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Pakistan Journal of Biological Sciences, 2 (3): 962-966, 1999 **Research Article**

Synthesis of Mungbean Germplasm with Improved Economic Traits

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Abstract
Nuclear Institute for Agriculture and Biology has been actively involved in improvement of mungbean for the past two decades. An introgression of large seed size into an indigenous cytoplasmic adapted background has been accomplished following pedigree selection method. Plant architecture has been changed. Early and synchronous maturity has been induced, in addition to high yield potential along with durable disease resistance. True breeding lines possessing desirable combination of economic traits were evaluated in a series of yield trials at NIAB, Faisalabad. The present study discusses the results of these significant achievements and their implication in enhancing and sustaining mungbean productivity.

Introduction
Mungbean (*Vigna radiata* L. Wilczek) is an important summer pulse crop grown on an area of 192400 ha with an annual production of 89500 tons having an average seed yield of 465 kg ha^{-1} (Anonymous, 1997). It is an excellent source of easily digestible protein of low flatulence. It is consumed as dhal, sprouts, noodles and boiled dry beans. Mungbean improvement programme initiated in late seventies at the Nuclear Institute for Agriculture and Biology (NIAB) was successful in evolving improved plant type contrasting with the traditional varieties/cultivars which were predominantly indeterminate, tall and leafy, asynchronous in flowering and maturity, small seeded with poor harvest index, and low seed yield. Deliberate efforts were made to restructure the plant and to create the proper genetic combination for superiority in seed yield from known parental sources. Breeding efforts culminated in the development of high yielding germplasm. Some of these were released as commercial varieties for general cultivation while the rest is being exploited as donor parents in conventional breeding. With the introduction of these varieties, seed yield had increased to more than two tons ha^{-1} (Ali *et al.*, 1997). This increase was mainly due to an improvement in yield components i.e. seed size, and weight, and number of pods per plant (Poehlman, 1991). The present study describes the morpho-physiological traits of improved mungbean germplasm synthesized through conventional breeding as well as mutation breeding techniques.

Materials and Methods
The experimental material comprised of breeding lines developed through hybridization (Boling *et al.*, 1961) among local and exotic Asian Vegetable Research and Development Centre (AVRDC) germplasm introduced in Pakistan in late seventies. Single, reciprocal and three way crosses were made and segregating generations were advanced following pedigree selection method (Dahiya *et al.*, 1985). Mungbean Kabuli, was grown as a susceptible spreader to increase the disease inoculum under natural epiphytotic environments. Visual selection based on semidwarf plant height, early flowering, synchronous maturity, resistance to diseases, higher number of pods, and high number of seeds per pod, was carried in the segregating populations. Plant selections were raised in progeny rows, 4m long spaced 0.3m apart having 0.1m distance between plants. True breeding progenies were bulked for yield evaluation in different sets of trials at NIAB, Faisalabad. Microplot yield trials were laidout in randomized complete block design with three replications having a plot size of 4.8 m^2. Each entry consisted of 4 rows, 4m long, spaced 0.3 m apart with plant to plant distance of 0.1m. High yielding lines were evaluated in macroplot yield trial. Experimental details were similar to microplot yield trial except to number of rows which were six. After germination, thinning was done at first trifoliate leaf stage and single seedling per hill was maintained. Weeds were removed manually and plant protection measures were adopted for the control of insect pest. Mungbean yellow mosaic virus (MYMV) infection was recorded (Shukla *et al.*, 1978).

Data on plant height, days to flower and mature, biomass yield, and seed yield were recorded and statistically analyzed (Singh and chaudhry, 1979). Harvest index was calculated as seed yield x 100/biomass yield. Characters associations were determined (Dewey and Lu, 1959).

