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Further Studies on Some Morphological Characters of *Vigna* sp. Collected in the Republic of Nauru

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Introduction

From November 27 to December 10 in 1975, the writer was dispatched to the Republic of Nauru for ecological studies in agriculture. Twenty six strains of *Vigna* sp. were collected during the trip. They were detected as *Vigna marina* MERR. In the previous paper[2], the distribution areas, 6 characters, *i.e.*, length, width, thickness, ratio of length to width, ratio of length to thickness, ratio of width to thickness, and some relations among them were reported. In the present paper, 3 characters, *i.e.*, weight, area and volume of grains, and some mutual relations were mainly described, in order to confirm the morphological characters of grains and as well as to make clear the ecotypic differentiations of those grains.

These characters newly employed here were applied for the investigation of grain morphology in rice and some legumes[4], and some noteworthy meanings were shown. So in the present paper, these characters was made a trial to analyze the strain differentiation.

This species is in growth in a form of a wild plant. While several species belonging to the genus, *i.e.*, *V. sinensis*, *V. sesquipedalis*[5], are usually being cultivated as the most important grain legumes. So, this species may also be subjected to a consideration for the realization of agricultural improvement, in which suitable or recommendable germplasm is to be made as an attempt to bring back the wild status.

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Materials and Methods

Twenty six strains were used in the present experiment (Table 1). Their collection-number, collection-date, district and habitat were mentioned in Table 1 of the previous paper[2]. Fifty grains were used for the measurement of each strain, excepting No. 2 (34 grains), No. 12 (32), No. 18 (45) and No. 24 (19). Measurements were done in weight at the individual grain level in mg. Area and volume of the grains were calculated by length × width (mm^2) and length × width × thickness (mm^3), respectively. The whole data referring to the three characters were illustrated by the average values in the whole grains. Inquiries were done to fix the variation ranges for 9 characters, *i.e.*, 1 — length (mm), 2 — width (mm), 3 — thickness (mm), 4 — ratio of length to width (%), 5 — ratio of length to thickness (%), 6 — ratio of width to thickness (%), 7 — weight (mg), 8 — area (mm^2), and 9 — volume (mm^3) (Tables 2 and 3). In characters Nos. 1–6, the data were cited from the previous paper.

Table 1. Materials used in this experiment, district collected and three characters

Strain No.	District	Weight (mg)	Area (mm^2)	Volume (mm^3)
1	Aiwo	51.51±7.24	26.54±1.94	109.20±11.78
2	Aiwo	47.19±4.74	26.07±2.38	99.33±12.34
3	Boe	47.77±4.55	24.22±1.70	94.68± 9.38
4	Boe	45.98±6.69	25.41±1.68	100.57±11.57
5	Yaren	43.25±6.34	24.36±2.19	97.14±11.16
6	Yaren	49.30±5.92	25.82±2.05	106.88±10.47
7	Meneng	41.99±3.61	22.98±1.44	91.11± 6.32
8	Meneng	56.23±5.51	28.15±1.58	117.39±10.21
9	Meneng	49.85±4.51	27.12±1.96	107.63± 9.98
10	Meneng	62.35±4.47	27.83±1.82	118.44± 9.55
11	Anibare	50.38±5.24	27.40±1.73	110.31± 9.74
12	Anibare	42.17±5.11	24.08±1.38	92.97± 6.46
13	Anibare	50.98±5.27	26.47±2.24	106.49±12.99
14	Ijuw	46.78±4.07	24.59±1.68	96.27± 8.11
15	Anabar	47.32±4.14	25.76±1.62	103.34±11.27
16	Anabar	43.52±5.52	26.26±2.44	103.46±13.64
17	Anetan	59.25±3.00	29.22±1.61	120.62± 9.11
18	Anetan	38.26±4.67	22.92±2.50	87.24±13.06
19	Ewa	42.58±3.83	23.87±1.43	92.98± 7.13
20	Ewa	46.13±7.54	25.46±2.14	106.12±13.81
21	Baiti	41.65±9.74	26.19±2.96	102.94±15.86
22	Uaboe	49.76±6.82	26.72±1.99	107.51±11.45
23	Nibok	39.95±9.31	24.38±2.11	103.34±11.78
24	Denigomodu	44.25±3.61	24.61±1.52	96.51± 8.35
25	Denigomodu	50.58±4.31	25.00±1.77	104.09±11.46
26	Buada	38.41±6.86	27.46±1.95	100.84±10.12

To make clear the relationships between practical value and its standard deviations (no table), between the two respective characters in view of the practical values (Table 4), between the two respective characters in view of the standard deviations (Table 5), and between two respective characters in view of variation ranges (Table 6), correlation coefficient and linear regression of them were calculated. Moreover, relations between the variation ranges and its average value and its standard deviations were calculated (Table 7). At last, comparisons of the four relation-groups were done, using mainly the data shown in Tables 4, 5 and 6 (Table 8).

In this report, the following abbreviations were used, *i.e.*, ratio of length to width (R·L/W), ratio of length to thickness (R·L/T), ratio of width to thickness (R·W/T), correlation coefficient (c.c.), linear regression (l.r.) and standard deviations (s.d.).

Results

PART I. Respective character

1. Practical values of weight

The results are given in Table 1. Weights for the individual grain level ranged from 72.7 mg (No. 10) to 26.8 mg (No. 21). In the strain level, the heaviest (62.35 mg) was obtained in No. 10,

followed by No. 17 (59.25 mg) and No. 8 (56.23 mg). The lightest (38.26 mg) was noted in No. 18, followed by No. 26 (38.41 mg) and No. 23 (39.95 mg). It was noted that the value was peculiarly large in No. 10. Modes were found within 50.1 to 51.0 mg, 49.1 to 50.0 mg and 47.1 to 48.0 mg (3 strains each). The differences in the weight were confirmed to be large in accordance with each strain. Average and its s.d. through the whole strains were found to be 47.21 ± 5.95.

2. Practical values of area

Areas for the individual grain level ranged from 34.56 mm^2 (No. 22) to 17.06 mm^2 (No. 18). In the strain level, the widest (29.22 mm^2) was obtained in No. 17, followed by No. 8 (28.15 mm^2) and No. 10 (27.83 mm^2). The narrowest (22.92 mm^2) was noted in No. 18, followed by No. 7 (22.98 mm^2) and No. 19 (23.87 mm^2). Modes were found within 26.01 to 26.30 mm^2 and 24.21 to 24.50 mm^2 (3 strains each). The differences in the area were confirmed to be large in accordance with each strain. Average and its s.d. through the whole strains were found to be 25.73 ± 1.60.

