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GROWTH ANALYSIS STUDIES IN MUNG (*Vigna radiata* L. Wilczck)

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ABSTRACT

Variations in plant dry weight, leaf area, leaf arearatio, leaf dry weight, specific leaf weight, leaf nitrogen contents, relative growth rate, net assimilation rate and the interrelationships between these characters were observed on six varieties of mung with diverse genetic makeup. The variety SML-32 responsive high tofertilization tended to show high specific leaf weight and leaf blade nitrogen contents in most of its growth stages as compared to other varieties in the test. The specific leaf weight and leaf nitrogen contents were highly significant and positively correlated with each other as well as with calculated net assimilation rate. Leaf area ratio showed negative correlation with net assimilation rate and total plant dry weight. It also showed positive correlation with relative growth rate. Net assimilation rate and relative growth rate showed positive correlation. Total dry matter production and leaf area ratio tended to be the highest in AUM-127 and minimum in variety AUM-10.

INTRODUCTION

The efficiency of mung plant to make best use of available nutrients depends upon the growth process which to a great extent is controlled by genetic factors. Although groth analysis techniques have been used for 50 years and have made a substantial contribution to the current concepts of physiological system in crop plants (Koller *et al.*, 1970), yet there have been few attempts to apply these techniques for the improvement of grain legumes in Pakistan. Considerable work on different crops has been reprted by Brougham (1960), Pearce *et al.* (1969), Khan and Tsunoda (1970a), Westfall (1973), Ishaq (1973), Gill (1974), Khan (1975) and Ahmad (1982). A precise growth analysis of mung varieties viz. AUM-10, AUM-127, AUM-233, Tehran 8085,

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SML-32, Philippine No. 8 was conducted to screen out genetic differences for growth systems. Generation of such an information will tremendously contribute towards the synthesis of physiologically more efficient mung genotypes for better grain productivity.

MATERIALS AND METHODS

The experimental materials consisted of six varieties of mung namely AUM-10, AUM-127, AUM-233, Tehran 8085, SML-32, abd Philippine No. 8. These varieties were sown in pots filled with nutrient free river sand during last week of Febraury, 1982 in two replications having 15 pots per variety per replication. Single plant was maintained in each pot after germination. The crop was raised on Sach's nutrient solution.

A random sample of 3 pots per variety per replication was taken at an interval of 10 days starting from the 30th day after planting. Leaf area was measured with the help of a planimeter when the leaves were fully turgid andt the plants were then uprooted and washed in running tap water. The plan parts like leaves, stem, roots were then cut and preserved separately. These were dried to a constant weight at 90 °C to determine the individual dry weights and the following characters were studied on these plants.

1. Leaf area (LA).
2. Leaf area ratio (LAR).
3. Specific leaf weight (SLW).
4. Total dry weight per plant (TDW).
5. Relative growth rate (RGR).
6. Net assimilation rate (NAR).
7. Nitrogen contents of the leaf blade.

Nitrogen analysis was conducted by the micro Kjeldahl method taking sub-samples of 100 mg powdered leaf material per variety.

Relative growth rate and net assimilation rate were determined for each interval between two samplings by the formula :

$$RGR = \frac{(\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

$$NAR = \frac{(W_2 - W_1)}{(t_2 - t_1)} \frac{(Log_e L_2 - Log_e L_1)}{(L_2 - L_1)}$$

Where W_2 and W_1 and L_2 and L_1 represent the total plant dry weights and leaf areas at times t_1 and t_2, respectively (Watson, 1952).

Phenotypic interrelationships between the following characters were computed :

1. RGR v/s LAR
2. NAR v/s LAR
3. RGR v/s NAR
4. TDW v/s LAR
5. Leaf area v/s root dry weight
6. Leaf area v/s leaf dry weight
7. Leaf dry weight v/s root dry weight
8. NAR v/s SLW
9. SLW v /s N_2 contents in leaf blade
10. NAR/v/s N_2 content in leaf blade

RESULTS AND DISCUSSION

Dry weights of different organs and leaf areas at various stages of growtq are presented in Table 1.

