"I do not suppose that even Mr McMahon would enjoy long periods of flying a Tiger Moth at this height . . .": de Havilland's ubiquitous biplane operating at low level in its agricultural role

CROP-SPRAY DRIFT

Would a pilotless aircraft be the answer to present problems?

By R. J. Courshee

ON a bright day, with the light in the right direction, it is possible to see behind a crop-spraying aeroplane a pair of helical trails of spray ten to twenty feet in diameter. If there is no wind, the twin clouds merge and settle slowly on to the crop below. If there is even a slight wind, however, the trails thin quickly and disappear from sight as they settle or drift away.

Aerial spraying against crop pests usually lays this blanket of spray fairly high up, and consequently a number of difficulties arise. For example, if the wind freshens a little—to, say, seven miles an hour at six feet—the effectiveness of the operation may drop, depending mainly on the pest and the pesticide used against it. Because of this, spray operations are limited in England to about 200 spraying hours a year during the main season, which at present runs from June to October.

Secondly, even if the pesticides to be used are effective despite the wind, some of them can cause harm to crops or animals downwind, and spraying has to stop as soon as the wind freshens. As a result, a great deal of potential spraying business cannot be accepted. I have in mind the very extensive areas of cereal crops which are now sprayed with weedkillers by ground machines, whereas an aeroplane might just be competitive in price. Most air contractors are very reluctant to engage in this work. They probably remember the early examples of damage occurring in America many miles downwind.

Both the restriction of work to a few hours a year and the embargo upon the hazardous weedkilling bear on a third problem of aerial spraying—its cost. Fixed costs are high—about £5,000 a year for each aircraft—and have to be spread over the 10,000 or so acres which can be treated annually at present.

There is not much of a future in a spraying business with non-operational costs running at around ten shillings an acre, and the main way out is to do more work. That is, there needs to be more work which an aeroplane can do effectively; it must be able to spray during a more extended season and in weather which is now considered unsuitable. Also, flying during this more windy or turbulent weather must be no less safe than it now is.

A vicious circle thus exists. The cost of the work is high because insufficient work is done to spread the fixed costs thinly; and sufficient work is unobtainable, partly because the price is higher than it is for the same job done by ground machines.

It is necessary to break this circle in some way. A few English firms spend between 60 and 90 per cent of their time working abroad in off-seasons. Others regard spring fertilizer-application as a solution to their standing costs outside the spraying season. Applications of only small amounts of fertilizer are made—about 100lb an acre—on a growing crop where ground machines should not go. But most spray aeroplanes are not well suited to this work, carrying as they do a payload for at most, ten acres. So perhaps this should not be relied on.

An international movement of spraycraft to follow the seasons around through Europe and perhaps North Africa and the Middle East is the long-term way of keeping the work flowing in. But a longer season in England would be a valuable interim step and that means applying weedkillers from the air, since this is almost the only spring work which is available.

Large granules of weedkiller, about a tenth of an inch in diameter, can be applied with almost complete safety as regards crops in adjacent fields—provided the granules are free from fine dust. Certainly, granular applications will be a growing source of work in the spring. However, sprays applied to the foliage—the granules are applied mainly to the ground between the plants—are still the main type of weedkiller application. To apply these safely from the air—that is, without contaminating down-wind crops—the spray-drop size, the angle and speed of projection of the spray and the flying height must all be precisely correct. The sort of variation in these which now tends to be accepted as part of the luck of the game can cause a change in the amount of dangerous drift of 100 per cent or more.

Therefore a really coarse spray, devoid of nearly all fine particles as small as 1/250th of an inch in diameter, is a first requirement. It can usually be obtained in this way. The spray pressure should be kept at a low level of 10lb/sq in (for water-based sprays). The sheet of liquid which exists for a distance of about half-an-inch from the nozzle has then to be protected from the slipstream, or it will be blasted into tiny particles. One way of doing this is to place a wire mesh screen in front of the nozzle—about a square inch, one inch in front. The drag of this hardly increases the drag of the nozzle itself. These two measures are most useful in avoiding the fine spray at the low speeds which might be used by a helicopter, e.g., 40 knots. We have no measurements yet of what their effect is at the 70kt often used by fixed-wing aeroplanes.

Finally, the spray requires to be treated to make it less likely to form small drops. This is done by adding a gelling agent to the spray liquid. Again this is most effective at 40kt or below. Checks have still to be made to ensure that this gelling agent does not alter the effectiveness or safety of the weedkiller to be applied. Other formulations cause a similar result, but not so cheaply or so well, I think, as does the gelling agent.

So far so good; we have coarse spray. But even this will drift if it is released high in the sky and if it takes several seconds to fall to the ground, because it usually evaporates rapidly (e.g., in 10sec) and may then become fine enough to drift a long way. Different-sized drops propelled at various speeds from a nozzle penetrate a few inches if they are small and a few feet if they are large. They then come to rest and are susceptible to both the wind and the wing-tip vortex. So to avoid drift of drops, say 200 microns in diameter, the distance from the nozzle to the crop should be not more than 2ft. Then these drops can be shot down onto the crop before they have time to become drift.

I can speak only of what I would like to see from the spraying point of view, i.e., large drops, and 2ft or less between the nozzle and the crop. If 2ft is a dangerously small distance for a fixed-wing aeroplane, then only a helicopter, autogyro or perhaps a robot ducted-fan can do this work. Even for these aeroplanes the nozzles may have to be mounted flexibly on a retractable boom. A chance contact between the nozzles and the ground need not then be disastrous, and landing and take-off might not be made very much more difficult.

In experiments with fixed-wing aircraft, when Mr J. McMahon of Crop Culture flew for us with 3ft between the nozzles and the crop, the drift could be reduced to 1½ per cent of the spray which was emitted. A more usual figure is 10 per cent or more. I do not suppose that even Mr McMahon would enjoy long periods of flying a Tiger Moth at this height, and so it is probable that only VTO aircraft can fly low enough to apply most weedkillers safely in a country of small fields like ours.

While helicopters remain so costly or (as in the case of some types with ramjets on the rotor tips) so heavy on fuel, spraying done by helicopter is dearer than it is with a fixed-wing aircraft. So we must hope for lower prices for helicopters and autogyros.

Or are we barking up the wrong tree? Perhaps an aeroplane is not really the vehicle for agricultural aviation. A ground cushion vehicle is out of the question for spraying, for several cogent reasons. But perhaps a crude vehicle carried by a group of ducted fans will be the answer. A lot depends upon our friends of the Air Registration Board, but perhaps we can by-pass them by flying at under 6ft and insisting that the vehicle is not an aeroplane.

Come what may in the way of future air vehicles, the present outlook for airspray contractors seems to require a more extended working season. The greatest room for expansion lies with weedkilling chemicals, but the risks involved should not be dismissed carelessly. I am quite sure that weedkilling *can* be done safely from the air in nearly all situations provided all the precautions suggested can also be taken. This means that aeroplanes with very low stalling speeds may have to do the work.

Perhaps, however, the pilot will ultimately be able to sit on a five-barred gate in the corner of a field with a black box across his knees, while a miniature robot buzzes up and down the field doing his work for him. With such a device flying 3ft up, weedkiller applications would become possible, the cost of the work should be low and, we hope, the contracts would roll in during a season which is now pretty unproductive for airsprayers.