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PARTITIONING OF NUTRIENT ELEMENTS AND ASSIMILATE IN RELATION TO PRODUCTIVITY OF GREENGRAM (*Vigna radiata* (L.) WILCZEK) GENOTYPES*

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An attempt has been made to assess the partitioning of nutrient elements and assimilate from various parts of the plant into the seeds of 15 genotypes of greengram, classified as high yielders, medium yielders and low yielders in relation to yield. The behaviour of the 15 genotypes with reference to total uptake by the plant was considered along with partitioning of nitrogen, phosphorus and carbohydrate which showed positive association with yielding ability of the genotypes, while calcium and magnesium exhibited uncertain relationship. Potassium behaved rather favourably in most of the high yielders. The high yielders recorded high protein content and protein turn over.

Although inherently pulses are comparatively, low yielders, among the genotypes wide range of variability is seen, not only in respect of yield but in case of other characters also. With the establishment and functioning of International Crops Research Institute for the Semi-arid Tropics (ICRISAT) at Hyderabad, Asian Vegetable Research and Development Centre (AVRDC) in Taiwan and International Institute for Tropical Agriculture (IITA), Ibadan, gainful research and information have been made available on the physiological attributes in tropical legumes. Physiological studies in a greater depth will assist the plant breeders in evolving desirable material. Genotypic variation and specifcity regarding uptake, partitioning and utilization of nutrient elements and assimilates is enormous. Therefore a comparative study of the nutritional pattern of greengram genotypes is attempted. Ohlrogge (1960) while considering the nutrition of soybean, reported that nitrogen content in seeds was fairly constant. On the other hand in leaf and stem decline from 2.42 to 0.44 per cent was noted, most of it translocated to the developing seed. Sheldrake *et al.* (1977) noted that a substantial quantity of phosphorus requirement by the seeds was received from stem and aging leaves. Ohlrogge (1960) made a detailed assessment of the distribution of the potassium in stem and leaves of soybean. In soybean, 15 fold increase in magnesium concentration was recorded at pre-bloom stage, Ohlrogge (1960). While studying the pattern of distribution of assimilates in soybean using 14C, Stephenson and wilson(1977) clearly pointedo ut that at late stages of the crop, current assimilates move directly from leaves to the pod. Hymowitz *et al.* (1975)

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showed that in 32 entries of greengram a range from 24.5 to 31.2 per cent protein was recorded and the variation was largely due to the relative efficiency for protein synthesis and translocation.

MATERIAL AND METHODS

Investigations outlined in this article, were carried out during 1978-81, in the Department of Crop Physiology, Tamil Nadu Agricultural University Coimbatore-3. The object of the investigations was primarily directed towards the study of partitioning of nutrient elements and assimilate in the genotypes of greengram (*Vigna radiata* (L.) wilczek) in relation to yield. The genotypes chosen, varied in yield but had a duration of 60-63 days. In the present study an attempt has been made to make a comparative evaluation of 15 genotypes of greengram classified as high yielders (PIMS 4, Co.3, 11/99, ML 69 and Pusa Baisakhi), medium yielders (T 44, 11/395, LAM GG 127, ML 73 and 10/303), and low yielders (KM 1, PH 6, ML 62, DM/2 and MH 1). Plant samples were taken at four stages of crop growth namely vegetative, stray flowering peak flowering and harvest corresponding to 22nd, 36th, 50th and 64th day after sowing when nutritional changes are expected. A total of 30 plants per genotypes (10 from each replication) was taken for sample. The plants were dried, pooled and separated into root, stem, leaf reproductive parts and seed. These independent parts were weighed, powdered and analysed chemically for their total nitrogen (Humphries, 1956) total phosphorus (Jackson, 1962) carbohydrate (Somogyi, 1952) and for three cations namely, calcium, magnesium (Titre method) and potassium (Flame photometer method). The protein content in seed was estimated by method described by Lowry *et al.* (1951)

RESULTS AND DISCUSSION

In a comparative assessment of the present genotypes, diagnosis of nutritional status would be facilitated by knowing the cardinal concentration of not only different parts of the plant, but the total plant as well. The quantitative values can only guide us in the genotypic evaluation in a given situation. Based on the quantitative status of the elements and assimilate and partitioning of the material from the plant to the seed a brief discussion is attempted which may be of significance in the present study. In the tables (1 to 3), the total uptake, the content in the seed and percentage partitioning into the seed have been given. Although most of these elements are not related to yield directly their participation in stimulation of the metabolic pathway is certain. The role of individual element is discussed below.

