Screening of mungbean (*Vigna radiata* (L) Wilczek) and cowpea (*Vigna unguiculata* (L) Walp) for higher growth and yield

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Abstract

A series of screening trials were conducted to identify superior genotypes of mung bean (Vigna radiata (L) Wilczek) and cowpea (Vigna unguiculata (L) Walp) with high yielding potential and growth performances, at Bata-atha in the Hambantota district, dry zone of Sri Lanka. Over 45 genotypes of mung bean and over 100 genotypes of cowpea were used for initial screening. Row seeding (15m length row) was done representing each genotype for each row replicated 5 times. In between row spacing was 45cm and within row spacing was 15cm. After several rounds of screening, five superior genotypes of mung bean i.e. VC 1378, VC 3580-B, Berken, T-77 and Ranna Yellow and five superior genotypes of cowpea i.e. IT 85 D-3428, IT 82D-504-4, IT84 D-449, IT 86D-1054 and Bombay were selected, considering their growth (shoot weight and total phytomass production) and yield (pod weight) parameters with N (20 kg of N/ha) and without N (0 kg of N/ha) fertilizer application. The highest seed yield was recorded from the mungbean-genotypes VC 1378 (1058 kg/ha) and VC 3580 B (800 kg/ha) and cowpea genotypes IT 82D-504-4 (1664kg/ha) and IT 85D-3428-4 (1623 kg/ha).

Results revealed that there was a high genotypic variability in all growth and yield parameters of cowpea and mung bean. Low yielding genotypes did not respond to N fertilizer in terms of growth and yield but high yielding genotypes showed a positive response to N fertilizer (20 kg of N/ha). There were some genotypes which showed higher nodulation and higher BNF capacity, which could contribute positively to the yield without the application of fertilizer N. Considering the overall performances, five genotypes of mung bean; VC 1378, VC 3580 B, Berken T-77 and Ranna Yellow and five genotypes of cowpea; IT 85D-3428-4, IT 82D-504-4, IT 84D-449, IT 86D-1054 and Bombay were selected as superior genotypes for the Southern Dry Zone of Sri Lanka.

Keywords: Genotypes, cowpea, mungbean, Hambantota district, dry zone, N-fertilizer

Introduction

Mung bean (*Vigna radiata* (L) wilczek), native to the Indo-Burma region is an excellent source of high quality vegetable protein, which compliments the staple rice diet in Asia. Cowpea (*Vigna ungiculata* (L) Walp) is an important food legume in the semi-arid region of Africa which forms a significant part of the diet of a large segment of the African population. Since both these legumes are of short duration (maturing in 55-70 days), they fit well into many cropping systems with other field crops under irrigated and rainfed conditions. Generally, legumes are able to derive a considerable proportion of their N requirement from the atmosphere via symbiotic N_2 fixation. An increasing attention is being paid in improving the N_2 fixation and N-residual effect of these legumes to develop sustainable cropping systems. This indicates that, the legumes can be used to ease the dependency of costly chemical fertilizers for rapid food production programmes. A considerable genotypic variability in N_2 fixation (Awonike et al., 1990, Subasinghe et al 2000, Dayatilake et al 2000 and Dayatilake *et al.*, 2001) and in N occurring in the non-harvested residue (Seneratne and Gunasekara, 1991) and in root mass (Subasinghe *et al.*, 2000) of legumes has been reported. The amounts of N_2 fixed by some leguminous crops have been estimated by using ^{15}N dilution technique; 86-92% of the N in Groundnut (Giller et al., 1987), 88% of the N in Pigeon pea (Kumar Rao *et al.*, 1987) and 18-35% of the N in groundnut (Subasinghe *et al.*, 2000) was derived from atmospheric N_2 fixation. Thus, it is quite probable that, considerable genotypic variability may occur in the N-supplying ability of legumes to succeeding or component crop (Dayatilake *et al.*, 2000). In this regard, identification of genotypes with higher growth and yield performances is important in improving and sustaining the productivity of low-input cropping systems. Therefore, a series of screening trials were conducted to identify superior genotypes of Mung bean and Cowpea with higher growth and high yields under low input conditions.