3. Practical values of volume

Volumes for individual grain level ranged from 146.66 mm^3 (No. 8) to 51.18 mm^3 (No. 18). In the strain level, the largest (120.62 mm^3) was obtained in No. 17, followed by No. 10 (118.44 mm^3) and No. 8 (117.39 mm^3). The smallest (87.24 mm^3) was noted in No. 18, followed by No. 7 (91.11 mm^3) and No. 12 (92.97 mm^3). Mode was found within 106.01 to 108.00 mm^3 (5 strains). The differences in volume were confirmed to be large in accordance with each strain. Average and its s.d. through the whole strains were found to be 102.98 ± 8.33.

4. Standard deviations of 3 characters mentioned above

In Table 1, the standard deviations, *i.e.*, intra-strain's variations, are given. S.d. of the weight ranged from 9.74 (No. 21) to 3.00 (No. 17). Mode was found within 4.51 to 4.80 (4 strains). The average and its s.d. through the whole strains were found to be 5.49 ± 1.69.

S.d. of the area ranged from 2.96 (No. 21) to 1.38 (No. 12). It may be noted that the value was peculiarly large in No. 21. Mode was found within 1.61 to 1.70 (5 strains). The average and its s.d. through the whole strains were found to be 1.92 ± 0.38.

S.d. of the volume ranged from 15.86 (No. 21) to 6.32 (No. 7). It may be noted that the value was peculiarly large in No. 21, which was the same in case of area. Mode was found within 11.01 to 11.50 (4 strains). The average and its s.d. through the whole strains were found to be 10.66 ± 2.31.

PART II. Ranges among the respective characters

1. Length

Maximum: The results are given in Table 2. In this table, the maximum, the minimum and its range are shown. The longest (7.20 mm) was obtained in No. 22, followed by No. 16 (7.00 mm) and Nos. 21 and 26 (6.95 mm). The shortest (5.95 mm) was noted in No. 7, followed by Nos. 3 and 18 (6.20 mm) and No. 4 (6.30 mm). Average and its s.d. through the whole strains were found to be 6.62 ± 0.30.

Minimum: The longest (6.05 mm) was obtained in No. 17, followed by Nos. 8, 9 and 26 (5.70 mm). The shortest (4.55 mm) was noted in No. 18, followed by No. 7 (4.75 mm) and Nos. 6 and 19 (5.00 mm). Average and its s.d. through the whole strains were found to be 5.32 ± 0.32.

Table 2. Ranges of 5 characters in the strain level; length (mm), width (mm), thickness (mm), ratio of length to width (%) and ratio of length to thickness (%)

Strain No.	Length			Width			Thickness			Length/Width			Length/Thickness		
	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range
1	6.70	5.50	1.20	4.75	4.05	0.70	4.60	3.75	0.85	1.57	1.25	0.32	1.66	1.32	0.34
2	6.85	5.20	1.65	4.65	3.65	1.00	4.20	3.40	0.80	1.61	1.20	0.41	1.85	1.30	0.55
3	6.20	5.25	0.95	4.70	3.80	0.90	4.30	3.50	0.80	1.53	1.18	0.35	1.68	1.30	0.38
4	6.30	5.10	1.20	4.90	3.50	1.40	4.70	3.50	0.80	1.55	1.13	0.42	1.67	1.18	0.49
5	6.85	5.05	1.80	4.75	3.80	0.95	4.50	3.35	1.15	1.53	1.13	0.40	1.82	1.17	0.65
6	6.45	5.00	1.45	5.00	4.00	1.00	4.50	3.85	0.65	1.47	1.09	0.38	1.58	1.16	0.42
7	5.95	4.75	1.20	4.55	3.85	0.70	4.20	3.65	0.55	1.45	1.06	0.39	1.53	1.19	0.34
8	6.75	5.70	1.05	4.95	4.10	0.85	4.55	3.75	0.80	1.50	1.21	0.29	1.67	1.34	0.33
9	6.75	5.70	1.05	4.75	4.10	0.65	4.30	3.65	0.65	1.57	1.27	0.30	1.76	1.41	0.35
10	6.80	5.45	1.35	5.10	4.25	0.85	4.55	3.95	0.60	1.52	1.14	0.38	1.66	1.27	0.39
11	6.65	5.40	1.25	5.00	4.25	0.75	4.30	3.70	0.70	1.56	1.11	0.45	1.65	1.29	0.36
12	6.40	5.45	0.95	4.35	3.70	0.65	4.05	3.55	0.50	1.64	1.31	0.33	1.73	1.39	0.34
13	6.70	5.45	1.25	4.80	4.00	0.80	4.55	3.55	1.00	1.60	1.17	0.43	1.78	1.26	0.52
14	6.50	5.40	1.10	4.60	3.75	0.85	4.20	3.55	0.65	1.56	1.22	0.34	1.72	1.34	0.38
15	6.50	5.50	1.00	4.65	4.00	0.65	4.40	3.55	0.85	1.50	1.21	0.29	1.65	1.25	0.40
16	7.00	5.40	1.60	4.90	3.95	0.95	4.50	3.25	1.25	1.56	1.19	0.37	1.79	1.32	0.47
17	6.90	6.05	0.85	4.80	4.20	0.60	4.45	3.75	0.70	1.56	1.31	0.25	1.79	1.43	0.36
18	6.20	4.55	1.65	4.70	3.25	1.45	4.30	3.00	1.30	1.62	1.17	0.45	1.79	1.18	0.61
19	6.35	5.00	1.35	4.55	3.60	0.95	4.25	3.50	0.75	1.65	1.14	0.51	1.70	1.25	0.45
20	6.85	5.10	1.75	4.50	3.65	0.85	4.70	3.35	1.35	1.75	1.28	0.47	1.76	1.28	0.48
21	6.95	5.20	1.75	4.90	3.70	1.20	4.25	3.20	1.05	1.65	1.20	0.40	1.91	1.36	0.55
22	7.20	5.30	0.90	4.80	3.85	0.95	4.40	3.25	1.15	1.70	1.18	0.52	2.06	1.26	0.80
23	6.45	5.20	1.25	4.70	3.50	1.20	4.60	3.90	0.70	1.57	1.18	0.39	1.57	1.20	0.30
24	6.60	5.50	1.10	4.35	3.80	0.55	4.15	3.55	0.60	1.67	1.33	0.34	1.75	1.41	0.34
25	6.40	5.40	1.00	4.65	3.85	0.80	4.60	3.70	0.90	1.56	1.24	0.32	1.57	1.29	0.28
26	6.95	5.70	1.25	4.70	3.90	0.80	4.15	3.15	1.00	1.60	1.31	0.29	1.99	1.52	0.47

Range: The largest (1.80 mm) was obtained in No. 5, followed by Nos. 20 and 21 (1.75 mm) and No. 18 (1.65 mm). The smallest (0.85 mm) was noted in No. 17, followed by No. 22 (0.90 mm) and Nos. 3 and 12 (0.95 mm). Mode was found in 1.25 mm (4 strains). Average and its s.d. through the whole strains were found to be 1.26 ± 0.28.

