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EVALUATION OF LOCAL AND EXOTIC PEA *PISUM SATIVUM* GERMPLASM FOR VEGETABLE AND DRY GRAIN TRAITS

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Abstract

Sixty-eight pea genotypes both local and exotic were evaluated for 17 quantitative traits related to earliness, green pod yield, shelled fresh yield and grain yield. Results based on basic statistics, frequency distribution and correlation studies gave hope for the improvement of pea varieties for green pod yield and shelled fresh yield. Three genotypes (10303, 10603 and 10413) were selected for better yield of green pods and fresh green seeds. Evaluation of present germplasm revealed elite lines for earliness and pea grain yield through simple selection. Classification exhibited some outstanding genotypes with unique traits that could be exploited directly or be included in hybridization program for pea improvement.

Introduction

Pea (*Pisum sativum*), an important winter legume crop is used as fresh green seeds or tender green pods. It is grown in many countries of the tropics and subtropics including Burma, India, Ethiopia, Morocco, Columbia, Ecuador, Peru and Pakistan. It is cultivated during winter in plains of Pakistan and during summer in highlands (Nazir *et al.*, 1994). During 1999-2000, the crop was grown over an area of 135600 ha with 81,900 tonnes production of dry peas (Anon., 2000). Little attention has been given to varietal improvement of peas outside the temperate regions of developed countries. Breeding work in field crops is based on the utilization of germplasm either exotic or local, as germplasm is the building blocks for crop improvement (Singh *et al.*, 1976; Singh, 1985, Ghafoor *et al.*, 1998). Simakov (1989) presented the results of many years' study of yield components in a collection of varieties. Ranalli *et al.*, (1999) made comparison tests between dry grain pea lines and three commercial varieties for yield and some other traits and best ones were selected. Basavarajaiah *et al.*, (2000) studied genetic variability of 16 quantitative characters in 81 genotypes of pigeon pea. Shinde (2000) evaluated 73 pea cultivars belonging to different eco-geographical regions of India for genetic variability with respect to 13 quantitative and 2 qualitative traits. Highly significant differences in seed yield, 100-seed weight, pod size and plant height have been reported by Sugui *et al.*, (2000) in pigeon pea. Keeping in view the importance of crop and germplasm, the present study was conducted to estimate the genetic variation in available pea germplasm for economically important traits to select elite genotypes for further utilization by the breeders.

Materials and Methods

Fifty local pea germplasm accessions, collected by scientists of Plant Genetic Resources Institute (PGRI) along with 13 varieties from Australia, 3 from India and 2 from Romania were evaluated for various morphological and agronomic traits in an

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augmented design with two checks (Green Feast and Mateor) after every 10 rows under the field condition at the National Agricultural Research Center, Islamabad during winter-2000. One row of 5m length for each accession was planted with 75cm row spacing and intra-row distance was kept at 15cm. Recommended cultural practices were followed throughout the cropping season (Nazir *et al.*, 1994). The data for days to flowering were recorded on line basis when 50% flowers emerged. Other quantitative data i.e., leaf area (cm^2), flower (wing) size (cm), pods per plant, biological yield (g) and grain yield were recorded on 10 competitive plants sampled at random and then averaged to per plant basis. Fresh pod length (cm), fresh pod width (cm), fresh pod thickness (cm), number of locules in fresh pod, number of seeds in fresh pod, pod weight (g), grain weight per pod (g), dry pod length (cm) and seeds per pod were recorded on 5 pods sampled at random and then averaged to per plant basis. The 100-seed weight was recorded after counting 100 seeds by seed counter and weighed in grams. Harvest index was calculated as grain yield expressed in percentage over biological yield. The averaged data were analyzed for simple statistics including means, standard deviation, variance, frequency distribution and simple correlation coefficients using computer program MS Excel.

Results and Discussion

The basic statistics for the measured traits revealed that high variance was observed for days to flowering, leaf area (cm^2), number of seeds in fresh pods, fresh pod weight (g), fresh grain weight per pod (g), number of pods per plant, seeds per pod, 100-seed weight (g), biological yield (g), grain yield (g) and harvest index (Table 1). Frequency distribution indicates that maximum accessions flowered from 71 to 100 days (Table 2). Eight accessions took 60 to 70 days for flowering that are good source for development of short duration varieties.

