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EVALUATION OF BLACKGRAM *VIGNA MUNGO* (L.) HEPPER GERMPLASM

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Abstract

Two hundred and eighty five blackgram germplasm accessions, collected from different parts of Pakistan were evaluated for morphological and agronomical traits. The evaluation results based on basic statistics and correlation studies blazed good hope for blackgram improvement through simple selection for maturity, branches, pods, biomass, grain yield and harvest index. Classification of quantitative traits showed some outstanding accessions with unique traits which could be exploited directly or be included in hybridization programme for blackgram improvement. Data analyzed on the basis of harvest index revealed that the genotypes within 25 to 40% harvest index exhibited better performance for most of the yield contributing traits. As a result of these findings, 25 genotypes were selected and recommended for further testing under wide range of agro-ecological conditions in search of the best blackgram cultivars.

Introduction

Sound breeding programme in any field crop depends mainly upon the availability of genetic variability either existing and/or created through mutation or gene recombination. 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 (Anon., 1995, 1996). Virmani *et al.*, (1983) categorised mungbean germplasm in various groups for different traits. Bakhsh *et al.*, (1992) categorised lentil germplasm on the basis of quantitative traits and suggested the utilization of short statured lentil germplasm for crop improvement. The high yielding accessions selected from the local germplasm might prove their superiority in advance testing under various agro-ecological condition (Ghafoor *et al.*, 1989). In a study on mungbean Ghafoor *et al.*, (1992) selected 28 genotypes on the basis of high yield potential and resistance to diseases. Ghafoor *et al.*, (1989) classified blackgram germplasm and selected 11 pure-lines for further exploitation. Singh & Srivastava (1985) categorised pea germplasm in to various groups.

Blackgram or mash (*Vigna mungo* (L.) Hepper) is an important summer pulse crop of many South Asian countries including Pakistan, India, Bangladesh, Thailand and Korea. In Pakistan it is cultivated over on an area of 70900 ha with 32000 tonnes production under a wide range of agro-ecological zones mainly of rainfed nature (Anon., 1995). Among pulses, blackgram is the least researched crop as no international centre admit this as a mandate crop. Keeping in view the importance of germplasm, a wide range of local germplasm of blackgram collected from various parts of Pakistan during the last decade was evaluated and categorized under field condition for various qualitative and quantitative traits for further utilization by the breeders.

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Material and Methods

Four hundred and fifty local blackgram/mash germplasm accessions, collected by scientists of Plant Genetic Resources Institute (PGRI) during the past decade were evaluated for various morphological and agronomical traits in an augmented design under the field condition at National Agricultural Research Centre, Islamabad during summer-1995. One row of 4 meter length for each accession was planted with 75 cm and 10 cm inter and intra-row spacing. Three varieties viz., Mash 1, Mash 2 and Mash 3 were repeated as check after every 20 rows. Recommended cultural practices were followed throughout the crop season. Out of 450 accessions, 285 were observed phenotypically homozygous and hence underwent characterization for preliminary evaluation about varietal characteristics. The plant traits or qualitative characteristics were recorded on the plot basis under field condition. Plant pubescence was recorded as presence or absence of hairs on the plant. Growth habit was recorded as erect, semi-erect and spreading. Terminal leaf shape was graded as delate, ovate, lanceolate, rhombic etc. Seed colour was observed as green or brown whereas, spots on seeds were recorded as present or absent. The data for days to maturity were recorded on line basis when about 90% pods turned brown/black after the days of planting. The other quantitative data i.e., branches, pods, grain yield and biological yield were recorded on 10 competitive plants selected at random and then averaged to per plant basis. Pod length and seeds per pod were recorded on 10 pods selected at random within the accessions. The seed weight was recorded after counting 100 seeds by seed counter and weighed in grams. Harvest index was calculated as economic yield expressed in percentage over total biomass. The averaged data were analyzed for simple statistics including means, standard error, standard deviation, variance, frequency distribution and simple correlation coefficients using computer software written in "BASIS" by one of the authors.

Table 1. Basic Statistics for nine quantitative traits in *Vigna mungo* germplasm lines.