Materials and Methods

Experiment 01: Screening of mung bean genotypes

Mung bean screening trials were conducted at Bata-atha (6^0 15' N and 80^0 54' L, 5m amsl) in the Hambantota district, dry zone of Sri Lanka. Forty-five Mung bean genotypes (Table 1), received from the Asian Vegetable Research and Development Center (AVRDC) and Australia together with some local recommendations were screened for higher dry matter production and yield performance under two N regimes i.e. with N (20 kg N/ha^{-1}) and without N. Pots were filled with reddish brown earth, which possesses the following chemical properties; soil pH 4.6, organic matter 0.8%, P content (Olsens) 4.0 ppm, Exchangeable K 0.23 me/100g, total N 0.008%, Ca 4.9 me/100g, Mg 1.63 me/100g. Each pot was filled with 17 kg of soil and each pot was given N, P and K at the rate of 10, 25 and 25 mg/kg of soil respectively and mixed thoroughly. A parallel set of pots were used without fertilizer N. Then seeds were sown and four plants/pot were maintained after germination. During the experimental period, watering, weeding and pest and disease management were done when necessary. Upon germination, all genotypes were observed for high vigor according to the rate of growth and leaf colour. At physiological maturity (about 45-50 days after germination), number of nodules/plant and the nodule fresh weight were recorded. Dry matter (DM) yield of stover and pod yield were recorded at harvesting.

Table 1. Mung bean genotypes used for initial screening

Type 77	VC 2719A	CP 3
VC 1007A	VC 2770	CP 4
VC 1089A	VC 2771A	CP 6
VC 1158A	VC 2777A	CP 7
VC 1177A	VC 2802A	CP 8
VC 1177B	VC 2917A	CP 10
VC 1209C	VC 3029	CP 11
VC 1482C	VC 3199A	CP 13
VC 1560B	VC 3541A	CP 20
VC 1560D	VC 3580B	Berken
VC 1628C	VC 3738A	Celera
VC 1642C	VC 3907A	King
VC 1750B	V 1378	Satin
VC 2307A	V 1484	Shantung
VC 2764A	V 2184	
VC 2768A	V 2984	

Experiment 02- Screening of cowpea genotypes

Over 100 genotypes of cowpea (Table 2) obtained mainly from the International Institute of Tropical Agriculture (IITA), were screened at the same location where the screening trails of Mung bean were conducted.

IT 82 E-27	IT 83 D-328-1	IT 81 D-985
IT 81 D-1137	IT 87 S-1321	IT 87 S-1393
IT 81 D-988	IT 82 D-889	IT 81 D-832
IT 82 E-32	IT 83 D-219	IT 86 D-519
IT 84 E-666	IT 83 D-442	IT 82 D-504-4
IT 86 D-2062-5	IT 85 F-2345	IT 82 E-49
IT 85 D-3482-4	IT 86 D-1113	IT 84 D-449
IT 85 D-3850-1	IT 85 D-3517-2	IT 81 D-1151
IT 84 E-116	IT 86 D-782	IT 84 D-718
IT 86 F-2086-5	IT 84 D-853	IT 84 D-552
IT 86 D-1035	IT 87 S-1394	IT 82 E-3
IT 85 D-3577	IT 84 S-2231-15	IT 82 D-827
IT 84 D-448	IT 85 F-1380	IT 85 D-8350-2
IT 87 D-1827	IT 86 D-1054	IT 86 D-560
IT TVX-3236	IT 86 D-534	IT 86 D-755
IT 86 D-633	IT 84 E-275-9	IT 86 D-568
Suvita -2	IT 82 D-849	IT 83 S-960
IT 86 D-716	IT 87 S-1459	IT 83 S-720-2
IT 86 D-389	IT 86 D-535	IT 85 F- 2687
IT 86 D-1124	IT 85 F-1936	IT 84 S-2081
IT 82 E-18	IT 86 D-378	IT 85 F-3139
IT 86 D-648	IT 85 F-1517	IT 81 D-1157
IT 83 S-818	IT 86 D-379	IT 83 S-844
IT 83 S-911	IT 84 S-2163	MI - 35
IT 83 S-842-1	IT 83 S-686	Bombay
IT 83 S-728-13	IT 83 S-990	IT 83 D-338-1
IT 83 S-797	IT 84 S-2213	IT 86 D-1065
IT 85 D-3428-4	IT 82 D-511-3	IT 82 E-70
IT 83 D-442	IT 86 D-769	IT 86 D-622
IT 81 D- 988	IT 81 D-1007	IT 84 S-2208-7
IT 86 D- 1054	IT 81 D-994	IT 81 D-1228-14
IT 84 D-640	IT 81 D-985	IT 86 D-1065
IT 82 D-504-4	IT 81 D-975	IT 82 E-70
MI 86 D-1105	IT 86 S-899	IT 86 D-622
IT 86 D-1110	IT 86 D-440	IT 84 S-2208-7
IT 86 D-1016	IT 82 D-744	IT 81 D-1228-14
IT 84 D-453	IT 84 D-466	
IT 86 D-71	IT 82 E-56	

