STUDIES ON THE EFFECT OF SOME UREA-HERBICIDES ON THE WATER-BALANCE OF VICIA FABA

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INTRODUCTION

In the previous work on the effect of herbicides on plant transpiration attention has been given to the action of these chemicals on stomata, being the major pathway for transpiration. Most of the available data point to a decrease in transpiration resulting from stomatal closure. Brown (1946) reported reduced transpiration rate in bean plants treated with 0.1% 2,4—D. The effect remained for five days after treatment where transpiration was 34% less than the control. Similar, results were obtained by Kasperik (1955) and Rakitin *et al.* (1959). Also Sivadjian (1967) observed that saturated solution of atrazine reduced transpiration in *Phaseolus* leaflets ; the effect remained 3—4 hours after treatment. Minshall (1960) reported a decrease in transpiration of 40—50% in the leaves of kidney beans when their petioles were immersed in monuron solution at an internal concentration of 15—20 mg/gm fresh weight of leaf. However, with internal concentration of 5—10 mg/gm fresh weight of leaf, transpiration was increased. Smith *et al.* (1964) also observed a marked reduction in transpiration after treatment with many chemicals including linuron and referred the reduction partly to stomatal closure. It is possible that stomatal closure might be the indirect result of suppression of photosynthesis. That ibhibition of photosynthesis results by the application of urea-herbicides was observed by Rogers *et al.* (1968) in cucmber and beans. The consensus is that CO_2 concentration in the leaves occupies a key position in the sequence of events leading to stomatal opening and closure. A reduction in the use of CO_2 in photosynthesis could result in its accumulation and the consequent closure of stomata (Kettelaper 1959).

As plants respond differently to a certain herbicide depending on their nature ; the work presented herein was undertaken to test

the response of *Vicia faba* to linuron and cotoran supplied in sublethal concentrations.

MATERIAL AND METHODS

The same variety of Vicia faba and technique of cultivation as in the previous communication (Amer, unpublished) was followed. Potometer experiments were also performed with rooted plants. The potometers were filled either with the nutrient alone for control or with the nutrient containing the appropriate concentration of the herbicide. Sublethal concentrations of two urea-herbicides were used. Linuron at 1, 10, 20 and 75 p.p.m. and cotoran at 1, 10 and 100 p.p.m. Duplicate potometers were used for the control and for each of the herbicide concentration. The mean values of transpiration and absorption calculated as mg/hr/dcm^2 are presented graphically. Also water content expressed as percentage of the original for each plant was recorded Air temperature and percentage relative humidity deficit for each hour of the experiment are also given.

RESULTS AND DISCUSSION

Linuron 3 — (3,4 dichlorophenyl) —1— methoxy —1— methyl urea was added at 1 and 10 p.p.m. concentrations in the first experiment. There was a slight rise in transpiration in the first two hours after application (Table 1 Fig. 1) which was more pronounced with 10 p.p.m. concentration, becoming twice its initial value. This increase was almost kept till 4 p.p.m. then the rate ran slightly below that of the control. With 1 p.p.m. concentration, however, transpiration rate was quite close to that of the control throughout the experimental period. The iucrease observed with the 10 p.p.m. concentration is in close agreement with the results of Minshall (1960), who observed similar increase in kidney-bean leaves when their petioles were dipped in low concentration of munuron another herbicide of the urea group. Though, the author did report no effect of the chemical on water absorption. In the present investigation, a continuous but slight rise above the control was observen. The fact that both transpiration and water absorption increased with low concentration of linuron, while opposite changes were observed with the same concentration of gramoxone (Amer, previous communication) indicates different mode of action of the two chemicals. Linuron might be effective through biochemical changes in the leaf cells activating absorption, while gramoxone cause permeability changes not functional in water absorption. It has been stated by Homer *et al.* (1960) and Mees

(1960) that bipyridilium herbicides cause extensive disorganization of cell membranes by the effect of their energetic radicals.

In a second experiment with linuron supplied at 10 and 20 p.p.m. (Table 2 Fig. 2), the same trend in transpiration was observed, slight increase after application was observed with both concentrations followed by a decrease except for the afternoon peak. The decrease was more apparent in the 10 p.p.m. treated plants pulling down the total loss to 8% compared to the control. This value is quite close to the reduction observed with the same concentraion in the pevious experiment. These results are in close agreement with those obtained by Allerup (1964), who stated that growth regulators like IAA, IBA and NAA cause only transient increase in the rate of transpiration followed by a fall. Also they agree with the results of Sitinkova (1966) using GA and IAA. Yet, they differ from the results obtained by Rao *et al.* (1963) who reported uniformly high rate of transpiration. However they partly agree with the results of Smith *et al.* (1964) who reported a marked reduction in transpiration after 4 hours of application of 20 mg/1. linuron ; yet it is possible that they overlooked the initial transitory increase. It is fairly well established that linuron exerts its effect on transpiration through its effect on stomatal mechanism. That the chemical causes stomatal opening followed by closure that lasted from 3—5 days was previously demonstrated in this laboratory.

