Annals of Arid Zone 33(3) 223—227 1994

Response of Groundnut Genotypes to Photosynthetically Active Radiation

R.B. Gajjar, A.M. Shekh and N.M. Patel*
Department of Agril. Meteorology, B.A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand 388 110, India

Abstract The causes of high yield potential of groundnut (*Arachis hypogaea* L.) genotype Robut 33-1 in comparison to GG-2 (the released variety) during summer season were assessed under experimentally created varying environments using meteorological parameters. The genotype Robut 33-1 had higher PAR conversion use efficiency (CUE) than GG-2 at all the growth stages studied. The relation between PAR absorption coefficient (Y) and days after sowing (D) for Robut 33-1 was : $Y = -0.647 + 0.018\ D - 0.000057\ D^2$ and for GG-2 it was : $Y = -1.016 + 0.029683\ D - 0.000125\ D^2$, with $R^2 > 0.86$. The rate of dry matter production was linear over the intercepted PAR ($R^2 > 0.88$). The CUE (dry matter produced per unit of intercepted PAR), by linear regression technique was 1.542 g MJ^{-1} in Robut 33-1 and 1.067 g MJ^{-1} in GG-2. The results revealed that PAR and CUE could be utilized in selection programme for high yield potential.

Key words Groundnut, photosynthetically active radiation, conversion use efficiency, absorption coefficients, dry matter, yield

Groundnut being *kharif* crop of Saurashtra region of Gujarat is recently introduced in the middle Gujarat as 'summer crop in non-traditional area'. Due to climatic variation, genotype suitable for *kharif* season may not perform better under summer season. Robut 33-1 performs better under summer season than GG-2, the released variety (GAU, 1986). Variables causing such variation need to be studied, especially for groundnut genotypes.

The yield or dry matter production of a crop is partly the reflection of efficiency of the conversion of light energy into chemical energy through photosynthesis. Boote *et al.* (1980) observed a close relation between leaf area and light interception and consequent influence on canopy photosynthesis. The conversion efficiency is affected by the amount and intensity of photosynthetically active radiation (PAR) intercepted and the photosynthetic efficiency of the leaves of the crop. This phenomenon has been evaluated through field experimentation by creating different environments, thereby differences in radiation and leaf area through dates of sowing and irrigation levels.

Present addresses
* Department of Agril. Statistics, B.A. College of Agriculture, Gujarat Agricultural University, Anand Campus, Anand 388 110, India.

Materials and Methods

A field experiment on Robut 33-1 and GG-2 genotypes was conducted during 1989 with two dates of sowing (D_1 - 20th January and D_2- 5th February) and three levels of irrigation (I_1- irrigation at 10 day interval, I_2 - irrigation at 15 day interval and I_3 - irrigation at T_c-$T_a = \pm 0.5^oC$, i.e., canopy air temperature differences equal $\pm 0.5^oC$) in randomized block design with three replications at the Agronomy Farm of B.A. College of Agriculture, GAU, Anand. The kernels were drilled at 45 cm spacing between rows.

The soil of the experimental field is loamy sand of alluvial origin. The soil had maximum water holding capacity of 33%, field capacity at 17% and permanent wilting point at 5% moisture (w/w) with a density of 1.5 gm cm^{-3}. The PAR, solar radiation, outgoing reflected radiation, intercepted PAR were measured at weekly intervals after 56 days of sowing (DAS) in Robut 33-1 and 40 DAS in GG-2 with the help of 90 cm line quantum sensor (LQA 0704, LICOR INC, U.S.A.) and pyranometer sensor (LI-188 B, LICOR INC, U.S.A.) at 0830, 1100, 1400 and 1630 hours. The values of total solar radiation during the intermittent days of the observations were used from the pyranometer installed in the field. The relationship between solar radiation (S) and PAR was worked out to be in the form of PAR = 0.57 S. Similar relationships were worked out by Britton & Dodd (1976) and Nathan (1982). This relation was used to estimate PAR during the intermittent days. The coefficients of reflectance (r), transmittance (t) and absorptance (a) were calculated by the following relationships (Anonymous 1987):

$$r = (Ir/I),\quad t = (It/I) \quad \text{and} \quad a = 1 - t - r$$

where,

I = incoming solar radiation measured above the canopy,

Ir = reflected radiation measured above the canopy, and

It = transmitted radiation measured just above the ground surface.