2. Width

Maximum: The widest (5.10 mm) was obtained in No. 10, followed by Nos. 6 and 11 (5.00 mm) and No. 8 (4.95 mm). The narrowest (4.35 mm) was obtained in Nos. 12 and 24, followed by No. 20 (4.50 mm) and Nos. 7 and 19 (4.55 mm). Average and its s.d. through the whole strains were found to be 4.73 ± 0.19.

Minimum: The widest (4.25 mm) was obtained in Nos. 10 and 11, followed by Nos. 8 and 9 (4.10 mm). The narrowest (3.25 mm) was noted in No. 18, followed by Nos. 4 and 23 (3.50 mm) and No. 19 (3.60 mm). Average and its s.d. through the whole strains were found to be 3.85 ± 0.25.

Range: The largest (1.45 mm) was obtained in No. 18, followed by No. 4 (1.40 mm) and Nos. 21 and 23 (1.20 mm). The smallest (0.55 mm) was noted in No. 24, followed by No. 17

(0.60 mm) and Nos. 9, 12 and 15 (0.65 mm). Modes were found in 0.95 mm and 0.85 mm (4 strains each). Average and its s.d. through the whole strains were found to be 0.89±0.23.

3. Thickness

Maximum: The thickest (4.70 mm) was obtained in Nos. 4 and 20, followed by Nos. 1, 23 and 25 (4.60 mm). The thinnest (4.05 mm) was noted in No. 12, followed by Nos. 24 and 26 (4.15 mm) and Nos. 2, 7 and 14 (4.20 mm). Average and its s.d. through the whole strains were found to be 4.39±0.19.

Minimum: The thickest (3.95 mm) was obtained in No. 10, followed by No. 23 (3.90 mm) and No. 6 (3.85 mm). The thinnest (3.00 mm) was noted in No. 18, followed by No. 26 (3.15 mm) and No. 21 (3.20 mm). Average and its s.d. through the whole strains were found to be 3.53±0.24.

Range: The largest (1.35 mm) was obtained in No. 20, followed by No. 18 (1.30 mm) and No. 16 (1.25 mm). The smallest (0.50 mm) was noted in No. 12, followed by No. 7 (0.55 mm) and No. 24 (0.60 mm). Mode was found in 0.80 mm (4 strains). Average and its s.d. through the whole strains were found to be 0.85±0.24.

4. Ratio of length to width (R·L/W)

Maximum: The largest (1.75) was obtained in No. 20, followed by No. 22 (1.70) and No. 24 (1.67). The smallest (1.45) was noted in No. 7, followed by No. 6 (1.47) and Nos. 8 and 15 (1.50). Average and its s.d. through the whole strains were found to be 1.58±0.07.

Minimum: The largest (1.33) was obtained in No. 24, followed by Nos. 12, 17 and 26 (1.31). The smallest (1.06) was noted in No. 7, followed by No. 6 (1.09) and No. 11 (1.11). Average and its s.d. through the whole strains were found to be 1.20±0.07.

Range: The largest (0.52) was obtained in No. 22, followed by No. 19 (0.51) and No. 20 (0.47). The smallest (0.25) was noted in No. 17, followed by Nos. 8 and 15 (0.29) and No. 9 (0.30). Modes were found within 0.39 to 0.40 and 0.29 to 0.30 (4 strains each). Average and its s.d. through the whole strains were found to be 0.38±0.07.

5. Ratio of length to thickness (R·L/T)

Maximum: The largest (2.06) was obtained in No. 22, followed by No. 26 (1.99) and No. 21 (1.91). The smallest (1.53) was noted in No. 7, followed by Nos. 23 and 25 (1.57) and No. 6 (1.58). Average and its s.d. through the whole strains were found to be 1.73±0.13.

Minimum: The largest (1.52) was obtained in No. 26, followed by No. 17 (1.43) and Nos. 9 and 24 (1.41). The smallest (1.16) was noted in No. 6, followed by No. 5 (1.17) and No. 4 (1.18). Average and its s.d. through the whole strains were found to be 1.30±0.09.

Range: The largest (0.80) was obtained in No. 22, followed by No. 5 (0.65) and No. 18 (0.61). The smallest (0.28) was noted in No. 25, followed by No. 23 (0.30) and No. 8 (0.33). It may be noted that the value was peculiarly large in No. 22. Mode was found within 0.33 to 0.35 (6 strains). Average and its s.d. through the whole strains were found to be 0.44±0.12.

6. Ratio of width to thickness (R·W/T)

Maximum: The results are given in Table 3. The largest (1.36) was obtained in No. 26, followed by No. 22 (1.35) and No. 13 (1.31). The smallest (1.08) was noted in No. 25, followed by No. 24 (1.11) and Nos. 1 and 23 (1.13). Average and its s.d. through the whole strains were found to be 1.21±0.07.

Table 3. Ranges of 4 characters in the strain level; ratio of width to thickness (%), grain weight (mg), grain area (mm^2) and grain volume (mm^3)