In this experiment absorption also increases with lapse of time, but it did not restore the water content to its original level, it dropped to 93% of this value. Such results are different from those reported by Kozinka (1967) where loss caused a reduction in water uptake when he used growth substances. This again indicates a different mode of action between growth regulators and substituted-urea compounds. This indicates that urea-compounds have no damaging effect on roots but only affect the Hill reaction and consequently stomatal closure (cf Moreland *et al.* 1958).

In a third experiment (Fig. 3 Table 3) using 20 and 75 p.p.m. linuron, again the same trend in transpiration rate was observed, a transient increase followed by a fall. But, in general the reduction was lower and was reflected in a less rduction in water content pulling it down to 97% their original values with both concentrations. Such lower reduction might be partly attributed to the prevailing atmospheirc conditions where air temperature and relative humidity deficit being less severe. The effect of the atomspheric evaporating power is more pronounced in *Vicia* where cuticular téanspiration is appreciables.

On using another substituted-urea herbicide (fluometron) N-N-dimethyl-N' (3 - tri fluoro methyl pheynl) at 1 and 10 p.p.m. concentration in one experiment (Table 4 Fig. 4) the following results were obtained. Transpiration showed a slight rise till early afternoon both in control and treated plants. Later a clear drop was observed in all ; but the gross amount of water lost was lower in the treated plants and was proportional to the concentration of the herbicide. Such results are in agreement with those of Sivadjian et al. (1965) using saturated atrazine. Yet they deviate from the results of Rao et al. (1963) using 2,4-D on *Trianthema* sp. As in the case of linuron there seems to be a different mode of action of urea-herbicides on the water economy in plants compared to growth hormones. It also suggests an explanation for the work of Rogers *et al.* (1968) who observed a reduction in photosynthesis when using flumetron on cucumber, bean and cotton Photosynthesis is definetely a function of water-content.

Absorption, also showed a slight drop after treatment, it rose slightly later then dropped again in the afternoon. The water content changed slightly showing a mean of 94, 93 and 97% of the original values in the control and treated plants respectively.

In another experiment with fluometron at 10 and 100 p.p.m. (saturated solution) transpiration showed the following trend (Table 5 Fig. 5) ; there was a slight rise just after treatment followed by a drop that was more pronounced with the saturated solution.

This recalls again the conclusion by Sivadjian *et al.* (1965). Absorption also as in the previous experiment increased slowly in control and treated plants. In the afternoon, it started to drop only in the treated plants thus clearly deviating from the control. This relation restored the water content where only a drop of 3% of the original value resulted in the plants treated with 100 p.p.m. fluometron.

SUMMARY

Potometer experiments were performed on *Vicia faba* plants supplied with Linuron and Fluometron ranging in concentrations from 1 p.p.m. to saturation. Linuron solution, at all concentrations, caused an increase in transpiration followed by decrease. Absorption also increased slowly restoring the water content of the plants. Fluometron, resulted in a less discernible increase after application followed by more pronounced reduction which is a function of concentration.

It seems that the effects of urea-herbicides are different from hose of Gramoxone on the water economy of *Vicia faba* plants. With he former herbicides the decrease was accompanied by increase in

absorption, whereas with gramoxone, absorption did not increase. This recalls the statement of Sivadjian (1967) that the increase in the water loss with gramoxone spray is not transpirational but resulted from water loss from the damaged leaf areas and did not result in an increase in the transpirational pull.

