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SPRAY EMISSION AND DEPOSIT VOLUME VS. DROP DIAMETER AND DEPOSIT DENSITY

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The relationship between fluid volume, the number of spray drops produced and their size is a relatively simple mathematical one. However, its implications are often not recognized by administrators, research planners and managers and even those only one step removed from actual deposit measurement. Let us look at the problem.

The volume of a spherical spray drop is proportional to the cube of its diameter, i.e. double the drop size gives eight times the volume. The number of uniform drops produceable from a given volume of fluid is inversely proportional to the cube of the diameter, i.e. half the volume yields eight times the number. This relationship is illustrated in graph form in terms of GPA in Randall, A.P. 1971 (Proc. 4th.Agr. Aviation Congr. P 313) and in oz/ac in Haliburton, Hopewell and Yule P.64 in Aerial Control of Forest Insects in Canada, Prebble, M.L. ed. "in press", and in ℓ/ha on the attached graph.

During recent discussions re recommendations for B.t. applications, figures of 50 drops per sq,cm. 150-300 µm diameter and 0.5 GPA were proposed as effective values. On the face of it, these figures are not compatible (see attached table). For uniform drops, or a drop diameter value equivalent to the drop of average volume (VAD), the volume represented by fifty drops of that size range should be somewhere in the range of .94 to 7.G GPA (8.8 - 71 ℓ/ha). If on the other hand, the diameter values were given as "volume median diam." (VMD=MMD), the commonly used but imprecise and often misunderstood and misused atomatization parameter, the values might be more nearly compatible. The VMD is invaribly larger than the VAD in the size-frequency distributions characteristic of spray atomization. It is

the diameter at the 50% point in the cumulative size-volume distribution of the spray - half the total spray volume below and half above this diameter. The top 10% (say) of the drops may contain 50% or more of the total volume which will be largely "wasted" in terms of a deposit that is rated in terms of drops deposited per sq.cm. The value is sensitive to the size and frequency of the larger drops which may be inadequately sampled. On the other hand the VAD is sensitive to the large numbers of small drops containing only a relatively small portion of the total volume of spray emitted. The smaller drops may not contain adequate active agent, or may deposit inefficiently so that that portion of the total spray may not becone part of the effective deposit.

Another consideration: the area to be sprayed may actually contain much more foliage to receive a specified deposit than its apparent projected area would indicate. Mean measured deposits are seldom more than 25-30% of the nominal applied rate, so that total spray emission must be enough to allow for the "vertical dilution" of the deposit as well as that portion considered as ineffective.

Returning to the case in point, 50 drops/cm^2 in the range 150-300 µm: let 200 µ be the estimated VAD value. This is equivalent to 2.27 GPA. If say 80% of the spray volume is available for effective deposit and vertical dilution results in an apparent 30% deposit efficiency then the net efficiency is 24%. This implies that the emitted volume should be 2.27 ÷ .24 =9.5 GPA which is operationally unacceptable. The case may be extreme, but it illustrates the point that it is sometimes necessary to compromise on concentration of the active agent, acceptable drop size range, and drop deposit density to bring the total spray application rate down to an operationally acceptable level.

