increase was noticed during 1979. Probably higher grain yield was obtained at higher population due to more plant stand during 1980 when the rainfall received was nearly 50 per cent of the rainfall received in 1979.

The differences in grain yield of greengram might have been the result of differences in its yield components. Thus it is noticed that all the yield components of greengram were adversely affected by sorghum intercrop resulting in reduced grain yield of greengram. Table 2 and 3 redgram was more compatible with greengram it indicates that redgram+greengram combination makes better use of resources by complementing each other and giving rise to temporal effect Shelke (1977) reported that the system in which greengram was intercropped with sorghum (both the component crops at optimum population density) gave 63 per cent yield recovery of the intercropped greengram over its sole crop. Although grain weight per plant of greengram decreased when its plant population was increased from 50 to 100 per cent of its normal population overall grain yield increased with a yield recovery of 84 per cent of its sole crop.

Intercropping reduced the dry matter production per plant of greengram during 1979 (Table 3) probably due to greater competition offered by intercrops. But during 1980, intercropping had no adverse effect. This may be due to the poor growth of sorghum and slow growth of redgram in early stages which might have offered less competition. Sorghum as intercrop reduced significantly the dry matter per plant in greengram as compared to redgram. It indicates the dominance and aggressiveness of sorghum crop. The reduction in the dry matter per plant resulted in reduced grain yields. Similarly, decreasing the plant population of either greengram or intercrops increased the dry matter in greengram which may be due to the reduction of intra and inter-crop competition.

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PHYSIOLOGICAL ASPECTS OF DROUGHT TOLERANCE IN GROUNDNUT (*Arachis hypogala* L.)

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The groundnut cultivars *viz.*, VG 77, JL 24 and CO 2 possess greater drought tolerance characters like higher root-shoot ratios, accumulations of cations, K^+ in particular. These characters have contributed for the higher pod yields in groundnut under moisture stress conditions. Thus K^+ content in the leaf can also be considered as one of the criteria for the drought tolerance in groundnut.

India ranks first both in area (7.4 m ha) and production (6.0 m.t) of world groundnut but productivity wise it is lowest (850 kg/ha). The reason for the low productivity is that groundnut crop is predominantly cultivated as rainfed crop and exposed to the vagories of monsoon. Inadequacy and uneven distribution of rain bring about low yield and in extreme

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cases, complete failure of the crop. Under this situation evolving drought tolerant groundnut varieties will be a real boon to the farmers. However, physiological indices for selecting drought tolerant genotypes are lacking. With a view to evaluate the traits responsible for drought tolerance, the present study was undertaken with promising groundnut varieties and cultures.

MATERIALS AND METHODS

The study was conducted at Regional Research Station, Vriddhachalam (Tamil Nadu) during summer, 1985 employing eleven groundnut cultures/varieties *viz.*, CO 1, CO 2, JL 24, JLM 4, JLM 6, VG 75, VG 76, VG 77, ICG 1697 and CGC 4018. The crop was raised under irrigated condition and fertilizer was applied basally at the rate of 10-10-75 kg of NPK/ha. plant protection measures were undertaken whenever necessary. Moisture stress was imposed at 25 days after sowing by withholding irrigation. The stressed plots were irrigated uniformly when the plants did not recover turgor at hight that was identified by visual observation. Normal irrigation schedule was adopted for the untreated control. Sampling was done on 55th day of sowing and the dry weights of the plant components were recorded. The potassium content of leaf was estimated by versanate Titration method (Jackson 1962). Dry pod yields were recorded and expressed in g/m².

RESULTS AND DISCUSSION

Dry matter accumulation :

The data recorded on dry matter accumulation indicated a marked reduction in dry matter and yield under moisture stress conditions (Table 1). Under normal irrigated conditions, the dry matter accumulation was higher (15 01 and 14.31 g/plant) in VG 77 and JL 24 than others. Under stress conditions, the culture JLM 6 registered the highest dry matter accumulation of 4.47 g/plant fo lowed by VG 76 and VG 75. It was obvious from the data that percent reduction was higher in VG 77 (65.97 per cent) and in JL 24 (65.0 per cent). It might be possible for low rate of transpiration thereby lesser loss of water. A positive association was observed between dry matter accumulation and pod yield ($r = 0.709^*$). Considering the root-shoot ratios (mg root/g shoot), the culture VG 77 recorded the highest ratio of 104.29 under stress conditions, followed by JLM 6 and CO 2. Incidentally, the larger and deeper root systems observed in these cultures are considered to be the adaptive mechanisms for drought tolerance. The higher percent reduction of dry matter coupled with higher root-shoot ratios might have helped in the efficient absorption and utilisation of water and nutrients under stress conditions. The deep-root systems observed in the drought tolerant rice cultures under upland conditions, land support for the present findings (IRRI, 1976).

Cation concentration :

In general, the cation content of leaf and total cations were reduced under moisture stress conditions, when compared to control plots. Also, higher amounts of calcium are taken up by the plants both under stress and control conditions, as compared to other cations. Under normal irrigated conditions, Ca^{2+} was higher in VG 77 (2.64 %) and JL 24 (1 92 per cent). Under stress conditions its concentration was 2 05 per cent and 1.92 per cent in VG 77 and CO 2 respectively. Magnesium content was not affected much under moisture stress conditions except in VG 77 and JL 24. Higher uptake of Ca^{2+} in the two varieties/cultures, VG 77 in particular, resulted in low value of Mg^{2+} in VG 77 and JL 24 Moisture stress affected K^+ content in the varieties/cultures studied. The mobility of K^+ in the soil is much reduced under moisture stress conditions, a lower amounts of K^+ is available for obsorption by plant roots and hence a lower concentration of K^+ is observed in the leaves. Mengel and Scmic (1973) showed that the quantity of water moved upward by root pressure was redu-

Table 1 : Dry matter accumulation, cation content of leaf and pod yield of eleven groundnut genotype under moisture stress and normal conditions.

