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EVUALUATION OF GROUNDNUT GENOTYPES UNDER SWAT VALLEY CONDITIONS

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Abstract

Forty-nine exotic groundnut geramplasm were screened for their physiological efficiency for future breeding program of groundnut. Our results indicated that genotype ICGS 31 had the highest harvest index of 31.43% with dry pod yield of 4556 kg ha^{-1} and was considered as physiologically the most efficient genotype in term of total assimilate partitioning into haulm and pod. Genotype ICGV 90120 exhibited maximum photosynthetic efficiency i.e., haulm yield of 59222 kg ha^{-1} with a significant lowest harvest index of 2.64 %. Significantly ($p<0.05$) positive correlation ($r = + 0.167$) was found between dry pod yield and harvest index, whereas significantly ($p<0.05$) negative correlation ($r = -0.359$) was recorded between haulm yield and harvest index.

Introduction

Population improvement of a crop is the primary objective of plant breeding program of any crop but the progress in a breeding program mainly depends upon the genetic diversity and the effectiveness of the selection criteria (Asghar & Medhi, 2010; Yagdi & Sozen, 2009; Ali *et al.,* 2008; Chema *et al.,* 2004; Arshad *et al.,* 2004; Sarwat *et al.,* 2004). Pod yield is the result of numerous complex interactions between the plant and its environment. Two characteristics seem to have a major impact on crop productivity; the ability to (1) produce high level of photosynthate over a wide range of environmental conditions and (2) transport and efficiently partition a high proportion of assimilate into economically important organs (pod/seed). When a plant does not allocate a major amount of the fixed carbon to yield components, more photosynthate cannot be translated into superior yield. Positive correlation between net-photosynthesis and yield were reported by Khan *et al.,* (1998) in groundnut, Khan *et al.,* (2004) in chickpea and Christy & Porter (1982) in soybean. Harvest index is the percent ratio between total bio mass and economic yield. Legumes generally exhibit low harvest index as compared with cereals. Park (1988) reported that traits like biological yield and harvest index are closely related to sink size, source activity and sink source ratio. Olsen (1982) reported that photosynthesis, light independent reactions and the partitioning of assimilates are the essential pre-requisite for increased and stable plant productivity. Khan *et al.,* (2004) reported a significant positive correlation between harvest index and economic yield and negative correlation between harvest index and biological yield in chickpea. Varietal difference for harvest index in chickpea and mung bean have been reported by Singh *et al*., (1980); Malik *et al*., (1981; 1986). In groundnut, doubling of pod yield in peanut was due primarily to increased harvest index rather than to increased total yield (Gifford *et al.,* 1984). Such results concerning the importance of changes in dry weight partitioning between organs have focused attention on harvest index as a specific selection criterion for plant breeder. The present study was conducted to identify physiologically efficient genotypes (if any) in the recently introduced exotic and indigenous groundnut genotypes and their further utilization in a breeding program.

Material and Methods

Forty-nine exotic groundnut genotypes viz., ICGS 32, ICGS 19, ICGS 31, ICGS 4528, ICGS 18, ICGS 02, ICGS 34, ICGS 42, ICGS 95, ICGS 86549, ICGS 2355, ICGS 12, ICGS 2261, ICGS 4993, ICGS 6826, ICGV 90120, ICGV 90135, ICGV-90127, ICGV-90115, ICGV-90133, ICGV 91256, ICGV 86300, ICGV-90104, ICGV 91263, ICGV 86635, ICGV 91265, ICGV 87846, ICGV 90260, ICGV 87830, ICGV 90116, PI-275693, PI-403834, PI-139921, PI-259606, PI-145044, PI-275690, New Mexico, PI-145041, PI-429411, PI-196614, PI-230328, BARD 479, BARD 699, BARI-89, GORI, SP-2000, Banki and Parachinar of diverse origin (India, USA and Pakistan) were tested with one local variety Swat Phalli-96, at Agriculture Research Station (N) Mingora (ARSNM) (1150 m, 72^{0}21'E and 34^{0}46'N) KPK, Pakistan. Metrological data of ARSNM is shown in Fig. 1. The experiments were laid out in randomized complete block design with four replications having sub-plot size of 4 m x 2.4 m. A basal dose of fertilizer was applied at a rate of 25 N and 60 P_20_5 kg ha^{-1} in the form of Diammonium phosphate (DAP) and urea. All agronomic operations i.e. weeding, hoeing and plant protection measures were adopted as and when required equally for all plots. However, at physiological maturity ten plants were randomly selected in each plot and data on pod yield, haulm yield, harvest index, sound mature kernel %, shelling %, 100-kernel weight (g), pod plant$^{-1,}$ and kernel pod^{-1} were recorded. While days to maturity were noted when above 80% plants showed their sound mature kernel % value. Biological (haulm) and economical (pod) yield data were recorded from the two central rows of each sub-plot. Biological yield was calculated as the total bio mass (above ground) just before threshing. Harvest Index was calculated using the formula reported by Yoshida (1981). The experimental area falls in medium to high rainfed of Malakand division. The soils of experimental sites were normal having pH range from 5.5 to 7.0, EC 0.52 to 0.91 d Sm^{-1} and textured class was sandy loam to silt loam.