Strain No.	Width/Thickness			Grain weight			Area			Volume		
	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range
1	1.13	1.01	0.12	64.5	34.2	30.3	31.49	22.88	8.61	137.23	89.23	48.00
2	1.24	1.01	0.23	56.8	41.8	15.0	30.69	20.99	9.70	120.12	71.37	48.75
3	1.20	1.03	0.17	58.1	40.3	17.8	27.97	20.71	7.26	120.27	72.49	47.78
4	1.22	1.00	0.22	56.7	33.2	23.5	29.16	22.19	6.97	133.57	85.96	47.61
5	1.21	1.00	0.21	54.8	34.4	20.4	31.85	21.53	10.32	122.62	81.74	40.88
6	1.18	1.02	0.16	62.9	35.6	27.3	30.24	22.00	8.24	130.61	88.00	42.61
7	1.18	1.00	0.18	49.7	34.5	15.2	26.55	20.21	6.34	106.20	76.80	29.40
8	1.18	1.02	0.16	68.7	45.6	23.1	32.59	23.99	8.60	146.66	91.16	55.50
9	1.22	1.01	0.21	60.2	42.4	17.8	32.06	23.37	8.69	133.05	91.14	41.91
10	1.24	1.00	0.24	72.7	56.3	16.4	32.75	24.23	8.52	144.10	100.04	44.06
11	1.29	1.02	0.27	60.9	40.8	20.1	31.85	23.65	8.20	130.59	88.69	41.90
12	1.18	1.00	0.18	46.7	33.6	13.1	26.23	21.46	4.77	104.92	76.18	28.74
13	1.31	1.01	0.30	60.8	39.6	21.2	31.68	21.00	10.68	142.56	83.55	59.01
14	1.16	1.00	0.16	55.8	39.9	15.9	27.95	21.00	6.95	112.87	78.75	34.02
15	1.21	1.02	0.19	58.9	38.9	20.0	29.58	22.55	7.03	125.72	81.65	44.07
16	1.24	1.01	0.23	53.2	33.5	19.7	34.30	22.52	11.78	140.63	73.19	67.44
17	1.22	1.01	0.21	66.2	52.8	13.4	32.43	26.15	6.28	138.29	98.06	40.23
18	1.21	1.00	0.21	46.2	30.5	15.7	26.79	17.06	9.73	107.06	51.18	55.88
19	1.25	1.00	0.25	49.7	36.5	13.2	27.45	21.42	6.03	107.54	74.97	32.57
20	1.16	0.91	0.25	57.0	34.0	23.0	29.59	20.15	9.44	135.45	80.60	54.85
21	1.27	1.00	0.27	54.3	26.8	27.5	33.47	19.24	14.23	142.25	70.23	72.02
22	1.35	1.00	0.35	63.0	36.9	26.1	34.56	23.10	11.46	143.42	86.03	57.39
23	1.13	0.84	0.29	57.5	28.3	29.2	29.85	18.73	11.12	136.90	77.73	59.17
24	1.11	1.00	0.11	46.8	41.7	5.1	26.97	22.00	4.97	111.01	84.85	26.16
25	1.08	0.93	0.15	63.2	43.8	19.4	29.44	22.14	7.30	129.54	86.35	43.19
26	1.36	1.07	0.29	50.0	27.8	22.2	32.20	23.40	8.80	133.63	80.33	53.30

Minimum: The largest (1.07) was also obtained in No. 26, followed by No. 3 (1.03) and Nos. 6, 8, 11 and 15 (1.02). The smallest (0.84) was noted in No. 23, followed by No. 20 (0.91) and No. 25 (0.93). Average and its s.d. through the whole strains were found to be 1.00 ± 0.04.

Range: The largest (0.35) was obtained in No. 22, followed by No. 13 (0.30) and Nos. 23 and 26 (0.29). The smallest (0.11) was noted in No. 24, followed by No. 1 (0.12) and No. 25 (0.15). Mode was found in 0.21 (4 strains). Average and its s.d. through the whole strains were found to be 0.21 ± 0.06.

7. Weight

Maximum: The heaviest (72.7 mg) was obtained in No. 10, followed by No. 8 (68.7 mg) and No. 17 (66.2 mg). The lightest (46.2 mg) was noted in No. 18, followed by No. 12 (46.7 mg) and No. 24 (46.8 mg). Average and its s.d. through the whole strains were found to be 57.5 ± 6.9.

Minimum: The heaviest (56.3 mg) was obtained in No. 10, followed by No. 17 (52.8 mg) and No. 8 (45.6 mg), which were the same as those in the maximum. The lightest (26.8 mg) was noted in No. 21, followed by No. 26 (27.8 mg) and No. 23 (28.3 mg). Average and its s.d. through the

whole strains were found to be 37.8±7.0.

Range: The largest (30.3 mg) was obtained in No. 1, followed by No. 23 (29.2 mg) and No. 21 (27.5 mg). The smallest (5.1 mg) was noted in No. 24, followed by No. 12 (13.1 mg) and No. 19 (13.2 mg). Modes were found within 19.1 to 20.0 mg, 15.1 to 16.0 mg and 13.1 to 14.0 mg (3 strains each). Average and its s.d. through the whole strains were found to be 19.7±5.8.

8. Area

Maximum: The widest (34.56 mm^2) was obtained in No. 22, followed by No. 16 (34.30 mm^2) and No. 21 (33.47 mm^2). The narrowest (26.23 mm^2) was noted in No. 12, followed by No. 7 (26.55 mm^2) and No. 18 (26.79 mm^2). Average and its s.d. through the whole strains were found to be 30.37±2.46.

Minimum: The widest (26.15 mm^2) was obtained in No. 17, followed by No. 10 (24.23 mm^2) and No. 8 (23.99 mm^2). The narrowest (17.06 mm^2) was noted in No. 18, followed by No. 23 (18.73 mm^2) and No. 21 (19.24 mm^2). Average and its s.d. through the whole strains were found to be 21.83±1.89.

Range: The largest (14.23 mm^2) was obtained in No. 21, followed by No. 16 (11.78 mm^2) and No. 22 (11.46 mm^2). The smallest (4.77 mm^2) was noted in No. 12, followed by No. 24 (4.97 mm^2) and No. 19 (6.03 mm^2). Mode was found within 8.51 to 9.00 mm^2 (5 strains). Average and its s.d. through the whole strains were found to be 8.54±2.22.

9. Volume

Maximum: The largest (146.66 mm^3) was obtained in No. 8, followed by No. 10 (144.10 mm^3) and No. 22 (143.42 mm^3). The smallest (104.92 mm^3) was noted in No. 12, followed by No. 7 (106.20 mm^3) and No. 18 (107.06 mm^3). Average and its s.d. through the whole strains were found to be 128.34±13.24.

Minimum: The largest (100.04 mm^3) was obtained in No. 10, followed by No. 17 (98.06 mm^3) and No. 8 (91.16 mm^3). The smallest (51.18 mm^3) was noted in No. 18, followed by No. 21 (70.23 mm^3) and No. 2 (71.37 mm^3). Average and its s.d. through the whole strains were found to be 81.55±9.91.

Range: The largest (72.02 mm^3) was obtained in No. 21, followed by No. 16 (67.44 mm^3) and No. 23 (59.17 mm^3). The smallest (26.16 mm^3) was noted in No. 24, followed by No. 12 (28.74 mm^3) and No. 7 (29.40 mm^3). Mode was found within 47.01 to 49.00 mm^3 (4 strains). The differences in the volume were confirmed to be large in accordance with each strain. Average and its s.d. through the whole strains were found to be 46.79±11.56.