Traits	Mean±SE	δ^2	δ	δ^2(%)	Min.	Max.
Days to maturity	85±0.71	144.32	12.01	169.15	64.0	115
Branches per plant	16±0.50	70.52	8.40	415.56	2.6	62
Pods per plant	53±1.60	726.82	26.96	1365.18	4.0	195
Pod length (cm)	4.45±0.03	0.18	0.43	4.04	3.08	6.84
Seeds per pod	6±0.05	0.64	0.80	10.36	2.80	8.20
100-seed weight (g)	4.88±0.03	0.32	0.57	6.57	2.84	6.45
Biological yield per plant (g)	57.09±1.72	848.32	29.13	1485.93	4.36	195.35
Grain yield per plant (g)	12.70±0.42	50.19	7.08	395.20	0.30	40.25
Harvest index (%)	23.16±0.56	88.27	9.40	381.13	0.84	47.98

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

Results and Discussion

The basic statistics for the measured quantitative traits; days to maturity, branches per plant, pods per plant, pod length, seeds per pod, 100-seed weight, biological yield, grain yield and harvest index is presented in Table 1. High variance (expressed as percent of means) was observed for days to maturity, branches per plant, pods per plant, biological yield per plant, grain yield per plant and harvest index. For other characters viz., pod length, seeds per pod and 100-seed weight, low variance was observed and hence improvement for these traits seemed to be difficult in the present local germplasm under study. The days to maturity in this blackgram germplasm ranged from 64 to 115 days after planting with high variance which revealed that various maturity groups in present blackgram germplasm could be established. The other important yield traits; branches, pods, biomass, grain yield and harvest index also exhibited high range alongwith high variation which in general revealed that the selection for these economic traits is effective in developing high yielding varieties of blackgram. For pod length, seeds per pod and 100-seed weight, low genetic variability seemed to restrict the scope of selection for these traits in the present germplasm collection. Hence, the genes for these important economic traits should be investigated or exploited from other sources i.e., inter-specific hybridization, mutation etc. Large scale testing of broad base germplasm need to be built up by making extensive local collection and obtaining germplasm from abroad to develop a sound breeding programme is suggested (Ghafoor *et. al.*, 1992).

Table 2. Frequency distribution of plant traits (qualitative) in *Vigna mungo*.

	Frequency	Percent
Hairiness		
Hairy plants	218	76.49
Non-hairy plants	67	23.51
Growth habit		
Erect plant type	59	20.70
Semi-erect plant type	202	70.88
Spreading plant type	24	8.42
Leaf shape		
Ovate	276	96.84
Lanceolate	7	2.46
Rhombic	2	0.70
Seed colour		
Brown	283	99.29
Green	2	0.70
Seed spots		
Spotted	282	98.95
Non-spotted	3	1.05

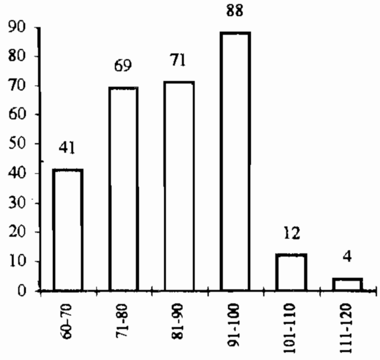


Fig.1. Frequency distribution for days to maturity in blackgram.

Morphological/Qualitative Traits: The data for morphological traits were recorded for plant pubescence, growth habit, leaf shape, seed colour and seed spots. Various distinct groups were made for these characters (Table 2). Sixty seven accessions which were 23.51% of the total were observed non-hairy and all others were having hairs on plants. For plant growth habit, 59 accessions (20.70%) were observed as erect, 202 i.e., (70.88%) observed as semi-erect and other 24 i.e., (8.42%) were spreading types. For leaf shape, the maximum accessions (276) were ovate, 7 accessions with lanceolate leaf shape and other 2 accessions showed rhombic leaf shape. In the germplasm under study, 283 accessions were with brown seed colour and only 2 accessions were observed as green seeded. Almost similar pattern was observed for the presence of spots on seed where 3 accessions were without spots and all others were spotted. We observed that in blackgram the seed colour is either brown or green and the presence of spots on seed coat exhibit the seed colour blackish. The plant traits of qualitative nature are important for germplasm characterization as some of these traits are reflected to some biotic/abiotic stresses. For example, prostate plant type is preferred for planting under rainfed condition as they facilitate in moisture conservation. Lanceolate leaf shape (narrow leaves) in most cases are drought tolerant. Crop with hairiness is more tolerant against some insects whereas glaborous cultivars facilitate in manual harvesting and threshing.