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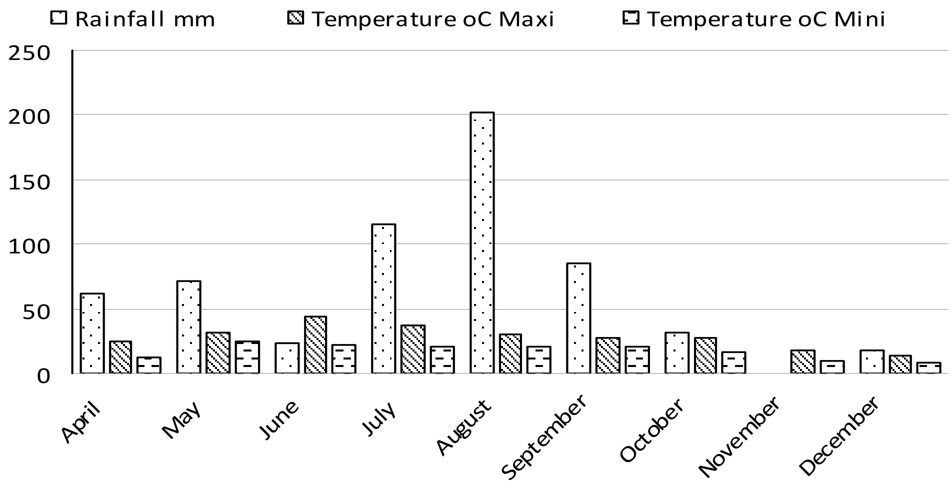

Fig. 1. Metereological record at ARSNM Swat during the experimental year.

Statistical analysis: All data are presented as mean values of three replicates. Data were analyzed statistically for analysis of variance (ANOVA) following the method described by Gomez & Gomaz (1984). MSTATC computer software was used to carry out statistical. The significance of differences among means was compared by using Duncun’s Multiple Range test (DMRT). Correlation was calculated by using the "CORRELATION" sub-program of the same package (Bricker, 1991).

Results and Discussion

Analysis of variance for various parameters studied revealed highly significant differences at p≤0.01 (Table 1). The result indicated that dry pod yield ranged from 4556 kg ha^{-1} to 559 kg ha^{-1}. Three genotypes produced pod yield above 4000 kg ha^{-1}, 9 genotypes ranged from 3889 to 3000 kg ha^{-1}, 18 genotypes between 2978 and 2000 kg ha^{-1}, 14 genotypes ranged 1922 to 1000 kg ha^{-1} and 5 genotypes produced dry pod yield less than 1000 kg ha^{-1} (Table 2). Maximum dry pod yield (4556 kg ha^{-1}) was produced by genotype ICGS 31 while minimum by PI 196614 (559 kg ha^{-1}). Similarly, pods plant^{-1} ranged from 29.22 to 6.55. Seven genotypes recorded pods density plant^{-1} between 29.22 and 20.55, 34 genotypes had pods density plant^{-1} of 19.89 and 10.10 while 8 genotypes had less than 10 pods density plant^{-1}. In case of kernel pod^{-1}, 5 genotypes had 2-kernel pod^{-1} and the rest of the genotypes ranged between 1.97 and 1.31 kernel pod^{-1}. Data pertaining to 100 kernel weight (g), 10 genotypes gave kernel weight between 80.59 and 60 g, 31 genotypes ranged from 58.63 to 40 g while 8 genotypes gave less than 40 g of 100 kernel weights. Maturity period was in the range of 177 to 164 days in the tested genotypes (Table 2).

