International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 1826-1830

Received: 04-05-2020
Accepted: 06-06-2020

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Morphological and physiological characterization of groundnut (*Arachis hypogea*. L) Genotypes for higher translocation efficiency and yield

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4s.9892

Abstract
The objective of the present experiment was to select the physiologically efficient genotype(s) on the basis of morphophysiological and biochemical characteristics in some elite germplasm lines earlier identified as drought tolerant based on pod yield during the year 2014-15. These genotypes were as follows: ISK1 2009-5, INS 2008-1, TVG 0602, ISK 2008-9, ISK 2009-19, ICGV 95386, ISK 2009-7, 0916, ISK2 2008-10, ISK 2008-18, VG 420 and ADRVT 1. Twelve genotypes were tested with three check high yielding varieties. Data were recorded on plant height, number of branches per plant, leaf area, total dry matter, photosynthetic rate (Pn), transpiration rate (E; mmol m-2 s-1) and stomatal conductance (µmol H2O m-2 s1), days to first flowering, days to 50% flowering, Number of flowers per plant (Nos.), No. of pods per plant (Nos.), fertility co-efficient and pod yield (kg/ha) and protein content. Some of the genotypes showed high values for multiple physiological traits. Interestingly, only two genotypes, ISK12009-5 and ISK12009-5, showed high values for all the physiological traits. These two genotypes could be used in groundnut crop improvement programme for yield enhancement as well as in stress tolerance.

Keywords: Groundnut, morphological traits, physiological traits, biochemical traits and pod yield

Introduction
Groundnut (*Arachis hypogaea* L.) is the fore most important oil seed crop of India. In terms of area and production, it occupies an important position among the oil seed crops in the world. The Groundnut oil is rich in unsaturated fatty acid (80%), oleic acid and linoleic acid accounting for 38 to 58 per cent and 16 to 38 per cent, respectively. Among the saturated fatty acids, palmitic acid is the major one with the proportion of about 10 to 16 per cent, higher iodine value (82 to 106) and refractive index values (1.4697 to 1.4719 ND20) indicating its susceptibility to oxidation.

Yield is a complex trait, governed by many factors and there are ample evidences to show that selections directly for grain yield in plants are not easy. Thus, any morphological, physiological and biochemical characters that is associated with higher pod yield or which makes a significant contribution to yielding ability that would be useful in the improvement of grain yield. The basic studies on the basis of morpho-physiological and biochemical traits are needed to overcome the yield barriers within the genotypes. (Hukum Singh *et al*, 2014) [4]. There are two physiological approaches to achieve the target of yield potential. One is Physio-genetic, which consists the genotypic differences in physiological traits and another one is the Physio-agronomic relates with the management practices. (Dharanguttikar, and Borkar, 2014) [3]. It is ultimately the morpho-physiological variations, which is important for realizing higher productivity as evident from very high and positive association within traits. (Mathur, 1995) [6]. Therefore, the present study was undertaken with the objectives to evaluate groundnut genotypes for physiological traits.

Materials and Methods
Twelve groundnut genotypes were evaluated in Randomized Block Design with three replications during Kharif and Rabi, 2014-15 at Oilseeds Research Station, Tindivanam with the spacing of 30 x 10 cm under irrigated condition. The basal dose of N: P: K was given at the time of sowing.

Randomly five plants were selected for recording the observations on morpho-physiological traits. The observations on morphological traits, dry matter production, physiological parameters and yield parameters were recorded. The photosynthetic rate (Pn), transpiration rate (E; mmol m^{-2} s^{-1}) and stomatal conductance (gs; µmol H_2O m^{-2} s^{1}) were measured using Infra-red Gas Analyzer (IRGA; Model Portable Photosynthesis System LI 6400, LI-COR® Inc, Lincoln, Nebraska, USA). No. of flowers per plant (Nos.), No. of pods per plant (Nos.), fertility co-efficient, pod yield (kg/ha) were also recorded. The number of flowers per plant was counted individually from the tagged plants in each treatment and replication. Ten plants from each treatment were tagged and the flowers were counted periodically and were expressed in number. The number of days taken for flowering in fifty per cent of plant population was recorded as days to fifty per cent flowering and expressed in days.

Results and Discussion

Impact of groundnut genotypes for morphological characters

The knowledge of crop physiology through growth analysis technique, which involves tracing the history of growth and identifying the growth and yield factors contributing for yield variation, is a vital tool for understanding the crop behavior. This would be vital to the breeder as well as agronomist in tailoring suitable genotype or management technology for boosting up the growth and yield factors of the crop. Therefore, for a complete analysis of biological yield, it is necessary to investigate crop growth through computation of growth indices such as vegetative growth and source, dry matter production and growth analysis.