Seed dry weight, total plant dry weight, leaf area ratio, relative growth rate and net assimilation rate and their inter relationships for various periods of growth

The difference in the initial plant dry weight at particular growth stages can be analysed in terms of seed dry weight and relative growth rate. Seed dry weight was the highest in Tehran 8085 (44.1 mg) and the lowest in SML-32 (31.2 mg), but the highest dry weight production was recorded in AUM-127 (Table 1). Dry matter seemed to increase with corresponding increase in leaf area in all varieties with enhancement of growth periods. Brougham (1960) also reported an increase in RGR with increase in leaf area ratio. There existed a positive correlation ($r = +0.0552$) between RGR and LAR (Fig. 1). Similar positive correlation betwoen RGR and LAR was also observed by Khan and Tsunoda (1970) in wheat and Khan (1975) in mung. Fig. 2 depicts

Table 1 (a). *Dry weights of different plant organs and leaf areas at various stages of growth*

Varieties	Seed dry weight (mg)	April 6, 1982					April 16, 1982					April 26, 1982				
		Leaf area (cm^2)	Dry weights (gm)				Leaf area (cm^2)	Dry weights (gm)				Leaf area (cm^2)	Dry weights (gm)			
			Leaf	Stem	Root	Total		Leaf	Stem	Root	Total		Leaf	Stem	Root	Total
AUM-10	34.9	33.89	0.16	0.10	0.04	0.30	56.41	0.25	0.18	0.06	0.49	180.66	0.68	0.41	0.13	1.22
AUM-127	33.3	26.61	0.15	0.14	0.02	0.31	65.89	0-29	0.23	0.07	0.59	224.35	1.31	0.83	0.31	2.45
AUM-233	34.3	23.39	0.14	0.09	0.03	0.26	49.09	0.28	0.15	0.07	0.50	175.48	0.88	0.58	0.16	1.62
Tehran 8085.	44.1	23.35	0.15	0.08	0.02	0,25	51.60	0.29	0.23	0.08	0.60	148.09	0.98	0.69	0.20	1.87
SML-32	31.2	27.50	0 14	0.08	0.03	0.25	47.11	0.32	0.23	0.08	0.63	161.17	1.03	0.66	0.22	1.91
Philippine No. 8	34.4	25 50	0,12	0.09	0.03	0.24	48.18	0.22	0.10	0.08	0.40	142.60	0 99	0.66	0.32	1.97

Table 1 (b). *Dry weights of different plant organs and leaf areas at various stages of growth*

Varieties	May 6, 1982					May 16, 1982				
	Leaf area (cm^2)	Dry weights (gm)				Leaf area (cm^2)	Dry weights (gm)			
		Leaf	Stem	Root	Total		Leaf	Stem	Root	Total
AUM-10	440.76	1.41	1.15.	0.32	2.88	1049.96	4.45	3.72	0.81	8 98
AUM-127	621.07	2.56	2.31	2.31	7.18	1645.67	6.56	5.81	1.48	13.85
AUM-233	488.79	2.18	1.86	0.50	4.54	1347.32	6.51	5 84	1.20	13.55
Tehran 8085	414.72	1.84	1.56	0.47	3.87	1061.98	5.10	4.10	1.06	10.56
SML-32	370.80	1.84	1.28	0.59	3.71	1160.63	5.74	5.28	1.22	12.24
Philippine No.8	567.44	2.92	2.27	0.77	5.96	825.77	3.69	2.98	0.91	7.58

a positive correlation (r = +0.866) between NAR and RGR. Similar results were also obtained by Gill (1974) in wheat and Khan (1975) in mung. Fig. 3 indicates a negative and significant relationship (r = − 0.52) between LAR and NAR. Almost similar findings were also reported by Khan (1975) in mung and Ahmad (1982) in wheat, that is NAR decreased with increase in leaf area index. Ishaq (1973) reported the same tendency of NAR while working with soybean. Further a non-significant negative correlation (r = _0.097) was obtained between LAR and total plant dry weight as shown in Fig. 5. These findings are in agreement with the ones earlier reported by Khan (1975) while working on mung.

Generally speaking the total dry matter accumulation experienced a corresponding increase with the increase in total leaf area. Differential inerease in different varieties may, however, depend upon genetic factor which possibly can affect various levels of growth at the same level of seed dry weight. Further study in this respect seems to be important to elaborate whether the observed differences among varieties in the leaf area ratio, at the same level of plant dry weight, are due to the genetic factors or due to the environmental influences because in this experiment the temperature and other environmental conditions were not controlled during the course of plant growth.

Variation in total leaf area and dry matter

The variety AUM -127 which exhibited good vegetable growth, despite having the largest leaf area (1645.67 sq. cm) and total dry matter (13.85 gm) may not necessarliy show high grain production. Nevertheless, grain production largely depends on dry matter production of the flowering period. Grain production is also influenced by the peculiar physiological system of the individual varieties which mobilizes most of the photosynthetic products and diverts them to economically important plant organs. AUM-233 ranked close to AUM-127 in leaf area and total dry matter production. The values were 1347.32 sq, cm and 13.55 gm, respectively.

