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LEAF COVERAGE PERFORMANCE OF TOBACCO SPRAY MACHINERY IN NORTH QUEENSLAND

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SUMMARY

The spray distribution patterns of three types of commercial machines used in tobacco pest and disease control in north Queensland were determined using a fluorescent tracer technique. A "datum" level for leaf cover for commercial pest control is suggested. Tests indicate deficiencies in the commonly used offset boom and the low-volume misting machine. These deficiencies are thought to be critical in terms of commercial pest control. A high-clearance, rear-mounted boom sprayer with inter-row droppers proved most satisfactory.

I. INTRODUCTION

During the past 10 years a wide range of pesticides has been screened for use in commercial tobacco growing. More recently, following the apparent ineffectiveness of recommended pesticides, the distribution of spray droplets on the tobacco plant was suspected of being inadequate. Wright (1964) and G. W. Saunders (personal communication 1966) indicated the various types of sprayers used by tobacco growers in north Queensland and Saunders questioned the ability of a number of these sprayers to control the common tobacco pests.

The importance of distribution of the spray deposit in an efficient spray programme (Fulton 1965; Paddick 1965) was recognized and the need for information on the distribution of the pesticide on the tobacco plant became apparent. To obtain the above information, investigations were conducted at the Queensland Department of Primary Industries Research Station at Parada from 1964 to 1968 into factors which control spray distribution on the tobacco leaf surface. The results reported here were obtained during the 1965-66 tobacco season and indicate the efficiency of the commonly used commercial sprayers in distributing spray deposits on the tobacco leaf surface.

II. METHODS AND MATERIALS

Determination of spray distribution.—The distribution of the spray deposit on the tobacco plant was determined by a fluorescent tracer technique (Staniland 1959). The method involved the incorporation of a fluorochrome into the spray and the examination of the dried deposit under ultraviolet light. The fluorescent pigment "Saturn Yellow" and a small quantity of wetting agent were applied through the sprayer at 8 oz per 100 gal. A direct visual examination of the spray distribution was made by studying each leaf surface under two 125W ultraviolet lamps arranged over a white background. Photographic recordings of the standards used for assessment were obtained with Ilford FP3 (ASA125) film exposed for 30 sec at f4.0, using a wide-angle lens at a distance of 18 in. A Walz Y2 yellow filter was satisfactory for excluding ultraviolet light from the camera lens.

Assessment of spray distribution.—Assessment of spray distribution was based on the leaf area covered by the fluorescent dye. Three categories of leaf cover were recognized:

(i) Satisfactory distribution (S) (Figure 1): approximately 75% or more of the leaf surface showed a fluorescent deposit.

(ii) Nil distribution (L) (Figure 2): approximately 15% or less of the leaf surface showed a fluorescent deposit.

(iii) Medium distribution (M) (Figure 3): 15% to 75% (approximately) of the leaf surface showed a fluorescent deposit.

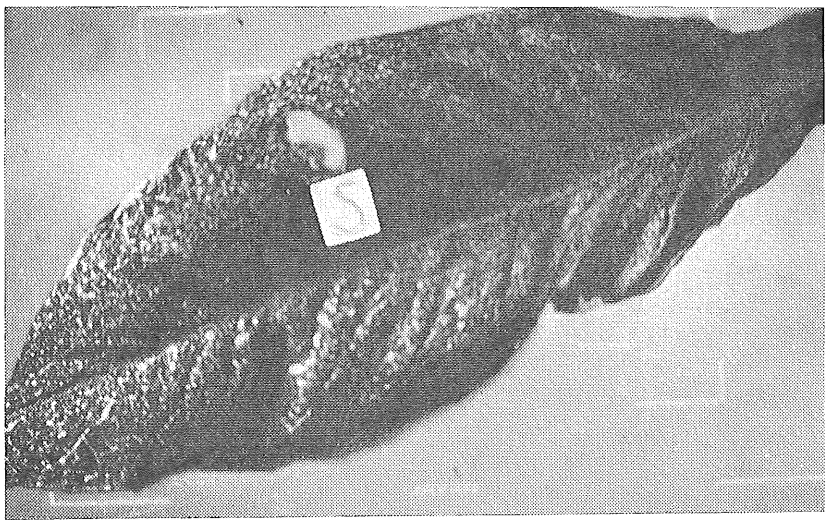

Fig. 1.—"Satisfactory" distribution: 75% of leaf surface shows a fluorescent deposit.