Results and Discussion

Experiment 01: Mung bean screening

Growth and yield parameters of 45 mung bean genotypes used for initial screening trials are shown in Table 3.

In growth and yield parameters, a positive response was observed in most of the genotypes, and it was more prominent in total phytomass production (ppm) and then in pod yield. There were some genotypes, which showed higher performance without applied fertilizer (– N).

Table 3. Growth and yield of mung bean genotypes used for the initial screening

Genotypes/Variety	With nitrogen			WIthout nitrogen		
	Shoot weight (g/plant)	Pod weight (g/plant)	TPP* (g/plant)	Shoot weight (g/plant)	Pod weight (g/plant)	TPP* (g/plant)
Type 77	13.33	10.60	23.73	11.23	8.05	19.25
VC 1007A	12.20	7.00	19.20	7.53	5.70	13.23
VC 1089A	10.55	9.40	19.95	8.60	6.90	15.50
VC 1158A	12.15	15.95	28.10	9.25	9.60	18.85
VC 1177A	10.25	8.30	18.55	8.10	5.40	13.50
VC 1177B	10.15	8.00	18.15	14.70	13.70	28.40
VC 1209C	7.50	8.00	15.50	5.60	5.20	10.80
VC 1482C	9.27	7.50	16.77	9.03	5.80	14.83
VC 1560B	10.32	9.30	19.62	9.10	12.10	21.20
VC 1560D	9.80	9.30	19.10	11.05	11.80	22.85
VC 1628C	9.05	8.60	17.65	7.37	6.90	14.27
VC 1642C	8.45	10.95	19.40	4.25	5.20	9.45
VC 1750B	11.50	8.20	19.70	8.95	2.20	11.15
VC 2307A	14.60	12.30	26.90	7.10	5.50	12.60
VC 2764A	13.10	6.70	19.80	7.55	4.40	11.93
VC 2768A	9.60	9.80	19.40	11.20	8.70	19.90
VC 2719A	12.85	14.00	26.85	12.75	9.30	22.05
VC 2770	9.15	9.20	18.35	12.40	13.00	25.40
VC 2771A	8.10	11.10	18.20	8.05	7.30	15.35
VC 2777A	11.85	13.00	24.85	8.45	9.50	17.95
VC 2802A	10.15	11.60	21.75	9.10	15.50	24.60
VC 2917A	11.65	13.50	25.15	11.45	6.90	18.35
VC 3029	12.32	13.45	25.77	7.40	7.20	14.60
VC 3199A	12.50	14.20	26.70	15.60	7.90	23.50
VC 3541A	12.25	5.60	17.85	10.10	9.60	19.70
VC 3580B	11.75	5.50	17.25	18.35	9.70	28.05
VC 3738A	13.80	14.10	27.50	10.60	8.00	18.60
VC 3907A	15.60	10.30	25.90	9.90	8.10	18.00
V 1378	7.50	16.00	23.50	23.20	15.40	38.60
V 1484	12.95	8.80	21.75	13.85	9.50	23.35
V 2184	12.20	12.00	24.20	7.80	5.25	13.05
V 2984	7.35	8.20	15.55	8.40	8.50	16.90
CP 3	12.27	5.60	17.87	6.30	2.90	9.20
CP 4	11.35	8.10	19.45	10.05	8.60	18.65
CP 6	14.15	10.70	24.85	12.75	8.30	20.05
CP 7	12.55	6.20	19.25	9.63	4.20	13.83
CP 8	16.40	17.20	33.60	13.30	5.30	18.60
CP 10	17.30	8.90	26.20	9.40	6.20	15.60
CP 11	12.45	9.10	21.55	8.85	7.10	15.95
CP 13	10.60	14.30	24.90	6.15	4.40	10.55
CP 20	12.25	13.10	25.35	8.10	6.70	14.80
Berken	17.20	23.40	40.60	12.15	14.30	26.45
Celera	17.00	11.30	28.30	16.25	9.90	26.15
King	12.00	8.20	20.20	14.85	8.90	23.75
Satin	16.25	10.10	26.35	15.00	6.70	21.70
Shantung	13.20	15.30	28.50	10.50	10.10	20.60