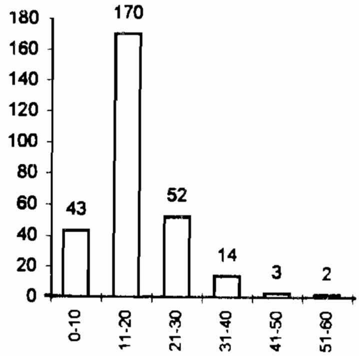


Fig.2. Frequency distribution of branches in blackgram.

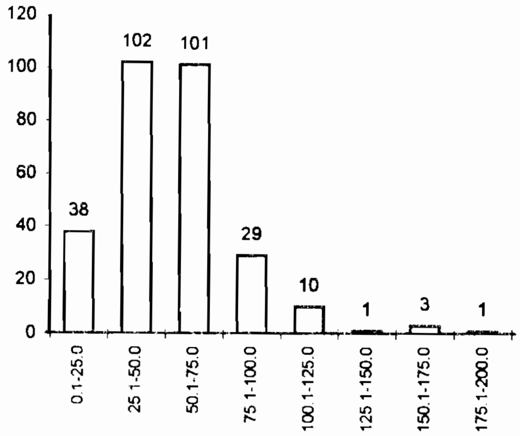


Fig.3. Frequency distribution of pods in blackgram.

Quantitative Traits: The frequency distributions for various quantitative traits are presented in the graphic form (Fig. 1-9). Maximum accessions (88) which were 28.30% of the total matured between 91-100 days and it was followed by the maturity range 71-80 days (Fig. 1). About 78% accessions matured from 71 to 100 days.

Forty one accessions matured in less than 70 days and hence these could be considered as short duration which is one of the important characters in legumes as already described by Bakhsh *et al.*, (1992). The short duration blackgram cultivars can very well be fitted in various cropping systems and one of the recent approach to fit summer legumes in rice wheat system can increase the farmer's income by introducing any short duration summer legume (mungbean or blackgram) after the harvest of wheat and before the transplanting of rice. The local germplasm is quite rich in this important trait and should be utilized for development of short duration blackgram cultivars suitable to fit in various cropping systems. The data regarding frequency distribution for branches per plant showed that the highest number of accessions (170) which was 59.65% of the total have the branches range of 11-20 and it was followed by 21-30

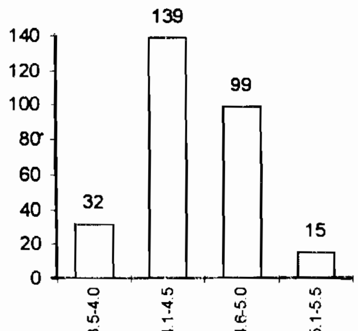


Fig.4. Frequency distribution of pod length (cm) in blackgram.

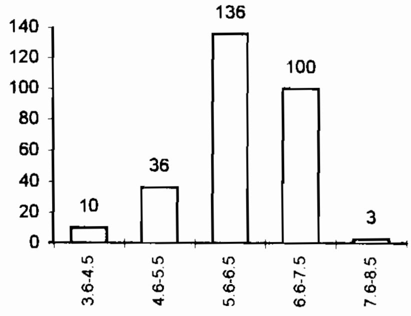


Fig.5. Frequency distribution of seeds per pod in blackgram.

branches per plant with the frequency value of 52 accessions (Fig. 2). Five accessions were observed to be bushy with very high number of branches i.e., 41-60 branches per plant. One of the approaches to increase the grain yield in blackgram could be the selection for high branches and pods keeping harvest index in consideration to develop bushy type plants with increased productivity. This ultimately might reduce the plant population on unit area basis. Pods per plant ranged from 4-195 pods per plant and on the basis of class interval, 8 groups were made (Fig.3). It is evident from the results that 102 accessions which were 35.79% of the total produced 25.1-50 pods per plant which was followed by the group from 50.1-75 with 101 accessions and these two groups can be considered medium pod bearing whereas 4 accessions produced high pod number i.e., 126-200 pods per plant and hence these accessions could be exploited for improving this trait. Maximum accessions (139) which were 48.77% exhibited 4.1 to 4.5 cm pod length and very few accessions (15) were having long pods (5.1-5.5cm). Maximum accessions (136) produced 5.6 to 6.5 seeds per pod and it was followed by 100 accessions with 6.6-7.5 seeds/pod. Pod length and seeds per pod do not exhibit much genetic variation which is associated with narrow genetic base.