Results
True breeding lines were sifted through different yiel[d] evaluation trials laidout at NIAB farm during 1998. Th[e] results are presented hereafter:

Microplot Yield Trials: Nonsignificant differences for see[d] yield between lines 46-5-2 and 36-13-1-3 were observe[d] though line 46-5-2 gave the highest seed yield of 3136 k[g] ha^{-1} (Table 1). The standard checks NIAB MUNG 98 an[d] NIAB MUNG 92 gave seed yield of 2333 kg ha^{-1} and 208[...] kg ha^{-1} respectively. Genotype 53-49 had the minimu[m] seed yield. Genotype 46-5-2 having high seed yield h[ad] significantly also the highest seed weight whereas NIA[B] MUNG 98 and NIAB MUNG 92 had 39 g and 56[...] respectively. Nonsignificant differences between genotyp[es] 31-20-9 and 46-5-2 for harvest index were observed. [...] the genotypes showed resistance to moderately resista[nt] reaction to MYMV disease. The genotype 36-13-1-3

Table 1: Seed yield and morphological characteristics of thirty genotypes in microplot yield trial at NIAB, Faisalabad.

Genotype	Parentage	Flowers days	Mature days	Plant height (cm)	Disease reaction	Biomass yield	Seed yield Kg ha⁻¹	Harvest index (%)	1000-seed wt. (g)
2-B	NIAB MUNG 92 x VC 1973A	41	84	83	R	5489	1438	35	61
31-20-7	"	32	75	35	R	2589	1311	50	56
31-20-7-1	"	33	75	33	R	2685	1293	48	58
31-20-9	"	32	75	33	R	2379	1312	55	57
31-20 9-1	"	37	85	59	R	5119	2206	43	57
31 39-2	"	36	85	59	MR	4193	2055	49	52
36-11-1	VC1560D x NIAB MUNG 92	39	83	55	R	4930	2289	46	63
36 1-2-1	"	39	85	74	R	4913	1892	38	62
36-1-2 3	"	39	83	46	MR	4129	2016	49	62
36-13-1-2	"	38	83	57	MR	5009	2470	49	58
36-13-1-3	"	36	83	53	MR	7095	2988	42	58
36-15-1	"	39	84	62	MR	5760	2464	43	53
36-15-3	"	38	83	58	R	4588	2260	49	48
41-27	VC 3726 x NM 93	40	85	65	R	5283	2296	43	50
45-10	NIAB MUNG 92 x NM 93	36	83	45	R	4749	2264	48	50
45-24-1	"	39	84	52	MR	4403	2094	47	53
46-5-2	NIAB MUNG 92 x NM 96	39	82	50	MR	5784	3136	54	71
46-9-1	"	38	82	49	MR	4091	1627	40	53
46-12	"	39	83	50	MR	3912	1999	51	56
46-14-2	"	38	82	50	MR	3946	1924	49	56
46-15 1	"	38	80	47	R	3274	1526	47	55
47-27-5-2	NIAB MUNG 92 x VC3902A	39	86	77	MR	4992	2072	41	50
53-24	NIAB MUNG 92 x NIAB MUNG 51	40	84	69	MR	5660	2139	38	51
53 28	"	39	86	67	R	4570	1728	38	50
53-49	"	40	85	100	R	5379	1293	24	45
NM93	NM 36 x VC 2768A	39	85	55	MR	5135	2071	40	50
NM 96	Var.6601 x VC 1973A	40	83	66	MT	4624	1776	38	56
NIAB MUNG51	"	42	85	78	R	5811	1800	31	43
NIAB MUNG92	NM 36 x VC 2768B	38	82	51	MR	4208	2081	49	56
NIAB MUNG98	NIAB MUNG 20-1xVC1482E	39	84	84	R	6134	2333	38	39
	LSD 1%	2	3	7	.	343	254	7	1
	5%	2	3	5	-	258	191	5	1

Table 2: Seed yield and morphological characteristics of twenty genotypes in microplot yield trial at NIAB, Faisalabad.