Variation in leaf area development relative to root dry weight

Variation in leaf area relative to root dry weight are presented in Fig. 6.AUM-127 showed the heighest leaf area production in (1645.67 sq. cm) and root dry

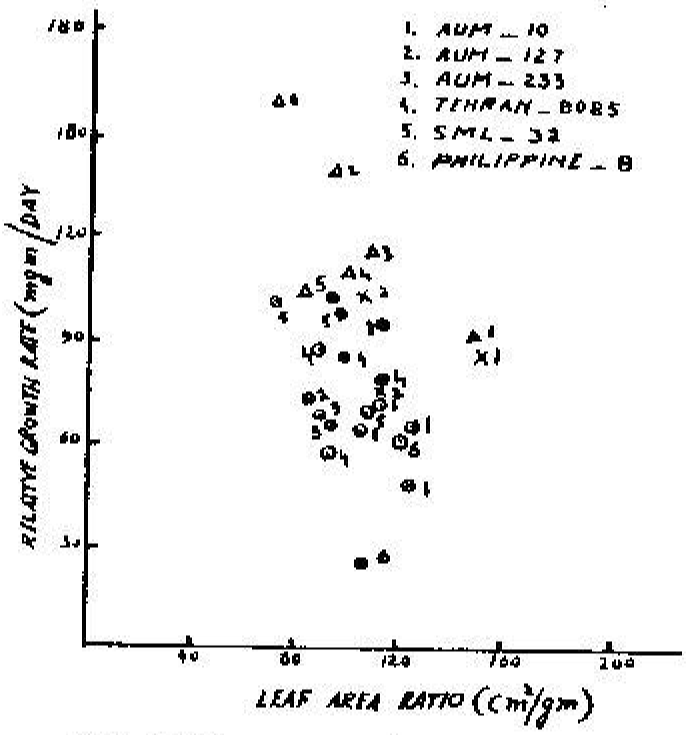

FIG. 1. RELATIONSHIP BETWEEN RELATIVE GROWTH RATE & LEAF AREA RATIO

● I APRIL . 6 . 1982 r = 0.0681 N.S.
⊙ II " 16, " r = -0.8583 *
Δ III " 26 . " r = -0.7265 N.S.
X IV MAY 6 , " r = -0.1213 N.S.
● V MAY 16 . " r = 0.1707 N.S.
DATA IN BULK = r = + 0.0552 N.S.

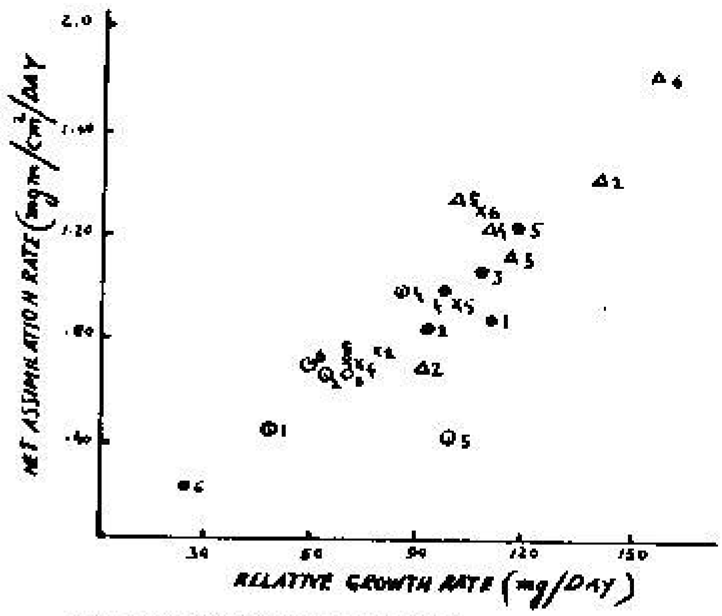

FIG. 2 RELATIONSHIP BETWEEN NET ASSIMILATION RATE & RELATIVE GROWTH RATE

⊙ II APRIL . 16 , 1982 r = + 0.1142 N.S.
Δ III " 26 , " r = + 0.8961 *
X IV MAY . 6 , " r = + 0.5034 N.S.
● V " 16 , " r = + 0.9465 **
DATA IN BULK = r = + 0.8662 **

