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Dropleg – Application Technique for better targeted sprays in row crops

Introduction and Hints for Growers and Advisers

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Summary

The goal of the herewith presented brochure is to provide a practical introduction to the application technique with subcanopy devices (droplegs) for growers and advisers. The brochure is meant to contribute to a better and more comprehensive knowledge of the dropleg-application technique.

The brochure describes and illustrates the design and function of droplegs. A series of chapters outlines the use of droplegs in various crops such as vegetables, field crops and specialty crops. Advantages and disadvantages of the dropleg application technique are discussed. Based on applied field research with droplegs and practical experiences by contract sprayers and a range of ordinary farmers the brochure lists recommendations for the purchase and use of droplegs.

For a correct and efficient use of droplegs the brochure will need to be complemented by the help of a technical adviser who takes into account the distinct crop situation on each farm.

1 Introduction

1.1 Efficient crop protection - a key element of crop production

One of the main tasks of agriculture is the sustainable production of healthy food for humans and good feed for animals. In order to achieve economical yields of a high quality commensurate with market requirements most crops will need a well targeted and timed crop protection. Good agricultural practises (robust varieties, appropriate use of water and fertilizers, field hygiene etc.) aim at the production of healthy, well developing crops. Despite these indirect measures pests and diseases do occur to variable degrees depending on local climate and seasonal weather conditions. If unchecked pests and diseases may lead to unacceptable reductions in yield and quality. Both in organic and integrated production the grower can choose from a range of officially registered crop protection products. The educated and trained grower is responsible for the judicious and professionally correct use of the crop protection products. Crop protection products have to be dosed in accordance with the label. The time of application should be well chosen and the application should be efficient, economical and safe for the user, the consumer and the environment. Whatever equipment is used for the application of crop protection products it is a paramount goal to achieve the highest possible rate of recovery. That means that the highest possible amount of applied product should be deposited in a well distributed manner on the target areas which usually are the leaves, stems and / or the fruit of the crop. In row crops devices for sub canopy treatments, so called droplegs, can be mounted on horizontal spray booms and these devices can enhance the deposition of the applied product on the target areas. Based on a series of on farm field experiments it has been shown that droplegs can make a rewarding contribution to an efficient and economical use of crop protection products.

1.2 What are Droplegs ?

The dropleg is an complementary device to be used on conventional spray booms. The term "Dropleg" describes a device which allows for sub - canopy treatments in row-crops (Fig. 1).

Fig. 1: *Droplegs with each two pairs of deflector nozzles for the application of fungicides and insecticides in Brussels sprouts. The top nozzles on the boom remain closed.*

The commonly used standard spray technique uses nozzles on a horizontal boom which spray from **above** the crop in a basically vertical direction down into the crop (Fig. 2).

With the dropleg technique one or several nozzles are carried through the crop canopy in the space between the plant rows (Fig. 3). The type and the calibre of the nozzles on the droplegs can be chosen according to the kind of spray operation to be executed. Deflector nozzles for example can be adjusted in such a way that fungicides and insecticides can be sprayed on plant parts which are difficult to spray such as the ground facing sides of leaves and the lower parts of shoots. The dropleg can also be fitted with one wide angle deflector nozzle which points to the ground. This allows to spray herbicides below the lowest layer of leaves of the canopy with a minimal impact on the crop (e.g. in maize, sugar beets, potatoes).

The dropleg application technique has been tested in a number of vegetables including potatoes. Testing of the technique goes on in various crops and thus additional experiences are gained. What has been learnt so far and described below stands a good chance to be applicable also to further row crops so far untested.

Fig. 2: *Standard boom with flat fan nozzles which spray vertically down onto the crop canopy (carrots).*

Fig. 3: *Droplegs between the rows of a French bean crop with two deflector nozzles each. For the control of Sclerotinia/Botrytis on bush beans the nozzles on the boom remain closed.*

1.3 The development of the dropleg application technique

In Europe simple devices in principle similar to modern droplegs were used already in the midst of the 20th century in potato crops. Around 1990 the British company Benest built a modern dropleg based on an aluminium tube which was connected to a robust steel head that was screwed to the carrying boom. The device allowed lateral and backward movements of the dropleg upon contact with the plants or the ground. From 1992 to 1997 extensive experimental work was carried out in England and Scotland predominantly in potato crops. This intensive research work carried out by scientific institutes on their own premises and on farm showed that the dropleg application technique resulted in more efficient control of late blight on potatoes as compared to standard boom spraying. Due to the higher biological efficacy the overall number of spray could be reduced in many cases. Field experiments in potatoes and wheat showed also that the dropleg technique has good potential to reduce spray drift. At the beginning of the 21st century the dropleg application technique of Benest was taken over by the British company Micron Sprayers. Further experimental work which combined boom and dropleg spraying in Brussels sprouts resulted in very efficient disease and pest control and a high percentage of premium class roses.

In Switzerland the Federal Agricultural Research Stations at Wädenswil and Tänikon (today called Agroscope Switzerland) initiated experimental work with the dropleg technique of the company Micron in vegetable and field crops in 1998. On farm work showed that the British dropleg was rather heavy and prone to mechanical damage. After consultation with Micron Sprayers in the UK the Federal Research Station at Wädenswil decided that lighter and yet more flexible types of droplegs ought to be developed. The Swiss company Kuhn Agricultural Machines Ltd. proved to be a suitable partner and in a step by step process better droplegs were designed, manufactured and intensively tested. A series of field experiments with the Swiss built dropleg showed that the deposition and distribution of the crop protection products in the crop canopy of vegetables was clearly improved and so was the biological efficacy against pests and diseases. Concurrently the risk for spray drift was reduced. Results were published in English and German. A selection of references is given at the end of this document.