Genotype	Parentage	Flowers days	Mature days	Plant height (cm)	Disease reaction	Biomass yield	Seed yield Kg ha⁻¹	Harvest index (%)	1000-seed wt. (g)
3960A-89	VC1482ExNIAB MUNG 20-21	48	87	60	R	7563	2678	35	38
6153B-20-10	VC3920AxNIAB MUNG 92	46	86	75	R	1045	2757	26	65
6163	VC 1973Ax "	48	86	80	R	6874	1770	26	52
6173	VC1560D x "	47	86	74	R	9283	2530	27	54
6173B-37-1	"	49	87	80	R	7725	1946	25	55
6367	NIAB MUNG 92 x NM 96	48	87	82	R	7153	2086	30	54
6367A	"	49	87	64	R	6912	1780	26	61
6368	"	48	86	74	R	7369	2568	35	56
6368A	"	49	87	83	R	6508	1586	25	52
6369	NIAB MUNG51X NIAB MUNG92	49	87	83	R	8002	2099	26	53
6370-92	VC 2768B x NM 36	47	86	62	R	8594	2608	30	55
6406	TC 1966 x NIAB MUNG 92	47	86	63	R	7428	2277	31	47
6408-15-1	VC 1482CxNIAB MUNG 92	50	87	75	R	8478	2526	30	45
6408-17-2	"	49	87	65	R	8551	2206	26	43
6408-18-2	"	49	87	78	R	8449	2484	29	50
6408 24-2	"	49	87	78	R	7388	1822	25	44
6409-32-2	VC 1482E x NIAB MUNG 92	50	88	80	R	8590	1756	20	51
6409-56-2	"	47	87	72	R	8393	2391	28	47
6419-151-2	VC 1945 x NIAB MUNG 92	49	86	75	R	7679	1982	26	47
NM 93	NM 36 x VC 2768A	46	85	64	R	6883	1908	28	49
NM 96	Var.6601 x VC 1973A	49	87	88	R	6864	1310	19	50
NIAB MUNG92	NM 36 x VC 2768B 46	86	67	R	6317	1780	28	57	
NIAB MUNG98	NIAB MUNG 20-21xVC1482E	49	88	75	R	8118	2203	27	37
	LSD1%	3	2	7		472	251	2	1
	5%	2	1	5		351	186	3	1

Table 3: Seed yield and morphological characteristics of twenty genotypes in microplot yield trial at NIAB, Faisalabad.

Genotype	Parentage	Flowers days	Mature days	Plant height (cm)	Disease reaction	Biomass yield	Seed yield Kg ha[1]	Harvest index (%)	1000-seed wt. (g)
6	NIAB MUNG 92 x Berken	56	86	56	R	5980	1552	26	49
16	″	58	87	59	R	5383	1919	36	48
25	″	56	86	57	R	5728	1964	34	57
31	″	60	88	73	MR	7870	2357	30	44
43	″	53	84	53	R	6338	1760	28	61
45	″	57	87	55	R	7211	2190	30	57
55	″	59	88	63	R	6520	2311	35	50
56	″	61	91	45	R	7365	1927	26	45
58	″	58	87	45	R	5878	1605	27	62
59	″	52	83	58	R	5362	1821	34	56
72	″	55	86	61	R	5730	2529	44	57
76	″	59	88	53	R	5558	2163	39	59
77	″	57	87	61	R	5943	1826	31	47
81	″	55	85	50	R	4663	1459	31	58
83	″	49	82	53	R	6024	1683	28	53
85	″	54	84	64	R	6762	2061	30	55
89	″	53	84	57	R	6142	2533	41	38
90	″	58	88	46	R	6615	2215	35	57
112	″	61	89	58	R	4768	1665	35	39
117	″	62	90	72	R	8480	2440	29	49
NIAB MUNG92	NM 36 x VC 2768B	50	84	56	R	5926	2021	34	54
NIAB MUNG98	NIAB MUNG20-21xVC1482E	52	85	60	R	7039	1966	28	40
	LSD 1%	6	4	9		704	355	6	1
	5%	4	3	7		526	265	4	1

Table 4: Seed yield and morphological characteristics of thirty genotypes in macroplot yield trial at NIAB, Faisalabad.

