

## Herbicides as harvest aids

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### Introduction

The presence of weeds at the harvesting time can cause problems such slowing the speed of harvest, blocking combine operation, resulting in combining losses, losses in price and quality when the crop is sold, and even creating problems to the storage. To overcome these problems preharvest application of herbicides may be used. In colder areas of the world, a frost is a good preharvest weed treatment, but not for the tropics. Since is not possible to predict the frost, farmers can accelerate the harvest by applying herbicides to kill weeds. Technically the herbicides, in this case, can be classified as harvest aids and growth regulators: Harvest Aids - defoliation of plants, use of desiccants. Growth Regulators - Fruit ripens uniformly, uniform height, hormones.

Besides helping the harvesting process, the use of herbicides as harvesting aids can be useful in producing better quality seeds by allowing the harvesting at the most appropriate time. Herbicides help the desiccation of crops with indeterminate growth such as some soybean varieties, reduces weed populations and decreases weed seed production, and allows the use of crops as forage in temperate weather zones when planted too late to reach maturity before a killing frost. In the latter case the crop could be used to feed livestock as forage or hay rather than harvested for grain, following the restrictions applied. In general the benefits can be the following:

- Harvest earlier
- Uniformity
- Kill weeds
- Easier harvesting
- Better harvesting planning
- Better quality yield
- Decrease weed seed population

Another implication of using this process is related to tropical regions where the crop can be harvested earlier, allowing the production of another crop. This is what is happening in large areas of central Brazil where the farmers are able to harvest soybean with the help of a desiccant and to sow corn immediately afterward in no-tillage systems. The area in Brazil where desiccants are used, mainly in soybeans, are estimated of 1.3 to 2.0 ha per year. (Zeneca Brasil, 2000).

## Main crops

**Soybean:** Soybean harvest aids should be applied only after the crop has reached maturity indicated by a rapid dropping of leaves and drying of the stems. The final maturing process is so rapid that herbicides applied early enough to cause leaf drop can also reduce yields. The time of application is based on the soybean growth stage, and application must take place after soybeans reach stage R7, the physiological maturity. That means at least 50 percent of the plants have at least one pod that has reached its mature pod color. (Helsel, and Anderson, 1999)

A study conducted at the University of Illinois has determined more precisely the amount of leaves yellow with yield reduction when using desiccant. Four days interval of application can be crucial for drastic yield reduction. (Table 1).

Table 1. Relationship of stage of soybean maturity and yield reduction due to desiccation.

Date herbicide applied	Stage of soybean maturity	% yield loss
August 28	1 % of leaves yellow	31
September 2	8 % of leaves yellow	20
September 6	75 % of leaves yellow	14
September 10	50 % leaf drop	0
September 14	Mature	0

Adapted from Hager, McGlamery, and Pike, 1999.

Several herbicides can be used for chemical desiccation in soybean. Paraquat, glyphosate, sodium chlorate, diquat and dinoseb can be used. Diquat and dinoseb are used for soybean seed production.

Paraquat causes a rapid drying of green foliage, mainly under sunlight. It can be used on both, indeterminate and determinant soybean varieties. For indeterminate, when at least 65 percent of the seedpods have reached a mature brown color or when seed moisture is 30 percent or less. For determinant soybean varieties, paraquat should be applied only when (a) the beans are fully developed, (b) at least half of the leaves have dropped, and (c) the remaining leaves are yellow. (Hager, McGlamery, and Pike, 1999; Cerdeira, Cole, and Luthe, 1985)

Glyphosate may also be used, as a soybean harvest aid adapting the formulation to the transgenic crop, if is the case, applied after the soybean pods have lost all green color. Glyphosate is a systemic herbicide. It can translocate within the plant. Since is a slow acting herbicide, it does not speed up the harvest. It can also translocate to soybean seeds and should not be used for seed production. (Hager, McGlamery, and Pike)

**Corn:** 2,4-D may be used as preharvest treatments controlling certain broadleaf species.

Other option for corn is glyphosate. The moisture of the grain should be no more than 35 percent, physiologically mature (black layer).

When using for forage, several questions regarding to restrictions must be evaluated. There are several herbicides, applied as harvest aids or not, which restrict harvest options for corn as showing on the following table 2.

Table 2. Forage, feed, and grazing restrictions for corn herbicides.