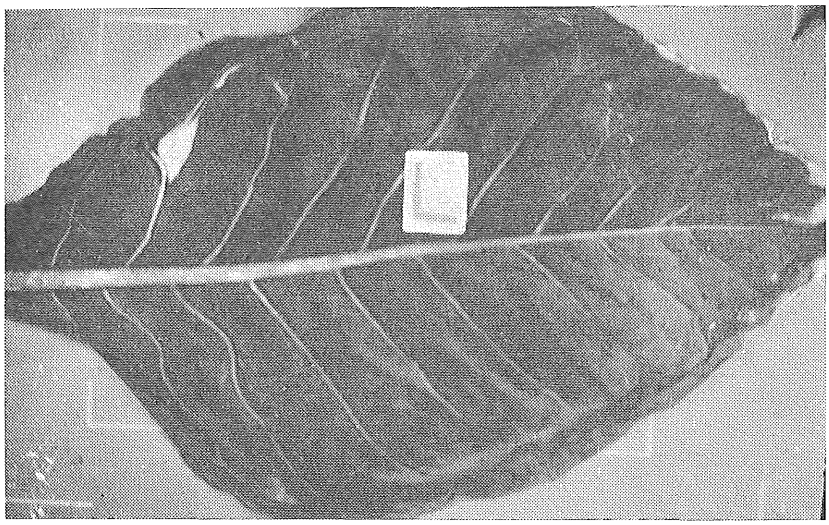

Fig. 2.—"Nil" distribution: no fluorescent deposit.

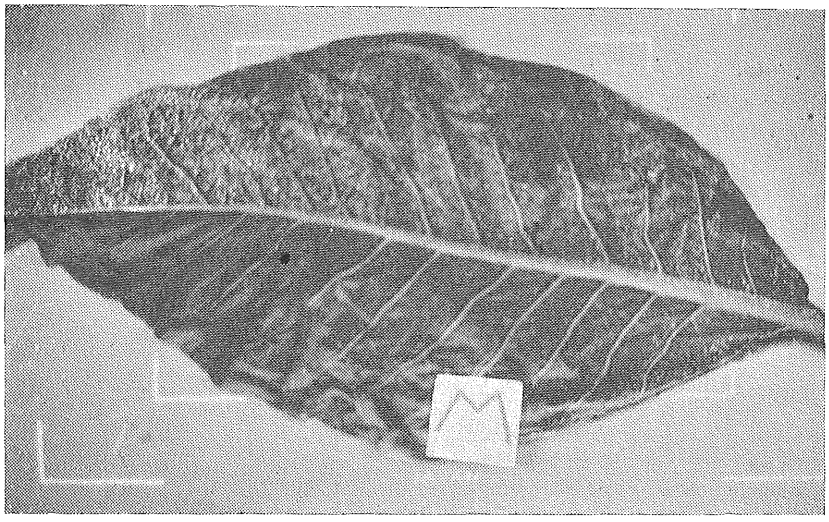

Fig. 3.—"Medium" distribution: between 15% and 75% of leaf surface shows a fluorescent deposit.

Using the system of rating described above, many complicated patterns arose in the "medium" rating due to shading of leaves and curled edges. For practical reasons, viz. speed, ease of assessment and the difficulty in interpretation, all partly covered leaves were classified in one category.

In recording the results, the number of leaf surfaces in each assessment category was expressed as a percentage of the total number of leaf surfaces examined.

As commercial tobacco crops require spraying for insect and disease control at all stages of growth, leaf coverage determinations were made at the following growth stages:

1st spraying: plants less than 12 in. high, at the 12-leaf stage.

2nd spraying: plants less than 24 in. high, at the 18-leaf stage.

3rd spraying: plants fully grown, and the flower-head removed.

Spray machinery.—The three types of machines examined are used to spray 90% of the tobacco grown in the Mareeba–Dimbulah area. Two of the sprayers, viz. the side-mounted boom without droppers and the low-volume misting machine, are widely used and are capable of covering relatively large areas quickly. The third machine, a self-propelled, high-clearance, rear-mounted boom sprayer with inter-row droppers, is a recent development in tobacco pesticide application and has been used on a limited scale with excellent results (G. W. Saunders personal communication 1966). Tests on each machine closely followed commercial spray practices.

The side-mounted boom sprayer without inter-row droppers is commonly known as an offset boom. The machine is tractor-drawn and capable of spraying six rows through four overhead nozzles directed at each row. It operates at 100 p.s.i. pressure, delivering 80–90 gal/ac. Spraying was conducted using

"Drewburn" hollow-cone nozzles. The experimental area sprayed on each occasion consisted of a block of 12 rows 3 chains in length. Two plants from each row were removed after spraying for examination of the spray deposit.

The low-volume misting machine travelled at 2 m.p.h. with an output of 240 cu ft of air per minute and applied 20 gal/ac across 13 rows. For examination of the spray distribution, the experimental area consisted of 26 rows 1½ chains in length. Spraying was conducted parallel to the outside rows with the spray directed across 13 rows. Starting at the first row, two plants were removed for examination from every second row up to row 13. The second 13 rows were sampled in a similar manner. Spraying on each occasion was done in the early morning when the effect of air movement was negligible.

