

# Influence of preharvest herbicides on black bean desiccation, yield, and canning quality



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## Introduction

- Michigan is the top black bean producing state in the U.S., with most varieties being of Type II upright architecture, which is essential for direct harvest.
- To effectively direct harvest black beans, preharvest herbicide applications are used to provide uniform dry down by desiccating green tissue and weeds.
- Recently, the dry bean canning industry has observed a loss of 'black' color after canning, which is an important aspect for consumer acceptance.
- Several factors may influence the loss of color in the canning process of black beans and some of these factors are thought to be part of external production practices.
- Potential influences may include black bean variety selection, seasonal growing conditions, and possibly preharvest herbicide selection and/or timing of application.

## Objective

- Evaluate the effects of preharvest herbicide treatments on the desiccation, yield, and post-canning color of three black bean varieties.

## Materials and Methods

### Experiment design

- A field trial was conducted at the Saginaw Valley Research and Extension Center near Richville, MI in 2013 and 2014
- Split-split-split plot design, 4 replications
- Main plot: two planting dates
  - June 13 and 26, 2013
  - June 5 and 27, 2014
  - Different seasonal growing conditions
- Sub-plot: three Type II black bean varieties
  - 'Eclipse' - standard ND and MN grown variety (96 d maturity)
  - 'Zorro' - standard Michigan grown variety (100 d maturity)
  - 'Zenith' - new Michigan State University variety (100 d maturity)
- Sub-sub plot: application timing
- Sub-sub-sub plot: preharvest herbicide treatments

### Preharvest herbicide treatments

- Two application timings
  - Early: 50% of pods were yellow
    - Representing worst case scenario of uneven dry down within a field (not labeled)
  - Standard: 80% of pods were yellow
- Three herbicide treatments
  - Glyphosate (0.84 kg a.e. ha<sup>-1</sup>) + AMS (2% w/w)
  - Paraquat (0.56 kg ha<sup>-1</sup>) + NIS (0.25% v/v)
  - Saflufenacil (0.05 kg ha<sup>-1</sup>) + MSO (1% v/v) + AMS (2% w/w)

### Data collection and analysis

- Desiccation was evaluated 3, 7, and 14 DAT
- Beans were direct harvested, adjusted to 18% moisture, and canned using a small scale protocol
- Color after canning was assessed by a trained panel of 22 evaluators using a scale from 1 (poor) to 5 (excellent)
- Color was also evaluated by measuring luminosity (L) with a colorimeter, using a scale from 0 (black) to 100 (white)
- Data were analyzed using PROC MIXED in SAS and means were separated using Fisher's protected LSD<sub>(0.05)</sub>

## Results and Discussion

### Desiccation



Figure 1. Black bean desiccation with various treatments, 3 DAT.

- Desiccation, yield, and canning color results were similar for both planting dates, so only the first planting date will be discussed.
- All three black bean varieties responded similarly to the preharvest herbicide applications (data not shown).
- At both application timings, paraquat and saflufenacil provided the most rapid desiccation, 3 DAT (Fig. 1 and 2).
- Black bean desiccation with glyphosate was generally slower.
- Even though the preharvest herbicide treatments followed the same trends, differences in the magnitude of responses occurred between the two application timings (Fig. 2).
- In general, by 7 DAT, desiccation was greater than 95% for the early applications of paraquat and saflufenacil. However, this only occurred about 50% of the time when glyphosate was applied early to 'Zorro' and 'Zenith'.
- Early applications of saflufenacil negatively impacted yield (Table 1).
- At the standard application timing, yield was lower in 2014 with glyphosate and saflufenacil (Table 2).