Part III. Relations between the two respective characters

1. Relations between the two respective practical values

C.c. and l.r. of the practical value on another practical value among 36 combinations were calculated, and are shown in Table 4. Twelve, 3 and 7 combinations showed significances at 0.1%, 1% and 5% levels, respectively. For example, c.c. of width on weight through the whole strains was +0.7476 to the degree of freedom of 24, which was obviously significant at 0.1% level. Generally speaking, the wider is the width, the heavier is the weight. L.r. of weight on width was calculated as follows; $Y=0.613X+2.258$, where Y and X indicate width and weight, respectively. This formula indicates that the width becomes 0.613 mm wider, by becoming 1 degree heavier the

Table 4. Correlation coefficient and linear regression of the practical value (Y) on another practical value (X) for 36 combinations

Combination	Correlation coefficient	Linear regression	Combination	Correlation coefficient	Linear regression
1·2	0.3563	—	3·7	0.5086**	Y=0.404X+3.220
1·3	0.1563	—	3·8	0.3387	—
1·4	0.6002**	Y=0.498X−0.343	3·9	0.6912***	Y=0.784X+1.854
1·5	0.7128***	Y=0.904X+2.690	4·5	0.6712***	Y=0.971X+3.331
1·6	0.3028	—	4·6	−0.1315	—
1·7	0.4571*	Y=0.373X+1.514	4·7	−0.1341	—
1·8	0.8487***	Y=0.775X+0.828	4·8	0.5347**	Y=0.588X+1.941
1·9	0.7072***	Y=0.826X+0.468	4·9	0.0685	—
2·3	0.4589*	Y=0.474X−0.662	5·6	0.6247***	Y=0.616X−1.973
2·4	−0 3746	—	5·7	−0.0941	
2·5	−0.0221	—	5·8	0.4319*	Y=0.311X−2.291
2·6	0.4628*	Y=0.581X+0.655	5·9	0.0678	—
2·7	0.7476***	Y=0.613X+2.258	6·7	0.0565	—
2·8	0.7850***	Y=0.719X+0.535	6·8	0.4555*	Y=0.333X−0.590
2·9	0.8842***	Y=1.036X+0.191	6·9	0.0920	—
3·4	0.0287	—	7·8	0.7206***	Y=0.806X−2.967
3·5	−0.4084*	Y=−0.503X+0.666	7·9	0.8401***	Y=1.201X−3.355
3·6	−0.4820*	Y=−0.585X+1.457	8·9	0.9072***	Y=1.161X−0.468

Character number (O point): 1 — length (5.93 mm), 2 — width (4.31 mm), 3 — thickness (3.94 mm), 4 — ratio of length to width (1.37), 5 — ratio of length to thickness (1.55), 6 — ratio of width to thickness (1.09), 7 — weight (5.05 mg), 8 — area (25.85 mm^2), 9 — volume (103.00 mm^3).

***, **, *; significant at 0.1%, 1% and 5% levels, respectively.

d.f.=24.

weight (O points, 4.31 mm and 50.5 mg in width and weight, respectively).

The remaining 14 combinations showed no significance even at 5% level.

2. Relations between the practical value and its s.d.

C.c. of practical value on its s.d. among the weights through the whole strains was −0.1065 to the degree of freedom of 24, showing no significance even at 5% level. C.c. of the practical value on its s.d. among the areas through the whole strains was +0.0848 to the degree of freedom of 24, showing no significance even at 5% level. C.c. of practical value on its s.d. among the volumes through the whole strains was +0.1890 to the degree of freedom of 24, showing no significance even at 5% level.

3. Relations between the standard deviations of the two respective characters

C.c. and l.r. of s.d. on another s.d. among 36 combinations were calculated, and are shown in Table 5. Thirteen, 9 and 6 combinations showed significances at 0.1%, 1% and 5% levels, respectively. For example, c.c. of s.d. of length on s.d. of R·L/W was +0.7024 to the degree of freedom of 24, which was obviously significant at 0.1% level. Generally speaking, the larger is the s.d. of length, the larger is the s.d. of R·L/W. L.r. of s.d. of length on s.d. of R·L/W was calculated as follows; Y=1.328X−0.705, where Y and X indicate s.d. of length and it of R·L/W,

Table 5. Correlation coefficient and linear regression of the standard deviations (Y) on another standard deviations (X) for 36 combinations

Combination	Correlation coefficient	Linear regression	Combination	Correlation coefficient	Linear regression
1·2	0.5938***	Y=1.169X+0.361	3·7	0.5429**	Y=0.435X+1.039
1·3	0.3886*	Y=0.539X−0.207	3·8	0.6273***	Y=0.756X+0.659
1·4	0.7024***	Y=1.328X−0.705	3·9	0.8023***	Y=0.798X−0.931
1·5	0.5367**	Y=1.421X+2.143	4·5	0.6846***	Y=0.479X+1.157
1·6	0.4116*	Y=1.154X−0.364	4·6	0.2380	—
1·7	0.2752	—	4·7	0.1702	—
1·8	0.6017**	Y=0.601X+0.603	4·8	0.2988	—
1·9	0.5882**	Y=0.811X−0.621	4·9	0.2522	—
2·3	0.6796***	Y=0.478X−0.467	5·6	0.5394**	Y=1.143X−1.857
2·4	0.6132***	Y=0.589X−0.955	5·7	0.3345	—
2·5	0.8007***	Y=0.862X+0.790	5·8	0.4666*	Y=0.295X−1.386
2·6	0.6943***	Y=0.687X−0.736	5·9	0.4544*	Y=0.237X−2.022
2·7	0.5814**	Y=0.328X+0.294	6·7	0.2548	—
2·8	0.7378***	Y=0.738X+0.731	6·8	0.4582*	Y=0.273X+0.256
2·9	0.6758***	Y=0.473X−0.891	6·9	0.3286	—
3·4	0.4441*	Y=0.606X−1.068	7·8	0.5811**	Y=0.875X−0.102
3·5	0.7781***	Y=1.486X+1.972	7·9	0.5999**	Y=0.745X−0.982
3·6	0.4969**	Y=1.005X−0.728	8·9	0.8819***	Y=0.727X−2.178

Character number (O point): 1 — length (0.31), 2 — width (0.21), 3 — thickness (0.20), 4 — ratio of length to width (0.085), 5 — ratio of length to thickness (0.12), 6 — ratio of width to thickness (0.05), 7 — weight (6.15), 8 — area (2.15), 9 — volume (10.75).
***, **, *; significant at 0.1%, 1% and 5% levels, respectively.
d.f.=24.

respectively. This formula indicates that the s.d. of length becomes 1.328 larger, by becoming 1 degree larger the s.d. of R·L/W (O points, 0.31 in s.d. of length and 0.085 in s.d. of R·L/W, respectively).

