LR-4606
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RESEARCH ARTICLE

Legume Research- An International Journal

Interrelations between Canopy Architecture and Growth Yield Attribute on Selected Growth Habit Peanut Genotypes

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10.18805/LR-4606

ABSTRACT

Background: Crop architecture plays a major role in the growth and development of semi determinate crops like peanut.The orientation of branches and leaves in the plant canopy plays a major role in the radiation penetration, which influences the canopy photosynthetic rate and hence the crop productivity. Light penetration and radiation use efficiency effect the drymatter production of many crops. However, links between canopy orientation, growth attributes and yield potentiality of peanut are poorly understood. Hence the aim of the present study was to determine interrelationships among various growth habit peanut genotypes for canopy architecture, canopy photosynthesis, growth parameters and yield attributes.

Methods: The experiment was laid out in a randomized block design with ten treatments and replicated thrice. Ten spanish bunch peanut genotypes varying in growth habits *viz*., decumbent-2, decumbent-3 and erect growth habit.Five plants were selected randomly in each plot by avoiding border rows and recorded canopy traits. Canopy photosynthetic parameters *viz*., light interception (Lux meter) and photosynthetic rate (IRGA) were recorded at the grand growth period (45 and 60 DAS).

Result: Plant height had a significant negative correlation with peg to pod ratio. Among the various canopy architecture traits, wider angle between primary branch and main stem and number of secondary branches per plant established significantly positive correlation with rate of photosynthesis, radiation use efficiency, growth attributes, pod yield, shelling percentage and test weight. Spreading architecture exhibit a higher maximum quantum yield of photosynthesis.

Key words: Canopy architecture, Canopy photosynthesis, Growth parameters, Peanut growth habit, Yield attributes.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) the king of oilseed crops is a valuable crop in dry areas of Asia, Africa, Central and South America, Australia and the Caribbean in view of its economic, food and nutritional value. In the world it occupies fourth place in important source of edible oil and the third place in important source of vegetable protein. It is a primary source of edible oil (44-50%), protein content (25%) and is also a valuable source of Vitamin B, E and K. It is the richest source of thiamine and niacin, which are low in cereals.

In crop improvement programme for getting higher yields canopy architecture has been a prime target. Harvest index of peanut is low due to poor sink activity despite bearing sufficient source. Hence to improve the source sink relation in peanut crop there is a need to identify the ideal peanut plant type to achieve higher yield. Most of the peanut genotypes cultivated in India belong to spanish bunch however, they vary in growth and branching pattern.

The orientation of branches and leaves in the plant canopy plays a major role in the radiation penetration, which influences the canopy photosynthetic rate and hence the crop productivity. Light penetration and radiation use efficiency effect the drymatter production of many crops. However, links between canopy orientation, growth attributes and yield potentiality of peanut are poorly understood. Hence the aim of the present study was to determine interrelationships among various growth habit peanut genotypes for canopy architecture, canopy photosynthesis, growth parameters and yield attributes.

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How to cite this article: Sreelatha, P., Sudhakar, P., Umamahesh, V., Subramanyam, D. and Vasanthi, R.P. (2023). Interrelations between Canopy Architecture and Growth Yield Attribute on Selected Growth Habit Peanut Genotypes. Legume Research. doi:10.18805/LR-4606.

Submitted: 09-03-2021 **Accepted:** 31-05-2023 **Online**: 26-06-2023

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2017 and *kharif* 2018, which is situated at 13.5°N latitude and 79.5°E longitude, with an altitude of 182.9 m (Deccan Plateau, hot arid ecoregion). The soil of the experimental field was sandy loam in texture, neutral in soil reaction, medium in organic carbon and available nitrogen, medium in available phosphorus and potassium. The experiment was laid out in a randomized block design with ten treatments and replicated thrice. Ten spanish bunch peanut genotypes varying in growth habits *viz*., decumbent-2 (K 9, KadiriAmaravathi), decumbent-3 (TCGS1157, ICGS 76, Dharani) and erect growth habit (TCGS 894, TAG 24, K 6, Narayani, TMV2) were procured from the two groundnut research stations of ANGRAU *viz*., Regional Agricultural Research Station, Tirupati, Agricultural Research Station, Kadiri. Fertilizers @ 40 kg ha^{-1} N_2, 60 kg ha^{-1} P_2O_5 and 40 Kg ha^{-1} K were applied as basal and gypsum @ 500 kg ha^{-1} at the time of flowering. Seeds were sown in lines by dibbling 1 seed per hill with a spacing of 30×10 cm on 17 July during *kharif* 2017 and on 05 July during *Kharif* 2018.