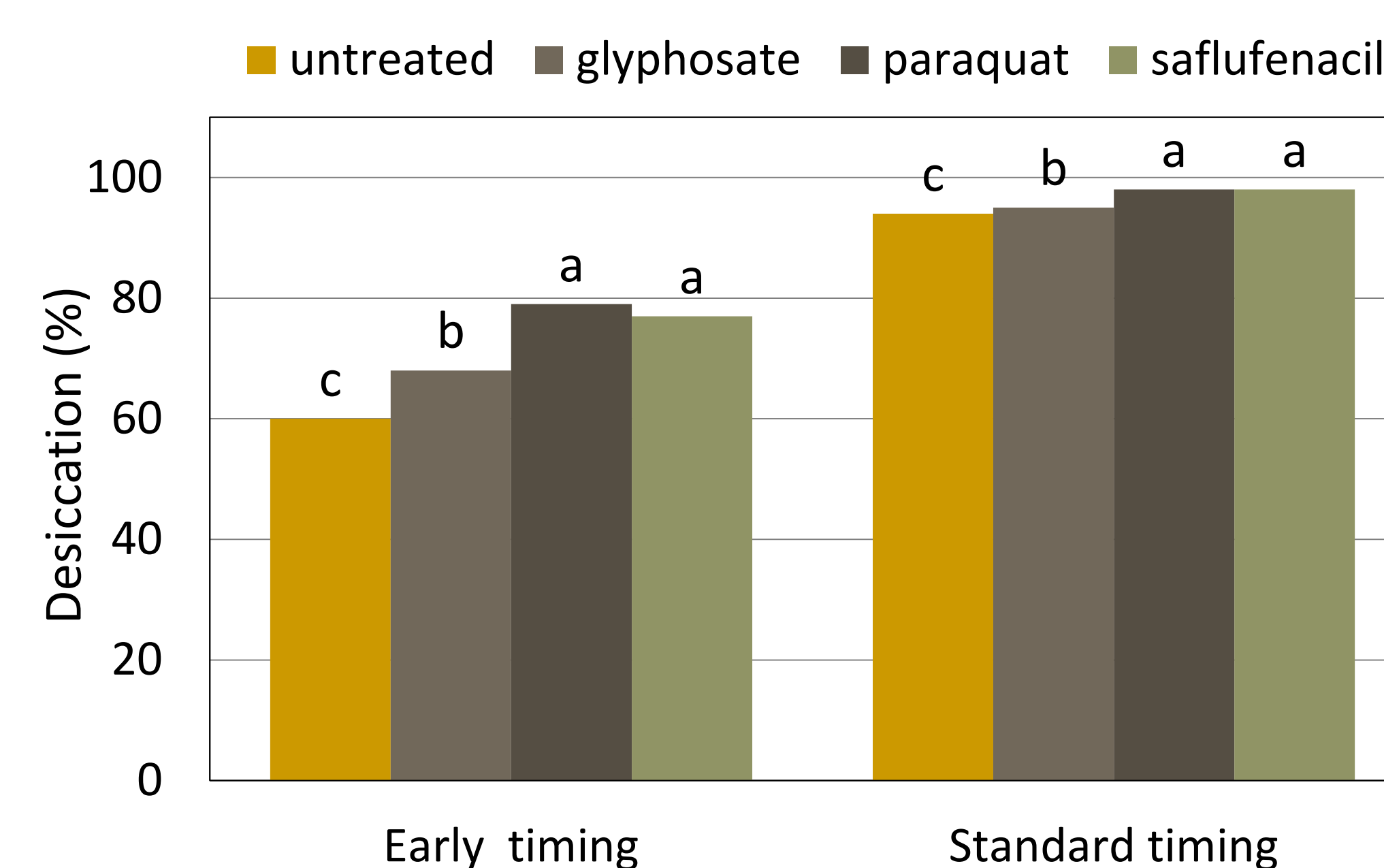


Figure 2. Main effect of preharvest treatment on black bean desiccation 3 DAT for the first planting in 2014.

### Black bean yield and canned color

Table 1. Early application timing- Black bean yield and canned color.

Main effects Treatment	Yield		Canned color	
	2013 <sup>a</sup>	2014	2013	2014
	kg ha <sup>-1</sup>		L* scale	
untreated	2650 a	2890 a	16.5 a	15.2 a
glyphosate	2620 a	2390 b	17.6 b	17.8 b
paraquat	2280 b	2290 b	17.3 b	15.5 a
saflufenacil	1990 c	1070 c	17.0 ab	15.7 a
Variety				
'Eclipse'	2240 b	2260 a	19.0 c	18.0 c
'Zorro'	2500 a	2060 b	17.6 b	16.1 b
'Zenith'	2420 a	2150 a	14.6 a	14.0 a

<sup>a</sup> A variety by treatment interaction existed, with fewer differences in yield with 'Eclipse'.

Table 2. Standard application timing- Black bean yield and canned color.

Main effects Treatment	Yield		Canned color	
	2013	2014	2013	2014
	kg ha <sup>-1</sup>		L* scale	
untreated	2630 a	3010 a	16.5 a	15.1 a
glyphosate	2670 a	2480 b	16.4 a	14.9 a
paraquat	2550 a	2860 a	16.7 a	15.2 a
saflufenacil	2670 a	2450 b	16.3 a	15.4 a
Variety				
'Eclipse'	2320 b	2740 a	19.0 c	17.2 c
'Zorro'	2750 a	2730 a	17.0 b	14.8 b
'Zenith'	2820 a	2630 a	13.4 a	13.5 a

- The main effect of black bean variety was always significant for canned color for luminosity readings and panel assessments (data not shown).
  - 'Eclipse' (lightest) < 'Zorro' < 'Zenith' (darkest) (Fig. 3).
- The main effect of preharvest treatment applied early resulted in luminosity differences (Table 1).
  - Early applications of glyphosate resulted in the greatest loss in black color after canning (Fig. 3).
  - Treatments applied at the standard timing did not affect black bean color after canning, only a variety difference was observed (Table 2).

### Canned color difference

#### Variety



'Eclipse' 'Zorro' 'Zenith'

#### Treatment



untreated glyphosate

Figure 3. Differences in black bean color after canning for an early desiccation application.

## Conclusions

- If desiccation treatments are made too early the contact herbicides, saflufenacil and paraquat, can decrease yield and early applications of glyphosate can affect black bean color after canning.
- To avoid issues with the loss of the dark color that consumers desire in canned black beans, the canning industry should work with growers on variety selection and the appropriate timing of preharvest herbicide applications and product selection.

## Acknowledgements



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COMMISSION