Table 1. Basic statistics for 17 quantitative traits in *Pisum sativum* germplasm lines.

	Mean ±SE	σ^2	σ^2 (%)	σ	Min.	Max.
Days to flowering	89.31 ±1.85	231.68	259.41	15.22	60.00	122.00
Leaf area (cm^2)	49.70 ±1.48	149.00	299.81	12.21	26.90	79.19
Flower (wing) size (cm)	3.39 ±0.05	0.15	4.51	0.39	2.42	4.26
Fresh pod length (cm)	6.22 ±0.08	0.43	6.96	0.66	5.16	8.87
Fresh pod width (cm)	1.20 ±0.02	0.02	1.49	0.13	0.84	1.56
Fresh pod thickness (cm)	0.95 ±0.01	0.01	1.52	0.12	0.63	1.21
Number of locules in fresh pods	6.63 ±0.08	0.49	7.39	0.70	5.20	9.20
Number of seeds in fresh pods	5.19 ±0.11	0.76	14.61	0.87	3.40	7.80
Fresh pod weight (g)	2.99 ±0.12	1.06	35.32	1.03	1.52	7.12
Fresh grain weight per pod (g)	1.32 ±0.06	0.22	16.63	0.47	0.71	3.04
Number of pods per plant	31.65 ±2.37	381.49	1205.35	19.53	7.40	103.60
Pod length (cm)	5.82 ±0.08	0.46	7.93	0.68	2.26	8.22
Seeds per pod	4.51 ±0.10	0.69	15.24	0.83	2.20	6.60
100-Seed weight (g)	14.07 ±0.50	17.28	122.85	4.16	7.96	34.42
Biological yield (g)	370.85 ±24.58	41071.27	11074.98	202.66	37.18	1157.20
Grain yield (g)	53.75 ±5.47	2031.25	3779.34	45.07	2.57	213.90
Harvest index	14.78 ±1.14	88.01	595.44	9.38	1.87	53.75

σ^2 - Variance, σ - Standard deviation and σ^2 (%) - Variance expressed as percent of mean.

Table 2. Frequency distribution for 17 quantitative traits in *Pisum sativum* germplasm lines.

Variables	Range	Frequency	%age
Days to flowering			
	51-60	1	1.47
	61-70	7	10.29
	71-80	21	30.88
	81-90	1	1.47
	91-100	19	27.94
	101-110	16	23.53
	111-120	2	2.94
	121-130	1	1.47
Number of seeds in fresh pods			
	3.01-4.00	6	8.82
	4.01-5.00	29	42.65
	5.01-6.00	21	30.88
	6.01-7.00	10	14.71
	7.01-8.00	2	2.94
Fresh pod weight (g)			
	1.01-2.00	11	16.18
	2.01-3.00	30	44.12
	3.01-4.00	17	25.00
	4.01-5.00	7	10.29
	5.01-6.00	1	1.47
	6.01-7.00	1	1.47
	7.01-8.00	1	1.47
Fresh grain weight per pod (g)			
	0.01-1.00	20	29.41
	1.01-2.00	43	63.24
	2.01-3.00	4	5.88
	3.01-4.00	1	1.47
Fresh pod length (cm)			
	5.01-6.00	29	42.65
	6.01-7.00	34	50.00
	7.01-8.00	3	4.41
	8.01-9.00	2	2.94
Fresh pod width (cm)			
	0.80-1.00	8	11.76
	1.01-1.20	23	33.82
	1.21-1.40	35	51.47
	1.41-1.60	2	2.94
Fresh pod thichness (cm)			
	0.60-0.80	9	13.24
	0.80-1.00	36	52.94
	1.01-1.20	22	32.35
	1.21-1.40	1	1.47

Table 2 (Cont'd.)