Based on the Swiss dropleg and encouraged by the results achieved with this technique the German based company Lechler designed a German version of the dropleg. This dropleg is mainly sold and used for the use in French beans and for sub canopy spraying of herbicides in maize. In Switzerland and in Germany droplegs are being tested in „new“ crops where the technique has not been deployed so far. Droplegs are tested for example in sugarbeets for the subcanopy application of herbicides at late growth stages. In maize droplegs are already used for the application of herbicides at late growth stages in both countries. In Switzerland a specially built long version of the dropleg is tested in maize crops at consecutive growth stages for the control of the nasty weed Yellow Nutsedge (Cyperus esculentus). Fungicide applications in rape with the dropleg in Germany have shown that this technique allows to very markedly reduce the residues of fungicides in honey because the nozzles travel through the canopy below the bulk of the rape flowers. In Switzerland a long version of the dropleg with three pairs of deflector nozzles at a low, central and high position are being tested in specialty crops (asparagus, Caucasian fir). The dropleg application technique could be further developed and tested in other crops both in Europe and overseas.

To our knowledge the dropleg application technique is currently used on a number of farms in Switzerland, Germany and the UK. The technique is mainly, but not exclusively, deployed on larger farms or by contract sprayers. Droplegs can be used in conventional and organic farming. In general the technique allows to deposit a higher percentage of the spray volume on target and a lower percentage off target than what can be achieved with the standard technique. As a result the biological efficacy is enhanced and crop protection becomes more reliable. Better targeted and more efficient use of crop protection products can contribute to a safer and more economical use of this input factor.

2 Advantages and Disandvantages of the Dropleg – Application Technique

2.1 Advantages

- Better distribution of the spray broth in the canopy and higher deposition of active ingredients on plant parts which are difficult to reach such as the lower sides of leaves and the lower parts of shoots (Fig. 4).
- Better and more reliable biological efficacy against pests and diseases, particularly if they are found on plant parts difficult to reach. For French beans, to give an example (compare with chapter 4.1.1), the biological efficacy against *Sclerotinia* sp. was raised from 40% to 80% on average of all field trials carried out in Germany and Switzerland. In Germany the number of sprays against this fungal disease could be reduced from four to two or three by deploying droplegs instead of a conventional boom. At the same time the bean yields were often increased by 10% and the quality was equal or superior. In Switzerland two sprays with droplegs usually suffice to give good control of *Sclerotinia* sp. in French beans. Even in years with difficult rainy weather conditions the disease control with droplegs was good, and the high requirements by the harvesting company were met reliably. Dropleg spraying thus allows for a more reliable production of good quality French beans.
- The dropleg-application technique can be combined with the standard boom application technique, thus combining nozzles from above the crop with nozzles inside the crop which can be advantageous for certain crops (e.g. potatoes, Brussels sprouts).
- The dose of the product can be adjusted to the growing canopy. Droplegs can help to keep crops in a healthy condition and if this is the case towards the end of the growth cycle then the number of sprays may be reduced and the withholding period can get longer. This in turn may contribute to a lower level of residues and a delayed development of resistance buildup.
- Droplegs carry their nozzles inside the canopy which helps to reduce drift by wind. The timing of the spray operation becomes more flexible.
- With droplegs herbicides can be applied sub canopy at advanced growth stages of the crop without damaging it and with a high efficacy against weeds.
- The dropleg technique can be used both in conventional and organic farming.
- Droplegs are a simple, low cost technique easy to use and maintain.

Fig. 4: *Plant diseases are often found in the lower part of a crop which remains moist and cool for longer periods (left: French Beans). Eggs, larvae and adults of insect pests are frequently found on the lower side of leaves (right: cauliflower). Droplegs allow to deposit active ingredients on such tricky plant parts with subsequent higher biological efficacy.*

2.2 Disadvantages

- Droplegs can only be used in crops which were planted or sown in rows.
- Putting droplegs on the boom before spraying and taking them off again after spraying will require 10 to 15 minutes depending on the type of dropleg and the width of the boom (Fig. 7 a-c). On farms where droplegs are frequently used it will be advantageous and time saving to leave the droplegs on the boom by using devices which can hold droplegs idle in a horizontal position (Fig. 7 d-f) or leave them permanently on a separate boom.
- If spray operations are carried out on many small plots which require frequent turning of the machine and folding and unfolding of the boom the total spray time per hectare will be higher as compared to conventional spraying without droplegs.

3 Application Technique with Droplegs

3.1 Requirements concerning the boom which carries the droplegs

Booms folding horizontally

The boom to which the droplegs are attached should unfold in a horizontal direction as shown in the sketch in green. Opening, closing and lifting of the boom can be mechanical or hydraulic (e.g. booms of the company Amazone, Berthoud, Hardi and others).