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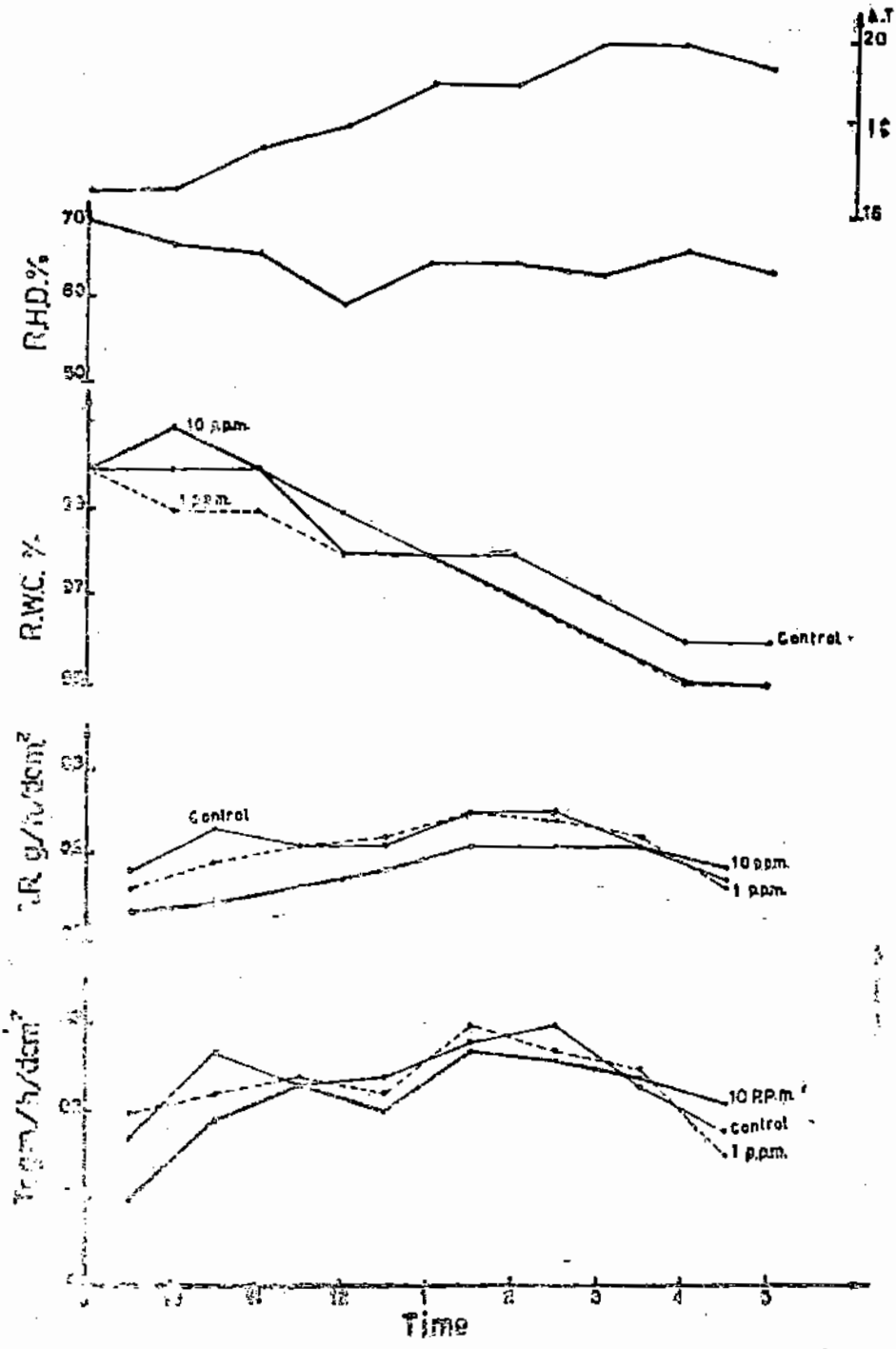

Fig. 1 : The effect of 1 and 10 p.p.m. Linuron supply on the daily march of transpiration, absorption and % relative water content of Vicia faba.