Variables	Range	Frequency	%age
Number of locules in fresh pods			
	5.01-6.00	16	23.53
	6.01-7.00	39	57.35
	7.01-8.00	11	16.18
	8.01-9.00	1	1.47
	9.01-10.00	1	1.47
Leaf area (cm^2)			
	20.01-30.00	1	1.47
	30.01-40.00	17	25.00
	40.01-50.00	16	23.53
	50.01-60.00	17	25.00
	60.01-70.00	14	20.59
	70.01-80.00	3	4.41
Number of pods per plant			
	0.01-20.00	19	27.94
	20.01-40.00	34	50.00
	40.01-60.00	9	13.24
	60.01-80.00	3	4.41
	80.01-100.00	2	2.94
	100.01-120.00	1	1.47
Seeds per pod			
	2.01-3.00	2	2.94
	3.01-4.00	12	17.65
	4.01-5.00	42	61.76
	5.01-6.00	7	10.29
	6.01-7.00	5	7.35
100-seed weight (g)			
	00.01-10.00	7	10.29
	10.01-20.00	55	80.88
	20.01-30.00	5	7.35
	30.01-40.00	1	1.47
Biological yield (g)			
	000.01-200.00	13	19.12
	200.01-400.00	30	44.12
	400.01-600.00	17	25.00
	600.01-800.00	6	8.82
	800.01-1000.00	1	1.47
	1000.01-1200.00	1	1.47
Grain yield (g)			
	00.01-50.00	41	60.29
	50.01-100.00	18	26.47
	100.01-150.00	5	7.35
	150.01-200.00	3	4.41
	200.01-250.00	1	1.47

Table 2 (Cont'd.)

Variables	Range	Frequency	%age
Harvest index			
	0.01-10.00	24	35.29
	10.01-20.00	28	41.18
	20.01-30.00	11	16.18
	30.01-40.00	3	4.41
	40.01-50.00	1	1.47
	50.01-60.00	1	1.47
Flower (wing) size (cm)			
	2.01-3.00	10	14.71
	3.01-4.00	55	80.88
	4.01-5.00	3	4.41
Dry pod length (cm)			
	2.01-3.00	1	1.47
	3.01-4.00	1	1.47
	4.01-5.00	0	0.00
	5.01-6.00	48	70.59
	6.01-7.00	16	23.53
	7.01-8.00	1	1.47
	8.01-9.00	1	1.47

In case of green yield and shelled fresh yield, the important characters are fresh pod length (cm), fresh pod width (cm), fresh pod thickness (cm), number of locules in fresh pod, number of seeds in fresh pod, fresh pod weight and fresh grain weight per pod (g). Significant variation in germplasm exists for number of seeds in fresh pod, fresh pod weight and fresh grain weight per pod (Table 1).

It was observed that in case of number of seeds in fresh pod, most of accessions have range between 4.01 and 7.00. While for fresh pod weight most of accessions are between 1 to 4 g, 7 range from 4 to 5 g while 3 exceed 5 g. For fresh grain weight, 63 accessions range between 0.01 to 2.00 g while 5 accessions have range between 2.01 to 4.00 g (Table 2). Variance for fresh pod length (cm), fresh pod width (cm), fresh pod thickness (cm) and number of locules in fresh pod was low. To overcome this, a large-scale germplasm acquisition and inter-specific hybridization is suggested to improve these important traits (Khan *et al.*, 1994). Fresh pod length of most of the accessions is between 5.01-7.00 cm while five accessions have between 7.01-9.00 cm. In case of fresh pod width, most of accessions ranged between 1.01-1.40 cm. Only 8 accessions have lesser fresh pod width and 2 exceeded it. Similarly, in case of fresh pod thickness, most accessions were between 0.8 to 1.2 cm with 9 accessions having lesser and one having greater thickness.

Number of locules were between 5 and 8 and only 2 accessions have greater number of locules in fresh pod (Table 2). While considering the available variation, three accessions (10303, 10603 and 10413) exhibited better characters for green yield and shelled fresh yield and can be used in the breeding program for peas as vegetable.