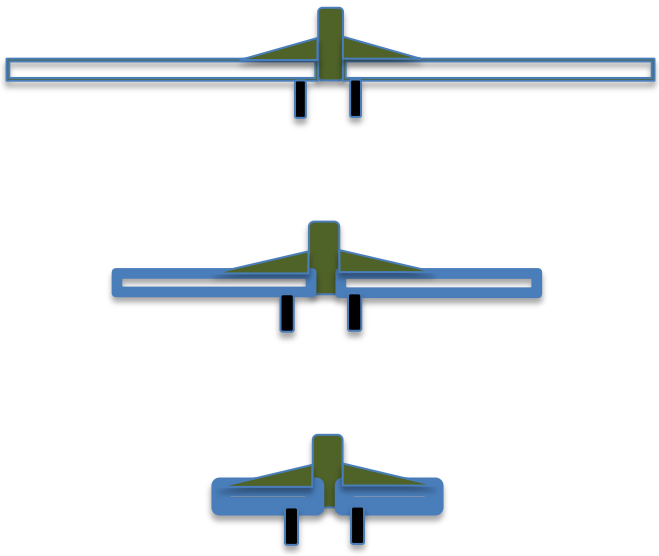


Fig. 5a: *Booms folding horizontally*

Booms folding vertically

Booms which open and close in a vertical plane and form an X when in transport position as shown in the sketch can be used as well. However it is necessary to equip them with an inexpensive device which allows to hold the inactivated droplegs in a horizontal position on the boom after folding them up manually (Fig. 7d - f).

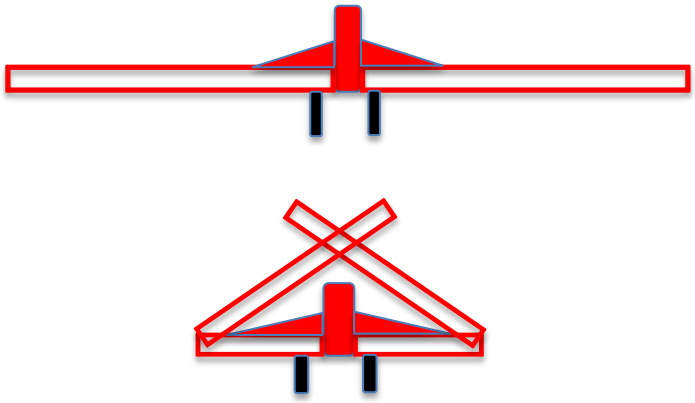


Fig. 5b: *Booms folding vertically*

3.2 Requirements regarding the droplegs

- A dropeg should be built in such a way that it can bend forward or backward in the direction of the forward travelling movement upon contact with the ground. This flexibility will protect the dropleg from being damaged upon impact on the ground due to uneven ground or imprecise boom operation.
- Droplegs must be attached to the boom in such a way that lateral movements of the dropleg tube are possible. This will allow the dropleg to meander through the crop in the interrow space without damaging the crop's canopy.
- Attaching and detaching of the droplegs to the boom should be an easy and quick process. Where droplegs are used frequently it is recommended to fit the boom with dropleg - holders (Fig. 7 d-f) and connect the droplegs to multiple nozzle outlets which can be easily turned in order to activate or deactivate the droplegs. Depending on farm conditions it may also prove advantageous to deploy the droplegs on a separate boom on which the droplegs can remain mounted permanently for the entire season.
- The whole dropleg construction should be light weight so as to put no unacceptable extra weight on the boom (Fig. 6 and 7).
- For simplicity the feeding hose of the dropleg should connect directly to the main boom's standard nozzle outlets. If nozzles on the boom and droplegs need to be activated at the same time a T-shaped coupling device can be used (see Fig. 23f). The dropleg should be operational under a pressure range of two to six bar. The addition of an extra feeder line for the droplegs should not be necessary.
- The manufacturer of a standard dropleg will usually offer a dropleg of a given length (Fig. 6 and 8) which carries one to two nozzles at its lower end. It may prove advantageous if the manufacturer can offer droplegs of a variable length and a variable number of nozzles so as to cater for the distinct needs of the various types of crops (Fig.6).

Figure 6: Example of a dropleg – construction:

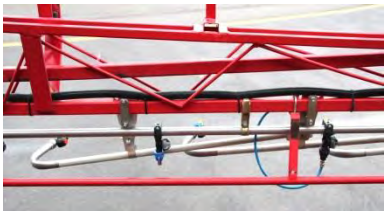
a **b** **c**

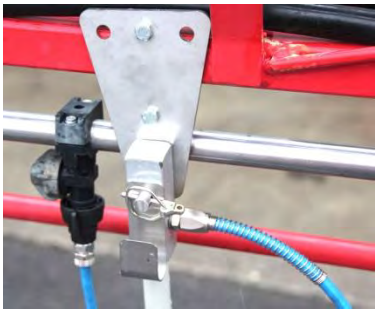
The dropleg of the Swiss company Kuhn Agricultural Machinery Ltd. Depending on the uses the dropleg carries 2, 4, or 6 nozzles and the length of the central tube can be manufactured at a length ranging from 70 to 140 cm according to the wishes of the customer. The long versions of the dropleg are suitable for tall growing row crops and the nozzles can be switched on an off to in adaptation to the actual height of the crop.

Figure 7: Fixation of the hook-up device on the boom according to the row distance of the crop

a **b** **c**

a) *with opposite plate, position on the boom variable.*
b) *screwed to the boom in a fixed position.*
c) *quick clipping on and off of the dropleg to the hook-up device.*