(* TPP- Total Phytomass Production)

The percentage increase of growth and yield parameters (i.e., shoot dry weight, total phytomass production and pod yield) compared to the local check, Type 77 was calculated under two nitrogen regimes. Based on these results, some promising genotypes were selected, as shown in Tables 4, 5 and 6.

Table 4. Percentage increase of shoot weight compared to local check, Type 77

Genotypes	With N	Genotypes	Without N
CP 10	31.75	VC 1378	106.58
Berken	30.99	VC 3580B	63.40
Celera	29.47	Celera	44.70
CP 8	24.90	VC 3199	38.91
Satin	23.76	Satin	33.54
VC 3907A	18.81	King	32.23
VC 2307 A	11.19	VC 1177B	30.89
CP 6	7.77	VC 1484	23.33
VC 3738 A	5.10	CP 8	18.43
Shantung	0.53	CP 4	13.53

Table 5. Percentage increase of pod weight compared to local check, Type 77

Genotypes	With N	Genotypes	Without N
Berken	120.75	VC 2802A	92.54
CP 8	62.26	VC 1378	91.30
VC 1378	50.94	VC 1177B	78.18
VC 1158A	50.47	Berken	77.64
Shantung	44.34	VC 2770	61.49
CP 13A	34.90	VC 1560B	50.31
VC 3199A	33.96	VC 1560D	46.58
VC 3778A	33.01	SHUNTANG	25.46
VC 2719A	32.08	Celera	22.98
VC 2917	27.36	VC 3508B	20.49

Table 6. Percentage increase of Total Phytomass Production compared to local check, Type 77

Genotypes	With N	Genotypes	Without N
CP 10	71.09	VC 1378	100.20
Berken	41.59	VC 3580B	47.30
Celera	20.10	Celera	37.19
CP 8	19.29	VC 3199	35.63
Satin	18.42	Satin	31.77
VC 3907A	15.88	King	27.59
VC 2307A	13.36	VC 1177B	23.18
CP 6	13.15	VC 1484	21.88
VC 3738 A	9.14	CP 8	21.11
Shantung	1.98	CP 4	18.52

Based on these observations, four genotypes i.e., VC 1378, VC 3580B, Berken and Celera, which showed higher overall performance were selected and those lines were further tested and compared with some newly introduced AVRDC lines and a few local recommendations (Table 7) at the same location and under similar conditions with 5 replications.

At the end of the 2nd round of screening trial, five superior genotypes were selected i.e., VC 1378, VC 3580B, Berken, Ranna Yellow (RY) and these five were used for yield trials. Their yield performances are presented in Table 8.

Table 7. Mung bean genotypes used for 2nd round of screening

Varieties/Genotypes	Origin
VC 3580 B	Selected genotype form AVRDC
V 1370	Selected genotype form AVRDC
Type 77	Local check
Small green (Ranna green)	Land race
Small yellow (Ranna yellow)	Land race
Berken	Selected variety form Australia
Celera	Selected variety form Australia
Type 51	Local check
V 1364	New Genotype form AVRDC
V 1327	New Genotype form AVRDC
V 1945	New Genotype form AVRDC
V 1947	New Genotype form AVRDC
V 1946	New Genotype form AVRDC
V 3109	New Genotype form AVRDC
V 3092	New Genotype form AVRDC

Table 8. Yield performance of selected mung bean genotypes

Genotype	Pod Yield (Kg/ha^{-1})
VC 1378	1057.52^{a}
VC 3580B	800.09^{ab}
Berken	731.75^{b}
T 77	664.45^{b}
Ranna Yellow	640.35^{b}

Means with same letter are not significantly different ($P<0.05$)

According to the results, genotypes VC 1378 and VC 3580B gave the highest yields and thus, can be successfully incorporated in to multiple cropping systems; i.e. intercropping/crop rotation and probably the best to be used as parental lines in hybridization programmes.