The vegetative phase governs the overall phenotypic expression of the plant and prepares the plant for next important reproductive phase. The root, stem, branches and leaves, all these parts constitute vegetative phase and perform specific functions. In the present investigation, plant height, number of branches $plant^{-1}$ increased progressively with the advancing age of the crop. The rate becomes rapid upto 80 DAS and rather slow after 80 to 100 DAS and 100 DAS to harvest. However, leaf area $plant^{-1}$ was declined after 100 DAS due to defoliation of leaves and diversion of dry matter towards pod development (Table 1).

TVG 602 (30.98 cm) and ISK 2009-7 (29.14 cm) were found to be taller, whereas ISK 2008-18 (24.20 cm) and ISK1 2009-5 (24.35 cm) were dwarf genotypes. Mensah and Okpere (2000) [7] showed the significant variances for plant height during the growth period. The genotypes, ISK1 2009-5 (11.20), TVG 0602 (10.5), INS 2008-1 (9.8) and ISK 2009-19 (9.8) had profuse branching, whereas ISK 2008-9 (7.00) had less number of branches per plant. Deshmukh and Dev (1993) [2] recorded the significant positive correlation between numbers of branches per plant with pod yield. The genotype, ISK1 2009-5 maintained higher leaf area (22.67 dm^2) followed by TVG 602 (21.98 dm^2) and ISK 2009-19 (21.29 dm^2).

The genotypes, ISK1 2009-5 (19.15) and TVG 0602 (20.97) required minimum number of days for initiation of first flower, whereas, the genotype ISK 2009-19 (28.27) required highest number of days for appearance of flowering. The genotype ISK1 2009-5(24.62), ISK2 2008-10(27.35) and TVG 0602(28.27) required minimum number of days for 50% flowering. The genotypes, ISK 2009-19(33.74) required maximum days to attend 50% flowering (Table 2).

The pattern of dry matter production and it's distribution into component plant parts has been of phenomenal interest to the research workers engaged in yield analysis. In view of this, in the present investigation, it envisaged to know the pattern of dry matter accumulation, it's distribution in component parts of plant (Table 2). The genotype, TVG-0602 (52.87 g) maintained the higher dry matter production. In addition, ISK1 2009-5 (50.45 g) and ISK 2008-9 were also recorded the higher dry matter production per plant.

Impact of groundnut genotypes for Physiological and biochemical characters

The physiological parameters influenced by groundnut genotypes are presented in Table 3. The genotypes, ISK1 2009-5 (32.56 µ mol m-2 s-1), TVG 0602 (31.98 µmol m-2 s-1) and ISK 2008-18 (30.24 µmol m-2 s-1) recorded the higher rate of photosynthesis, at the same time, these three genotypes have (ISK1 2009-5, TVG 0602 and ISK 2008-18) had lower rate of transpiration2.67, 2.30 and 2.12 respectively.

The genotypes, TVG 0602 (0.36 µmol m-2 s-1), ISK2 2008-10 (0.35 µmol m-2 s-1), ISK1 2009-5 (0.34 µmol m-2 s-1) and ISK 2009-7 (0.33 mol m-2 s-1) showed maximum stomatal conductance. The results are conformity with the results of Kalpana *et al*. (2003) [5].

Increased protein content was noted in T1 – ISK1 2009-5, T3 - TVG 0602 followed by T9 - ISK2 2008-10 genotypes.

Impact of groundnut genotypes for yield and yield parameters

The generative growth constitutes the development and growth of reproductive parts. From yield point of view, this phase assumes significance as the sink lies in the reproductive parts. Hence, the detailed observations were made on various aspects of generative growth at the stage of maturity. The number of flowers, pegs, and pods are the most important yield components that affect the yield potential of groundnut. Awal, and Ikeda, 2003 [1] reported that groundnut cultivars showed a wide range in the number of reproductive components at different developmental stages.

In the present study, the genotype ISK1 2009-5(21.59) recorded the highest number of pods $plant^{-1}$ followed by TVG 0602 (18.95), ICGV 95386 (17.56) and VRI 6 (17.46). The genotype ISK1 2009-5 (58.47) recorded the highest number of flowers $plant^{-1}$ followed by TVG 0602 (56.07). Fertility co efficient was also recorded higher in the genotype ISK1 2009-5 (34.70). The highest pod yield (kg/ha) was recorded by the genotypes ISK1 2009-5 (2742.83 kg/ha). (Table 4).

From the results obtained in the present investigation, it was concluded that, the morphological characters *viz.*, plant height, number of branches, leaf area and total dry matter production are mainly responsible for growth in groundnut. The physiological parameters like photosynthesis, transpiration and stomatal conductance, days to first flowering, days to 50% flowering, number of flowers per plant, number of pods per plant, fertility coefficient, pod yield and protein content were found at highest rate in ISK1 2009-5 and TVG 0602 genotypes which resulted in highest yielding. Therefore, these genotypes can be considered in future breeding programme for boosting up the yield heterosis and improvement in protein content.

