | 2343.32** | 78.80** | $1281.70^{ns}$ | $0.06^{ns}$ | $4.81^{ns}$ | 2044430.98** |
| A x H | 1 | $11.97^{ns}$ | $1.23^{ns}$ | $1492.01^{ns}$ | $0.0008^{ns}$ | $0.87^{ns}$ | $863057.05^{ns}$ |
| C x H | 4 | $18.28^{ns}$ | $5.90^{ns}$ | $226.11^{ns}$ | $0.03^{ns}$ | $5.29^{ns}$ | $411709.03^{ns}$ |
| A x C X H | 4 | $63.03^{ns}$ | $6.23^{ns}$ | $417.21^{ns}$ | $0.01^{ns}$ | $0.46^{ns}$ | $49578.20^{ns}$ |
| Erro 1 | 2 | 41.20 | 3.20 | 303.36 | 0.006 | 1.67 | 30657.73 |
| Erro 2 | 8 | 38.00 | 3.75 | 426.87 | 0.021 | 1.79 | 413572.30 |
| Erro 3 | 28 | 29.44 | 6.94 | 505.37 | 0.03 | 2.31 | 459597.01 |
| Mean | | 90.0 | 14.1 | 80.5 | 2.3 | 15.9 | 3865.4 |
| CV 1 (%) | | 7.13 | 12.63 | 21.63 | 3.54 | 8.09 | 4.53 |
| CV 2 (%) | | 6.85 | 13.61 | 25.66 | 6.22 | 8.39 | 16.64 |
| CV 3 (%) | | 6.03 | 18.58 | 27.92 | 7.45 | 9.52 | 17.54 |
| Factors | | Mean values² | | | | | |
| **Crop season** | | | | | | | |
| 2012/13 | | $91.2^{a}$ | $15.3^{a}$ | $66.9^{b}$ | $2.4^{a}$ | $181.5^{a}$ | $3752.7^{a}$ |
| 2013/14 | | $88.7^{a}$ | $13.0^{b}$ | $94.0^{a}$ | $2.3^{b}$ | $138.2^{b}$ | $3978.2^{a}$ |
| **Herbicides** | | | | | | | |
| Roundup® | | $90.6^{a}$ | $14.5^{a}$ | $76.4^{a}$ | $2.3^{a}$ | $162.1^{a}$ | $3845.2^{a}$ |
| Robust® | | $89.3^{a}$ | $13.7^{a}$ | $84.5^{a}$ | $2.3^{a}$ | $157.5^{a}$ | $3885.6^{a}$ |
| **Cultivars** | | | | | | | |
| BRS Favorita RR® | | $85.7^{b}$ | $15.2^{b}$ | $111.5^{a}$ | $2.2^{b}$ | $197.6^{a}$ | $4134.2^{a}$ |
| Anta 82 RR® | | $97.2^{a}$ | $13.0^{c}$ | $55.6^{b}$ | $2.3^{b}$ | $160.1^{b}$ | $3836.4^{a}$ |
| NS 7100 RR® | | $84.4^{b}$ | $11.7^{c}$ | $63.8^{b}$ | $2.1^{b}$ | $164.3^{b}$ | $2760.7^{b}$ |
| TMG 1179 RR® | | $86.2^{b}$ | $12.3^{c}$ | $93.8^{a}$ | $2.4^{a}$ | $132.2^{c}$ | $4393.8^{a}$ |
| TMG 1176 RR® | | $96.2^{a}$ | $18.5^{a}$ | $77.6^{b}$ | $2.5^{a}$ | $144.9^{c}$ | $4201.9^{a}$ |

¹ ** and * significant at 1 and 5% probability by F test, respectively. ns, Non-significant; df, degrees of freedom; CV, coefficient of variation.² Means followed by the same letter in columns belong to the same group by Scott Knott test (1974), at 5% probability

significant difference (p≤0.01) in plant height, first pod insertion and grain yield (Table 3). These results are similar to those reported by Correa and Alves (2009). By evaluating the efficiency of herbicides applied in conventional and transgenic soybean cultivars, no significant difference was found in first pod insertion and grain yield when comparing selective herbicides, glyphosate and the mix between them.

As for the differences found among evaluated traits, it is possible to notice that the range of yield variation between TMG 1179RR® (4394 kg.$ha^{-1}$) and NS 7100 RR® (2761 kg.$ha^{-1}$) cultivars is considerably high.

In addition to grain yield, other agronomic traits, such as plant height and first pod insertion height, are extremely important and desirable to a cultivar. These features are linked to the cultivar genetic profile, and they are also influenced by environmental factors such as soil fertility, climate, crop season, humidity, among other factors (Lambert et al., 2007).

Regarding plant height, Rezende and Carvalho (2007) recommended an optimal soybean plant height to improve harvest efficiency, and described the ideal height between 60 and 120 cm. All the tested cultivars in both crop seasons reached mean plant heights consistent with the recommended optimal height.