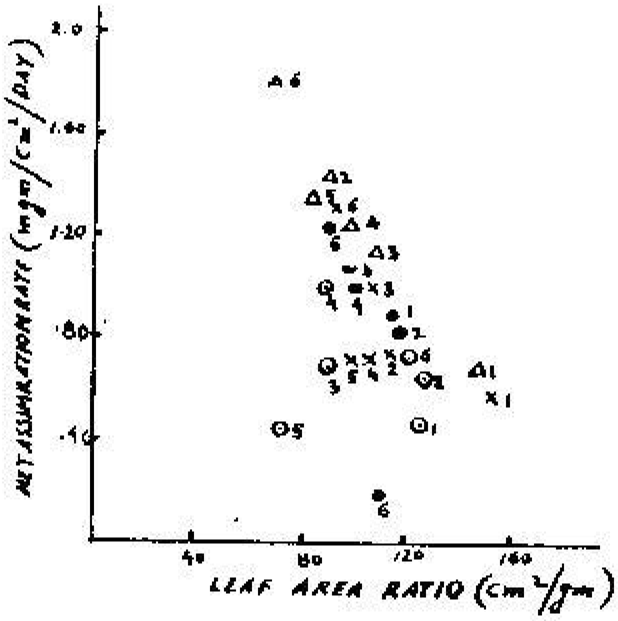

FIG. 3 RELATIONSHIP BETWEEN NET ASSIMILATION RATE AND LEAF AREA RATIO

⊙ II . APRIL 16 , 1982 r = - 0.0689 N.S.
Δ III . " 26 , " r = - 0.9192 **
X IV . MAY 6 , " r = - 0.6448 N.S.
● V . " 16 , " r = - 0.5159 N.S.
DATA IN BULK = r = - 0.5200 **

