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DESIGN AND FABRICATION OF A LEAF AREA METER WITH PHOTODIODE

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A photodiode has been in one arm of simple bridge circuit. Leaf specimen, when placed on the stage, causes light flux to change. This change corresponds to area of leaf and is read from digital multimeter. This fabricated instrument measures the area of leaves quicker than planimeter and with more accuracy.

INTRODUCTION

In the field of Agriculture among different parameters of leaf study, the leaf area has basic importance as it throws light on the physiology of the plant. In a number of branches of Agriculture, the reserach about leaf has the basic role. Among the other informations about the leaf, leaf area is very important. Leaf area is usually measured by conventional methods. This is an attempt to design a "Leaf Area Meter" (Bate *et al.* 1971). For statistical analysis of growth, a number of parameters are used. Leaf area is one of the important growth parameters, as it throws light on the physiology of the plants and is widely used to estimate the mathematical terms involved (i.e., growth parameters) such as leaf area ratio (LAR), net assimilation rate (NAR), Leaf Area Index (LAI) and relative leaf growth rate (RLGR) etc.

REVIEW OF LITERATURE

Gregory (1917) developed a mathematical model of growth analysis from primary growth data and defined the term net assimilation rate (NAR) and estimated the yield and production.

Darrow (1930) described three methods of leaf area measurement:

a) Graphic method

b) Leaf product method

c) Planimeter method.

Salisbury (1957) discussed the construction, working and accuracy in measurements by planimeter.

Frederic *et al.* (1969) mentioned that precision of instrument is measured by the standard deviation of error in measurements. They also described other informations of statistical use.

Sol (1971), Ronald (1975) and Charles (1979) described different types of electric instruments and transducers in which photodiode has key role.

Zafar (1975) measured the effect of "c c c" on the Leaf Area per plant during the growth analysis of tomato. He used a planimeter and recorded the observations in Sq. cm.

Azhar (1979) calculated Leaf Area by leaf product method.

Ahmad (1982) designed and fabricated a Leaf Area meter and determined the area of about 150 specimen.

MATERIAL AND METHOD

A) Principle. Light from a source of long wavelength radiation is allowed to fall on the stage and then converged to target point where the photodiode is mounted. The circuitry is of a simple bridge circuit with two variable resistance. One of them is photodiode and other is the adjust knob. For full stage illumination the read-out unit (Digital multimeter, D.M.M) is adjusted to zero. Then the specimen is placed on the stage. It cuts down the light flux and accordingly the resistance of photodiode is increased. This shifts the balance point of bridge circuit and D.M.M. shows the reading of area of specimen. Exact reading is manipulated with the help of response curves (James)[8].

B) Circuit Diagram. In the circuit diagram, R_1 is a photodiode, R_2 is a one Megohm variable resistance, R_3 and R_4 are two 10K resistance. All the above mentioned resistances form the bridge circuit as shown in Fig. 1.

C) Reliability in Measurement. For comparative study of area measuring methods, area of 50 specimen (of

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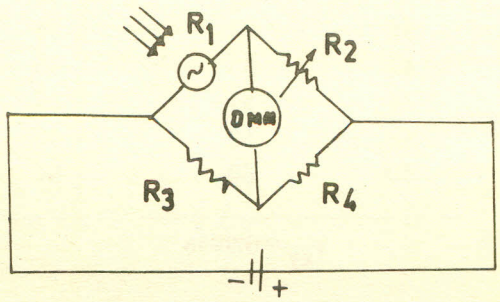

Fig. 1.

standard area) were measured with "Leaf Area Meter" and then area of 50 specimen were also measured with "Planimeter." Three methods of area measurements are given below:

1. Standard method
2. Leaf area meter method
3. Planimeter method

RESULT AND DISCUSSION

After the fabrication of "Leaf Area Meter," observations were made for comparative study of "Leaf Area Meter" and "Planimeter" (for exact reading of area measured by the meter, the reading shown by DMM were manipulated by conversion graph fixed at the face of Leaf Area Meter). The graph showing photodiode characteristics at different voltages is shown in Fig. 2.

