INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

EFFECT OF SOWING WINDOWS AND IRRIGATION REGIMES ON APAR AND DRY MATTER OF SUMMER GROUNDNUT IN WESTERN MAHARASHTRA

S.V. Khadtare* and H.N. Aiwale

AICRP on Safflower, Krishak Bhawan, ZARS, 97, Raviwar Peth, Solapur.

E.mail: khadtareagronomy@gmail.com

ABSTRACS:

The field experiment was conducted during summer season of 2014 and 2015 with the objective to develop the relationship between radiation interception and dry matter production in groundnut. The experiment composed of three dates of sowing and four irrigation regimes. Early sowing in 7th MW and irrigation of 100 % of CPE through microsprinkler significantly increased absorbed photosynthetically active radiation. The radiation use efficiency showed increasing trend with advancement in crop age up to peg formation, thereafter, it was declined towards physiological maturity. Higher RUE was recorded under 7th MW till peg formation. Higher values of fraction of PAR intercepted were recorded under groundnut sown at MW 7. The crop received higher irrigation showed significantly higher radiation interception. It was in the order of 100 % of CPE> 80 % of CPE > 1.0 IW/CPE> 60 % of CPE.

Key words: - *Groundnut, sowing windows, microsprinkler, APAR, RUE*

INTRODUCTION:

Groundnut (*Arachis hypogaea* L.) is one of the prominent and momentous short-day annual legume crop of the world. It is grown on 35.5 mha across 82 countries in the world. It is grown on area of 5.5 mha with a total production of 9.7 mt with productivity of 1.75 t ha^{-1} in India. While, biological potency of groundnut is estimated to reach 3.0 - 4.5 tonha^{-1} (Anonymous, 2018).

The opportunities to increase peanut production are large under summer season due to ample light and lower infestation of disease and pests. Higher temperature in tropics is likely to influence crop yield negatively while increasing the demand for already limited water supply in our country. Economic yield of a crop comprises of the function of growth rate, duration of growth and proportion of growth realized in the grain component. Peanut, like other plants requires not only adequate water and nutrient but also solar radiation that can effectively improve the yields. Light is one of the major factors for growth and biomass production of groundnut and dry weight (Nautiyal *et al.*1999). Canopy structure may affect peanut responses to plant population in terms of solar radiation interception and growth of the crop. The total dry weight increases with increasing solar radiation. There was a belief that the conversion efficiency is controlled genetically, but environmental factors and variety, climatic changes, plant arrangement and soil fertility play an important role on photosynthesis. Since water stress brings about changes in growth and dry matter partitioning in groundnut, there is need of efficient and economic use of irrigation water so as to increase the area and productivity of summer groundnut.

Due to scenario of climate change, an emphasis was made with the objective to develop the relationship between radiation interception and dry matter production in groundnut at Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri during summer, 2014 and 2015.

MATERIAL AND METHODS:

The field experiment was conducted for two consecutive years at the farm of Water Management Project, MPKV, Rahuri, during summer season of 2014 and 2015. MPKV, Rahuri lies between 19^0 48´ N and 19^0 57´ N latitude and 74^0 32´ E and 74^0 19´ E longitudes. Climatologically, this area falls in semi-arid tropics with annual rainfall varying from 307 to 619 mm. The annual maximum and minimum temperature ranges between 33 and 43^0C and 3.0 and 18.0^0C, respectively, while relative humidity during morning and evening hours is 59 to 35 per cent, respectively. The pan evaporation ranges between 5. 3 and 12.1 mm while, the sunshine hours between 7 and 9 days^{-1}. Annual bright sunshine hours day^{-1} were 8.0 and 8.8 during 2014 and 2015, respectively.

The experiment composed of three windows of sowing. viz. D_1: 7th Meteorological week (MW), D_2: 9th MW and D_3: 11th MW with four irrigation regimes. *viz.* I_1: micro-sprinkler irrigation at 60 % of cumulative pan evaporation (CPE), I_2: micro-sprinkler irrigation at 80 % of CPE, I_3: micro-sprinkler irrigation at 100 % of CPE and I_4: surface irrigation at 1.0 IW/CPE ratio. Cumulative pan evaporation (CPE) is the sum of daily evaporation between two successive irrigations. While, irrigation water (IW) is pre-determined depth of irrigation water. The irrigation frequency was twice a week. The growth observations were recorded at the end of physiological growth stage during both the years. The growth stages were P_1: Sowing to germination, P_2: Germination to branching, P_3: Branching to first flower, P_4: First flower to 50 % flowering, P_5: 50 % flowering to peg formation, P_6: Peg formation to rapid kernel growth, P_7: Rapid kernel growth to physiological maturity (Varaprasad, 2010). For determining dry matter per plant, one randomly selected plant was washed and all the plant parts, *viz.* leaves, stem, roots, flower and pods were separated. The parts were sundried and then allow drying in thermostatically controlled hot air oven at 60 $\pm$ 2^0C till constant weight was recorded. The dry matter study was carried out at the end of each growth stage. Radiation measurements were made at each physiological growth stage in each plot at mid noon using line quantum sensor and digital lux meter. Solar radiation from crop canopy and soil was also recorded by inverting the sensor.