Total nitrogen (Table 1): It has been shown in the present study that for retention and development of pods adequate nitrogen was essential The redistribution of nitrogen towards harvest is important which will actually indicate the balance sheet and economy of the element. The work finds support from the work of Ohlrogge (1960). During pod filling, nitrorgen drops in root, stem and leaf corresponding to this, high nitrogen content in the developing seed was evident. The date will show that the quantitative redistribution and mobilization of nitrogen into the seed will also decide the performance of the genotype. Lathwell and Evans (1951) showed in soybean that high nitrogen accumulation throughout life cycle resulted in better yield. The final total uptake gave a very reliable indication of the differential partitioning of nitrogen into the seed: thus, the extent of variation in the partitioning of nitrogen will be useful in the judgement of the genotypes.

Total phosphorus (Table 1): Phosphorus is mainly for satisfactory root development and crop maturation. As a mobile element, moderate level maintains the productivity, where as high level is not proportionately useful. Regarding the total uptake by the plant the data did not show much of variation, justifying genotypic classification, The variation among genotypes was mostly in the partitioning of the material into the seed and subsequent conversion to the final product. Among the high yielders, 48.17 to 66.88 per cent of the total phosphorus was transferred to the seed. But in the case of low yielders a range from 36.50 to 45.68 per cent only was transferred. The position of the medium yielders was not clear, most of the genotypes either merging with high or low yielders while there was great demand by seed for phosphorus, its role in improving the yield is not certain, though such an association was indicated.

Potassium (*Table2*)

Regarding potassium, high accumulation in stem, rather than in root or leaf has been noted in soybean by Ohlrogge (1960). Towards seeds development, potassium moved to the seed. The total uptake of potassium showed that low yielders as well as some of the high yielders behave similarly. If one consider the quantity of potassium in the seed and percentage distribution, variation existed between the genotypes. In general the potassium partition to seed in low yielders was less than in high yielders Regarding partition to seed the medium yielders behaved similar to low yielders as in the case of total uptake.

Calcium (*Table 2*):

Although calcium is relativley immobile, plants may take the element without further utilization. From the table, it was amply evident that total uptake was fairly good in all the genotypes except perhaps MH 1, ML 62 and PIMS 4. The point of interest is that the total uptake varied widely among genotypes, although this was not associated with the genotypic performance and not even specific to the group. Another feature was that the partitioning of calcium into the seed varied widely again, indicating the great degree of variation among the genotypes. Taking into consideration the percentage of partition, the genotypes did not appear to convey particular information which will enable to establish any relationship. Except PIMS 4, KM 1, PH 6 and DM/2, the rest of the genotypes recorded close values of partition percentage. Inspite of this there was high variation in yield. Hence the direct or indirect relationship between the calcium status and the yield was uncertain The genotypes PIMS 4 alone recorded high distribution as well as yield.

Magnesium (Table 3): The element is mostly related to chlorophyll development as well as nodulation, although it is found in all the tissues. As in the case of other elements, level of magnesium was marked at the top portion of the plant, with peak at flowering, thereafter dropping heavily. As in the case of calcium, the genotypic variation in total uptake was rather high, with no particular association with genotypic groupings. Further, the partitioning of the element to the seed also indicated that between total uptake and percentage partition there was no marked trend. Except genotypes Co.3, 11/99, ML 69, KM 1, DM/2 and MH 1, the rest recorded varying yields, although the range of partitioning was between 7 and 9 per cent. The only suggestion was that with highest partitioning in PIMS 4 the maximum yield was in that genotype Similarly with lowest partitioning of 6.18 to 6.27 in DM/2 and MH 1 respectively, the genotypes were the lowest yielders.