The relation was used in computing energy conversion efficiency in g MJ^{-1} which was based on total dry biomass and the regression analysis was also carried out to study the relation between PAR absorption coefficient and DAS. Dry matter production and their respective available PAR for different treatments were used for computing the CUE during the growing season.

Results and Discussion

Yield attributes

The genotype Robut 33-1 yielded 50 per cent more pods and 27 per cent more haulm than GG-2 (Table 1). Robut 33-1 sown in February gave significantly more pod yield than January sown crop, while GG-2 was not influenced by date of sowing. The irrigation levels I_1 and I_3 were at par and gave significantly more pod yield than I_2 level. Haulm yield was not influenced by irrigation levels, but interaction effect V x I was significant. The results revealed that Robut 33-1 had higher haulm and pod yield potential than GG-2 under summer cultivation.

Photosynthetically active radiation

The correlation coefficients between PAR absorption coefficients and DAS for different treatment combinations ranged from 0.88 to 0.98. The results thus suggested that PAR absorption increases with crop ageing. Since high correlation was observed between PAR, absorption coef-

Table 1 *Mean pod yield and dry haulm yield (kg ha^{-1}) as influenced by date of sowing and irrigation levels*

Factor	Pod yield			Haulm yield		
	Robut 33-1	GG-2	Mean	Robut 33-1	GG-2	Mean
Date of sowing						
D_1	1257	930	1094	5058	4077	4568
D_2	1556	953	1255	5812	4492	5152
Mean	1407	942	–	5435	4285	–
Irrigation levels						
I_1	1527	978	1252	5339	4532	4936
I_2	1285	798	1041	5498	3800	4649
I_3	1408	1050	1229	5469	4521	4995
Mean	1407	941	–	5435	4284	–
CD (0.05) for						
Genotypes (V)		85		274		
Dates (D)		85		274		
Irrigation (I)		104		NS		
V x D		120		NS		
V x I		NS		335		

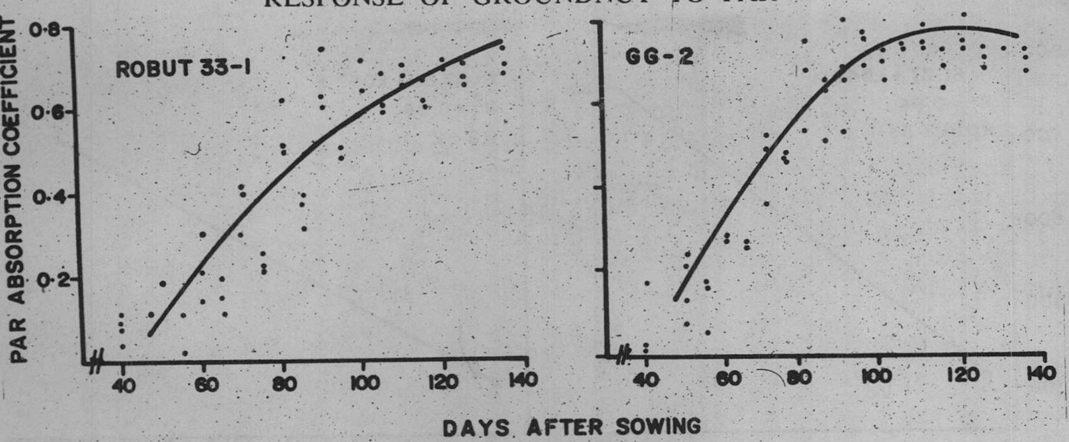

Fig 1 Relation between PAR and days after sowing for Robut 33-1 and GG-2

ficient and DAS (D), the data were pooled over dates of sowing and irrigation levels for each cultivar. The regression analysis (Fig.1) resulted in the following equations with curvilinear response:

$$PAR = -0.647 + 0.018\ D - 0.000057\ D^2 \quad (R^2 = 0.86^*)$$

for Robut 33-1 (n = 57)

$$PAR = -1.016 + 0.029\ D - 0.000125\ D^2 \quad (R^2 = 0.90^*)$$

for GG-2 (n = 57)