Variety	DMA (g/plant)		Root-shoot ratio (mg root/g shoot)		Cation content of leaf (%) Ca^{2+}		Mg^{2+}		K+		Total cations (percent)		Pod yield g/m2)	
	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress	Normal
CO 1	5.30	7.20	66.39	43.48	1.85	1.94	0.61	0.64	1.21	1.61	3.67	4.19	34.0	114.2
CO 2	5.04	10.15	83.87	48.45	1.92	2.05	0.66	0.71	1.05	1.42	3.63	4.18	60.7	135.0
JL 24	4.87	14.31	82.22	33.21	1.64	2.25	0.51	1.00	1.01	1.02	3.16	4.27	64.1	132.0
VG 75	6.09	12.02	81.71	41.59	1.05	1.64	0.49	0.95	1.05	1.91	2.59	4.50	32.1	109.3
JLM 4	5.93	10.44	49.56	49.25	1.45	1.89	0.72	0.82	1.64	1.84	3.81	4.35	38.4	131.7
JLM 6	7.47	12.51	84 18	54.81	1.71	1.75	0.61	0.64	1.31	1.35	3.51	3.74	50.5	123.8
VG 76	6.16	12.79	80.70	42.38	1.05	2.14	0.72	0.99	1.05	1.29	2.82	4.42	60.5	140.0
VG 77	5 40	15.01	104.29	42.36	2.61	2.64	0.64	1.21	1.71	2.05	4.96	5.90	84.7	177.8
VG 15	5.84	9.16	71.56	40.91	1.95	2.05	0.81	1.08	1.11	1.19	3.87	4.32	40.1	95.4
ICG 1697	5.45	11.33	68.63	41.36	0.99	1.92	0.64	0.71	1.18	1.63	2.81	4.26	85.4	259.2
CGC 4018	4.36	9.46	73.89	45.30	1.24	1.76	0.84	0.99	1.25	1.45	3.28	4.20	67.2	212.1

		DMA	Pod yield
Cultivars	SE	0.39	5.70
	CD	1.16	16.77
Treatment	SE	0.17	2.43
	CD	0.49	7.15
C x T	SE	0.56	8.06
	CD	1.64	23.72

ced as K+concentration in the medium was lowered. Evenhere, the culture VG 77 has accumulated higher amounts of K+ *viz.,* 1.71 per cent by its adaptive feature of higher-root-shoot ratios for greater absorption of nutrients and water, K+ in particular. The accumulation of K+ might help in lower loss of water from plants by regulatory mechanism of stomatal opening and closure of guard cells (Humble and Raschke, 1971 ; Mengel and Kirkly, 1980). Nutrient content in the leaf cell contributed to the osmoregulation and is important in drought tolerance (Pitman, 1981) The positive correlation obtained between K+ content of leaf and dry matter production ($r=0.94^*$) indicated the effect of K+ on translocation of photosynthates (Hartt, 1970). The results indicated for the existence of a well-knit association between K+ content of leaf on one hand and the dry matter production on the other for the higher pod yield under moistures stress conditions.

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ZINC LEVELS IN RELATION TO GROWTH AND ZINC CONTENT OF WHEAT*

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Wheat (*Triticum aestrivum L.*) plants were grown in the greenhouse using a Zn deficient soil (Typic Torripsamment) treated with nine levels of Zn ranging from 0 to 100 ppm. The magnitude of Zn response was dependent on growth stage and Zn level. A dose upto 20 ppm Zn had no deterimental effect on yield. In early stage of growth, 2.5 ppm Zn was found better than the other levels tried. But, at later stages a higher rate of Zn (10 ppm) could meet the requirement of the crop. Concentration of Zn in different plant parts increased with the rate of its application and it was invaulable higher in lower leaves than in middle and upper ones. There was considerable build up in tissue Zn concentration at higher. Zn levels without substantial difference in yield. The amount of DTPA extractable Zn decreased. With time primarily due to fixation in soil during crop growth as the total amount of Zn removed through shoot growth was only a small proportion.

Large tracts of land all over the world have been found to be deficient in one or the other micronutrient resulting in low productivity of soils. Among different micronutrients, the deficiency of Zn is widespread in Indian soils. Soil application of Zn in large amount has been found to exert an appreciable influence on crops and soils for a relatively long periods of time (Ellis *et al*, 1969) and its unplanned or excessive application may develop toxicity. Deb and Zeliang (1975) did not find any response to Zn application in terms of dry weight of wheat plants in a greenhouse experiment and Zn content of the plant was not affected by the treatment Gattani *et al*, (1976) round that dry matter yield of eight week old wheat crop increased upto 5 ppm Zn level and thereafter it decreased with increasing level of Zn.

Detailed information relating to changes that occur with age, in the content of Zn in different parts of plants is fragmentary. The present study was, therefore, undertaken to find out the effect of varying Zn levels on dry matter yield, Zn, concentration in different plant parts at three growth stages and available Zn in post harvest soil samples.

MATERIALS AND METHODS

A greenhouse experiment was conducted in polythylene lined clay pots (25 cm in diameter), filled with 4kg of Zn deficient sandy (Typic Torripsamment) soil of pH 8.3, EC 0.26 mmhos/cm, CEC 45 meq/100g. organic carbon 0.05%. The available N. P and K were 31.0, 4.2 and 63.0 ppm. respectively. The sand, silt and clay contents were 93.3, and 4%. respectively. The DTPA extractable Zn (0.36 ppm) was determined according tothe procedure of Lindsay and Norvell (1978). Allthe soil properties were esti-

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