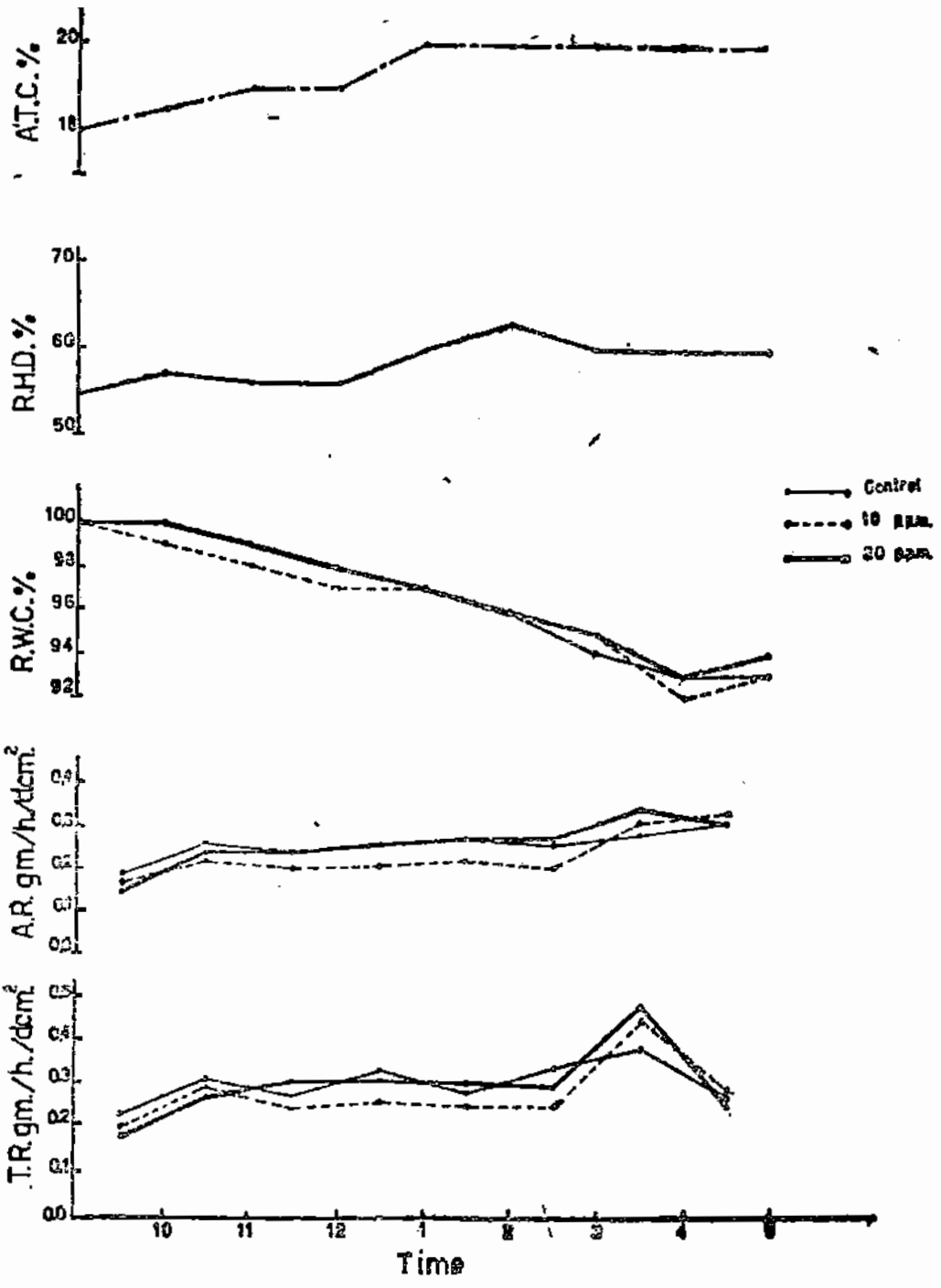

Fig. 2 : The effect of 10 and 20 p.p.m. Linuron supply on the daily march of transpiration, absorption and % relative water content of Vicia faba.