High variance was observed for leaf area, number of pods per plant, seeds per pod, 100-seed weight, biological yield, grain yield and harvest index. Leaf area of one accession ranged between 20.01 to 30.00 cm^2 followed by 17 accessions between 30.00

to 40.00 cm^2. Nineteen accessions have less than 20 pods per plant while 34 accessions ranged from 20 to 40 pods/plant. Five accessions have maximum seed number of 6 or 7. Most of genotypes exhibited 100-seed weight from 10.01 to 20.00 g. Five genotypes range from 20.01 to 30.00 g while one (10601) exceeds 30.00 g. For biological yield, 60 accessions range from 0.01 to 600g and 8 accessions are between 600 to 1200g. Fifty nine genotypes have less than 100g grain yield/plant while 9 genotypes (10645, 10646, 10610, DMR 4, 88P090-5-15, DMR 20, 88P090-5-21, 10607, 10603) have greater grain yield that can be used for developing high yielding pea varieties. Sixty three genotypes have less than 60% harvest index while 5 accessions (10646, 10645, 10610, 10620, 10607) have greater harvest index. For flower size (cm) and pod length, low variance was observed and hence improvement for these traits seems to be difficult in the present germplasm under study.

Four accessions 10646, 10645, 10610, 10607 produced high grain yield from 150.01 to 250.00g and have maximum harvest index (30.01-60.00g). These are suggested to be tested under a wide range of agro-ecological conditions for their yield potential confirmation and should be exploited in breeding high yielding cultivars in peas.

On the basis of evaluation promising genotypes were selected for specific traits for future evaluation (Table 3). Accessions from local origin were important for all the characters while exotic varieties proved their superiority for number of pods per plant, seeds per pod, 100-seed weight, biological yield and grain yield.

Days to flowering have significant positive correlation with leaf area and negative with fresh and dry pod length (Table 4). As days to flowering has positive correlation with grain yield, so there must be an optimum level for short duration with grain yield and harvest index (Singh, 1985). Leaf area has significant positive correlation with flower size and 100-grain weight. Flower (wing) size has significant positive correlation with 100-seed weight, fresh pod width and thickness. It has significant negative correlation with number of locules in fresh pod.

Fresh pod length has highly significant positive correlation with fresh pod width (cm), fresh pod thickness (cm), number of locules in fresh pod, number of seeds in fresh pod, pod weight, grain weight per pod (g) and dry pod length. It has significant negative correlation with biological yield. Fresh pod width has highly positive correlation with fresh pod thickness, pod weight, grain weight per pod and 100 seed weight. Fresh pod thickness has highly significant positive correlation with pod weight, grain weight per pod and 100-seed weight. It has significant negative correlation with pods per plant. Number of locules per plant has highly positive correlation with number of seeds in fresh pod, pod weight and grain weight per pod. Number of seeds in fresh pod has highly positive correlation with pod weight and grain weight per pod. Pod weight has highly significant positive correlation with grain weight per pod and 100-seed weight. Grain weight per pod has significant positive correlation with 100-seed weight.

Pods per plant has significant positive correlation with biological yield, grain yield and harvest index. Klysha (1988) presented information on the basis of a study of 16, 18 and 19 varieties in 1983, 1984 and 1985, respectively about yield correlations in peas. Seed yield was positively correlated with number of pods/plant. Davletov (1990) and Odenbach (1989) observed number of pods per plant as the most useful yield component. Selection for seed weight and seed number/plant increased the amount of time needed for shelling and so could be replaced by selection for pod number when the requirement was for acceleration of the breeding process. After selection for pod number, only the highest

Table 3. Selection of genotypes for important quantitative traits in *Pisum sativum* germplasm.