Five plants were selected randomly in each plot by avoiding border rows and recorded canopy traits *viz*., plant height, intermodal length, number of primary branches, number of secondary branches, branch angle with the main stem, leaf angle with main stem, leaf pubescence. All these parameters were recorded non-invasively without disturbing the plant, except leaf pubescence. Canopy photosynthetic parameters *viz*., light interception (Lux meter) and photosynthetic rate (IRGA) were recorded at the grand growth period (45 and 60 DAS). Radiation use efficiency (g MJ-1) was calculated as the ratio of the dry matter production to intercepted photosynthetically active radiation by the plants (Kumar *et al*., 2008).

Growth attributes *viz*., leaf area, total dry matter, dry matter partitioning, crop growth rate, leaf area index, leaf area ratio, net assimilation ratio, specific leaf area, SCMR were recorded at 15 days interval. At harvest yield attributes *viz*., peg to pod ratio, total number of filled and unfilled pods, shelling percentage, sound mature kernel percentage, pod yield, haulm yield and harvest index.

RESULTS AND DISCUSSION

Data on Pearson correlation between canopy architecture traits and canopy photosynthetic parameters (Table 1), canopy architecture and growth attributes (Table 2) and canopy architecture and yield attributes (Table 3) were presented.

Canopy architecture and Canopy photosynthesis

Number of primary branches and plant height recorded non significant positive association with canopy photosynthetic parameters *viz.*, rate of photosynthesis, radiation use efficiency and light interception, however, they established insignificant negative correlation with light extinction coefficient.

Number of secondary branches showed a significantly positive correlation with primary branch angle (r = 0.68), rate of photosynthesis (r = 0.64) at 0.05 level, however, it showed a negative correlation with leaf thickness, leaf pubescence, plant height and light extinction coefficient.

Branch angle between Primary branch and main stem, showed a significantly positive correlation with light interception (r = 0.88), rate of photosynthesis (r = 0.79) and radiation use efficiency (r = 0.72), however it showed a negative association with light extinction coefficient (r = -0.73). Leaf angle with the main stem showed a significantly negative correlation with a light interception (r= -0.67), however, it had a non-significant negative correlation with leaf pubescence, leaf thickness, plant height, rate of photosynthesis, radiation use efficiency.

Pusa Jagannath being a spreading plant type recorded the highest radiation use efficiency of 1.36 g/Mj. Due to more light interception during whole crop growth period (Somnath *et al*., 2012).

Canopy architecture and growth parameters

Plant height did not show a significant relationship with any of the growth parameters. The number of primary branches recorded significantly positive association with growth attributes *viz*., leaf area duration (r = 0.69) at 0.05 level, it showed a significant negative relation with specific leaf area, leaf area ratio, plant height, leaf thickness. Number of secondary branches proved to be important trait for peanut ideal plant type, as it had a significantly positive association with leaf area (r = 0.74) at 0.05 level, total drymatter (r = 0.80)

Table 1: Correlation studies of canopy attributes with canopy photosynthesis.

	PBR	SBR	BA	LA	LTH	PLH	LPBS	RPHT	k	RUE	LINTR
PBR	1										
SBR	0.59	1.00									
BA	0.48	0.68*	1.00								
LA	0.10	0.03	-0.31	1.00							
LTH	-0.04	-0.24	0.17	-0.36	1.00						
PLH	-0.41	-0.54	0.20	-0.30	0.44	1.00					
LPBS	0.23	-0.31	0.12	-0.50	0.42	0.41	1.00				
RPHT	0.40	0.64*	0.79**	-0.14	0.12	0.06	0.25	1.00			
K	-0.59	-0.50	-0.73*	0.09	-0.09	-0.03	-0.22	-0.78**	1.00		
RUE	0.34	0.52	0.72*	-0.38	-0.02	0.01	0.37	0.84**	-0.76*	1.00	
LINTR	0.37	0.47	0.88**	-0.67*	0.35	0.28	0.35	0.62	-0.66*	0.69*	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

PBR- Number of primary branches: SBR number of secondary branches: BA- Parimary branch angle with main stem: LA- Leaf angle with main stem: LTH- Leaf thickness: PLH- Plant height: LPBS- Leaf pubescence: RPHT- Rate of photosynthesis: k- Light extinction coefficient: RUE- Radiaton use efficiency: LINTR- Light interception.

at 0.01 level, leaf area index (r = 0.71) at 0.05 level, leaf area duration (r = 0.73) at 0.05 level, SCMR (r = 0.63) at 0.05 level.