Table 1. Analysis of variance for dry pod yield, haulm yield, harvest index, pods plant^{-1}, kernel pod^{-1}, SMK, shelling %, 100-kernel weight and maturity period of 49 groundnut genotypes grown at ARSNM Swat KPK.

Source of variance	Degree of freedom	Mean sum of square								
		Dry pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index %	Pods plant^{-1}	Kernel pod^{-1}	SMK %	Shelling %	100-kenel wt (g)	Maturity period
		10.381**	6745.9**	19131.14**	3479.56**	0.10NS	767.27NS	2.09	26.11NS	5881.72**
Error	4	0.008	3.693	13.25	8.69	0.04	109.26	15.05	3863	15.81
Genotype	48	0.058**	18.95**	152.48 **	112.23**	0.11**	69.11**	226.87**	550.79**	34.29**
Year x Genotype	48	0.031**	14.21**	134.48**	60.82**	0.07**	42.86NS	10.75**	131.75**	30.66**
Error	192	0.002	2.859	10.48	11.13	0.02	28.46	8.23	35.91	5.20
Total	293									
Cv%		12.40	21.27	16.29	18.24	7.09	6.06	4.95	11.03	1.38

*, **, Asterisks indicate significant difference at p≤0.05 and p≤0.01 level of probability, respectively, while n.s. stands for non-significant difference

Our results also revealed that biological yield ranged from 59222 to 7667 kg ha^{-1} and harvest index from 31.43% to 2.30% (Table 3). The highest biological yield of 59222 kg ha^{-1} was recorded for genotype ICGV 90120 followed by genotype ICGV 90135 with 56333 kg ha^{-1}. While minimum biological yield of 7667 kg ha^{-1} was noted for genotype ICGS 32. Genotype ICGV 86635 had lower harvest index (2.30%) compared to genotype ICGS 32 with 31.43%, which can be attributed due to higher biological yield. Similar trend was also revealed by other genotypes under study. The highest harvest index was observed for genotype ICGS 32 (31.43%) followed by genotype ICGS 31 (14.90%) exhibiting their physiological efficiency for appropriate partioning of total biomass into haulm and pod. Other genotypes in the present study were efficient in accumulating dry matter but inefficient in partioning of assimilated dry matter in to pod. Maximum variation in harvest index indicated the possibility of improving harvest index and hence boosting up pod yield in groundnut. Similar results are also reported by Malik *et al*., (1986), Fida *et al*., (1993) and Singh *et al*., (1980).

Table 2. Yield and yield component of 49 groundnut genotypes at sown at ARSNM Swat KPK.