Table 1: Morphological parameters influenced by Groundnut Genotypes

S. No	Genotypes	Plant height plant^{-1}	Number of braches plant^{-1}	Leaf area (dm^2)	Total dry matter production (g/plant)
1	T1 – ISK1 2009-5	24.35	11.2	22.67	50.45
2	T2 - INS 2008-1	25.40	9.8	20.45	45.32
3	T3 - TVG 0602	30.98	10.5	21.98	52.87
4	T4 - ISK 2008-9	26.85	7.0	20.55	47.54
5	T5 - ISK 2009-19	25.01	9.8	21.29	46.98
6	T6 - ICGV 95386	26.91	8.7	19.56	42.12
7	T7 - ISK 2009-7	29.14	7.7	20.58	44.65
8	T8 - 0916	27.07	9.8	20.76	43.34
9	T9 - ISK2 2008-10	25.59	8.0	20.27	46.26
10	T10 - ISK 2008-18	24.20	7.3	19.09	45.87
11	T11 – VG 420	23.87	7.0	19.50	46.00
12	T12 – ADRVT 1	25.67	6.1	18.80	45.36
13	T13 – TMV 2 (Check)	26.42	9.6	20.70	47.35
14	T14 – VRI 6 (Check)	26.59	10.1	21.61	49.87
15	T15 – CO 6 (Check)	26.20	9.9	21.22	49.22
	CD (0.05)	5.322	2.892	0.957	1.345
	S.Ed	1.774	0.943	0.319	4.465

Table2: Days to first flowering and 50% flowering influenced by different groundnut genotypes

Treatments	Days to flower initiation	Days to 50% flowering
T1 – ISK1 2009-5	19.15	24.62
T2 - INS 2008-1	24.62	31.00
T3 - TVG 0602	20.97	28.27
T4 - ISK 2008-9	26.44	32.82
T5 - ISK 2009-19	28.27	33.74
T6 - ICGV 95386	25.53	31.91
T7 - ISK 2009-7	23.71	30.09
T8 - 0916	23.71	31.00
T9 - ISK2 2008-10	20.97	27.35
T10 - ISK 2008-18	22.80	29.18
T11 – VG 420	24.62	31.00
T12 – ADRVT 1	26.44	33.74
T13 – TMV 2 (Check)	24.62	30.09
T14 – VRI 6 (Check)	25.53	31.00
T15 – CO 6 (Check)	26.44	33.74
CD (0.05)	2.73	3.37
S.Ed	1.33	1.64

Table 3: Physiological parameters influenced by different groundnut genotypes

Treatments	Photosynthesis rate (µ mol m-2 s-1)	Transpiration rate (mmol m-2 s-1)	Stomatal conductance (µmol m-2 s-1)
T1 – ISK1 2009-5	32.56	2.67	0.34
T2 - INS 2008-1	29.23	3.67	0.24
T3 - TVG 0602	31.98	2.30	0.36
T4 - ISK 2008-9	28.81	3.01	0.27
T5 - ISK 2009-19	28.11	3.98	0.31
T6 - ICGV 95386	29.17	3.87	0.30
T7 - ISK 2009-7	29.45	3.98	0.33
T8 - 0916	27.34	4.67	0.26
T9 - ISK2 2008-10	27.90	4.82	0.35
T10 - ISK 2008-18	30.24	2.12	0.23
T11 – VG 420	26.98	4.34	0.21
T12 – ADRVT 1	26.65	4.23	0.24
T13 – TMV 2 (Check)	27.87	2.78	0.28
T14 – VRI 6 (Check)	27.19	2.86	0.28
T15 – CO 6 (Check)	27.55	2.56	0.31
CD (0.05)	0.48	0.27	0.03
S.Ed	1.72	0.86	0.08

Table 4: Yield parameters influenced by different groundnut genotypes

Treatments	No. of flowers per plant	No. of pods per plant	Fertility co-efficient	Total pod yield kg/ha	Protein content (g/100g)
T1 – ISK1 2009-5	58.47	21.59	34.70	2742.83	22.5
T2 - INS 2008-1	53.69	16.34	28.61	1999.33	19.5
01T3 - TVG 0602	56.07	18.95	31.77	2435.53	22.1
T4 - ISK 2008-9	53.68	16.11	28.21	2251.44	18.9
T5 - ISK 2009-19	53.05	17.09	30.28	1953.78	17.9
T6 - ICGV 95386	55.14	17.56	29.93	2038.54	21.8
T7 - ISK 2009-7	51.01	15.30	28.20	1842.04	19.8
T8 - 0916	55.37	14.52	24.65	1907.42	21.2
T9 - ISK2 2008-10	55.37	15.32	26.01	2326.93	21.7
T10 - ISK 2008-18	50.84	16.88	31.21	1862.82	19.7
T11 – VG 420	53.77	16.37	28.62	2211.11	20.5
T12 – ADRVT 1	53.59	15.99	28.05	2028.26	20.7
T13 – TMV 2 (Check)	54.82	16.00	27.44	2277.38	21.3
T14 – VRI 6 (Check)	54.87	17.46	29.91	2237.76	21.5
T15 – CO 6 (Check)	55.37	16.63	28.23	2319.09	22.1
CD (0.05)	2.99	2.49	78.12	339.74	2.10
S.Ed	1.46	1.21	78.12	165.85	6.45