Experiment 02: Cowpea screening

Trials were conducted in batches. Eight rows were planted from each genotype and were screened for the following traits; growth, total phytomass production and pod yield. 50 promising genotypes were selected from initial screening. Pod yield and total phytomass production of these cultivars of cowpea under high and low N regime were determined and presented in Table 9.

Table 9. Pod yield and total phytomass production of selected 50 genotypes of cowpea from initial screening

Genotypes	Total phytomass production (g/plant)		Pod weight (g/plant)	
	with N fertilizer (40 kg/ha)	Without N fertilizer	With N fertilizer (40 kg/ha)	Without N fertilizer
MI 35	27.00	30.90	18.00	14.00
IT 82 E-27	22.53	30.90	12.09	13.15
IT 81 D-1137	26.45	25.80	15.15	12.65
IT 81 D-988	**31.00**	**34.11**	**15.20**	**23.80**
IT 82 E-32	32.10	26.50	17.60	12.60
IT 84 E-666	22.50	28.77	8.75	13.97
IT 86 D-2262-5	**33.60**	**36.20**	**14.00**	**15.00**
IT 85 D-3428-4	**20.15**	**22.45**	**12.40**	**11.25**
IT 85 D-3850-1	**39.45***	**36.50**	**9.45**	**15.00**
IT 84 E-116	34.95	31.36	13.95	10.20
IT 86 F-2089-5	**18.19**	**39.35**	**10.14**	**16.15**

IT 86 D-1035	33.86	29.37	7.66	9.95
IT 85 D-3577	24.45	28.10	17.45	12.45
IT 85 D-448	20.61	23.02	11.29	7.65
IT 87 D-1827	**22.80**	**37.22**	**9.00**	**12.42**
TVX 3236	15.52	26.30	4.92	10.00
IT 86 D-633	26.30	23.55	13.30	12.75
Suvita 2	22.17	22.55	10.27	10.40
IT 87 S-1321	18.79	19.66	19.46	11.50
IT 82 D-889	13.35	22.61	9.91	13.81
IT 83 D-442	19.10	31.59	7.50	16.20
IT 83 D-442	**33.08**	**32.20**	**18.70**	**19.40**
IT 85 D- 2345	16.33	23.36	6.75	11.30
IT 86 D-1113	22.65	21.72	12.50	11.02
IT 85 D-3517-2	26.50	26.56	14.60	14.45
IT 86 D-782	**26.73**	**31.62**	**13.90**	**16.25**
IT 84 S-853	18.08	33.04	12.22	9.62
IT 87 S-1394	18.42	25.29	6.39	11.48
IT 84 S-2231-15	14.87	21.89	8.00	11.19
IT 85 F-1380	12.89	26.95	5.72	10.40
IT 86 D-1054	56.32*	21.00	23.00	9.40
IT 86 D-534	**26.86**	**19.97**	**12.50**	**6.50**
IT 84 E- 275-9	25.40	32.96	9.60	7.80
IT 82 D-849	**26.22**	**36.72**	**8.12**	**15.07**
IT 87 S-1459	**32.51**	**41.65**	**10.71**	**16.55**
IT 82 D-446	**21.14**	**34.65**	**7.83**	**20.15**
IT 82 E-56	15.64	24.39	6.62	12.77
IT 81 D- 985	7.43	22.20	3.70	14.70
IT 87 S-1393	17.65	11.53	6.28	4.00
IT 81 D-832	25.82	23.33	10.67	11.10
IT 81 D-519	19.80	17.27	6.12	7.07
IT 82 D-504-4	**48.40***	**34.57**	**23.75**	**18.70**
IT 82 E-49	-	27.16	-	15.00
IT 84 D-449	**30.16**	**30.05**	**9.54**	**12.50**
IT 81 D-1151	**37.46***	**39.00**	**11.36**	**20.50**
IT 84 D-718	16.18	34.96	8.31	11.02
IT 84 E-552	13.18	24.88	7.08	13.80
IT 82 E-3	**21.16**	**30.91**	**11.94**	**16.86**
IT 82 D-827	**23.51**	**40.72**	**16.69**	**23.33**
IT 85 D-3850-2	36.15*	-	9.70	-