Product	Restrictions
Atrazine	•Do not graze or feed forage from treated areas for 21 days following application, or illegal residues may result.
Dicamba	•Do not harvest or graze corn for dairy or beef feed prior to the ensilage (milk) stage of the crop.
Bentazon	•Do not graze treated fields for at least 12 days after last application.
Bromoxynil	•Do not cut crop for feed or graze within 30 days after application.
EPTC	•No restrictions on the label.
Paraquat	•Do not graze treated areas or feed treated forage to livestock.
Sethoxydim	•Do not apply to SR corn within 60 days of harvest of grain. Do not apply to SR corn within 45 days of harvest of corn forage/silage.
Pendimethalin	•No restrictions on label.
Glyphosate	•Do not harvest or feed treated crops for 8 weeks after application. Allow 14 days following spot treatment or selective equipment use before grazing domestic livestock.
Metribuzin (postemergence)	•May be grazed or harvested for silage or grain 60 days after treatment.
2,4-D amine or ester	•Do not forage or feed corn fodder for 7 days after application.

Adapted from Kells, 1997.

**Wheat:** Glyphosate and 2,4-D can be used as harvest aids.

Glyphosate may be applied, except for seed production, after the hard dough stage of wheat (30% or less grain moisture) and at least 7 days prior to harvest as a non-selective herbicide which will control most broadleaf and grass weeds. Wheat stubble may be grazed immediately after harvest. (Johnson, Kephart, and Kendig, 1999). 2,4-D may also be applied at the hard dough stage of wheat. 2,4-D will control most broadleaf weeds and suppress wild garlic but it will not control grasses. (Johnson, Kephart, and Kendig, 1999).

**Cotton:** Besides defoliant, hormones also can be used in cotton as harvest aids. One rule to determine when to use a defoliant on cotton is when 60% of the bolls are open. (Wright and Sprenkel, 1996).

Examples of defoliants and hormones are shown on table 3.

Table 3. Cotton harvest-aid chemical information.

Common Name	Trade Name(s)	Formulation
S,S,S-tributyl phosphorotrithioate	Folex 6EC	6.0 lb/gallon
Thidiazuron	Dropp 50WP	50% wettable powder
Dimethipin	Harvade 5F	4.9 lb/gallon
Ethephon	PrepSuper Boll Ethephon	6.0 lb/gallon
paraquat	Starfire	1.5 lb/gallon
Glyphosate	Roundup	4.0 lb/gallon

Adapted from Wright and Sprenkel, 1996.

**Other crops:** Harvest aids can be used in many other crops such as potato, sugar cane, and peanuts, among others.

**Effects on weed and crop seeds:** Desiccants have effect in reducing weed seed population. Studies to evaluate the desiccants bromoxynil, glufosinate, glyphosate, oxyfluorfen, paraquat, and sodium chlorate as desiccants in Group IV soybean, sicklepod [*Senna obtusifolia* (L.) Irwin & Barneby] and pitted morningglory (*Ipomoea lacunosa* L.) were conducted. Oxyfluorfen plus sodium chlorate, glyphosate plus sodium chlorate, and glyphosate alone reduced pitted morningglory germination 40 to 43% compared to the untreated. Glyphosate plus sodium chlorate, paraquat plus sodium chlorate, glyphosate alone, glufosinate, and oxyfluorfen reduced seedling growth of pitted morningglory (germinated from seed collected from treated plants) 29 to 61%. Oxyfluorfen plus sodium chlorate and bromoxynil plus sodium chlorate reduced sicklepod germination by 77 and 70%, respectively. Glyphosate plus sodium chlorate, bromoxynil plus sodium chlorate, oxyfluorfen, and glufosinate reduced seedling growth of sicklepod (germinated from seed of treated plants) 45 to 75%. (Bennett *et al.*, 1997).

Depending on the maturity stage crop seed quality can be reduced by desiccants mainly when using systemics such as glyphosate and 2,4-D (Cerdeira, Cole, and Luthe, 1985). It is also possible to find effects on seed protein, amino acids, and some enzymes such as lipoxygenase. (Cerdeira *et al.*, 1998).

**Main herbicides:** Glyphosate, paraquat, diquat, MSMA, sodium chlorate, and dinoseb, among others are the main herbicides utilized as harvest aids.

**Adverse effects:** On the other hand, some problems can be associated with the use of this process. Besides the possible effect on the vigor and germination of crop seeds, depending on their mode of action and also on the maturity stage of the crop seeds when the crop is treated, herbicide residues can be present in the harvested material, although this is a controversial aspect. Desiccants have restrictions concerning the use of treated fields for grazing or harvested feed for livestock.

### Conclusion

The use of herbicides as harvest aids is an important tool to the farmers, and, when done in proper way, can improve yields and seed quality, decrease weed populations, and, in some cases in the tropics, allow more than one crop in a single season.

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