S. No.	Genotypes	Pod yield (kg ha^{-1})	Pods $plant^{-1}$	Kernel pod^{-1}	100-k. wt (g)	SMK (%)	Shelling (%)	Maturity (days)
1.	ICGS 32	2444	19.56	1.70	55.32	90.17	63.33	174.67
2.	ICGS 19	3000	16.89	1.60	76.57	89.92	45.10	172.67
3.	ICGS 31	4556	27.00	1.57	69.87	92.39	61.00	166.33
4.	ICGS 4528	2333	24.67	1.75	51.34	89.98	65.00	170.33
5.	ICGS 18	1778	15.89	1.97	39.59	94.85	52.33	165.00
6.	ICGS 02	2556	11.23	1.43	53.15	84.39	55.00	177.33
7.	ICGS 34	2333	11.99	1.66	56.61	86.47	63.00	170.00
8.	ICGS 42	1556	18.56	1.69	48.65	91.58	48.33	164.67
9.	ICGS 95	2967	22.46	1.80	58.63	92.26	48.33	170.00
10.	ICGS 86549	2556	29.22	1.85	51.52	84.48	49.40	175.33
11.	ICGS 2355	3111	11.53	1.92	51.68	89.53	55.00	169.67
12.	ICGS 12	2367	18.68	1.62	53.45	90.92	60.42	174.33
13.	ICGS 2261	2233	17.88	1.86	67.57	87.15	54.00	165.00
14.	ICGS 4993	1667	23.78	1.58	78.67	93.46	68.00	165.67
15.	ICGS 6826	1228	10.10	1.60	50.45	92.59	41.00	167.00
16.	ICGV 90120	1556	11.78	2.27	44.77	85.70	51.20	168.00
17.	ICGV 90135	1789	9.66	1.74	53.04	91.10	64.21	173.00
18.	ICGV-90127	1569	9.11	1.97	49.31	91.21	56.49	170.33
19.	ICGV-90115	1922	15.22	1.50	48.02	91.51	57.79	168.33
20.	ICGV-90133	1144	7.43	1.89	51.97	90.07	58.05	165.00
21.	ICGV 91256	2344	6.77	1.65	57.92	88.39	60.67	170.00
22.	ICGV 86300	4222	20.55	1.86	49.92	89.35	48.00	173.33
23.	ICGV-90104	2278	12.45	1.91	57.07	87.58	56.08	173.00
24.	ICGV 91263	1449	10.33	1.93	36.63	89.12	61.00	165.00
25.	ICGV 86635	900	6.55	2.23	38.31	84.80	55.17	172.67
26.	ICGV 91265	3556	8.89	1.80	62.51	88.76	61.14	173.67
27.	ICGV 87846	3003	17.77	2.13	67.07	89.49	63.09	175.00
28.	ICGV 90260	2978	13.56	1.93	78.25	89.47	70.64	172.67
29.	ICGV 87830	3556	15.89	1.58	68.54	89.75	72.33	173.00
30.	ICGV 90116	2300	14.33	1.53	55.09	89.97	68.13	164.67
31.	PI-275693	902	14.43	1.69	52.84	92.36	66.62	167.67
32.	PI-403834	567	10.90	1.57	36.54	94.06	49.78	165.67
33.	PI-139921	2333	12.33	1.63	80.59	86.25	52.68	167.67
34.	PI-259606	3678	11.11	1.50	74.17	84.75	56.00	176.00
35.	PI-145044	2667	13.43	1.60	56.35	86.87	60.08	177.67
36.	PI-275690	1006	9.39	2.03	42.23	86.98	45.82	177.67
37.	New Mexico	2111	7.83	1.68	55.50	83.37	48.33	170.00
38.	PI-145041	2449	17.78	1.59	54.40	93.48	68.35	168.00
39.	PI-429411	1144	13.33	1.75	37.95	95.17	69.98	165.33
40.	PI-196614	559	13.78	2.03	39.98	90.28	64.10	164.00
41.	PI-230328	900	15.57	1.42	42.78	90.81	66.57	165.33
42.	GORI	3111	16.88	1.63	54.58	88.92	53.00	165.67
43.	BARD 699	4033	19.89	1.78	54.22	93.03	65.85	167.67
44.	BARI 89	2111	15.00	1.50	43.27	90.30	55.67	173.00
45.	BARD 479	1667	12.78	1.60	34.31	90.67	54.19	170.00
46.	SP-2000	3444	12.89	1.31	63.93	81.94	56.23	173.33
47.	SP 96	3889	15.11	1.67	53.21	85.47	54.67	169.33
48.	BANKI	2567	22.66	1.82	46.96	94.42	55.00	168.67
49.	PARACHINAR	1044	12.33	2.00	42.08	98.92	66.87	164.67
DMR test value $p \leq 0.01$ for genotype		744	5.01	0.18	9.00	8.01	4.30	3.43
DMR test value $p \leq 0.01$ for year x genotype		1055	7.09	0.26	12.73	11.33	6.09	4.84

Significantly ($p<0.05$) positive correlation ($r = +0.167$) was found between dry pod yield and harvest index, whereas significantly negative correlation ($r = -0.359$) was recorded between haulm yield and harvest index (Table 4). The results are in agreement with the findings of Khan *et al.,* (1998), Deshmukh *et al*., (1993) and Fida *et al*., (1993). Higher positive relationship between harvest index and economic (pod) yield evidently suggested that in varieties which produced higher pod yield, partitioning of dry matter was relatively more in favor of pods. These results, therefore, indicated that harvest index might serve as indices for identifying groundnut genotypes with higher pod yield. Thus, it can be inferred from this study that varieties having the potential of high dry matter production are of no use if they do not have the potential of converting large portion of biological yield into economic (pod) yield. Improving harvest index can substantially increase groundnut yield. Therefore, it is of vital importance to give due attention to harvest index while selecting groundnut varieties for commercial cultivation.