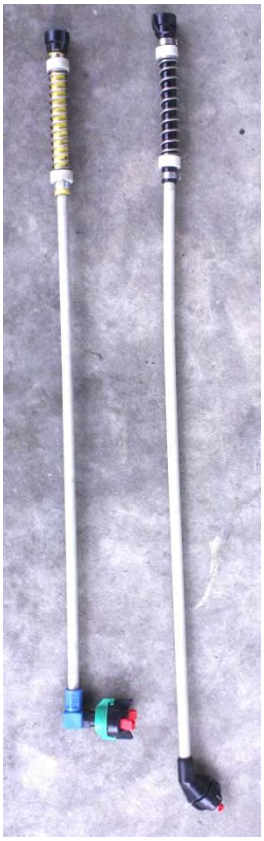


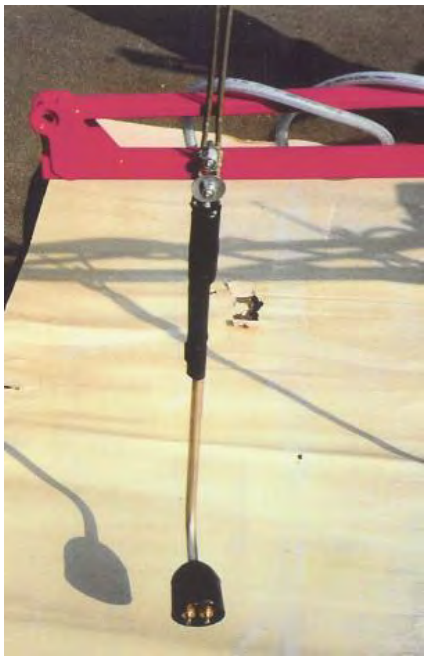
d **e** **f**

d), e), f): *simple device to hold the dropleg in a horizontal, idle position on the boom. Conveniently the dropleg should be connected to a multiple nozzle outlet on the boom for quick activating and deactivating of the dropleg.*

Figure 8: Examples of other droplegs

A selection of Swiss companies are listed at the end of this document).





a **b** **c**

a) *Dropleg[UL] of the company Lechler Ltd. (without spray head), marketed in one standard length with one or two nozzles depending on the envisaged use. (The foto was kindly supplied by the company Lechler Ltd.).*

b) *One to two nozzles on flexible tubes manufactured by the German company Agrotop. Only coupling to single nozzle holders feasible, no coupling to multiple nozzle holders. If the row distance differs from the distance between the nozzles on the boom special extensions must be used to place the nozzles between the plant rows.*

c) *Below canopy spray device of the Swiss company Fischer Ltd – Version 04.329 Bell-Shaped-Spray. (The foto was kindly supplied by the company Fischer Ltd.).*

4 The deployment of droplegs in various crops

4.1 Vegetables

4.1.1 French Beans

Fungal diseases on shoots and pods of French beans caused by Sclerotinia and Botrytis can cause total crop failure under conditions of recurring rainfall (Fig. 9). Yet even relatively modest levels of disease occurrence can lead to a complete reject of the crop at harvest time since quality requirements by the processing companies are very high. Several field trials in Switzerland and Germany have shown that the biological efficacy of two to three fungicide applications per crop were on average around 80% as compared to 40% with conventional boom spraying. On a large farm in Northern Germany the number of sprays could be reduced from 4 to 3 due to the deployment of droplegs. Concurrently yield and quality were better. In Switzerland experience by a contract sprayer shows that two well timed applications of fungicides with droplegs give very good control of fungal diseases on French beans (Fig. 10). Fig 10c shows deflector nozzles of the calibre 015, which, according to the contract sprayer tend to block up despite filters and sieves. It is recommended to use deflector nozzles of the calibre 02; (see also fig. 23e and 27a). The nozzles on the boom remain closed.

Fig. 9 Severe attack of French beans by the fungus Sclerotinia*, particularly on the lower ground facing part of the stems (right side) and beans. For an effective control of the disease it is thus important to deposit enough product on the lower part of the canopy which is readily achieved by the dropleg-application technique.*

a **b** **c**

Fig. 10: Droplegs on a 21 m Amazone boom in French Beans. a) *the boom opens and closes hydraulically.* ***b)*** *The droplegs travel about 15 cm above ground through the crop with a row distance and thus a dropleg distance of 50 cm. The forward speed is about 5 km/h and the spray volume 250 liters per hectare (pressure 2.5 - 3 bar).* ***c)*** *The deflector nozzles with a spray angle of about 95 degrees are positioned in a horizontal direction so as to spray the plant laterally from the ground level to the top.*

4.1.2 Carrots

In carrot fields and with varieties that tend to be prone to leaf damage caused by *Alternaria* sp. droplegs can help to prevent a buildup of the disease which usually starts on the older leaves close to the ground. On farm field experiments have shown a clearly higher efficacy of the applied fungicides as compared to conventional boom spraying. It is currently (2012) not known whether the dropleg technique could also improve the insecticide efficacy against the carrot fly.

a b c

Fig. 11: Droplegs on a 28 m boom in carrots. a) *the nozzles on the boom remained shut down;* ***b)*** *the droplegs can also be used in combination with the nozzles on the boom depending on the kind of diseases and pests occurring; a simple t- shaped coupling device is used in this case (compare to fig. 23f).* ***c)*** *A simple test with water sensitive paper showed that the lower parts of the crop can be sprayed effectively with droplegs.*

4.1.3 Brussels sprouts

A number of on farm field trials have shown that the dropleg application technique combined with the nozzles on the boom and the use of a spreading adjuvant results in a clearly higher efficacy of the applied fungicides and insecticides. In late summer when crops are in good healthy condition the intervals between subsequent sprays can be chosen longer and thus the total number of sprays can be reduced. It is however important to note that the package of the improved application technique be used **right from the beginning of the crop's growth cycle**.