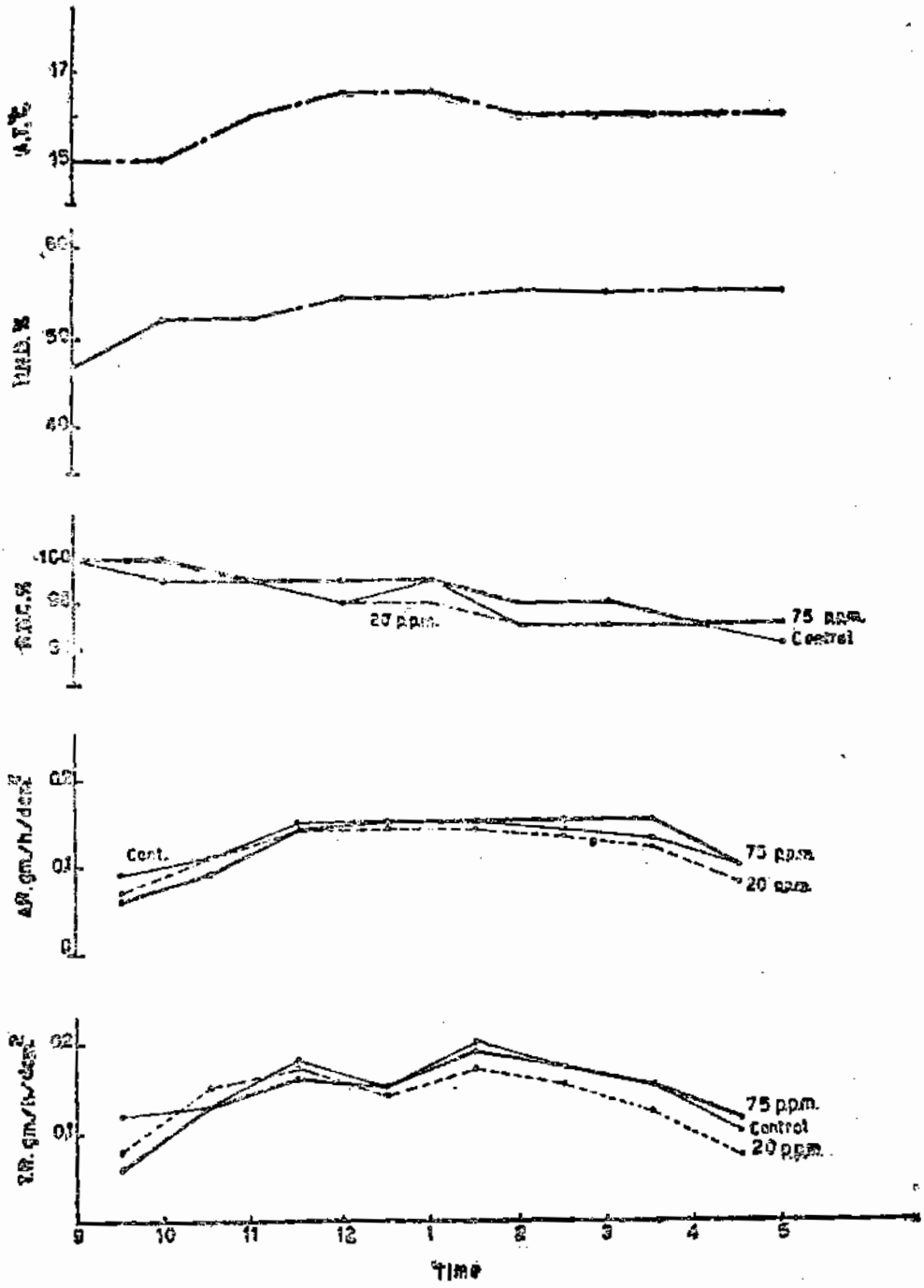

Fig. 3 : The effect of 20 and 75 p.p.m. Linuron supply on the daily march of transpiration, absorption and % relative water content on Vicia faba.