The self-propelled, high-clearance boom spray locally known as a "tricrop" is capable of spraying four rows. The length of the inter-row "dropper" and the number of nozzles per dropper were varied with the stage of growth of the crop. When the plants were less than 12 in. high four nozzles were used per row with the dropper nozzles at ground level. For the remaining spray dates six nozzles were used per row and the dropper length adjusted according to the height of the crop. The bottom nozzles were at ground level and the middle nozzles at a height equal to the middle of the tobacco plant. At each spraying the overhead nozzles were about 9 in. above the crop. The machine applied 50–60 gal/ac when using four nozzles per row and 80–90 gal/ac when using six nozzles per row. Spraying was conducted at 100 lb p.s.i., using "Rega" adjustable No. 6 nozzles. The experimental area sprayed consisted of eight rows 1½ chains in length. On each spray date four plants were sampled from each row.

III. RESULTS

The results (Table 1) indicate the relative performance of the various machines in depositing spray on the tobacco plant for the three comparable growth stages. The tricrop sprayer at each growth stage has resulted in a higher percentage of leaf surfaces being completely or partly covered, though deficiencies in leaf cover on both the upper and the lower leaf surfaces occur with all machines. The importance of these deficiencies in terms of economic control would depend on their magnitude and also on the habit of the pest.

TABLE 1

SPRAY COVERAGE RESULTS EXPRESSED AS THE PERCENTAGE OF LEAF SURFACE FALLING INTO EACH ASSESSMENT CATEGORY

Growth Stage	Leaf Surface	Tricrop			Offset Boom			Low-volume Mister		
		S	M	L	S	M	L	S	M	L
12-leaf ..	Upper ..	84	5	11	72	9	19	69	8	22
	Lower ..	33	13	54	5	5	90	5	7	88
18-leaf ..	Upper ..	79	3	18	79	3	18	65	6	29
	Lower ..	39	33	28	18	12	71	13	20	67
After topping	Upper ..	100	..	..	94	5	1	89	9	2
	Lower ..	43	37	20	3	5	92	17	34	49

S, > 75%; M, 15 to 75%; L, < 15%

Further examination of each growth stage indicates the occurrence of the deficiencies in relation to the leaf position on the plant (Tables 2-4).

Plants at the 12-*leaf stage*.—Until flowering, the top 3–4 leaves form a tightly packed whorl which is commonly known as the "heart" of the plant. Examination of Table 2 indicates that at this growth stage, with all machines, the deficiency in leaf cover occurs in two plant positions:

(i) The heart of the plant. The magnitude of the deficiency varies with the machine, the tricrop being the most efficient.

(ii) Lower leaf surfaces. It is apparent that the offset boom was incapable of depositing spray on this section of the plant. The tricrop sprayer with droppers into the inter-row spaces resulted in a slight improvement but 70–80% of these leaf surfaces showed no spray deposit.

TABLE 2

SPRAY COVERAGE RESULTS EXPRESSED AS THE PERCENTAGE OF LEAF SURFACES FALLING INTO ASSESSMENT CATEGORY FOR THREE LEAF GROUPS FOR PLANTS AT THE 12-LEAF STAGE

Leaf Position	Leaf Surface	Tricrop			Offset Boom			Low-volume Mister		
		S	M	L	S	M	L	S	M	L
Top 4 leaves ..	Upper ..	58	14	28	44	17	39	22	17	61
	Lower ..	68	17	15	11	6	83	16	24	60
Middle leaves	Upper ..	100	..	..	100	..	..	93	7	..
	Lower ..	20	10	70	..	3	97	19	22	59
Lower 4 leaves	Upper ..	98	..	2	80	6	14	97	3	..
	Lower ..	6	4	90	5	5	90	8	4	88

S, > 75%; M, 15% to 75%; L, < 15%

Plants at the 18-*leaf stage*.—Plants at this stage were actively expanding. Deficiencies in leaf cover (Table 3) occurred in similar plant positions as was recorded for the earlier growth stage:

(i) The absence of leaf cover in the heart of the plant was most marked with the low-volume misting machine.

