

## Effect of sequential treatments

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DOI 10.5073/jka.2016.455.39



Split application of one herbicide, or two in combination, can be more efficient than just one spraying with the same total dose. In this study we examined the effect of sequential treatment with the same herbicide or different herbicides on common ragweed.

### Material and methods

Plants of common ragweed were sown in 2 L pots in a potting mixture consisting of field soil, sand and peat (2:1:1 w/w) and grown in a glasshouse. Prior to herbicide application the number of plants per pot was reduced to a pre-set number.

Florasulam, mecoprop-P, mesotrione, clopyralid and glyphosate were applied as single treatments at two different timings: T1 (=2-4 leaf stage) and T2 (=2 weeks after T1). In addition sequential treatments with different combinations of the herbicides were made. Each herbicide was applied at four doses and each treatment was replicated three times. Herbicide preparations were applied using a laboratory pot sprayer equipped with a boom fitted with two Hardi ISO F110-02 flat fan nozzles using a volume rate of ca. 150 L/ha.

Three to four weeks after T2 the plants were harvested and foliage fresh and dry weights are recorded. Dose-response curves were estimated using non-linear regressions and the ED<sub>50</sub> and ED<sub>90</sub> doses for each herbicide preparation estimated.

The Additive Dose Model was used to determine whether dose-splitting was additive i.e. that one herbicide dose applied at a specific time can be replaced by an equivalent dose ratio at another time.

### Results and discussion

The experiments were analyzed using a joint-action model as dose-splitting can be considered a special case of joint action of herbicides, not as mixtures, but as staggered applications. The Additive Dose Model (ADM) which is generally accepted as the joint action reference model for mixtures of herbicides has previously been used to evaluate the efficacy of split applications. ADM implies that the ED doses of dose-splitting treatments should follow the isobole between the ED doses of the single treatments. If the calculated ED dose of a dose-splitting treatment is located above the isobole, the response to dose splitting is antagonistic and location below the isobole indicate a synergistic response (Figure 1) Most of the split treatments tested yielded a synergetic or synergetic-to-additive response. None were antagonistic (Table 1). Thus split applications with proper herbicides resulted in a higher efficacy than a single treatment, even when the total dose remained the same.

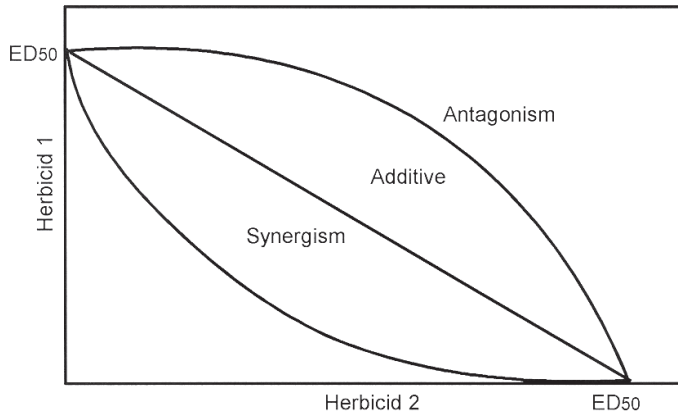


Figure 1: Schematic illustration of possible interactions between split applications according to the Additive Dose Model. The x- and y-axes represent relative doses of same or different herbicides at timing 1

Table 1. Classification of sequential treatment efficacy

Synergistic	Additive	Antagonistic
Mesotrione x 2 (T1 + T2)		
Florasulam x 2 (T1 + T2)		
MCPP x 2 (T1 + T2)		
	Florasulam (T1) + Clopyralid (T2)	
	Florasulam (T1)+ Glyphosate (T2)	
		MCPP (T1) + Clopyralid (T2)
		MCPP (T1) + Glyphosate (T2)

Split or sequential application of herbicides could be a recommendation to ensure effective control of early as well as late cohorts of germinating common ragweed on uncropped areas and in crops with low competitiveness. In these cases a low dose is applied at an early growth stage and followed up by another application when new seedlings emerge. This strategy leads to repeated application on plants that have survived the first spraying. The results show that the susceptibility of plants affected by a previous herbicide treatment is equal to or higher than the susceptibility of untreated plants.

**Conclusions**

Sequential treatments or split applications showed synergistic or additive effects. Most split applications were more effective than one single application (florasulam, MCPP and mesotrione) while treatments with florasulam or MCPP as the first application followed by clopyralid or glyphosate in the second application were additive. Consequently split applications can be used without loss of efficacy.