Quantitative traits	Range	Unit	Selected genotypes
Days to flowering	51-70	Days	10474, 10475, 10612, 10600, 10620, 10604, 10610, 10634 (Pakistan).
Fresh pod length	7.01-9.00	Centimeters	10303, 10523, 10474, 10475, 10413 (Pakistan).
Fresh pod weight	5.01-8.00	Grams	10303, 10603, 10413 (Pakistan).
Number of pods per plant	40.01-120.00	Number	10603, 10607, 10610, 10621, 10627, 10645, 10646 (Pakistan). 88P090-5-15, 88P090-5-21, 88P090-5-26, Spring Pea 3 (Australia). DMR 20, DMR 4 (India), P157/87, P75/87 (Romania).
Dry pod length	7.01-9.00	Centimeters	10413, 10523 (Pakistan).
Seeds per pod	6.01-7.00	Seeds	10611, 10413, 10636, 10523 (Pakistan), WA 933 (Australia).
100-seed weight	20.01-40.00	Grams	10474, 10506, 10601, 10603, 10606 (Pakistan), 88P001-4-9 (Australia).
Biological yield	600.01-1200.00	Grams	10611, 10614 (Pakistan), 88P007-2-1, 88P090-5-15, 88P090-5-16, 88P090-5-21 (Australia), DMR 20, DMR 4 (India).
Grain yield	100.01-250.00	Grams	10603, 10607, 10610, 10645, 10646 (Pakistan), 88P090-5-15, 88P090-5-21 (Australia), DMR 20, DMR 4 (India).
Harvest index	30.01-60.00	%age	10646, 10645, 10610, 10620, 10607 (Pakistan).

Table 4. Correlation coefficients among quantitative traits in peas.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
B	0.345**															
C	0.104	0.444**														
D	-0.269*	-0.105	-0.152													
E	0.198	0.215	0.288*	0.343**												
F	0.057	0.121	0.277*	0.309**	0.585**											
G	-0.101	-0.188	-0.264*	0.463**	0.012	-0.054										
H	-0.062	-0.144	-0.135	0.437**	0.117	0.211	0.725**									
I	-0.024	0.120	0.135	0.550**	0.598**	0.694**	0.354**	0.486**								
J	0.099	0.093	0.054	0.518**	0.370**	0.649**	0.426**	0.598**	0.829**							
K	0.231	0.020	-0.144	-0.130	-0.117	-0.265*	-0.109	-0.202	-0.137	-0.142						
L	-0.303*	0.015	0.064	0.372**	0.008	0.071	0.053	-0.030	0.182	0.081	0.032					
M	-0.022	-0.212	-0.164	0.175	-0.120	0.031	0.189	0.223	0.046	0.114	0.093	0.349**				
N	-0.109	0.271*	0.317**	0.211	0.351**	0.363**	-0.142	0.076	0.369**	0.305*	-0.057	0.046	-0.298*			
O	0.177	0.227	0.059	-0.275**	-0.086	-0.168	-0.224	-0.169	-0.114	-0.070	0.496**	-0.094	0.159	-0.053		
P	0.204	0.047	0.000	-0.123	0.029	-0.124	-0.223	-0.171	-0.082	-0.151	0.838**	0.039	0.045	0.104	0.474**	
Q	0.025	-0.161	-0.045	-0.069	0.012	-0.062	-0.184	-0.150	-0.125	-0.226	0.608**	0.090	-0.004	0.066	-0.057	0.771**

A-Days to flowering, B-Leaf area (cm^2), C-Flower (wing) size (cm), D=Fresh pod length (cm), E=Fresh pod width (cm), F=Fresh pod thickness (cm), G=Number of locules in fresh pod, H=Number of seeds in fresh pod, I=Pod weight, J=Grain weight per pod (g), K=Pods per plant, L=Dry pod length, M=Seeds per pod, N=100 seed weight, O=Biological yield (g), P=Grain yield (g), Q=Harvest index

* Significant at 5% level

** Significant at 1% level

yielding plants should be selected for shelling to obtain material for sowing. Dry pod length has highly significant positive correlation with seeds per pod. Seeds per pod have significant negative correlation with 100-seed weight and significant positive correlation with harvest index. Walton (1991) concluded that plant breeders should select for increased seed number/pod in early flowering, medium to tall pea plants, to improve the total seed weight from the first 3 reproductive nodes produced on the main stem. Biological yield has significant positive correlation with grain yield and grain yield has significant positive correlation with harvest index. Significant correlation of grain yield with pods per plant, biological yield and harvest index revealed that biomass and pods play an important role in economic partitioning and grain yield and hence these traits should be given due consideration to select high yielding cultivars from the germplasm. Positive association of biological yield with harvest index showed physiological efficiency for appropriate partitioning of total dry matter towards economic yield.

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