Angle between primary branch and main stem is also an important canopy trait as it recorded highly significant positive correlation with crop growth rate (r = 0.64), leaf area (r = 0.81), leaf area index (r = 0.82), total drymatter (r = 0.84), leaf area duration (r = 0.85) at 0.01 level and NAR, LAR, SLA, SCMR, plant height, leaf thickness recorded a non significant positive correlation. Leaf pubescence recorded non significant positive correlation with all growth attributes except leaf area duration and specific leaf area.

Table 2: Correlation studies of canopy attributes with growth parameters.

	PBR	SBR	BA	LA	LTH	PLH	LPBS	LA	TDM	CGR	LAI	NAR	LAD	SLA	LAR	SCMR
PBR	1															
SBR	0.59	1.00														
BA	0.48	0.68*	1.00													
LA	0.10	0.03	-0.31	1.00												
LTH	-0.04	-0.24	0.17	-0.36	1.00											
PLH	-0.41	-0.54	0.20	-0.30	0.44	1.00										
LPBS	0.23	-0.31	0.12	-0.50	0.42	0.41	1.00									
LA	0.60	0.74*	0.81**	-0.26	0.20	-0.09	0.10	1.00								
TDM	0.49	0.80**	0.84**	-0.04	-0.15	-0.07	0.02	0.73*	1.00							
CGR	0.39	0.42	0.64*	-0.39	-0.16	0.09	0.46	0.48	0.78**	1.00						
LAI	0.63	0.71*	0.82**	-0.27	0.20	-0.03	0.18	0.99**	0.74	0.51	1.00					
NAR	0.22	0.22	0.42	-0.52	-0.13	-0.01	0.37	0.09	0.41	0.78**	0.11	1.00				
LAD	0.69*	0.73*	0.85**	-0.30	0.20	-0.04	0.20	0.98**	0.75*	0.55	0.99**	0.18	1.00			
SLA	-0.20	0.56	0.30	-0.34	-0.23	-0.33	-0.35	0.34	0.48	0.38	0.27	0.36	0.24	1.00		
LAR	-0.36	0.44	0.27	-0.30	0.14	-0.16	-0.49	0.29	0.24	-0.05	0.21	0.02	0.17	0.83**	1.00	
SCMR	0.38	0.63*	0.56	-0.17	-0.23	-0.30	0.08	0.25	0.66*	0.63	0.25	0.76*	0.32	0.43	0.22	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

PBR- Number of primary branches: SBR number of secondary branches: BA- Parimary branch angle with main stem: LA- Leaf angle with main stem: LTH- Leaf thickness: PLH- Plant height: LPBS- Leaf pubescence: LA- Leaf area: TDM- Total drymatter: CGR- Crop growth rate: LAI- Leaf area index: NAR- Net assimilation rate: LAD- Leaf area duration: SLA- Specific leaf area: LAR- Leaf area ratio.

Table 3: Correlation studies of canopy attributes with yield and yield attributes.

	PBR	SBR	BA	LA	LTH	PLH	LPBS	pegs	pods	Peg/ pod	SMK	Shelling %	100 kernel weight	Pod yield	HI
PBR	1														
SBR	0.59	1.00													
BA	0.48	0.68*	1.00												
LA	0.10	0.03	-0.31	1.00											
LTH	-0.04	-0.24	0.17	-0.36	1.00										
PLH	-0.41	-0.54	0.20	-0.30	0.44	1.00									
LPBS	0.23	-0.31	0.12	-0.50	0.42	0.41	1.00								
Pegs	0.50	0.76*	0.88**	-0.21	0.08	-0.04	0.20	1.00							
Pods	0.49	0.85**	0.82**	-0.04	0.12	-0.16	-0.02	0.94**	1.00						
Flower/peg	0.16	0.30	-0.25	0.53	-0.22	-0.64	-0.32	0.02	0.15						
Peg/pod	0.16	0.30	-0.25	0.53	-0.22	-0.64*	-0.32	0.02	0.15	1.00					
SMK	0.16	0.30	-0.25	0.53	-0.22	-0.64*	-0.32	0.02	0.15	1.00	1.00				
Shelling%	0.45	0.71*	0.78**	-0.19	-0.16	-0.01	0.22	0.88	0.79**	0.13	0.13	1.00			
100 kernel weight	0.53	0.76*	0.87**	-0.17	-0.16	-0.01	0.18	0.93	0.84**	-0.05	-0.05	0.95**	1.00		
Pod yield	0.55	0.82**	0.66*	-0.16	-0.11	-0.35	0.16	0.90	0.87**	0.29	0.29	0.86	0.84**	1.00	
HI	0.43	0.71*	0.43	0.23	-0.17	-0.46	-0.04	0.74	0.75**	0.65	0.65	0.69	0.63**	0.85**	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