Determination of absorbed radiation

Absorbed PAR was worked out by adopting the equation given by Gallo and Daughtry, 1986.

$$Ra = (Ri + Rs) – (Rt + Rr)$$

Where,

Ra = Absorbed PAR, Ri = Incident PAR, Rr = Plant canopy reflected PAR

Rt = Transmitted PAR, Rs = Soil surface reflected PAR

To calculate light use efficiency, cumulated absorbed PAR was converted from $\mu molm^{-2}s^{-1}$ to MJm^{-2} by multiplication of factor 0.0188.

Light interception (LI) and Light interception (%) was calculated using the formula as given by (Flenet *et al.*, 1996).

$$LI = (Ri- Rt)$$

$$LI (\%) = (Ri- Rt)/(Ri)$$ Where,

LA = Intercepted PAR, Ri = Incident PAR, Rt = Transmitted PAR

and radiation use efficiency (RUE) was calculated by using formula,

$$RUE = \frac{\text{Amount of dry matter produced (g m}^{-2})}{\text{Amount of cumulative PAR absorbed}} = (MJ\ m^{-2})$$

In order to find out the quantum of I PAR in dry matter production, correlation between radiation interception and dry matter produced under different sowing dates were done by statistical analysis using SPSS 8.0 software.

RESULTS AND DISCUSSION:

APAR and RUE

Early sowing in 7th MW had significantly increased absorbed photosynthetically active radiation (PAR) as compared to sowing in 9th and 11th MW at all the stages of crop growth and it was significantly increased with adequate irrigation of 100 % of CPE micro-sprinkler irrigation regime followed by 80 % of CPE, 1.0 IW: CPE surface irrigation and 60 % of CPE micro-sprinkler irrigation regimes at all the days of observations of the experimentation. The interaction was found non-significant at all the crop growth stages. The radiation use efficiency showed increasing trend with advancement in crop age up to peg formation, thereafter, it was declined towards physiological maturity due to senescence of the leaves.

Higher RUE was recorded under 7th MW sown groundnut and irrigation at 100 % of CPE. The highest PAR and radiation use efficiency were found when crop was sown in 7th MW these might be due to crop sown in proper sowing window and adequate soil moisture conditions results in production of maximum leaf area. A positive linear correlation existed between the intercepted radiation and the dry matter accumulation in the groundnut. Similar results were reported by Haro *et al.* (2011).

Previous research of Kiniry *et al.* (2005) showed that, top 42 per cent of the leaf area in a groundnut stand intercepted 74 per cent of the incident light. The contribution of younger leaves (leaves 2 to 6) in absorbing PAR decreases due to wilting and nastic folding during the high period of irradiance under stressed condition and leaf expansion in micro-sprinkler irrigation at 100 % of CPE remains unchanged even at peak noon hours. This might be the probable reason of high values of APAR under higher frequency irrigation (100 % of CPE) through microsprinkler.

The highest values of RUE recorded in irrigation treatment of 100 % of CPE through micro-sprinkler was might be due to higher leaf area and biomass production. When LAI is large, maximum light interception moves deeper into the canopy thus, amount of absorbed insol radiation is higher through canopy. The results are in agreement with previous research of Black *et al.* (1985).

Radiation interception

Data pertaining to radiation interception during different phenophases has been shown in Table 3. Higher values of fraction of PAR intercepted were recorded under groundnut sown at MW 7. While, MW 11 registered lowest values of I PAR. The per cent values of intercepted PAR with incident PAR showed highest light interception by canopy at P_4 to P_6. Higher interception under 7th MW was attributed to higher groundcover due to increased leaf area.

Radiation interception as influenced due to various irrigation regimes showed that crop received higher irrigation showed significantly higher radiation interception. It was in the order of 100 % of CPE> 80 % of CPE > 1.0 IW/CPE> 60 % of CPE, pointed out that optimum irrigation is resulted in

comparatively higher light interception. The per cent values of I PAR under 100 % of CPE showed that, at the end of P4, P5 and P6 phenophases, intercepted PAR accounted to the tune of 76.6, 88.6 and 86.6 per cent of APAR.