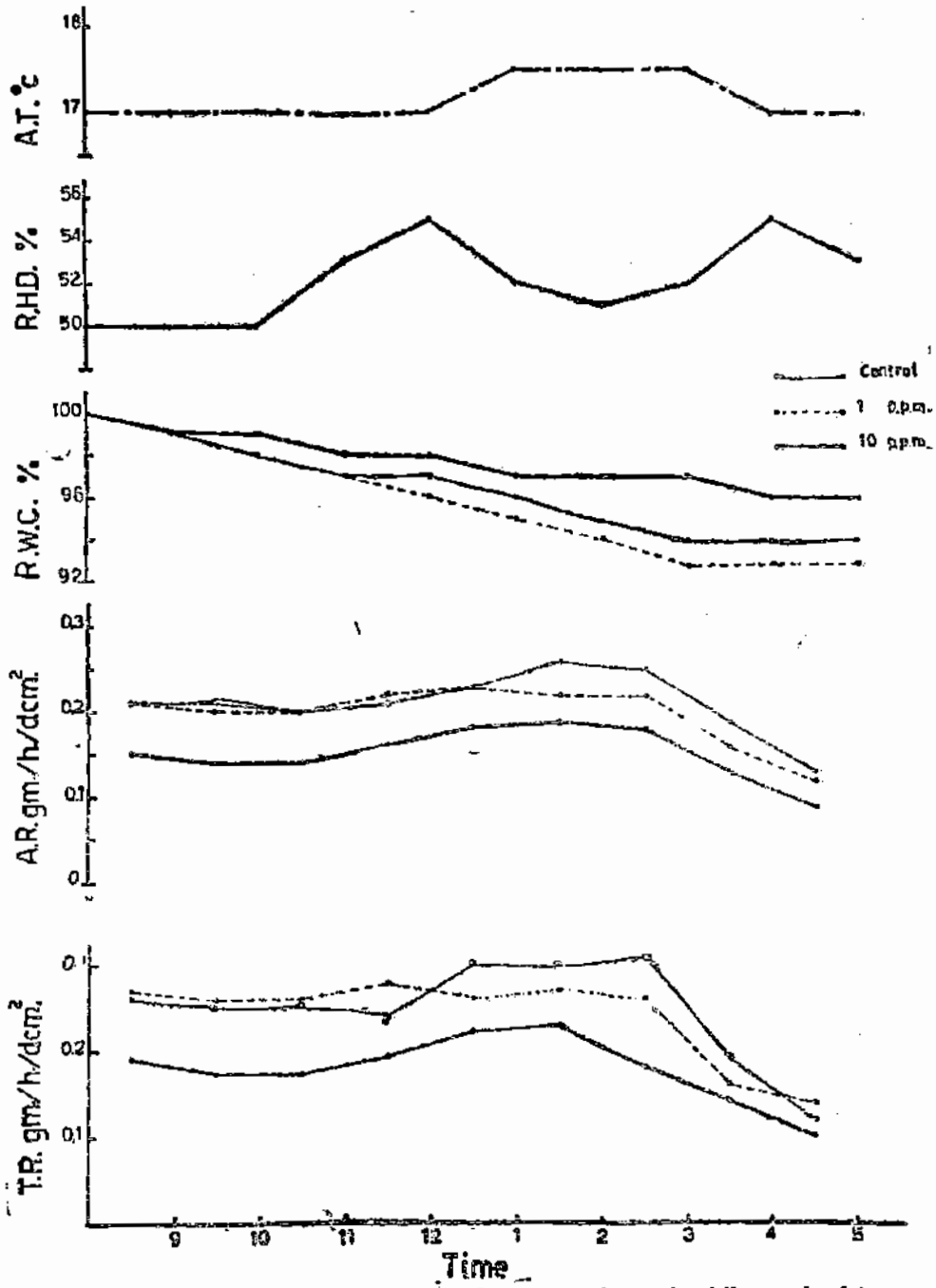

Fig. 4 : The effect of 1 and 10 p.p.m. Cotoran supply on the daily march of transpiration, absorption and % relative water content of Vicia faba.