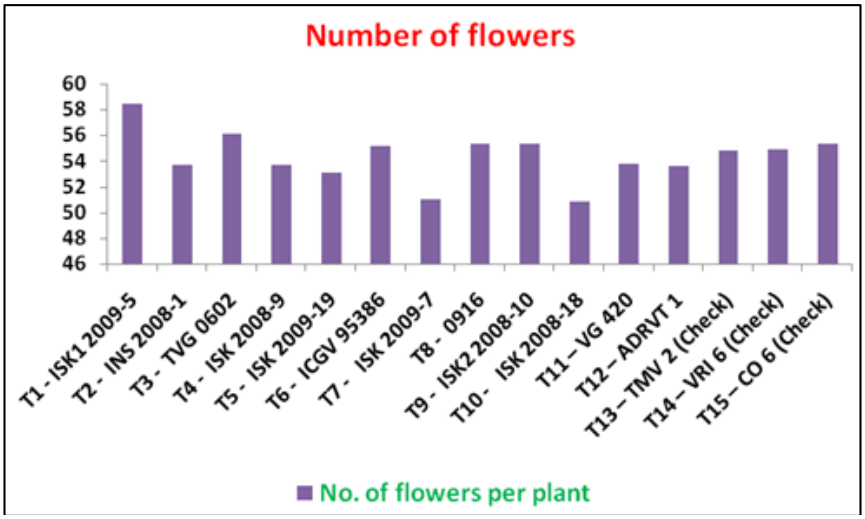

Fig 1: Number of flowers (Numbers) influenced by different groundnut genotypes

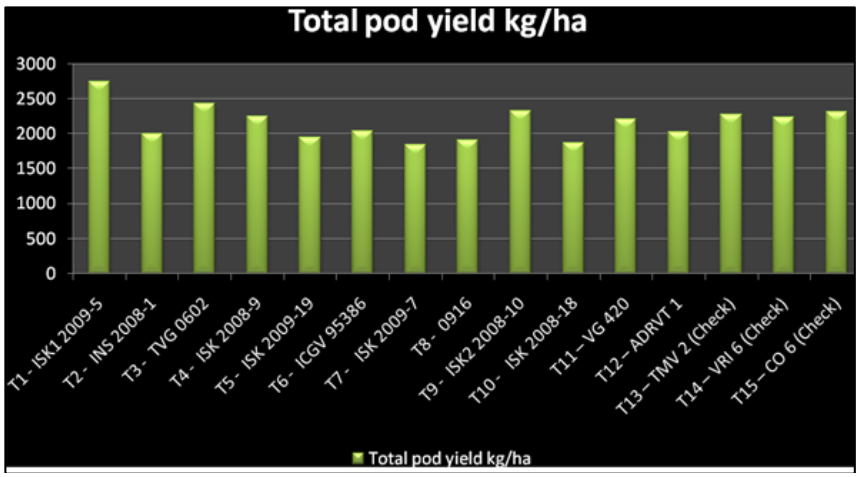

Fig 2: Total pod yield (kg/ha) influenced by different Groundnut genotypes

Conclusion

1. From the result obtained in the present investigation, it was concluded that, the genotype ISK1 2009-5 recorded the highest dry pod yield may be due to more leaf area, more number of flowers per plant.
2. The genotype ISK1 2009-5 showed high fertility coefficient. Translocation efficiency from source to sink impacts fertility co efficient.
3. The physiological processes like photosynthesis, transpiration rate and stomatal conductance rates were found highest in ISK1 2009-5, TVG 0602 and ISK 2008-18 which resulted in high photosynthetic rate and higher yield.
4. Number of kernels/pod and leaf area at harvest showed positive correlation association with dry pod yield per plant. Therefore, these traits could be considered for

further breeding programme from the high dry pod yield per plant.

Acknowledgements
The author would like to thank Tamil Nadu Agricultural University for providing partial funding for this research and would like to thank Dr. Vaidyanathan, Professor and Head, Oilseeds Research Station, Tindivanam for giving full support during the research programme.
Research project name or number: Research station trials

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