Fig. 12: *A special version of the dropleg with two pairs of nozzles at a low and upper level (see also fig.1 and 6) is particularly useful in tall crops such as Brussels sprouts. At early crop stages the top nozzles on the dropleg are shut down. The dropleg is carried through the crop with all four nozzles travelling within the canopy thus drift due to wind is reduced very much.*

4.1.4 Cauliflower and Broccoli

In cauliflower and broccoli it is recommended to combine the nozzles (e.g. flat fan compact injector nozzles) on the boom with a dropleg (Fig.13) carrying a pair of deflector nozzles at the bottom. A spreader as adjuvant (e.g. Break-Thru) should be added to the tank mix. The nozzles on the droplegs must be carried about 5 - 10 cm above the ground so that the ground facing side of the leaves can be sprayed successfully. With uneven ground the droplegs may temporarily touch the ground without being damaged.

Fig. 13: *Droplegs with each two deflector nozzles combined with flat fan injector nozzles on the boom in broccoli and cauliflower.*

4.1.5 Savoy Cabbage and Chinese Cabbage

Because the droplegs can easily move lateral (like a pendulum) they can also be used in very broad leaved crops such as Savoy cabbage or Chinese cabbage without harming them (Fig. 14). Experiments with deflector nozzles with a spray angle of 95 degrees (Fig. 14 b) or in dense crops with 140 degrees (Fig. 14c) have given much higher product deposition on the lower side of the leaves which is important for the effective control of the various development stages of the white fly. It is highly recommended to also use a spreader adjuvant.

a

b

c

Fig. 14: *Field experiment in Germany with droplegs in Savoy cabbage..*

4.1.6 Onions and Leek

In years and regions with recurring rainfall downy mildew can damage or completely destroy onion crops. On farm field experiments in Switzerland with the dropleg application technique plus the adjuvant Break-Thru gave **high biological efficacy of over 90%** provided the fungicides were sprayed well timed. Droplegs allowed to deposit clearly higher amounts of active ingredients on the lower half of onion crops than conventional boom spraying.

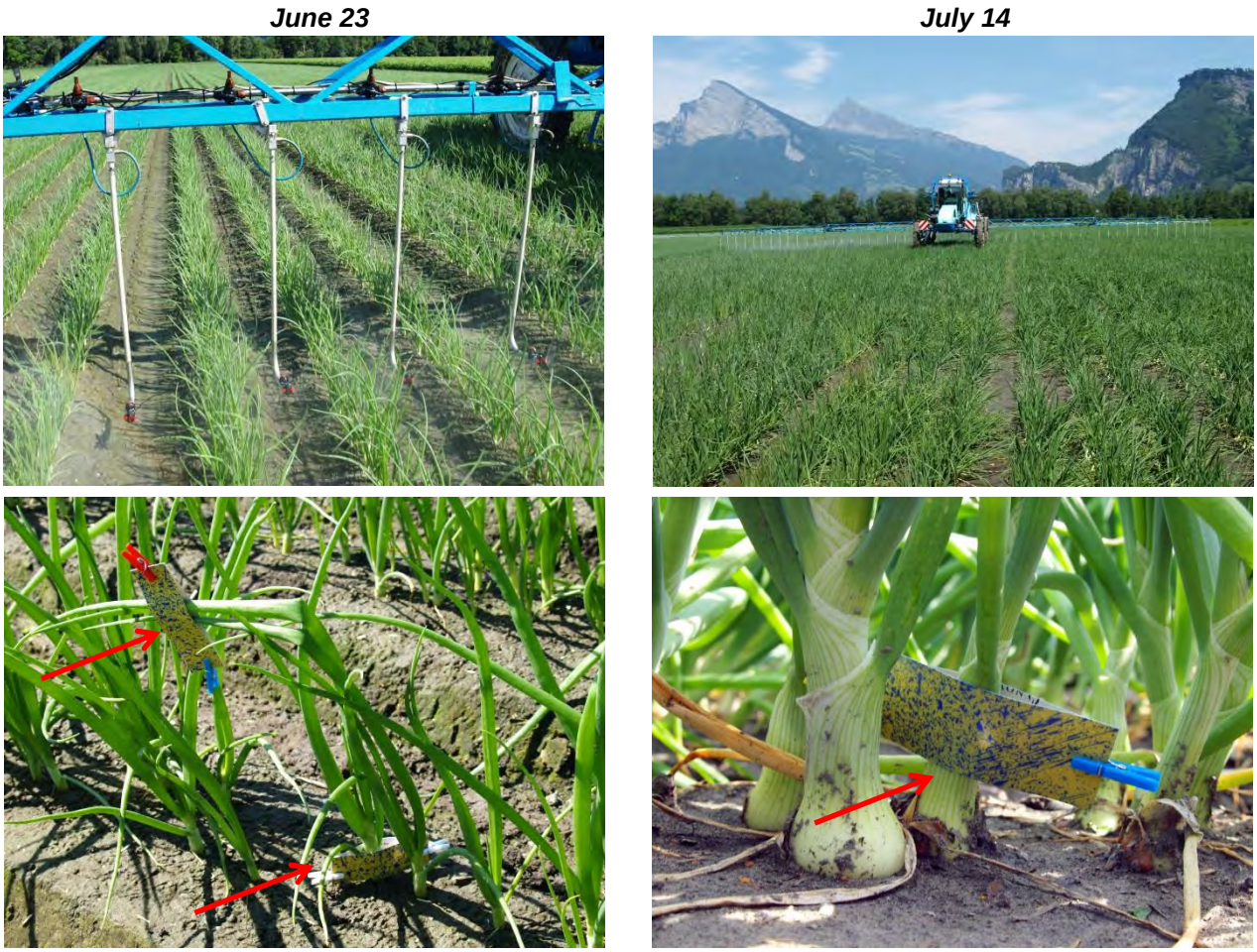


Fig. 15: *Droplegs on a self propelled 28 m wide boom in onions. A simple test with water sensitive paper showed that in both an early (23 June) and a later growth stage (14 July) deflector nozzles (95 degree spray angle) on droplegs gave a good spray result on the bottom and upper part of the canopy. The control of downy mildew was clearly much better than in early years with the standard boom technology despite a high disease pressure.*