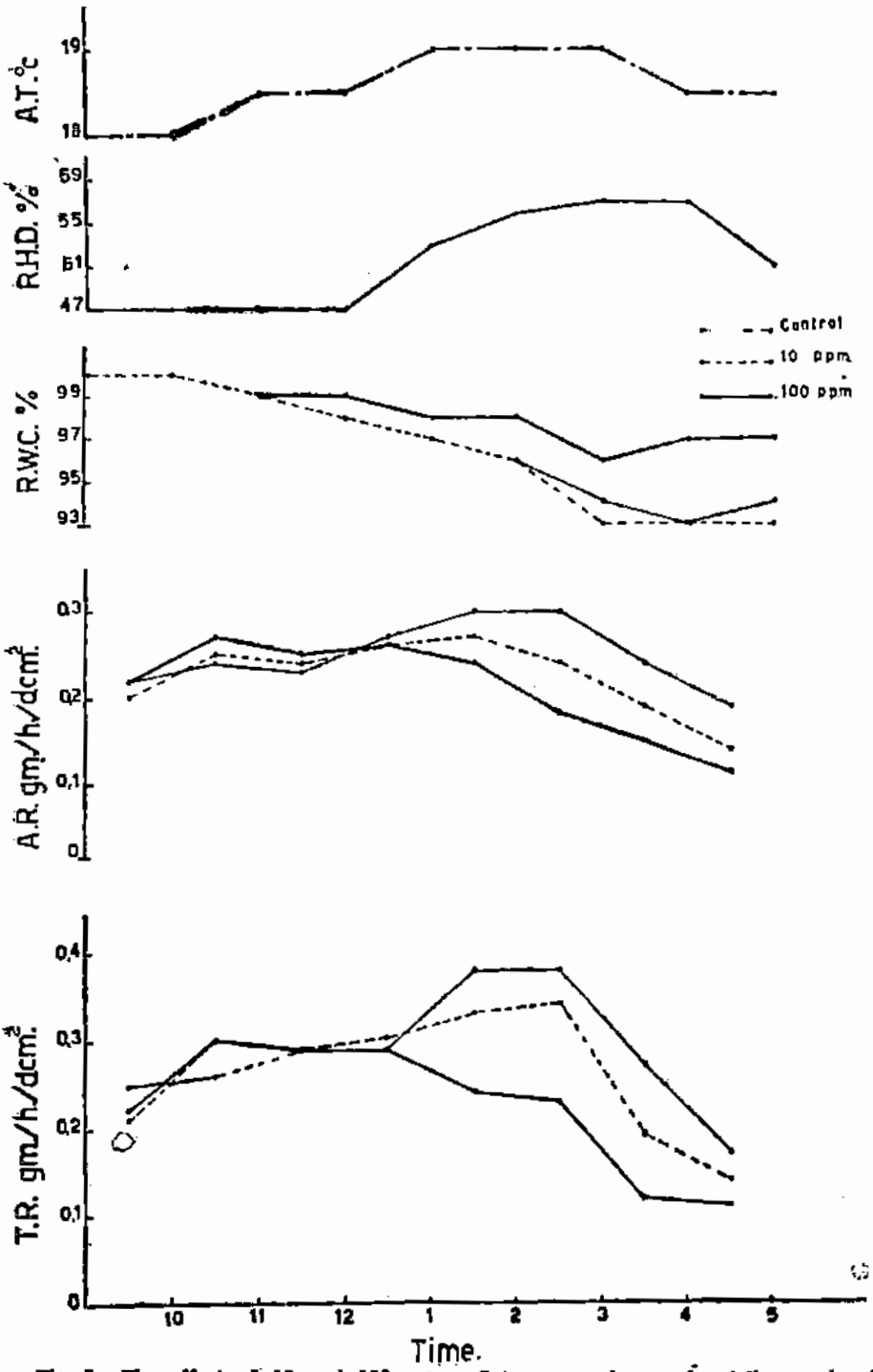

Fig. 5 : The effect of 10 and 100 p.p.m. Cotoran supply on the daily march of transpiration, absorption and % relative water content in Vicia faba.

Table 1: The effect of 1 and 10 ppm lindron supply on the daily march of transpiration, absorption and % relative water content in 4 weeks old plants.

	Control	1 ppm	10 ppm
Final fresh wt. of shoot (gm)	8.94	11.02	10.22
Oven dry wt. of shoot (gm)	0.48	0.63	0.62
Leaf area (dcm^2)	2.01	2.66	2.18
w. content% fresh wt.	94.60	94.30	93.90

Time	Atmospheric factors		Control			1 ppm			10 ppm		
	A.T °C	R.H.D %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %
9 am	16.5	69			100			100			100
			0.17	0.18		0.20	0.16		0.10	0.13	
10	16.5	66			100			99			101
			0.27	0.23		0.22	0.19		0.19	0.14	
11	17.5	65			100			99			100
			0.23	0.21		0.24	0.21		0.23	0.16	
12 N	18.0	58			99			98			98
			0.24	0.21		0.22	0.22		0.20	0.18	
1 pm	19.0	64			98			98			98
			0.28	0.25		0.30	0.25		0.27	0.21	
2	19.0	64			98			97			97
			0.30	0.25		0.27	0.24		0.26	0.21	
3	20.0	63			97			96			96
			0.23	0.21		0.25	0.22		0.24	0.21	
4	20.0	66			96			95			95
			0.18	0.17		0.15	0.16		0.21	0.18	
5	19.5	63			96			95			95

Table 2: The effect of 10 and 20 ppm Linuron supply on the daily march of transpiration, absorption and % relative content in 4 weeks old plants.

	Control	10 ppm	20 ppm
Final fresh wt. of shoot (gm)	9.93	9.96	8.39
Oven dry wt (gm)	0.68	0.67	0.57
Leaf area (dcm^2)	2.07	1.86	1.59
W.content % fresh wt.	93.20	93.30	93.20

Time	Atmospheric factors		Control			10 ppm			20 ppm		
	A.T °C	R.H.D %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %
9 am	18.0	55			100			100			100
			0.23	0.19		0.20	0.17		0.18	0.15	
10	18.5	57			100			99			100
			0.31	0.26		0.29	0.22		0.25	0.24	
11	19.0	56			99			98			99
			0.27	0.24		0.24	0.20		0.30	0.24	
12 N	19.0	56			98			97			98
			0.33	0.26		0.26	0.21		0.31	0.26	
1 pm	20.0	60			97			97			97
			0.28	0.27		0.25	0.22		0.30	0.27	
2	20.0	63			96			96			96
			0.34	0.26		0.25	0.20		0.29	0.27	
3	20.0	60			95			95			96
			0.38	0.28		0.45	0.31		0.48	0.34	
4	20.0	60			93			92			93
			0.27	0.31		0.28	0.33		0.25	0.31	
5	20.0	60			93			93			94

Table 3: The Effect of 20 and 75 ppm linuron supply on the daily march of transpiration, absorption and % relative water content in 4 weeks old plants.