Correlation analysis

Correlation between dry matter production and radiation

It is well understood the role of temperature and bright sunshine in different plant physiological processes. However, least information on role of incident and intercepted PAR in dry matter accumulation in groundnut is available. Hence, an attempt is made in order to quantify the relationship between stagewise resultant total dry matter accumulation per plant and incident PAR (incident PAR above canopy- PAR below canopy) during different sowing windows.

It was observed that from the data presented in Table 4, absorbed and incident PAR had positive relationship with dry matter production at each stage under all sowing windows. While, significantly positive association was noticed from branching to rapid kernel growth under crop sown during MW 7. The magnitude of relationship (r) was recorded higher at MW 7> MW 9> MW 11 at each growth stage during both the years of experimentation. Dry matter produced under midlate (MW 9) and late sown (MW 11) groundnut exhibited non-significant relationship at rapid kernel growth and physiological maturity.

REFERENCES:

Anonymous. 2018. Economic survey 2014-15, statistical appendix. Available at www.indiabudget.nic.in /es2014-15/estat.1.pdf

Black, C.R., Tang, D.Y. and Ong, C.K. 1985. Effect of moisture stress on the water relations and water use of groundnut stands. *New physiologist.* 100: 313- 328

Flenet, F., Kiniry, J.E., Board, J.E., Westgate, M.E.,Reicosky, D.C. 1996. Row spacing effects on light extinction coefficients of corn, sorghum, soybean, and sunflower. Agron. J. 88: 185-190.

Gallo, P. and Daughtry, C.S.T. 1986. Technique for measuring interception and absorbed photosynthatically active radiation in corn canopies. *Agron. J.* 78:752-756.

Haro, R.J., Mantese, A. and Otegui, M.E. 2011. Peg viability and pod set in peanut: Response to impaired pegging and water deficit. *Flora.* 206 (10): 865-871.

Kiniry, J. R., Simpson, C. E., Schubert, A. M. and Reed, J. D. 2005. Peanut leaf area index, light interception, radiation use efficiency and harvest index at three sites in Texas. *Field Crops Res.* 91: 297-306.

Varaprasad, P.V., Kakani, V.G. and Upadhyaya, H.D. 2010. Growth and production of groundnut. In: Soils, plant growth and crop production. Vol. 2. *Encyclopaedia of Life Support System.*

Nautiyal, P.C., Ravindra, V. and Joshi, Y.C. 1999. Net photosynthetic rate in peanut (*Arachis hypogaea* L.): Influence of leaf position, time of day and reproductive sink. Photosynthetica, 36: 129-138.

Table-1. Effect of sowing dates and irrigation regimes on APAR (micro mol. m^{-2} s^{-1}) of groundnut

Treatments	Absorbed photosynthetically active radiation (micro mol. m^{-2} s^{-1})						
	P$_1$	P$_2$	P$_3$	P$_4$	P$_5$	P$_6$	P$_7$
Sowing dates							
7th MW (12-18 Feb)	8.5	202	350	664	781	697	527
9th MW (26 Feb-04 Mar)	7.5	173	322	606	685	633	498
11th MW (12-18 Mar)	8.5	158	285	563	642	582	458
SE.m $\pm$	1.03	5.8	6.1	6.9	6.9	10.4	8.2
CD (0.05 %)	NS	18.4	19.0	21.5	21.3	31.3	24.8
Irrigation regimes							
60 % of CPE	9	151	260	551	646	585	446
80 % of CPE	8	186	344	626	725	659	507
100 % of CPE	9	205	364	672	758	695	540
1.0 IW/CPE (Surface)	9	172	312	595	683	611	485
SE.m $\pm$	0.8	7.6	7.2	5.6	5.6	9.2	3.7
CD (0.05 %)	NS	22.9	21.8	17.0	16.9	27.5	11.1
Interaction							
SE.m $\pm$	2.3	17.7	24.0	32.9	47.5	43.3	30.1
CD (0.05 %)	NS	NS	NS	NS	NS	NS	NS

Table-2. Effect of sowing dates and irrigation regimes on radiation use efficiency (g MJ^{-1}) of groundnut

Treatments	Radiation use efficiency (g MJ^{-1})						
	P$_1$	P$_2$	P$_3$	P$_4$	P$_5$	P$_6$	P$_7$
Sowing dates							
7th MW (12-18 Feb)	0.05	0.81	1.03	1.22	1.42	1.11	0.53
9th MW (26 Feb-04 Mar)	0.05	0.71	0.94	1.10	1.33	1.00	0.42
11th MW (12-18 Mar)	0.05	0.65	0.83	1.05	1.23	0.91	0.35
SE.m $\pm$	0.05	0.08	0.06	0.03	0.04	0.06	0.05
CD (0.05 %)	NS	NS	0.13	0.10	0.14	0.17	0.14
Irrigation regimes							
60 % of CPE	0.05	0.65	0.80	0.95	1.13	0.85	0.30
80 % of CPE	0.06	0.74	0.99	1.20	1.35	1.06	0.47
100 % of CPE	0.05	0.78	1.06	1.30	1.61	1.20	0.55
1.0 IW/CPE (Surface)	0.05	0.73	0.88	1.04	1.19	0.92	0.40
SE.m $\pm$	0.04	0.06	0.07	0.05	0.11	0.07	0.04
CD (0.05 %)	NS	NS	0.13	0.17	0.34	0.22	0.13
Interaction							
SE.m $\pm$	0.05	0.14	0.10	0.13	0.19	0.30	0.12
CD (0.05 %)	NS	NS	NS	NS	NS	NS	NS