To overcome this, a large scale germplasm acquisition and/or inter-specific hybridization is suggested to improve these important traits. The frequency distribution regarding seed weight as depicted in Fig. 6 revealed that 106 accessions were having

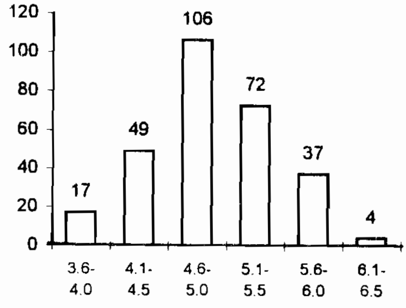


Fig.6. Frequency distribution for 100-seed weight (g) in blackgram.

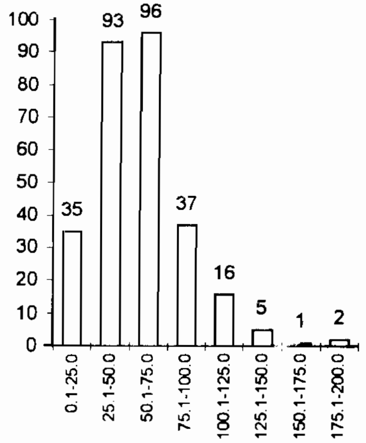


Fig.7. Frequency distribution of biological yield (g) in blackgram.

4.6-5.0g seed weight and 4 accessions were having more than 6.0g seed weight and hence could be utilized for the manipulation of this trait in developing bold seeded blackgram cultivars as high seed weight in any grain crop is preferred by the consumers.

Maximum accessions (96) produced 51.1-75.0 g biomass followed by 25.1-50.0 g in 93 accessions (Fig.7). As observed in the present study and also reported by (Malik *et al.*, (1981; 1986) and Ghafoor *et.al.*, (1993) that biomass is significantly associated with pods and branches per plant, therefore, this trait should be considered while selecting genotypes for high number of pods and ultimately grain yield. The frequency distribution regarding harvest index in blackgram revealed that maximum accessions (111) which were 38.95% of the total produced harvest index ranging from 16.1 to 24.0% followed by the range from 24.1-32.0% with 74 accessions (Fig.8). Harvest index

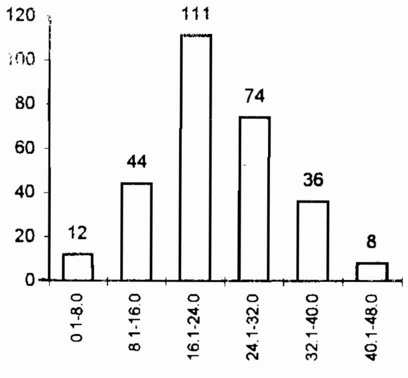
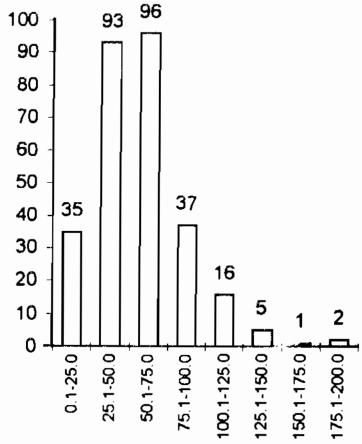


Fig.8. Frequency distribution of harvest index (%) in blackgram.



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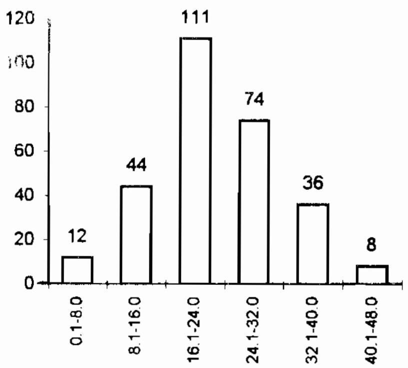

Fig.8. Frequency distribution of harvest index (%) in blackgram.

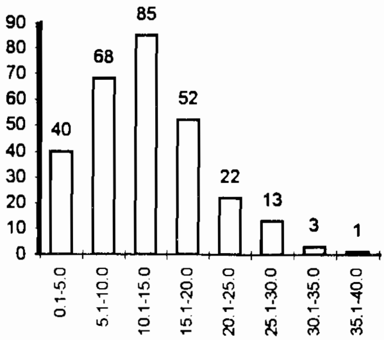

Fig.9. Frequency distribution of grain yield (g) in blackgram.