The remaining 8 combinations showed no significance even at 5% level.

4. Relations between the variation ranges of the two respective characters

C.c. and l.r. of variation range on another range among 36 combinations were calculated, and are shown in Table 6. Nine, 8 and 8 combinations showed significances at 0.1%, 1% and 5% levels, respectively. For example, c.c. of variation ranges of weight on ranges of volume was +0.6478 to the degree of freedom of 24, which was obviously significant at 0.1% level. Generally speaking, the larger is the range of weight, the larger is the range of volume. L.r. of ranges of weight on ranges of volume was calculated as follows; Y=0.640X+2.600, where Y and X indicate variation ranges of weight and of volume, respectively. This formula indicates that the range of weight becomes 0.640 mg larger, by becoming 1 degree larger the range of volume (O points, 17.5 mg in the range of weight and 48.0 mm^3 in the ranges of volume, respectively).

The remaining 11 combinations showed no significance even at 5% level.

5. Relations between the average value and its variation ranges

C.c. of average value on its variation ranges among 9 characters were calculated, and are shown in the left column of Table 7. Whole characters showed no significance even at 5% level.

Table 6. Relations between the two respective characters in view of ranges among 36 combinations

Combination	Correlation coefficient	Linear regression	Combination	Correlation coefficient	Linear regression
1·2	0.5164**	Y=0.644X+0.794	3·7	0.3426	—
1·3	0.5527**	Y=0.658X−0.034	3·8	0.6385***	Y=0.682X−0.030
1·4	0.4583*	Y=0.744X−0.778	3·9	0.6837***	Y=0.554X−0.680
1·5	0.4567*	Y=0.655X+1.122	4·5	0.6522***	Y=0.576X+1.711
1·6	0.2288	—	4·6	0.5711**	Y=0.343X+0.604
1·7	0.1586	—	4·7	0.1753	—
1·8	0.5701**	Y=0.724X+0.339	4·8	0.3224	—
1·9	0.3662	—	4·9	0.1758	—
2·3	0.4227*	Y=0.404X−1.904	5·6	0.6074***	Y=0.413X−2.181
2·4	0.5034**	Y=0.655X−2.381	5·7	0.2248	—
2·5	0.4890*	Y=0.563X−0.750	5·8	0.5450**	Y=0.483X−2.082
2·6	0.3293	—	5·9	0.4135*	Y=0.278X−2.164
2·7	0.3586	—	6·7	0.3334	—
2·8	0.4915*	Y=0.501X−1.595	6·8	0.6087***	Y=0.792X−0.296
2·9	0.5261**	Y=0.407X−2.073	6·9	0.5425**	Y=0.536X−1.114
3·4	0.3923*	Y=0.535X−1.062	7·8	0.6123***	Y=0.797X+3.365
3·5	0.6616***	Y=0.797X+1.208	7·9	0.6478***	Y=0.640X+2.600
3·6	0.4012*	Y=0.329X−0.532	8·9	0.8840***	Y=0.671X−1.036

Character number (O point): 1 — length (1.28 mm), 2 — width (0.98 mm), 3 — thickness (0.88 mm), 4 — ratio of length to width (0.38), 5 — ratio of length to thickness (0.52), 6 — ratio of width to thickness (0.23), 7 — weight (17.5 mg), 8 — area (9.25 mm^2), 9 — volume (48.0 mm^3).
***, **, *; significant at 0.1%, 1% and 5% levels, respectively.
d.f.=24.

Table 7. Correlation coefficient and linear regression of the average value and its standard deviations (Y) on its variation ranges (X) for 9 characters

Character	Average	Standard deviations			
	Correlation coefficient	Correlation coefficient	Linear regression	O points	
				Y	X
Length	−0.1169	0.7484***	Y=0.836X−0.296	0.31	1.28
Width	−0.1537	0.7972***	Y=0.564X+0.066	0.21	0.98
Thickness	−0.1744	0.8002***	Y=0.768X−0.440	0.20	0.88
Length/Width	−0.0668	0.7390***	Y=0.709X−0.165	0.085	0.38
Length/Thickness	0.2171	0.8500***	Y=0.515X−0.825	0.12	0.52
Width/Thickness	0.2275	0.8328***	Y=0.324X−0.016	0.05	0.23
Grain weight	0.0136	0.8046***	Y=0.791X−4.097	6.15	17.50
Area	0.0008	0.8924***	Y=0.758X−1.268	2.15	9.25
Volume	0.2488	0.8597***	Y=0.672X+0.157	10.75	48.00

***; significant at 0.1% level.
d.f.=24.

6. Relations between the standard deviations and its variation ranges

C.c. and l.r. of s.d. on its variation ranges among 9 characters were calculated, and are shown in the right column of Table 7. Whole characters showed significances at 0.1% level. For ex-

Table 8. Comparisons of 7 relation-groups; relations between the 2 respective characters in view of practical values (A), standard deviations (B), variation ranges (C), sum-up of A, B and C groups (D); relations within the same characters in view of practical value and its standard deviations (E), practical value and its variation range (F), standard deviations and its variation range (G)

Group	Character	Character								
		Length	Width	Thick-ness	R·L/W	R·L/T	R·W/T	Weight	Area	Volume
A	Width	—								
	Thickness	—	*							
	R·L/W	**	—	—						
	R·L/T	***	—	*	***					
	R·W/T	—	*	*	—	***				
	Weight	*	***	**	—	—	—			
	Area	***	***	—	**	*	*	***		
	Volume	***	***	***	—	—	—	***	***	
B	Width	***								
	Thickness	*	***							
	R·L/W	***	***	*						
	R·L/T	**	***	***	***					
	R·W/T	*	***	**	—	**				
	Weight	—	**	**	—	—	—			
	Area	**	***	***	—	*	*	**		
	Volume	**	***	***	—	*	—	**	***	
C	Width	**								
	Thickness	**	*							
	R·L/W	*	**	*						
	R·L/T	*	*	***	***					
	R·W/T	—	—	*	**	***				
	Weight	—	—	—	—	—	—			
	Area	**	*	***	—	**	***	***		
	Volume	—	**	***	—	*	**	***	***	
D	Width	2								
	Thickness	2	3							
	R·L/W	3	2	2						
	R·L/T	3	2	3	3					
	R·W/T	1	2	3	1	3				
	Weight	1	2	2	0	0	0			
	Area	3	3	2	1	3	3	3		
	Volume	2	3	3	0	2	1	3	3	
E	Average & s.d.	—	—	—	—	—	***	—	—	—
F	Average & range	—	—	—	—	—	—	—	—	—
G	s.d. & range	***	***	***	***	***	***	***	***	***