Carbohydrate (Table 3): As the final product of assimilation the status of carbohydrate is also considered and presented in Table 3. Judging from the total amount in whole plant at harvest, not only wide variation existed but genotypic individuality or specificity was evident. The content of carbohydrate in respective genotype or group did no appear to be related to the yield factor Regarding total amount, the amount of carbohydrate in the seed showed rather clearly the association between carbohydrate and the yield of the genotype (Stephenson and witson, 1977) The consistent low values in low yielders was also characteristic and moderate values in medium yielders was also specific to the group. Among the high yielding genotypes Co.3 and Pusa Baisakhi ranked high in respect of this partitioning of the assimilates in the seed It was clearly seen that except genotype ML 69 the other four maintained a distinct group Similarly, among low yielders PH 6, ML 62, DM/2 and MH 1 occupied a distinct position. Although the five medium yielding members were close, the genotype ML 69 from high yielders and genotype KM1 from low yielders were seem to merge with medium yielders. From the above statement it appeared that carbohydrate amount and partitioning can be relied upon as one of the major factors in deciding yield of chosen genotype.

Regarding all the elements, genotype PIMS 4 responded maximum and gave highest yield.

Protein content in seed (Table 4):

The protein content in seed was not generally related to the yield as seen in the table. The genotype showed a variation from 21 71 per cent (11/395, PH 6) to 24.06 recorded in genotype 11/99 while the high yielders recorded high protein content, between medium and low yielders there was no particular difference.

Protein turnover (Table 4):

The protein turnover/ha is as important as the yield and vast differences among the genotypes as well as groups were observed. The maximum turnover was in PIMS 4 (293.78 kg/ha) while lowest was in MH 1 (146 16 kg/ha. Considering the groups. the high yielders recorded a range between 245.41 and 293.78 kg/ha whereas the medium yielders recorded a range between 205.70 and 221.83 kg/ha

The protein turn over was rather poor in the case of low yielders being in the range from 146.16 to 192.36 kg/ha. The ranking based on the protein turn over strictly followed the yield pattern.

The protein and protein turn over are considered together. Regarding the content of protein, the high and medium yielders perhaps recorded slightly more than the low yielders. It is primarily concerned with protein turn over for a unit area which speaks of the yielding capacity of the genotype besides efficiency in protein synthesis The protein turn over was evidently more in the high yielders followed by medium yielding members. As per the report of Hymowitz *et al* 1975 efficient synthesis and translocation of protein assimilates to the seed decides the protein status of a variety which was applicable here.

TABLE 1 Total uptake of nitrogen and phosphosur (mg/plant), distribution to the seed (mg) and partition percentage in seed (%) of greengram genotypes.

Genotype	Total nitrogen			Total phosphorus			Yield Plant
	(a)	(b)	(c)	(a)	(b)	(c)	(g)
PIMS 4	211.6	163.6	77.3	27.9	18.7	66.8	4.25
CO 3	228.0	162.6	71.3	31.9	17.2	53.8	4.15
11/99	208 6	146.3	70.1	30.9	16 1	52.1	3.80
ML 69	216.0	137.8	61.8	32.3	15.5	48.1	3.58
Pusa Baisakhi	221.6	137 0	61.8	27.8	15.1	54.3	3.56
T 44	224.6	122.4	54 4	27 3	13.7	50.1	3.30
11/395	176.2	118.6	67 3	25.1	13.8	55.0	3.26
LAM GG 127	178.1	127.2	71.4	22.8	14.5	63.5	3.19
ML 73	225 7	123.8	54.8	35.6	14 3	40 3	3.16
10/303	182.0	114.6	60.6	29.7	13.6	45.6	3.09
KM 1	186.6	106 9	57.3	26.8	11.7	43.8	2.83
PH 6	193.1	93.1	48.2	28.9	10 6	36.7	2.56
ML 62	159.3	91.4	57.3	23.2	10.2	44.2	2.42
DM/2	202.9	91.6	45.1	29.0	10.5	36.5	2.38
MH 1	145.6	82 7	56.8	24.5	9.1	37.2	2.15

a) = Total uptake by plant
b) = Distribution to the seed
c) = Percentage in seed

TABLE 2 Total uptake of potassium and calcium (mg/plant) distribution to the seed (mg) and partition percentage in seed (%) of greengram genotypes