ranging from 16-32% could be considered of medium magnitude and one of the approaches in legume breeding is to breed for high harvest index (Donald, 1962; Lal, 1967; Singh., 1977; Singh *et.al.*, 1980; Malik *et.al.*, 1981, 1986; Khan & Malik, 1989, Ghafoor *et.al.*, 1993). Eight accessions produced harvest index more than 40% and these are suggested to be exploited either directly or may be included in the breeding material for developing high yielding blackgram cultivars. On the basis of grain yield per plant, the germplasm was categorized in to 8 classes (Fig.9). Maximum (85 accessions) produced the grain yield from 10.1 to 15.0 g which was followed by the range from 5.1 to 10.0 with 68 accessions. About 86% of the total germplasm under investigation produced the grain yield up to 20 g per plant which is considered the optimum range of grain yield in blackgram. In the present study some accessions were observed as high yielding since they produced the grain yield ranging from 20.1 to 40.0 g per plant. Four accessions (45221, 45060, 45152 and 45775) produced very high grain yield and these are suggested to be tested under a wide range of agro-ecological conditions for their yield potential confirmation and if found better under diversified and/or specific environments, should be exploited in breeding high yielding cultivars in blackgram.

Correlation Studies: The correlation coefficients were computed among quantitative traits i.e., days to maturity, branches, pods, pod length, seeds per pod, 100-seed weight, biological yield, grain yield and harvest index (Table 3). The results revealed that days to maturity had positive correlation with all the characters except harvest index. Branches and pod length had positive correlation with all the characters. Pods per plant and seeds per pod had positive association with all the characters except with seed weight in both cases. Biological yield per plant has positive correlation with all the characters except with harvest index which revealed that total biomass failed to partition the economic yield. Grain yield exhibited positive association with all the characters under study. High correlation of grain yield with branches, pods per plant and biological yield and harvest index revealed that biomass and pods play an important role in economic partitioning of the grain yield and hence these traits should be given due consideration alongwith branches to select high yielding cultivars of mash from the local germplasm. Strong association of grain yield with branches, pods, biomass and

Table 3. Correlation coefficients among nine yield contributing traits in blackgram.

Variables/	Branches per plant	Pods per plant	Pod length (cm)	Seeds per pod	100-seed weight (g)	Biological yield per plant (g)	Grain yield per plant (g)	Harvest index (%)
Days to maturity	0.138*	0.099	0.041	0.112	0.272**	0.223**	0.091	-0.145*
Branches per plant		0.495**	0.161**	0.169**	0.111	0.419**	0.447**	0.096
Pods per plant			0.231**	0.257**	-0.005	0.681**	0.736**	0.157**
Pod length (cm)				0.538**	0.107	0.215**	0.246**	0.109
Seeds per pod					-0.029	0.239**	0.274**	0.101
100 seed weight (g)						0.109	0.120*	0.038
Biological yield per plant (g)							0.732**	-0.168**
Grain yield per plant (g)								0.443**

*-Significant and **-Highly significant.

Table 4. Analysis on the basis of harvest index class intervals.

Harvest index range	f	Harvest index	Days to maturity	Branches	Pods per plant	Pod length	Seeds per pod	100-seed weight	Biological yield	Grain yield
5.0-10.0	26	7.34	85.27	14.87	41.37	4.35	5.73	4.67	58.58	4.53
10.1-15.0	25	13.00	84.76	14.65	44.31	4.36	6.09	4.77	58.18	7.67
15.1-20.0	53	17.92	92.06	17.15	50.46	4.47	6.22	7.93	63.78	11.43
20.1-25.0	78	22.44	84.67	17.37	54.62	4.42	6.26	5.05	58.84	13.21
25.1-30.0	43	27.55	81.86	17.75	63.59	4.61	6.35	4.79	61.39	16.84
30.1-35.0	32	32.24	82.66	17.81	60.38	4.47	6.29	4.79	50.95	16.47
35.1-40.0	14	37.33	82.64	20.69	61.07	4.49	6.29	4.94	48.26	17.87
40.1-45.0	6	41.99	86.00	13.59	47.12	4.31	5.8	5.01	33.03	13.83
45.1-50.0	8	48.37	83.43	14.17	29.74	4.31	5.57	4.70	22.84	11.09

f = frequency

Table 5. Some elite pure-lines selected from local blackgram germplasm with high harvest index.