***, **, *; significant at 0.1%, 1% and 5% levels, respectively.

Figure used in column D shows the number of significant relations in the respective combination in disregarding of the grade of significances.

ample, c.c. of s.d. of length on variation ranges of length was +0.7484 to the degree of freedom of 24, which was obviously significant at 0.1% level. Generally speaking, the larger is the s.d. of length, the larger is the variation range of length. Linear regression of s.d. of length on ranges of length was calculated as follows; $Y=0.836X-0.296$, where Y and X indicate s.d. and variation ranges of length, respectively. This formula indicates that the s.d. of length becomes 0.836 larger, by becoming 1 degree larger the variation range of length (O points 0.31 in s.d. of length and 1.28 mm in variation range of length, respectively).

7. Comparisons of four relation groups

From the data obtained in the previous paper[2] and in the present experiment, relations between the two respective characters were compared, and are shown in Table 8. In this table, at first, 3 relation-groups, *i.e.*, relations between the two respective practical values (A group in the table), relations between the two respective s.d. (B), and relations between the two respective variation ranges (C), were shown. In addition to these, summed-up-data from groups A, B and C were regulated, and are shown (D), provided that the calculation was made only by the significance in disregard of significant levels. And thirdly, 3 relations within the same characters, *i.e.*, between the practical value and its s.d. (E), between practical value and its variation range (F), and between s.d. and its variation range (G), are shown.

In summed-up-data from the former three groups, 16, 11 and 5 combinations showed significances in 3, 2 and 1 groups, respectively. It may be noted that the combinations constructed by length, width or thickness in one or both components, showed significances through the whole cases.

On correlations between the latter 3 groups, 1 and 8 characters showed significances in 2 and 1 cases, respectively.

Discussion

Although the discussions and conclusive hypotheses on the inter- and intra-strain's variations of grain morphology are to be drawn basing on the extensive analysis, the following facts may appreciably be drawn, from the data obtained in the previous and the present experiments.

It will be expected that if the practical values, its s.d. and its variation ranges found in the respective character, and their native localities were ascertained, it might naturally throw light on the evolutional prospect of the plant[3].

1. In view of genus *Vigna* and nearly related genera, original locality and migrating route to here has not been made clear. The following theories were announced in connection with the indigenous place, ancestral species, distribution route and areas. A number of hypotheses regarding the putative indigenous centers of genus *Vigna* have already been published, and some ones are concluded as it to be India. However, archaeological evidence in India has not been proved. In the Sudanic Complex (B.C. 5,000~4,000), which had been originated in West Africa and expanded eastward, about 30 crop species were brought forth to cultivation status[1]. Probably cultivated species belonging to genus *Vigna* may be applicable to these plant species. Wild species, *Vigna marina* MERR., collected here could also be looked upon as the plant, which was originated in Africa and migrated to Oceanian region through Indian Continent.

2. According to the previous paper, the strains used were divided into several groups basing on the three characters, *i.e.*, length, width and thickness. They may be divided also several groups

basing on another characters measured here. For example, Nos. 8, 10 and 17 were seen as heavy (weight) — wide (area) — large (volume), No. 26 as light — wide — large (the same order), Nos. 18 and 23 as light — narrow — small, etc. Basing on the analyses mentioned above, the following items may be noted in view of the geographical specificities. No. 26, which was collected near Lagoon Lake, showed peculiarly light weight, in spite of large area and volume. On the contrary, Nos. 8, 10 and 17, which were collected at the inside of road, showed peculiarly heavy — wide — large characters.

In comparison with strains distributed both inside and outside of the road, *i.e.*, near sea and far from sea, however, clear tendency was recognized in view of the practical values obtained in weight, area and volume.

In view of the s.d., *i.e.*, intra-strain's variation, the following facts were ascertained. Strains distributed in north and northwest sides of the island showed relatively large s.d. in weight, area and volume, especially Nos. 16, 20 and 21. On the contrary, strains distributed in the inside of the road showed relatively small s.d. in three components. These phenomena were the same as those of length, width and thickness[2]. This meant that the latter strains were genetically in stable state, especially in Nos. 7, 12, 15 and 17. The differences found in stability seemed to have been mainly due to the ecological conditions. The former were always subjected to the relatively severe environmental conditions, while the latter was more or less protected by a tree's or herb's shelter, as may be easily deduced from the ecological status. These findings propose a quite interesting problem concerning the strain- or variety-differentiations.

3. In the present state of affairs, it is not clear whether variation ranges obtained in several characters could be used for analysing strain differentiations or not. So, this character was attempted for this plant morphology. In conclusion, it may be said that variation ranges might be looked upon as a useful character and having a sort of universal validity as one of indices for examining strain differentiations in this plant. For example, grains of No. 22 showed the maximum or near maximum values in R·L/W, R·L/T and R·W/T, in spite of showing the minimum or near minimum values in length. It means that width and thickness of this strain were genetically in an unstable state. Grains of No. 26, collected near Lagoon Lake, frequently were observed to have been disordered from the standard values in the whole strains. It may be considered that this strain was growing in inland area and under environmental conditions differing from those of other strains.

It was also noticeable that strains distributed in actually seashore showed relatively large variation ranges in several characters, especially Nos. 1, 5, 16 and 22. On the contrary, strains distributed in inside of road showed small variation ranges during the whole characters, especially Nos. 7, 8, 12, 15 and 17. This meant that the latter strains were genetically in stable state. The differences found in stability seems to have been mainly due to the ecological conditions. These tendencies were explained in the same way as it was described in the previous chapter.

4. Yoshitomi studied the correlations among several characters of *Glycine max* and *G. soya* and found the positive significant correlations between grain weight and length, between weight and width, and between weight and thickness[6]. In the present experiment, the same results were gotten. He found also the negative significant correlations between weight and R·L/T, and between weight and R·W/T. In the present experiment, the negative but non-significant correlations were shown. These discrepancies may be partly due to the fact that in the present experiment wild samples were used.

Weight, area and volume showed significances in 5, 7 and 5 combinations among 8 ones,

respectively. So, it meant that area is relatively of stable character in these three characters.

Among 36 combinations, 14 cases showed no significance even at 5% level. In other words, 61.1% of them showed positive significances. It may be concluded that several characters are fundamentally exhibited independently of the other characters.

