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STUDY OF THE EFFECT OF TWO SURFACTANTS ON SPRAY RETENTION BY BARLEY LEAVES

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INTRODUCTION

Spraying is widespread in agricultural practice to protect crops from a variety of pests and so to maintain yields. The most obvious priority is to achieve a distribution of pesticide such that sufficient active ingredient reaches the sites required for effective pest control. Wastage occurs from material reaching the ground and from off-target drift. Both of these situations have a large potential for environmental damage and so their reduction is not just an economic demand but is deemed necessary both in good practice and in legislation.

A wide variety of additives have been shown to increase spray deposition on foliage, notably surfactants. These products are often described in the technical literature as wetting and/or spreading agents. On these basis, the aim is to investigate the eventual effect of changes in spraying operations upon retention efficacy with two approaches: spectrofluorimetry and high-speed imaging.

MATERIAL AND METHODS

Retention, defined as the amount of spray retained by plant leaves, and drop impact types were studied for two surfactants and compared to water on barley leaves (BBCH12). Break-Thru® S240 (Organosilicone surfactant) at the concentration of 0,1% and Li700® (Phospholipid surfactant) at the concentration of 0,25% were applied to foliage in aqueous sprays. The sprays were produced by a flat-fan nozzle and a pressure of 2bars, mounted 50cm height above the target on a ramp moving at a speed of 2m/s. Sprayings were performed in laboratory at a temperature of 24°C and relative humidity of 60%.

Retention was quantified on whole plants using fluorescent tracer at a concentration of 0,2 g/l. The results were compared to those of a spray of water with fluorescein at the same concentration. A test of matrix effect has been done on barley leaves with both surfactants used in order to verify an eventual increase of fluorescein retention (Figure 1).

Impact types were determined on small pieces of Barley leaves (0,3 cm²) using a high-speed camera coupled with a retro-LED lighting. The size and velocity of drops were extracted by image analysis, and the impact type was determined by the operator. Volumetric proportions of the three impact types adhesion, rebound and fragmentation were determined (Figure 2).

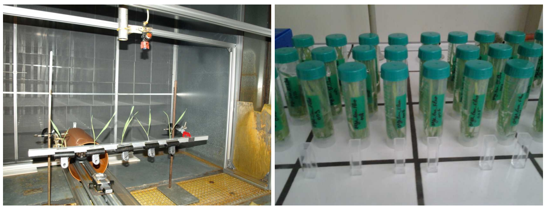


Figure 1

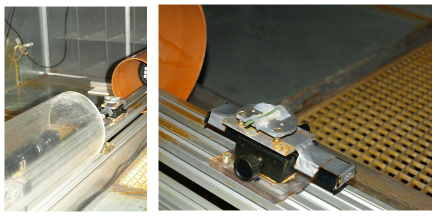


Figure 2

RESULTS AND DISCUSSION

The spectrofuorimetry provided that the quantity of retention on Barley leaves were doubled by addition of Li700 comparing to water, while Break-Thru triple it.

première modalité: Eau-Fluo

N°	[c](µg/ml)	S(cm²)	V(µl)	d(µl/cm²)
1	0,0233	62,0949	2,3328	0,0376
2	0,0272	67,6164	2,7206	0,0402
3	0,0172	58,3920	1,7201	0,0295
4	0,0193	61,5544	1,9346	0,0314
5	0,0357	61,8436	3,5700	0,0577
6	0,0151	57,5584	1,5064	0,0262
7	0,0236	63,4784	2,3578	0,0371
8	0,0169	60,5258	1,6880	0,0279
9	0,0199	66,1435	1,9936	0,0301
10	0,0176	61,3391	1,7640	0,0288
moyenne	0,0216	62,0547	2,1588	0,0347
Ecartype	0,0062	3,0994	0,6192	0,0094