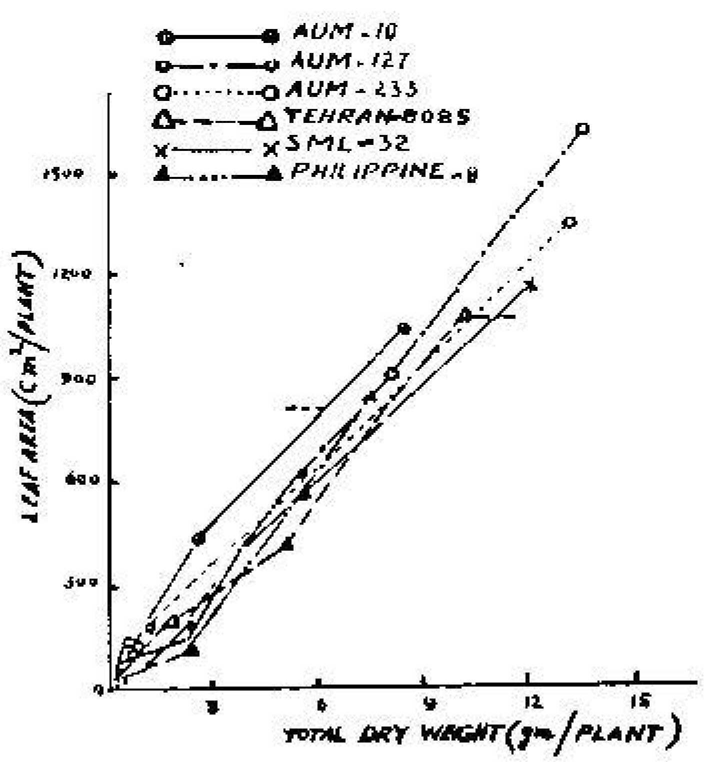

FIG. 4 RELATIONSHIP BETWEEN LEAF AREA AND TOTAL DRY WEIGHT

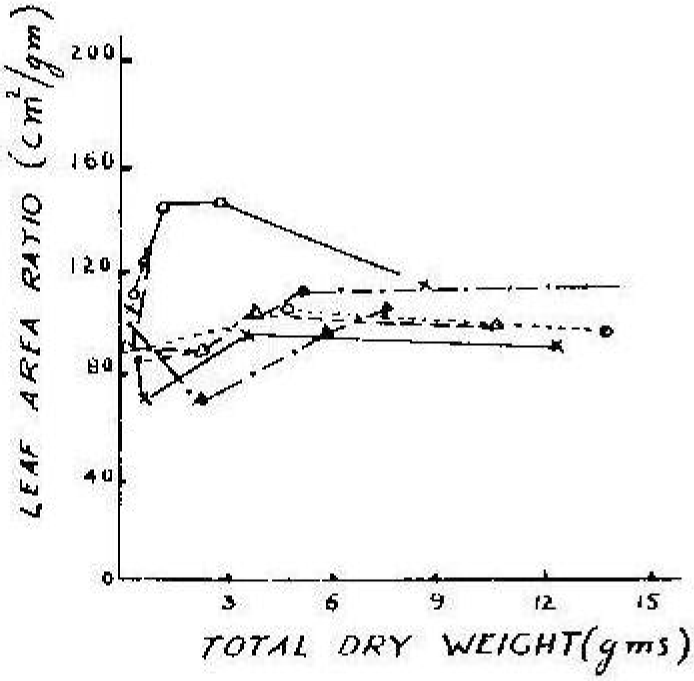

FIG.5 RELATIONSHIP BETWEEN TOTAL DRY WEIGHT & LEAF AREA RATIO

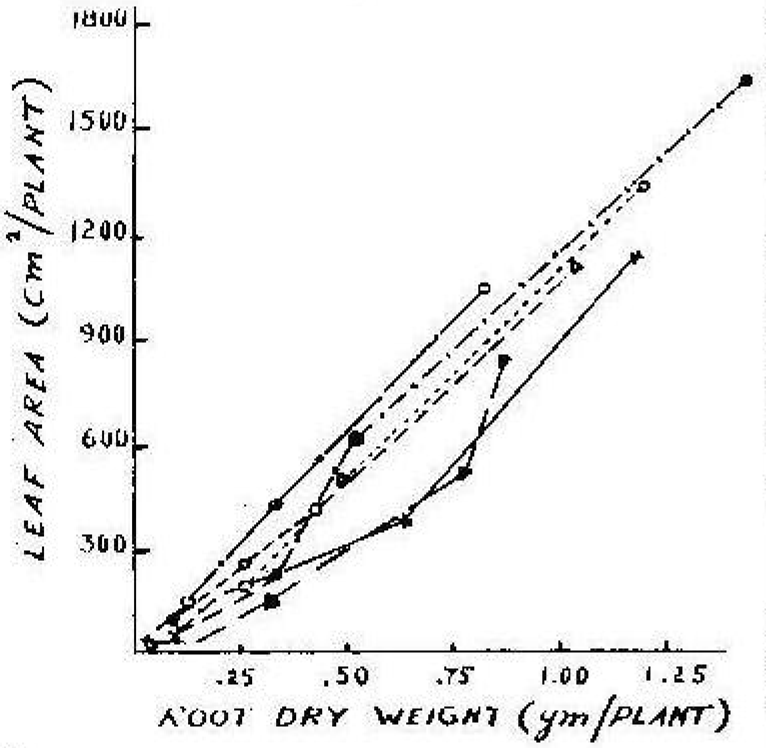

FIG.6 RELATIONSHIP BETWEEN LEAF AREA & ROOT DRY WEIGHT

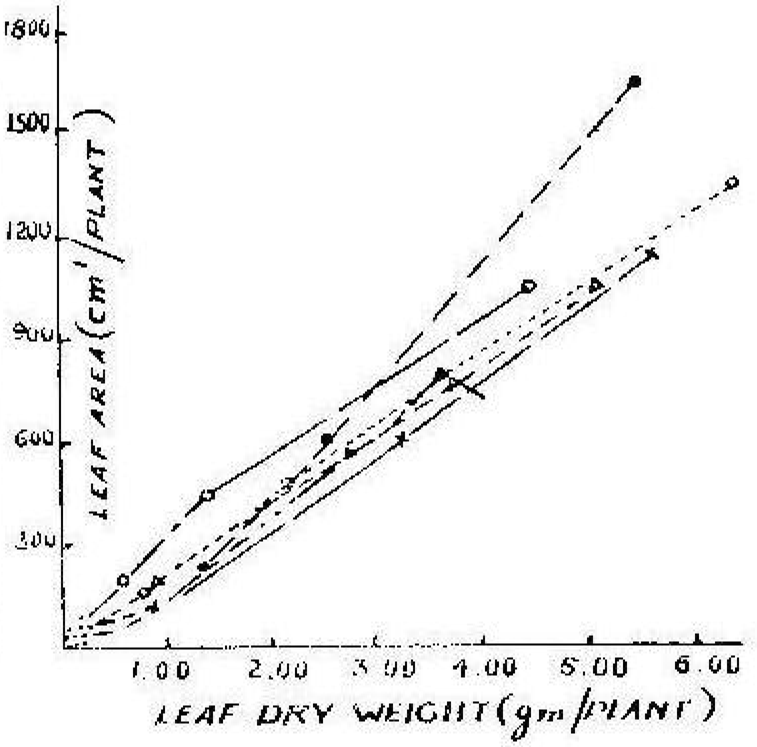

FIG.7 RELATIONSHIP BETWEEN LEAF AREA & LEAF DRY WEIGHT

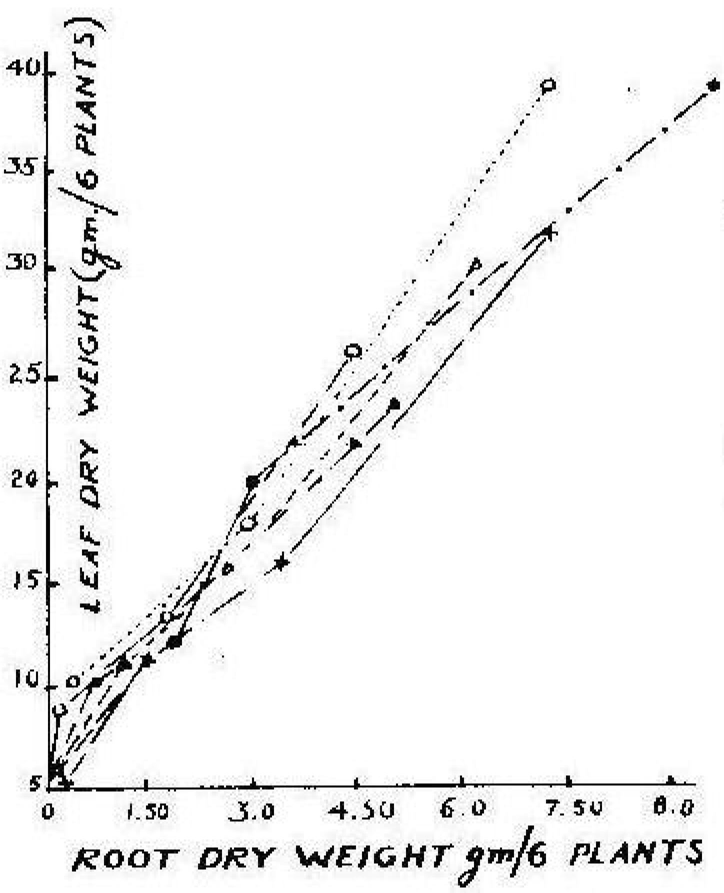

FIG. 8 RELATIONSHIP BETWEEN LEAF DRY WEIGHT & ROOT DRY WEIGHT

weight (1·48 gm) while Philippine No. 8 showed the least development of the leaf area (825.77 sq.cm) and root dry weight (0.91 gm). This may have been caused due to the peculiar balance of photosynthesis and nutrient absorption as well as the balance of transpiration and water absorption under different levels of temperature, nutrients and moisure supply.

Relationship of leaf area to leaf dry weight and leaf dry weight to root dry weight

The experimental data of these important attributes are presented in Fig. 7, Fig. 8 and Table 1. Perusal of Table 1 clearly suggests that variety Philippine No. 8 showed the least leaf area and leaf dry weight. The values being 825.77 sq. cm and 3.69 gm, respectively, while higher values were recorded for AUM-127, actual figures being 1645.67 sq. cm and 6.56 gm, respectively. These results are in close agreement with the interpretation already made by Khan and Tsunoda (1970 a & b) while working on wheat, where varieties adapted to light fertilization tended to show a higher leaf area/leaf dry weight. The data ploted in Fig. 8 show somewhat straight linear position between leaf dry weight to root dry weight ratio almost throughout the growth period.

Specific leaf weight, net assimilation rate and nitrogen contents in leaf blade and their interrelationships

The specific leaf weight (dry weight basis), i. e., the association of leaf area to leaf dry weight is one of the many indications of internal anatomy of plants. NAR and SLW were the highest in the last growth period in variety SML-32 (Table 2), whereas the minimum NAR was recorded in variety Philippine No. 8 with a value of 0.235 and the lowest value of specific leaf weight was observed in variety AUM-127. Fig. 9 reveals a possitve and highly significant correlation ($r = +0.5305$) between specific leaf weight and net assimilation rate. A positive correlation between SLW and photosynthetic rate was also reported by Pearce *et al.* (1969).

Fig. 10 reveals the association between nitrogen contents in leaf blade and NAR. The correlation was found to be positive and highly significant ($r = +0.8506$). There also existed a positive and highly significant correlation ($r = +0.9066$) between specific leaf weight and nitrogen contents. Almost similar observations have earlier been recorded in wheat by Khan and Tsunoda (1970a).