Table-3. Effect of sowing dates and irrigation regimes on radiation interception (micro mol. m^{-2}) of groundnut

Treatments	Radiation interception (micro mol. m^{-2})						
	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Sowing dates							
7th MW (12-18 Feb)	25 (3)	279.5 (23.2)	508 (47.1)	754.5 (75.1)	894 (86.8)	801.5 (80.7)	601.5 (63.2)
9th MW (26 Feb-04 Mar)	25.5 (3.1)	245.5 (21.8)	420 (38.1)	609 (68.8)	701.5 (76.6)	627.5 (71.7)	430.5 (56.4)
11th MW (12-18 Mar)	28 (3.3)	211 (19.9)	349.5 (26.3)	506 (56.4)	606.5 (65.4)	566.5 (61.1)	370.5 (48.6)
SE.m $\pm$	3.5	16.2	37.15	59.8	72.8	53.85	43.5
CD (0.05 %)	NS	48.5	111.5	179.5	218.5	161.5	130.5
Irrigation regimes							
60 % of CPE	26.5 (3.1)	205 (19.7)	345.5 (28.2)	545.5 (57.5)	644.5 (64.6)	579 (59.9)	364.5 (44.1)
80 % of CPE	23 (3.1)	248 (22.4)	439.5 (39.5)	645.5 (69.4)	740 (79.9)	670 (71.8)	516 (59.9)
100 % of CPE	27.5 (3.1)	301.5 (24.3)	522.5 (43.6)	719 (76.6)	854 (88.6)	789 (86.6)	559 (68.7)
1.0 IW/CPE (Surface)	28.5 (3.2)	225 (20.2)	396 (34.6)	584 (63.7)	697.5 (72.1)	623 (66.4)	430.5 (51.4)
SE.m $\pm$	3.1	22.7	34.85	34.6	47.3	43.6	19.9
CD (0.05 %)	NS	68	104.6	103.8	141.9	130.7	59.5
Interaction							
SE.m $\pm$	4.5	23.2	43	69.4	93.7	75.8	50.1
CD (0.05 %)	NS	NS	NS	NS	NS	NS	NS

Table-4. Correlation coefficient between stagewise dry matter and APAR and radiation interception (micro mol m^{-2})

Treatments Sowing dates	Correlation between dry matter (g plant^{-1}) and I PAR and A PAR (micro mol. m^{-2})													
	2014													
	P_1		P_2		P_3		P_4		P_5		P_6		P_7	
	A PAR	I PAR	A PAR	I PAR	A PAR	I PAR	A PAR	I PAR	A PAR	I PAR	A PAR	I PAR	A PAR	I PAR
7th MW	0.468	0.351	0.783*	0.682*	0.811*	0.723*	0.819**	0.742*	0.823**	0.702*	0.623*	0.641*	0.433	0.315
9th MW	0.416	0.271	0.742*	0.647*	0.773*	0.671*	0.781*	0.703*	0.789*	0.631*	0.511*	0.473	0.312	0.267
11th MW	0.392	0.232	0.698*	0.601*	0.709*	0.632*	0.723*	0.658*	0.742*	0.578*	0.467	0.332	0.296	0.231
	2015													
7th MW	0.491	0.366	0.823*	0.716*	0.846*	0.732*	0.854*	0.749*	0.879**	0.771*	0.719*	0.623*	0.431	0.416
9th MW	0.441	0.316	0.754*	0.631*	0.761*	0.654*	0.792*	0.688*	0.806**	0.732*	0.632*	0.532*	0.374	0.396
11th MW	0.302	0.219	0.687*	0.603*	0.713*	0.614	0.729*	0.651*	0.756*	0.682*	0.579*	0.399	0.263	0.307

P_1: Sowing to germination P_2: Germination to branching P_3: Branching to first flower
P_4: First flower to 50 % flowering P_5: 50 % flowering to peg formation P_6: Peg formation to rapid kernel growth
P_7: Rapid kernel growth to physiological maturity

* Significant at 0.05   ** Significant at 0.01
*A PAR- Absorbed PAR
*I PAR- Intercepted PAR