deuxième modalité: BT-Fluo

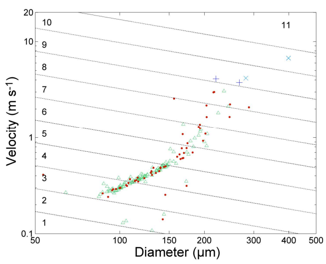
N°	[c](µg/ml)	S(cm²)	V(µl)	d(µl/cm²)
1	0,0830	76,3548	8,3000	0,1087
2	0,0718	69,7199	7,1800	0,1030
3	0,0533	70,7772	5,3300	0,0753
4	0,0679	70,4987	6,7900	0,0963
5	0,0667	71,4985	6,6700	0,0933
6	0,0896	76,1590	8,9600	0,1176
7	0,0634	61,2390	6,3400	0,1035
8	0,0592	73,1560	5,9200	0,0809
9	0,0859	74,0314	8,5900	0,1160
10	0,0579	60,8788	5,7900	0,0951
moyenne	0,0699	70,4313	6,9870	0,0990
Ecartype	0,0125	5,4344	1,2516	0,0138

troisième modalité: Li700-Fluo

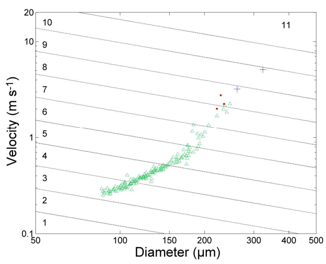
N°	[c](µg/ml)	S(cm²)	V(µl)	d(µl/cm²)
1	0,0745	74,7098	7,45	0,0997
2	0,0581	69,6719	5,81	0,0834
3	0,0405	62,7187	4,05	0,0646
4	0,0538	59,3095	5,38	0,0907
5	0,0361	56,3816	3,61	0,0640
6	0,0189	66,0979	1,89	0,0286
7	0,0674	64,8098	6,74	0,1040
8	0,0280	62,8606	2,8	0,0445
9	0,0275	64,7769	2,75	0,0425
10	0,0276	75,2490	2,76	0,0367
moyenne	0,0432	65,6586	4,3240	0,0659
Ecartype	0,0191	6,0968	1,9058	0,0274

The imaging method provides information on the quality of impact on barley leaves. It apears that rebound has been considerably decreased by Break-Thru® and the adhesion increased greatly. The addition of Li700® increased the fragmentation and decreased the rebound relatively.
This method allowed us to observe that VMD has been increased by Li700® addition, which can promote the fragmentation .
Spray retention was better increased by the organosilicone surfantant (Break-Thru) than by the phospholipid one (Li700).

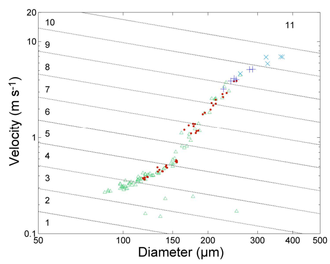
Water



Break-Thru® S240 0,1% v/v



Li700® 0,25% v/v



Δ adhesion ●rebound +fragmentation (Cassie-Baxter) x fragmentation (Wenzel)

Our results corroborate those of Holloway and al. (1999): there was complete leaf coverage from sprays containing organosilicone surfactants, as would be predicted from their high surface-active nature, while the phospholipid adjuvants gave 20% less spray coverage.

Because leaf pieces were mounted horizontally, impaction volume was greater than the retention volume obtained by spectroflurimetry on vertical plants in the first experimentation. It should be regarded only as comparative indicators of impact types and qualitative effect of surfactants used. Barley foliage was oriented mainly vertically and the leaves are difficult to wet because of their dense covering of microcrystalline epicuticular wax. None of the additives examined increased fluorescein retention.

CONCLUSION

The results confirmed that tank-mix adjuvants can have a considerable influence on the delivery efficiency of aqueous sprays. However, the magnitude of this effect is dependent on the nature of the additive. It affects the physicochemical properties of spray droplets in terms of their size and velocity, and determine their impact behaviour. The high-speed imaging method support chemical results and provide a better understanding of spray retention phenomenon.
Further study will focus on the link between retention assessed by spectrofluorimetry and that determined by high speed imaging.