Based on their performance, 17 genotypes were selected which are listed in Table 10.

Table 10. Cowpea genotypes selected from 2nd round of screening trials

IT 81 D-988	IT 83 D-442	IT 84 D-449	IT 86 D-1054
IT 86 D-2262-5	IT 86 D-782	IT 81 D-1151	IT 87 D- 1827
IT 85 D-3428-4	IT 82 D-849	IT 82 E-3	
IT 85 D-3850-1	IT 87 S-1459	IT82D 827	
IT 86 F-2089-5	IT 82 D-504-4		

At the 3rd phase of the cowpea screening programme, these 16 genotypes were further screened with two locally recommended CVs; MI 35 and Bombay, under the same conditions. The best five genotypes for each trait were shown in Table 11 in descending order.

Table 11. Summary of the results of cowpea after 3rd round of screening

(1) Superior genotypes for high vigour and growth

Without N	With N
IT 82D-504-4	IT 85D-3428-4
IT 81D-998	IT 82D-504-4
IT 86D-1054	IT 83D-442
IT 84D-449	IT 81D-998
IT 81D-985	IT 86D-1054

(2) Superior genotypes for nodulation

Without N	With N
IT 82D-504-4	IT 81D-998
IT 81D-988	Bombay
IT 84D-994	IT 84D-449
IT 82D-849	IT 81D-994
IT 86D-1054	IT 81D-985

(3) Superior genotypes for biomass production

At 45 DAP		At PM	
Without N	With N	Without N	With N
IT 86F-2089-5	IT 81D-985	IT 81D-998	Bombay
IT 81D-998	IT 82D-504-4	IT 81D-985	IT 83D-442
IT 86D-1054	IT 85D-3428-4	IT 86F-2089-5	IT 86D-1054
IT 84D-449	IT 84D-449	IT 86D-1054	IT 84D-449
IT 81D-1151	IT 81D-998	IT 84D-449	IT 82D-1054-4

(4) Superior genotypes for yield

Without N	With N
IT 82D-504 -4	Bombay
IT 85D-3428-4	IT 84D-449
IT 44D-449	IT 85D-3428-4
IT 86D-1054	IT 82D-504-4
Bombay	IT 83D-442

So, after considering the performance of all traits, the following genotypes were selected as best genotypes with overall superior performance (Table 12).

Table 12. Yield performance of selected cowpea genotypes

Without N	With N
IT 85D-3428 -4	1664[a]
IT 82D-504-4	1623[a]
IT 84D-449	1612[a]
IT 86D-1054	1568[a]
Bombay	1560[a]

The total biomass production responded positively to applied fertilizer N, as indicated by the positive effect on shoot dry weight at 45 DAP as well as at physiological maturity. At both stages dry weight has almost doubled in response to applied N.

As revealed from yield data, increase in shoot dry matter content in response to applied fertilizer N did not contribute positively to increase yield. Because, higher pod yields were obtained without fertilizer N, compared with N treatments. But, at the same time, it was evident from the results that, genotypes which showed a higher number of nodules/plant without fertilizer N, were the ones which gave higher pod yields without applied N. This cooperative relationship may prove the fact that, under experimental conditions, certain genotypes could fix substantial amounts of atmospheric N_2 to meet the demand of the plant and can produce higher yields without fertilizer N.

Conclusion

There was a high genotypic variability on growth and yield among mung bean and cowpea genotypes. While low yielding genotypes did not respond to N fertilizer, response to N was different for high yielding genotypes. There were some genotypes which showed higher nodulation and thus higher BNF, which could contribute positively to the yield, without fertilizer N.

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