The control of the tiny thrips was also clearly superior as compared to boom spraying. By sucking on leaf tissue thrips can do severe damage to leaves of onions (Fig. 16). The tiny insects live preferably between the lower parts of the leaves close to the ground level. The dropleg application technique allows to deposit much higher amounts of active ingredients in this critical zone than the standard boom, which results in clearly higher biological activity of the insecticide sprayed.

Fig. 16: *By applying insecticides with droplegs the active ingredient is deposited mainly in those areas where the thrips are found predominantly (here in onions). This leads to a clearly higher biological efficacy against this pest.*

As in onions higher amounts of active ingredients can be deposited on the lower half of leek crops (Fig. 17) when spraying with droplegs fitted with deflector nozzles. Since leek crops can grow to considerable height it is recommend to make use of a combined spraying with the nozzles on the droplegs and those on the boom, or use a dropleg with two pairs of deflector nozzles, see figure 6b.

In a leek field in Germany droplegs each with two deflector nozzles (spray angle 95 degrees) allowed for a high product deposition in the lower half of the crop (Fig. 17, area marked in yellow) whereas the flat fan nozzles on the boom predominantly sprayed the upper half of the canopy. The combination of these two techniques plus the addition of a spreader can lead to high biological efficacy of the sprayed products. The dose per hectare is not increased but the total amount of active ingredient is better distributed within the canopy. At the same time the risk of product losses due to wind drift is greatly reduced.

Fig. 17: *The yellow marked zones show the parts of the leek crop which get sprayed by droplegs fitted with one pair of deflector nozzles (spray angle 95 degrees).*

4.1.7 Fennel

A preliminary on farm experiment showed that the droplegs can also be used in fennel crops (Fig. 18). So far however there are very few experiences with the dropleg technique in this crop since fennel often does not pose serious crop protection problems.

Fig. 18: *Spray test with droplegs in a fennel crop..*

4.1.8 Zucchini and Celery

Downy and powdery mildew are among the serious crop protection problems in zucchini. Experiences in southern and northern Switzerland have shown that particularly for downy mildew fungicide treatments must be started very early. The dropleg technique may make a valuable contribution to a sufficient control of these two diseases however so far few on farm experiences have become available (Fig 19).

Fig. 19: *Spray test with droplegs in zucchini.*

In celery crops droplegs may give better control of *Alternaria* spots on leaves and stems but so far no on farm experiences have been worked out (Fig. 20).

Fig. 20: *Spray test with droplegs in celery.*

Fig. 21: *Use of droplegs in asparagus. The water sensitive paper gives an idea of the spray coverage on the lower parts of the shoots.*

4.1.9 Asparagus

In late summer and early autumn fungal leaf diseases (*Stemphylium*, rust, botrytis) can reduce the actively assimilating canopy of asparagus considerably. This in turn can lead to plants overwintering in a weakened state which is later reflected in lower yields in the subsequent year. In Switzerland a special version of droplegs was tested on farm (Fig. 6c and 22). A test with water sensitive paper showed good penetration into the canopy at a low, medium and high level above the ground. More experimental work will be needed to demonstrate the validity of the dropleg technique in asparagus.

Fig. 22: *Preliminary spray trial in asparagus on the 18th of July 2012 with a special version of droplegs with a length of 120 cm and with three pairs of deflector nozzles caliber 05; row distance 1.8 m, spray broth volume 1000 l/ha at a pressure of 5 bar and a forward speed of 5 km/h.*

4.2 Field Crops

4.2.1 Potatoes

In regions and with varieties (conventional or organic farming) for which it is known by experience that late blight *(Phytophthora infestans)* occurs frequently and to a considerable degree it is recommended to use a combination of a boom spraying top down and droplegs spraying bottom up (Fig.23). Figure 23f shows a coupling device for the concurrent use of nozzles on the boom and on the droplegs. If varieties are chosen which grow to a great height it may be advisable to deploy a dropleg with 2 pairs of nozzles (see Fig 6b); in this case the nozzles on the boom can be shut down. Droplegs usually have a "slim" design which enables them to travel even through closed canopies at a forward speed of 4-6 km/h. The calibre of the nozzles has to be chosen according to the desired spray volume and the chosen forward speed. Where boom and droplegs are combined it is recommended to go for a 40% to 50% output from the boom and 50% to 60% output from the droplegs.