PBR- Number of primary branches: SBR- Number of secondary branches: BA- Parimary branch angle with main stem: LA- Leaf angle with main stem: LTH- Leaf thickness: PLH- Plant height: LPBS- Leaf pubescence: HI- Harvest index.

Canopy architecture and yield and yield attributes

Plant height recoded a significantly negative correlation with peg to pod ratio and Sound Mature Kernel (SMK) at 0.05 level *i.e.* -0.64 and -0.64 respectively. Number of primary branches recorded a positive non significant correlation with all yield and yield attributes, however, leaf thickness and plant height recorded a negative non significant correlation. The number of secondary branches recorded a positive significant correlation with primary branch angle with the main stem (r = 0.68), shelling percentage (r = 0.71), 100 kernel weight (r = 0.76) and a number of pegs (r = 0.76) at 0.01 level. Pod yield (r = 0.82) and a total number of filled pods (r=0.85) at 0.05 level, however, peg to pod ratio, flower to peg ratio and sound mature kernel percentage recorded positive correlation but not significant. Leaf thickness, plant height and leaf pubescence showed a negative non significant correlation.

Deshmukh and Dev (1993) also observed similar results number of primary and secondary branches per plant showed positive correlation with pod yield.

Branch angle between primary branch and main stem recorded significantly positive correlation with number of pegs (r = 0.88), number of filled pods (r = 0.82), shelling percentage (r = 0.78) and 100 kernal weight (r = 0.87) at 0.01 level, pod yield (r = 0.66) at 0.05 level. However, it showed a nonsignificant negative association with sound mature kernal percentage and positive non significant correlation with Peg to pod ratio, harvest index. These results indicate that primary branch angle is an important feature of groundnut plant architecture, especially in spanish bunch types. Decumbent-3 genotypes that possess a wider angle showed higher physiological efficiency and yield compared to other types.

Leaf angle with main stem recorded non significant positive association with flower to peg ratio, peg to pod ratio, SMK, harvest index. However, it had non significant negative correlation with Pod yield, total filled pods, shelling percentage, 100 kernel weight and total number of pegs. Hence leaf angle has a limited role in terms of yield and its attributes.

The number of secondary branches had a non significant positive correlation with pod yield and total number of pods because which increases the flower-bearing area and chances of pod formation because the flower born at the basal part of the plant has greater chances to develop into pods. (Singh, 2003).

Pusa jagannath (mean 1357 kg/ha) recorded highest pod yield than erect type (mean 1231 kg/ha), radiation use efficiency is more due to higher accumulated light interception, photosynthetically active radiation and genetic character may be the reason behind it (Somnath *et al*. 2012).

Lastly, varieties with more spreading architecture exhibit a higher maximum quantum yield of photosynthesis indicating a canopy-level impact on photosynthetic efficiency.

CONCLUSION

Among the canopy architecture related traits primary branch angle with main stem showed plays critical role in light interception and radiation use efficiency. Wider primary branch angle with main stem recorded significantly positive correlation with light interception, radiation use efficiency and significant negative correlation with light extinction coefficient (k). Plant height had significant negative correlation with peg to pod ratio. Compared to number of primary branches, number of secondary branches per plant is important canopy trait as it had significant positive correlation with growth parameters leaf area, total drymatter, LAI, LAD, SCMR and pod yield, shelling percentage and test weight. Primary branch angle with main stem also showed to be important branch canopy architecture requirement, as wider angle recorded highly significant correlation with growth parameters viz., CGR, leaf area, LAI, total drymatter, LAD and pod yields, shelling percentage and test weight.

Conflict of interest: None.

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