Table 3. Pooled data of days to maturity, biological (haulm) yield, economic (pod) yield and harvest index (%) of 49 groundnut genotypes at ARSNM Swat KPK.

S. No.	Genotypes	Maturity (days)	Economic yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
1.	ICGS 32	174.67	2444	7667	14.90
2.	ICGS 19	172.67	3000	26222	13.51
3.	ICGS 31	166.33	4556	24778	31.43
4.	ICGS 4528	170.33	2333	25889	10.25
5.	ICGS 18	165.00	1778	29666	7.94
6.	ICGS 02	177.33	2556	22222	9.75
7.	ICGS 34	170.00	2333	33666	8.38
8.	ICGS 42	164.67	1556	16333	10.99
9.	ICGS 95	170.00	2967	37000	9.59
10.	ICGS 86549	175.33	2556	23555	11.14
11.	ICGS 2355	169.67	3111	31222	10.04
12.	ICGS 12	174.33	2367	17778	12.58
13.	ICGS 2261	165.00	2233	40222	5.52
14.	ICGS 4993	165.67	1667	34666	4.91
15.	ICGS 6826	167.00	1228	38889	3.21
16.	ICGV 90120	168.00	1556	59222	2.64
17.	ICGV 90135	173.00	1789	56333	3.19
18.	ICGV-90127	170.33	1569	51666	3.18
19.	ICGV-90115	168.33	1922	49444	3.88
20.	ICGV-90133	165.00	1144	50222	2.23
21.	ICGV 91256	170.00	2344	35222	6.48
22.	ICGV 86300	173.33	4222	48555	8.74
23.	ICGV-90104	173.00	2278	42555	5.27
24.	ICGV 91263	165.00	1449	37000	4.09
25.	ICGV 86635	172.67	900	40777	2.30
26.	ICGV 91265	173.67	3556	53111	7.03
27.	ICGV 87846	175.00	3003	53666	5.66
28.	ICGV 90260	172.67	2978	44444	6.67
29.	ICGV 87830	173.00	3556	53666	6.65
30.	ICGV 90116	164.67	2300	53666	4.12
31.	PI-275693	167.67	902	23889	3.81
32.	PI-403834	165.67	567	21778	3.16
33.	PI-139921	167.67	2333	17778	13.51
34.	PI-259606	176.00	3678	43888	8.39
35.	PI-145044	177.67	2667	24222	10.75
36.	PI-275690	177.67	1006	40777	2.42
37.	New Mexico	170.00	2111	40333	5.34
38.	PI-145041	168.00	2449	28555	8.60
39.	PI-429411	165.33	1144	43555	2.59
40.	PI-196614	164.00	559	24111	2.82
41.	PI-230328	165.33	900	17000	5.22
42.	GORI	165.67	3111	39222	7.81
43.	BARD 699	167.67	4033	30222	11.43
44.	BARI 89	173.00	2111	38777	5.45
45.	BARD 479	170.00	1667	32000	5.27
46.	SP-2000	173.33	3444	19222	15.77
47.	SP 96	169.33	3889	33889	11.55
48.	BANKI	168.67	2567	21111	12.36
49.	PARACHINAR	164.67	1044	40888	2.66
DMR test value $p \leq 0.01$ for genotype		3.43	744	2.54	1.25
DMR test value $p \leq 0.01$ for year x genotype		4.84	1055	3.59	2.61
C.V. (%)		11.38	12.40	21.27	16.12

Table 4. Correlation coefficient among maturity period, economic yield, biological yield and harvest indices for 49 groundnut genotypes grown at ARSNM Swat KPK.

	Traits		
Traits	**Maturity (days)**	**Biological yield ($kg\ ha^{-1}$)**	**Economic yield ($kg\ ha^{-1}$)**
Biological yield ($kg\ ha^{-1}$)	-0.075 ns	-	-
Economic yield ($kg\ ha^{-1}$)	0.062 ns	0.256*	-
Harvest index (%)	0.138 ns	-0.359**	0.167 ns

An asterisks indicate significance at $p \leq 0.05$(*) and $p \leq 0.01$(**). NS = Non Significant

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