Accession	A	B	C	D	E	F	G	H	I	J	K
Pak45336	71	8	85	5.1	6.8	4.91	73.76	21.00	28.47	1	0
Pak45157	75	19	70	4.6	7.2	5.18	68.44	21.04	30.75	1	1
Pak45091	100	23	75	4.7	6.2	5.29	77.23	21.28	27.56	1	0
Pak45712	89	16	81	4.9	7.8	4.41	84.79	21.47	25.33	0	0
Pak45342	72	22	85	4.5	6.4	4.53	65.94	21.57	32.71	1	0
Pak45047	100	16	55	4.4	6.0	4.92	80.71	21.66	26.84	1	1
Pak45352	90	15	62	3.9	5.6	4.47	70.28	21.92	31.19	0	0
Pak45333	95	14	58	4.3	5.0	5.75	71.31	22.72	31.86	0	0
Pak45136	74	30	90	4.4	7.0	4.13	84.80	23.39	27.58	0	0
Pak45751	110	17	75	4.3	6.8	4.55	71.37	23.79	33.34	0	0
Pak45350	70	20	83	4.7	6.2	4.28	80.17	23.83	29.72	0	0
Pak45207	88	16	93	4.4	6.4	5.40	57.20	24.20	42.31	0	0
Pak45072	90	13	106	4.6	6.6	5.05	64.78	24.58	37.95	0	0
Pak45094	98	37	102	4.3	7.2	4.41	67.80	24.71	36.45	1	1
Pak45347	70	14	63	4.8	6.6	4.33	74.31	26.26	35.34	0	0
Pak45695	90	25	62	4.9	7.0	5.15	77.91	26.29	33.75	1	0
Pak45206	95	19	74	4.4	6.4	4.48	96.25	27.33	28.40	0	0
Pak45098	74	25	110	4.2	6.0	4.21	81.76	27.63	33.79	0	0
Pak45717	70	19	81	4.2	5.8	4.66	107.03	28.91	27.01	1	0
Pak45063	98	25	80	4.5	6.8	5.59	113.87	29.10	25.55	0	0
Pak45138	92	25	90	4.7	7.4	5.40	87.48	29.46	34.82	0	0
Pak45221	99	25	95	4.8	6.6	5.71	114.40	30.49	26.65	0	0
Pak45060	100	19	164	4.7	6.4	4.95	119.27	32.22	27.01	0	0
Pak45152	75	62	195	4.5	6.6	4.70	105.63	39.21	37.12	0	0
Pak45775	75	38	163	4.8	6.6	4.40	135.17	40.25	29.77	0	0

A = Days to maturity, B = Branches per plant, C = Pods per plant, D = Pod length, E = Seeds per pod, F = 100-seed weight (g), G = Biological yield per plant (g), H = Grain yield per plant (g), I = Harvest index, J = Yellow mosaic virus and K = Leaf crinkle virus.

harvest index indicated the importance of these traits in determining yield potential in blackgram. Malik *et al.*, (1987) and Ghafoor *et al.*, (1993) reported positive association of grain yield with biological yield. Negative association of biological yield with harvest index showed physiological inefficiency for appropriate partitioning of total dry matter towards economic yield. Consequently the varieties with low grain yield attained low harvest index (Table 4). As harvest index is considered very important trait in improving grain yield in most of the crops and the green revolution in cereals is largely supported by the evidence that tremendous increase in harvest index was made which in turn enhanced the world wide cereal productivity. Similar emphasis is being given in legumes to select genotypes with appropriate harvest index. Harvest index in legumes is very tricky and sensitive to environmental fluctuation and it requires to find the optimum range of harvest index. In order to find the optimum harvest index alongwith other desirable traits we classified all the accessions into groups on the basis of harvest index classes (Table 4). These results gave interesting clue for the selection of high yielding blackgram cultivars from local germplasm. The accessions with harvest index (25.1-30.1%) gave good average values for most of the traits i.e., days to maturity (81.86), pods per plant (63.59), pod length (4.61) and seeds per pod (6.35). Highest values for branches (20.69) and grain yield per plant (17.87) were observed in the germplasm ranging from 35.1 - 40.0% harvest index. In a previous study conducted by Patel & Shah (1982) and Ghafoor *et.al.*, (1993), high selection indices were obtained in blackgram where harvest index ranged from 26 - 36%.

The results obtained in this study supported that the germplasm with high harvest index (25.1 - 40.0%) is the future potential source for blackgram breeding. On the basis of these results, 25 high yielding accessions were identified from the groups constructed on the basis of harvest index and data for these selected accessions are presented in Table 5. These selected accessions are suggested for further testing under wide range of agro-ecological conditions to utilize for selection/breeding of high yielding blackgram cultivars.

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