Genotype	Potassium			Calcium			Yield Plant
	(a)	(b)	(c)	(a)	(b)	(c)	(g)
PIMS 4	214.6	65.4	30 4	108.1	6.8	6.2	4.25
Co 3	256.0	63.0	24.6	153.6	5.8	3.7	4 15
11/99	252.8	53.9	21.3	160.8	6.0	3.7	3.80
ML 69	260.6	52.2	20.0	154.4	5.7	3.7	3.58
Pusa Baisakhi	237.2	50.5	21.3	138.1	5.7	4.1	3.56
T 44	277 2	46.2	16.6	144 6	5.2	3.6	3.30
11/395	234.6	49.5	21 1	117.4	5.2	4.4	3.26
LAM GG 127	238.2	49.9	20.9	128.2	5.1	3.9	3.19
ML 73	271.7	49.9	18.3	121.7	5.0	4.1	3.16
10/303	246.1	45.7	18.5	140 6	4.9	3.5	3.09
KM 1	233.0	41.3	17.7	124.4	6.7	5.4	2.83
PH 6	218 4	39.4	18.0	112.5	6.1	5.5	2.56
ML 62	184.7	37.2	20.1	93.9	3.8	4.1	2 42
DM/2	270.2	37.6	13.9	146.4	3.8	2.6	2.38
MH/1	165.7	32.6	19.7	79 9	3.4	4.3	2.15

(a) = Total uptake by plant
(b) = Distribution to the seed
(c) = Percentage in seed

TABLE 3 Total uptake of magnesium and total amount of carbohydrate (mg/plant), distribution to the seed (mg) and partition percentage in seed (%) of greengram genotypes

Genotypes	Magnesium			Carbohydrate			Yield/ plant
	(a)	(b)	(c)	(a)	(b)	(c)	(g)
PIMS 4	82.5	12.2	4.8	685.9	301.7	43.9	4 25
Co 3	96.3	5.9	6.2	687.9	356.9	51.8	4.15
11/99	101.1	10.9	10.8	663.8	268.3	44.9	3·80
ML 69	95.2	6.8	7.2	752.0	264 9	35.2	3.58
Pusa Baisakhi	84.0	6 8	8.1	674.6	316.8	46.9	3 56
T 44	97.8	7.9	8.0	719.9	237.6	33.0	3.30
11/395	75.7	6.2	8.2	774 4	247.7	31.9	3.26
LAM GG 127	82.5	6.1	7.4	644.7	236.0	36.6	3.19
ML 73	94.9	7.5	7.9	543.3	201 8	37.1	3.16
10/303	85.7	5.9	6.9	720.2	228.6	31.7	3.09
KM 1	85 4	8.1	9.5	618.3	200.9	32.5	2.83
PH 6	78.1	8.6	11.0	700 4	161.2	23.0	2.56
ML 62	69 1	5.8	8.4	524.5	166.9	31 8	2.42
DM/2	92.3	5.7	6.1	659 0	152.3	23.1	2.38
MH ,	65.9	4.1	6.2	616.7	260.9	26.0	2 15

(a) = Total uptake by plant or total amount in plant
(b) = Distribution to seed
(c) = Percentage in seed

TABLE 4 Seed number/pod, 100-seed weight, protein content and protein turn over in 15 genotypes of greengram

Genotypes	Seed Number/ pod	100 seed weight (g)	Protein content %		Protein turn over (Kg/ha)
PIMS 4	10.5	3.73	23.0	230.6	293.7
Co.3	10.7	3.75	23.1	231.0	288.0
11/99	10.8	4.47	24.0	240.6	174.0
ML 69	10.6	3.97	23.2	232.6	249.5
Pusa Baisakhi	10.5	3.88	23.0	230.0	245.4
T 44	10.1	3.62	22.2	229.9	220.8
11/395	9.9	3.61	21.7	217.5	212.5
LAM GG 127	9.9	3.70	23.0	230.4	220 4
ML 73	9.9	3.53	23.4	234.0	221.8
10/303	9.4	3.44	22.1	221.9	205.7
KM 1	9.5	3.50	22.6	226.3	192.3
PH 6	9 3	3.42	21.7	217.5	167.2
ML 62	9.2	3.40	22.6	222.3	164.5
DM/2	9.3	3.38	22.8	228.0	163.0
MH 1	9;2	3.93	22.6	226,6	146 1
CD (P=0.05)	0.91 **	0.18 **	—	—	—

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