One (area), 6 (length, width, thickness, R·L/T, weight, volume), 1 (R·W/T) and 1 (R·L/W) character showed significant correlations in 7, 5, 4 and 3 combinations, respectively.

Strain No. 26 was found to have been disordered from the standard pattern to be set in the exceptional regions from several combinations, *i.e.*, relations between length and weight, width and weight, thickness and weight, R·L/T and weight, and R·W/T and weight. In other words, the weight of No. 26 was remarkably to have been slipped out. These phenomena may duely be attributed to the environmental conditions and artificial selections.

5. In the previous paper, relations among the practical values of 6 characters measured and these respective intra-strain's variations were calculated, but significance was shown only in one case. In the present experiment, these relations were unexpectedly decided as non-significant through the whole cases. It could not be concluded whether these components have not biologically principal meaning or not, and whether these components are independent of stability and flexibility or not.

6. Correlation coefficients of the intra-strain's variation of the respective characters were expectedly decided as significant in 28/36 cases, *i.e.*, 77.8% of them. Generally speaking, the larger is the variation in one character, the larger is the variation in another character. It may be said that, through almost all the characters, strains considered to be stable or unstable showed negligible or considerable variations, respectively.

Two (width, thickness), 3 (length, R·L/T, area), 1 (volume), 1 (R·W/T) and 2 (R·L/W, weight) characters showed significant correlations in 8, 7, 6, 5 and 4 relations, respectively. It may be noted that width and thickness showed significances through the whole combinations, and R·L/W and weight showed significances only in 4 cases.

7. On relations between the two respective characters in view of ranges among 36 combinations, 25 cases, *i.e.*, 69.4% of them, showed positive significances. It meant that the larger is the range in some character, the larger is the range in another character. In other words, most of them were genetically in stable state. However, Nos. 22 and 24 were always observed to have been constantly disordered from the standard pattern to have been set in exceptional regions for several characters.

In a strict sense, character specificities were found to some degree. Three (thickness, R·L/T, area), 2 (width, volume), and 3 (length, R·L/W, R·W/T) characters showed significant correlations in 7, 6 and 5 relations, respectively. It was noticeable that 1 character (weight) showed significant correlations only in 2 relations, *i.e.*, area and volume. It may be presumable that the weights of grains are fundamentally exhibited independently of length, width and thickness, but dependently of area and volume. To sum up, the weights of grain have been decided by surface area and in total volume in disregard of the grain-shape or -type.

8. Correlation coefficients of the practical value on its variation ranges were unexpectedly of no significance through the whole characters. These phenomena were left uninvestigated and could not be solved only by an uncomplicated experiment.

9. On the other hand, correlation coefficients of s.d. and variation ranges of the respective character were expectedly decided as significant with no exception. Moreover, they were shown to have some high levelled relationships in 0.1% level. These phenomena were clearly different from

the former relations. Generally speaking, the larger is the s.d., the larger is the variation range. In other words, it may be concluded that these two components were the most stable characters, and were intimately correlated.

10. Three relations were summed-up, and are shown in Table 8. In D column in the table, the figure means the number of significant relations in the 3 respective combinations. In the table, 75/108 cases, *i.e.*, 78.6% of them, showed significances at 0.1%, 1% or 5% levels. In detail, length, width, thickness, R·L/W, R·L/T, R·W/T, weight, area and volume showed significances in 17, 19, 20, 12, 19, 14, 11, 21 and 17, respectively. It was noticeable that they were divided into two groups, *i.e.*, high correlation- and low correlation-groups, showing the gap found within 17 to 14 relations. Length, width, thickness, R·L/T, area and volume belonged to the former group, and R·L/W, R·W/T and weight belonged to the latter group, respectively.

In columns E, F and G in the table, the followings may be noted. Three relations, *i.e.*, between the practical value and its s.d. (E), between practical value and its range (F), and between s.d. and range (G) in the same strain, were compared. It was a peculiar phenomenon that relation G showed highly significant correlations. It may be concluded that 1 character-combination (= s.d. and range) are fundamentally exhibited dependently on one another, but other 2 character-combinations are exhibited independently from each other. These relations may duely be attributed to the actions of genes.

11. Many characters were used for analysing species or strain differentiations, but several characters used here have been disregarded in the previous experiment. In the present experiment, significant correlations in these characters were found, for example, relations between length and R·L/W, between length and R·L/T, between length and R·W/T, between width and R·W/T, etc. So, it may be requested that these characters or these combinations are to be used for analysing strain differentiations. Moreover, it was confirmed that such indices or ideas can be used as an useful index for these experiments.

Summary

Succeeding to the previous paper, some morphological studies on grain characters and considerations on distribution and ecotypic differentiations of *Vigna* sp., which were collected in the Republic of Nauru in 1975, were reported in the present experiment. The results obtained here were summarized as follows:

Weight, area and volume of grains were found to be 47.21 mg, 25.73 mm^2 and 102.98 mm^3 in average values, respectively. Variation ranges in length, width, thickness, R·L/W, R·L/T, R·W/T, weight, area and volume were found to be 1.26 mm, 0.89 mm, 0.85 mm, 0.38, 0.44, 0.21, 19.7 mg, 8.54 mm^2 and 46.79 mm^3 in average values, respectively.

On correlation coefficients between the two respective characters among 36 combinations in view of the practical value, 12, 3 and 7 cases showed significances at 0.1%, 1% and 5% levels, respectively. On correlation coefficients between the respective two characters among 36 combinations in view of s.d., 13, 9 and 6 cases showed significances at 0.1%, 1% and 5% levels, respectively. On correlation of these in view of variation ranges, 9, 8 and 8 cases showed significances at 0.1%, 1% and 5% levels, respectively.

On correlation coefficients between the average value and its variation ranges among 9 characters, whole cases showed no significance even at 5% level. On correlation coefficients between the s.d. and its variation ranges among 9 characters, whole cases showed significances at 0.1%

level.

In summed-up-data from the former three relation-groups, 16, 11, 5 and 4 combinations showed significances in 3, 2, 1 and 0 groups, respectively. On correlation between 3 components in the same character, *i.e.*, between average and its s.d., average and its variation ranges, and s.d. and its ranges, 1, 0 and 8 characters showed significances, respectively.

Ecotypic differentiations were extensively discussed in values found in 9 characters in 6 correlation-relationships and ecological conditions. It may be noticeable that strains distributed in the inside of the road showed relatively small variations through the whole characters. It means that they are genetically in stable stage. Characters and character-combinations used here were to be looked upon as useful and as having some universal validities as indices for examining strain differentiations.

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