Genotype	Parentage	Flowers days	Mature days	Plant height (cm)	Disease reaction	Biomass yield	Seed yield Kg ha[1]	Harvest index (%)	1000-seed wt. (g)
30A-2	NIAB MUNG92 30 kR	39	82	52	MT	4722	1916	41	52
30 4	″	39	81	58	MR	5261	1477	28	51
30A-34	″	39	83	53	MR	5782	1804	31	52
30 44	″	39	81	57	R	5584	2067	37	53
30A-44-1	″	39	82	56	MR	5264	1875	36	51
30 67	″	39	83	57	MR	4850	1741	36	54
40-8	″ 40 kR	40	82	58	MR	5571	1933	35	55
31-28	VC1973Ax NIAB MUNG 92	39	82	54	R	4548	1974	43	51
31-28-1	″	38	79	51	R	4768	1997	42	49
34 7	NIAB MUNG 92 x VC 2771A	38	81	52	R	4775	1857	39	53
34-8	″	38	80	56	R	5057	2299	46	55
36 11-1	VC 1560A x NM 90	42	84	88	R	6608	1456	22	55
38-20 3	VC 2754A x NIAB MUNG 92	40	83	60	R	5992	1982	33	53
39 9	VC 2768B x NM 93	41	83	72	MR	5799	1548	27	49
39-9-1	″	39	83	69	T	6652	2122	32	52
39 9-2	″	41	84	61	T	5648	1662	29	50
39-9-3	″	39	83	75	MR	6907	2026	30	51
45-2	NIAB MUNG 92 x NM 93	38	82	56	MR	5710	1883	33	51
45-3-1	″	39	82	57	R	4718	2006	42	51
45 13-3	″	38	81	49	MR	4082	1902	47	53
46-6	NIAB MUNG 92 x NM 96	42	82	62	MR	5898	1600	27	54
46-34-1	″	41	84	64	R	5951	1710	29	62
46 36	″	40	83	60	MR	5441	1968	36	59
47-32-4	VC3902A x NIAB MUNG 92	41	83	61	MR	6074	1976	33	60
53-51	NIAB MUNG 51x NIABMUNG 92	38	82	63	T	5001	2036	41	52
53-99	″	41	82	76	MR	6336	1683	27	47
6144-5	NIAB MUNG 92 x VC 3902A	40	83	63	MR	5932	1726	29	53
6144 17	″	41	83	61	R	5057	1728	34	61
NIAB MUNG92	NM 36 x VC 2768B	39	81	53	MR	4239	1681	40	53
NIAB MUNG89	NIAB MUNG 20-21 x VC1482E	41	83	63	R	7033	2117	30	37
	LSD 1%	2	3	6		277	226	4	2
	5%	2	3	4		208	168	3	1

Table 5: Interrelationships between morpho-physiological traits in mungbean germplasm.

Character	Days to flower	Days to mature	Plant height	1000 seed wt.	Biomass Yield	Harvest index
Days to mature ■	0.659**					
	0.805**					
	0.745**					
	0.952**					
Plant height	0.619**	0.567**				
	0.722**	0.722**				
	0.474*	0.385NS				
	0.151NS	0.0061NS				
1000 seed weight	0.113NS	0.173NS	-0.043NS			
	-0.195NS	-0.305NS	-0.462NS			
	-0.410NS	-0.428*	0.044NS			
	-0.280NS	-0.298NS	-0.386NS			
Biomass yield	0.484**	0.539**	0.575**	-0.222NS		
	0.637**	0.732**	0.652**	-0.181NS		
	-0.073NS	0.092NS	-0.039NS	0.072NS		
	0.290NS	0.368NS	0.413NS	-0.164NS		
Harvest Index	-0.752**	-0.647**	-0.734**	0.066NS	-0.626**	
	-0.588**	-0.540**	-0.848**	0.504**	-0.529**	
	0.240NS	0.341NS	0.004NS	-0.023NS	0.188NS	
	-0.024NS	-0.052NS	0.120NS	-0.081NS	0.399NS	
Seed yield	-0.559**	-0.344NS	-0.337NS	-0.186NS	-0.029NS	0.631**
	0.297NS	0.447*	0.068NS	0.236NS	0.719**	0.199NS
	-0.308NS	-0.174NS	-0.437*	-0.017NS	0.689**	0.002NS
	0.205NS	0.241NS	0.493*	-0.210NS	0.539**	0.553**

■ Macroplot Yield Trial □ Microplot Yield Trial

produced significantly the highest biomass yield of 7095 kg ha-1 followed by NIAB MUNG 98.