Drop Diameter, Spray Deposit Volume and Equivalent Drop Density:-

I. Deposit Density 50 drops/cm^2

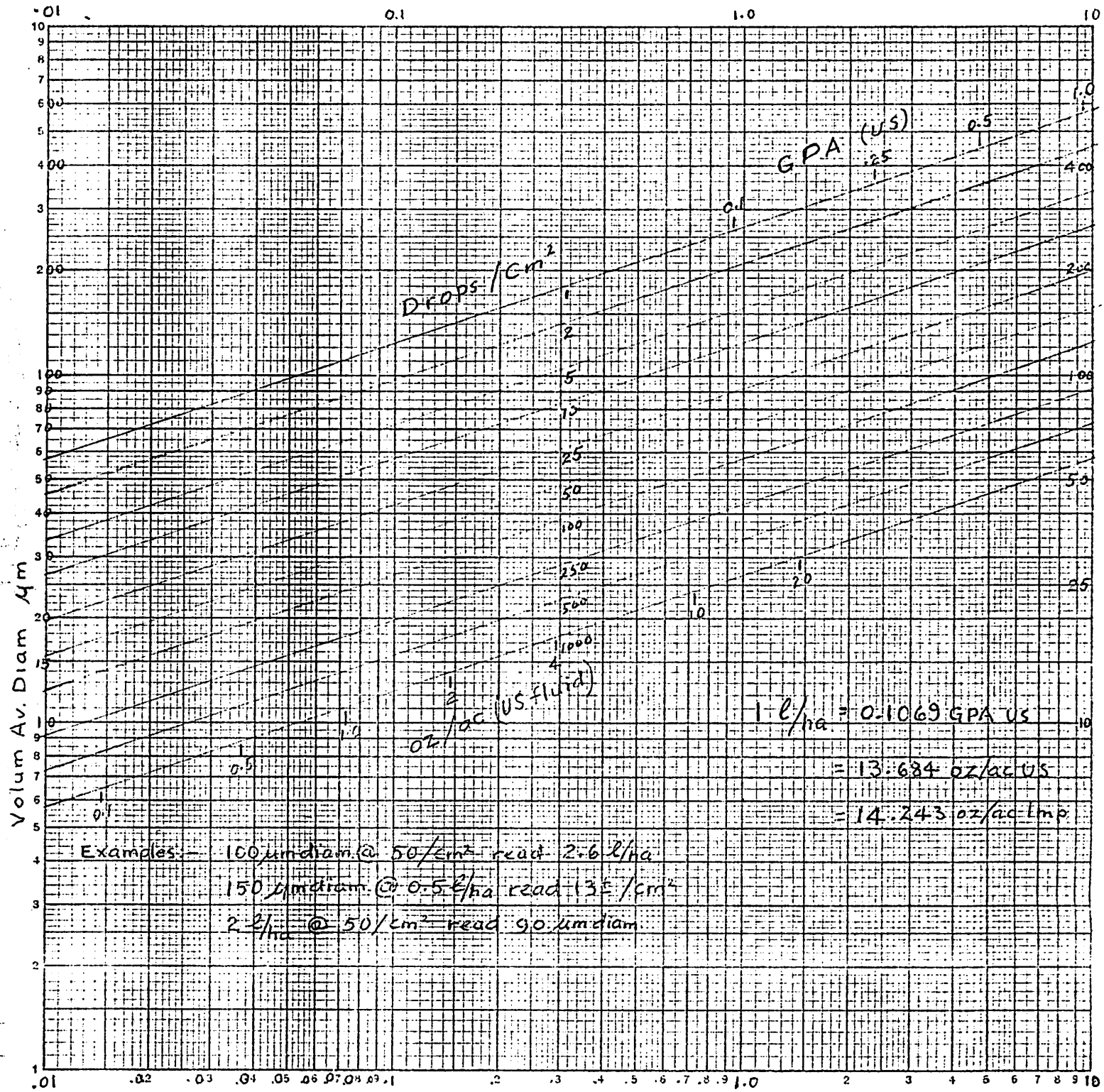
Volume average diam. (VAD) Range µm	Deposit Volume oz/ac US	GPA	ℓ/ha
20 - 30	.28 - .99		.021 - .072
30 - 50	.99 - 4.45		.072 - .327
50 - 75	4.5 -15.5		.327 -1.13
75 -100	15.5 -36	.121 - .28	1.13 - 2.62
100 -150		.28 - .94	2.62 - 8.77
150 -200		.94 - 2.97	8.77 -21.2
200 -300		2.3 - 7.6	21 -71

II. Deposit Volume vs. Drop Density

Drops /cm^2	75-150 µm Diam.			150-300 µm Diam.		
	oz/ac	GPA	ℓ/ha	oz/ac	GPA	ℓ/ha
1	.302 - 2,42		.035 - .177	2.42- 19.4		.177 - 1.41
2	.604 - 4.84		.07 - .353	4.84- 38.7		.353 - 2.8
5	1.51 - 12.1		.14 - .884	12.1 - 96.8		.884 - 7.1
10	3.02 - 24.2		.28 -1.77		.19 - 1.55	1.77 - 14.1
25	7.56 - 60.5		.55 -4.42		.48 - 3.9	4.42 - 35.4
50	15.1 - 121	.118- .945	1.115 -8.8		.95 - 7.7	8.8 - 70.7
100	30.2 - 242	.236-1.89	2.21 -17.7		1.9 -15.5	17.7 -141.4

III. Drop size vs. Deposit Density @ 0.5 GPA = 4.68 ℓ/ha

VAD Range	Drops/cm^2 Range
20 - 30	11000 - 3300
30 - 50	3300 - 715
50 - 75	715 - 212
75 - 100	212 - 89
100 - 150	89 - 14
150 - 200	14 - 11.2
200 - 300	11.2 - 3.31



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