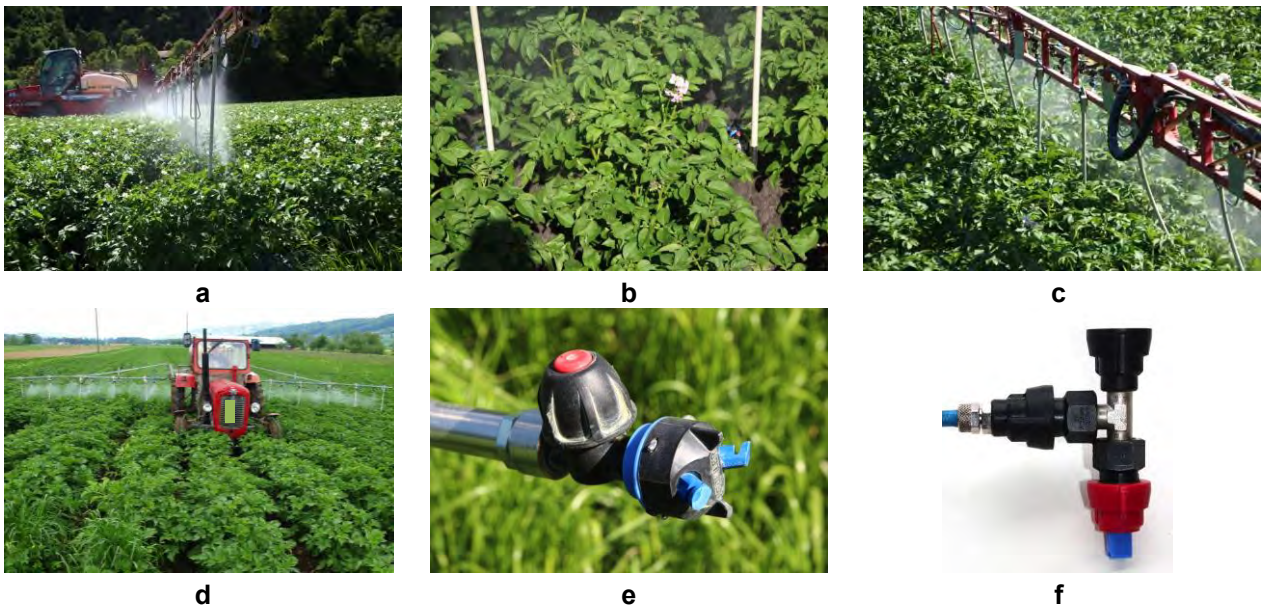


Fig. 23: *Use of the combined spraying technique - boom plus droplegs - for the application of fungicides in a potato field with integrated production* ***(a-c)****; spray broth volume 700 l/ha. Boom plus droplegs in an organic potato field, spray broth volume 800 l/ha* ***(d)****. Deflector nozzles caliber 03 in a Lechler Twin-Spray-Cap at the lower end of the dropleg* ***(e)****. T-shaped coupling device with a compact flat fan injector nozzle Lechler IDK 120-03* ***(f)****.*

At a late growth stage, depending on variety, crop height and weather, some plants may begin to lodge. No currently available spraying technique will allow to spray lodged plants completely satisfactorily. Flexible droplegs will easily move over such lodged plants without doing damage to them. The deployment of droplegs will no longer make sense under conditions of a complete lodging of the crop. Practical experiences in Switzerland have shown that spraying products for the desiccation of a by and large upright canopy prior to harvest is more effective when carried out with droplegs than with a standard boom only.

4.2.2 Maize

In maize crops for seed, grain or silage production herbicides can be applied at advanced growth stages with droplegs without damaging the crop's canopy. In Germany and in Switzerland droplegs have been used in maize crops of variable height from 50 to 150 cm (Fig. 24). Such a use of droplegs is useful for the split application of herbicides on light soils or where repeated herbicide applications are necessary to control nasty weeds such as the Yellow Nutsedge (*Cyperus esculentum*). Sub canopy applications of herbicides with droplegs are also carried out in potatoes and sugar beets. Care must be taken under all circumstances to use the herbicides according to the registered label prescriptions.

Fig. 24: *Use of droplegs at an advanced growth stage of maize (a). The spray droplets are only deposited on the lowest part of the shoots whereas the leaves remain unsprayed (picture at the right). For that purpose the dropleg carries a 140 degree deflector nozzle which points towards the ground (b, c). The chosen height of the nozzles on the droplegs above the ground (height of the boom above ground) determines the width of the spray swath on the ground.*

4.3 Various Crops

Droplegs of variable height and with a variable number of nozzles can basically be used in a wide range of special crops provided they are planted or sown in rows.

In sunflowers grown as ornamental aphids can cause considerable damage at advanced growth stages. By sucking and sugar excretions, which attract various fungi, leaf aphids cause damage to the flowers and thus make them unsellable. Aphids are found on the upper and particularly also on the lower side of the young flower heads where they are hardly affected by conventional boom spraying of insecticides. With droplegs whose spray heads travel below the level of the flower heads insecticides for organic or integrated production can be sprayed on the lower side of the flower heads and the adjacent upper sections of the shoots. The result is a better biological efficacy. Water sensitive paper which is yellow when dry will turn blue when sprayed upon. The test with this paper revealed a good coverage on the plant parts in need of protection (Fig. 25).

Fig. 25: *Organically grown sun–flowers, which are sold as ornamental flowers, may need to be sprayed at advanced growth stages against aphids (e.g. with Pyrethrum FS).*

Other examples of specialty crops are Christmas trees, young bushes and trees in nurseries, high growing cut flowers and others. Figure 26 shows a demonstration of long droplegs between Caucasian fir trees planted on 20 hectares as Christmas trees. Aphids which tend to suck preferably on the underside of the young needles on the new shoot tips need to be controlled. Otherwise the trees will look rather deformed which lowers their market value considerably.

a **b** **c**

Fig. 26: *Demonstration of a special version of the dropleg with a total length of 140 cm and three pairs of deflector nozzles at a low medium and high level above the ground in Caucasian firs cultivated as Christmas trees (a). The water sensitive paper test showed that both the upper (b) and the lower side (c) of the young shoots were sprayed adequately.*