Nonsignificant differences in seed yield among genotypes 6153B-20-10, 3960A-89, 6370-92, 6368, 6173 and 6408-15-1 were observed (Table 2). All these lines showed highly significant differences in seed yield as compared to standard checks NIAB MUNG 98 and NIAB MUNG 92. High yielding line 6153B (20-10) significantly produced also the highest biomass yield and one thousand seed weight. NIAB MUNG 92 produced the lowest biomass yield. The genotypes 3960A-89 and 6368 had significantly the highest harvest index (35%). All the genotypes showed resistance against MYMV.

The genotypes; 89, 72, 117, 31 and 55 showed nonsignificant differences in seed yield though genotype 89 gave the maximum seed yield of 2533 kg ha^{-1}, whereas the lowest was produced by genotype 6. NIAB MUNG 92 and NIAB MUNG 98 gave seed yield of 2021 kg ha^{-1} and 1966 kg ha^{-1} respectively (Table 3). The genotype 117 produced maximum quantity of biomass yield (8480 kg ha^{-1}). The lowest biomass yield. was obtained in genotype 81. Harvest index ranged from 26-44 per cent.

Macroplot Yield Trial: True breeding lines viz 34-8, 39-9-1 and NIAB MUNG 98, did not differ significantly for seed yield (Table 4). The genotype 34-8 produced the highest seed yield (2299 kg ha^{-1}) whereas NIAB MUNG 98 produced 2117 kg ha^{-1}. The disease reaction for MYMV ranged from resistant to tolerant. The genotype 45-13-1 and 34-8 gave similar harvest index.

Character Association

Days to flower showed positive significant association with days to mature and had nonsignificant relationship with one thousand seed weight (Table 5). Variable association of days to flower was observed with seed yield, harvest index, and biomass yield. One thousand seed weight showed nonsignificant association with seed yield and biomass yield. Significant positive association between biomass yield and seed yield was observed among true breeding lines evaluated in the micro plot yield trials. Harvest index showed significant positive association with seed yield in macroplot yield trial and one set of microplot yield trials.

Discussion

Asian vegetable Research and Development Centre (AVRDC) large seeded mungbean germplasm is photoperiod sensitive and hence is unadaptive, and as such, cannot be introduced directly in Pakistan (Sadiq *et al.*, 1999). Based on combining ability analysis for seed yield and its components, AVRDC accessions, 1973A, 2768B, and 2778A had been identified as good combiner for mungbean breeding programme (Peerasak, 1991). To introgress desirable seed yield and yield components into in an otherwise indigenous germplasm with genetic background carrying gene complexes adapted to productive agriculture, hybridization programme was initiated at NIAB, Faisalabad during late seventies. Genetic variation created through selective intermating led to genetic improvement for different morpho-physiological triats (Dahiya and Singh, 1986; Dahiya *et al.*, 1987). In the present study superior recombinants i.e. genotypes 46-13-1-3, 46-5-2, 6153B-20-10, 3960A-89, 72, 89 and 34-8 for seed yield, 46-5-2-, 46-12, 31-20-7, 45-13-1 and 34-8 for harvest index, 36-13-1-3, 6153B-20-10, 6173, 31 and 39-9-3 for high biomass yield were isolated. These genotypes will be released directly as commercial varieties or may be used indirectly in conventional breeding to improve desired attributes.

Seed yield is a complex character resulting from the interaction of a number of component traits influenced by environmental fluctuations, as such it is difficult to manipulate yield through recording yield alone. A knowledge of correlation between component traits is essential while aiming at improvement in seed yield through selection so that the antagonistic association do not nullify the expected progress under selection programme. In the present study nonsignificant correlation of seed yield and one thousand seed weight may limit the genetic advance and this association had confirmed the earlier results (Zubair and Peerasak, 1986). Positive and highly significant association of biomass yield, and harvest index with seed yield indicates an enhanced physiological efficiency in partitioning the photosynthates towards grain formation. Similar pattern of positive and significant association of days to mature and plant height with seed yield was earlier reportedd (Singh and Bhatnagar, 1965; Giriraj and Vijayakumar, 1974; Malhotra *et al.*, 1974; Yohe and Poehlman, 1975).

The strong relationship of seed yield with biomass yield, harvest index, plant height, and maturity period in the present population provides an idea about the plant type to be selected for improvement of seed yield. Based on character association, it may be inferred that during selection due consideration may be placed on high biomass yield and harvest index alongwith medium maturity period.

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