TABLE 3

SPRAY COVERAGE RESULTS EXPRESSED AS THE PERCENTAGE OF LEAF SURFACES FALLING INTO EACH ASSESSMENT CATEGORY FOR THREE LEAF GROUPS FOR PLANTS AT THE 18-LEAF STAGE

Leaf Position	Leaf Surface	Tricrop			Offset Boom			Low-volume Mister		
		S	M	L	S	M	L	S	M	L
Top 4 leaves ..	Upper ..	17	6	77	30	10	60	..	3	97
	Lower ..	19	21	60	40	20	40	2	10	88
Middle leaves	Upper ..	98	2	..	100	..	..	90	6	5
	Lower ..	54	38	8	3	13	94	18	26	56
Lower 4 leaves	Upper ..	94	3	3	1	..	..	95	3	2
	Lower ..	11	36	53	..	..	100	4	8	88

S, > 75%; M, 15% to 75%; L, < 15%

(ii) As in the earlier growth stage, the offset boom was incapable of depositing spray on the lower leaf surface. A marked deficiency also occurred in this section of the plant with the low-volume misting machine. The advantage of the dropper nozzles on the tricrop sprayer was obvious, as it is only in the lower quarter of the plant that the lower leaf surfaces did not show a spray deposit.

Plants after topping.—At this growth stage the plants had 20–24 leaves. The heart of the plant had opened and the flower-head had been removed. The marked difference between the sprayers at this growth stage (Table 4) resulted from their ability to deposit spray on the lower leaf surface. The tricrop sprayer was the most efficient in this regard as it was only in the lower four leaves on the plant that the spray deposit was absent on the lower leaf surface.

TABLE 4

SPRAY COVERAGE RESULTS EXPRESSED AS THE PERCENTAGE OF LEAF SURFACES FALLING INTO EACH ASSESSMENT CATEGORY FOR THREE LEAF GROUPS FOR PLANTS WHICH HAD BEEN TOPPED

Leaf Position	Leaf Surface	Tricrop			Offset Boom			Low-volume Mister		
		S	M	L	S	M	L	S	M	L
Top 4 leaves ..	Upper ..	100	..	..	100	..	..	56	38	6
	Lower ..	71	23	6	7	13	80	45	50	5
Middle leaves	Upper ..	100	..	..	100	..	..	84	15	1
	Lower ..	46	50	4	..	3	97	15	37	48
Lower 4 leaves	Upper ..	100	..	..	89	6	5	86	12	2
	Lower ..	12	12	76	..	..	100	1	7	92

S, > 75%; M, 15% to 75%; L, < 15%

IV. DISCUSSION

Paddick (1965) indicated that the performance of a pesticide was dependent on the degree of cover obtained relative to that required. The efficiency of a pesticide is therefore closely related to the sprayer, the efficiency of which can be defined as the level of cover obtained relative to that required. The key to the efficiency of the machines examined in these trials would be the level of cover required for economic control.

Cunningham and Saunders (1964) indicated that for budworm (*Heliothis punctigera* (Wall.)) commercial control could be obtained by confining spray applications to the heart and upper portions of the plant but the control of leaf-miner (*Phthorimaea operculella* (Zell.)) and looper (*Plusia argentifera* (Guen.)) require an overall application to both leaf surfaces. Recommendations for the control of blue mould (*Peronospora tabacina* Adam) require a preventive spray to be deposited on the upper and the lower leaf surfaces of all rapidly expanding leaves on the plant (Pont and O'Brien 1965).

The cover necessary to control the various tobacco pests would involve the distribution of spray deposits to all leaf surfaces on the plant. In commercial practice this does not appear feasible, as no sprayer in current use is capable of achieving such a spray distribution. The deficiencies which have appeared in the various sprayers in these trials would appear to be critical. In commercial practice the tricrop sprayer has given excellent control over a number of years (Wright 1964; G. W. Saunders personal communication 1966). Therefore, it is logical

to assume that the differences that occurred between the recommended and observed levels of cover for an efficient commercial spray programme are not critical in terms of effective control. In the absence of biological evidence to the contrary, such an approach is justified as it is practical in terms of the farm spraying programme, and it allows for a realistic standard which is attainable with commercial sprayers. To obtain complete cover of both leaf surfaces of all leaves on the tobacco plant would require precision spraying, which does not appear to be warranted in terms of either time or machinery.

Accepting the level of cover obtained with the tricrop sprayer as the standard necessary for commercial pest and disease control, the main deficiency of the other two machines examined is their inability to deposit spray on the lower leaf surface below the heart. The low-volume mister is somewhat more efficient than the offset boom. Experience indicates, however, that the deficiencies in both machines are critical in commercial practice. The other important point about the low-volume misting machine is that the results obtained were susceptible to spraying conditions. Spraying in windy conditions resulted in little of the spray being deposited on the leaf surface.

The data obtained from these studies indicate that for pest and disease control in north Queensland the tricrop sprayer is the most efficient of the machines examined. Where practical, a change to this machine or a similar type is warranted. Both the low-volume misting machine and the offset boom sprayer show marked deficiencies in distributing sprays onto the lower leaf surfaces and into the heart of the plant.

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