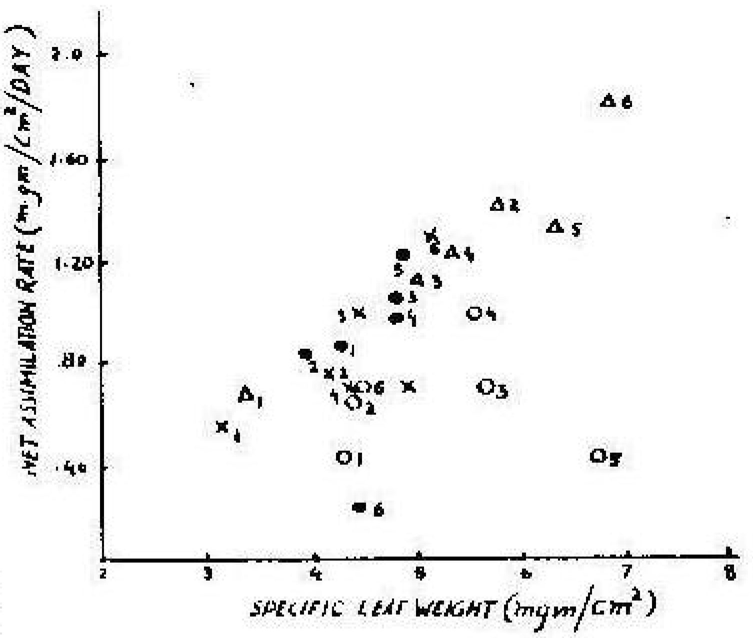

FIG. 9 RELATIONSHIP BETWEEN NET ASSIMILATION RATE & SPECIFIC LEAF WEIGHT

- o II. APRIL 16, 1982 r = + 0.5248 N.S.
- Δ III. APRIL 26, 1982 r = + 0.9563 N.S.
- x IV. MAY 6, 1982 r = + 0.6924 N.S.
- • V. MAY 16, 1982 r = + 0.4944 N.S.

DATA IN BULK = r = + 0.5505 * *

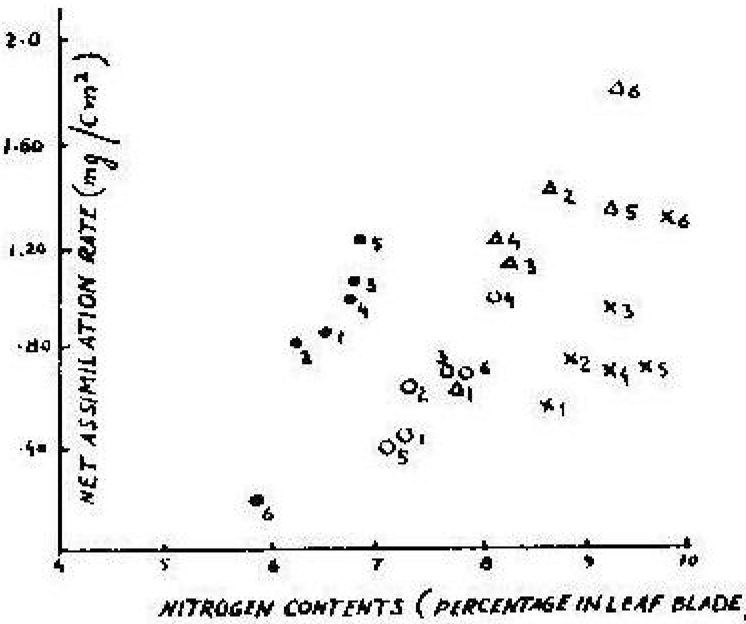

FIG. 10 RELATIONSHIP BETWEEN NET ASSIMILATION RATE & NITROGEN CONTENTS IN LEAF BLADE

- o II. APRIL 16, 1982 r = + 0.9337 * *
- Δ III. APRIL 26, 1982 r = + 0.8426 *
- x IV. MAY 6, 1982 r = + 0.7197
- • V. MAY 16, 1982 r = + 0.9338 * *