	Control	20 ppm	75 ppm
Final fresh wt. of shoot (gm)	7.21	8.64	9.79
Oven dry wt. (gm)	0.40	0.48	0.52
Leaf area (dcm^2)	1.63	1.97	2.35
W. content % fresh wt.	94.50	94.40	94.70

Time	Atmospheric factors		Control			20 ppm			75 ppm		
	A.T °C	R.H.D %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %	T $g/h/dcm^2$	A $g/h/dcm^2$	R.W.C %
9 am	15.0	47			100			100			100
			0.12	0.09		0.08	0.07		0.06	0.06	
10	15.0	52			99			100			100
			0.13	0.11		0.15	0.11		0.13	0.09	
11	16.0	52			99			99			99
			0.18	0.15		0.17	0.14		0.16	0.14	
12 N	16.5	54			98			98			99
			0.15	0.15		0.14	0.14		0.15	0.15	
1 pm	16.5	54			99			98			99
			0.20	0.15		0.17	0.14		0.19	0.15	
2	16.0	55			97			97			98
			0.17	0.14		0.15	0.13		0.17	0.15	
3	16.0	55			97			97			98
			0.15	0.13		0.12	0.12		0.15	0.15	
4	16.0	55			97			97			97
			0.10	0.10		0.07	0.08		0.11	0.10	
5	16.0	55			96			97			97

Table 4: The effect 1 and 10 ppm coteran supply on the daily march of transpiration, absorption and % relative water content in 4 - weeks old plants.

	Control	1 ppm	10 ppm
Final fresh wt. of shoot (gm)	10.81	9.51	10.75
Oven dry wt. (gm)$_2$	0.73	0.67	0.74
Leaf area (dcm^2)	1.80	1.73	1.74
W. content % fresh wt.	93.20	92.90	93.10

Time	Atmospheric factors		Control			1 ppm			10 ppm		
	A.T °C	R.H.D %	T g/h/dcm^2	A g/h/dcm^2	R.W.C %	T g/h/dcm^2	A g/h/dcm^2	R.W.C %	T g/h/dcm^2	A g/h/dcm^2	R.W.C %
8 am	17.0	50			100			100			100
			0.26	0.21		0.27	0.21		0.19	0.15	
9	17.0	50			99			99			99
			0.25	0.21		0.26	0.20		0.17	0.14	
10	17.0	50			98			98			99
			0.25	0.20		0.26	0.20		0.17	0.14	
11	17.0	53			97			97			98
			0.24	0.21		0.28	0.22		0.19	0.16	
12 N	17.0	55			97			96			98
			0.30	0.23		0.26	0.23		0.22	0.18	
1 pm	17.5	52			95			95			97
			0.30	0.26		0.27	0.22		0.23	0.19	
2	17.5	51			95			94			97
			0.31	0.25		0.26	0.22		0.18	0.18	
3	17.5	52			94			93			97
			0.19	0.19		0.16	0.16		0.14	0.13	
4	17.0	55			94			93			96
			0.12	0.13		0.14	0.12		0.10	0.09	
5	17.0	53			94			93			96

TABLE 5

The effect of 10 and 100 ppm cotoran supply on the daily march of transpiration, absorption and % relative water content in 4 weeks old plants.

	Control	10 ppm	100 ppm
Final fresh wt. of shoot (gm)	8.39	7.45	6.96
Oven dry wt. (gm)	0.50	0.42	0.42
Leaf area (dcm^2)	1.78	1.70	1.71
w. content % fresh wt.	94.00	94.40	94.00

Time	Atmospheric factors		Control			10 ppm			100 ppm		
	A.T °C	R.H.D %	T g/h/dcm^2	A g/h/dcm^2	R.W.C %	T g/h/dcm^2	A g/h/dcm^2	R.W.C %	T g/h/dcm^2	A g/h/dcm^2	R.W.C %
9 am	18.0	47			100			100			100
			0.25	0.22		0.21	0.20		0.22	0.22	
10 -	18.0	47			100			100			100
			0.26	0.24		0.30	0.25		0.30	0.27	
11	18.5	47			99			99			99
			0.29	0.23		0.29	0.24		0.29	0.25	
12 N	18.5	47			98			98			99
			0.29	0.27		0.30	0.26		0.29	0.26	
1 pm	19.0	53			97			97			98
			0.38	0.30		0.33	0.27		0.24	0.24	
2	19.0	56			96			96			98
			0.38	0.30		0.34	0.24		0.23	0.18	
3	19.0	57			94			93			96
			0.27	0.24		0.19	0.18		0.12	0.15	
4	18.5	57			93			93			97
			0.17	0.19		0.14	0.14		0.11	0.11	
5	18.0	51	—		94			93			97