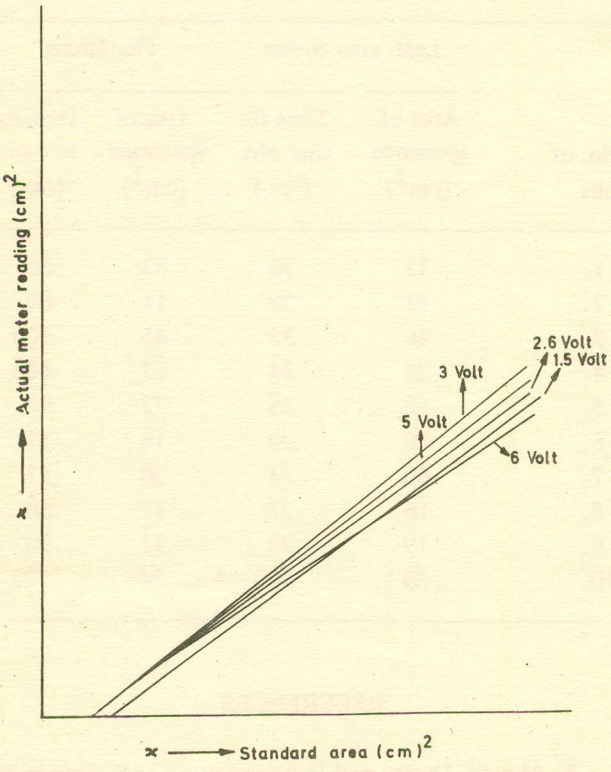

Fig. 2. Diagram showing the photodiode characteristics curves at different volts.

The comparative statistics of the two instruments is given below in Table 1.

Table 1.

		Leaf area meter	Planimeter
1.	Correlation co-efficient of area measurements.	$r_{xy} = 0.9986$	$r_{xz} = 0.984$
2.	Coefficient of determination of area measurement.	$r^2_{xy} = 0.997$	$r^2_{xz} = 0.968$
3.	Standard deviation of error in measurements.	S.D. = .028	S.D = .557
4.	T-values (paired)	$t_c = .211$ NS	$t_c = 5.56$*
5.	Mean time for one observation (sec.).	$T_y = 30$	$T_z = 87.4$

x : Area measurement by Standard Method " cm^2
y : Area measurements by "Leaf Area Meter Method" cm^2
z : Area measurements by "Planimeter method" cm^2
T_y: Mean time of observation by "Leaf Area Method"
T_z: Mean time of observation by "Planimeter method"

Results 1 to 3 given in Table 1 are taken from APPENDIX – I and the results 4 to 5 from the data of APPENDIX – II.

Table 1 shows that there is approximately zero dependence between the specimen and the time for one observation by "Leaf Area Meter" (i.e. time for observations is not affected by the area of the specimen). But in case of "Planimeter" the time of observation depends upon the area of the specimen. In case of leaves with irregular margins, time for one observation further increases.

CONCLUSIONS

i) "Leaf Area Meter" measures the area of leaves more accurately than planimeter. ii). "Leaf area meter" is quicker in measurement of leaf area than that of planimeter, iii). "Leaft Area Meter" measures the area of all types of (compound as well as diseased) leaves with same accuracy.

APPENDIX – I

	Standard area (cm^2)	Area by meter (cm^2)	Area measured by Planimeter. (cm^2)
	x	y	z
1.5 Volt	28	25	28
	30	30	26
	36	37	32
	40	43	39
	43	43	39
	46	45	47
	48	46	53
	68	66	68
	75	75	78
	80	80	94
		r_{xy} = 0.96418	
2.6 Volt	28	28	28
	30	29	26
	32	31	30
	34	34	30
	36	35	32
	42	43	40
	43	41	44
	46	44	47
	48	47	53
	68	68	68
		r_{xy} = .9981	
3 Volt	x	y	z
	24	25	24
	32	31	30
	42	43	40
	49	48	49
	59	58	60
	63	62	65
	64	60	65
	72	68	73
	80	80	90
		R_{xy} = 0.8022	
5 Volt	10	10	9
	18	17	16
	20	17	19
	22	19	21
	29	26	28
	38	34	35
	42	35	40
	54	51	59
	56	52	56
	60	60	61
		r_{xy} = 0.9956	
6 Volt	x	y	z
	10	12	9
	18	19	16
	20	20	19
	24	23	24
	25	24	23
	28	29	28
	45	43	56
	48	46	53
	54	54	59
	90	90	106
		r_{xy} = 0.9986	

APPENDIX – II

	Leaf area meter		Planimeter	
No. of obs.	Area of specimen (cm^2)	Time for one obs. (sec.)	Area of specimen (cm^2)	Time for one obs. (sec.)
1.	33	30	33	60
2.	13	26	11	80
3.	46	35	45	100
4.	22	34	53	108
5.	16	25	72	90
6.	50	30	14	111
7.	60	33	20	57
8.	16	27	37	60
9.	19	29	32	90
10.	29	36	74	110

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