DATA IN BULK = r = + 0.8506 * *

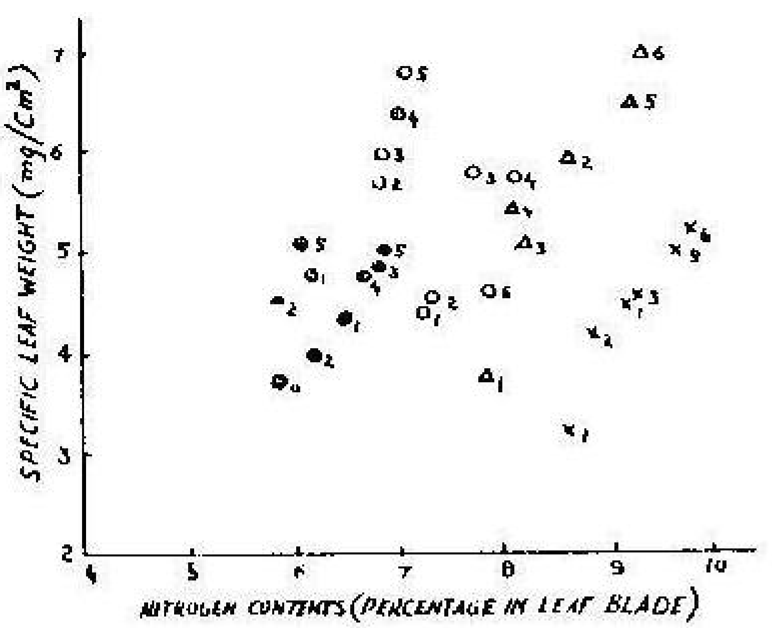

FIG. II RELATIONSHIP BETWEEN SPECIFIC LEAF WEIGHT AND NITROGEN CONTENTS OF LEAF BLADE (IN %)

- Φ i APRIL 6, 1982 r = + 0.9543 * *
- o ii APRIL 16, 1982 r = + 0.9779 * *
- Δ iii APRIL 26, 1982 r = + 0.9374 * *
- x iv MAY 6, 1982 r = + 0.9569 * *
- • V MAY 16, 1982 r = + 0.7336

DATA IN BULK = r = + 0.9066 * *

SML-32, however, tended to show high SLW and leaf nitrogen contents in most of its growth stages as compared to other varieties (Table 2). This obviously suggests that the line has physiological potential for higher yields.

Varietal differences in nitrogen contents in leaf blade

SML-32 tended to have more nitrogen contents in leaf blade as compared to other varieties which probably was due to the fact that it possessed higher specific leaf weight as compared to other varieties under study (Table 2). However, there seemed small varietal differences in foliar nitrogen contents of the varieties. This may be due to the application of nutrientsin equal proportion to all varieties and whatever small variations occur may really be due to the peculiar genetic makeup of individual plants.

The nitrogen content continued to increase till 4th sampling, where it was maximum. Thereafter, it had a decreasing trend and the minimum value of 5.87 per cent was recorded in the last sampling done on May 16, 1982 when plants were almost mature. The same tendency was observed by Westfall *et al.* (1973).

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Table 2. *Different physiological characters and nitrogen contents (%) in leaf blade of Mung varieties under study*

Varieties	Sampling No.	LAR	RGR	NAR	SLW	Nitrogen contents
AUM-10	1	112.966	71.70	—	4.721	6.12
	2	125.355	49.06	0.444	4.310	7.22
	3	148.081	91.22	0.683	3.763	7.88
	4	153 041	85.89	0.569	3.199	8.65
	5	116.922	95.72	0.869	4.238	6.50
AUM-127	1	85.838	74.36	—	5.636	6.92
	2	126.711	64.35	0.640	4.401	7.30
	3	91.571	142.37	1.438	5 539	8.66
	4	115.440	78.66	0.752	4.121	6.89
	5	118.820	80.55	0.805	3 986	6.18
AUM-233	1	89.961	67.51	—	5.985	6.98
	2	90.907	65.49	0.692	5.703	7.75
	3	108.320	116.93	1.128	5 014	8.24
	4	107.162	103 05	0.951	4.459	9.26
	5	99.433	98.34	1.064	4.831	6 87
Tehran-8085	1	93.401	57.83	—	6.382	7.02
	2	90 526	87.54	0.932	5 620	8.12
	3	98.443	113 67	1.219	5 323	8.12
	4	107.162	72.73	0 704	4.436	9.20
	5	100.566	88.78	0 971	4.802	9.80
SML-32	1	110.000	69.36	—	5.000	6.01
	2	74.777	100.06	0.418	4.792	7.16
	3	81.382	103.27	1.326	6.390	9.22
	4	99.943	66.39	0.715	4.962	9.68
	5	94.005	100 36	1.238	4.988	6 98
Philippine No. 8	1	106.250	64.75	—	4.705	5.85
	2	120.450	60.08	0.729	4.566	7.88
	3	72.385	159.43	1.804	6.942	9.34
	4	95.208	110.70	1.297	5.145	9.86
	5	108.940	24.04	0.235	4.468	5 87

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