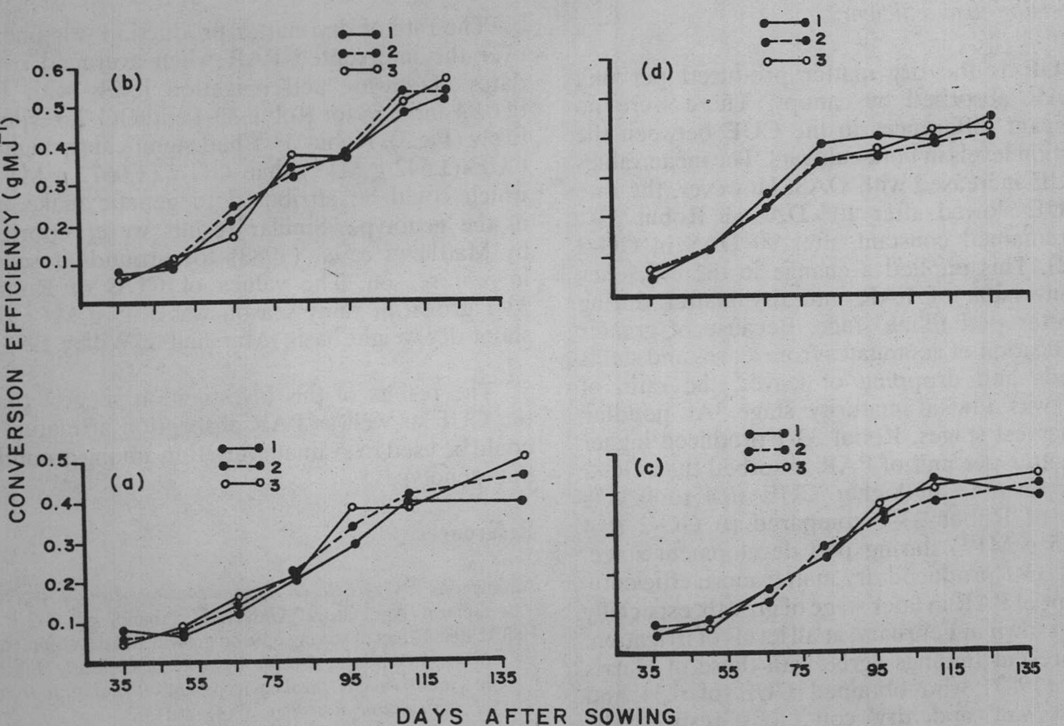

Fig 2 Effect of levels of irrigation on PAR conversion efficiency (g MJ^{-1}) of Robut 33-1 : (a) 20 January sowing, (b) 5 February sowing and GG-2, (c) 20 January sowing, (d) 5 February sowing

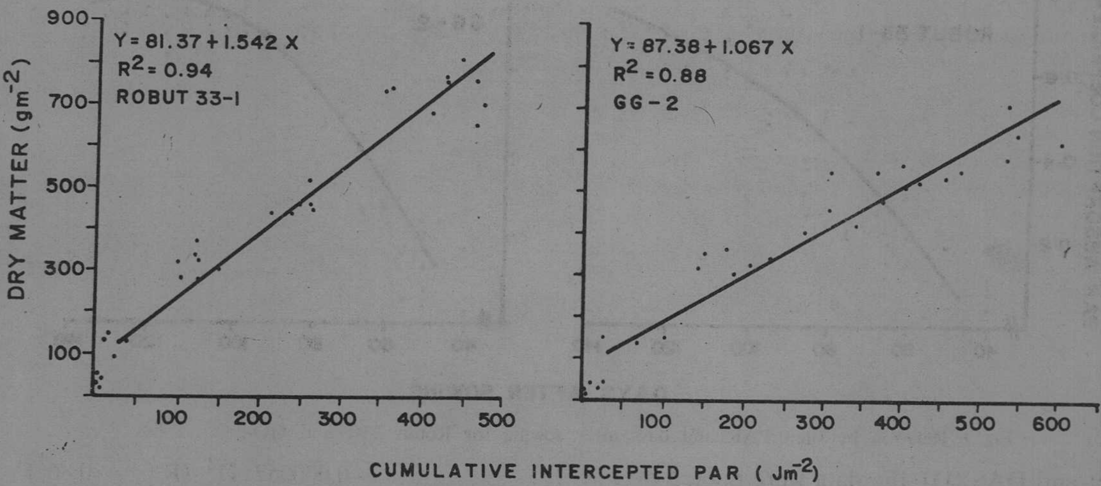

Fig 3 Relations between dry matter accumulation and cumulative intercepted PAR by groundnut genotypes

These results are akin to those reported by Bell (1986). Similarly, Pallas & Samish (1974) also reported that the photosynthetic rate per unit leaf area in groundnut usually shows a curvilinear response to increased irradiance.