5 Tips for the purchase and the crop adapted deployment of droplegs

- When purchasing droplegs the grower should have a clear idea of the crops to be sprayed and the range of spray volumes to be applied. The length of the droplegs must be carefully chosen particularly for crops which ought to be sprayed by combining the top nozzles on the boom and the bottom up directed nozzles on the droplegs. The nozzles on the boom should travel at about 50 cm above the top part of the crop while the nozzles on the droplegs should travel low enough so as to efficiently spray the bottom part of the crop and the lower side of the leaves.
- It is recommended to get professional advice when selecting the appropriate type of dropleg, and the type and caliber of the nozzles.
- Droplegs need a robust type of fixation to the boom since the droplegs will be exposed to backward pulling forces particularly in dense crops at advanced growth stages (e.g. Brussels sprouts) and / or higher forward speed (6 - 12 km/h).
- The nozzles on the droplegs should be of the caliber 02 (yellow) or bigger (e.g. 03 blue or 04 red). The small calibers 01 (orange) and 015 (green) are not recommended since they tend to get blocked despite filters and sieves. The caliber of the nozzles on the droplegs should allow the application of adequate spray volumes at moderate pressures of 2 to 4 bars. Particularly when applying products with mere contact activity all plants parts must receive a good spray coverage, yet run - off should be avoided by all means.
- A good penetration of the spray droplets into the canopy is facilitated by an adequate forward speed rather than by higher pressure. High pressure spraying leads to an increased share of very fine droplets which are very prone to drift.
- Deflector nozzles which spray sidewise or flat fan nozzles which spray at a narrow angle backwards (insecticides, fungicides) or deflector nozzles which spray downwards (herbicides) can all be turned in their nozzle holding devices (Fig. 27a). Care must be taken to set nozzles in the correct position to achieve a good spray coverage on those parts which need to be sprayed. It is recommended to use water sensitive paper for a preliminary spray test with water. This will substantially help to judge the spray picture and set the nozzles right.
- All activated nozzles on the droplegs and on the boom should be checked for proper operation prior to spraying. Periodic cleaning of nozzles, filters and sieves is recommended. When cleaning or dismantling droplegs care should be taken that the rubber rings used for sealing are not lost. They should be checked and possibly exchanged when leaking is observed (Fig. 27b).

a

b

Fig. 27: *Deflector nozzles in a Twin-Spray-Cap (Lechler); they can be adjusted to selected positions depending on the part of the crop that needs to be sprayed.*

- When crops with rather waxy leaves (e.g. Brussels sprouts, cabbages, onions, leeks) are sprayed it is recommended to use an adjuvant which acts as a spreader. The adjuvant should be used according to the label and the water volume may need to be reduced to avoid run-off. Adjuvants can obviously only act on those surfaces onto which they are being applied. The choice of the nozzle type and calibre and the proper setting of the nozzles in relation to the crop remain of paramount importance for the achievement of a good spray result on the plant parts that need to be protected.
- Depending on the conditions on the farm the droplegs may remain attached to the same boom for the entire spray season or, if infrequently used, they may be taken off the boom after spraying. Though not mandatory a simple rack may prove very useful for stowing away the droplegs when they are not in use (Fig. 28 a, b).
- In order to avoid a buildup of devastating diseases and pests in a given crop it is of paramount importance that effective spraying is started early. Droplegs are **not a miracle technique** which can do wonders at late crop stages when rampant disease and insect problems prevail! The dropleg application technique must be **deployed already at early crop stages** with the aim to achieve healthy crops at early to late crop stages. If a given crop is truly healthy at fairly advanced growth stages then the spray intervals may be chosen longer and there may be the opportunity to save one or two sprays towards the end of the growth cycle.
- A grower who intends to use the dropleg application technique must be willing to devote a certain amount of time to getting to know this technique similarly to the effort needed in getting acquainted with other techniques such as special mechanical weed control devices or tractor guidance with GPS technology. More precision and efficacy in crop protection will require a certain additional effort in time and dedication.

Fig. 28: *Examples of racks built by growers for quick and easy storage of droplegs.*

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7 Swiss Companies offering various types of droplegs

Kuhn Landmaschinen AG Dorfstrasse 46 5606 Dintikon Tel: +41 56 624 30 20 Kontaktperson: Hr. Roger Näf Mobil: +41 78 816 31 01 e-mail: info@klmag.ch Internet: www.klmag.ch	• Manufacturing and marketing of the dropleg[klm] in various versions according to the expected height of the crops and the customer's needs. • Swiss representative of the German company Lechler GmbH which is the manufacturer of the dropleg[UL] Lechler GmbH, agricultural nozzles, Postfach 1323, D-72544 Metzingen, www.lechler.de
UW – Pumpen, Spritzen, Motorgeraete Zuecherstrasse 11 4922 Buetzberg **Tel:** +41 62 963 14 10 Kontaktperson: Hr. Ulrich Wyss Mobil: +41 79 435 45 62 e-mail: info@wysspumpen.ch Internet: www.wysspumpen.ch	• Swiss representative of the German company Agrotop the manufacturer of the flexible tubes fitted with one to two nozzles at the lower end (agrotop GmbH, Koeferinger Strasse 5, D-93083 Obertraubling, www.agrotop.com);
Fischer Nouvelle Sarl Zone industrielle 1868 Collombey-Muraz Tel: +41 24 473 50 80 Kontaktperson: Hr. Hansueli Reusser Mobil: +41 79 745 10 41 e-mail: h.reusser@mails.ch Internet: http://www.fischer-gmbh.ch	• Manufactoring and marketing oft he Fischer- subcanopy spray device

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