As for the first pod insertion, the current results indicate difference of 18.56cm in TMG 1176 RR® cultivar and 1175cm in the NS 7100 RR® one. Despite the consistent

**Table 4.** Variance and average value analyses of plant height (PH), first pod insertion (FPI), number of pods per plant (NPP), seeds per pod (SPP), 1,000-grain weight (TGW) and grain yield (GY) taken under consideration of the study on different kinds of weed management in RR® soybean cultivars during the 2013/14 crop season in Lavras – MG.

| Source of variation | DF | ANOVA (Mean Squares - MS)¹ | | | | | |
|---|---|---|---|---|---|---|---|
| | | PH | FPI | NPP | SPP | TGW | GY |
| | | cm | | unidade | | g | Kg ha$^{-1}$ |
| Blocks | 2 | 1149.51 | 3.73 | 1938.73 | 0.06$^{ns}$ | 1.32 | 827761.22 |
| Cultivars (C) | 4 | 901.62** | 172.64** | 3236.00** | 0.50** | 56.94** | 4882692.59** |
| Management (M) | 2 | 0.64$^{ns}$ | 1.43$^{ns}$ | 1404.05$^{ns}$ | 0.02$^{ns}$ | 4.75$^{ns}$ | 362579.36$^{ns}$ |
| C x M | 8 | 41.33$^{ns}$ | 6.77$^{ns}$ | 619.93$^{ns}$ | 0.01$^{ns}$ | 1.90$^{ns}$ | 133496.77$^{ns}$ |
| Error 1 | 4 | 126.75 | 5.61 | 128.50 | 0.02 | 3.40 | 185959.93 |
| Error 2 | 24 | 14.37 | 3.22 | 626.36 | 0.04 | 2.67 | 213033.47 |
| Mean | | 88.7 | 13.1 | 92.0 | 2.2 | 135.7 | 3939.3 |
| CV 1 (%) | | 6.34 | 18.01 | 12.31 | 6.21 | 13.59 | 10.95 |
| CV 2 (%) | | 4.27 | 13.65 | 27.18 | 8.71 | 12.05 | 11.72 |
| Factors | | | | Mean values² | | | |
| **Management** | | | | | | | |
| Roundup® | | 88.9$^{a}$ | 13.3$^{a}$ | 85.0$^{a}$ | 2.3$^{a}$ | 141.7$^{a}$ | 3838.1$^{a}$ |
| Robust® | | 88.5$^{a}$ | 12.8$^{a}$ | 103.1$^{a}$ | 2.2$^{a}$ | 134.7$^{a}$ | 4118.3$^{a}$ |
| Capina | | 88.7$^{a}$ | 13.3$^{a}$ | 88.1$^{a}$ | 2.2$^{a}$ | 130.6$^{a}$ | 3861.6$^{a}$ |
| **Cultivars** | | | | | | | |
| BRS Favorita RR® | | 79.6$^{b}$ | 10.2$^{c}$ | 120.9$^{a}$ | 2.1$^{b}$ | 170.4$^{a}$ | 3483.0$^{b}$ |
| Anta 82 RR® | | 103.2$^{a}$ | 13.7$^{b}$ | 71.9$^{b}$ | 2.2$^{b}$ | 134.5$^{c}$ | 4476.8$^{a}$ |
| NS 7100 RR® | | 81.8$^{b}$ | 11.0$^{c}$ | 82.3$^{b}$ | 1.9$^{c}$ | 149.4$^{b}$ | 2856.9$^{c}$ |
| TMG 1179 RR® | | 84.1$^{b}$ | 10.1$^{c}$ | 99.7$^{a}$ | 2.4$^{a}$ | 109.4d | 4440.8$^{a}$ |
| TMG 1176 RR® | | 95.0$^{b}$ | 20.5$^{a}$ | 85.4$^{b}$ | 2.6$^{a}$ | 114.6d | 4439.1$^{a}$ |

¹ ** and * significant at 1 and 5% probability by F test, respectively. $^{ns}$, Non-significant; DF, degrees of freedom; CV, coefficient of variation. ² Means followed by the same letter in columns belong to the same group by Scott Knott test (1974), at 5% probability.

variation, cultivars NS 7100 RR®, Anta 82 RR® and TMG 1179 RR® could be considered to be suitable for mechanical harvesting. Even belonging to a group with lower height of first pod insertion, only the NS 7100 RR® cultivar showed lower first pod insertion values, although they were still close to the desirable ones.

Regarding the production components, it was found distinct performance among cultivars under divergent edaphoclimatic conditions, fact that was already expected due to the unequal genotypic structure and to the intense environmental influence on plant phenotype.

There were significant differences ($p \leq 0.01$) among cultivars in all evaluated traits, except for the NS 7100 RR® cultivar, which presented no significant difference in grain yield among cultivars. Furthermore, it was also found that there was no difference between the types of weed management tested in post - emergence, as well as in the season x herbicide interaction (Table 4).

Differently, Zadinello et al. (2012) reported results that do not meet those in the current study. They found 15% yield reduction as the result from herbicide application in the $R_2$ stage. Such reduction was caused by glyphosate application in post-emergence stage and it was also described by Albrecht and Ávila (2010) and by Santos et al. (2007a, 2007b).

By analyzing the averages from the evaluated traits related to post-emergence weed management, it is possible to notice that the management using manual weeding or herbicides (Roundup® or Robust®) do not affect soybean agronomic traits and yield (Table 4). It is possible to assume that these herbicides do not affect the evaluated soybean cultivars, fact that makes them suitable due to their high efficiency.

According to the herein found results, it is possible to see the relation between desiccation management and soybean agronomic performance. The desiccation 7 days before sowing appears to be responsible for higher soybean yield in comparison to the “Apply and Sow” method. It seems that the different types of post-emergence weed management (Glyphosate, Fluazifop-P-Butil and Fomesafen or manual weeding have no effect on soybean agronomic traits and grain yield.

## Conflict of Interest

The authors have not declared any conflict of interest.

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