Conversion use efficiency

CUE is the dry matter produced per unit of PAR absorbed by canopy. There were no significant differences in the CUE between the irrigation levels in both cultivars. The mean values of CUE increased with DAS. However, the rate of CUE slowed after 105 DAS in Robut 33-1 and remained constant after 90 DAS in GG-2 (Fig.2). This implied a change in the efficiency of conversion of PAR into dry matter during and after pod filling stage. Because of greater translocation of assimilates from leaves and stems to pods and dropping of leaves, the ratio of CUE was low at maturity stage. At podding and harvest stages, Robut 33-1 produced higher dry matter per unit of PAR absorbed than GG-2 which resulted in higher CUE (0.4 to 0.56 g MJ^{-1}) of Robut 33-1 compared to GG-2 (0.4 to 0.45 g MJ^{-1}) during pod development stage. Robut 33-1 produced dry matter more efficiently per unit of PAR in later stage of growth, especially in crop sown in February, at all levels of irrigation. The present findings agree with those of Harris *et al.* (1987) who obtained CUE of 0.54 and 0.44 in 'wet' and 'dry' conditions, respectively, during pod development stage of groundnut. Reddy & Willey (1981) recorded CUE of 0.20 to 0.60 in groundnut cv. Robut 33-1 after 61 DAS.

Dry matter production and cumulative intercepted PAR

The rate of dry matter production was linear over the intercepted PAR when averaged over dates of sowing and irrigation levels with R^2 of 0.94 and 0.88 for Robut 33-1 and GG-2, respectively (Fig.3). Robut 33-1 had significantly higher CUE (1.542 g MJ^{-1}) than GG-2 (1.0672 g MJ^{-1}) which could be attributed to genetic make up of the genotype. Similar results were reported by Matthews *et al.* (1988) for groundnut sown in *rabi* season. The values of CUE of Robut 33-1 grown in rainy season was 1.25 g MJ^{-1} on shoot dry weight basis (Marshall & Willey 1983).

The results of this investigation suggest that the CUE as well as PAR absorption at maturity could be used to evaluate variation among groundnut genotypes.

References

Anonymous 1987 *AICRP on Agrometeorology Annual Report.* Gujarat Agricultural University, Anand, pp. 5-7

Bell M 1986 Effect of sowing date on growth and development of irrigated peanut *Arachis hypogaea* L. Cv. Early Bunch in a monsoonal tropical environment. *Australian Journal of Agricultural Research* **37**(4) 361-373

Boote KJ, Jones JW, Sukerage GH, Borfiedd CS & Berger 1980 Photosynthesis of peanut canopies as affected by leaf spot and artificial defoliation. *Agronomy Journal* **72**(2) 247-252

Britton CM & Dodd JD 1976 Relationship of photosynthetically active radiation and shortwave radiation. *Agricultural Meteorology* **17** 1-7

GAU 1986 *GAU Annual Research Report. Oilseed Crops.* Gujarat Agricultural University, Junagadh, 9p

Harris D, Natrajan M & Willey RW 1987 Physiological basis for yield advantages in a sorghum/groundnut inter crop exposed to drought (1) Dry matter production, yield and light interception. *Field Crops Research* **17** 259-272

Marshall B & Willey RW 1983 Radiation interception and growth in an intercrop of pearl millet/groundnut. *Field Crops Research* **7(2)** 141-160

Matthews RB, Harris D, William JH & Nageswara Rao RC 1988 The physiological basis for yield differences between four genotypes of groundnut (*Arachis hypogaea* L.) in response to drought-solar radiation interception and leaf movement. *Experimental Agriculture* **24(2)** 203-213

Nathan KK 1982 Note on relationship between photosynthetically active radiation and total radiation. *Annals of Arid Zone* **22** 259-262

Pallas JE Jr & Samish YB 1974 Photosynthetic response of peanut. *Crop Science* **14** 478-482

Reddy MS & Willey RW 1981 Growth and resource use studies in an intercrop of pearl millet/groundnut. *Field Crops Research* **4** 13-24